NATIONAL REPORT

FOR
THE JOINT CONVENTION
ON THE SAFETY OF SPENT FUEL MANAGEMENT
AND
ON THE SAFETY OF RADIOACTIVE WASTE MANAGEMENT

MAY 2003

THE REPUBLIC OF KOREA

FOREWORD

The government of the Republic of Korea, as a contracting party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter referred to as 'Joint Convention') which entered into force on June 18, 2001, and deposited the ratification of on September 16, 2002, described the state of implementing the contracting party's obligations in the National Report, pursuant to Article 32 ("Report") of the Joint Convention.

This National Report was prepared in accordance with the "Guidelines Regarding the Form and Structure of National Reports" under the Joint Convention. This Report maintains the structure of an article-by-article approach based on the topical arrangement of the Joint Convention.

Nuclear facilities covered in this National Report are the civilian facilities and its land, buildings and equipment in which radioactive materials are produced, processed, used, handled, stored or disposed of on such a scale that consideration of safety is required under the jurisdiction of the Republic of Korea as defined in Article 2 of the Joint Convention.

This National Report was drafted by the "Working Group for the Implementation of the Joint Convention" organized by the Ministry of Science and Technology, in collaboration with the Ministry of Foreign Affairs and Trade. This Report was reviewed by relevant governmental and industrial organizations, and deliberated over by the Nuclear Safety Commission.

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List of Acronyms

AEC	Atomic Energy Commission
ADU	Ammonium Di-Uranate
AFR	Away From Reactor
AUC	Ammonium Uranyl Carbonate
ALARA	As Low As is Reasonably Achievable
DAW	Dry Active Waste
EOC	Emergency Operation Center
HANARO	High Advanced Neutron Application Reactor
HLW	High-Level Radioactive Waste
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IMEF	Irradiated Material Examination Facility
INES	International Nuclear Event Scale
KAERI	Korea Atomic Energy Research Institute
KEPCO	Korea Electric Power Corporation
KHNP	Korea Hydro & Nuclear Power Co., Ltd.
KINS	Korea Institute of Nuclear Safety
KISOE	Korea Information System on Occupational Exposure
KIRAMS	Korea Institute of Radiological & Medical Science
KNFC	KEPCO Nuclear Fuel Co., Ltd.
KOPEC	Korea Power Engineering Co., Inc.
KPS	Korea Plant Service & Engineering Co., Ltd.
KRIA	Korea Radioisotopes Association
KRR	Korea Research Reactor
LILW	Low and Intermediate-Level Radioactive Waste
LWR	Light Water Reactor
MOCIE	Ministry of Commerce, Industry and Energy
MOCT	Ministry of Construction and Transportation
MOE	Ministry of Environment
MOGAHA	Ministry of Government Administration and Home Affairs
MOL	Ministry of Labor

MOST	Ministry of Science and Technology
MTU	Metric Tons of Uranium
NETEC	Nuclear Environment Technology Institute
NPP	Nuclear Power Plant
NSC	Nuclear Safety Commission
PHWR	Pressurized Heavy Water Reactor
PIEF	Post-Irradiation Examination Facility
PNSC	Plant Nuclear Safety Committee
PWR	Pressurized Water Reactor
RI	Radioisotope
RIPF	Radioisotope Production Facility
RASIS	Radiation Safety Information System
SFSP	Spent Fuel Storage Pool
ST-1	Safe Transport of Radioactive Material
TLD	Thermo-Luminescence Dosimeter
WACID	Waste Comprehensive Information Database.

A. Introduction

The Korean government has maintained a consistent national policy for stable energy supply by fostering nuclear power industries under the circumstances that energy resources are scare in the country. Korea has one of the most dynamic nuclear power programs in the world. For a couple of decades, Korea has deployed very dynamic nuclear power program. The first nuclear power plant (NPP), Kori #1, started its commercial operation in April 1978. As of September 2002, there are 17 units of nuclear power plants in operation and 3 units under construction*. Four of the 17 operating units are Pressurized Heavy Water Reactors (PHWRs) at the Wolsong site. All other units distributed in three sites (Kori, Yonggwang, and Ulchin) are Pressurized Water Reactors (PWRs). Nuclear power generation is as high as 40% of total domestic electricity generation.

Only one research reactor is in operation: The HANARO reactor at the Korea Atomic Energy Research Institute (KAERI) located in Daejeon. Operations commenced its operation in 1995 and it has thermal power of 30 MW. The two research reactors, KRR-1 & 2, situated in the former KAERI site in Seoul had been shut down and unloaded of fuel. All the fuel rods were returned to the USA according to the bilateral agreement between the governments of Korea and the United States. Now the reactor buildings and auxiliary facilities are under decommissioning.

The KEPCO Nuclear Fuel Co. (KNFC) in Daejeon fabricates fuel for all of the PWR and PHWR power plants. In the course of conversion and fabrication, contaminated wastes may be generated. The number of facilities utilizing radioactive materials in medicine, research work and industry has increased steadily to reach about 2000. These facilities are wide spread over the country and generate various types of radioactive waste (hereinafter referred to as RI wastes).

Since the beginning of the 1980's, the Korean government has strived to devise measures for radioactive waste disposal. However, no satisfactory results has been achieved yet. Consequently, spent fuels are stored in the spent fuel storage pools (SFSP) at reactor and on-site dry storages (for spent PHWR fuels only). The radioactive wastes are stored on reactor sites, while the RI wastes at the KAERI site.

At the 249th meeting held in September, 1998, the Atomic Energy Commission (AEC) decided on the "National Radioactive Waste Management Policy" aiming to construct and operate a low and intermediate-level radioactive waste (LILW) disposal facility no later than 2008 and a centralized spent fuel interim-storage facility by 2016. Particularly, the AEC policy emphasizes the enhancement of public relations in the course of siting these facilities to improve perceptions on radioactive wastes.

Figure A.1-1 shows Locations and operational status of major radioactive waste generation sources and management facilities in Korea.

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* As of December 2002, there are 18 units of nuclear power plants in operation.

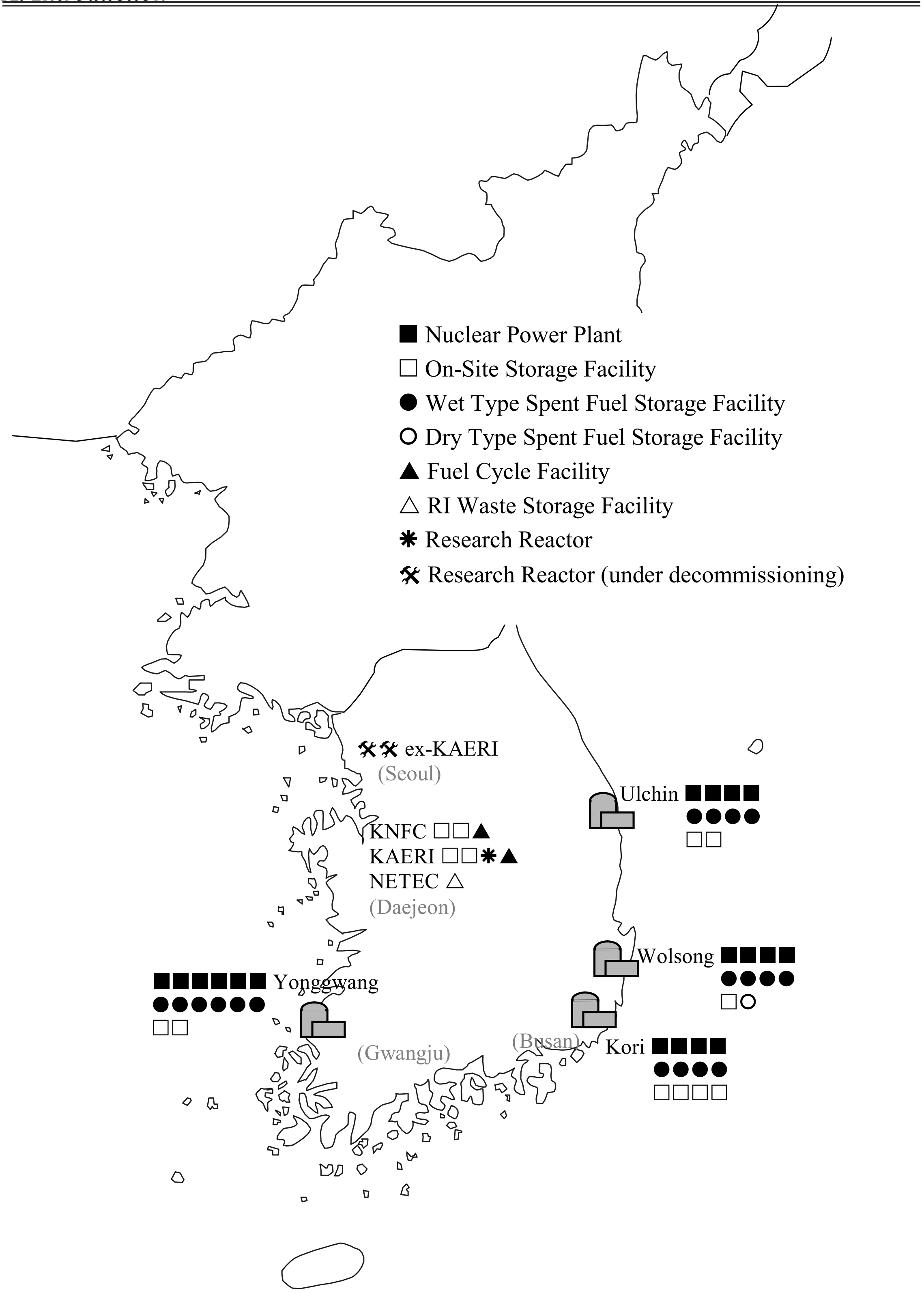


Figure A.1-1 Locations and operational status of major radioactive waste generation sources and management facilities (As of December 2002)

B. Policies and Practices (Article 32, Paragraph 1)

B.1 National policy and principles

B.1.1 National policy

The AEC of the Korean government made a new decision on the "National Radioactive Waste Management Policy" at the 249th meeting held on September 30, 1998, seriously taking into account the situation that the siting of the first radioactive waste repository had been forced to defer resulting from the intensive pressure from stakeholders, and particularly from the residents in and around the proposed site, without any promising progress. The national policy incorporated in the policy statements includes the following:

1) Direct control by the government

   Radioactive waste, which needs long-term safe management, shall be managed under the responsibility of the government.

2) Top priority under safety

   Radioactive waste shall be safely managed in due consideration of biological and environmental impact so as to protect the individuals, society and the environment from the harmful effects of radiation and to observe international norms on the safety of radioactive waste management.

3) Minimization of radioactive waste generation

   Radioactive waste generation shall be minimized.

4) "Polluter pays" principle

   The expenses related to radioactive waste management shall be levied on the radioactive waste generator at the point of radioactive waste generation, without imposing undue burden on future generations.

5) Transparency of site selection process

   Radioactive waste shall be managed transparently and openly, and the radioactive waste management project shall be promoted in cooperation and harmony with the local community, and keeping abreast with enhancing community development.

B.1.2 Fundamental principles

The fundamental principles incorporated in the national policy are as follows;

1) Sites that will accommodate radioactive waste facilities shall be selected through an open and democratic procedures.

2) The LILW shall be disposed of in a near surface repository (including rock cavern repository) after they are managed in storage facilities on site and RI radioactive waste in the exclusive storage facility.

3) Spent fuel shall be managed by expansion of on-site storage capacity and construction of off-site interim storage facilities in consideration of national policy.

B.1.3 Implementation plans

1) Organizations in charge

Spent fuel and radioactive waste shall be managed under the chain of responsibility linking the Ministry of Commerce, Industry and Energy (MOCIE), the Korea Electric Power Corporation (KEPCO), and the Korea Hydro and Nuclear Power Co., Ltd (KHNP). The Nuclear Environment Technology Institute (NETEC), a subsidiary organization of the KHNP, shall deal with technical matters associated with radioactive waste management.

2) Regulations, codes of practice, and standards

The Ministry of Science and Technology (MOST) in conjunction with the Korea Institute of Nuclear Safety (KINS) develops regulations, codes of practice and standards needed for the safe management of spent fuel and radioactive waste. Specific guidelines may be formulated by the operating organization, the KHNP. Domestic regulations and codes shall be consistent with international norms including relevant Safety Fundamentals, Safety Principles, and Safety Guides provided by the IAEA.

3) Interim storage for spent fuel

A centralized spent fuel interim storage facility shall be prepared by the year 2016. Either wet storage or dry storage shall be selected in consideration of site conditions and the status of technological development. During the first stage, the facility will have a capacity of 2,000 MTU, to be expanded by stages (Total capacity: 20,000 MTU).

4) Radioactive waste repository

A near surface repository (including rock cavern repository) shall be constructed by the year of 2008 for low and intermediate level radioactive wastes. During the first stage, the facility will be constructed with a capacity of 100,000 drums, and its expansion will be considered on demand (Total capacity: 800,000 drums).

5) Radioactive waste management fund

According to the Electricity Business Act, a dedicated fund has been founded as a budget resource on radioactive waste management, in which the nuclear power generation licensee should fund the future liability cost for nuclear power plant decommissioning and radioactive waste disposal, whereas the non-nuclear power generation licensee should pay a waste management fee for radioactive waste treatment and disposal to the disposer required by law.

6) Stakeholders' involvement

For the initial stage of proposing candidate sites for the repository/spent fuel interim storage facilities, adequate channels shall be provided to the stakeholders to have an opportunity of involvement.

B.2 Spent fuel management practices

B.2.1 Nuclear power plants

The annual spent fuel generated by NPPs amount to approximately 14 MTU for 600 MWe PWR-type plants such as Kori #1, and 19 MTU for a 1,000 MW plant such as Kori #3, and 95 MTU for a PHWR.

Annex A-1 shows the status of capacities of the available spent fuel storage facilities. The spent fuel discharged from nuclear power reactors was intended to be stored for the nominal cooling time in a spent fuel storage pool (SFSP) at the reactor before shipment to an away-from-reactor (AFR) interim storage facility. Due to the unexpected delay of construction of AFR storage, however, the storage capacity of SFSP at earlier reactors had to be expanded by adopting high-density storage racks. For Kori #1 and #2, for which neither of the two methods of expanding capacity is adequate, spent fuel overflow has been shipped to the SFSP of Kori #3 and #4. For the PHWR at Wolsong site, an on-site dry storage facility has been installed to solve the shortage of capacity of the SFSP of Wolsong #1.

B.2.2 Research facilities

Korea research reactor (KRR-1 & 2)

Out of KRR-1 & 2, 299 rods of nuclear fuel had been discharged. Among them, 113 rods were transferred to the KAERI site, Daejeon, in 1985, and were stored in the spent fuel pool of HANARO Research Reactor, while the remaining 186 rods were stored in the pool of KRR-2.

All of the 299 spent fuel rods in storage were sent back to the USA in June 1998, as decommissioning projects for KRR-1 & 2 were commenced at the time.

HANARO research reactor

HANARO research reactor is equipped with a spent fuel pool capable of storing spent fuel generated by HANARO for 20 years. The spent fuel pool can store the spent fuel from KRR-1 & 2, as well as those from HANARO and the irradiated test fuel that is subjected to post-irradiation examinations.

Post-irradiation examination facility (PIEF)

The PIEF has the maximum capability of storing up to 20 PWR-type fuel assemblies in the spent fuel pool wherein fuels transported from nuclear power plants for post-irradiation examination are stored. Test specimens selected and fabricated from those fuels are kept in a hot cell adjacent to the pool.

B.3 Radioactive waste management practices

B.3.1 Nuclear power plants

Gaseous radioactive waste management

Gaseous radioactive waste is generated mainly from the degassing of the primary system and ventilation systems for the radiation-controlled area in nuclear power plants. The gaseous waste from the primary system shall be treated by gas decay tank or charcoal delay bed to reduce radioactivity and released into the atmosphere after getting through a radiation monitor. Gaseous waste from the building ventilation system is also to be exhausted through a high-efficiency particulate filter and charcoal filter under continuous monitoring into the environment. The Notices of the MOST addresses the maximum radioactivity concentration limits for gaseous effluent being released into the atmosphere on the restricted area boundary, and the licensee shall conduct a periodic evaluation for the expected off-site dose due to gaseous effluent released into the environment, and routinely report results to the regulatory body. The off-site dose limit related to the release of gaseous waste is specified in subsection F.4.1 hereof.

Liquid radioactive waste management

Liquid radioactive waste is generated mainly from reactor coolant and related systems containing radioactivity. In general, liquid radioactive waste is treated with evaporators, demineralizers and filters. The effluent is either recycled or released after monitoring to the sea through the circulating water system. The Korean Standard Nuclear Power Plant is furnished with a selective ion exchanger instead of an evaporator to increase efficiency in the treatment of liquid radioactive waste. The Notices of the MOST prescribe the maximum radioactivity concentration limits for liquid effluent being discharged into the environment on the restricted area boundary, and the operator shall conduct periodic assessment for the expected off-site dose due to liquid effluent discharged into the environment, and routinely report results to the regulatory body. The off-site dose limit related to the discharge of liquid effluents is also specified in subsection F.4.1 hereof.

Solid radioactive waste management

Most of solid radioactive waste is dry active waste (DAW) such as replaced component parts, papers, used clothes, gloves, shoes, etc. generated in the course of maintenance and repair of the primary system, and secondary waste generated from the liquid and gaseous radioactive waste treatment system. Secondary wastes are such things as concentrated wastes from evaporators, spent resin from demineralizers, and spent filters from liquid purification systems.

DAW is compressed by conventional compactor (Capacity: 10 tons) into drums, and additional volume reduction of DAW is conducted with a super compactor (Capacity: 2,000 ton). Solidification method by cement, which was commonly applied in the past, is not used any longer. Instead, the concentrated waste is now dried and stabilized by paraffin in drums and spent resin is kept in a high-integrated or equivalent container, after being dried in the spent resin drying facility. Spent filters are stored in a shielding container.

B.3.2 Research facilities

The KAERI has several facilities handling radioactive materials, such as HANARO facility, PIEF, radioisotope production facility (RIPF), irradiated material examination facility (IMEF), and other laboratories. Additionally, it operates radioactive waste treatment facilities for radioactive waste treatment and storage.

Gaseous radioactive waste management

The ventilation system is equipped with filters to treat off-gas before its release to the atmosphere. The stacks of such facilities, that is, being the end outlets, have a continuous air monitor for the ventilation system.

Liquid radioactive waste management

The liquid waste generated from each facility of the KAERI is transferred through an underground pipeline to a collection tank of the radioactive waste treatment facility, and all the waste is processed by solar evaporation.

Solid radioactive waste management

The solid radioactive waste, except for spent fuel, generated from each facility, is transferred to the radioactive waste treatment and storage facility. Solid radioactive waste having a radiation dose rate above internal criteria is packed in 50ℓ stainless steel drums, and kept in a monolith having an enough shielding effect, while solid radioactive waste with a radiation dose rate below internal criteria is packed in 200ℓ steel drums after compaction, and kept in the storage room.

B.3.3 Nuclear fuel fabrication facility

Gaseous radioactive waste management

Gaseous radioactive waste, from which has to be treated to remove radioactive substances through a filter in the ventilation system before its release through the stack outside, is properly controlled so that the off-site exposure dose induced by radioactive materials released to the outside may not exceed the target control value Should there be any excess of the reference dose detected under continuous monitoring of radioactivity in gaseous effluent, the release would be automatically stopped.

Liquid radioactive waste management

Liquid waste is separated into two kinds of waste; one is PWR type waste from the PWR fuel fabrication facility and the other is PHWR type waste from the PHWR fuel fabrication facility. They are treated by several treatment systems such as lime precipitation, polymer coagulation, and centrifugation based on the their characteristics. The treated liquid waste, which is below the release limits, is allowed to discharge by batch type release. Data, such as discharge volume and level of radioactivity at the time of release, are recorded and kept.

Solid radioactive waste management

Most solid waste from the fuel fabrication facility consists of protective articles such as clothes, gloves, etc., metals generated in facility repair work, and lime deposits. They are separated into miscellaneous wastes, metals, synthetics, lime deposits wood, glass, etc., and packed in 200ℓ steel drums. The drums are stored in the waste storage facility, after measuring radioactivity, weight, surface contamination level, and radiation dose rate for each package.

B.3.4 Radioisotope waste storage facility

Radioisotopes are used in two forms; sealed source and unsealed source. Unsealed source waste is classified into combustibles, incombustibles, non-compactable, spent filters, animal carcasses, organic liquid waste, and inorganic liquid waste. Of all waste generated by radioisotope users, unsealed source waste is collected and delivered to the NETEC of the KHNP by the Korea Radioisotopes Association (KRIA), while disused sealed source waste is delivered by respective radioisotope users directly, or through an authorized agency, to the NETEC. The NETEC stores and safely manages radioisotope waste in the radioisotope waste storage facility.

In order to improve the storage efficiency of the radioisotope waste storage facility, part of the radioisotope waste in storage is treated for volume. Compactors treat incombustible wastes like glass, etc. Very low-level, combustible waste and organic liquid waste are incinerated.

For safe and efficient storage, sealed sources are stored in a special container after being separated into source part and pigtail.

B.4 Definition and classification of radioactive waste

The Atomic Energy Act defines "Radioactive Waste" as radioactive materials or materials contaminated with radioactive materials which are the object of disposal, including spent fuel. The Enforcement Decree of the Atomic Energy Act defines that high-level radioactive waste (HLW) is radioactive waste that emits radioactivity and heat generation over the limit value specified by the MOST, while those other than HLW are categorized as LILW. The limit value on radioactivity and heat generation is specified in Notice No: 2002-1 of the MOST (Entitled: "Criteria for radiation protection", etc.) as follows:

- Radioactivity : $\geq$ 4,000 Bq/g for α -emitting nuclide having a half life longer than 20 years
- Heat Generation : $\geq$ 2 kW/m^3

Until 1998, radioactive waste classification based on IAEA Technical Report Series No. 101 (1970) had been applied to the Korean nuclear community. In August 1998, the criteria for radioactive waste classification were amended with a view to emphasizing radioactive waste disposal safety as above, in due regard to the IAEA revised classification system of IAEA Safety Series No.111-G-1.1 (1994).

C. Scope of Application (Article 3)

The National Report is applied to the safety of spent fuel management and radioactive waste management as defined under the national atomic energy laws and the related technical standards. The spent fuel and radioactive waste generated from nuclear power and research reactor facilities, the radioactive waste generated from the nuclear fuel cycle facility, and the radioactive waste generated from radioisotope users are covered. The definition and classification of radioactive waste are specified in B.4.

Based on national policy and implementation plan on spent fuel management, the recycling or reprocessing of spent fuel is not taken into consideration for the present.

Pursuant to Article 3(2) and 3(3) of the Joint Convention, waste that contains only naturally occurring radioactive material and does not originate from nuclear fuel cycle and radioactive waste within military or defense programs are not declared as radioactive waste for the purpose of the Joint Convention.

D. Inventories and Lists (Article 32, Paragraph 2)

D.1 Spent fuel management

D.1.1 Nuclear power plants

Spent fuel discharged from reactors is stored in the spent fuel pool in each reactor unit for a certain period, and the on-site storage capacity is expanded. Annex A-1 represents the location and characteristics of spent fuel storage facilities in each plant.

As of September 2002, spent fuel inventories for PWRs and PHWRs are 2,810 MTU and 2,978 MTU, respectively. The inventories, the mean discharge burn-up and types of spent fuel in storage are as given in Table D.1-1.

D.1.2 Research facilities

HANARO research reactor

HANARO is a multi-purpose research reactor with the main object of its use for fuel performance testing, material irradiation testing, radioisotope production, basic science and applications study, and is currently in use for various research and development activities. The exclusion area of HANARO is within a radius of 200m from the reactor, and under the KAERI's control. Annex A-2 represents the location and characteristics of the spent fuel storage pool at HANARO.

The spent fuel storage pool of HANARO is a heavy concrete structure, of which the inside is lined with stainless steel plate. The vault comprises three storage lattices. The vault has enough capacity for temporarily storing new fuel as well as spent fuel to be generated in the normal operation of HANARO for 20 years.

177 spent fuel assemblies discharged from HANARO are stored at the HANARO spent fuel storage pool as shown in Table D.1-2. HANARO fuel is a mixture of U_3Si and Al with aluminum cladding. 20% low-enriched uranium is used for the fuel.

The discharge burn-up of the 36-rod fuel assemblies stored in the HANARO spent fuel pool is up to 107 GWd/MTU, and their mean is 55 GWd/MTU. Meanwhile, the maximum, minimum, and average burn-up of the 18-rod assemblies are 130 GWd/MTU, 9 GWd/MTU, and 60 GWd/MTU, respectively.

Table D.1-1 Inventory of spent fuels stored in NPPs

NPP	Type	Volume stored		Maximum enrichment on loading (w/o)	Average burn- up after unloading (GWd/MTU)	Fuel type
		ton (MTU)	assembly			
Kori #1	wet	149	419	3.4～3.8	41～43	14×14 PWR
Kori #2	wet	310	792	3.4～3.8	34～39	16×16 PWR
Kori #3	wet	461	1116	3.9～4.2	39～46	17×17 PWR
Kori #4	wet	368	872	3.9～4.2	39～46	17×17 PWR
Yonggwang #1	wet	323	772	3.9～4.2	39～46	17×17 PWR
Yonggwang #2	wet	281	668	3.9～4.2	39～46	17×17 PWR
Yonggwang #3	wet	145	352	3.8～4.4	35～55	16×16 PWR
Yonggwang #4	wet	117	284	3.8～4.4	35～55	16×16 PWR
Yonggwang #5	wet	—	—	3.8～4.4	35～55	16×16 PWR
Ulchin #1	wet	268	620	3.9～4.2	39～46	17×17 PWR
Ulchin #2	wet	244	568	3.9～4.2	39～46	17×17 PWR
Ulchin #3	wet	73	176	3.8～4.4	35～55	16×16 PWR
Ulchin #4	wet	71	348	3.8～4.4	35～55	16×16 PWR
Wolsong #1	wet	707	37,452	natural uranium	7.2	CANDU
	dry	1,091	57,780	natural uranium	7.2	CANDU
Wolsong #2	wet	485	25,500	natural uranium	7.2	CANDU
Wolsong #3	wet	406	21,424	natural uranium	7.2	CANDU
Wolsong #4	wet	289	15,236	natural uranium	7.2	CANDU

Table D.1-2 Inventory of spent fuels in the storage pool of HANARO

<table>
<tr><th colspan="2">Category of spent fuel</th><th>No. of assemblies</th><th>U-235 remained (g)</th></tr>
<tr><td rowspan="2">HANARO spent fuels stored in assembly form</td><td>36 rod element</td><td>118</td><td>33,210</td></tr>
<tr><td>18 rod element</td><td>59</td><td>9,162</td></tr>
<tr><td rowspan="2">Disassembled HANARO spent fuel (left-over after PIE)</td><td>36 rod element</td><td>1</td><td>432</td></tr>
<tr><td>18 rod element</td><td>1</td><td>207</td></tr>
<tr><td colspan="2">Disassembled HANARO type-A test fuel (left-over after PIE)</td><td>2</td><td>57</td></tr>
<tr><td colspan="2">Disassembled test fuel (left-over after PIE)</td><td>3</td><td>22</td></tr>
<tr><td colspan="2">Post-irradiation examination specimens</td><td>40</td><td>2</td></tr>
</table>

Post-irradiation examination facility

Annex A-3 represents the location and characteristics of the spent fuel storage pool at the PIEF.

The PIEF was constructed for the purpose of performance testing and evaluation for fuels irradiated in nuclear power plants. It is equipped with pool and hot cell facilities to examine PWR fuel assemblies and fuel rods. Examinations for other types of nuclear fuels including PHWR fuel can be conducted in hot cell and pool test facilities whenever deemed to be necessity.

The PIEF consists of 3 pools, 4 concrete hot cells, 2 lead hot cells, and supporting installations. Its main characteristics are receiving, unloading and examination of PWR spent fuel assemblies in the pool, the examination of spent fuel rods in the hot cell, and the chemical analysis for specimens selected from those fuels.

As of September 2002, the spent fuel assemblies from Kori #1 and #2, defective fuel basket from Kori #1, and spent fuel rods from Kori #2, Ulchin #2, and Yonggwang #4 are stored in the PIEF. The spent fuels stored in the PIEF facility have wide range of discharge burn-up from about 17 GWd/MTU to 53 GWd/MTU according to the irradiation histories in the NPP. Table D.1-3 represents the detailed status of storage, the burn-up and enrichment by fuel forms.

Table D.1-3 Inventory of spent fuels in the storage pool of PIEF

Fuel Type	Quantity	Origin of NPP	Burn-up (MWd/MTU)	Enrichment (w/o)
14 × 14 PWR	6 assemblies	Kori #1	17,071 ~ 37,840	< 3.8
16 × 16 PWR	1 assembly	Kori #1	35,018	< 3.8
17 × 17 PWR	1 assembly	Ulchin #2	52,000	< 4.5
Defective fuel rod storage basket	one basket	Kori #1	35,000	3.8
Fuel rods	14 rods	Kori #2, Ulchin #2, Yonggwang #4	35,000 ~ 43,000	3.2 ~ 3.8

D.2 Radioactive waste management

D.2.1 Nuclear power plants

Seventeen power reactors currently in operation are furnished with gaseous, liquid, and solid waste treatment facilities and on-site storage facilities to ensure the safety of radioactive waste management generated in the process of operation. The location and characteristics of these facilities are listed in Annexes B-1 and B-2. The gaseous waste treatment system comprises gas decay tanks and/or charcoal delay beds. The liquid waste treatment system is equipped with either liquid waste evaporators or selective ion exchangers. The solid waste treatment facility has spent resin drying systems, spent filter processing and packaging systems, concentrated waste drying systems, and low-pressure/super compactors.

The on-site solid radioactive waste storage facility is a concrete slab-type building with separate storage for wastes according to radioactivity level, and is equipped with a radiation monitoring system, drainage collection and storage system, and ventilation system.

As of September 2002, 59,865 drums of radioactive waste generated from nuclear power plants are stored in the on-site storage facilities. The disposal of radioactive waste has not been implemented yet. Table D.2-1 shows the inventory status of radioactive waste stored in the on-site storage facility.

Table D.2-1 Inventory of radioactive wastes stored in NPPs

Facility	Volume [200ℓ drum]	Major radionuclides	Total activity [Bq] (a)
Kori No.1	9,445	Co-60, Cs-137	7.13E+13
Kori No.2	4,300	Co-60, Cs-137	6.56E+13
Kori No.3	6,535	Co-60, Cs-137	1.40E+14
Kori No.4	12,107	Co-60, Cs-137	1.04E+14
Wolsong No.1 (b)	3,577	Co-60, Cs-137	5.07E+14
Yonggwang No.1	10,399	Co-60, Cs-137	8.56E+13
Yonggwang No.2	1,679	Co-60, Cs-137	9.22E+12
Ulchin No.1	6,395	Co-60, Cs-137	1.06E+14
Ulchin No.2	5,428	Co-60, Cs-137	2.04E+14

Remarks: (a) Calculation by dose to Curie conversion program
(b) Spent resin is stored in large vaults [291 m^3 (equivalent to 1,455 drums)]

D.2.2 Research facilities

The KAERI operates a radioactive waste treatment and storage facility for the safe management of liquid and solid radioactive waste generated from research facilities. In Annexes B-3 and B-4, the location and characteristics of the KAERI's radioactive waste management facilities are listed.

All liquid radioactive waste from the KAERI is processed through an evaporation process followed by solar evaporation facilities. The liquid concentrate is solidified by bituminization process, and stored in the storage vault. Solid waste is treated for volume reduction with a compactor before storage in the storage facility. This facility is divided into the two storage vaults for LILW.

The radioactive wastes generated from KRR-1 & 2 in the former site of the KAERI in Gongneung-Dong, Seoul were solidified in cement and packaged in 200ℓ drums. Since was moved to the KAERI in Daejeon in 1985, these drums have been transported and stored at the radioactive waste storage facility. Table D.2-2 represents the inventory status of radioactive waste in storage together with major radionuclides.

Table D.2-2 Inventory of radioactive waste stored in the KAERI

Facility	Volume [drum]	Major radionuclides	Total activity [Bq]
Storage No.1	10,319 *	Mn-54, Co-60, Cs-137, I-131, etc.	under assessment
Storage No.2	88 **	Mn-54, Co-60, Cs-137, I-131, etc.	

* 200ℓ drum, ** 50ℓ drum

D.2.3 Nuclear fuel fabrication facility

Two nuclear fuel fabrication facilities are now in operation: The 1st plant constructed in 1988 and the 2nd plant started its commercial operation in 1998. The solid waste treatment and storage concept for the 1st plant and the 2nd plant are same, while the liquid waste treatment process for PWR fuel fabrication facility is different from that of PHWR fuel fabrication facility as listed in Annexes B-5 and B-6.

As of September 2002, the amount of waste generated from the nuclear fuel fabrication facilities is up to 4,482 drums, and all of them safely in storage and managed in the on-site waste storage facility. Table D.2-3 shows the inventory of radioactive waste stored in the on-site storage facilities.

Table D.2-3 Inventory of radioactive waste stored at nuclear fuel fabrication facility

Facility	Volume [200ℓ drum]	Major Radionuclides	Total Activity [Bq]
Storage No.1	2,090	U-234, U-235, U-238	2.8 E +11
Storage No.2	2,392	“	

D.2.4 Radioisotope waste storage

Radioisotope waste generated from domestic radioisotope users is collected and stored at the radioisotope waste storage facility. The storage capacity of this facility is 9,277 drums, and an incinerator to process very low-level burnable radioisotope waste is in operation. Annexes B-7 and B-8 list the location and main characteristics of the facility.

Table D.2-4 shows the inventory status of radioisotope waste stored in the radioisotope waste storage facility, as of September 2002.

Table D.2-4 Inventory of radioisotope wastes in the radioisotope waste storage facility

Facility	Volume [200ℓ drum]	Major radionuclides	Total activity [Bq]
Radioisotope waste storage facility	4,442 (unsealed source waste)	I-125, Tc-99m, etc.	2.4E+14
	172 (disused sealed source waste)	Co-60, Cs-137, Am-241, etc.	

D.3 Decommissioning

D.3.1 KRR-1 & 2

Outline

The KRR-1 & 2 are located in Gongneung-Dong, Seoul. The site has an area of around 48,000 m^2, and the building area totals about 7,800 m^2. Construction began on KRR-1, the first reactor in Korea, in July 1959, and reached the first criticality on March 19, 1962. This reactor had been operated for the education and training of nuclear engineering students and for basic nuclear characteristic tests, as well as radioisotope production, until operation was stopped in January 1995. KRR-2, which started in 1972, that is, 10 years after KRR-1, came into operation enabling the operator to conduct more wide-ranging nuclear characteristic tests and to produce radioisotopes and labeled compounds.

In November 2000, the government approved the decommissioning plan and the environmental impact assessment report. Actual decommissioning work was started from June 2001, and will be completed until 2008.

Main characteristics

The KRR-1 operated for 36,535 hours in total from its start-up on March 19, 1962 to its shutdown in January 1995, with a total power output of 3,735 MWh. KRR-2 operated for 55,226 hours from its start on May 10, 1972 to its shutdown on December 31, 1995, having generated a total output of 68,740 MWh.

The KRR-1, which was initially designed to have a thermal power of 100 kW was refurbished to 250 kW in June 1969. The thermal power of KRR-2 was 2MWh. 20 % -enriched uranium fuel and 70 % -enriched uranium fuel was loaded in KRR-1 & 2, respectively.

Estimated amount of decommissioning waste

The estimated volume of decommissioning waste from KRR-1 & 2 is 168 m^3 and 453 m^3, respectively. Most of wastes are contaminated mainly with Co-60 and Cs-137 except for the small volume of waste activated by neutrons. Annex C-1 shows the list of nuclear facilities in the process of being decommissioning along with the estimated waste inventory.

D.3.2. Uranium conversion facility

Outline

The uranium conversion facility is located at the KAERI campus in Youseong-Gu, Daejeon. The area of this facility is 1,500 m^3, and the building areas of the ADU (Ammonium Di-Uranate) facility and AUC (Ammonium Uranyl Carbonate) facility are 880 m^2 and 570 m^2, respectively. Additionally, there are two liquid waste ponds called 'lagoons' constructed of concrete, which have the capacity of 1,200 m^3 and 970 m^3, respectively.

The decommissioning plan and the environmental impact assessment report were submitted for government approval in October 2002. Actual decontamination and decommissioning work will start from the end of 2003, and be completed by 2007.

Main characteristics

The uranium conversion facility with an annual capacity of 100 tU was constructed in 1982 for the development of PHWR fuel. But, uranium dioxide powder obtained through the ADU conversion process was inadequate for the fuel of PHWR-type Wolsong #1, so this facility was redesigned to adopt the AUC process in 1987. From 1989 to 1992, the uranium conversion facility produced sintered uranium dioxide powder of around 350 tons, and they were supplied to the Korea Electric Power Corporation (KEPCO). This facility shut down and notified its operational closure to the MOST in 1993, due to aging facilities and economic reasons caused awing to its small-scale production.

Estimated amount of decommissioning waste

The estimated volume of decommissioning waste is 380 m^3. All equipment of this facility was contaminated by natural uranium. After decontamination work, there will be expected clearance level wastes. Annex C shows the list of nuclear facilities in the process of being decommissioned along with the estimated waste inventory.

E. Legislative and Regulatory Framework

E.1 Implementing measures, legislative and regulatory framework (Articles 18 & 19)

E.1.1 Legislative framework

Nuclear legislative framework

National laws related to the safety of spent fuel management and the safety of radioactive waste management are the Atomic Energy Act, the Electricity Business Act, the Environmental Impact Assessment Act and others as shown in Table E.1-1. All provisions on nuclear safety regulation and radiation protection are entrusted to the Atomic Energy Act. The Atomic Energy Act was enacted as the main law concerning safety regulations for spent fuel and radioactive waste.

The laws concerning nuclear regulation, as shown in Figure E.1-1, consists of 4 stages: the Atomic Energy Act, the Enforcement Decree of the same Act, the Enforcement Regulations of the same Act (including regulations concerning technical standards of nuclear facilities, etc., and regulations concerning technical standards of radiation safety management), and the Notices of the MOST.

The Atomic Energy Act provides for basic and fundamental matters concerning the development and utilization of nuclear energy and safety regulation. It includes provisions on the AEC, the Nuclear Safety Commission (NSC), the nuclear energy promotion program, the construction permit and operating license of nuclear facilities, and others as shown in Tables E.1-2. The Enforcement Decree of the same Act (the Presidential Decree) provides the particulars entrusted by the Act, and the administrative particulars including the detailed procedures and methods, etc., necessary for the enforcement of the same Act.

The Enforcement Regulation of the same Act (the MOST Ordinance) provides the particulars including detailed procedures, the format of documents, and technical standards, as entrusted by the same Act and the same Decree.

The Enforcement Regulations were divided into namely, the Enforcement Regulation Act, the Enforcement Regulation Concerning the Technical Standards of Reactor Facilities, etc., and the Enforcement Regulation Concerning the Technical Standards of Radiation Safety Management, etc.

Table E.1-1 Laws concerning nuclear regulation

Title	Major Contents	Competent Authorities	Remarks
Atomic Energy Act	Integrated law on the development and utilization of nuclear power and nuclear regulations	MOST	—
Korea Institute of Nuclear Safety Act	Provides the establishment and operation of the Korea Institute of Nuclear Safety	MOST	—
Nuclear Damage Compensation Act	Provides the procedures and extent of compensation for any damages which an individual has suffered from a nuclear accident	MOST	—
Nuclear Damage Compensatory Contract Act	Provides the particulars on a contract between the government and the operator to make up any compensation not covered by insurance	MOST	—
Electricity Business Act	Provides the basic system of electricity business	MOCIE	The Atomic Energy Act is entrusted with the particulars on safety regulations for the installation, maintenance, repairs, operation and security of nuclear facilities
Act on Special Cases Concerning Electric Source Development	Provides special cases relevant to the development of electric sources	MOCIE	Prior notice of nuclear site
Basic Law of Environmental Policy	Mother law of the environmental preservation policy	MOE	The Atomic Energy Act is entrusted with the particulars on measures to prevent radiological contamination
Environmental Impact Assessment Act	Provides the extent and procedures to assess environmental impact according to the Basic Law of Environmental Policy	MOE	Assessment of environmental impacts excluding radiological impacts
Fire Services Act	Provides for general matters on the prevention, precaution and the extinguishment of fires	MOGAHA	The requirements for safety management of inflammables
Building Act	Provides for general matters on construction	MOCT	The Atomic Energy Act is entrusted for the particulars on construction permits for a nuclear facility
Industrial Safety and Health Act	Provides for the preservation and enhancement of workers' health and safety	MOL	The Atomic Energy Act is entrusted with the particulars on radiological safety
Industrial Accident Compensation Insurance Act	Provides insurance to compensate workers in case of an industrial disaster	MOL	—
Basic Law of Civil Defense	Provides for general matters on the civil defense system	MOGAHA	Preparedness against disasters due to nuclear accidents is included in the basic civil defense plan
Disaster Control Act	Provides for general matters on the control of man-made disasters	MOGAHA	It prescribes corrective or complementary measures for violations in the implementation of the basic civil defense plan

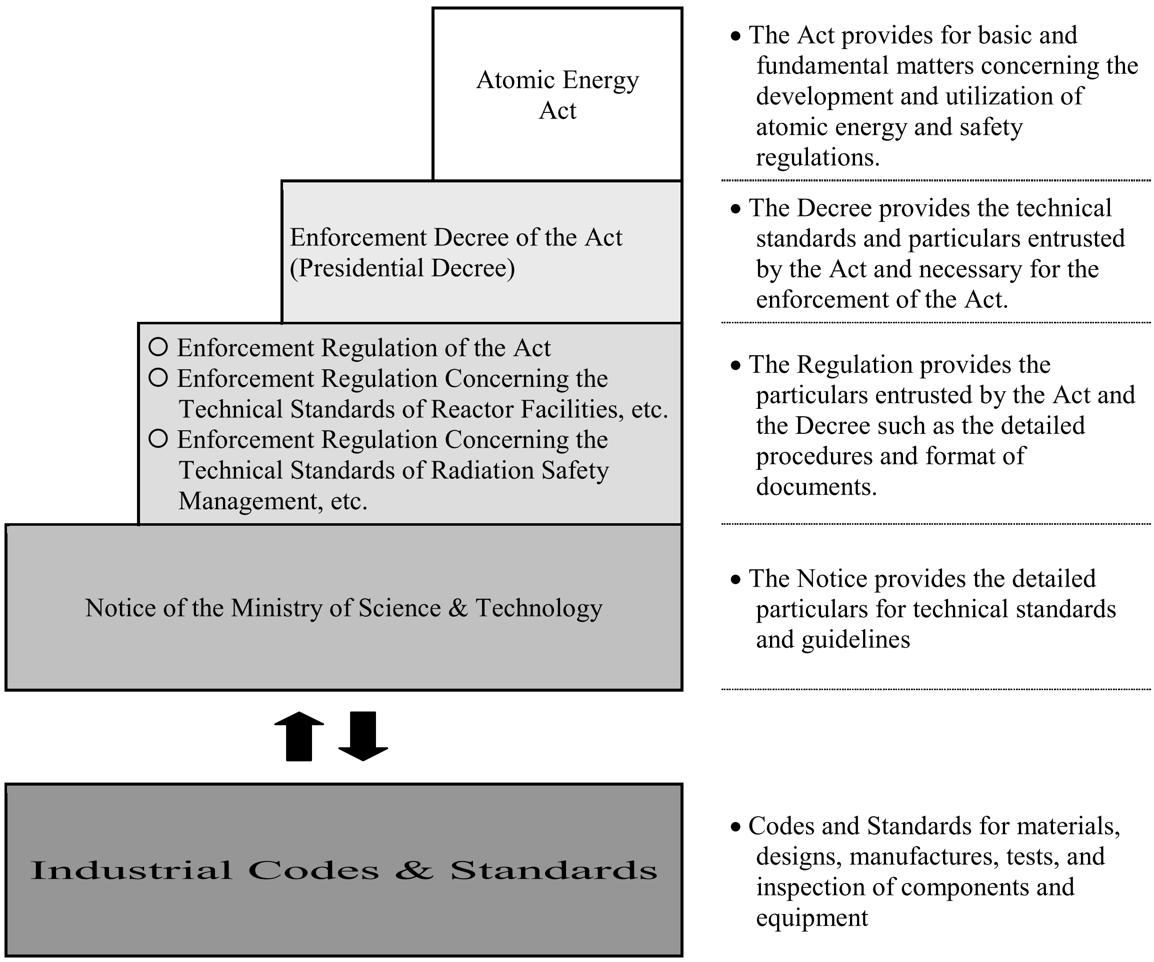


Figure E.1-1 Legal hierarchy of the Atomic Energy Laws

The Notices of the MOST prescribes specific issues including regulatory requirements and technical standards, as entrusted by the same Act, the same Decree and the same Regulation. Table E.1-3 lists the Notices of the MOST applicable to the safety management of radioactive waste.

The industrial standards applicable to nuclear activities are endorsed by the regulatory body and applied to the design, operation and inspection of waste management facilities. The guidelines on safety reviews and regulatory inspections developed by the KINS, an expert organization for safety regulation, are in practical use.

Table E.1-2 Contents of the Atomic Energy Act

Title		Major Contents
Chapter 1	General provisions	The purpose of this Act and definitions of the terminology used in this Act
Chapter 2	Atomic Energy Commission and Nuclear Safety Commission	Establishment, functions, and composition of the Atomic Energy Commission and the Nuclear Safety Commission
Chapter 3	Establishment and enforcement of the overall nuclear energy promotion program, research and development, etc., of nuclear energy	Establishment and enforcement of the comprehensive promotion plan for nuclear energy, nuclear energy research and development institution, burden of cost for nuclear energy research and development work
Chapter 3-2	Nuclear energy research and development fund	Establishment, management, and operation of the fund
Chapter 4	Construction and operation of nuclear power reactors and related facilities	Criteria for permits (license), licensing procedures, license application documents to be submitted, regulatory inspection, records and record keeping, appointment (dismissal) and obligation of responsible persons for nuclear reactor operation, notification of suspension or disuse of operation, transfer and inheritance, measures for suspension, and decommissioning
Section 1	Construction of nuclear power reactors and related facilities	
Section 2	Operation of nuclear power reactors and related facilities	
Section 3	Construction and operation of nuclear research reactors, etc.	
Chapter 5	Deleted	Deleted
Chapter 6	Nuclear fuel cycle business and use, etc. of nuclear materials	Criteria for permits (license), licensing procedures, license application documents to be submitted, and regulatory inspection
Section 1	Nuclear fuel cycle business	
Section 2	Use of nuclear materials	
Chapter 7	Radioisotopes and radiation generating devices	Criteria for permits (license), licensing procedures, and regulatory inspection
Chapter 8	Disposal and transport	Permit for construction /operation of radioactive waste management facilities, and regulatory inspections
Chapter 9	Personnel dosimetry service	Approval or permit for personnel dosimetry service and regulatory inspection
Chapter 10	License and examination	License examination and certification of licenses
Chapter 11	Regulation and supervision	Establishment of exclusion area and preventive measures against radiation hazards
Chapter 12	Supplementary provisions	Conditions for permit or designation, approval of report on specific technical subjects, hearing, protection for the individual in charge of safety management, education, and training
Chapter 13	Penal provisions	Penal provisions, fines for negligence, and joint penal provisions
Addenda		Enforcement date, transitional measures, and relations with other laws

Table E.1-3 Notices of the MOST, applicable to radioactive waste management

Number	Title	Effective date (day/month/year)
90-07	Regulation on the classification, collection, and delivery of radioisotope waste	28/08/90
91-08	Siting criteria for spent fuel interim storage facilities	22/11/91
91-09	Design criteria for low- & intermediate-level radioactive waste disposal facilities	22/11/91
92-17	Quality assurance criteria of radioactive waste management facilities	24/11/92
94-04	Standard format and contents of site characteristics report for low and intermediate level radioactive waste repositories	10/01/94
96-11	Regulation on the performance of low- & intermediate-level radioactive waste disposal facilities	26/04/96
96-12	Standard format and contents of site characteristics report for spent fuel interim storage	26/04/96
01-23	Regulation on the packaging and transport of radioactive materials, etc.	18/09/01
01-24	Regulation on the environmental radiation survey and impact analysis in the vicinity of nuclear facilities	19/09/01
01-25	Regulation on the evaluation statement preparation of environmental impact by radiation at nuclear facilities	19/09/01
01-30	Regulation on the clearance level of radioactive waste	28/11/01
01-31	Incineration criteria of low- & intermediate-level radioactive waste	28/11/01
01-32	Acceptance criteria for low- & intermediate-level radioactive waste	28/11/01
01-33	Acceptance criteria for spent fuel	28/11/01
01-44	Regulation on the reporting of events and accidents of reactor facilities	01/12/01
02-13	Regulation on the education and training for radiation safety management, etc	17/10/02
02-23	Standards on radiation protection, etc.	06/01/03
02-24	Siting criteria for low- & intermediate-level radioactive waste repositories	06/01/03

Legislative framework for electricity business

The Atomic Energy Act prescribes all provisions on the nuclear safety regulations and radiation protection related to the safety of spent fuel management and radioactive waste management, while the Electricity Business Act provides the particulars on the designation of radioactive waste management licensees, the operational scope of radioactive waste management businesses, and fund raising for such businesses.

Pursuant to the same Act, the MOCIE shall designate the nuclear power generator licensee as the waste management licensee, and the licensee's work scopes are as follows:

– Transport, storage, treatment and disposal of radioactive waste generated from nuclear power plants,
– Storage, treatment and disposal of radioactive waste generated from non-nuclear power sources,
– Packaging, transport and interim-storage of spent fuel,
– Transport, storage, treatment and disposal of radioactive waste generated in the decommissioning of nuclear power plant,
– Siting, construction and operation of permanent radioactive waste disposal facilities and centralized spent fuel interim-storage facilities, and
– Reporting of the status of radioactive waste generation, research and development (R&D), and promotional activities.

The nuclear power generation licensee should fund the future liability cost for nuclear power plant decommissioning and radioactive waste disposal. The non-nuclear power generation licensee should pay the waste management fee for radioactive waste treatment and disposal to the disposer required by the law.

E.1.2 Nuclear regulatory framework

The governmental organizations concerned with nuclear activities, as shown in Figure E.1-2, are mainly formed of administrative authorities: The MOCIE supervising the nuclear power program, the Ministry of Environment (MOE) responsible for regulating issues on the general environment excluding the radiological environment, and the MOST responsible for nuclear safety regulations including the licensing of nuclear facilities. There is also the AEC under the jurisdiction of the Prime Minister, as the supreme organization for decision-making on national nuclear policy. Its responsibility is to deliberate and decide on important matters concerning the development and utilization of nuclear energy. And lastly, the NSC, under the jurisdiction of the MOST is responsible for the deliberation and decision on important matters concerning the safety of nuclear facilities.

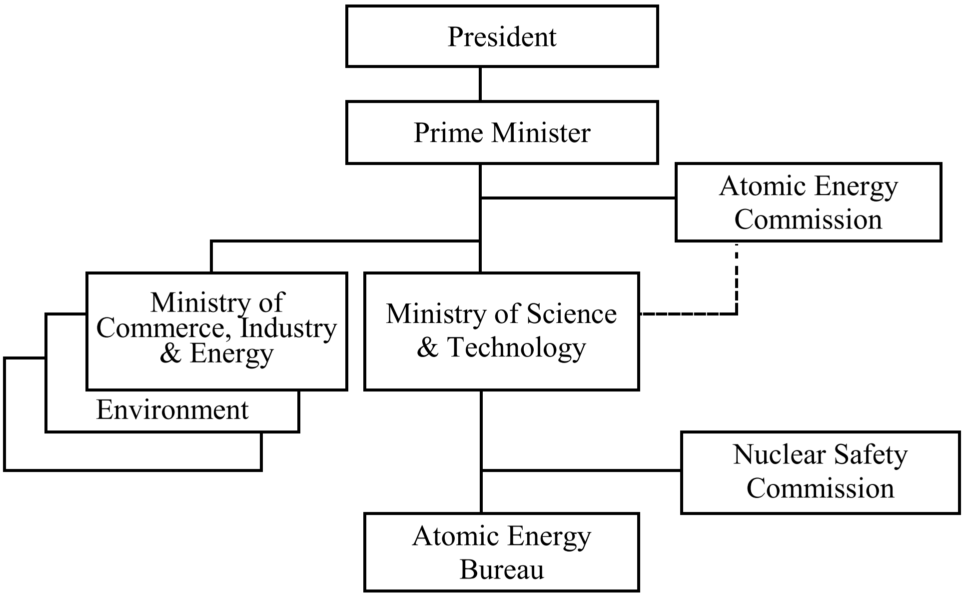


Figure E.1-2 Governmental organizations related to radioactive waste management

Nuclear safety regulatory organizations are mainly composed of the MOST and the NSC as safety regulatory authorities, and the KINS as a safety regulatory expert body as shown in Figure E.1-3.

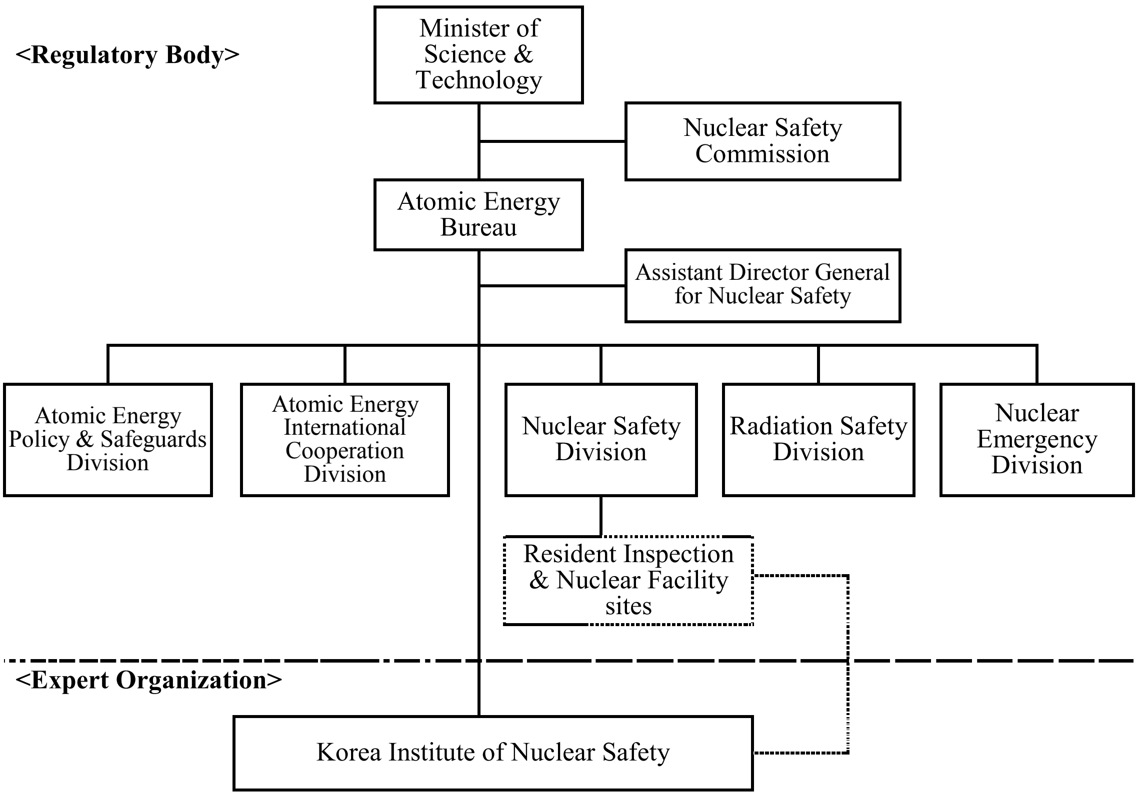


Figure E.1-3 Nuclear safety regulatory framework in the MOST

In addition, there are two organizations supporting regulatory activities of the MOST, namely, the KAERI which transacts trusted affairs relevant to the legal retraining of radiation workers, and the KRIA in charge of maintaining and keeping documents related to the occupational radiation exposures of radiation workers. The details of regulatory organizations are described in Section E.2.

E.1.3 Licensing system and safety evaluation

The licensing procedure of spent fuel management facilities and radioactive waste management facilities is lumped under one step process that combines into a construction/operating permit, pursuant to the Atomic Energy Act as shown in Figure E.1-4.

Early site approval

In order to begin limited construction work on a proposed site before a construction/operation permit is issued, an applicant for early site approval shall submit an application for approval accompanied with a site survey report and a radiological environmental impact assessment report to the MOST. Based on the results of the safety review by the KINS of the application for early site approval, the Minister will grant official approval. The objective of the safety review is to evaluate the adequacy of the proposed site for radioactive management facilities and the radiological impacts on the environment adjacent to the site. The MOE is in charge of reviewing non-radiological environmental impacts.

Permission for the construction/operation of a radioactive waste management facility

In order to obtain permission for the construction/operation of a radioactive waste management facility, the applicant shall submit an application for permission accompanied with a radiological environmental impact assessment report, a safety analysis report, safety management regulations, specifications of design and work process, and quality assurance program for construction and operation to the MOST. Based on the result of the safety review by the KINS of the application for the construction/operating permit, the Minister will issue permission for construction/operation after deliberation by the NSC.

The safety review of the application for permission is conducted to confirm that the site and the design of radioactive waste management facility are in conformity with the relevant regulatory requirements and prevailing technical guidelines. It includes safety reviews of the principles and concepts of facility design, the implementation of regulatory criteria in due course, the assessment of environmental effects resulting from the construction and operation of the facility, and a proposal for minimizing those effects. The radiological environmental impact assessment report to be submitted together with the application for permission as well as for early site approval should contain the public opinion from the area surrounding the site. Furthermore, a public hearings can be held, if necessary.

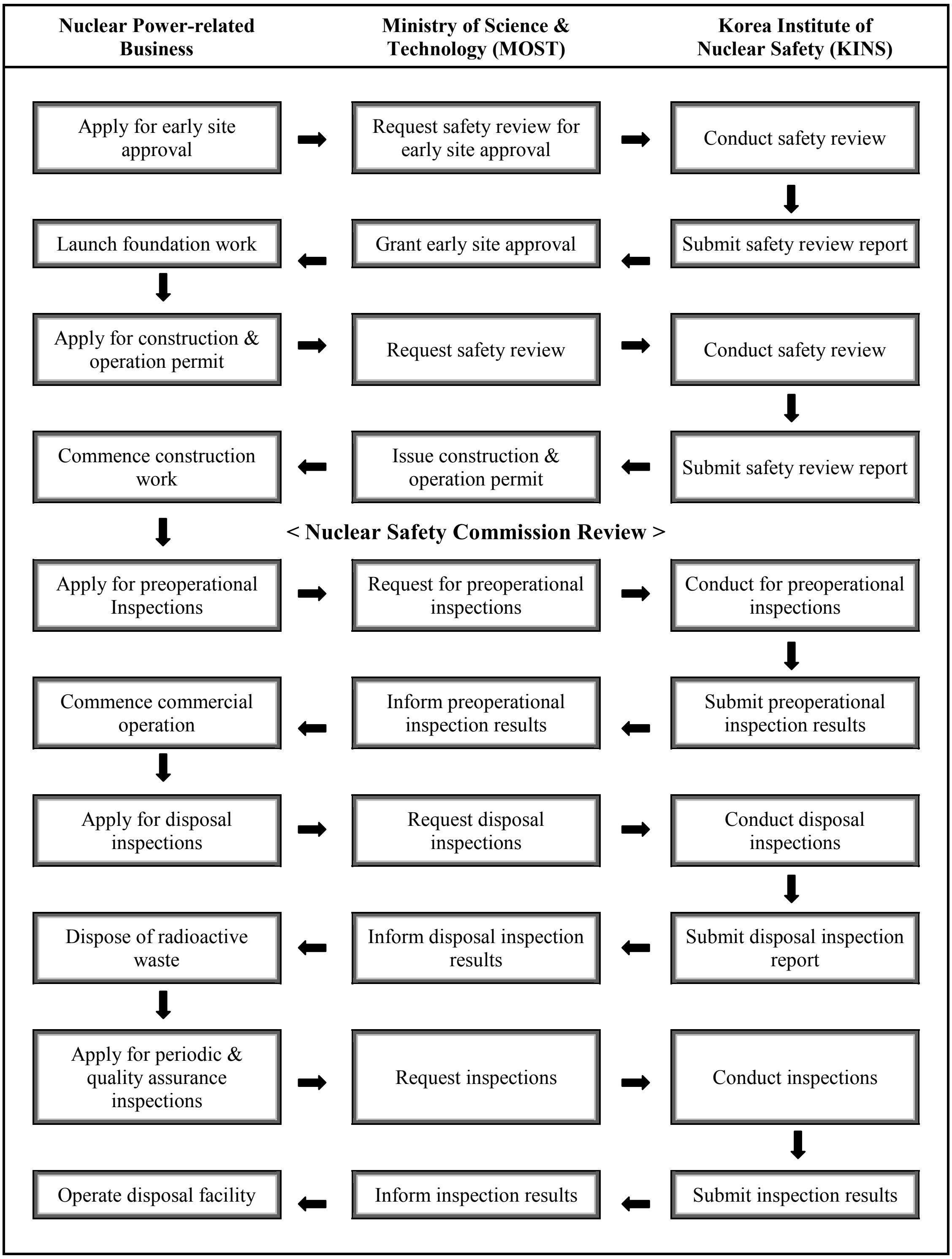


Figure E.1-4 Licensing procedures for radioactive waste management facility

E.1.4 Regulatory inspections

Regulatory inspections for radioactive waste management facilities under construction or in operation include the preoperational inspection for the construction and performance of facility, radioactive waste disposal inspection, periodic inspections, quality assurance audit, and daily inspection by resident inspectors. General procedures for each inspection are schematically described in Figure E.1-5.

Preoperational inspection for the construction and performance of a radioactive waste management facility

The preoperational inspection is conducted to verify whether the radioactive waste management facility is properly constructed in conformity with the terms and conditions of the construction permit, and whether the constructed facility may be operated safely throughout its lifetime. It is conducted for the construction and the performance of facility by means of field inspection as well as document inspection.

Radioactive waste disposal inspection

The radioactive waste disposal inspection is conducted to verify whether radioactive waste is properly disposed of in conformity with all the related technical standards provided in the Atomic Energy Act, before disposal and by means of document inspection and field inspection.

Periodic inspection for in-service radioactive waste management facilities

The periodic inspection of in-service radioactive waste management facilities is conducted to verify whether the facility is properly operating in conformity with the conditions of the operating license; whether the facility can still withstand the pressure, radiation and other stresses of the operating environment; and whether the performance of the facility maintains its license-based conditions. It is performed by means of document inspection and field inspection.

Quality assurance audit

The quality assurance audit is conducted to verify whether all activities affecting quality at every stage of the design, construction/operation of a radioactive waste management facility are being performed in conformity with the quality assurance program approved by the regulatory body. It is conducted periodically for in-service management facilities.

Daily inspection by resident inspectors

The main purpose of the daily inspection by resident inspectors is to carry out daily check on the radioactive waste management facility under construction or in operation. It includes field inspection of surveillance tests, investigation of the measures taken when the facility has reached an abnormal state, and the verification of adequacy of the operator's radiation safety control activities.

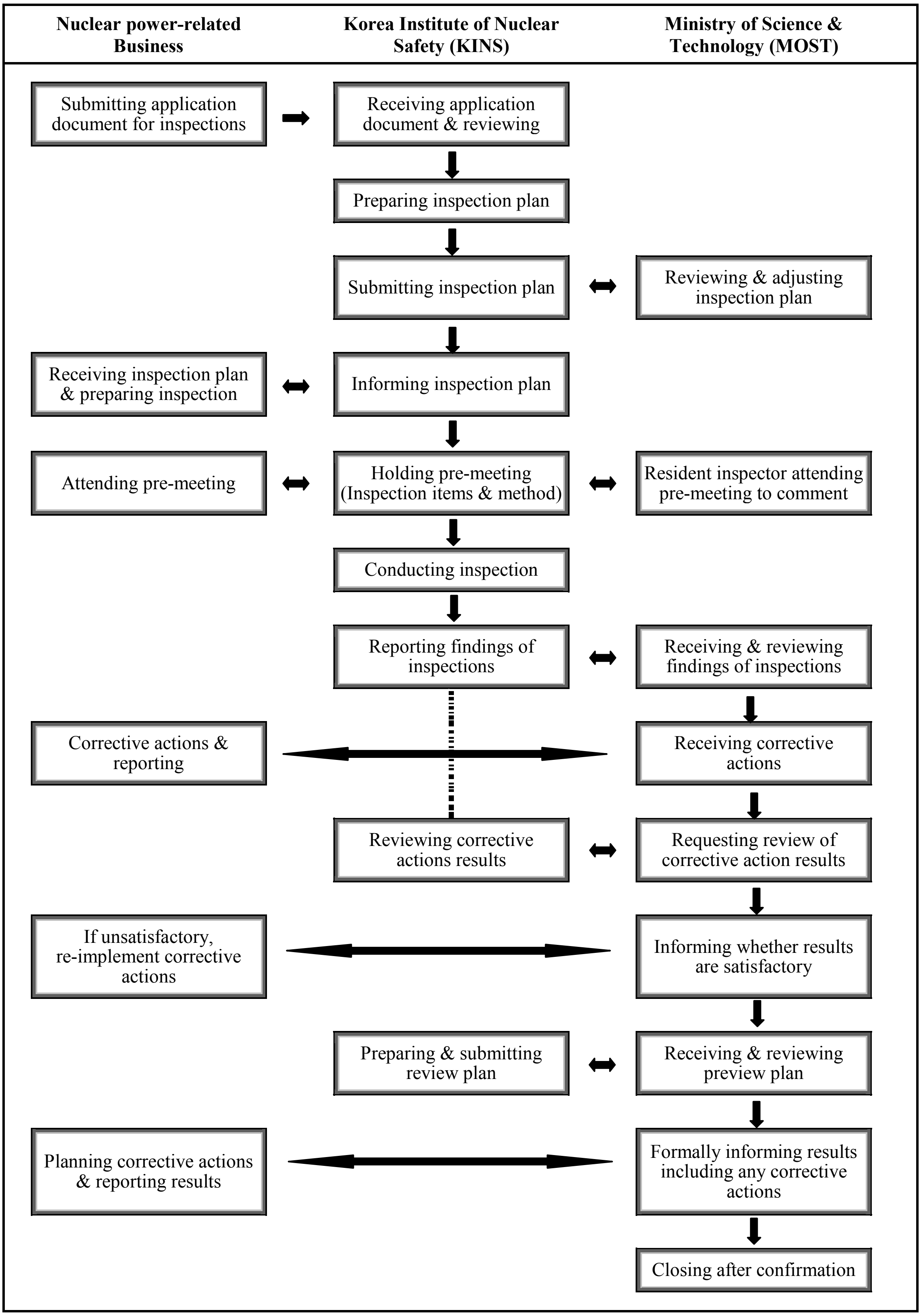


Figure E.1-5 General inspection procedures for radioactive waste management facility

E.1.5 Enforcement

In case that the results of a safety review for a license application meet the relevant requirements, the MOST will issue the corresponding license. The Minister may impose minimum conditions therein, and when if judged that necessary safety measures can be fully secured. If any violation is found as a result of regulatory inspection, the Minister may order the license holder to take corrective or complementary measures in accordance with the Atomic Energy Act.

If it is deemed necessary for the enforcement of the regulations, the MOST is authorized and empowered to order the nuclear-related licensee to submit necessary documents on their business and to complement any submitted documents. The Minister may also conduct regulatory inspections to verify that the documents are in conformity with field conditions, and order the operator to take corrective or complementary measures, if any, as the result of such inspections.

The MOST may order the revocation of license, or the suspension of business within one year, if the operator of a radioactive waste management facility falls under one of the following cases:

- Where the operator has modified any matter subject to the permit without approval,
- Where the operator has failed to meet the criteria for licensing,
- Where the operator has violated an order of the MOST to take corrective or complementary measures as the result of regulatory inspections for the construction or operation of a radioactive waste management facility, and
- Where the operator has violated any of the licensing conditions or regulations on safety measures in the operation of a radioactive waste management facility.

It is prescribed in the Atomic Energy Act that any violation of the relevant provisions specified in the same Act shall result in a penalty and/or a fine according to its extent.

E.1.6 Allocation of responsibility

The Atomic Energy Act and the Electricity Business Act prescribe definitely where responsibility lies for each stage of spent fuel and radioactive waste management. Under the Atomic Energy Act, the MOST is responsible for construction/operation permit and the safety-related regulations of spent fuel and radioactive waste management facilities, while the KINS performs safety-related regulatory activities as entrusted by the MOST. In accordance with the Electricity Business Act, the MOCIE has responsibility for formulating basic policy and implementing measures for spent fuel and radioactive waste management, with the exception of spent fuel treatment and disposal, and for designating a radioactive waste management disposer. The KHNP is designated as a radioactive waste disposer by the MOCIE.

E.1.7 Clearance

In the Atomic Energy Laws of Korea, clearance level is defined as an annual individual dose below 10μSv/y and a total collective dose below 1man-Sv/y as specified in IAEA Safety Series No. 115 (1996).

E.2 Regulatory body (Article 20)

E.2.1 Mandates and duties of the regulatory body

The primary mission of the MOST is to ensure adequate protection of the public health and the environment against radiation hazards that may occur in the course of carrying out the peaceful use of nuclear energy.

Main duties

- To formulate basic national policy for the promotion of science and technology, and to coordinate research and development projects,
- To conduct research in basic sciences, and to develop and support frontier and key industries and public welfare technology,
- To control and coordinate nuclear power utilization and development policies and to conduct safety regulations, and
- To control the investment, manpower, information and international cooperation policies related to science and technology.

Major functions related to nuclear safety regulations

- To establish policies for nuclear safety and regulation,
- To review and assess safety information of nuclear facilities,
- To issue, amend or revoke licenses for the construction and operation of nuclear facilities,
- To conduct regulatory inspections,
- To establish technical standards and regulatory requirements,
- To take necessary enforcement action, where a violation of regulatory requirements has taken place,
- To ensure that corrective actions are taken where unsafe or potentially unsafe conditions are detected,
- To ensure appropriate emergency response capabilities,

– To ensure that occupational radiation exposure records are maintained,
– To assure the qualifications of radiation workers, and
– To provide the public with nuclear safety information, and to strengthen international cooperation for the enhancement of the pubic confidence.

The Ministry is responsible to perform the following additional functions:

– To operate the national environmental radiation monitoring program, and
– To initiate and coordinate nuclear safety research and development.

E.2.2 Authority and responsibility of the regulatory body

The authority of the MOST, which is prescribed in the Atomic Energy Act and the Enforcement Decree of the National Government Organization Act, is as follows:

– To issue, amend and revoke licenses for the construction and operation of nuclear facilities, and to take necessary enforcement actions, whenever a violation of regulatory requirements has taken place,
– To conclude agreements with other domestic governmental or non-governmental bodies, and to delegate tasks to other organizations, wherein such delegation is directly essential to the performance of the body's regulatory responsibilities,
– To obtain such documents and opinions from public, private organizations or persons as may be both necessary and appropriate,
– To maintain contact with foreign regulatory bodies and relevant international organizations, and
– To enter, at any time, the premises of any nuclear facility licensed or under review.

The MOST assumes responsibility to develop the acceptance criteria for the construction and operation of on and off-site radioactive waste disposal facilities, to develop technical standards for operational safety measures, and to secure safety management of radioactive waste at every stage of the siting, design, construction, operation, closure, and decommissioning of on and off-site radioactive waste disposal facilities.

E.2.3 Structure and resources of the regulatory body and supporting organizations

Ministry of Science and Technology (MOST)

As shown in Figure E.2-1, the NSC, under the jurisdiction of the MOST, is responsible for deliberating and making decision on important matters concerning nuclear safety. The Vice Minister and the Director General in charge of the Atomic Energy Bureau are staffed along vertical hierarchic line under the Minister.

The Atomic Energy Bureau consists of 5 divisions: The Atomic Energy Policy and Safeguards Division, the Atomic Energy International Cooperation Division, the Nuclear Safety Division, the Radiation Safety Division, and the Nuclear Emergency Division. An Assistant Director General for nuclear safety assists and advises the Director General of the Bureau in matters of nuclear safety regulation.

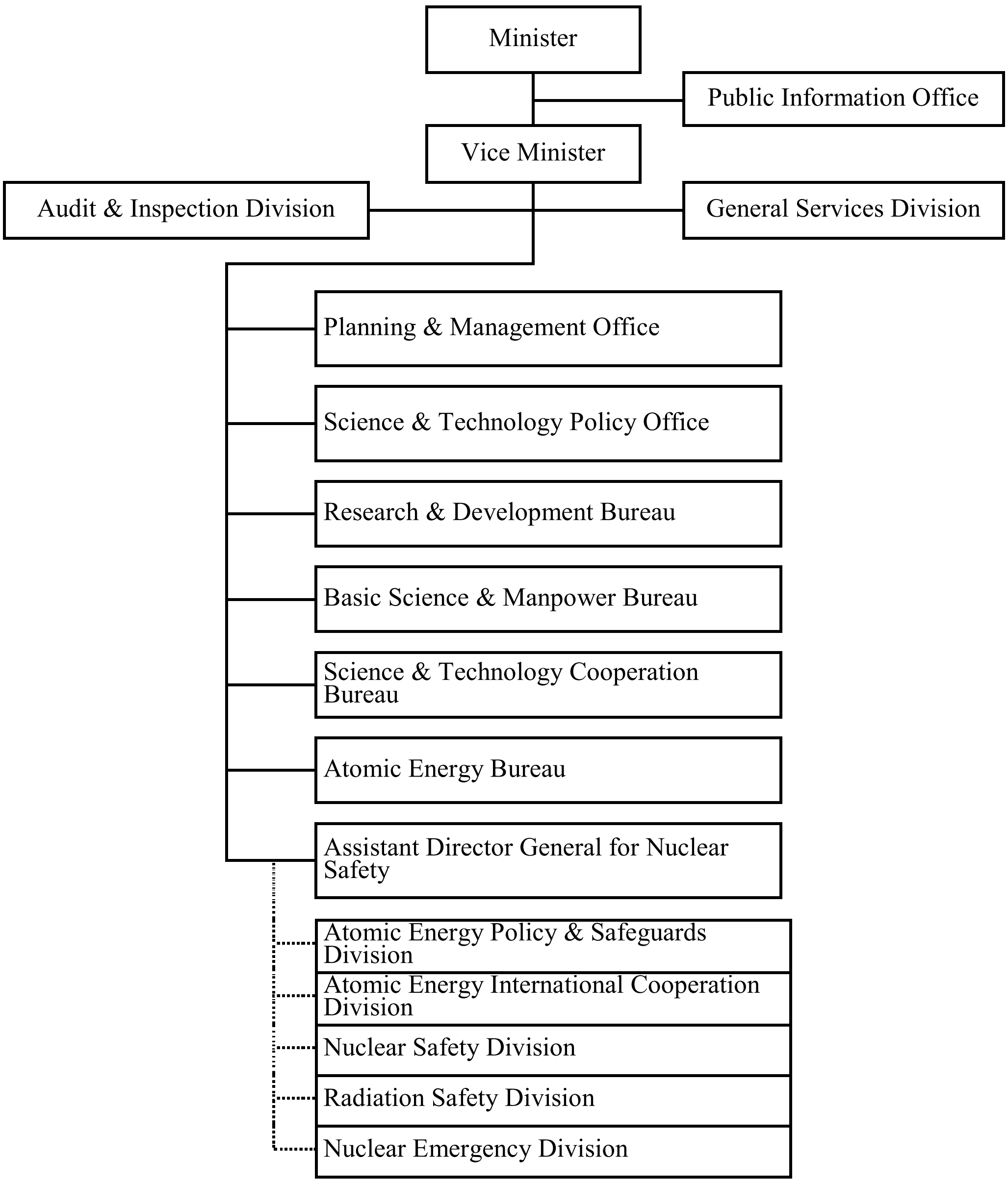


Figure E.2-1 Organization chart of the MOST

Nuclear Safety Division

- To establish and coordinate basic policies on nuclear safety regulation,
- To coordinate and control nuclear safety regulation activities,
- To disseminate and diffuse nuclear safety culture among the public,
- To formulate and implement plans for the technical standards of nuclear safety, and
- To transact matters in nuclear safety conventions.

Radiation Safety Division

- To formulate and coordinate protective measures against radiation hazards,
- To transact matters in the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management,
- To license and supervise the production and use of nuclear materials, radioisotopes and radiation-generating devices, and to conduct safety regulation,
- To formulate and coordinate radiation measures for safty management measures of radioactive sources, and
- To license and supervise the construction and operation of radioactive waste disposal facilities, and to conduct safety regulation.

Nuclear Emergency Division

- To formulate and coordinate plans for radiological emergency preparedness,
- To oversee and evaluate the radiological emergency exercises,
- To conduct, direct and supervise the evaluation of radiological environmental impacts around nuclear facilities,
- To monitor and evaluate the national environmental radiation, and
- To have overall control of the conditions of radiological disaster.

Nuclear Safety Commission (NSC)

The NSC is established under the jurisdiction of the MOST in order to deliberate and decide on important matters concerning nuclear safety, pursuant to the Atomic Energy Act. The Commission deliberates and decides on the following:

- Consolidation and coordination of matters concerning nuclear safety control,
- Matters concerning the regulation of nuclear materials and reactors,
- Matters concerning protection against hazards due to radiation exposure,
- Matters concerning plans for the estimation and allocation of expenditures for nuclear safety management,

– Matters concerning the formulation of tests and research for nuclear safety management,
– Matters concerning the fostering and training of researchers and engineers in the area of nuclear safety management,
– Matters concerning the safety management of radioactive waste,
– Matters concerning measures against radiation accidents, and
– Other matters deemed important by the chairman.

The NSC, which is chaired by the Minister of Science and Technology, consists of 9 members including 8 members appointed or commissioned by the Minister. In order to strengthen nuclear safety regulation activities, the MOST prescribs that any person who is engaged in the operation of nuclear facilities should not be commissioned to be a member of the Commission.

The NSC organized the Special Committee on Nuclear Safety to technically investigate and deliberate matters under its jurisdiction. This Committee is composed of 25 experts or less, and for its effective operation, it is divided into 5 Sub-committees, as shown in Figure E.2-2, of the Reactor System Subcommittee, the Radiation Protection Subcommittee, the Nuclear Emergency and Environment Subcommittee, the Site and Structure Subcommittee, and the Regulatory Policy Subcommittee. The NSC may also organize and operate the Special Investigation Committee if any nuclear and/or radiation accidents occur.

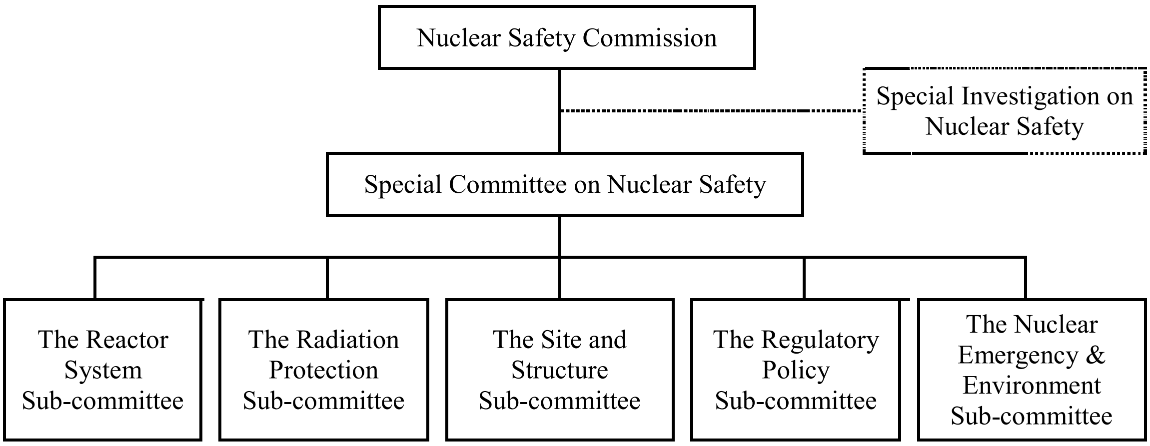


Figure E.2-2 Organization chart of the NSC

Korea Institute of Nuclear Safety (KINS)

The KINS was established in December 1981, and initially operated under the name of the "Nuclear Safety Center" as a branch outfit of the KAERI. It started functioning as an independent spin-off expert organization in February 1990, according to the "Korea Institute of Nuclear Safety Act", and conducts matters on nuclear safety regulation as entrusted by the MOST in accordance with the Atomic Energy Laws.

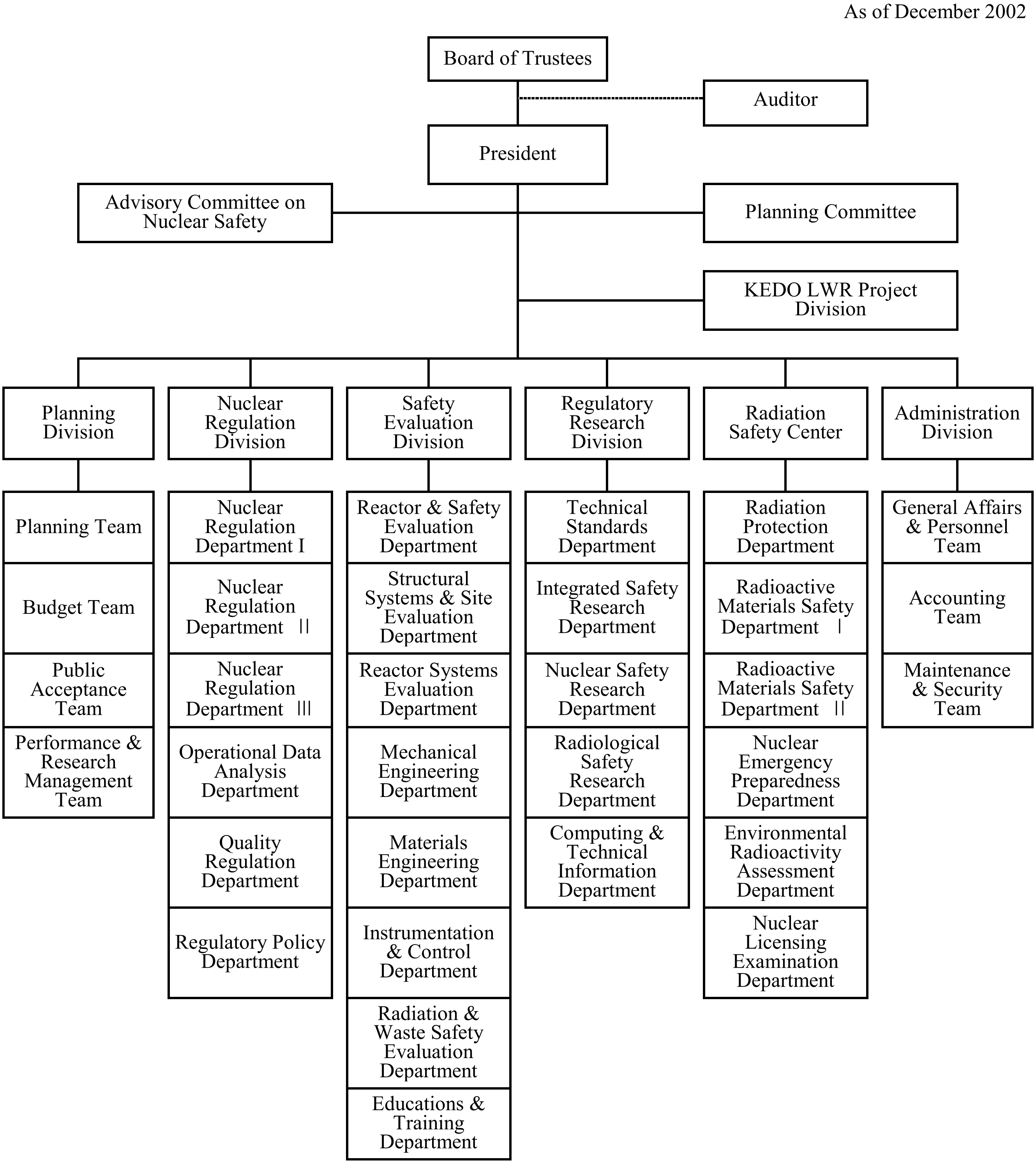


Figure E.2-3 Organization chart of the KINS

Its major functions relevant to nuclear safety regulation are as follows:

- To conduct safety reviews in relation to the licensing and approval of nuclear facilities,
- To conduct regulatory inspections during the manufacturing, construction and operation of nuclear facilities,
- To perform research and development on technical standards of safety regulations for nuclear facilities,
- To conduct license examinations for the handling of nuclear materials and radioisotopes, and the operation of nuclear facilities,
- To receive and process notifications relevant to licensing formalities, and
- To conduct quality assurance examination and inspection.

The KINS also takes responsibility of various activities such as the development of nuclear safety regulation technology, technical support to the MOST for policy development and radiation protection, information management on safety regulations, and the monitoring and evaluation of environmental radioactivity.

The KINS consists of 1 center, 6 divisions, and 32 offices/teams, as shown in Figure E.2-3, and operates the Advisory Committee on Nuclear Safety, a consultative body for technical matters on safety regulations, which is composed of experts from the KINS and other various organizations. As of September 2002, the staff of the KINS numbers 298, of which 248 persons are technical experts. The budget is covered by special assessment borne by relevant utilities and government subsidies in accordance with the Atomic Energy Act.

Meanwhile, the KINS has concluded agreements with China, Germany, France, Japan, Romania, Spain, UK, and USA (in alphabetic order) for bilateral cooperation regarding radiological emergency preparedness as well as strengthening techniques and knowledge of nuclear safety regulation through international collaboration with regulatory agencies in the cited countries.

The KINS, an expert organization that pertains in nuclear safety regulation, implements a mid- & long-term manpower supply plan which is devised to secure enough human resources for regulatory affairs, according as the demand for regulation increases.

Korea Atomic Energy Research Institute (KAERI)

The KAERI, an organization conducting research and development activities for the peaceful use of atomic energy, is in charge of basic and applied research in atomic energy, the research, development, and production of nuclear fuel materials, research and development related to the storage, treatment and storage of spent fuel and radioactive waste, fostering and training of nuclear-related technical personnel, the production and distribution of radioisotopes, and research in radiation medicine and agriculture.

Korea Radioisotopes Association (KRIA)

The KRIA, as entrusted by the MOST according to the Atomic Energy Laws, is responsible for maintaining the national registry of occupational radiation exposures. Additionally, the Association is in charge of declaring the import and export of radioisotopes and radiation-generating devices, educating and training radiation workers, providing and training for radiation-related licensees, and collecting and transporting of radioisotope waste, in order to promote the use of radioisotope and radiation, and to enhance safety.

E.2.4 Regulatory independence

The MOST, the nuclear safety regulatory body has complete authority and responsibility for construction permits and operating licenses and the safety regulation of spent fuel and radioactive waste management facilities, under the Atomic Energy Act, and it is free from the intervention of other Ministries in the area of safety regulation. The Minister, who joins the AEC as an *ex-officio* member, is involved in making decisions on important national policies related to the development and utilization of atomic energy. The KINS has in charged with safety-related regulation affairs, as trusted by the MOST.

The MOCIE, the body responsible for radioactive waste management, formulates and implements general management measures including basic policies and business programs for spent fuel and radioactive waste management, except for spent fuel treatment and disposal, pursuant to the Electricity Business Act. On the other hand, the MOST, a safety regulatory body, performs independently the regulatory functions for the construction and operation of radioactive waste management facilities, apart from the MOCIE as far as nuclear safety regulation is concerned. The MOST also operates the NSC under its umbrella, an independent deliberative organization, to enhance objectivity and unbiasedness in safety regulation.

F. Other General Safety Provisions

F.1 Responsibility of the license holder (Article 21)

F.1.1 Ultimate responsibility

The holder of a construction and operation permit of nuclear facilities assumes the responsibility for safety management of spent fuel and radioactive waste generated in operation according to the related laws and regulations until the construction of centralized interim storage facilities for spent fuel and construction of radioactive waste disposal facility to be managed by the government are completed and the operation of such facilities get started.

According to the “Nuclear Safety Policy Statement”, the ultimate responsibility for the safety of a nuclear facility rests with the operating organization and is in no way diluted by the separate activities and responsibilities of designers, suppliers, installers and regulators thereof.

The ultimate responsibility for spent fuel and radioactive waste management lies with the government as follows:

- The MOCIE shall formulate and implement management measures including basic policies and business programs for radioactive waste management, according to the Electricity Business Act.
- The deliberation and decision of the AEC after full consultation with the MOST is the prerequisites to formulating management measures.
- In formulating the radioactive waste management measures, the radioactive waste management should be clearly adopted as its basic guidelines, in which the ultimate responsibility rests with the government.

F.1.2 Mechanism for the regulatory body to ensure that the license holder will meet its primary responsibility for safety

The MOST, in accordance with the Atomic Energy Act, assumes the responsibility to verify by means of regulatory inspections described in Section E.1.4, that the installer or operator of nuclear facilities complies with permit or license conditions during construction or throughout the lifetime of the nuclear facility. If a violation takes place, the said Minister immediately orders the installer or operator to take corrective and complementary measures so as to secure the safety of the nuclear facilities.

The operator of the nuclear facility shall verify, by means of safety regulatory inspections under the Atomic Energy Act, that he will comply with the permit or license conditions during construction or operation.

If the operator has failed to meet the permit or license conditions, the MOST may order the revocation of the permit or license, or the suspension of business for a given period of time. Additionally, if the performance of a nuclear facility does not meet technical standards or if safety measures for the operation of the nuclear facility are unsatisfactory, the Minister may order the operator to take corrective actions or stronger safety measures.

F.2 Human and financial resources (Article 22)

F.2.1 Nuclear power plants

Human resources

The KHNP, a subsidiary of the KEPCO, was established in succession to all the nuclear facilities and employees of the KEPCO, and has a headquarters consisting of 3 divisions and 10 departments/offices, a branch consisting of 4 nuclear power sites and 2 hydro power stations, and a special branch of 3 institutes, as shown in Figure F.2-1. The KHNP's employs about 6,200 workers, and has assets amounting to 14 billion USD (17,600 billion won). Personnel engaged in the operation and construction of reactor facilities number about 5,700.

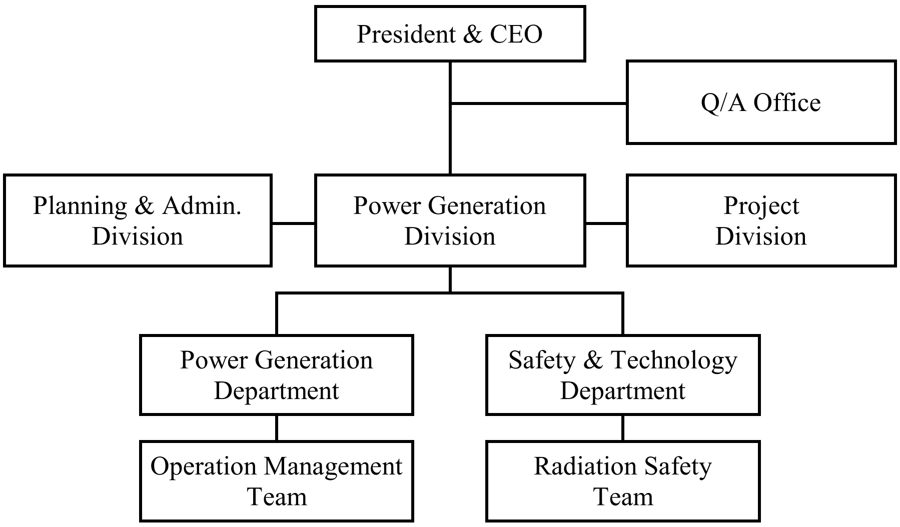


Figure F.2-1 Nuclear-related organization chart of the KHNP

Figure F.2-2 depicts the reactor facility operating organization of the KHNP, which is entitled to safely manage all radioactive waste under the organization system of cooperation with other organizations.

The KHNP places the Radiation Safety Team to have full charge of radioactive waste management work under the framework of the Safety Technology Department of its headquarters, and the Radioactive Material Management Section to control the treatment and storage of radioactive waste generated from reactors in each reactor facility. The NETEC, an affiliate of the KHNP, gives technical support to the KHNP in the construction and operation of radioactive waste management facilities and the management of spent fuel, while several service companies, including Korea Plant Service & Engineering Co., Ltd. (KPS), support the KHNP in the operation and maintenance of radioactive waste treatment systems, and radioactive waste management at sites.

The KHNP also has the Nuclear Review Board to deliberate and decide on nuclear safety in its headquarters. In each reactor facility, the Plant Nuclear Safety Committee (PNSC) is organized to advise the plant manager on matters concerning nuclear safety.

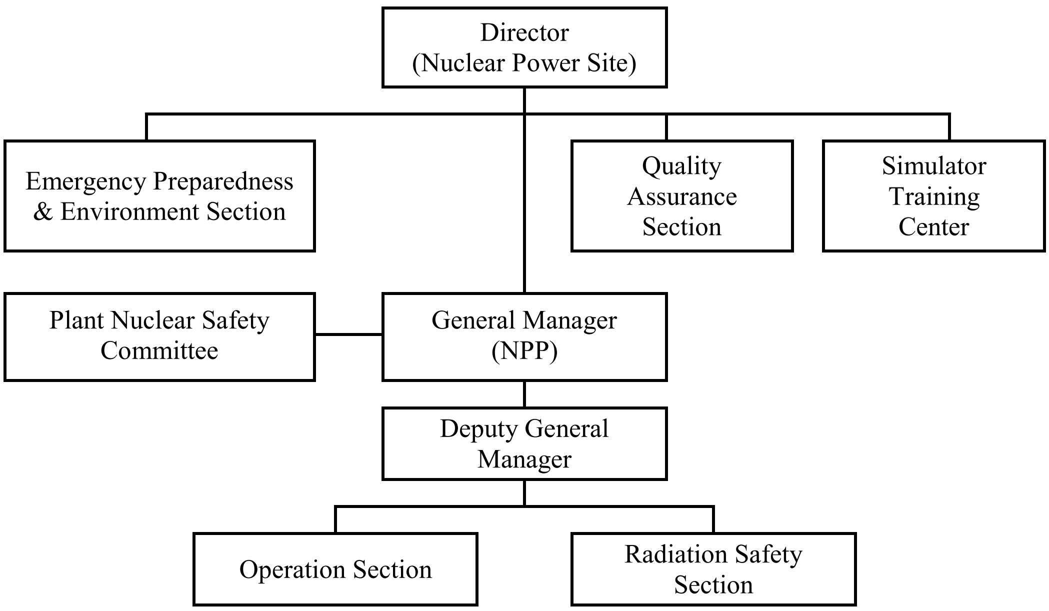


Figure F.2-2 Organization chart for the operation of nuclear power plants

Financial resources

The Electricity Business Act prescribes that, to secure funds for the decommissioning of reactor facilities, the centralized interim storage and disposal of spent fuel, and the disposal of low and intermediate-level radioactive waste (LILW), the reactor facility operator should reserve fund for plant decommissioning, disposal for LILW and interim storage and disposal for spent fuel. Accordingly, the KHNP, the reactor facility operator, has laid aside 134.9 million USD (16.19 billion Won) per unit of reactor for reactor decommissioning, by installments, together with 451.7 USD (542,000 Won) per kgU of spent fuel for spent fuel disposal, and 543.3 USD (652,000 Won) per drum of LILW for radioactive waste disposal, as in-house liability as of 1992, and the annual fund is adjusted for inflation every year.

The reactor maintenance and management fund is being appropriated for the disposal and volume reduction of radioactive waste generated from reactor facilities, the improvement of necessary equipment for such processes, the securing of on-site storage capacity, and the on-site transport of waste.

F.2.2 Research facilities

Human resources

In the KAERI, there are several facilities such as the HANARO facility, post-irradiation examination facility, radioisotope production facility, irradiated material examination facility, radioactive waste treatment and storage facility, and other laboratories. Figure F.2-3 represents the organization of the KAERI.

1) HANARO research reactor

Eighteen operating staff members of the Operation Division in HANARO Center operate HANARO in three shifts.

2) Post-irradiation examination facility

The Nuclear Fuel Cycle Examination Division of the Nuclear Fuel Cycle Development Center in the KAERI operates the PIEF. This facility is run and maintained by 12 general operating and examining/managing staff members whose work scopes are divided by their specialties and backgrounds. The general operating staff are responsible for utility equipment operations such as electric power supply maintenance and water quality control of the facility, the operation of ventilation equipment, etc., and internal and external inspections including nuclear material accountancy, and licensing, while the examining/managing staff are in charge of post-irradiated examination for spent fuel, with the management of the relevant examination facility. Additionally, they conduct radiation safety management, environmental radioactivity control, water supply control, nuclear material safeguards and management in cooperation with the related expert departments within the KAERI.

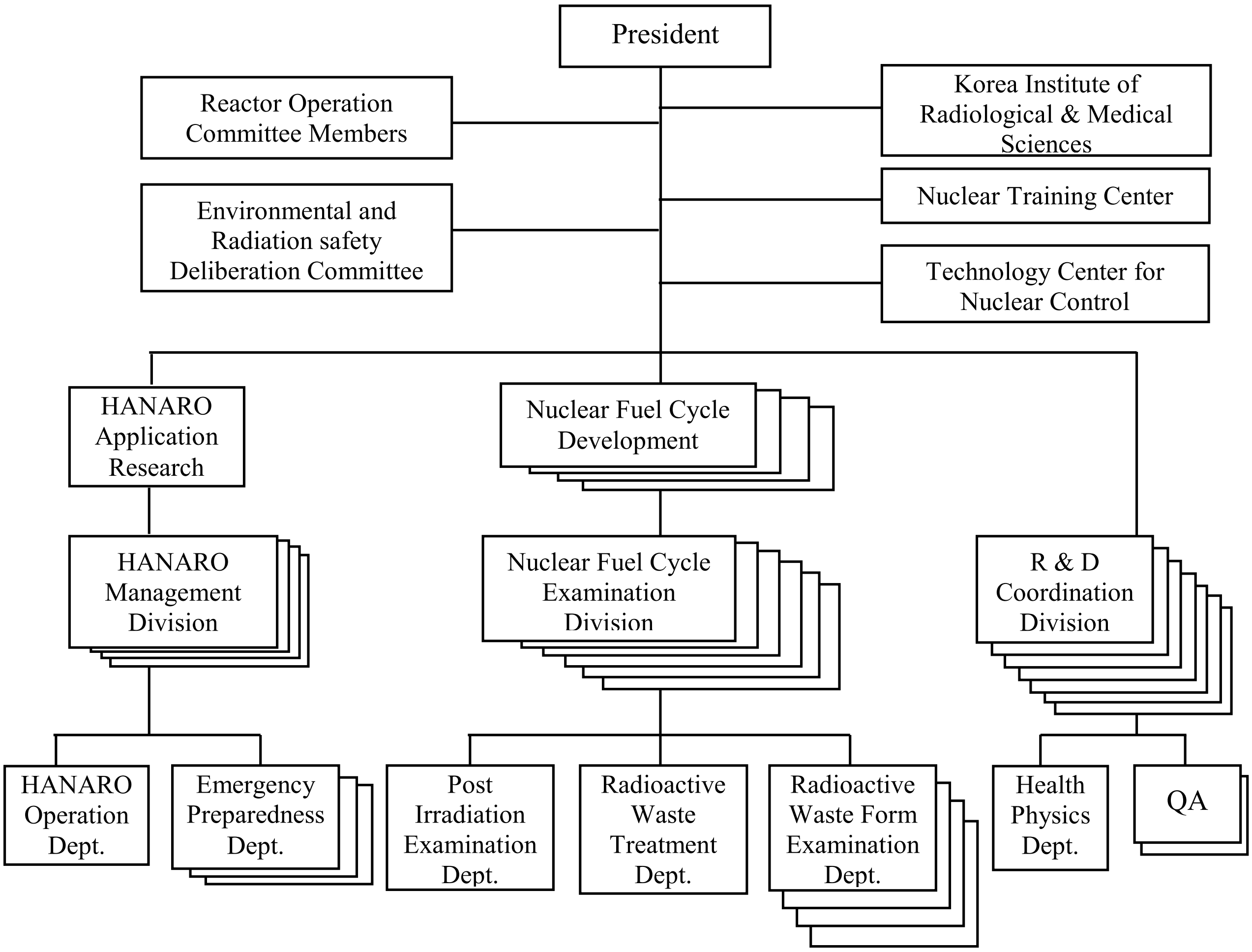


Figure F.2-3 Organization chart of the KAERI

3) Radioactive waste treatment and storage facility

Eleven staff members of the Nuclear Fuel Cycle Examination Division, Nuclear Fuel Cycle Development Center, KAERI operate the radioactive waste treatment facility and the storage facility. They operate the equipment related to evaporation, bituminization, solar evaporation, and compression (only for solid waste), cementation, decontamination, and ventilation. The KAERI is furnished with two storage facilities for LILW. For radiation safety management, 2 managing staff members are manned at the facility, and environmental radioactivity management and quality assurance are performed with the support of the related expert departments in the KAERI.

Financial resources

All facilities of the KAERI are in operation with the organizational project fund budgeted by the government.

F.2.3 Nuclear fuel fabrication facility

Human resources

The KNFC has the Radiation and Environment Management Department for the radiation safety, radioactive waste and nuclear material management under the Fuel Production & Technical Division. The Radiation and Environment Management Department consist of the Radiation & Environment Safety Section and the Safeguards Section. The Radiation & Environment Safety Section consists of 6 staff members responsible for health physics, personal dose management, environmental radiation/radioactivity measurement and management, and radioactive material transport, and the Safeguards Section has 9 staff members responsible for nuclear material accountancy, safeguards, and waste management, carry out the safe treatment and storage of waste generated from the nuclear fuel fabrication facility, and the safe management of radiation. The operation and maintenance of radioactive waste treatment facilities is carried out with the support of 16 experts belonging to the subsidiary company (Figure F.2-4).

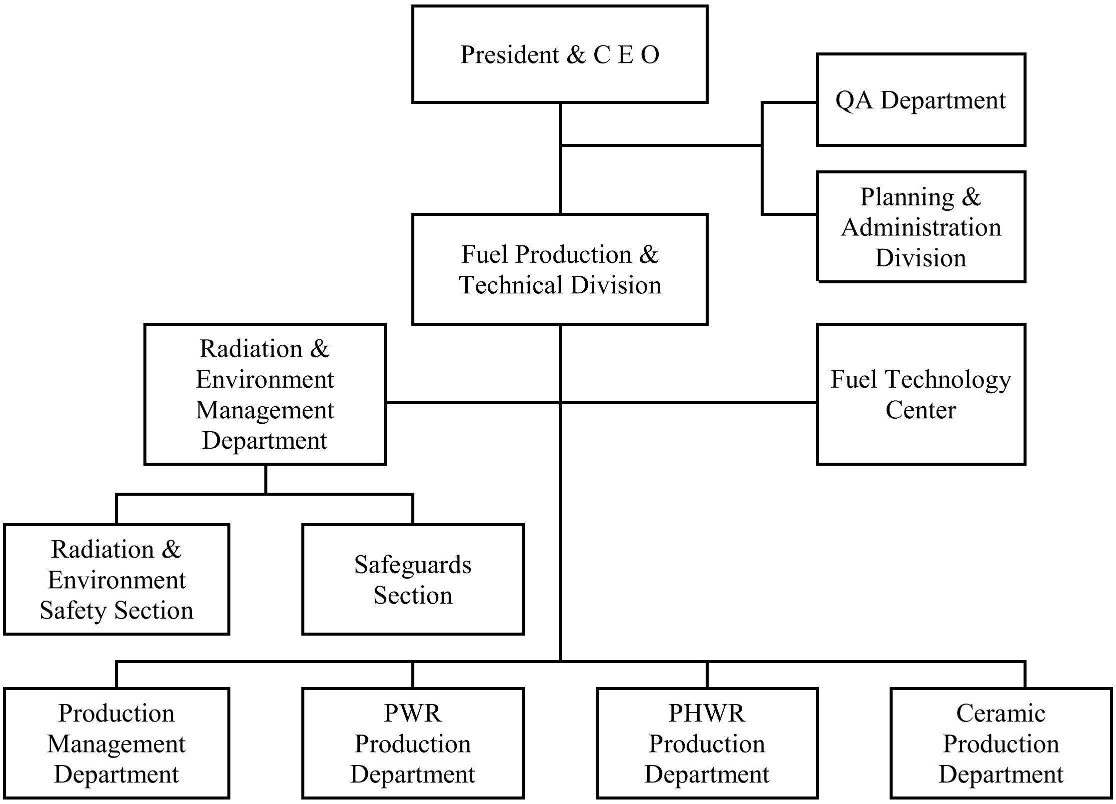


Figure F.2-4 Organization chart of the KNFC

Financial resources

Under the current Electricity Business Act, the radioactive waste generator at the point of delivering radioactive waste into the disposal area shall bear necessary expenses for radioactive waste management. In order to lessen the economic burden induced by the raise of waste management funds in one lot in waste delivery, the KNFC saves the money for waste management every quarter according to the quantity of generated waste. The facility operation fund budgeted every year is appropriated for radioactive waste treatment and management.

F.2.4 Radioisotope waste storage facility

Human resources

The NETEC, an affiliate of the KHNP, consists of 2 offices, 1 center, and 16 departments/groups, as shown in Figure F.2-5. There are a total of about 170 employees at NETEC, including 20 who are engaged in duties related to the operation of the radioisotope waste storage facility.

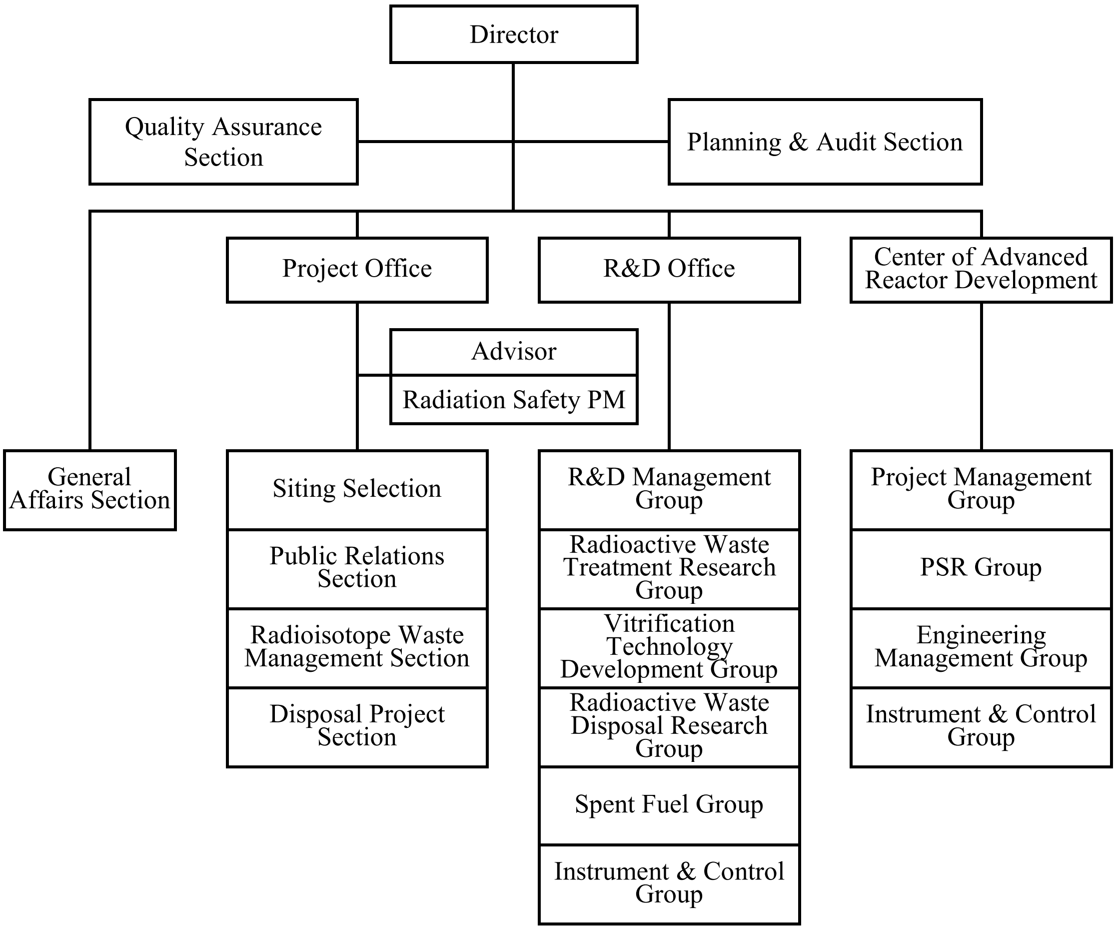


Figure F.2-5 Organization chart of the NETEC

The Radioisotope Waste Management Section operates and manages a radioisotope waste storage facility, and is entitled to safely store and manage all radioisotope waste with the cooperation of other sections.

Financial resources

The Electricity Business Act prescribes that the radioisotope waste generator should bear incurring management expenses related to waste treatment and disposal at the point of delivering waste to the disposal licensee, the KHNP.

F.2.5 Securing of financial resources for management after the closure of a radioactive waste disposal facility

The disposal facility needs an institutional management even after its closure and the expenses to be incurred thereby shall be borne by the radioactive waste generator. Accordingly, the fund for institutional management is also included within the allotment of financial resources for radioactive waste management work, as specified in the Enforcement Decree of the Electricity Business Act.

F.3 Quality assurance (Article 23)

F.3.1 Quality assurance policies

Under the Atomic Energy Act, the radioactive waste storage, treatment and disposal facility and its associated facilities are defined as 'disposal facility'. The radioactive waste treatment, exhaust and storage facility located in the nuclear power plant, the radioactive waste management facility in the research reactor facility, and the radioactive waste management facility in the fuel fabrication and conversion facility are considered to form a part of the reactor and related facilities, the research reactor facility, and the fabrication and conversion facility, respectively. It is provided that, in establishing quality assurance programs by the installer and operator of each facility comprising radioactive waste management facilities as well as the disposal facility, related regulations for nuclear facility and operation should apply *mutatis mutandis*. In accordance with the Atomic Energy Act, the facility constructor and operator should formulate a quality assurance system, and establish and implement a quality assurance program in order to ensure systematic quality assurance activities in every stage of the design, procurement, manufacturing, construction, commissioning, operation, maintenance, and decommissioning of a radioactive waste management facility.

According to this provision, the applicant for a permit to construct or operate the radioactive waste management facility shall submit a quality assurance program manual for the construction or operation of related facilities, accompanies by the application for construction/operation permit, to the MOST for approval. They must comply with the quality assurance program during the construction and operation of each facility.

F.3.2 Quality assurance programs

As for the framework of quality assurance programs, the Enforcement regulation concerning the technical standards of reactor facilities, etc. (quality assurance criteria for reactor facility construction and operation) stipulates 18 criteria for quality assurance programs as follows:

- Organization,
- Quality assurance program,
- Design control,
- Procurement document control,
- Instructions, procedures, and drawings,
- Document control,
- Control of purchased material, equipment, and services,
- Identification and control of materials, parts, and components,
- Control of special processes,
- Inspection,
- Test control,
- Control of measuring and test equipment,
- Handling, storage, and shipping,
- Inspection, testing, and operating status,
- Nonconforming materials, parts, and components,
- Corrective action,
- Quality assurance records, and
- Audits.

A comprehensive evaluation for the adequacy, effectiveness and practicability of a quality assurance program is performed during the process of the safety review of the program in accordance with the Atomic Energy Laws, and the relevant technical standards.

F.3.3 Implementation and assessment of quality assurance programs

The KHNP, a constructor and operator of nuclear facilities, requires all contractors who participate in the construction and operation of nuclear facilities to prepare and implement a quality assurance program pursuant to the Atomic Energy Laws. The KHNP is responsible for establishing an integrated system for all participants to implement quality assurance program.

All contractors involved in nuclear projects, including the design, manufacturing, construction, maintenance, and decommissioning are required to perform quality-related activities in accordance with regulatory requirements. All contractors' quality-related activities are verified by the KHNP. The licensee and its major contractors participating in each phase of nuclear facilities are subject to the safety review and regulatory inspection of the KINS.

An evaluation for the implementation and effectiveness of the quality assurance program is periodically conducted by the KHNP to verify whether quality assurance activities are being properly implemented by the KHNP per se, as well as the contractors and sub-contractors, in accordance with the quality assurance program. The method of assessing the implementation of a quality assurance program includes quality control inspection, quality assurance audits, quality assurance trend analysis, and effectiveness evaluation for the quality assurance program, in a way that.

- Quality Control Inspection is conducted by a qualified inspector on the basis of the pre-established inspection plan. Before starting the quality control inspection, the inspector selects the inspection points (witness point and hold point) in the inspection plan and then executes the inspection.
- Quality Assurance Audit is periodically conducted by a qualified auditor for both internal organizations and external contractors considering the characteristics of their activities.
- Quality Assurance Trend Analysis is conducted to revise the quality assurance program and to improve the quality assurance system. This is achieved by establishing recurrence-preventive measures and improvement plans from the investigation of causes for non-conforming items and corrective actions that are identified during the quality control inspection and quality assurance audit.
- Effectiveness evaluation for a quality assurance program is periodically conducted by the quality assurance organization to maintain the quality assurance program is suitable for the features of nuclear facilities. Major considerations given to the evaluation for quality assurance programs include, inter alias, the issuance and amendment of related regulatory requirements, corrective actions or recommendations made by the regulatory body, changes in quality assurance policy, the revision of applied technical standards, and the results of a self-quality assurance audit.

The responsible person of the quality assurance organization takes proper measures in time by reporting to a top manager the important issues resulting from the evaluation of the implementation and effectiveness of the quality assurance program. Further efforts are made to maintain the quality assurance program as a living document by revising the corresponding quality assurance program, if necessary, after such evaluation of effectiveness.

F.3.4 Regulatory control activities

The regulatory control activities concerning quality assurance are conducted through reviews and audits by the KINS, as entrusted by the Government. These activities are performed based on the Atomic Energy Laws, the safety review guidelines and the quality assurance guidelines for nuclear facilities as prepared by the KINS.

The safety review of quality-related activities is conducted to verify whether the quality assurance system is sufficient to implement the quality assurance program in accordance with the Atomic Energy Laws and the safety review guidelines. It also verifies whether the quality assurance procedures for the implementation of the program are properly established and practicable. The objectives of regulatory inspections for quality-related activities are to verify whether each organization participating in the design, manufacturing, construction, and operation of nuclear facilities have performed quality-related activities in accordance with the quality assurance program, and whether the program has been effectively implemented so as to ensure the safety and reliability of nuclear facilities.

In order to encourage voluntary and active quality assurance activities from licensees, the KINS has developed the “Guidelines for the Assessment of Licensee’s Quality Assurance Activities”, and is carrying out distinctive regulations, based on trend analysis of the accumulated regulatory inspection results for the quality assurance activities of the licensees. Under the “Quality Assurance Auditor Qualification System” for regulatory personnel, which was established by the KINS, qualified auditors who have completed the specified educational and training courses currently conduct quality assurance audits.

On the other hand, based on IAEA-TECDOC-1090, “Quality Assurance within Regulatory Bodies”(1999), the KINS has established quality assurance program for regulatory bodies to improve public trust and fairness of regulatory activities, and is developing the Quality Assurance Guideline for regulatory activities necessary to implement it.

F.4 Operational radiation protection (Article 24)

F.4.1 Regulations and requirements

The regulations and requirements related to radiation protection applicable to nuclear facilities which generate spent fuel and radioactive waste are specified in the Atomic Energy Act, the Enforcement Decree of the same Act, the Ordinance of the MOST and the Notices of the MOST, and can be summarized as follows:

Atomic Energy Act

The Atomic Energy Act prescribes basic matters on radiation protection to be applied to nuclear facilities, as follows:

- Provisions on protective measures against radiation hazards that keep radioactive material release and occupational radiation exposure as low as is reasonably achievable (ALARA),
- Provisions on safety measures related to operations stipulating the necessary actions to be taken for protecting human body, materials, and the public from radiation hazards which may accompany the operation of nuclear facilities,
- Provisions on the designation of exclusion areas to protect human body , materials, and the public from possible radiation hazards, in establishing nuclear facilities,
- Criteria for the registration of businesses related to personnel dosimetry services for any person who is employed in or who has access to nuclear facility, and
- Requirements for the education and training of the workforce involving radiation exposure.

Enforcement Decree of the Atomic Energy Act

The Enforcement Decree of the Atomic Energy Act specifies the detailed requirements for implementing basic matters on radiation protection referred to in the same Act, as follows:

- Radiation dose limits related to radiation protection. The dose limits defined are as enumerated in Table F.4-1,
- Detailed provisions on safety measures related to operation, stipulating the necessary action to be taken for protecting human body, materials, and the public from radiation hazards, which may accompany the operation of nuclear facilities,
- Provisions to minimize the exposure of workers employed in nuclear facilities, persons who have frequent access to the said installations, and the public living in nearby regions,
- Physical examination and exposure control for people who have access to nuclear facilities,
- Provisions on the measurement of radiation dose and contamination levels for any place, which is in a radiation hazard area within nuclear facilities, and the functional testing of dosimetry service providers,
- Detailed provisions necessary for implementing protective measures against radiation hazards, such as actions to be taken for any person suffered from radiation hazards, relevant reports, etc., and
- detailed provisions on the education and training of persons engaged in

radiation work or who have access to controlled areas.

Table F.4-1 Dose limits

Items	Radiation worker	Frequent access personnel /worker for transport	The public [2)]
Effective dose limit	100 mSv for five consecutive years [1)] and not exceeding 50 mSv/y	12 mSv/y	1 mSv/y
Equivalent dose limit – lens of the eye – skin, feet & hands	 150 mSv/y 500 mSv/y	 15 mSv/y 50 mSv/y	 15 mSv/y 50 mSv/y

1) "Five consecutive years" means the 5-year period from any given year (for example, 1998～2002). This calculation is not applicable to any period before 1998.

2) As for the general public, the value of over 1 mSv in a single year is acceptable within the limit of not exceeding 1 mSv per year for the average of values for five consecutive years.

※ Concerning a person who is proven to be pregnant among radiation workers and persons who restrictively or temporarily use any radioactive isotope among the public, it is necessary to comply with the standards prescribed and notified by the MOST.

Ordinance of the Ministry of Science and Technology (MOST)

The MOST Ordinance includes the Enforcement Regulations of the Atomic Energy Act, the Regulation Concerning the Technical Standards of Reactor Facilities, etc., and the Regulation Concerning the Technical Standards of Radiation Safety Management, etc., and prescribes detailed procedures and methods necessary for implementing the Atomic Energy Act and the Enforcement Decree of the same Act, and the detailed technical standards thereof.

- Detailed provisions on radiation protection equipment for protection against radiation exposure in the reactor and related facilities, and nuclear fuel cycle facilities, (technical standards of reactors)
- Detailed provisions on the particulars about and the actions taken for controlled areas within nuclear facilities, (technical standards of reactors; technical standards of radiation)
- Detailed provisions on radiation protection for persons who are engaged in radiation work, and persons who have frequent access to nuclear facilities, (technical standards of reactors)
- Detailed provisions on measures related to radiation protection plans for reactor and related facilities, and nuclear fuel cycle facilities, (technical

standards of reactors)

- Detailed provisions on the assessment and control of radiation dose for persons who are engaged in radiation work, and persons who have frequent access to nuclear facilities, (Enforcement Regulations)
- Detailed provisions on the place and personnel for measuring radiation dose and contamination level, (Enforcement Regulations)
- Provisions on technical capabilities for personal dosimetry, (Enforcement Regulations)
- Detailed provisions on the substance and duration of education and training for persons who are engaged in radiation work, and persons who have access to controlled areas, (Enforcement Regulations)
- Details of physical examination for persons who have access to nuclear facilities. (Enforcement Regulations).

Notices of the Ministry of Science and Technology

The Notices of the MOST present the detailed technical standards of radiation protection specified in the Atomic Energy Act, the Enforcement Decree of the same Act, and the Ordinance of the MOST, and the principal notices related to radiation protection are as follows:

- Criteria for radiation protection, etc.
- Provisions on the assessment and control of individual radiation dose
- Provisions on the criteria for the registration of a dosimetry service and its inspection
- Provisions on the education and training for radiation safety management, etc.

The criteria for radiation protection, etc. concretely define not only the constraints and limits in radiation protection such as the allowable surface contamination level, release control standards, annual limit on intake (ALI), derived air concentration (DAC), and design dose standards of shields, but also the details of the method to apply dose limits and the dose limitation and working procedures in emergency radiation work. Additionally, in order to prevent any environmental hazard, the criteria applicable to the design of corresponding facilities are specified.

F.4.2 Radiation protection framework by stages of nuclear facility management

ALARA activities for workers and the public

The KHNP incorporates the following radiation protection principles in the design and construction of nuclear facilities, for assuring ALARA and maintaining the radiation doses to workers and the general public within the applicable limits:

- ○ Radioactive equipment to be installed separately in a shielded room with a partition,
- ○ Installation of shields to fully attenuate radiation from pipes and equipment containing large amounts of radioactivity,
- ○ Use of remote controlled equipment and automatic equipment,
- ○ Installation of ventilation facilities in areas of potential air contamination,
- ○ Installation of a continuously operating radiation monitoring system in nuclear facilities, and
- ○ Appropriate zone classification and access control.

1) Radiation protection training

The Procedure prescribes that radiation workers and the personnel having frequent access to nuclear facilities should take appropriate radiation protection training courses in both the theoretical and practical aspects to acquire radiation-handling skills needed for radiation work, or for access to controlled areas. The curriculum is classified into the following courses:

- a course for radiation workers (First 20 hours),
- a course for personnel of frequent access (First 4 hours), and
- a refresher course (Radiation workers: 6 hours, Personnel of frequent access: 4 hours).

The training duration is assigned differently for each course in consideration of the specialty of each course. Educational subjects include fundamentals of radiation protection, health effects of radiation, access procedures to controlled areas, and emergency preparedness. Additional subjects include radiation exposure control, contamination control, waste management, and the use of instruments and protective equipment. Personnel who have taken the training courses shall be evaluated by proper means including a written examination. If the results of the evaluation are above a pre-established level, personnel will be qualified.

2) Management of radiation work

It is provided that any person who intends to have access to controlled areas and to perform radiation work should obtain approval in advance in the form of a radiation work permit. This is prepared separately in consideration of the radiation work type, the radiation level, and the working area conditions. For the issuance of a radiation work permit, the radiation safety control personnel evaluate the expected dose in consideration of the working environment and conditions if there is no problem in the result of checking the work applicant's records of radiation dose, protection training, and physical examination, and to further impose special conditions on the work applicant if necessary, giving work permission.

3) Dose reduction

The KHNP establishes and operates target values for reducing occupational radiation exposure according to classified categories, such as annual collective dose, collective dose during the planned preventive maintenance period, and job-specific collective dose. It is provided that any radiation work should be conducted following the plan, as established before undertaking the work, and causal analysis for excesses over the expected dose, if any, should be performed through ALARA post-examination after the work is completed, so that its result can be applied to any similar work in the future.

Individual dose control in normal operations

1) Personnel dose control

The KHNP established a target dose limit for radiation workers at 80% of the legal limit, and controls radiation doses to remain within the target dose limit. It is prescribed in the procedures that any person whose annual dose reaches the target value shall not perform any more radiation work during which said worker is expected to be additionally exposed above the target value, unless the approval of the person responsible for the operation of the facility is given or proper measure is taken.

2) Personnel dosimetry service and performance testing

All persons engaged in personnel dosimetry services, including the KHNP, transacts dosimetry services with approval of the MOST, and monthly or quarterly distribution, collection, and reading of thermo-luminescence dosimeters (TLDs). The results should be given to the individuals in question and reported to the government on a quarterly basis, and the calibration and performance verification for TLD reader are conducted every 6 months. TLD periodically undergoes a standardized performance inspection and a periodic inspection that meets international criteria in order to secure objectivity and reliability in undertaking personnel dosimetry.

Preventive measures aganist unplanned/uncontrolled release

1) Legal requirements

The Ordinances of the MOST provides for a requirement that the reactor and related facilities and nuclear fuel cycle facilities should be equipped with a measuring device for radioactivity concentration or indirect measuring device in drain outlets or ventilation system outlets, and prescribes that effluent monitors should comprise an automatic alarm device. Additionally, it is provided that the gaseous and liquid treatment systems have treatment capacity to satisfy the release control limits on the restricted area boundary, and radioactive waste should not be released from any other place than the designated gaseous and liquid effluents. The concentration of radioactive materials in the air and water released to the environment should not exceed the release control limits on the restricted area boundary and should be monitored by the process of a radioactivity monitoring system for air and liquid effluents to meet these limits.

2) Measures in the design stage

In the design stage for the implementation of legal requirements to prevent any unplanned/uncontrolled release, it is necessary to classify each system as a radioactive system, non-radioactive system, or potential radioactive system, and to install a process radiation monitor for checking radioactivity levels or leakage by systems. The effluent radiation monitor and sampling equipment shall be furnished in the main release path, if any, and the environmental release of effluents that hold radioactivity exceeding the legal limit shall be controlled through the securing of an interlock function to automatically suspend release in alarming. Additionally, in the design stage, there is a need to check every effluent release path and spot, and to create a design that permits the prevention of possible effluent release in any other path and spot than that intended, during the operation of a nuclear facility.

3) Measures in the operation stage

Before starting operation of a nuclear facility, the operator formulates an effluent management plan, with due regard to the characteristics of the facility, which includes detailed procedures of effluent monitoring and management, sampling planning, etc. Nuclear facilities must release all liquid and gaseous effluents according to the prearranged plan. In case any unplanned/uncontrolled release is made by mechanical malfunction or by human mistake, however, the operator shall evaluate or estimate the environmental efflux through post-assessment, and include the details of any action taken in the report to be periodically submitted to the regulatory body. The Notices of the MOST prescribes that, if any radioactivity exceeding the specified constraints is released from a nuclear facility into the environment, such fact should be reported to the regulatory body within 24 hours, and related documents should be submitted within 30 days.

F.4.3 Release restriction system for nuclear facilities

The Atomic Energy Act prescribes that the permission for construction and operation of nuclear facilities should be given on condition that the prevention of radioactive hazards to the public health and the environment is ensured.

Accordingly, the Enforcement Decree of the Act stipulates that the concentration of radioactive materials released from nuclear facilities should meet not only the limits defined by the MOST but also the limits defined by the said Ministry for other radioactive hazard prevention. In the Ordinances of the MOST, it is stipulated that the volume of radioactive material released should be minimized with the formulation of the radioactive waste management plan, and environmental impacts should be controlled to maintain as low as is reasonably achievable.

The Enforcement Decree of the Atomic Energy Act and Notice No. 2001-2 of the Ministry of Science and Technology prescribe the discharge limits of gaseous and liquid radioactive effluents to be released from nuclear facilities into the environment, along with annual dose constraints of the population living around nuclear facilities.

- Annual dose constraints for gaseous effluents on the restricted area boundary by a unit of nuclear facilities, which are specified in the Notices of the MOST, are as follows:
  - air absorbed dose by gamma rays: 0.1 mGy/y
  - air absorbed dose by beta rays: 0.2 mGy/y
  - effective dose from external exposure: 0.05 mSv/y
  - skin equivalent dose from external exposure: 0.15 mSv/y
  - organ equivalent dose from internal exposure to particulate radioactive substances, etc.: 0.15 mSv/y.

- Annual dose constraints for liquid effluents on the restricted area boundary by a unit of nuclear facilities, are as follows:
  - effective dose: 0.03 mSv/y
  - organ equivalent dose from internal exposure: 0.1 mSv/y.

- Annual dose constraints on the restricted area boundary per site where multiple units are operating, are as follows:
  - effective dose: 0.25 mSv/y
  - thyroid equivalent dose : 0.75 mSv/y.

Actually, nuclear facilities are in operation on their own targets more restrictive than the aforesaid legal limits, and some facilities also apply the derived release limits based on the dose limits in consideration of convenience in a field application. Whether related limits are met is verified with periodic inspection or the examination of regular reports submitted to the regulatory body.

Accordingly, the KHNP and KNFC discharge gaseous or liquid effluents into the environment after confirming that the concentration of released effluent are less than the prescribed discharge limits. Table F.4-2 and Table F.4-3 represent the actual status of annual release of gaseous and liquid radioactive waste recently generated from nuclear power plants and fuel fabrication facilities that do not affect the environment and the population.

The radiation dose to and its effect on the individual around nuclear facilities are assessed monthly by using the Off-site Dose Calculation Manual (ODCM). The assessments are based on the radioactivity of released liquid and gaseous effluents, atmospheric conditions, metabolism, and social data including agricultural and marine products of the local community within a radius of 80 km.

Table F.4-2 Annual release of liquid and gaseous radioactive waste from NPPs

Unit: TBq

Type of Effluents \ Year		1998	1999	2000	2001	2002
Kori #1 & 2	Liquid	2.05E-05	4.51E-06	1.36E-05	1.96E-05	2.87E-05
	Gaseous	9.90E-01	1.73E+00	4.16E-01	6.20E+00	2.36E+00
Kori #3 & 4	Liquid	Less than LLD	Less than LLD	9.14E-07	Less than LLD	Less than LLD
	Gaseous	2.26E+00	1.77E+00	1.33E+00	1.63E+00	6.54E+00
Yonggwang #1 & 2	Liquid	Less than LLD	Less than LLD	6.84E-08	Less than LLD	Less than LLD
	Gaseous	6.49E+00	6.74E+00	3.42E+00	3.61E-02	8.66E+00
Yonggwang #3 & 4	Liquid	Less than LLD	Less than LLD	1.95E-05	1.39E-05	1.29E-05
	Gaseous	7.86E-03	1.09E-02	7.98E-03	5.18E-02	6.28E-03
Ulchin #1 & 2	Liquid	1.67E-04	1.93E-05	2.17E-05	1.17E-05	7.40E-05
	Gaseous	6.04E-02	4.54E-02	3.25E+00	8.10E+00	2.03E+01
Ulchin #3 & 4	Liquid	Less than LLD	Less than LLD	8.23E-06	1.59E-05	3.37E-05
	Gaseous	1.09E-02	1.83E-01	5.34E-02	2.54E+00	2.44E+00
Wolsong #1 & 2	Liquid	Less than LLD	Less than LLD	2.13E-04	2.55E-04	2.34E-04
	Gaseous	1.01E+02	6.19E+01	3.92E+01	9.07E+01	2.34E+01
Wolsong #3 & 4	Liquid	Less than LLD	Less than LLD	7.62E-05	1.14E-04	1.49E-04
	Gaseous	6.03E+01	4.22E+01	1.37E+01	4.01E+01	1.08E+02

-LLD: Low Limit of Detection

-Not including tritium

Table F.4-3 Annual release of liquid and gaseous radioactive waste from the nuclear fuel fabrication facility

Unit: MBq

Year	1998	1999	2000	2001	2002
Liquid	3.16E+01	2.69E+01	2.25E+01	1.89E-01	1.25E+01
Gaseous	5.97E-01	7.17E-01	3.87E-01	7.85E-01	6.62E-01

F.4.4 System of implementing complementary measures against unplanned/uncontrolled release from nuclear facilities

Monitoring plan

Radioactive waste generated from abnormal conditions undergoes monitoring so that its release be kept below or within the limits specified by the Atomic Energy Act (concerning the general public's dose limit) and the Notices of the MOST (concerning the prevention of hazards to the environment), through sampling, sample analysis, and environmental impact assessment before its release.

Action Plan

The radioactive waste management facility, which is furnished with a proper radiation monitoring system in the expected radioactive material release path, is subject to formulate and implement various programs to take appropriate measures suitable to such an occasion that uncontrolled release of radioactive materials occurs. The facility shall make reports under the incidents reporting scheme, should there be any effluent of uncontrolled radioactive materials, taking proper action with the support of the facility operator and the emergency response organization. Subsequently, necessary actions shall be taken after assessments for individuals/the public dose and released volume of radioactive waste according to radiological data from the process and environment radiation monitoring system and a reasonably acceptable scenario. The existing action procedures must be complemented through analysis of the path and cause of the uncontrolled/unplanned radioactive material release.

F.5 Emergency preparedness (Article 25)

F.5.1 Regulations and requirements

Radiological emergency preparedness is based on the Atomic Energy Act and the Basic Law of Civil Defense that stipulates a national preparation against radiological accidents. Under the Basic Law of Civil Defense, the MOST is responsible for formulating a master plan at the interval of every 5 years and a yearly implementation plan based on the master plan. The local governments and agencies concerned yearly make a detailed implementation plan of their own, according to the master plan and the yearly implementation plan. The emergency plan for facilities related to spent fuel and radioactive waste is made based upon the emergency plan devised by the operator of the nuclear facility as above.

F.5.2 National radiological emergency response system

The radiological emergency response scheme is composed of the Central Response Committee which is chaired by the Prime Minister, the Central Response Headquarters, the Local Response Headquarters, the KHNP-Emergency Operation Center, and the KINS-Technical Support Center, as shown in Figure F.5-1.

The national government is responsible for the control and coordination of radiological emergency response. The Local Response Headquarters, established by the provincial governments concerned, deploys actions to protect the people and properties under their jurisdiction. If an accident occurs, the Local Response Headquarters sets up an Emergency Medical Center and designates medical institutions to provide prompt treatment for persons overexposed to radiation.

When an accident occurs, the KHNP and the operator of a nuclear facility are responsible for organizing an Emergency Operation Center and for taking measures to mitigate the consequences resulting from the accident, to restore installations, and to protect on-site personnel.

If any accident occurs in nuclear facilities, the operator shall immediately report the emergency situation to the MOST and the local government, in accordance with Notice No. 01-44 of the MOST (entitled "Regulation concerning the report on the incidents and accidents of nuclear facilities"). The operator is also responsible to provide the local government with advice and information on protective measures for the public in radiological emergencies. The operator maintains contracts with designated hospitals near the site of the nuclear facility to provide systematic emergency medical services to the emergency staff and the population in the vicinity of the region.

The KHNP Radiation Health Research Institute performs research on radiation and health physics, along with the physical examination of persons engaged in a nuclear facility and the population of the vicinal region, and provides a specialized radiation emergency medical service in radiological emergencies.

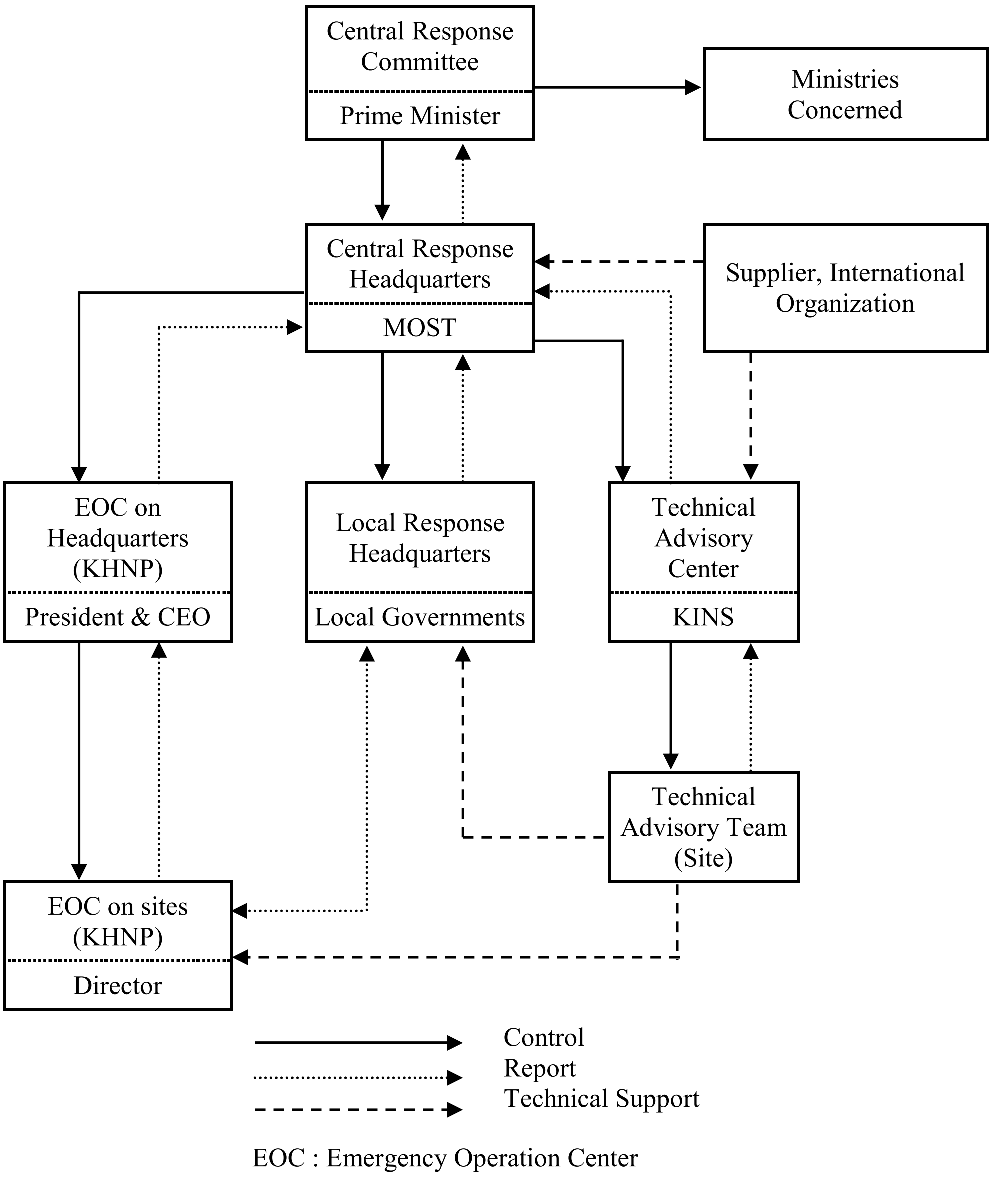


Figure F.5-1 National radiological emergency response system

F.5.3 Implementation of emergency preparedness measures

A radiological emergency plan shall be formulated in accordance with the Atomic Energy Act and the Basic Law of Civil Defense so as to be applied during the operation of related facilities, and the emergency response organization and facility must be secured according to the plan. Such emergency organization and facility secured must undergo periodic inspection for their activation in emergencies, and improvement if necessary. Thus, such requirements shall be satisfied to cope with any emergency accident that may occur in nuclear facilities, or Korean territory, or neighboring countries.

F.6. Decommissioning (Article 26)

F.6.1 Regulations and requirements

Under the Atomic Energy Act and the Enforcement Regulations of the same Act, the operator, with the intention of decommissioning a nuclear facility, shall submit a decommissioning plan and obtain approval from the MOST.

A decommissioning plan prepared shall include the following:

- Methods of decommissioning the nuclear facilities, and work schedule
- Methods of removing radioactive materials and methods of decontamination
- Radioactive waste treatment and disposal methods
- Necessary measures against radioactive hazards
- Assessment of environmental impact and measures for its minimization
- Quality assurance program with regard to the decommissioning
- Others, as specified by the MOST.

In the decommissioning plans of the KRR-1 & 2, description was made on additional information with regard to the conditions and radiological state of the facilities, the estimated radioactive waste generation, manpower required for decommissioning, expected dose of workers in normal operation and abnormal operation conditions, and the scheme of radiation safety, etc.

F.6.2 Human and financial resources

KRR-1 & 2 and uranium conversion facility

1) Human resources

For the decommissioning of KRR-1 & 2 and the uranium conversion facility to be implemented in Korea, the KAERI as the operator of the research reactors carries out a project for the decommissioning of the reactors and at same time the relevant research and development of technologies and their demonstration. For this, the KAERI organizes a division of “Decontamination and Decommissioning Technology Development”.

There are a total of 22 workers in this division, including the project manager. Additionally 3 external researchers, retirees from the KAERI with experience in reactor operation, are entrusted with the safe dismantling of the reactor.

At the decommissioning site, the number of workers totals 14 personnel, consisting of 3 for radiation safety, 5 for workers, 1 for radioactive waste management, 1 for quality control and 4 for security purposes. External private companies supply all the above manpower.

2) Financial resources

KRR-1 & 2 were constructed and had been operated by the KAERI, and funded by the Korean government. As such, the government provides all financial resources for the decommissioning of these reactors. The KAERI reported a master plan for the decommissioning of these reactors to the MOST in 1996 and started the project for decommissioning these reactors in 1997 with the financial support of the government.

The uranium conversion facility was also operated by the KAERI, and funded by the Korean Government. The project for the decommissioning of this facility is under way with the government's financial support.

Nuclear power reactor

1) Human resources

In Korea, there is no power reactors yet that requires decommissioning. As for Kori #1, the oldest nuclear power plant in Korea of which its design lifetime will be up to 2008, the KHNP, the operator, has an internal policy to extend its lifetime, and thus the decommissioning of the existing nuclear power plant is not anticipated within the next 10 years.

Now, the KAERI and the private companies participate in the projects for the decommissioning of the research reactors and the uranium conversion facility according to the strategies of the KAERI for training of experts and transfer of technologies to private companies. It is expected that the expertise will become useful in the decommissioning of power reactor facilities later.

2) Financial resources

In order to secure stable resources, the operator of the nuclear power reactors is now reserving the expenses for the decommissioning and waste management as part of the electric power rate.

F.6.3 Radiation protection

In the decommissioning of KRR-1 & 2 and uranium conversion facilities, the same regulations for the operation of the corresponding facilities can be applied to radiation protection and safety. The regulation is the Notices on the criteria for radiation safety, the regulation concerning the packaging and transportation of radioactive materials, the guidelines for preparing a report on the assessment of environmental impact, and the provisions on environmental surveillance and impact assessment in the vicinity of nuclear facilities.

F.6.4 Emergency response

In the decommissioning of the KRR-1 & 2, no severe radiological accident due to the breakage of spent fuel is anticipated because all of the spent fuel have already been removed wherefrom.

The exposure rate to workers was estimated for several scenarios of plausible accidents, and the highest possible exposure rate was expected in the case of a drop of equipment, which is highly radioactive because of activation by neutrons during reactor operation. But in this case, it was evaluated that the exposure rate could be minimized by securing enough time to take shelter.

In the guidelines for coping with such radiation accidents, it is defined that all work should be suspended, and all workers should be evacuated from the working area without delay. Further the radiation safety control personnel must control access to the working area and take necessary measures for preventing radioactive materials from spreading.

All decommissioning work is conducted within the building, and indoor air is released through filters set as part of the building ventilation system even in the case of radiation accident, so that radioactive materials are not spread outside the reactor building. Thus it is not necessary for the public adjacent to the reactor facilities to evacuate when such an accident occurs.

But, by way of preparedness against general industrial safety accidents as well as radiation accidents, an emergency network for communication was made with the Korea Institute of Radiological & Medical Sciences (KIRAMS), which is located in the vicinity of the research reactors, for the emergency evacuation of injured workers.

F.6.5 Record keeping

All information related to the decommissioning of research reactors is preserved. The information includes data about the condition and radiological state of the facilities, duration of each work involved, input of manpower and equipment for each work involved, radiation dose of each worker, radioactive waste generation and radioactivity of the waste, the quantity of released radioactive materials, the amount of treated liquid waste, and so on.

In the division of Decontamination and Decommissioning Technology Development, which is an organization responsible for the decommissioning of both the research reactor and the uranium conversion facility of the KAERI, a data base system has been developed as one of the national mid and long term R&D programs.

The final goal of the database system is to record and keep all information obtained from the decommissioning of the research reactors, and to systematically classify and rearrange the gathered information, so that such information can be readily available and easily utilized as basic data in the future decommissioning works of nuclear facilities. Another goal is to extend the database system to the decommissioning of the uranium conversion facility.

G. Safety of Spent Fuel Management

G.1 General safety requirements (Article 4)

G.1.1 Design criteria and requirements

According to the Atomic Energy Act, a comprehensive and systematic safety evaluation shall be performed before the commencement of construction, which provides reasonable assurance that the public health and the environment be protected against radiation hazard due to the construction and operation of a spent fuel management facility. The evaluation results shall be reported to the Minister of Science and Technology as a safety analysis report and radiological environmental impact assessment. Principal design criteria and requirements to be considered to ensure the safety of the facility are as follows:

Site suitability

The location of the spent fuel management facility shall be determined in accordance with consideration of meteorological conditions, hydro-geologic features, earthquakes, ecological characteristics, and the availability of existing water resources.

Safety evaluation

The spent fuel management facility shall be designed so that the leakage of radioactive materials into the environment is restricted by ALARA under the conditions of normal operation and abnormal accident, and that radiation exposure due to accidents including natural disasters can be efficiently mitigated.

Fire and explosion

The spent fuel management facility shall be designed to efficiently maintain its safety function even in fire and explosion accidents.

Prevention of heavy objects from falling

Spent fuel or vault shall be kept safe from detriment due to the falling of any heavy object such as a shipping cask.

Nuclear criticality safety

All equipment of the spent fuel management facility shall be designed to maintain a sub-critical state under any circumstances.

Test and inspection

The spent fuel management facility shall be designed and constructed to permit periodic testing and inspection to check the reliability of its use with sufficient safety margin.

G.1.2 Additional requirements to be considered

Minimization of spent fuel generation

The generation of spent fuel decreases with long-term operation accompanied with the utilization of more highly enriched fuel (4.2～4.5 w/o).

Means to and requirements for protection against radiation/radioactivity hazards

In accordance with the Atomic Energy Act, the spent fuel management facility shall maintain radiation-shielding capacity to sufficiently protect against dose rate due to the handling and storage of spent fuel. The facility shall also prevent the stored fuel from any severe damage, such as criticality.

Biological, chemical, and other hazards

In accordance with the Atomic Energy Act, the spent fuel management facility shall have enough capability to prevent itself from any impact of biological, chemical and other hazards such as fire or explosion, etc.

Requirements for restricting the effects on future generations

The potential risk of radiation exposure, to future generations, in the spent fuel management facility, shall be restricted within the radiation protection level of current application, in accordance with international technical standards.

Abatement of undue burden on future generations

The spent fuel shall be safely managed so that future generations may not be hazardous at a higher level of risk than those imposed upon the present generation, and the waste generators reserve funds for the payment of expenses incurred at the point of generating waste in order not to impose any financial burdens on the future generations.

G.2 Existing facilities (Article 5)

Even though there is no currently existing independent storage facility for spent fuel in the territory of Korea, a full range of safety improvement will be applied to the facility once it will be installed.

Safety evaluation

As the result of safety evaluation of facilities, safety analysis reports shall be submitted to the regulatory body, and an appropriate examination and verification as to whether such results could comply with the related regulations and design criteria should be achived.

Safety improvement

The spent fuel management facility shall be subjected to a comprehensive evaluation for its safety and performance through regulatory inspections by the MOST, and proper action shall be taken within a specified time according to the procedures, if there is any abnormality in safety and performance as the result of the safety evaluation.

G.3 Siting of proposed facilities (Article 6)

The siting of the spent fuel management facility shall be acquired in accordance with the Notice of the MOST (Criteria for the Location of Spent Fuel Interim-storage Facility), and technical standards of site in which the facility is located including various conditions such as demographic, geological and seismological characteristics, the hazard of man-made events induced by flying objects, industry, military activities and dangerous objects. It should also include data on atmospheric diffusion and dilution, natural phenomena such as rainfall, snowfall, lightning, tidal waves and typhoons, river flooding, and other hydrologic characteristics.

G.4 Design and construction of facilities (Article 7)

Prevention of the release and uncontrolled effluents

In order to ensure the safety of spent fuel management facilities, a multi-barrier concept based on the defense-in-depth principle is applied to the design of such facilities. Several basic concepts, particularly, of securing sufficient design margins, the interlock concept, and the multiple barriers concept are being considered to back-up the defense-in-depth principle.

The spent fuel management facility shall be designed to have a capability of properly controlling gaseous and liquid radioactive materials generated in normal operation including the anticipated operational transient, and inhibiting the release thereof, and to restrict the effects to the external environment with the limitation of gaseous and liquid effluent releases to the release control standards.

Application of decommissioning concept

The spent fuel management facility shall be designed to secure safety when decommissioning takes place.

Application of proven technologies

The spent fuel management facility shall be designed and constructed on such basic principle that technologies incorporated in a design shall be duly proven by experience or qualified by testing or analysis.

G.5 Assessment of safety of facilities (Article 8)

Safety and environmental impact assessment for facilities

It is necessary to prepare a safety analysis report and a radiological environmental impact assessment after evaluating safety and radiological environmental impacts for the period of operation for the spent fuel management facility. The safety analysis report contains the result of a comprehensive safety evaluation for the said facility, particularly, the design features of structures, systems and equipment in the facility, radiation protection, and site characteristics.

The radiological environmental impact assessment contains the effects of radiation or the release of radioactive materials from the spent fuel management facility on the population and the environment.

Supplementation of safety evaluation

The examination and verification as to whether the safety evaluation and environmental impact assessments conforms to regulatory requirements and technical standards, etc. should be performed, and matters needing amendment, if any, should be properly modified before the start of facility operation. The results should be reported to the regulatory body.

G.6 Operation of facilities (Article 9)

G.6.1 Technical requirements

The criteria for operating license for a spent fuel management facility are specified in the Atomic Energy Act as follows:

– Technical and economical capabilities necessary for the construction and operation of disposal facilities, etc. shall be secured.

- The location, structure, equipment and performance of disposal facilities shall conform to technical requirements, as prescribed by the Ordinance of the MOST, in such a way that there may not be any impediment to the protection of human body, materials, and the public against radiation hazards caused by radioactive materials.
- There shall not be any impediment to the protection of the public health and the environment against danger and harm due to radioactive materials, which may accompany the construction and operation of disposal facilities, etc.
- The equipment and manpower prescribed by the Presidential Decree shall be secured.

The spent fuel management facility shall be operated with the verification of its conformity to the design requirements through a startup operation, under operating license.

The technical requirements newly amended during the operation of spent fuel management facilities should be reflected in the operation of those facilities.

G.6.2 Determination of operational limiting conditions

The determination of operational limit conditions for spent fuel management facilities shall be described in the operational technical specifications, in accordance with the related laws and regulations.

G.6.3 Operating procedures

The operation, maintenance, monitoring, inspection and testing of facilities shall be made after an operating procedure is prepared on the basis of the operational technical specifications.

G.6.4 Engineering and technical support

The operator of a spent fuel management facility will cooperate with several organizations, which administer engineering and technical support according to facility features in all safety-related fields during its operational lifetime. The KHNP, being responsible for the construction and operation of the spent fuel management facility, receives support in engineering, maintenance, and facility operation from the KOPEC, the KPS and Samchang Enterprise Co., Ltd., and a radiation safety management service company, respectively.

G.6.5 Incident report and document control

The Atomic Energy Act stipulates that the organizations concerned in nuclear-related activities shall immediately take all necessary safety measures and report such measures to the MOST in case of the following:

- If radiation hazards occur,
- If any failure occurs in nuclear facilities,
- If there is any danger to nuclear facilities or radioactive materials due to earthquakes, fires or other disasters,
- If radiation-generating devices and radioactive materials in possession are stolen, lost, or destroyed by fire or any other incident, or
- If radioactive materials in transportation or packaging leak or are destroyed by fire or any other incident.

The Notice of the MOST (regulation concerning the report of incidents and accidents of nuclear facilities) stipulates in detail the incident reporting system. It includes the objects, means and procedures of reporting, and the classification of incidents and accidents. The classification of incidents and accidents is based on the International Nuclear Event Scale (INES) of IAEA.

G.6.6 Procedures of decommissioning plan formulation, supplementation, and review by regulatory body

In accordance with the Atomic Energy Act, any person who intends to decommission a spent fuel management facility must prepare a decommissioning plan, and submit it to the MOST for approval. The decommissioning plan is to be prepared on grounds of necessary measures against radiation hazards, the data obtained during the operation of the facility and data obtained by facility survey at the point of terminating operations.

G.6.7 Emergency plan

The operator of spent fuel management facility shall prepare an emergency plan, and secure and operate emergency response organizations and facilities as the subsequent measures of the plan.

G.7 Disposal of spent fuel (Article 10)

The development of technology related to the disposal of HLW including spent fuel, started in 1997 according to the "Comprehensive Promotion Plan for Nuclear Energy" as specified in the Atomic Energy Act, has been being carried out in stages toward the development of a Korean disposal system as a ten-year program. For this, the study of related technologies in four fields, i.e., the development of disposal system, researches on comprehensive disposal performance evaluation, researches in the characteristics of deep geological environment, and the clarification of chemical properties of radioactive nuclides in a deep disposal environment is now under way. And there is a plan to pursue various fundamental studies necessary for applying the developed design of a disposal system to a local geo-environment in the coming years.

H. Safety of Radioactive Waste Management

H.1 General safety requirements (Article 11)

H.1.1 Design criteria and requirements

According to the Atomic Energy Act, a comprehensive and systematic safety evaluation shall be performed before the commencement of construction, which provides reasonable assurance that the public health and the environment be protected against radiation hazard due to the construction, operation and closure of a radioactive waste management facility. The evaluation results shall be reported to the Minister of Science and Technology as a safety analysis report and radiological environmental impact assessment. Principal design criteria and requirements to be considered to ensure the safety of the facility are as follows:

Site suitability

The location of radioactive waste management facility shall be determined in due consideration of meteorological conditions, hydro-geologic features, earthquakes, ecological characteristics, and the usage of existing water resources. Engineering barriers shall be applied to complement natural barriers if necessary.

Safety evaluation

The radioactive waste management facility shall be designed to keep the radiological impact on workers, the population and the environment, resulting from the release of radioactive materials, along the concept of ALARA, within acceptable limits, in design, construction, operation, closure and monitoring stages, and to sufficiently decrease any radiation exposure caused by accidents including natural disasters.

Radiation protection

Every zone wherein radioactive materials are handled and managed shall be designed according to the requirements that radiation exposure be maintained as low as is reasonable achievable.

Fire and explosion

The radioactive waste management facility shall be designed to prevent the release of radioactive materials outside the facility, upon the occurrence of fire or explosion accidents.

Testing and inspection

The radioactive waste management facility shall be designed and constructed to permit periodic testing for ensuring the safety of its continuing operation.

Closure and post-closure management

The radioactive waste management facility shall be designed and constructed to allow its closure when the performance considered in design reaches a limit or when the normal function of the facility cannot no longer be maintained due to unexpected accident. For the post-closure management of the disposal facility, it is necessary to conduct environmental monitoring of the closed disposal facility and its surroundings that enables inspection and testing to check the safety of this facility for the reasonable duration.

H.1.2 Additional requirements to be considered

Minimization of radioactive waste generation

The generation of radioactive waste has been minimized by the introduction of the state-of-art technology and as the result of R&D activities to reduce the volume of generated waste, as well as the formulation and implementation of programs to minimize the generation of radioactive waste in advance.

The implementation of improved waste treatment procedures and equipment at nuclear power plants in the middle of the 1990's enabled the operator to reduce annual waste generation from 500 drums per unit early in the 1990's to 150 drums per unit in the 2000's. The generation of waste will decrease with continued investment in equipment and effective management. For further reduction of waste generation, vitrification, centrifugation, and selective ion exchange technologies will be implemented.

Means and requirements for protection against radiation/radioactivity hazards

For the effective and safe disposal of radioactive waste, the stability of the disposal site, the disposal facility, and radioactive waste should be maintained, as well as satisfying the waste acceptance criteria specified in the Notice of the MOST (acceptance criteria of low and intermediate-level radioactive wastes). Accordingly, radioactive waste is being treated in conformity with the acceptance criteria.

The performance criteria of the radioactive waste disposal facility are specified as the annual individual risk of less than 1.0E-6. The disposal facility shall be constructed in consideration of the performance criteria for the protection of workers, the general public, and future generations.

Biological, chemical, and other hazards

The radioactive waste to be disposed of should be removed of explosiveness, inflammability, ignitability, toxicity, decomposition and contagious substances. Furthermore, radioactive waste shall be treated to eliminate or reduce the generation of gas, steam and liquid induced by radiolysis, and biological and chemical reactions.

Limitation of possible impact on future generations

In accordance with the Notice of the MOST (performance criteria of low and intermediate-level radioactive waste disposal facilities), impact on future generations from radioactive waste disposal facilities shall be restricted to within the same level as the radiation protection criteria permitted for the current generation.

Abatement of undue burden on future generations

Radioactive waste shall be safely managed so that future generations may not be burdened with a higher level of risk than that imposed upon the present generation, and the waste generators are obliged to reserve funds for the payment of the expenses incurred at the point of generating waste in order not to impose any financial burdens on future generations.

H.2 Existing facilities and past practices (Article 12)

There is no radioactive waste management facility in the Republic of Korea as defined in Article 2 definition of the Joint Convention in Republic of Korea

The last three-years of effort for all radioactive waste management facilities, including nuclear power plants, to improve safety have been reviewed, simultaneously with the ratification of this Convention in September 2002.

Safety evaluation

A safety analysis report prepared on the basis of the result of the safety evaluation of operating nuclear power plants is submitted to the regulatory body for periodic safety review so as to ensure that the relevant regulations and design criteria are satisfied.

Safety improvement

Radioactive waste management facilities undergo a comprehensive evaluation for their safety and performance through periodic regulatory inspections by the MOST, and proper actions shall be taken within a specified time frame according to established procedures if there is any abnormality in safety or performance as the result of safety evaluations. The improvement of waste management facilities is in the process of further reducing the waste volume and improving the stability of waste forms and packages.

H.3 Siting of proposed facilities (Article 13)

H.3.1 Siting procedure

The 'Radioactive Waste Management Measures', which provide the basic strategy for siting the national radioactive waste management facility, are formulated by the MOCIE after consultation with the MOST, and are approved by the AEC through deliberation and resolution at the Commission meeting. The current "Radioactive Waste Management Measures" were resolved at the 249th AEC meeting in September 1998, and Figure H.3-1 depicts the siting procedures specified in the same Measures.

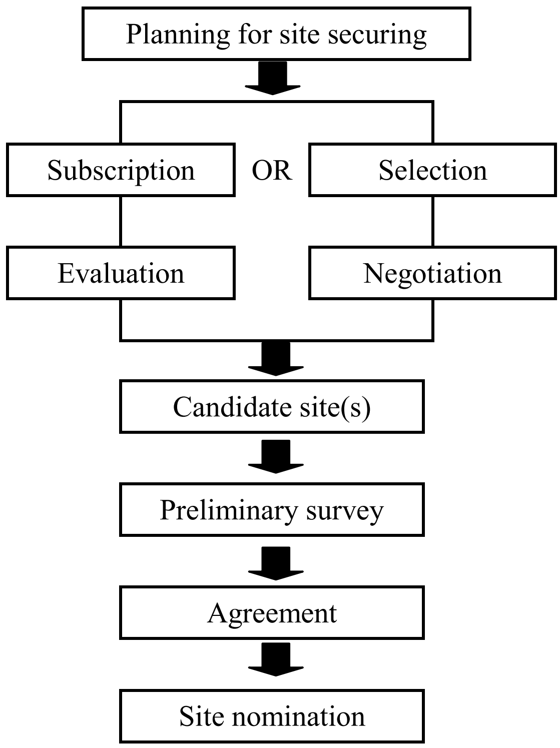


Figure H.3-1 Procedure for site selection of a radioactive waste management facility

The KHNP, which is responsible for the national radioactive waste repository project, shall devise a siting plan under the radioactive waste management measures pursuant to the Electricity Business Act, secure an optimal sites within the given period, manage and safely operate the national radioactive waste management facilities, and obtain an approval from the MOCIE, upon the preparation of a plan which contains the implementation of all provisions in the laws and regulations concerned to secure confidence in the prevention of environmental hazards, the efficient support to neighboring communities, and the enhancement of public trust.

It was decided that the course of siting should be steered to the system of public subscription or project organization-led siting in view of national consciousness and actual circumstances of the national radioactive waste management project. At present, siting is carried out in the project organization-led siting system wherein the KHNP selects the most suitable sites out of many coastal regions in Korea through site survey, and then enters into consultation with the relevant local government, while accepting the local government's voluntary application for subscription, if any.

The preliminary survey of candidate sites aims to demonstrate that the candidate sites satisfy the siting criteria as a site for a national radioactive waste management facility, and to collect necessary data for the comparison of site characteristics of candidate sites in preparation for the final selection of proposed sites. This survey covers fields related to the natural environment such as geology, hydrology and ecology and some limited fields related to human and social environment, and priority shall be given to a survey for ensuring disposal safety. Additionally, this preliminary survey shall include the 'preliminary environmental review' necessary for nomination of proposed sites under the 'Basic Law of Environmental Policy'. When surveys for several candidate sites are completed, the comprehensive evaluation based on the comparison of survey results and the result of consultation with each local government concerned shall be made before the final decision on the proposed sites.

Next, the project organization and the local government (i.e., City or County) to which the proposed site belongs shall make a site agreement that contains important issues with the local community, such as the particulars of site boundaries, regional support programs, site purchase and the compensation and relocation of residents, and preventive measures to prevent environmental pollution. Such an agreement enables the use of legal binding force, through the notarization of documents, etc., and promotes the local community's confidence in its implementation.

While the site agreement is concluded, the MOCIE shall designate and notify the site as the 'final site for the national radioactive waste management facility' through deliberation of the Electric Source Development Promotion Commission after consultation with the relevant Ministers of the central government, pursuant to the "Act on Special Cases Concerning Electric Source Development". The designation and notice of the final site are selective, not compulsory, procedures provided to smoothly and timely promote the repository siting.

H.3.2 Siting-related factors

General factors

It is planned that both a spent fuel interim-storage facility as well as a low and intermediate-level radioactive waste disposal facility will be constructed on the site for the national radioactive waste management facility according to the Radioactive Waste Management Measures. The siting criteria of the site are based on the Notice of the MOST "siting criteria for low and intermediate-level radioactive waste repository" in accordance with the Atomic Energy Act.

The siting criteria provide the technical standards of siting with regard to radiation safety in the aspects of both the natural environment and human and social environment. Many factors such as meteorological conditions, ground surface conditions, geological conditions, surface water, ground water, earthquakes, ecological characteristics, the use of water resources, other land use for industrial or military purposes, and the supplementary emplacement of engineering barriers are covered in the criteria.

Safety evaluation factors

Safety evaluation for a radioactive waste repository is categorized into 'environmental impact assessment' applicable to the non-radiation fields under the Environmental Impact Assessment Act, 'radiological environmental impact assessment' and the 'safety analysis' applicable under the Atomic Energy Act. Such safety evaluation shall be performed for the "approval of electric source development project plans" and the "approval of radioactive waste management project plans", as well as for the "construction/operation permit of radioactive disposal facilities".

1) Environmental impact assessment (non-radiation fields)

Aside from the radiological environmental impact assessment, the environmental impact assessment checks and evaluates non-radiological impacts induced by the construction and operation of a radioactive waste repository on the surrounding environment, in complying with the provisions of the "Environmental Impact Assessment Act". The licensee shall submit a 'protocol of environmental impact assessment' to apply for an approval of an electric source development project plan, and an environmental impact assessment' to apply for approval of a radioactive waste management project plan.

The environmental impact assessment shall be performed for 23 items related to 3 fields of the natural environment, living environment, and social and economic environment, while the opinions of the local residents living in the corresponding region shall be collected through a presentation meeting or public hearing before the preparation of an assessment, and be included in the assessment. The assessment submitted is to be approved by the MOCIE upon deliberation with the MOE.

2) Radiological environmental impact assessment

Under the Atomic Energy Act, the radiological environmental impact assessment shall be conducted to evaluate the impact of radiation or radioactive materials caused by the construction and operation of a radioactive waste disposal facility on the surrounding environment, as one of the fundamental requisites to obtain the construction permit and operating license for the radioactive waste disposal facility.

A radiological environmental impact assessment report contains facility information, the environmental status of neighboring regions, the predicted radiological impact due to the construction and operation of the facility on the surroundings thereof, the environmental radiation monitoring program to be implemented during the construction and operation of the facility, the radiological impact on the environment resulting from operational accidents/incidents, and the public opinions collected.

3) Safety evaluation

Under the Atomic Energy Act, the licensee shall prepare a safety analysis report and submit it to the MOST in order to ensure safety in every stage of construction and operation of a radioactive waste disposal facility, and this report is one of the core requirements to obtain the construction permit and operating license for the radioactive waste disposal facility.

The Enforcement Decree of the Atomic Energy Act specifies the items to be included in the safety analysis report, which covers safety-related matters, particularly, the outline and description of the facility, site characteristics, the design, construction, operation and maintenance of the facility, site closure and institutional control, safety evaluation and accident analysis, radiation protection, technical guidelines, etc.

Transparency of information

The Radioactive Waste Management Measures prescribe to follow the policy of driving forward the national radioactive waste management project while promoting the public's understanding and confidence through clear and open radioactive waste management activities, as well as contributing to the harmony of the local community and community growth.

Thus, it is a rule to secure transparency in the stage of siting by opening the results of candidate site selection, the results of site surveys and installation plan to members of the public, and to faithfully comply with the formalities of asking the local population's consent and collecting their opinions through public hearing and site agreement.

The public subscription, a siting system adopted before the current licensee-led siting, was a part efforts done to go through a democratic siting procedure open to the public, and to accept public opinions as much as possible. The principle of transparency of information will be kept consistent in the future.

The "Act on Special Cases Concerning Electric Source Development" prescribes to publish the details of the project to local residents for a certain period before notice of the designation of the final site and the approval of electric source development project plan. The Atomic Energy Act and the Environmental Impact Assessment Act also provide that public opinions should be collected through public hearings before the preparation of an environmental impact assessment report.

Consultation with neighboring countries

The Republic of Korea (ROK) has not concluded any specific international agreements with foreign countries on site selection, since the ROK, a peninsula surrounded by sea on three sides, is isolated from neighboring countries, with the exception of North Korea. The ROK maintains close cooperative relations with international organizations and neighboring countries on radioactive waste and radiation emergency preparedness. Additionally, ROK preserves the cooperative system for the peaceful uses and development of nuclear power under nuclear cooperation agreements made with 18 countries including U.S., China and Japan, and will cooperate with other Contracting Parties in siting through information exchange.

H.3.3 Site approval

The approvals required in siting stage of radioactive waste management facilities are the "Approval of Electric Source Development Plan" provided in the "Act on Special Cases concerning Electric Source Development", and the "Approval of Radioactive Waste Management Plan" provided in the "Electricity Business Act". Meanwhile, the "construction/operation license for disposal facility, etc." prescribed in the Atomic Energy Act is to make the final decision on the selected site as the radioactive waste repository site.

Approval of electric source development plan

The radioactive waste management project organization shall prepare an electric source development plan including information on the outline of the facility, the location and boundary of the facility, the project duration, necessary funds and fundraising, and the installation of public facilities and cost sharing plan, as well as an environmental impact assessment report, and submit it to the MOCIE. Then, the Minister gives official approval to the licensee through consultation with the relevant Ministers of the central government and deliberations at the Electric Source Development Promotion Commission, after consulting with the head of the relevant local government about the submitted plan.

Approval of radioactive waste management plan

The radioactive waste management project organization shall submit an implementation plan including facility location map, layout of main facilities, environmental impact assessment report, operation plan after construction, construction schedule, estimated funds and fundraising, etc. to the MOCIE. Then, the Minister reviews the implementation plan, and gives official approval to the licensee after consulting with the relevant Ministers of the central government.

Permit of construction/operation for the radioactive waste management facility

The radioactive waste management project organization shall submit an application for the construction permit and operating license of a radioactive waste management facility including a radiological environmental impact assessment report, safety analysis report, the implementation plan for safety management, documents on design and construction methods, a quality assurance program for construction and operation, documents related to the types of radioactive waste to be stored, treated and disposed of and the method of storage, treatment and disposal, a fund-raising plan, specifications of technical capabilities for construction and operation, etc. to the MOST. The Minister gives official approval to the licensee, if the application submitted meets the licensing criteria prescribed in the Atomic Energy Act.

H.3.4 Efforts in site selection of the radioactive waste repository

As a legal base of project promotion was established by the amendment of the Atomic Energy Act in 1986, the Korean government has strived to secure a site for the national radioactive waste repository, as summarized in Table H.3-1. As a result of the recent siting efforts based on both site subscription and project organization-led siting methods, 4 candidate sites were announced in February 2003 after comprehensive examination of the human/social environment, natural environment and public acceptance. The final site(s) will be decided considering the site characteristics and the consultation with the competent local governments.

Some important factors including the high level of disposal technology and safety, cost-effectiveness, public acceptance and quality of management program shall be taken into consideration in disposal facility construction. Among these, the importance of public acceptance, and more specifically, the participation of local residents in the site selection process from very early stages cannot be stressed enough, because of the past experiences at the Anmyun-Island case.

The Korean Government selected Anmyun-Island, an island near the west coast, as a candidate site for the construction of the radioactive waste disposal facility in September 1990. However, the decision had to be recalled a week later, as there was very violent and strong opposition from the residents of the island and also from environmental groups.

After years of strenuous effort by the Korean Government and the KAERI, Gulup-Island, an island in the Yellow Sea, was again chosen as a candidate site for the disposal facility in February 1995. Unfortunately, the decision was also withdrawn after a year' site characteristic study which indicated that an active fault exists in the bottom sea near the island and that this may pose a potential threat to the safety of disposal facility to be constructed.

These two past experiences in the process of site selection of the radioactive waste disposal facility taught us a many lessons, including the importance of public acceptance and awareness and the need for an in-depth technical investigation of on-site characteristics prior to making a decision and announcement.

Table H.3-1 History of site selection for a radioactive waste repository

Stage	Location	Background and results
1st ('86~'89)	East coast (Ulchin, Yongduk, Yong-Il)	- Candidate sites were selected, but site investigation was stopped due to opposition by local residents
2nd ('90)	Anmyun-Island in Chungnam Province	- Selected as the 2nd site proposed by the KAERI - Cancelled after uproar on Anmyun Island (Nov. 1990)
3rd ('91~'93)	Anmyun-Island in Chungnam Province, and Chungha in Kyungbuk Province	- 6 candidate sites were recommended based on a contracted study (Kosung & Yangyang in Kangwon Province, Ulchin & Yong-Il in Kyungbuk Province, and Tae-An in Chungnam Province)
4th ('93~'94)	Jang-An in Kyungnam Province, and Kisung in Kyungbuk Province	- Voluntary application by local residents (Financial support program was introduced.) - Violent opposition
5th ('94~'95)	Gulup-Island in Inchon City	- Nominated based on 「Act for promoting the radioactive waste management project and financial support for local community」 (Feb.'95) - The Government organized task force team. - Cancelled after the discovery of active faults (Dec.'95)
6th ('98~ Present)	46 Coastal Counties	- New siting strategy of either site subscription or project organization-led selection among candidate sites (1998) - Site subscription campaign ('00.6.28~'01.2.28) - Failed due to local government rejection despite voluntary application by 7 communities - Announcement of 4 candidate sites (Feb. '03)

H.4 Design and construction of facilities (Article 14)

Prevention of discharge and uncontrolled release

The radioactive waste management facility shall be designed to have a capability of properly controlling gaseous and liquid radioactive discharge in normal operations and anticipated operational transients, and to restrict environmental impact with the limitation of gaseous and liquid discharge to within allowable limits. Additionally, the facility shall be designed to have capabilities to safely store waste generated during operation.

Design considerations for decommissioning concept

All radioactive waste management facilities, except for the radioactive waste disposal facility, shall be designed in consideration of decommissioning.

Technical provisions for closure

With regard to the closure and post-closure management of the disposal facility, the Notice of the MOST on “Criteria for the design of a low and intermediate-level radioactive waste disposal facility” provides as follows:

- That the disposal facility should be designed to minimize, if possible, the contact of disposed waste with surface water or ground water in the stages of closure and post-closure management.
- That the disposal facility should be designed and constructed to allow its closure when the designed disposal volume or the licensed radiological capacity reaches a limit or when the normal function of the disposal facility can no longer be preserved due to unexpected accident.
- That the facility should be designed to allow the confirmation of its safety for a necessary period of time through environmental monitoring of the closed disposal facility and its surroundings.

Application of proven technologies

The radioactive waste management facility shall be designed and constructed with the application of technologies proven by experience and testing.

H.5 Assessment of safety of facilities (Article 15)

Safety and environmental impact assessment for operational period

It is necessary to prepare safety analysis report and radiological environmental impact assessment report after evaluating safety and radiological environmental impacts for the operational period of a radioactive waste management facility. The safety analysis report contains the result of a comprehensive safety assessment for the said facility, particularly, the design features of structures, systems and equipment in the facility, radiation protection, and site characteristics.

The radiological environmental impact assessment report evaluates the effects of radiation or radioactive material resulting from the radioactive waste management facility on the local population and the environment.

Safety and environmental impact assessment for the post-closure period

Since radiological impact due to a radioactive waste disposal facility may affect future generations as well as the present generation, long-term safety shall be secured through the combination of desirable site characteristics, engineering design features, adequate form and contents of waste, operating procedures, and institutional control.

The Notice of the MOST on ‘Performance criteria of LILW disposal facility’ prescribes that the conformity of the facility with safety requirements should be demonstrated by a systematic safety assessment.

It is provided that the safety analysis report and the radiological environmental impact assessment report for a radioactive waste disposal facility should include information about site closure and institutional control, post-closure safety assessment, environmental impact induced by the closure of the repository, and environmental radiation monitoring plans after closure.

Further details are specified in the 'guidelines for preparing a radiological environmental impact assessment for a radioactive waste disposal facility' annexed to the Notice of the MOST on regulation concerning the preparation of a radiological environmental impact assessment report of nuclear facilities.

Supplementation of safety evaluation

It is provided that the review and verification as to whether the safety evaluation and the environmental impact assessment conform to regulatory requirements and technical standards, etc. should be performed, and matters for amendment, if any, should be properly made before the start of facility operation.

H.6 Operation of facilities (Article 16)

H.6.1 Technical requirements

The criteria for operating license for radioactive waste management facilities are specified in the Atomic Energy Act as follows:

- Technical and economical capabilities necessary for the construction and operation of a radioactive waste management facility shall be secured.
- The location, structure, equipment and performance of a radioactive waste management facility shall conform to technical requirements, as prescribed by the Ordinances of the MOST, in such a way that there may not be any impediment to the protection of human body, materials, and the public against radiological hazards.
- There shall not be any impediment to the protection of the public health and the environment against radiological hazards that may accompany the construction and operation of a radioactive waste management facility.
- The equipment and manpower prescribed by the Presidential Decree shall be secured.

The radioactive waste management facility shall be operated with the verification of its conformity to the design requirements through a startup operation, under operating license.

Technical standards newly introduced or amended during the operation of radioactive waste management facilities shall undergo continuous review, and have to be reflected in the operation of those facilities.

H.6.2 Determination of operational limits and conditions

The operational limits and conditions for radioactive waste management facilities shall be described in the operational technical specifications, according to the Atomic Energy Laws and Notices.

The operational technical specifications contain the particulars of radioactive waste management, radiation safety management and radiation detector maintenance, to satisfy the provisions and requirements included in the Atomic Energy Laws and technical standards.

H.6.3 Operating procedures

The operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility shall be conducted in accordance with operating procedures prepared on the basis of the operational technical specifications.

H.6.4 Engineering and technical support

The operator of a radioactive waste management facility shall receive engineering and technical support organized in consideration of the facility specific conditions in all safety-related fields during its operational lifetime. The KHNP, which is responsible for the operation of the said facility, receives engineering support from the KOPEC, maintenance support from the KPS and Samchang Enterprise Co., Ltd., and facility operational support from a radiation safety management service company.

H.6.5 Procedures for the characterization and segregation of radioactive waste

The radioactive waste characteristics are evaluated pursuant to the Atomic Energy Act (Article on the restriction of radioactive waste disposal), the Enforcement Regulations of the Atomic Energy Act (Articles on the restriction of radioactive waste disposal and radioactive waste delivery), and the Notice of the MOST on acceptance criteria of low and intermediate-level radioactive wastes, while radioactive waste is classified according to the concentration of radioactive materials.

H.6.6 Incident reporting and document control

The Atomic Energy Act prescribes that organizations concerned in nuclear-related activities should immediately take all necessary safety measures and report such measures to the MOST in the following cases:

- If radiation hazards occur,
- If any failure occurs in nuclear facilities,
- If there is any danger or possibility of danger to nuclear facilities or radioactive materials due to earthquake, fire or other disasters,
- If a radiation generating device or radioactive materials are stolen, lost, or destroyed by fire or any other incident, or

– If radioactive materials leak or are destroyed by fire or any other incident during transportation or packaging.

The Notice of the MOST (regulation concerning the reporting of incidents and accidents of nuclear facilities) stipulates in detail the incident reporting system. It includes the objects, means and procedures of reporting, and the classification of incidents and accidents. The classification of incidents and accidents is based on the International Nuclear Event Scale (INES) of the IAEA.

H.6.7 Preparation and revision of decommissioning plans and regulatory review procedures

In accordance with the Atomic Energy Act, the project organization for decommissioning of a radioactive waste management facility must prepare a decommissioning plan, and submit it to the MOST for approval. The decommissioning plan is to be prepared on the grounds of necessary measures to prevent radiation hazards, the data obtained during operation of the facility and data obtained by facility surveys at the point of ending operations.

H.6.8 Preparation and revision of closure plans and regulatory review procedures

The operator of a radioactive waste disposal facility must prepare a closure plan before the designed disposal volume or the licensed radiological capacity reaches a pre-set limit, and will be allowed to close the facility after the regulatory body's review and verification. For this, the quantity of radioactive waste disposed of and radionuclide inventory thereof must be submitted to the regulatory body every year.

The closure plan covers a monitoring and maintenance plan to prevent any human intrusion and to check the integrity of drainage systems and barriers for a specified period of time after closure.

H.7 Institutional measures after closure (Article 17)

H.7.1 Record keeping

Pursuant to the Atomic Energy Act, radiological data related to radioactive waste disposal shall be permanently preserved. For this, the development of a national radioactive waste inventory management program is under way. The related records, particularly, the location and design documents of the disposal facility are to be preserved in accordance with the quality assurance program.

H.7.2 Institutional control

The institutional control of a radioactive waste disposal facility after its closure is to conduct repair and management activities and environment monitoring for the prevention of an unplanned release of radioactive materials into the environment for a proper period of time if it is necessary to cope with environmental change liable to impair the long-term safety of the disposal facility, pursuant to the Atomic Energy Laws.
It is also provided that the radiation exposure and the release of radioactive materials to the environment after the closure of a disposal facility should be kept ALARA within allowable limits, and the radiation exposure induced by accidents should be sufficiently decreased.

The period of institutional control after the closure of a radioactive waste disposal facility will be determined in conformity with international norms and practices, after due consideration of disposal method, waste characteristics, etc.

H.7.3 Intervention in the case of an unplanned release

It is provided that intervention measures should be taken, if an unplanned release of radioactive materials is detected through environmental monitoring after the closure of a disposal facility.

I. Trans-boundary Movement (Article 27)

I.1 Domestic transport regulations

Regulations for the transport of radioactive materials are described in the Atomic Energy Act, the Enforcement Decree of the Act, the Enforcement Regulations of the Act, the Technical Standards of Radiation Safety Management, etc., and the Notice of the MOST entitled 'Regulation on the packaging and transport of radioactive materials, etc.

The domestic regulations for the transport of radioactive materials are based on the 'Regulations for the safe transport of radioactive materials' of the IAEA, and the reflection of the 1996 IAEA Regulations for the Safe Transport of Radioactive Materials (ST-1) on the Atomic Energy Act were enacted between 1999 and 2001. At present, the 1996 IAEA Regulations reflected, as they are, on how the Atomic Energy Act is being applied to domestic regulations for the transport of radioactive materials.

The regulation for the packaging and transportation of radioactive materials, etc. and the regulation for manufacturing inspection and in-service inspection for transport containers are included in the Notices of the MOST.

I.2 Safety requirements

General requirements

The general safety requirements for the transport of radioactive materials specify radiation exposure and contamination controls for persons engaged in radioactive material transportation work, education and training, quality assurance, and measures, etc. in case of accidents.

Transport containers

The safety requirements for transport containers provide the safety requirements by type of transport container corresponding to each A-type package, B-type package, and packages containing fissile materials, while separating such requirements into general requirements and test requirements. General requirements and test requirements for transport containers conform to the requirements specified in the IAEA Regulations (ST-1).

Transport

The safety requirements for transport include requirements such as the packaging limits by type of load, for example, A-type package, B-type package and package containing fissile materiala as well as the surface dose rate, surface contamination limit of loads, and requirements such as the load limit by transport means such as vehicles, airplanes, ships, isolation, and the radiation dose rate at the surface of transport means. These safety requirements for transport conform to the requirements specified in the said IAEA Regulations (ST-1).

Additionally, it is provided that loads taken out of the Korean territory should be packed and transported in conformity with safety regulations concerning the transport of radioactive materials, to any country that said loads pass through or arrive in.

I.3 Approval and administrative action

Design approval

The approval prescribed in the Atomic Energy Act includes design approval for special radioactive material and low-dispersive radioactive material, and design approval for shipping casks specified in par. 801 IAEA ST-1, design approval for shipping casks, and the special arrangements specified in par.312 IAEA ST-1. The MOST issues a design approval for radioactive material or shipping cask that an application for design approval is made by model. It is a rule to check the integrity of shipping casks through source surveillance in making a cask for which design approval is given. Meanwhile, the manufactured cask in use requires integrity-related inspections at the interval of every 5 years from the manufactured date in order to secure safety in continued utilization.

Approval for transport containers

As for B-type packages, C-type packages, and packages containing fissile materials, it is provided that the details of transport including radioactive contents, the type of load, a written transport procedures and an accident response procedure should be notified to the MOST in advance of or after the transport day, and the Minister should review said details, and give order to rectify factors apt to impair safety, if any, before transportation. As for loads declared, transport surveillance or periodic inspections are conducted to check the possibility of violating transport regulations.

Special arrangements

A person who intends to have a ship or airplane loaded with radioactive materials arriving in any port or airport in Korea, or passing through Korean territorial waters or aerial routes shall notify the MOST of such fact not later than 7 days before the day planned to start operations after the loading radioactive materials.

Complements

As a result, the trans-boundary movement of spent fuel or radioactive waste specified in the Joint Convention on the Safety of Spent Fuel Management and Radioactive Waste Management, which are reflected in the 1996 IAEA Regulations, has come to be for the most part, standardized. To date, there has been no trans-boundary movement of spent fuel or radioactive waste to or from Korea, and such movement is not expected to happen in Korea for the foreseeable future.

J. Disused Sealed Sources (Article 28)

J.1 Legal system

The responsibility for radioactive waste management projects was transferred from the MOST to the MOCIE in June 1996. Thus disused sealed sources should be managed and handled according to the Atomic Energy Act and the Electricity Business Act, as follows: the MOST is in charge of regulatory works related to radiation safety management under the Atomic Energy Act, while the MOCIE is in charge of radioactive waste management under the Electricity Business Act.

J.2 Management of disused sealed sources

J.2.1 Requirements for facilities and handling

Disused sealed sources generated from radioisotope users are being temporarily managed by the owner of a storage facility which passed facility inspections by the KINS, and it is compulsory to specify matters on safety such as shielding, etc. in the radiation safety report with due regard to the storage capacity of the storage facility, and to keep them safely.

The radioisotope waste disposal facility is to be constructed and operated in accordance with the Atomic Energy Act, and to undergo periodic inspections every year.

J.2.2. Management

Procedures of waste management by radioisotope users

In accordance with the Atomic Energy Act (license for the use, etc. of radioisotopes and radiation generating devices), all radioisotope users should have a radioisotope utilization license. Radioisotope users who want to import radioisotopes should obtain permission for importation and import requirements from the KRIA, or users can purchase them from domestic producers with a radioisotope use license.

Especially, the source suspended from use shall be kept in a permitted facility, particularly, a storage box or disposal box in a storage room, and the disused sealed sources for disposal shall be transferred to the NETEC, or be returned to the overseas manufacturer. And the Notice of the MOST regulates packaging and transportation of radioactive materials.

Procedures of the operation & management for the radioisotope waste storage facility by the NETEC

The KHNP/NETEC takes over unusable sources of decayed radioactivity from radioisotope users under the Enforcement Decree of the Electricity Business Act (Radioactive waste delivery). In accordance with the Notice of the MOCIE (Regulation for the consigning of radioactive waste and its cost), currently the KHNP/NETEC operates the radioisotope waste storage facility and safely stores and manages radioisotope waste accepted from about 1,900 domestic radioisotope users. The radioisotope waste management system is as follows:

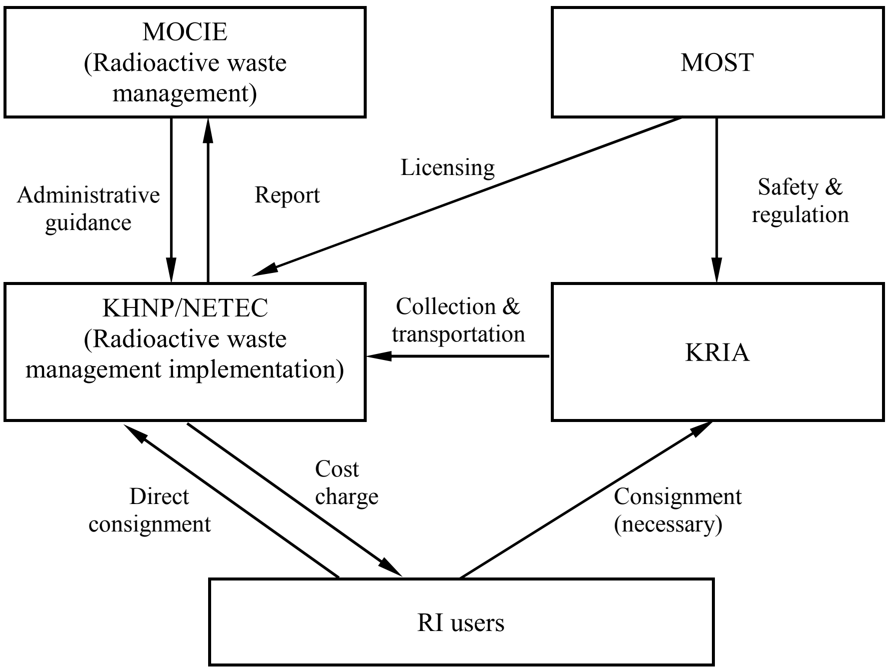


Figure J.2-1 Radioisotope waste management system

J.2.3 Return

The domestic made sealed sources that are exported to oversea countries can be returned to Korea, but presently no provision of the return is available. The standards and regulations on domestic return will be prepared sooner or later.

K. Planned Activities to Improve Safety

K.1 Development of commercial vitrification technology

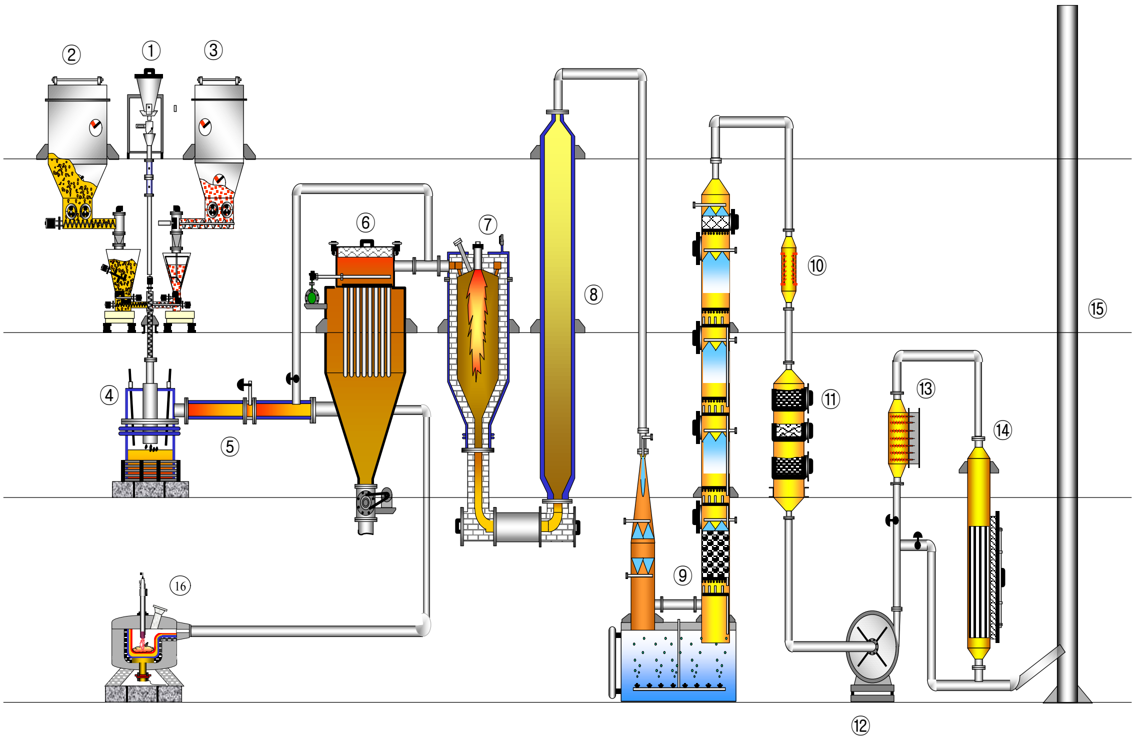
In 1994, the KHNP carried out a feasibility study on the development of vitrification technology for treatment of LILW from nuclear power plants. KHNP demonstrated its feasibility using laboratory-scale tests and devised a creative “combined vitrification process” as shown at Figure K.1-1, which is to treat combustible wastes with Cold Crucible Melter as well as non-combustibles with Plasma Torch Melter.

Then, a pilot research program was launched by KHNP, for development of vitrification technology to be applied to LILW. In 1999, a pilot-scale vitrification plant was constructed at Nuclear Environment Technology Institute of KHNP.

Using the pilot plant, KHNP developed vitrification process for each radioactive waste stream and demonstrated its performance by long duration tests in 2002. Thus, KHNP finally succeeded in developing vitrification technology for its commercial application. Total of M$ 15.9 was invested in research and development of the technology.

In September 2002, KHNP launched a project for "development of a prototype vitrification plant" which is partially funded by the Government. The first vitrification plant is to be constructed in Ulchin units 5,6 and tested with real radioactive wastes for verification of its performance. In 2007, KHNP is expected to begin vitrifying LILW from Ulchin nuclear power plants after it is licensed by the Korean regulatory body.

If successfully vitrified, annual radioactive waste would be reduced to 35 drums from 150 drums that are annually generated from 1000MWe PWR with conventional radioactive waste treatment facility. In addition, disposal safety will be remarkably improved thanks to long-term stability of the vitrified waste. The technology will also help to enhance integrity of radioactive wastes and its safety during on-site storage.



① Glass Frit Feeder
② DAW Feeder
③ Resin Feeder
④ Cold Crucible Melter
⑤ Pipe Cooler
⑥ High Temperature Filter
⑦ Post Combustion Chamber
⑧ Off-gas Cooler
⑨ Scrubber
⑩ Reheater
⑪ Activated Carbon/HEPA Filter
⑫ Extraction Fan
⑬ Reheater
⑭ DeNOX System
⑮ Stack
⑯ Plasma Torch Melter

Figure K.1-1 Vitrification process of the KHNP

K.2 Development of radioactive waste characteristic evaluation technology

Radioactive waste drums should be assayed for their management such as classification, preparation for storage and off-site transport according to their activity concentration of radionuclides. Also, drum assay is necessary to check whether the concentration of radionuclides and total radioactivity in the drum meet waste acceptance criteria and to determine design parameters for their repository.

Drum assay has actual difficulties in being carried out with conventional instruments or by radiochemical analysis method. Indirect analysis with instrumentation is one of the most reasonable methods although there is still a need to establish analysis technology such as the development of related programs and products for scaling factors. It is expected that every nuclear power site starts operation of a drum assay system in conformity to technical requirements in June 2006.

Technical specifications of drum assay systems will be determined by an in-depth review of reasonable overseas cases. Key radionuclides will be detected by instruments based on TGS (Thermographic Gamma Scanner) technology, while a scaling factor will be applied to calculate α- and β-particle emitters that are difficult to measure. Plant-specific scaling factors will be produced from a database obtained by analyzing the samples of each waste stream from all nuclear power plants in Korea. Necessary drum assay technology and radiological data are established through the development of radioactive waste characteristic evaluation technology.

K.3 Establishment of the radiation safety information system (RASIS)

In order to maximize support from the public as well as to simplify the administrative procedure of transacting business related to radioisotope safety management, which shows rapidly increasing demand as the usage scale of radioisotopes continues to increase, we operate the RASIS developed for the systematic, comprehensive safety management of radioisotopes through the Internet with the integration of related information. RASIS (http://rasis.kins.re.kr) consists of the Cyber Radiation Safety Information Center (http://rinet.kins.re.kr), the User Safety Management System (http://gate.kins.re.kr/), the Radiation Safety Regulation System (http://isotope.kins.re.kr/), the Relevant Organizations Business System and the License Control System (http://license.kins.re.kr/), and is engaged in activating the use of radioisotopes and promoting efficiency of related safety management work, as follows:

– Notice and posting of RI safety regulation activities: to raise the efficiency of regulation work through on-line sharing of regulation-related information between the agencies concerned, the standardization of business and the circulation of electronic documents,
– Strengthening of tracking management for radioactive materials: to fundamentally prevent the occurrence of orphan sources by managing the life-cycle of each source, such as radioisotopes and radiation generating devices,
– Support for radiation safety management activities of RI users; to strengthen the capabilities of safety management in domestic non-power reactor nuclear industry fields through the sharing and posting of information, and support in the field of radiation safety management business and activities, and
– Promotion of civil service; to provide a variety of information about

radiation and radiation safety management technology to radioisotope users and the general public through the Internet by the government.

K.4 Establishment of the waste comprehensive information database (WACID)

As the generation and accumulation of radioactive waste continues to increase with the domestic use of nuclear energy, the necessity arises for establishing a national level comprehensive database system to which is applied the-states-of-the-art information technology in order to manage every information related to the safety management of various and massive radioactive waste sources in the systematical manner.

Coping with the urgent national demand, a WACID (Waste Comprehensive Information Database system) is being developed by KINS from July 2003 to June 2004 as the 2-year project. It aims at not only facilitating the routine reporting of current status on its own radioactive waste of each waste generator and but also, integrating the enormous information up to now from every nuclear installations, through the internet network system, into the concerted DB system.

Simple conceptual system modeling, pre-defined format of data-set and functional configuration with the several sub-modules of the WACID DB system have been employed so as to maximize data sharing, minimize data redundancy, to enhance the effectiveness of system in operation, and to avoid unexpected complication of system itself, due to involvement of a variety of data characteristics from numerous waste generators.

With in-depth review of user requirements and basic conceptual modeling of the DB system, the 8-sub modules for grouping information which consisted of solid radioactive waste, liquid effluent, gaseous effluent, spent fuel, RI waste, decommissioning waste, disposal and others were finally decided as the system basic configuration as shown at Figure K.4-1. Further extension of WACID to final disposal of radioactive waste will also be anticipated as the next step to meet States' responsibility, ensuring of preserving the sorted information on disposal of radioactive waste for next generations.

The WACID system will play the great role to direct the radioactive waste policy by Government, to promote R&D activities, and upgrade the domestic level of safe management of radioactive waste. In addition, that will do much for realizing 5 principles (i.e., independence, openness, clarity, efficiency, reliability) of nuclear safety regulation, by the way of the opening of essential information to the general public.

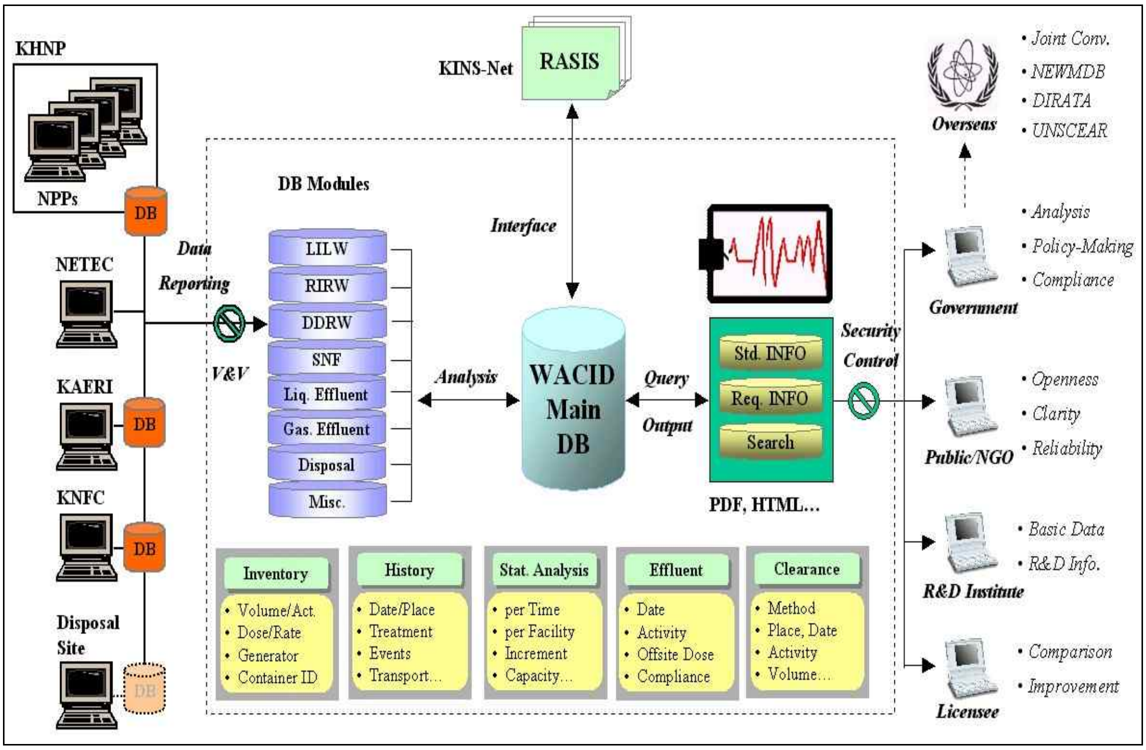


Figure K.4-1 Basic design configuration of the WACID system

K.5 Korea Information System on Occupational Exposure (KISOE)

A nationwide "Korea Information System on Occupational Exposure (KISOE)" was established within the framework of the KINS on November 27, 2002. This system includes detailed information on occupational radiation exposure and provides updated information regarding the number of radiation workers and specified dose trends as well as individual dose history.

Maintaining occupational exposures as low as possible has become a national goal that has been further emphasized in line with the growing trend in the nuclear industry. In response to this national program and to provide useful information for implementing optimization principles, the KINS has developed an integrated system, which is operated on a national scale, to manage all workers' individual information including radiation exposure, training history, limited medical background data and work area information.

The main functions of the KISOE are as follows:

– Maintaining and updating the KISOE system in conjunction with software programs specially designed to analyzed occupational exposure,

– Providing feedback information for regulation activities based on both radiation risk and analytical results,
– Providing quantitative indicators for use in determination of protective action in the work area and for the assessment of effectiveness of radiation safety regulations,
– Providing supplemental information to decision-makers to comply with the optimization principle. Maintaining and updating integrated individual dose history based on the concept of lifetime dosimetry tracking,
– Cooperation and communication with ISOE, IAEA, OECD/NEA and related organizations.

ANNEXES

Annex A. List of spent fuel management facilities

Annex B. List of radioactive waste management facilities

Annex C. List of nuclear facilities under decommissioning

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Annex F. References

Annex A. List of spent fuel management facilities

Annex A-1 Spent fuel storage facilities for NPPs

(Unit: MTU)

NPP	Location	Storage type	Storage capacity			
			Initial capacity (year)	Extended storage (year)	Extension method	Total capacity
Kori # 1	JangAnn-Eub GiJang-Gun Busan	wet	209(1978)	-	Transport between neighboring unit	209
Kori # 2	"	wet	360(1983)	-	Transport between neighboring unit	360
Kori # 3	"	wet	314(1985)	188(1993)	Addition	950
				448(2002)	Re-racking	
Kori # 4	"	wet	314(1986)	171(1996)	Addition	485
YGN # 1	HongNong-Eub, YeongGwang-Gun, JeonLaNam-Do	wet	314(1986)	171(1997)	Addition	485
YGN # 2	"	wet	314(1987)	171(1997)	Addition	485
YGN #3	"	wet	283(1995)	-	-	283
YGN #4	"	wet	283(1996)	-	-	283
YGN #5	"	wet	279(2002)	-	-	279
Ulchin #1	Buk-Myeon, Ulchin-Gun, GyeongSangBuk-Do	wet	199(1988)	470(1995)	Re-racking	669
Ulchin #2	"	wet	199(1989)	171(1995)	Re-racking	370
Ulchin #3	"	wet	283(1995)	-	-	283
Ulchin #4	"	wet	283(1996)	-	-	283
Wolsong #1	YangNam-Myeon, GyeongJu, GyeongSangBuk-Do	wet	827(1983)	-	-	827
		dry	816(1990)	612(1998)	Canister	1,428
Wolsong #2	"	wet	812(1983)	-	-	812
Wolsong #3	"	wet	812(1983)	-	-	812
Wolsong #4	"	wet	812(1983)	-	-	812

※ Including emergency cores

Annex A-2 Characteristics of the spent fuel storage pool at HANARO

Facility	**Location**	**Storage type**	**Storage capacity**		
			HANARO 36-element fuel assembly	**HANARO 18-element fuel assembly**	**TRIGA reactor fuel element**
HANARO spent fuel storage pool	Deokjin-Dong, Yuseong-Gu, Daejeon	Wet	600	432	315

Annex A-3 Characteristics of the spent fuel storage pool at PIEF

Facility	**Location**	**Characteristics**		
		Storage type	**Initial design capacity**	**Total capacity of storage**
PIEF spent fuel storage pool	Deokjin-Dong, Yusong-Gu, Daejeon	wet	20 spent PWR assemblies	20 spent PWR assemblies

Annex B. List of radioactive waste management facilities

Annex B-1 Storage facilities for LILW in NPPs

Facility	Location	Purpose	1st year of operation year	Capacity [200 ℓ drum]
Kori No.1	GiJang-Gun Busan	Storage from Kori # 1 ~ 4	1978	10,000
Kori No.2	〃	〃	1979	4,300
Kori No.3	〃	〃	1987	12,600
Kori No.4	〃	〃	1993	23,000
Wolsong No.1	GyeongJu GyeongSang Buk-Do	Storage from Wolsong # 1 ~ 4	1983	9,000
Yonggwang No.1	Hongnong-Eub JeonLaNam-Do	Storage from Yonggwang # 1, 2	1986	13,300
Yonggwang No.2	〃	Storage from Yonggwang # 1~6	2002	10,000
Ulchin No.1	Ulchin-Gun Buk-Myeon GyeongSang Buk-Do	Storage from Ulchin # 1, 2	1989	7,400
Ulchin No.2	〃	Storage from Ulchin # 1~ 4	1997	10,000

Annex B-2 Radioactive waste treatment facility for NPPs

Reactor type	Facility feature		
	Gaseous※	Liquid	Solid
PWR	Treatment by gas decay tank or charcoal delay bed for effluent processing	Treatment by filtering, evaporation or ion exchange method	Treatment by sorting, compacting, drying or solidification method
PHWR	Treatment by charcoal delay bed for effluent processing	Treatment by filtering, or ion exchange method	Treatment by sorting, compacting, drying

※ Room effluent is treated by HEPA or charcoal filter

Annex B-3 Storage facilities for radioactive waste in the KAERI

Facility	Location	Purpose	1st year of operation year	Capacity]
Storage No.1	Deokjin-Dong, Yusong-Gu, Daejeon,	LILW	1985	11,500 [200 ℓ drum]
Storage No.2	Deokjin-Dong Yusong-Gu, Daejeon,	LILW	1985	1,134 [50 ℓ drum]

Annex B-4 Radioactive waste treatment facility in the KAERI

Facility	Location	Purpose	1st year of operation year	Facility features	
				Process	Capacity
Radioactive waste treatment facility	Deokjin-Dong, Yusong-Gu, Daejeon	Treatment of radioactive waste generated from research facilities	1991	Bituminization	0.03 m^3/h
				Evaporation	1 m^3/h
				Compression	60 ton
				Solar evaporation	0.6 m^3/h

Annex B-5 Storage facility for radioactive waste in the KNFC

Facility	Location	Purpose	1st year of operation year	Capacity [200 ℓ drum]
Storage No.1	Deokjin-Dong, Yuseong-Gu, Daejeon	Storage of solid waste	1993	3,000
Storage No.2	“	“	1998	4,000

Annex B-6 Radioactive waste treatment system in nuclear fuel fabrication facilities in KNFC

Facility	Location	Purpose	1st year of operation year	Characteristics	
				Capacity	Main process
PWR liquid waste treatment system at Plant 1	Deokjin-Dong, Yuseong-Gu, Daejeon	Liquid waste treatment	1988	187 m^3/d	Lime precipitation & centrifuge
PWR liquid waste treatment system at Plant 2	"	"	1998	"	"
PHWR liquid waste treatment system at Plant 2	"	"	1998	"	Flocculation
Solid waste treatment system at Plant 1	"	Solid waste treatment	1988	—	Shredding & compaction
Solid waste treatment system at Plant 2	"	"	1998	—	Cutting & compaction

Annex B-7 Radioisotope waste storage facility in the KHNP/NETEC

Facility	Location	Purpose	1st year of operation year	Capacity [200 ℓ drum]
Radioisotope waste storage facility	Deokjin-Dong, Yuseong-Gu, Daejeon	Radioisotope waste interim storage	1983	9,277

Annex B-8 Radioactive waste incinerator in the KHNP/NETEC

Facility	Location	Purpose	1st year of operation year	Treatment capacity	
Radioactive waste incinerator	Deokjin-Dong, Yuseong-Gu, Daejeon	Incineration: - RI waste - Radioactive waste generated from KAERI	2000	Solid waste	15~25 kg/h
				Liquid waste	8 ℓ /h

Annex C. List of nuclear facilities under decommissioning

Facility	Location	Organi-zation	Specific	Year			Status	Volume [1]	
				1st year of opera-tion	Shut-down	To finish		Volume [m^3]	Total radio-activity [Bq]
KRR-1	Seoul	KAERI	TRIGA Mark-II (250 kWth)	1962	1995	2006	Under de-commissioning	168	3.7E+10
KRR-2	"	"	TRIGA Mark-III (2 MWth)	1972	1995	2004	"	453	1.2E+12
Uranium conversion	Daejeon	"	ADU [2] AUC [3] (100 ton/y)	1982	1992	2006	Applying for license	380	6.5E+05

Remarks: 1) The values are preliminary estimated.
2) ADU: Ammonium Diuranate
3) AUC: Ammonium Uranyl Carbonate

Annex D. Nuclear safety policy statement

1. Introduction

The following declares the Ministry of Science and Technology’s major policies for the assurance of nuclear safety through the settlement of nuclear regulatory goals and principles to meet growing public concern for nuclear safety and the environment. The purpose of this Statement is to improve the consistency, adequacy and rationality of nuclear regulatory activities by notifying the public and concerned people in and out of the nuclear field of the Government's basic policies regarding nuclear safety.

As declared in the report entitled, “Directions of Long-term Nuclear Energy Policy through the Year 2030”, which was approved at the 234th Atomic Energy Commission in July 1994, Korean nuclear policy is aimed at establishing the safe use of nuclear energy for peaceful purposes and improving public welfare. Therefore, the assurance of nuclear safety should be given the first priority in the development of nuclear power, and organizations and individuals engaged in nuclear power activities should adhere to safety principles as a top priority.

The Korean public’s distrust of nuclear safety has grown significantly due to the Chernobyl nuclear accident. Sometimes we are confronted with a vocal and often powerful anti-nuclear movement, particularly in regions where nuclear facilities will be built. Therefore, people in the nuclear field should possess a more pro-active attitude in assuring nuclear safety so that much-needed public’s trust and confidence can be obtained, and they should devote more efforts to communicating with the public to resolve outstanding issues.

As a matter of course, nuclear safety is not only a matter for one country but a worldwide concern. The "Nuclear Safety Convention" signed by IAEA member states during the 38th IAEA General Conference is one example of world-wide efforts to enhance nuclear safety. Its objectives are to establish national measures on nuclear safety and to ensure that each contracting party fulfills its obligations under the said Convention. As a result, each contracting country has an international responsibility for nuclear safety.

The Korean Government will continue to pursue its goal of achieving a high level of nuclear safety through the enhancement of safety technologies and the internationalization and rationalization of the regulatory system, recognizing that the overriding priority should be given to the assurance of nuclear safety before the development of the nuclear industry.

2. Safety Culture

The Government reaffirms that nuclear safety takes top priority in the development of nuclear energy and that it should be of foremost concern to organizations and individuals engaged in nuclear activities. The Government also develops safety culture, which was presented by the IAEA, recognizing that nuclear safety issues are more closely related to human factors rather than to technical ones, as demonstrated by two nuclear accidents of TMI and Chernobyl.

The safety of nuclear facilities can be secured through dedication to common goals for nuclear safety by organizations and individuals at all levels by giving a high priority to safety through sound thought, full knowledge and a proper sense of safety responsibility. The Government recognizes that nuclear safety is achieved not only by safety systems and strict regulations throughout the stages of design, construction, operation and maintenance of nuclear power plants, but also by the dissemination of safety culture.

In meeting this commitment, the Government strives for strict regulations through the development of clear safety goals and regulatory policies. It will actively encourage safety-related research and technical developments to achieve technical expertise in regulatory activities and will ensure regulatory independence and fairness by minimizing any undue pressure and interference.

Nuclear utilities establish management policies, giving high priority to nuclear safety, and foster a working climate in which attention to safety is a matter of everyday concern. Managers encourage, praise and provide tangible rewards to employees for commendable attitudes and good practices concerning safety matters. On the contrary, when errors are committed, individuals are encouraged to report them without concealment and delay and to correct them to avert future problems. For repeated deficiencies in or negligent attitudes toward nuclear safety, managers take firm measures in such a way to prevent the same errors from occurring again. In this way, safety culture can be achieved through sound safety policies and full understanding of safety culture by senior management and through proper practices and implementation by individuals engaged in the nuclear industry.

3. Regulatory Principles

The ultimate responsibility for safety of nuclear facilities rests with the licensee. This is in no way diluted by the separate activities and responsibilities of designers, suppliers, constructors and regulators.

The Government has an overall responsibility for ensuring the protection of the public health and the environment from radiation hazards that may occur in the development of nuclear energy. It inspects and ensures the appropriateness of the licensee's safety practices through nuclear regulations and establishes a high level of safety assurance in order to achieve safety goals on a government level. To effectively implement safety goals, the Government sets forth the following five principles to encourage high-safety performance.

A. Independence

The Government establishes the legal framework for the independent regulatory organization responsible for nuclear regulatory activities. It takes proper measures to ensure the independence of the regulatory organization, which is functionally separated from other organizations and systems involved in the development of nuclear energy. It also ensures that the regulatory organization acts on its own objectives and technical judgment without any political interference and influence from external sources.

The regulatory organization should maintain an extensive program of research and sufficient manpower resources to review and audit licensee’s submittals so that it can independently verify the validity of a licensee’s assertions, which are critical to regulatory decisions. The regulators do their work seeking to achieve the highest standards of ethical performance and professionalism. Regulators’ decisions and judgments must be based on objective, unbiased assessments, considering possible conflicting interests of those involved, and their work must be documented. Based on safety culture, the regulatory organization should support and guide the licensee in solving its problems, but only to the extent that the regulatory organization's independence is not impeded.

B. Openness

The purpose of nuclear regulations is to protect public safety and to ensure that all activities are legal and public. The Government maintains an open channel with the public for regulatory information so that the public can understand and rely on the regulatory process. The Government is also devoted to establishing a sound social stand on nuclear safety by making an effort to inform the public properly and openly of nuclear activities, including safety matters.

The Government also develops nuclear policies based on public consensus, paying attention to the public's right to know about the regulatory process. To accomplish this, the Government extends an opportunity to the public to participate in regulatory processes and publicizes related information under the principle entitled, “Openness and Democratization of Nuclear Administration”.

However, restricted information from industries or concerned individuals is protected and kept in confidence, and treated according to the provisions concerned. The Government objectively informs the public of its activities so that it may collect public opinions more soundly and properly, and it strives to get public consensus through constant communication and interaction with regulators, licensees and the public.

C. Clarity

Nuclear regulations should be enforced through clear regulatory policies, which are based on safety goals on a national level. There should be a coherent nexus between regulations and agency goals and objectives. Agency position should be documented to be readily understood and easily applied.

The Government endeavors to ensure that the licensee is fully informed of regulators' policies so that the licensee can prepare for new policies in advance in order to achieve nuclear safety effectively upon implementation. In a case where a new or revised regulations are expected, the Government informs the licensee of the regulatory policies and provides guidance in advance and establishes regulatory practices to minimize the licensee's process of trial and error caused by the revision of regulatory requirements.

The licensee should thoroughly observe the Atomic Energy Act, technical standards and regulatory guidance, and if there is a need to revise them or there are any unreasonable acts or technical standards, the licensee should communicate its view with the regulatory organization in order to initiate revisions.

D. Efficiency

The regulatory organization has the responsibility to provide the licensee and the public with the best possible management and administration of regulatory activities. To accomplish this, it must make constant efforts to evaluate and upgrade its regulatory capabilities.

The regulatory organization should possess a sufficient number of staff that is capable in performing regulatory activities, which are closely connected with many technical areas, and regulatory activities must be performed efficiently to contribute to the achievement of the goal of "Nuclear risk reduction".

Regulatory decisions must be made with the best use of all resources invested in the regulatory process to minimize undue impediments.

Before regulatory decisions related to the improvement in nuclear safety are made, the nuclear risk reduction scale and economic benefits that can be gained from the improvement should be reviewed first.

To efficiently perform regulatory activities with limited capabilities and time, appropriate prioritization of regulatory activities must be made based on risks, costs, and other factors. Regulatory alternatives, which minimize cost and efforts, are adopted unless they increase the degree of risk, and in all cases resources should be used effectively for the improvement of nuclear safety.

E. Reliability

The regulatory organization endeavors to eliminate public distrust and fear of nuclear activities and to obtain the public's trust and support through fair regulations based on technical and professional judgments. Regulatory decisions must be made promptly and fairly, and reliably based on the best available knowledge from research and operational experiences.

The Government obtains up-to-date technical information on nuclear safety and applies this information to regulatory activities. When regulatory requirements need to be either newly established or changed, the most suitable option is adopted after the effectiveness of its implementation and technological difficulties resulting from any changes are sufficiently reviewed.

The Government does its best to run its regulatory system efficiently and systematically, and to thoroughly enforce the regulations in order to secure the public's trust on nuclear safety systems.

4. Directions of Nuclear Safety Policy

To quickly realize the establishment of safety culture and a safety assurance system, each organization prepares its “Implementation Program of Safety Culture” and the regulatory body provides a systematic basis to evaluate the results of its implementation.

Nuclear power plants in operation or under construction are supplemented with regulatory requirements consistently and systematically to achieve an international level of nuclear safety, taking into account the possibility of severe accidents.

For newly constructed nuclear power plants, factors which may increase the total risk caused by the construction of an additional nuclear power plant at the same site of existing ones are to be mitigated by improving the safety level at each grade as compared with that of existing nuclear power plants. For nuclear power plants in operation, maintenance, repair, inspection, and monitoring of components are to be strengthened. “Periodic Safety Reevaluation” is established and implemented to reassess and supplement safety deficiencies which may be caused by the aging of facilities and application of old technical standards.

In accordance with regulatory requirement changes in and out of the country, the existing atomic energy law system is to be revised and supplemented, and related technical standards and regulatory guidance are to be maintained in order to efficiently perform regulatory activities.

In consideration of the technical expertise required for nuclear regulatory activities, safety research should be continuously strengthened to meet the growing demand of regulatory requirements due to technical advancements in the nuclear field.

Solutions for unresolved safety issues, including generic safety issues of nuclear power plants, are promptly found and reflected in policy. Operating records and accident and failure data are analyzed to determine factors that affect the safety of nuclear power plants, and efficient safety supplementary measures are also established.

The regulatory organization reviews the introduction of “Optimum Assessment &

Probabilistic Assessment" for safety analyses, and encourages the licensee to introduce new technologies when and if they are considered to be reasonable safety assurance measures, as proven by their application.

An "Overall Safety Assessment" is performed using probabilistic safety assessment and "Nuclear Regulation based on Risk" is done through sound safety regulations in consideration of cost-benefit factors.

Quantitative safety goals and regulatory guidelines for the examination, prevention and mitigation of severe accidents are established and improved to be gradually applied to advanced nuclear power plants as well as to existing facilities. In addition, design and operational safety of nuclear power plants are achieved through these measures in order to minimize human error.

Radiation protection is achieved by the concept, "Radiation exposure should be kept as low as reasonably achievable (ALARA)", taking into account economic and social circumstances, and for individual exposure dose, the introduction of radiation protection standards based on the new ICRP 60 recommendations are being favorably reviewed.

In response to growing public concern about nuclear safety, nuclear safety-related information and regulatory activities are open to the public through the publication of the "white paper on nuclear safety" and through the periodic release of information about accidents and failures at nuclear power plants.

5. Conclusion

The nuclear community strives for the public's proper understanding of nuclear energy and the establishment of safety culture by hearing and addressing the public's concerns with understanding and by using the collected wisdom of those involved to solve any problem together.

Nuclear safety cannot be achieved in a day, but it is rather secured through the licensee's constant efforts to improve nuclear safety and through the regulator's thorough enforcement activities. The basic concept of nuclear regulations is to protect the public from radiation hazards and to pursue a "better safety performance" as allowed by circumstances.

To this end, the Government is devoted to developing a higher level of nuclear safety technology and regulatory system, and to achieving an international level of nuclear safety through participation in the "Nuclear Safety Convention".

In conclusion, the Government reaffirms that the assurance of nuclear safety is the highest duty of the regulatory organization and ensures that such an important role is performed faithfully to secure nuclear safety on behalf of the public.

September 10, 1994

Annex E. KINS mission statement and code of conduct

KINS Mission Statement

The KINS's mission is to protect public health, safety and the environment from radiation hazards that might be incidental to the production and use of nuclear energy.

In order to perform our mission faithfully as a watchdog of nuclear safety, we make the following commitments directives in performing our mission:

- Recognizing that its ultimate client is the general public, KINS shall perform nuclear safety regulatory functions objectively and in fairness, and also maintain independence from any stakeholders including the licensees.
- KINS shall open information on the results of its work performance to the public faithfully to inspire public confidence on nuclear safety regulation.
- KINS shall carry out regulatory functions with state-of-the-art technology and knowledge, maintain and improve its technical capability continuously, and further make clear regulatory decisions without any undue delay.
- KINS shall pursue effectiveness and rationality in safety regulation.
- KINS shall endeavor for the establishment of nuclear safety culture so as to encourage the personnel engaged in nuclear energy to put foremost priority on safety in doing their job.
- Recognizing that nuclear safety is a matter of international concern, KINS shall maintain close cooperative relationships with international agencies and foreign institutes.

February 11, 2000

KINS Code of Conduct

As employees of KINS, we shall carry out regulatory function to protect public health, safety and the environment from radiation hazards that might be incidental to the production and use of nuclear energy. For this, recognizing the importance of our mission and responsibility, we are committed to exerting every effort to gain public trust, and at the same time, we shall hereby establish not only this Code of Conduct to be observed fundamentally but also further carry it into practice.

Chapter 1. General Principles

Article 1. Observance of Regulations
We shall have thorough knowledge of our mission and duty, and further observe all relevant rules and regulations in carrying out our work.

Article 2. Maintenance of Dignity
We shall take pride in the fact that we are working for the public, maintain a high level of morality and integrity and further behave in a decent manner.

Article 3. Reasonable Thinking
We shall think reasonably and perform our work faithfully on the basis of sound common sense.

Article 4. Participation and Respect
We shall actively participate in the decision-making process of our Institute and respect the results thereof.

Article 5. Prohibition of Unjust Use and Disclosure of Information
We shall not use or disclose any facts, materials, intellectual property of any industry and any personal information acquired or known in connection with performance of our duty.

Article 6. Security of Expertise
We shall secure expertise in our respective working fields, and further make every effort to improve the quality of our work.

Article 7. Creation of Working Environment
We shall create a harmonious and bright work environment through an attitude of mutual respect, neat and clean appearance and courteous words and behavior.

Chapter 2. Principles for Regulators

Article 8. Objectivity in Performance of Functions
We shall maintain the objectivity of regulation by deciding fairly on the basis of facts in accordance with clear standards in performing regulatory functions.

Article 9. Working Attitude and Self-Control
We shall do our regulatory work with a sense of responsibility and a sense of duty, and wear clothes suitable for each work situation. Also, we shall perform our work in good mental and physical condition after making sufficient preparations in advance.

Article 10. Attitude toward Licensee
While performing our regulatory functions, we shall not hinder work of licensees unduly, having good manners toward them, including use of gentle words and the like.

Article 11. Prohibition to Have any Common Interest
We shall neither have any individual interest with the licensees that might affect our regulatory functions, nor do any action that might rouse any suspicion about fairness of our regulatory work.

Article 12. Prohibition of Criticism
We shall not criticize any regulatory viewpoint held by any other department or any individual employee of our Institute in the presence of any licensees.

Article 13. Prohibition of Personal Opinion
We shall neither provide advice or suggestion for solutions to any pending regulatory issue as requested by the licensees, nor allow any personal opinion to be mistaken for the official one of our Institute.

Article 14. Prohibition against Receiving Money and other Valuables
We shall not receive any money, gift, entertainment and other convenience that might affect our regulatory functions from the licensees.

February 11, 2000

Annex F. References

F-1. Domestic

1) Atomic Energy Commission, National Radioactive Waste Policy, 1998

2) Ministry of Science & technology (MOST), Nuclear Safety Policy Statement, September 1994

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4) Korea Institute of Nuclear Safety, Annual Reports on Operational Aspects of Nuclear Power Plants in Korea, 2001.

F-2. Foreign

1) International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Material, ST-1, IAEA, 1996

2) International Atomic Energy Agency, The Principles of Radioactive Waste Management, Safety Series No. 111-F, 1995

3) International Commission on Radiological Protection, 1990 Recommendations of ICRP, ICRP Pub. 60, 1991

4) International Atomic Energy Agency, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources Safety Series No. 115, IAEA, 1996.