Applicability of Korean Nuclear Laws to High-Temperature Gas-Cooled Reactor for Hydrogen Generation

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1. Introduction

The nuclear laws of Korea are largely composed of atomic energy acts and other related laws. The former is a general law that provides for matters related to the utilization of nuclear energy and safety regulations which are not explicitly set forth in other laws. The latter refers to the laws enacted for direct application to nuclear-related areas [1]. On evaluating the applicability of the nuclear laws of Korea to a new-concept reactor, it is interesting in provisions related to technical safety regulation.

The atomic energy acts are applied for regulations of nuclear facilities, and are basically enacted to ensure the safety of electric power nuclear reactor and related facilities, nuclear research reactor, radioactive isotopes, and etc. Hence, it is expected that some provisions of the atomic energy acts be not applicable to high-temperature gas-cooled reactor (HTGR) using TRISO fuel.

HTGR has been developing for hydrogen generation as well as electricity generation. It uses helium gas for core cooling, and its safety concepts are different with pressurized-water reactor (PWR) for electric power generation. One of objectives for realizing HTGR is to extremely increase the coolant temperature of core, the target of which is about 900~1000°C. The high-temperature heat can be utilized to generate hydrogen from Iodine-Sulfur process or high temperature electrolysis, and/or to generate electric power generation. In Korea, nuclear hydrogen production technology development and demonstration project (NHDD) is on performing [2].

In this study, the applicability of the current atomic energy acts to HTGR is evaluated. This study is performed to prepare the atomic energy acts so that they are also applicable to HTGR for electric power generation and/or hydrogen generations.

2. Applicability of Atomic Energy Acts to High-Temperature Gas-Cooled Reactor

The atomic energy acts consist of five laws, as shown in Figure 1. Atomic Energy Act, Enforcement Decree of the Atomic Energy Act, Enforcement Regulation of the Atomic Energy Act, and Regulations on Technical Standards for Radiation Safety Control, etc. are basically technology-neutral provision, but Regulations on Technical Standards for Nuclear Reactor Facilities, etc. is basically technology-dependent provision [3].

Technology-neutral laws are applicable independently to reactor types, but technology-dependent laws are restrictively applied to some reactors. The atomic energy acts of Korea belong to technology-neutral law, but basically developed on the basis of water-cooled reactor using UO_2 fuel.

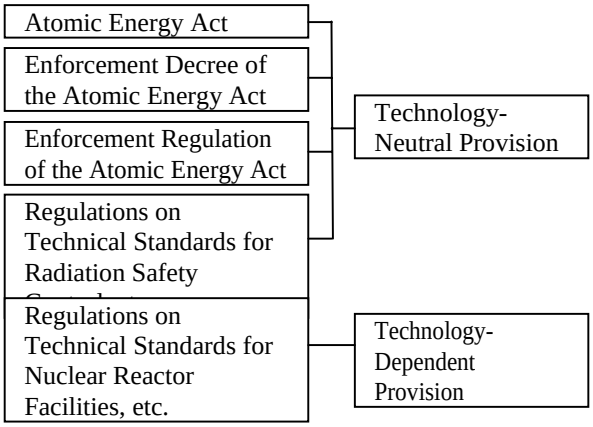

Figure 1 Technology Dependence for Atomic Energy Acts of Korea

2.1 Atomic Energy Act

One of the purposes of Atomic Energy Act is to ensure the safety of the general public by prescribing matters concerning research, development, production and utilization of nuclear energy and the safety control thereof and promoting the advancement of science and development of the industry [1].

Atomic Energy Act is almost technology-neutral law, and thus most technical provisions are applicable to HTGR, if corresponding with electric power reactor described in this Act.

2.2 Enforcement Decree of the Atomic Energy Act

The purpose of this Decree (hereinafter Enforcement Decree) is to prescribe matters delegated by the Atomic Energy Act and other matters necessary to implement the delegated matters. Enforcement Decree is almost

technology-neutral law, and thus most technical provisions are applicable to HTGR, if corresponding with electric power reactors described in Enforcement Decree.

2.3 Enforcement Regulation of the Atomic Energy Act

The purpose of this Enforcement Regulation (hereinafter Enforcement Regulation) is to prescribe matters delegated by the Atomic Energy Act and the Enforcement Decree thereof and other matters necessary to implement the delegated matters. Enforcement Regulation is almost technology-neutral law, and thus most technical provisions are applicable to HTGR, if corresponding with electric power reactors described in Enforcement Regulation.

However, in the application of a construction permit, standard design approval, operating license, etc. for nuclear electric power reactors and related facilities, details of licensing documents is founded on PWR, not on gas-cooled reactor. Hence, the provisions for describing subjects of licensing documents such as PSAR, FSAR, standard design, etc. should be revised.

2.4 Regulations on Technical Standards for Radiation Safety Control, etc.

These Regulations (hereinafter Technical Standard for Radiation) prescribe matters related to the technical standards of radiation safety control, etc. Technical Standard for Radiation is technology-neutral law, and thus all provisions are applicable to HTGR.

2.5 Regulations on Technical Standards for Nuclear Reactor Facilities, etc.

These Regulations (hereinafter Technical Standard for Facilities) prescribe technical standards as regards the location, structure, installations, etc. Technical Standard for Facilities consists of three chapters; general provisions, technical standards for reactor facilities, and technical standards for nuclear fuel cycle facilities. Technology-dependent provisions of them are technical standards for reactor facilities of Chapter 2, which are based on water-cooled reactor and UO_2 fuel.

Many provisions of them are not applicable to HTGR. The followings should be discussed for their applications:

(1) Specified Acceptable Fuel Design Limits (SAFDL) are defined to departure from nucleate boiling ratio (DNBR), fuel peak temperature, and so forth. HTGR doesn't use DNBR limit.
(2) Containment are one of most important barrier for radiation release in PWR. HTGR technically has concepts of confinement.
(3) Diverse protection system which has the functions of reactor shutdown, actuation of emergency auxiliary feedwater system, and turbine trip shall be prepared for anticipated transients without scram. This provision entirely depends on reactor type.
(4) Reactivity control system is applicable to water-cooled reactor. Each provision should be reviewed for its application.
(5) Technical provisions for structure, installations, and performance of reactor facilities are based on PWR. Technical provisions for systems and components proper to HTGR should be provided.
(6) The provisions are based on safety concept of LOCA, and safety limits of LOCA are used. HTGR has passive safety concept, which is different with that of PWR.
(7) Provisions to reactor operation for hydrogen generation are required.

3. Conclusion

Atomic energy acts of Korea provide technology-neutral provisions, but are basically based on water-cooled reactor and UO_2 fuel; in particular, technical standards. Hence, most of them are also applicable to HTGR, if electric power nuclear reactor is corresponding to HTGR.

However, others provide technical standards and requirements, and they are related to nuclear safety. For example, Technical Standard for Facilities generally gives technical safety requirements, which are applicable to only water-cooled nuclear reactor.

It is required that Technical Standard for Facilities be entirely reviewed for its application to HTGR. Also, its applicability is dependent on the design, safety concepts, and purposes of HTGR with gas-cooled core and for hydrogen generation.

REFERENCES

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