Reflection of Foreign Regulatory Requirements and Guides (RR&G) for SFRs in Domestic RR&G

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1. Introduction

An advanced sodium-cooled fast reactor (SFR) in Korea is based on the KALIMER-600 concept developed by KAERI. In 2008, the Korea Atomic Energy Commission established "Long-term R&D Plan for Future Reactor Systems", in which design approval application of the KALIMER-600 demonstration reactor was planned in 2017. However, current safety requirements for nuclear facilities in Korea specify to regulate mainly PWRs, and therefore the development of regulatory requirements for SFR is required.

In this study, through review of foreign RR&G (Regulatory Requirements and Guides) for SFRs, the reflection directions of foreign RR&G for SFRs in domestic RR&G were derived.

2. Review of Foreign Regulatory Requirements and Guides for SFRs

The nations with extensive experience in licensing and operating of SFRs are the U.S., Japan, France, and the European Communities, etc. In this section, the RR&G of these nations were reviewed.

2.1 U.S.

In the U.S., the RR&G related to site, design, production, and operation, etc. of nuclear power plants are specified in 10 CFR (Code of Federal Regulation) [1], SRP (Standard Review Plan) [2], and RGs (Regulatory Guides) [3]. However, these RR&G specifies regulations and guides for nuclear facilities focusing on PWRs.

Related to development of regulatory requirements for SFRs, U.S. NRC had discussed the differences between acceptable criteria for the CRBRP/PRISM [4, 5] design and the GDC (General Design Criteria) for LWRs in App. A to 10 CFR Part 50. In this process, the GDC was categorized as GDC directly applicable, GDC applicable but needing changes, and GDC not applicable. Above all, additional GDC proposed for SFR were derived. The additional GDC are as follows: (1) protection against sodium reactions, (2) sodium heating systems, (3) design of the intermediate coolant system, (4) reactor and intermediate coolant, and cover gas purity control, and (5) protection against coolant flow blockage. These additional GDC have reflected in a draft of domestic general requirements for SFRs [6].

2.2 Japan

In the regulatory framework for nuclear safety in Japan, under the Atomic Energy Basic Act, the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors, and the Act concerning Prevention from Radiation Hazards due to Radioisotopes, etc. have been established [7]. Under the Acts, there are Cabinet Orders as enforcement decree, Ministerial Ordinances as enforcement regulations, and Ministerial Public Notices. In addition, the NSC (Nuclear Safety Commission) has developed the guides to be used in the review and inspection of nuclear facilities.

In this framework, the RR&G for SFRs are shown in the following: (1) Ministerial Ordinance for Reactor at the Stage of Research and Development [8], (2) Ministerial Ordinance for Test Reactor [8], and (3) Philosophy in Safety Evaluation of Fast Breeder Reactors as NSC guide [9].

Two Ministerial Ordinances cover general design criteria for SFRs, and correspond to domestic general regulatory requirements. One NSC guide provides the guides for safety design and safety evaluation of LMFBR (Liquid Metal Fast Breeder Reactor), and corresponds to domestic specific regulatory requirements or guides.

2.3 France

In France, the legislative base governing the safety of nuclear facilities is the "TSN act" on transparency and security in the nuclear field [10]. In the subordinate framework, there are Decrees, Orders as enforcement regulations, and Decisions, etc. As practical regulatory guides, there are currently approximately 40 RFS (Basic Safety Rules) and other technical rules published by ASN (Nuclear Safety Authority).

However, these RR&G specify regulation for nuclear facilities focusing on PWRs.

2.4 European Communities

In 1990, the European Communities developed safety criteria and guidelines through a consensus view on basic LMFBR safety requirements based on knowledge and proven technology of those days [11]. These safety criteria and guidelines consist of the following items: (1) core reactivity fault, (2) general cooling faults, (3) sub-assembly faults, (4) faults

outside the core, and (5) initiating causes external to the station.

These RR&G include safety criteria and guidelines unrelated to reactor types as well as LMFBR specific ones. Especially, SFR specific criteria and guidelines are categorized as (1) safety criteria and guidelines reflecting entirely LMFBR specific characteristics such as sodium fire, sodium/water reaction in steam generator, etc. and (2) safety criteria and guidelines reflecting partially such as failure of core coolant supply structure, etc.

3. Development Directions of Domestic Regulatory Requirements and Guides for SFR

Related to development of domestic RR&G for a SFR demonstration reactor, KINS has developed a draft of GRRs (General Regulatory Requirements) for SFRs [6] and has evaluated the applicability of the SRRs (Specific Regulatory Requirements) for LWRs to the SFR [12]. Additionally, in order to reflect the foreign RR&G for SFRs in domestic RR&G, the reflection directions of the foreign RR&G were evaluated as shown in Table 1.

As a result, the items which need to be reflected on domestic RR&G for SFRs were derived as follows: (1) 14 GRRs to be modified, (2) 1 SRR to be modified, and (3) 7 RGs to be newly added.

4. Conclusions

In order to develop the domestic RR&G for SFR, review of foreign RR&G for SFRs were carried out and the items of foreign RR&G applicable to domestic RR&G were derived. As a result, the items which need to be developed were derived as follows: 14 GRRs, 1 SRRs, and 7 RGs.

Additional detailed review will be performed and the derived items will be reflected in the development of domestic RR&G for SFR.

REFERENCES

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Table 1. Reflection Directions of Domestic Regulatory Requirements and Guides for SFR

Requirements /Guides	Development Directions	Items	# of Items
GRR (General Regulatory Requirements)	To be modified	- Core, Fuel, Sodium, Sodium void, Reactor coolant boundary/cover gas boundary [9] - Ingress of cold sodium to core(SC*), Voiding by gas(SC), etc. [11]	14 Items
SRR (Specific Regulatory Requirements)	To be modified	- Pre-operational inspection [8]	1 Item
RG (Regulatory Guides)	To be newly added	- Selection of representative events, Judgment criteria for the conditions, Consideration in analysis of the conditions [9] - Voiding by gas(G*), Leak in IHX(G), Sodium fire(G), etc. [11]	7 Items

* SC : “Safety Criteria” as general requirements for a safe design
* G : “Guidelines” as recommendation on how safety criteria may be met