IAEA-SR-218/29

XA0101087

SAFETY AND REGULATORY ASPECTS OF THE SMART REACTOR

K. W. SEUL
Korea Institute of Nuclear Safety (KINS)
Taejon, Korea

W. S. KIM
Korea Institute of Nuclear Safety (KINS)
Taejon, Korea

M. H. CHANG
Korea Atomic Energy Research Institute (KAERI)
Taejon, Korea

The 330 MW thermal power of integral type pressurized water reactor, which is called SMART (System integrated Modular Advanced ReacTor), is under development for seawater desalination application and electricity generation in Korea [1,2]. The KAERI (Korea Atomic Energy Research Institute) is a leading institute being responsible for developing the SMART design, and some institutes and industry are involved in the related technology development. The KINS (Korea Institute of Nuclear Safety), a regulatory body, is also involved for SMART-related regulatory research, especially for identifying and resolving the safety concerns in the design stage.

The regulatory researches are carried out to support the SMART design development in the safety aspect. Because the SMART reactor has many different safety features from the current light water reactor (LWR) designs, it is necessary to identify the safety concerns and discuss with designer in the design stage in order to provide an early assurance of its safety. In particular, the early identification of general safety concerns based on the implementation of defense in depth concept is very important in the safety and regulatory aspects.

Basically, it is estimated that the existing safety requirements for LWR designs [3] are applicable to the SMART design because there are lots of common design concepts. However, some safety requirements related to the new safety features must be additionally considered to appropriately assess the safety. In addition, the safety requirements for the interface systems and desalination facility must be newly established because there are no design and regulatory experiences on the nuclear desalination plant in Korea. Particularly, due to possibility of a radioactivity contamination of fresh water and seawater, a high level of safety requirements for nuclear desalination plant is required to protect the public health and safety [4].

In recent, the IAEA emphasizes that a comprehensive implementation of defense in depth concept would improve the safety for future reactor designs [5]. The SMART design has several levels of protection and multiple barriers to prevent releases of radioactive materials and to minimize the possibility of failures leading to significant radiological consequences. Adopting a safeguard vessel surrounded the reactor pressure vessel and an additional heat exchanger between nuclear system and desalination system physically enhance the defense in depth to protect public and to prevent fresh water from the radioactivity contamination. It also provides various improvements at each level of defense in depth. In the level 1, sufficient design margins and response times are provided by low power density, large reactor coolant system (RCS) inventory and simplified RCS design. Level 2 is enhanced adopting the reliable digital instrumentation and control (I&C) system instead of conventional analogue system. Level 3 is also enhanced through passive safety features instead of traditional active safety features. Particularly, it is believed that the passive systems will simplify the plant design and operation, and provide the high reliability of systems. The level 4 is enhanced in requiring to consider the severe accident prevention and mitigation features in the design stage. As a result, it is expected that the SMART design will provide an enhanced defense in depth under normal and accident conditions.

Although the SMART reactor would achieve a high level of safety and reliability through the simplified, inherent and passive means, it has much different safety characteristics from the existing LWR designs. Thus, some general items to be considered in the safety aspects must be identified and discussed with designer to ensure the safety in the early design stage. Major safety concerns identified in this program include the use of proven technology for new safety features, event categorization and selection, enhancement of containment function, effects of desalination plant, maintainability of major components, and so on. In principle, the new safety features of nuclear power plant (NPP) should be introduced after sufficient research and prototype testing. Thus, the performance and interdependent effects of safety systems should be demonstrated through analysis, test program, experience, or their combinations. Also, the postulated initiating events and their sequences of SMART reactor may be different from those of current NPPs. Thus, all the possible events should be comprehensively categorized and analyzed according to the safety priority, and acceptable criteria for each event should be established. In addition, the nuclear system could be affected with an unstable operation of desalination plant. Thus, it is required to design and operate the nuclear desalination plant as an integrated plant sharing an essential information. Besides, safety classification of major structure, system, and components, reliability of software in the digital I&C, and accessibility of major components for maintenance should be comprehensively reviewed in the regulatory aspects.

These efforts to cooperate with regulatory body in the design stage are believed to provide an opportunity to early resolve the safety concerns and eventually the licensing stability of the SMART design. In the future, the specific safety concerns related to the SMART-unique safety features will be identified and, if necessary, the related safety requirements will be developed to resolve them.

REFERENCES

[1] M.H. CHANG, et al., "A SMART - An Advanced Small Integral PWR for Nuclear Desalination and Power Generation," Proceedings of Global '99, International Conference on Future Nuclear System, Wyoming, USA, August-September (1999).

[2] K.W. SEUL, et al., "Safety and Regulatory Researches on the SMART Reactor," International Workshop on Utilization of Nuclear Power in Oceans (N'Ocean 2000), Tokyo, Japan, February 21-24, (2000).

[3] REPUBLIC OF KOREA, "Atomic Energy Act, Revision 6", Korea (1998).

[4] IAEA, "User Requirements Documents for Small and Medium Reactors and Their Applications in Developing Countries: A Guide for Their Preparation," Draft TECDOC-xxx, IAEA, December (1997).

[5] IAEA, "Implementation of Defense in Depth for Next Generation Light Water Reactors," IAEA-TECDOC-986, December (1997).