Regulatory Framework for Advanced Fuel Cycle Facility Using Pyroprocess in Korea

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1. Introduction

Nuclear power plants of 20 units of in Korea are generating about 700 MTU of spent fuels annually. The inventory of spent fuels in Korea were estimated about 10,087.07 MTU at end of 2008, and the storage space of spent fuels won't be available any more at 2016 due to the saturation of the spent fuel pools in the plants. In addition, in order to reduce carbon emission and correspond to the enormous electricity demand in Korea, 8 units of nuclear power plants are under construction and several more plants are under planning. The 100,000 MTU of spent fuel inventory are expected by the year of 2095 in Korea. Therefore, short term and long term of spent fuel management plans are under discussion and implementation in Korea.

As a short term of spent fuel management strategy for the target year of 2016, central or local spent fuel dry interim storage options are mostly under discussion. As a long term of management plan, fast reactor and advanced fuel cycle R&D plan were approved by 255th meeting of Atomic Energy Commission (AEC) on Dec. 22, 2008. The approved advanced fuel cycle R&D plan is that the uranium and TRUs(transuranic elements) are recovered from PWR spent fuels using proliferation resistance technology such as pyrochemical processing (pyroprocessing), and formulates metal fuel for utilizing at the next-generation sodium fast reactors (Gen IV-SFRs). Heat load elements of spent fuel such as Cs and Sr are removed form the spent fuel. It is known as that it can be reduced the repository burden up to 1/100, compared with the case without removal. The fission products (FP) are also recovered and transferred to a repository. As a result of pyroprocessing, both repository efficiency and U usage are increased. The recycling of recovered resources results in increased uranium usage efficiency and a marked decrease in radiotoxicity and the amount of high-level radioactive waste generated. The spent fuels are classified as a high level radioactive waste in Korea. The basic concept of pyroprocessing is group recovery, which enhances the proliferation resistance significantly, as separation of sole plutonium is impossible. This technology is, known as, reduces the 300,000 year waste management period by a factor of 1,000.

Korea Atomic Energy Research Institute (KAERI) is now designing and constructing PRIDE (PyRoprocess Integrated inactive Demonstration facility) facility for the pyroprocessing research activity using inactive materials. The KAERI has the construction plan of active Engineering Scale Pyroprocess Facility (ESPF) that are composed of decladding, voloxidation, electroreduction, electrorefinning, electrowining, fuel fabrication, and waste salt treatment process, respectively by year of 2016 [1]. KAERI's pyroprocessing technology includes the decladding of spent fuel to separate the spent fuel pallets from the metal claddings, voloxidation to remove the volatile fission products at high temperature, electroreduction to produce uranium and TRU metal ingot using LiCl-Li_2O molten salt, an electrorefining process to recover pure uranium using LiCl-KCl molten salt, an electrowinning process to separate the TRU mixture using liquid cadmium cathode (LCC), and a waste treatment process to reuse of salt and produce stable waste forms for safe disposal in the environment. The application submission for ESPF facility construction to Korea Institute of Nuclear Safety (KINS), regulatory body in Koera, is expected by year of 2012~2013. Therefore, KINS initiated the regulatory technology development project to provide the criteria and standard to the AFC facility designer in time and apply the review process of ESPF facility application. Figure 1 demonstrates the pyroprocessing flow chart under development by the KAERI

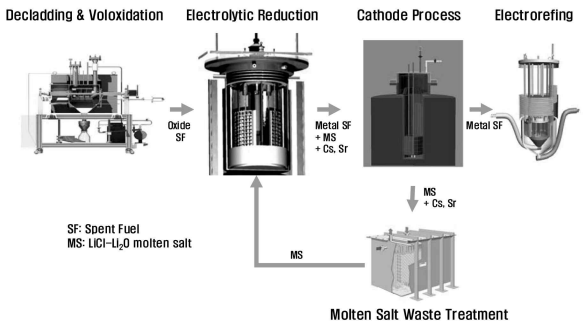

Fig. 1. Schematic Illustration of KAERI's Pyroprocessing. [1]

2. Regulatory Frame Review

The provisions of "nuclear fuel cycle business and use of nuclear material" in the Atomic Energy Act (AEA) of Korea is provided in the article 43 (permit, etc. for nuclear fuel cycle business) and 44 (standards for permit, etc.). However, the article 43 and 44 of the AEA are not applicable to the AFC (advanced fuel cycle) facilities such as pyroprocessing facility, because the scope of the spent fuel processing in the article 2 (definition) in AEA limited only for separation into nuclear fuel material and

other materials from spent fuel by physical or chemical processing. The scope of the spent fuel processing should be extended to include the fuel fabrication using the separated TRUs and treatment of other materials for storage or disposal. In addition, the article 43 of AEA for licensing spent fuel processing facility does not specify who the licensing authority to submit the application of the facility is. Therefore the related articles of atomic energy act, enforcement decree of the act, enforcement of the regulation of the act is needed to develop for application of the Korean-type pyroprocessing facility for AFC in Korea.

The regulatory technology development for the AFC facility are consisted of the establishment of the AFC licensing regulatory system, the establishment of the development direction for the AFC criteria and standards, and the development of the safety evaluation technology for the AFC system. The establishment of the AFC licensing regulatory system is for reviewing the applicability of the nuclear energy act for licensing of AFC facility, and establishment of reforming direction of nuclear energy act. The establishment of the development direction for the AFC criteria and standards are for reviewing regulation on the technical standards and notices for the AFC, and establishment of the reforming direction. The development of the safety evaluation technology for the AFC system is for the safety evaluation technology survey and review for the AFC system. The development of the safety evaluation technology is consisted of the evaluation technology for the accident classification and accident analysis, structural integrity, radiation shielding and criticality safety, gaseous effluent and solid (high level and low-level) radioactive waste management safety, the radiation protection, the spent fuel/nuclear material transport and storage, fire safety, emergency response and management plan, and site evaluation of the AFC facility. These contents of safety evaluation technology are essential to review the fuel cycle facility [2][3].

3. Results

Results of reviewing the applicability of the nuclear energy act related to licensing AFC facility pointed out that the article 43 and 44 of the AEA are not applicable to the AFC (advanced fuel cycle) facilities such as pyroprocessing facility. The scope of the spent fuel processing should be extended to include the fuel fabrication using the separated TRUs and treatment of other materials for storage or disposal. In addition, the article 43 of AEA for licensing spent fuel processing facility should specify who the licensing authority to submit the application of the spent fuel processing facility is. This provision shall be changed as the application of the fuel cycle facility shall be submitted to the Ministry of Education, Science and Technology (MEST), which has the regulatory authority of nuclear energy area in Korea. Then the applications shall be reviewed by the Korea Institute of Nuclear Safety (KINS). Also, the provision requires a person, who intends to obtain permit for the nuclear fuel cycle business, to submit the radiation environmental report, safety control regulations, explanatory statement of design and work methods, quality assurance program for the operation of the business and other documents as prescribed by the ordinance of the Ministry of Education, Science and Technology (MEST). However, the application for the license of AFC facility shall be submitted the safety analysis report (SAR) for the facility. The SAR shall include for the accident classification and accident analysis, structural integrity, radiation shielding and criticality safety, gaseous effluent and solid (high level and low-level) radioactive waste management safety, the radiation protection, the spent fuel/nuclear material transport and storage, fire safety, emergency response and management plan, and site evaluation of the AFC facility

The KINS is trying to develop safety requirements and guidelines to apply in the regulation of Korean-type pyroprocess facility before submitting the license application in 2013. The regulatory technology development will be focused mainly to provide the safety criteria to the pyroprocess system and facility designer on time. Using the result of this research, KINS will prepare a comprehensive set of safety standards including radiation shielding and protection, chemical hazards, fire and explosion, off-gas treatment, and high-level and low-level radioactive waste management.

REFERENCES

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