Proactive Role of Regulation for SMART Design Certification

Namduk Suh, Changwook HUH
Korea Institute of Nuclear Safety, P.O.Box 114, Yuseong, Daejeon, 305-600, Korea
E-mail : k220snd@kins.re.kr

1. Introduction

In Korea, a small-to-medium sized integral type reactor, called as "System integrated Modular Advanced ReacTor(SMART)", has been developed since late 1990's by KAERI (Korea Atomic Energy Research Institute). The reactor can be utilized in such areas as seawater desalination and district heating. The designer is targeting to get a Standard Design Approval(SDA) by the end of 2010. SMART aims at achieving enhanced safety and improved economics, the enhancement of safety and reliability is realized by incorporating inherent safety improving features and reliable passive safety systems. The improvement in the economics is achieved through a system simplification, component modularization, reduction of construction time, and high plant availability. The design characteristics contributing to the safety of SMART which is a small sized integral type PWR with a rated thermal power of 330 MWt are inherent safety features such as the integral configuration of the reactor coolant system and an improved natural circulation capability. By introducing a passive residual heat removal system and an advanced LOCA mitigation system, significant safety enhancement is achieved.

To accelerate the design certification process while ascertaining safety, KAERI is planning to apply for pre-application licensing review at the beginning of 2010. However, since the time period targeted for design certification of SMART is very short, it can be foreseen that uncertainties for successful licensing are high. To eliminate these uncertainties as much as possible, KINS (Korea Institute of Nuclear Safety) is asked to play a proactive role in this national SMART project under auspiece of the Korean government. This means that the regulation should not wait arms crossed for the designer to apply the licensing review officially, but review the design outcomes as early as they are produced, even in a draft version, and feedback the review results to designer. This paper describes this kind of preview activities for design certification of SMART

Section 2 describes preliminary review results of SMART by KINS. It covers the top tier requirement, design bases, the test and experimental plans, the phenomena identification and ranking table (PIRT), major safety issues and also the scope and level of design required for the SDA of SMART. Section 3 concludes our paper.

2. Proactive Role of Regulation for Design Certification

Among the draft documents[1,2,3,4] the designer has provided, KINS made a preliminary review on the top-tier requirement(TTR) and design bases(DB), the phenomena identification and ranking table (PIRT), verification test plan, the scope and level of design for SDA, and the expected safety issues.

It is not a common practice for a regulatory body to review the design requirement in advance but KINS reviewed the SMART TTR and DB to give a feedback from regulatory view to the SMART designer. The review raised some issues like, for example, an inconsistency with the current domestic requirement on the definition of operation modes, lack of requirement for ATWAS etc. Also the TTR didn't provide requirements for aircraft crash, cyber security and defense against sabotage. The designer accepted the raised issues and will revise the TTR and DB before applying the official design certification review.

2.1 Verification Test Plan

KAERI has provided verification test plan of SMART and KINS has reviewed validity of 18 experiments among this test matrix. The experiments include, for example, freon CHF test, water CHF test, flow distribution measurement test, SBLOCA simulation test using VISTA facility and performance test of digital MMIS safety system. The test requirement, test condition and the expected measurement outputs etc. are reviewed in view of the target the test should support. KINS raised questions on the adequacy of the test, for example, scaling analysis, higher test pressure for SG heat transfer characteristic test, needs of transient test condition for PRHRS etc. Also test condition for performance test of CRDM didn't include various operation conditions and KINS has asked these operation conditions to be included in the test condition. These results are feedbacked to the designer and KAERI is accepting the problems raised and revising the test plan taking into account the review results.

2.2 Expected Licensing Issues

In order to prevent unnecessary waste of resources due to repetitive design, and to reduce the time of safety review for the SDA, it is desirable to identify and resolve licensing issues as early as possible. Even though the design is not completed yet, we could identify several licensing issues. The expected issues are classified into 3 categories; policy issues and technical issues and design level and scope for SDA. Main technical issues, design level and scope for SDA are described below.

2.3 Technical Issues

Technical issues are the issues that need a detailed technical analysis to confirm the safety. Up to now we have identified 18 technical issues. Brief introduction to main technical safety issues identified so far are the following.

- removal of LBLOCA in SMART design ; SMART adopts an integral reactor vessel and all the main components are placed into a reactor vessel, so the designer has removed the LBLOCA from SMART design concept. But multiple breaks of pipes penetrating the reactor vessel is still concerned , so removal of LBLCOA from design is an issue.
- in-service inspection for major components ; all major components are tightly packed into a reactor vessel in SMART and thus the method of in-service inspection for major components including a helical steam generator is not clear. Designer expects a 3-dimensional model and mock up test could support to verify the accessibility for in-service inspection and this is identified as an issue.
- measurement of RCS flow rate ; measurement of reactor coolant system (RCS) flow rate is a regulatory requirement for nuclear reactor. Operating commercial reactor uses pressure difference between large pipes to measure the flow, but SMART has no large pipes connecting RCP and SG, for example. Designer is trying to develop a SMART specific flow measurement method.
- performance of PRHRS ; KINS has no experiences of licensing a passive system yet. Preliminary review shows that the PRHRS cannot satisfy the performance criteria of the active residual heat removal system. Thus, the performance criteria should be complemented considering the characteristics of the PRHRS and the performance of cooling capacity through natural convection should be proven by experimental tests.
- equipment qualification of digital I&C ; SMART adopts digital I&C system. Equipment qualification against various environmental conditions is needed and the design should satisfy all the regulatory requirements.

2.4 Scope and Level of Design for SDA

To determine in advance the scope and level of design for SDA is important for a successful licensing. Designer has provided a draft table of design scope and level referencing the U.S. NRC document[5,6]. One example for SG is like the following.

System	SSAR Chapter	Design Level
Steam Generator	5.4.2	2

According to the definition of SECY Report[5], Design Level 2 means that the "physically similar, and identical functional and performance characteristics, except for site specific characteristic" should be provided. But we found this definition of design level is confusing and hard to apply. We wanted to have a common language between the regulator and the designer, thus we are trying to define more clearly the design level and scope. One idea is to define the design level referencing the standard review plan. The discussion is still going on and we'd like to have a more clear and common definition of design levels.

3. Conclusion

A small-sized integral reactor SMART is under development in Korea, targeting to get a standard design approval by the end of 2011. Regulatory activities to prepare for the licensing of SMART SDA is explained. The activities are to review the draft documents as they are produced and to give a feedback to the designer as early as possible to enhance the design completeness. This pre-activities are needed for a successful review of SMART given the tight schedule planned. Brief examples of review results for top-tier requirement, verification test and the level of detail for design are presented

REFERENCES

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