Decommissioning in Korea

Current Status

Two research reactors (KRR-1 and KRR-2), TRIGA Mark-II (250 kWth) and Mark-III (2 MWth), were shut down for their decommissioning at the end of 1995. A project for their decommissioning was launched in January 1997 with the goals of a complete removal of all the radioactive material and a release for an unrestricted use of the buildings and site. The project was divided into four phases; (1) decontamination and dismantling of the auxiliary facilities of KRR-2 which consisted of the hot cells and laboratories for the radioisotope production, (2) dismantling of the reactor facilities of KRR-2, (3) dismantling of KRR-1 and the related facilities and (4) dismantling of the yard facilities around the reactor buildings and site cleanning. The first phase was completed at the end of 2002 and the dismantling of the KRR-2 facilities was started in January 2003. The dismantling of the reactor core, removal of the rotary specimen rack which was the most radioactive component of KRR-2, and the removal and cutting of the irradiation tubes for the radioisotope production were accomplished in 2003. Now, the activated graphite blocks in thermal columns are being removed with a controlled remotely handling device, specially designed for this removal work. The total project will be finished in 2008 after transportation of all the radioactive waste to a national repository facility, which will be constructed and operated by KHNP(Korea Hydro & Nuclear Power Co., Ltd).

The decommissioning of a uranium conversion plant, whose capacity was 100 tones of uranium dioxide production per year, has been under planning since 2001. The decommissioning engineering, including the environmental impact assessment and dose rate evaluation to the general public, has been finished and the resulting plan was submitted to the Ministry of Science and Technology (MOST), the national regulatory body. And the safety of the workers the during decommissioning was also evaluated. The dismantling works are expected to start from April of 2004 after permission is granted. The most important safety issues during the evaluation were: treatment of the sludge waste containing uranium which is stored in the lagoon, assurance of the uranium content after decontamination and the assessment of the structural integrity of the plant building for the temporary storage of the waste drums generated from the decommissioning of the conversion plant. This decommissioning project will be finished by 2007.

Separately, the plan for the decommissioning of a small research facility, where the uranium hexa-fluoride was handled, was discussed in early 2003. The site characterization, environmental impact assessment and decommissioning engineering have been scheduled, but the detailed safety criteria will need more discussion with the safety authority as to whether or not this small laboratory scale facility,10 tons/year, should be applied with the same safety criteria as the big facilities.

National Policy

Regulation

The regulation and licensing of the decommissioning of nuclear facilities are in the provisions of the Atomic Act, its Enforcement Decree and Regulation and the Notice by the MOST. Entrusted by the MOST in accordance with the Act and the Enforcement Decree, the KINS(Korea Institute of Nuclear Safety) performs the regulatory activities.

According to the Act, the decommissioning of the nuclear power plants is the responsibility of the licensed operator of the reactors. And the operator with on intent to decommission the reactors should submit a decommissioning plan and get the approval from MOST. In the decommissioning plan, the following should be included; (1) methods of decommissioning and a schedule of the work, (2) methods of removing radioactive materials and wastes, (3) methods of treatment and disposal of radioactive wastes, (4) necessary measures for preventing any accident by radiation, (5) assessment of the environmental impact and the countermeasures for minimization an impact, (6) quality assurance plan and (7) others as requested by the MOST. These provisions for power reactors regarding decommissioning are also extended to research reactors and nuclear fuel cycle facilities.

The process of the licensing for decommissioning of the nuclear power reactors and the related facilities can be summarized as follows; (1) In accordance with the Act, an applicant should submit the decommissioning plan documents of the nuclear power reactors and the related facilities (hereinafter referred to as the decommissioning plan) to the MOST, and they are reviewed by KINS as the entrusted regulator by the MOST, (2) The result of the safety evaluation and assessment is reported to the MOST and then reviewed by the Nuclear Safety Commission (NSC); (3) The MOST issues a permit of license to the decommissioning plan. During the decommissioning activities the MOST shall inspect and check the progress of the project and safety of the dismantling works.

Strategy

The responsibility of the decommissioning of the nuclear facilities is clearly divided into two groups: for nuclear power generation and for the facilities for research purposes.

In Korea, 18 power plants are in operation and 2 plants are under construction. The first unit, Kori-1, was commissioned in 1978 and has a designed lifetime of 30 years. It is expected to be shutdown in 2008 and to be decommissioned after 5~10 years safe enclosure of the power reactor. However, KHNP has a policy to extend the lifetime of the reactor through periodic safety reviews(PSR). In this circumstance, the decommissioning of the commercial power reactors is not an urgent matter in Korea. Nevertheless, by the Electricity Business Act, KHNP has laid aside 134.9 million US dollars per unit of the reactor for decommissioning. From the technology aspect, long-term research programs are being prepared for the

decontamination and decommissioning of the commercial facilities.

In KAERI, two research reactors and one uranium conversion plant are under decommissioning and one research facility is now being planned for. KAERI established the basic strategies for the decommissioning projects as follows.

- Immediate dismantling after the decision for the decommissioning
- Unrestricted use of the buildings and site after decommissioning
- Minimization of the radioactive waste and application of a zero release concept
- Prioritized safety in the dismantling activities
- Development of the technologies and application to the site during the project

Decommissioning Technique and Inspection

During the planning for the decommissioning of KRR-1 & 2, KAERI and the MOST assented to the development and application of the techniques required for the research reactor decommissioning. And the same principle was adapted to the decommissioning project of the uranium conversion plant. The techniques were divided into two categories; (1) site-dependent techniques to be urgently applied to the decommissioning works and (2) ones for the preparation of the future decommissioning projects.

The site-dependent techniques were developed in-project and the duration for the development was shorter than one year for most cases. The examples of these techniques are the solar evaporation system, membrane equipment for the laundry and shower waste treatment, remote observing equipment to overcome the browning of the shielding windows, decontamination systems for a metal surface by ultra sonic and chemical treatment, remote cutting tools, removal system for the graphite blocks and so on. The characteristics of the techniques are the selection of old and manual devices instead of fully developed and modern ones, and the modifications for a remotely controlled operation.

The development of the techniques for future projects are carried out as a project of the national middle and long term R&D program stipulated by the government. The examples are a data base system, 3-D simulator on a computer for the dismantling progress, treatment process of the activated graphite blocks, computer code for the estimation of the decommissioning cost and so on. These techniques seemed not to be essential for the decommissioning projects of the KRR-1&2 and the uranium conversion plant, but can be demonstrated and deployed at real dismantling sites and be applied to a future project without any modification.

Radioactive Waste Management

All of the operational and decommissioning liquid waste is concentrated by using a solar evaporating system, which has been operated since April 1999, with a maximum evaporation capacity of 200 tons/year.

Radioactive laundry and shower waste was treated by the membrane facility for the removal of the detergent component before the solar evaporation. This membrane facility was developed by KAERI and installed at the decommissioning site for the KRR-1 & 2 decommissioning project.

All the solid wastes generated from the decommissioning site were categorized into three groups. The first group is the ”not-contaminated”, and will be sent to the general industrial waste disposal site. The criterion for classification to “radioactive” or “not contaminated” is the minimum detectable activity limit by the approved detector. This means that there are no low limits for this classification. The second group is the radioactive waste, which will be packed in drums of 200 liters or in containers of 4 m^3 according to the physical properties, and temporally stored in the reactor hall of KRR-2 after dismantling and any structural modifications, and then finally sent to the national repository site. The Korean national repository site for low and intermediate level wastes is now planned by the KHNP (Korea Hydro and Nuclear Power Company) to start operation from 2008. The third is so-called “releasable” and the waste of a radioactivity above the minimum detectable activity and less than 0.4 Bq/g (0.04 Bq/g for the waste containing alpha materials) in average can be classified into this group, and was allowed for treatment by KAERI. But this value of 0.4 Bq/g is not the clearance level of Korea and therefore even when classified into the third group, the wastes cannot be freely discarded. In the future a scenario for the discarding route will be formulated and the environment impacts including the public individual exposure rate will be evaluated. When the exposure rate is proven to be lower than 10 micro Sv per year, the waste will be treated according to the prescribed route.

In order to minimize the radioactive wastes to be sent to the final repository site, the main two principles were adopted for the reduction: the suppression of the spread of the contaminants and the repeated decontamination. For the prevention of the spread of the contaminants, the usage of water was strictly limited for the decontamination and dismantling works. The drilling machine and the hydraulic bursting machine were used for the cutting the concrete because no cooling water was needed for the operation of the machines. And the dusts from the works should be effectively collected. For this purpose mobile vacuum clears were used. When a piece of the solid waste was classified into the radioactive and contaminants were considered to be removed, the waste was decontaminated according to the properties of the waste. For the concrete pieces, the surface layer was removed with a mechanical machine such as a scabbler. For the metal wastes such as aluminum plate, steel pipes and duct materials, the chemical decontamination was utilized and sometimes a supersonic or an electric current was applied for the improvement of the decontamination efficiency. For the plastic materials, a steam jet cleaner would be used, but still a modification is needed.

Competent Bodies

Organizations related to the approval of the decommissioning plan for the nuclear facilities are as

follows:

The Nuclear Safety Commission (NSC) is the highest advisory group for the Minister of MOST in order to deliberate and decides on important issues concerning nuclear safety. The Minister of MOST is the chairman of the NSC. The NSC consists of 6 members appointed or commissioned by the Minister. If necessary, the NSC organizes a Special Committee on Nuclear Safety to technically investigate and deliberate safety matters.

The Ministry of Science and Technology (MOST) is responsible for the approval of the decommissioning plan and environmental impact assessment report.

The Korea Institute of Nuclear Safety (KINS) is a group of experts who review the license application, make recommendations to MOST and perform the regulatory inspections as entrusted by the laws.

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