NATIONAL REPORT
FOR
THE CONVENTION ON NUCLEAR SAFETY

October 2001

GOVERNMENT OF THE REPUBLIC OF KOREA

Foreword

The second National Report, pursuant to Article 5 of the Convention on Nuclear Safety which entered into force on 24 October 1996, describes the official actions that the Government of the Republic of Korea, as a signatory to the Convention, has taken in order to fulfill its obligations prescribed in Articles 6 through 19 of the Convention.

This National Report was prepared in accordance with the "Guidelines Regarding National Reports under the Convention on Nuclear Safety", ***reflecting the observations given in the Summary Report of the first Review Meeting. Revised and added parts as compared with the first National Report were highlighted in bold and Italics.*** This Report maintains a structure of the article-by-article approach based on the topical arrangement of the Convention.

Nuclear installations covered in this National Report are land-based civil nuclear power plants under the jurisdiction of the Republic of Korea, including such storage, handling and treatment facilities for radioactive materials as are on the same site and are directly related to the operation of nuclear power plants, as defined in Article 2 of the Convention.

This National Report was drafted by the "Working Group for the Implementation of the Convention on Nuclear Safety" 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.

Major contributors to the preparation of this National Report were as follows: Mr. C.W. Cho, Mr. C.W. Kim, Mr. K.W. Lee, and J.H. Shin of the Ministry of Science and Technology; Mr. Y.S. Eun, Mr. S.K. Lee, Mr. D.K. Park, Mr. K.S. Choi, Mr. J.H. Song, Mr. K.S. Do, Mr. C.H. Jung, Mr. S.W. Kim and Mr. K.W. Cho of the Korea Institute of Nuclear Safety; Mr. H.K. Shim, Mr. G.J. Jung, Mr. P.S. Kim and Mr. K.Y. Suk of the Korea Hydro & Nuclear Power Co., Ltd.; and Mr. K.H. Chang of the Korea Power Engineering Company.

Table of Contents

D. Safety of Installations

List of Tables

List of Figures

List of Acronyms

AAC	Alternate Alternating Current
ABB-CE	Asea Brown Boveri-Combustion Engineering
AEC	Atomic Energy Commission
AECL	Atomic Energy of Canada, Limited
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
B&PV	Boiler & Pressure Vessel
CARE	Computerized Technical Advisory System for the Radiological Emergency
CDF	Core Damage Frequency
CEOG	Combustion Engineering Owner's Group
COG	CANDU Owner's Group
CRDR	Control Room Design Review
ECCS	Emergency Core Cooling System
EOF	Emergency Operation Facility
EPZ	Emergency Planning Zone
ERF	Emergency Response Facility
ERM	Environmental Radiation Monitors
ESF	Engineered Safety Feature
FROG	Framatome Owner's Group
HPES	Human Performance Enhancement System
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
INES	International Nuclear Event Scale
INPO	Institute of Nuclear Power Operation
IPE	Individual Plant Examination
ISI	In-Service Inspection
IST	In-Service Test
KAERI	Korea Atomic Energy Research Institute
KEDO	Korean Peninsula Energy Development Organization
KEPCO	Korea Electric Power Corp.
KHIC	Korea Heavy Industries and Construction Co.
KHNP	Korea Hydro & Nuclear Power Co., Ltd.
KINS	Korea Institute of Nuclear Safety
KOPEC	Korea Power Engineering Co.
KPS	Korea Plant Service and Engineering Co.
KRIA	Korea Radioisotopes Association
LWR	Light Water Reactor
MOCIE	Ministry of Commerce, Industry and Energy
MOE	Ministry of Environment

MOST	Ministry of Science and Technology
NEED	Nuclear Event Evaluation Database
NETEC	Nuclear Environment Technology Institute
NPA	Nuclear Plant Analyzer
NSC	Nuclear Safety Commission
ODCM	Off-site Dose Calculation Manual
OJT	On-the-Job Training
OM	Operation and Maintenance
OSC	Operational Support Center
PHT	Primary Heat Transport
PHWR	Pressurized Heavy Water Reactor
PNSC	Plant Nuclear Safety Committee
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PWR	Pressurized Water Reactor
SAR	Safety Analysis Report
SCC	Stress Corrosion Cracking
SPDS	Safety Parameter Display System
STA	Shift Technical Adviser
TLD	Thermoluminescence Dosimeter
TSC	Technical Support Center
USNRC	US Nuclear Regulatory Commission
WANO	World Association of Nuclear Operators
WH	Westinghouse Electric Co.
WOG	Westinghouse Owner's Group

I. Introduction

Ⅰ.1 National Nuclear Policy

Ⅰ.1.1 Long-term Nuclear Energy Policy

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 insufficient in the country. Kori Unit #1, the first nuclear installation in Korea, started its commercial operation in 1978. ***As of September 2001 there are 16 units in operation and 4 units under construction, as shown in Figure Ⅰ.1-1 and Annex A.***

The necessity of promoting a comprehensive and consistent policy has increased with the expansion of the nuclear industry, since the beginning of the 1990's. The Atomic Energy Commission, in consideration of such changes in situations, deliberated and decided on the "Directions of Long-term Nuclear Energy Policy towards the Year 2030" in July 1994. The Directions emphasize the safe and peaceful use of nuclear energy under a spirit of pursuing better life in harmonization with nature. It prescribes 4 primary objectives contributing to the economic and technological development and ultimately to the improvement of human welfare as follows:

(1) to enhance the stability in energy supply by promoting nuclear energy as a major energy source of domestic electricity generation,

(2) to achieve self-reliance in a nuclear reactor and proliferation-resistant nuclear fuel cycle technology through comprehensive and systematic nuclear energy research and development,

(3) to foster nuclear energy as a strategic export industry by securing international competitiveness through the advancement of nuclear technology, on the basis of active participation and initiatives of the civil sector, and

(4) to play a leading role in the improvement of human welfare and the advancement of science and technology by expanding the use of nuclear technology in agriculture, engineering, medicine, and industry, and by activating basic research of nuclear technology.

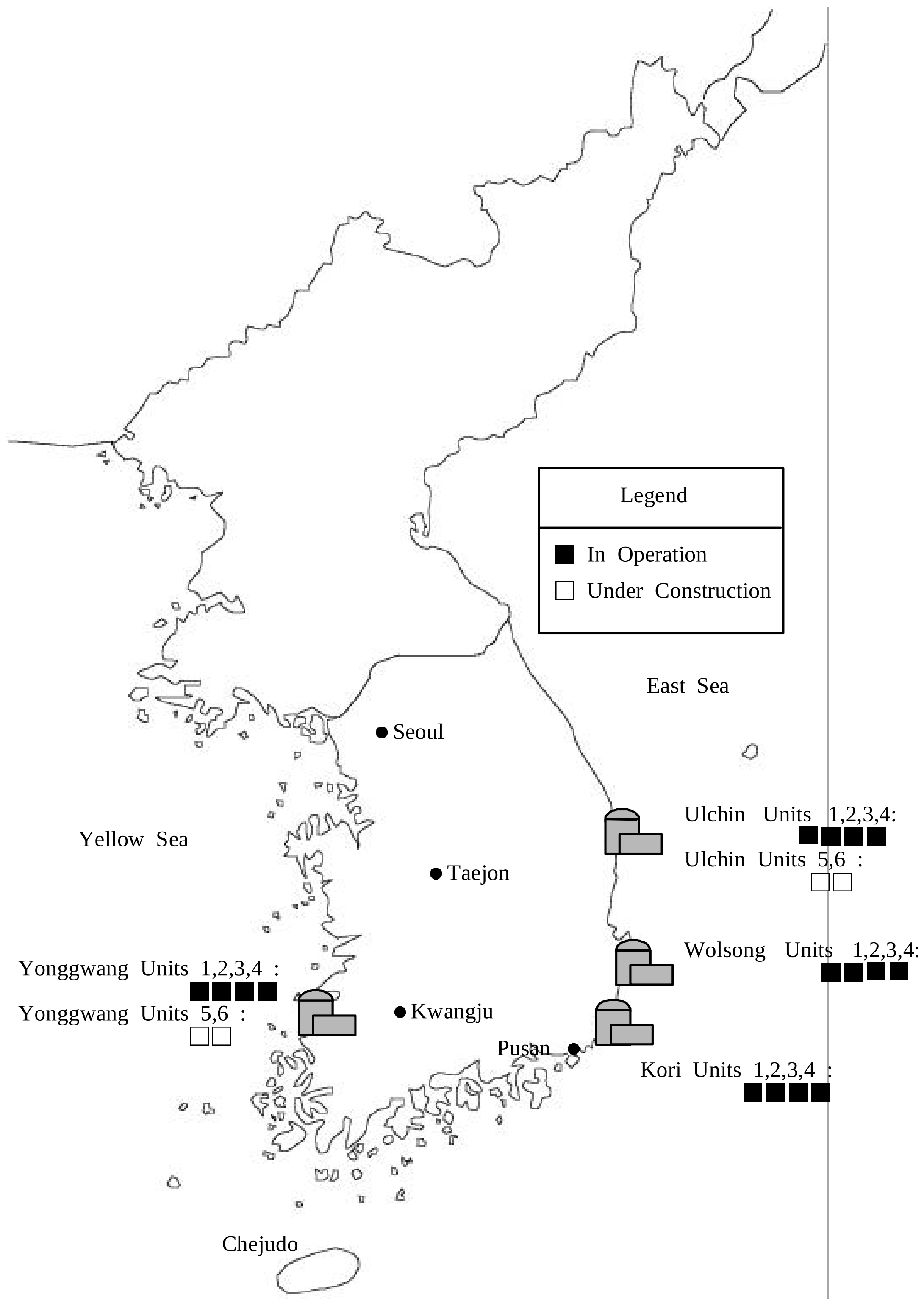


Figure Ⅰ.1-1 Locations of Nuclear Installations (As of September 2001)

For the effective achievement of these 4 objectives, 10 basic directions of long-term nuclear energy policy are established as follows:

(1) to continue expanding the development and utilization of nuclear energy in the future, unless an epoch-making alternative energy source becomes available in the foreseeable future,

(2) to develop and utilize nuclear energy for peaceful purposes only, and to keep consistently upholding this policy,

(3) to further strengthen the efforts to improve nuclear safety, recognizing the fact that securing nuclear safety is a prerequisite to the development and utilization of nuclear energy,

(4) to improve the economy and to strengthen the international competitiveness of domestic industries through the advancement of nuclear technology,

(5) to increase the public's understanding of and support for nuclear energy while respecting the public's right to know under the ideals of democracy and openness,

(6) to implement the nuclear energy policy in such a way as to promote a balanced development of the entire spectrum of both nuclear industries and technologies,

(7) to promote creative research and development activities so that nuclear energy can play a leading role in demonstrating the possibilities of technological innovation and challenging new areas of science and technology, as an integral part of the national science and technology policies,

(8) to conduct nuclear research and development activities in collaboration with industries, universities and research institutes by rational division of the responsibilities between the governmental and the non-governmental sectors, in view of specialization, complexity, and the immensity of nuclear research,

(9) to implement the nuclear energy policy on the basis of international understanding and cooperation to keep up with international harmonization, and

(10) to consistently implement the nuclear energy policy on the basis of long-term perspectives on techno-economic and socio-political environment.

In order to offer a legal basis for effectively implementing the aforementioned directions of long-term nuclear energy policy, the Government legislated for the

particulars on the "Formulation of a Comprehensive Promotion Plan for Nuclear Energy" through the amendment to the Atomic Energy Act in January 1995. As a national plan, "the first Comprehensive Promotion Plan for Nuclear Energy (1997-2001)" was formulated through the decision of the Atomic Energy Commission in June 1997.

In June 2001, "the second Comprehensive Promotion Plan for Nuclear Energy (2002-2006)" was also formulated through the decision of the Atomic Energy Commission.

The Comprehensive Promotion Plan for Nuclear Energy presents not only the objectives and directions of a long-term nuclear energy policy towards the year 2015, but also the objectives to be achieved in each subject area, based on the current status and future prospects for the use of nuclear energy. The Atomic Energy Act stipulates that every five years the Minister of Science and Technology and the heads of the concerned ministries shall formulate by-sector implementation plans for those areas under their jurisdiction, in accordance with the Comprehensive Promotion Plan for Nuclear Energy, and shall establish and implement annual action plans according to the by-sector implementation plans.

Ⅰ.1.2 Nuclear Safety Policy

In September 1994, the Minister of Science and Technology issued the "Statement of Nuclear Safety Policy" containing 5 principles of nuclear safety regulation to secure consistency, adequacy, and rationality of regulatory activities, and 11 directions of nuclear safety regulation policy to concretely implement those principles. (Refer to Annex B)

The Statement of Nuclear Safety Policy declares that securing safety is a prerequisite to the development and utilization of nuclear energy, and that all workers engaged in nuclear activities must adhere to the principle of "priority to safety". It emphasizes the importance of developing the nuclear safety culture that the International Atomic Energy Agency (IAEA) has referred to. It also prescribes that the ultimate responsibility for nuclear safety rests with the operating organizations of nuclear installations, and is in no way diluted by the separate activities and responsibilities of designers, suppliers, constructors, or regulators. Finally, it prescribes that the Government shall fulfill its overall responsibility to protect the public and the environment from radiation hazards that might accompany the development and utilization of nuclear energy.

In order to assure the institutional independence of nuclear safety regulation, the Government established the Nuclear Safety Commission through the amendment to the

Atomic Energy Act in December 1996. Its function is to deliberate and decide on important issues related to nuclear safety. It is under the jurisdiction of the Minister of Science and Technology and independent of the Atomic Energy Commission.

Ⅰ.2 National Nuclear Power Development Program

The Government has updated the Long-term Electricity Supply Plan every 2 years, since its formulation in 1991, ***and established the 5th Long-term Electricity Supply Plan (1999   2015) in 1999.***

According to this Plan, 12 units of nuclear power plants including 4 units now under construction will be completed by 2015, with the result that the nuclear power installed capacity and the ratio of nuclear installations to total capacity of power generating installations are to be increased to 26.1 GWe and 33.0% respectively. The expected generating capacity and power generation of nuclear installations are shown in Table Ⅰ.2-1.

In the recent restructuring process of electric industry in Korea, hydro & nuclear parts had been separated from Korea Electric Power Corporation(KEPCO) which was the owner of all power plants in Korea and Korea Hydro & Nuclear Power Co., Ltd(KHNP) was newly established. KHNP, a subsidiary of KEPCO, constructs and operates all of the hydro and nuclear power plants in this country.

Table Ⅰ.2-1 Nuclear Power Installed Capacity and Power Generation

Items \ Year	2000	2005	2010	2015
Number of operating units	16	20	25	28
Generating capacity in MWe (%)	***13,716 (28.3)***	17,720 ***(28.7)***	***22,530 (30.2)***	***26,050 (33.0)***
Power generation in GWh (%)	***108,964 (40.9)***	***126,364 (38.4)***	***153,156 (39.9)***	***190,125 (44.5)***

Source: 5th Long-term Electricity Supply Plan (1999-2015), Ministry of Commerce, Industry and Energy, January 2000

Ⅰ.3 Summary of Main Safety Issues

In order to complement any deterioration in safety due to the aging of structures, systems, and components of operational nuclear installations and to ensure a high level of safety commensurate with new installations, the Ministry of Science and Technology ***devised*** institutional measures to conduct a comprehensive periodic safety review in addition to the existing safety assessment and inspection for operating nuclear installations.

The Nuclear Safety Commission resolved to take up the periodic safety review(PSR) implementation plan covering the basic directions, the method of implementation, and the selection of nuclear power plants subject to the periodic safety review and its legislation in the 11th committee meeting of December 21, 1999. The policy basically aims to introduce and enforce a comprehensive and systematic safety assessment system including the operating experience in and outside Korea, the general safety activities of licensee, and the aging effect, that are essential to secure safety during the lifetime of operating nuclear plants. According to this plan, the periodic safety review must be implemented every 10 years from the date of licensing of operation, and by the operator of the plant, and its result is to be examined by a regulatory body. Additionally, it is feasible to modify the criteria for periodic safety review on the basis of 11 safety factors specified in the Guidelines on Periodic Safety Review provided by IAEA, and adjust the detailed scope of safety review according to the number of years of operation. The legislation of this periodic safety review system was completed in January 2001 and action items of the related organizations were decided.

The Ministry of Science and Technology plans to introduce the 1990 Recommendations of the International Commission on Radiation Protection (ICRP 60), in harmony with domestic circumstances for the improved radiation protection of workers, the public and the environment. The specifics on relevant programs and their schedules are described in Section Ⅲ.2.

Ⅱ. Article-by-Article Assessment

A. General Provisions

Ⅱ.1 Existing Nuclear Installations (Article 6)

Ⅱ.1.1 Status of Nuclear Installations

The status of the construction and operation of nuclear installations is shown in Annex A. Kori Unit #1, the first nuclear power plant in Korea, started its commercial operation in April 1978. ***As of September 2001 there are 16 units of nuclear power plants in operation and 4 units under construction. The 16 operating units consist of 12 PWR-type units and 4 PHWR-type units, while all 4 units under construction are of PWR type.***

Ⅱ.1.2 Safety Assessment for Nuclear Installations

Safety Assessment and Inspection for Pre-operational Nuclear Installations

The Atomic Energy Act stipulates that an applicant for a construction permit or an operating license, before commencing the construction and operation of nuclear installations, shall perform comprehensive and systematic safety assessments and file safety analysis reports (SARs) with the regulatory body for a safety review. According to this provision, all nuclear installations are under construction and in operation through safety assessment by the Korea Hydro & Nuclear Power Co., Ltd. (KHNP) as an applicant for construction permit and operating license, and through safety review and regulatory inspection by the Ministry of Science and Technology (MOST) as a regulatory body. The details of the stepwise safety review and regulatory inspection and the general licensing procedure for the operation of nuclear installations are described in Sections Ⅱ.2.3 and Ⅱ.2.4, while the details of the comprehensive safety assessment for the construction and operation of nuclear installations are described in Section Ⅱ.9.1.

Safety Assessment and Inspection for Operational Nuclear Installations

KHNP, the operator of nuclear installations, conducts a safety assessment for the refueled reactor core at every refueling period. MOST allows the reactor to be at a critical state if the result of a comprehensive safety and performance evaluation for nuclear installations is satisfactory through a systematic regulatory inspection as well as a safety review. The details of a safety assessment for operational nuclear installations are described in Section Ⅱ.9.2.

In order to ensure the safety of operating nuclear installations, KHNP carries out an overall safety examination for nuclear installations every 20 months, and improve the safety of the nuclear installation, if necessary, as a result of the evaluation of safety-related operating experience and incident cases. KHNP also conducts a periodic assessment for the main safety parameters, for example, unplanned reactor scram, and the operability of safety-related facilities. The specific activities are described in Sections Ⅱ.9.2 and Ⅱ.9.3.

In accordance with the resolution of the PSR in December 1999, KHNP has initiated the PSR for Kori Unit 1 in May 2000 and the review will be completed by November 2002. Detailed activities are described in Section III.1.

Probabilistic Safety Assessment for Nuclear Installations

To comprehensively evaluate the safety of operational nuclear installations and to identify the vulnerabilities to severe accidents, MOST recommended KHNP to perform a probabilistic safety assessment for each nuclear installation. In response thereto, ***KHNP completed or is now conducting the probabilistic safety assessment for relervant installations. The results also represent that core damage frequency of 10-4/reactor · year specified by IAEA. The particulars of the status of implementing probabilistic safety assessment and the core damage frequency are described in section II.9.2.***

Severe Accidents Management

MOST took measures to lower the risk of nuclear installations as low as possible in view of the defense in depth concept by conducting PSA for individual power plant against severe accident which may cause a damage of reactor core and/or the release of radioactive materials to the environment. In July 2001, Nuclear Safety Commission decided to formulate 'a Severe Accident Policy' which establishes quantitative safety goal and reactor performance goal and recommends the evaluation of NPP's risk with PSA methodology. The policy also requires licensee's capability to prevent severe accident and the establishment of severe accident management program.

According to this policy, KHNP is currently establishing the accident management program for nuclear installations.

Safety Improvement of Nuclear Installations

The safety vulnerability observed by the aforesaid safety assessments continues to be rectified through the improvement of installation, maintenance, and the modification of a relevant procedure. In fact, KHNP applied the Post-TMI Actions to all nuclear installations under construction or in operation, after the TMI nuclear accident in USA. As for the Kori Unit #1 which started working first in Korea in 1978, KHNP replaced all of two steam generators showing a performance deterioration inclusive of the tube plugging rate reaching 11.5% due to the damage of tubes by stress corrosion cracking (SCC), pitting, etc. in 1998, and conducted a safety reassessment, of which the result was duly confirmed by MOST.

KHNP also resolved the Y2K problems for all nuclear power plants, and now steadily improves the safety of reactor facilities with the safety assessment for power operated valves as well as the countermeasures against station blackout.(Refer to Annex F)

Ⅱ.1.3 Safety Status of Nuclear Installations

Through various types of systematic assessments for operating nuclear installations and continuous efforts to enhance safety, as mentioned above, the nuclear installations in operation show high performance in terms of unplanned scram rates, capacity factors and occupational radiation exposures as described in Section Ⅱ.9.2.

Consequently, the safety level of operating nuclear installations is in conformity with the international safety criteria and practices prescribed in Articles 10 to 19 of the Convention. Currently, there are no pending issues which require urgent special measures to enhance safety.

Ⅱ.1.4 Position as to Continued Operation of Nuclear Installations

Basing on the result of various evaluations, the Korean Government concludes that the continued operation of operational nuclear installations is reasonable.

B. Legislation and Regulation

Ⅱ.2 Legislative and Regulatory Framework (Article 7)

Ⅱ.2.1 Nuclear Legislative Framework

National laws related to the development, utilization and safety regulation of nuclear energy are the Atomic Energy Act, the Electricity Business Act, the Environmental Impact Assessment Act and others shown in Table II-2-1. 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 of nuclear installations.

The Atomic Energy Act System, as shown in Figure Ⅱ.2-1, consists of 4 stages : the Atomic Energy Act, the Enforcement Decree of the same Act, the Enforcement Regulations of the same Act and the Notice of the Minister of Science and Technology. The Atomic Energy Act provides the bases and the fundamental matters concerning the development and utilization of nuclear energy and safety regulation. It includes provisions on the Atomic Energy Commission, the Nuclear Safety Commission, nuclear energy promotion program, construction permit and operating license of nuclear installations, and others shown in Table Ⅱ.2-2.

The Enforcement Decree of the same Act (the Presidential Decree) provides the technical standards and particulars entrusted by the Act and necessary for the enforcement of the same Act.
The Enforcement Regulation of the same Act (the MOST Ordinance) provides the particulars including the detailed procedure, the format of documents, and technical standards, as entrusted by the same Act and the same Decree.
The Enforcement Regulations were divided into three on January 16 2001, namely, the Enforcement Regulation Concerning the Technical Standards of Reactor Facilities, etc., and the Enforcement Regulation Concerning the Technical Standards of Radiation Safety Management, etc.

The Notice of the Minister of Science and Technology prescribes specific issues including regulatory requirements and technical standards, as entrusted by the same Act, the same Decree and the same Regulation. Table II-2-3 lists the Notices of the Minister of Science and Technology applicable to nuclear installations.

The industrial standards applicable to nuclear activities are endorsed by MOST and applied to the design and operation of nuclear installations. The guidelines on safety reviews and regulatory inspections, developed by the Korea Institute of Nuclear Safety (KINS), an expert organization for safety regulation, are in practical use.

Table II.2-1 Laws Concerning Nuclear Regulation (1/2)

Title	Major Contents	Competent Authorities	Remarks
Atomic Energy Act	Integrated law on the development and utilization of nuclear power and nuclear regulations	Ministry of Science and Technology	—
Korea Institute of Nuclear Safety Act	Provides the establishment and operation of the Korea Institute of Nuclear Safety	Ministry of Science and Technology	—
Nuclear Damage Compensation Act	Provides the procedures and extent of compensation for any damages which an individual has suffered from a nuclear accident	Ministry of Science and Technology	—
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	Ministry of Science and Technology	—
Electricity Business Act	Provides the basic system of electricity business	Ministry of Commerce, Industry, and Energy	The Atomic Energy Act is entrusted for the particulars on the safety regulations of 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	Ministry of Commerce, Industry, and Energy	Prior notice of nuclear site
Basic Law of Environmental Policy	Mother law of the environmental preservation policy	Ministry of Environment	The Atomic Energy Act is entrusted for the particulars on the measures to prevent radiological contamination
Environmental Impact Assessment Act	Provides the extent and procedures to assess environmental impacts according to the Basic Law of Environmental Policy	Ministry of Environment	Assessment of environmental impacts excluding radiological impacts

Table II.2-1 Laws Concerning Nuclear Regulation (2/2)

Title	Major Contents	Competent Authorities	Remarks
Fire Services Act	Provides the general matters on the prevention, precaution and extinguishment of fire	Ministry of Government Administration and Home Affairs	The requirements for safety management of inflammables
Building Act	Provides the general matters on construction	Ministry of Construction and Transportation	The Atomic Energy Act is entrusted for the particulars on the construction permit for a nuclear installation
Industrial Safety and Health Act	Provides the preservation and enhancement of workers' health and safety	Ministry of Labor	The Atomic Energy Act is entrusted for the particulars on radiological safety
Industrial Accident Compensation Insurance Act	Provides insurance to compensate for workers with industrial disaster	Ministry of Labor	-
Basic Law of Civil Defense	Provides the general matters on the civil defense system	Ministry of Government Administration and Home Affairs	Preparedness against disasters due to nuclear accidents is included in the basic civil defense plan
Disaster Control Act	Provides the general matters on controls of man-made disasters	Ministry of Government Administration and Home Affairs	It prescribes corrective or complementary measures for violations in the implementation of the basic civil defense plan

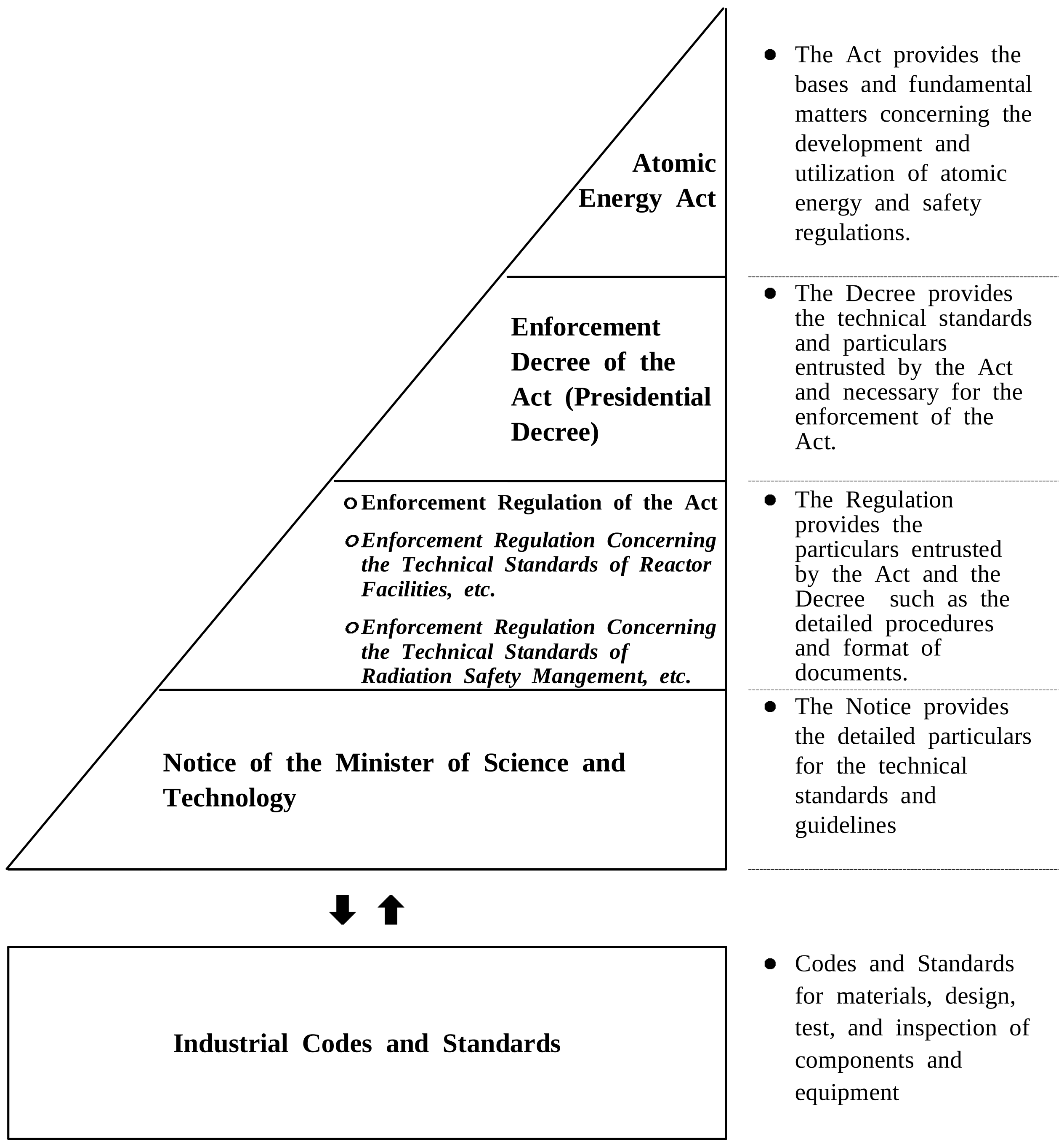


Figure Ⅱ.2-1 Legal System of the Atomic Energy Laws

Table II.2-2. The 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 permit (license), licensing procedures, license application documents to be submitted, regulatory inspection, records and keeping, appointment (dismissal) and obligation of responsible persons for nuclear reactor operation, notification of suspension or disuse of operation, transfer and inheritance, measure 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 enterprise and use, etc. of nuclear materials	Criteria for permit (license), licensing procedures, license application documents to be submitted, and regulatory inspection
Section 1	Nuclear fuel cycle enterprise	
Section 2	Use of nuclear materials	
Chapter 7	Radioisotopes and radiation generating devices	Criteria for permit (license), licensing procedures, and regulatory inspection
Chapter 7-2	Service provision business	Registration of service provision business, and duties of the service provider
Chapter 8	Disposal and transport	Permit for construction and operation of disposal 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 certificate of license
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, fine for negligence, and joint penal provisions
Addenda		Enforcement date, transitional measures, and relations with other laws

Table II.2-3 Notices of the Minister of Science and Technology Applicable to Nuclear Installations

No.	Title	Effective Date (day/month/year)
No. 83-3	Criteria for Preparation of Operational Technical Specification	5/8/83
No. 94-10	Safety Classifications and Applicable Codes and Standards for Reactor Facilities	19/4/94
No. 96-1	Retraining for Suspended Senior Reactor Operators and Reactor Operators	31/1/96
No. 96-4	Criteria for Establishing and Implementing Radiological Emergency Plan	11/3/96
No. 96-25	Incidents and Accidents Reporting of Nuclear Installation	31/10/96
No. 96-31	Provision on Environmental Surveillance and Impact Assessment in Vicinity of Nuclear Installations	12/8/96
No. 96-32	Application of Korea Electric Power Industry Codes to Reactor Facilities	31/8/96
No. 96-38	Packaging and Transportation of Radioactive Materials	17/10/96
No. 96-39	Administration of Inspection Findings from Nuclear Installations	31/10/96
No. 97-11	Guidelines for Education and Training of Radiation Workers	2/10/97
No. 97-17	Evaluation of Applicant's Career for Nuclear Related Licensing Examination	17/12/97
No. 98-10	Guidelines for Preparing Radiological Environmental Report	20/7/98
No. 98-15	***Provision of In-Service Inspection and In-Service Test of Reactor Facilities***	***12/10/98***
No. 2000-8	***Requirements for Location, Structures and Components of Reactor Facilities***	***23/6/00***
No. 2000-12	***Regulation Concerning the Scope of Agency Business for Radiation Safety Management***	***4/10/00***
No. 2000-14	***Other Facilities Related to Safety***	***29/12/00***
No. 2000-15	***Material Surveillance Criteria for Reactor Pressure Vessel***	***29/12/00***
No. 2000-16	***Pressure Integrity Test Criteria for Reactor Facilities***	***29/12/00***
No. 2000-17	***Guidelines for the Application of the Technical Standards of Electric-Power Industry to the Technical Standards of Reactor Facilities***	***29/12/00***
No. 2000-18	***Technical Standards of Safety Valve and Release Valve for Reactor Facilities***	***29/12/00***
No. 2000-19	***Criteria for the Performance of PWR Emergency Core Cooling System***	***29/12/00***
No. 2001-2	***Radiation Protection Standards***	***31/1/01***

Major amendments of the Atomic Energy Acts are as follows.

- ***Improvement of fundamental framework for permit/license provisions, with two(2)-step-procedure of nuclear power reactor such as construction permit and operational license, and with one(1)-step-procedure combined construction permit with operational license for other installations/activities such as research reactor, nuclear fuel cycle facilities and use of radioactive isotopes***

- ***Abolishment of three regulatory systems, namely, license for manufacturing business, license for performance verification business, and registration for business providing service.***

- ***Enlargement of the scope of utilities self-regulation due to the development of domestic technology, particularly, abolishment of nuclear fuel inspection system by regulatory body***

- ***Introduction of Periodic Safety Review system to make periodically overall safety assessment of operational nuclear power plants***

- ***Introduction of the quality assurance examination system with submittal of a quality assurance plan, in case of approval of decommissioning of nuclear power plant and nuclear fuel cycle facilities***

- ***Introduction of standard design approval system for avoidance of double regulation, in case of repeated construction on the same design***

- ***Increase of number of the Nuclear Safety Commissioner from 5 7 persons to 7 9 persons.***

- ***Legislation in the Act of the amount of fund to be borne by the utilities, related to a nuclear research and development fund and prescription of the fund use for nurturing nuclear energy experts.***

Nuclear Damage Compensation Related Laws

With regard to the utility's civil liability for any nuclear accident, the "Nuclear Damage Compensation Act" and the "Nuclear Damage Compensatory Contract Act" were established in 1969 and in 1975 respectively, for i) the proper compensation for the victims and ii) the sound development of nuclear industries, and they prescribes a general principle internationally adopted concerning the civil liability for nuclear damage. In order to reflect the spirit of the Vienna Convention revised in 1997, the Nuclear Damage Compensation Act was amended on January 16, 2001, and the amendment works for related laws are in process.

Ⅱ.2.2 Nuclear Regulatory Framework

The governmental organizations concerned with nuclear activities, as shown in Figure II.2-2 are mainly formed of administrative authorities: The Ministry of Commerce, Industry and Energy (MOCIE) supervising the nuclear power program, the Ministry of Environment (MOE) responsible for regulating issues on the general environment excluding the radiological environment, and MOST responsible for nuclear safety regulations including the licensing of nuclear installations. There is also the Atomic Energy Commission 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 Nuclear Safety Commission, under the jurisdiction of MOST is responsible to deliberate and decide on important matters concerning the safety of nuclear installations.

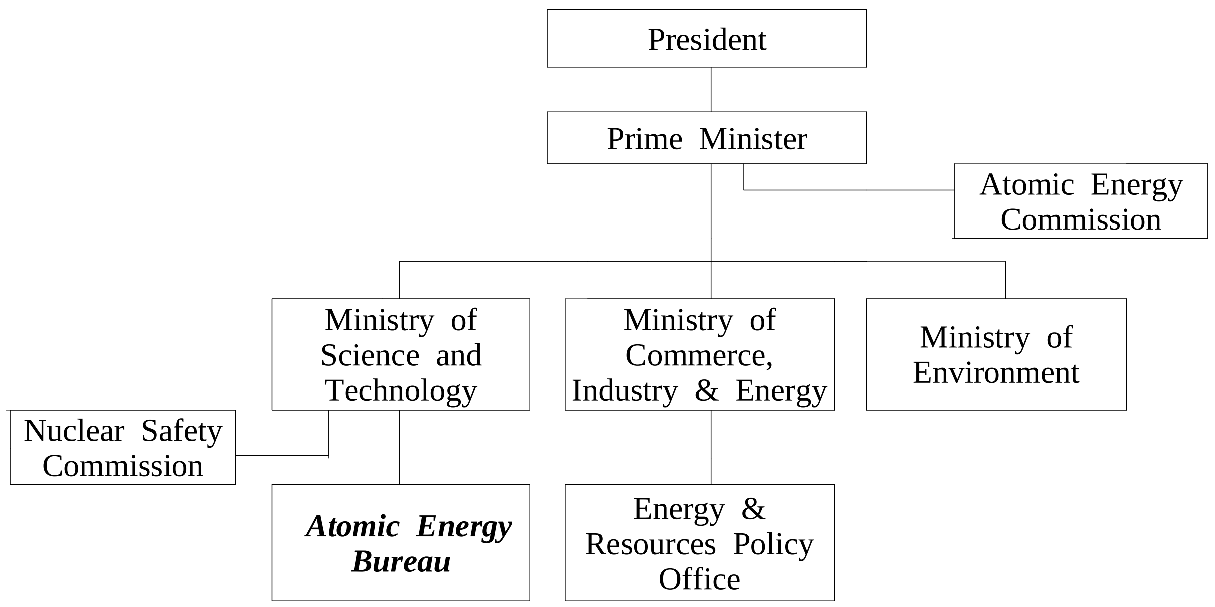


Figure II.2-2 Governmental Organizations Related to Nuclear Energy

Nuclear safety regulatory organizations, as shown in Figure Ⅱ.2-3, are mainly composed of MOST and the Nuclear Safety Commission as a safety regulatory authority, and KINS as an safety regulatory expert body. ***In addition, there are two organizations supporting regulatory activities of MOST, namely, the Korea Atomic Energy Research Institute (KAERI) which transacts the trusted affairs relevant to legal retraining for the radiation worker, and the Korea Radioisotopes***

Association (KRIA) is in charge of maintaining and keeping the related documents to occupational radiation exposures of the radiation worker. The details of regulatory organizations are described in Section Ⅱ.3.

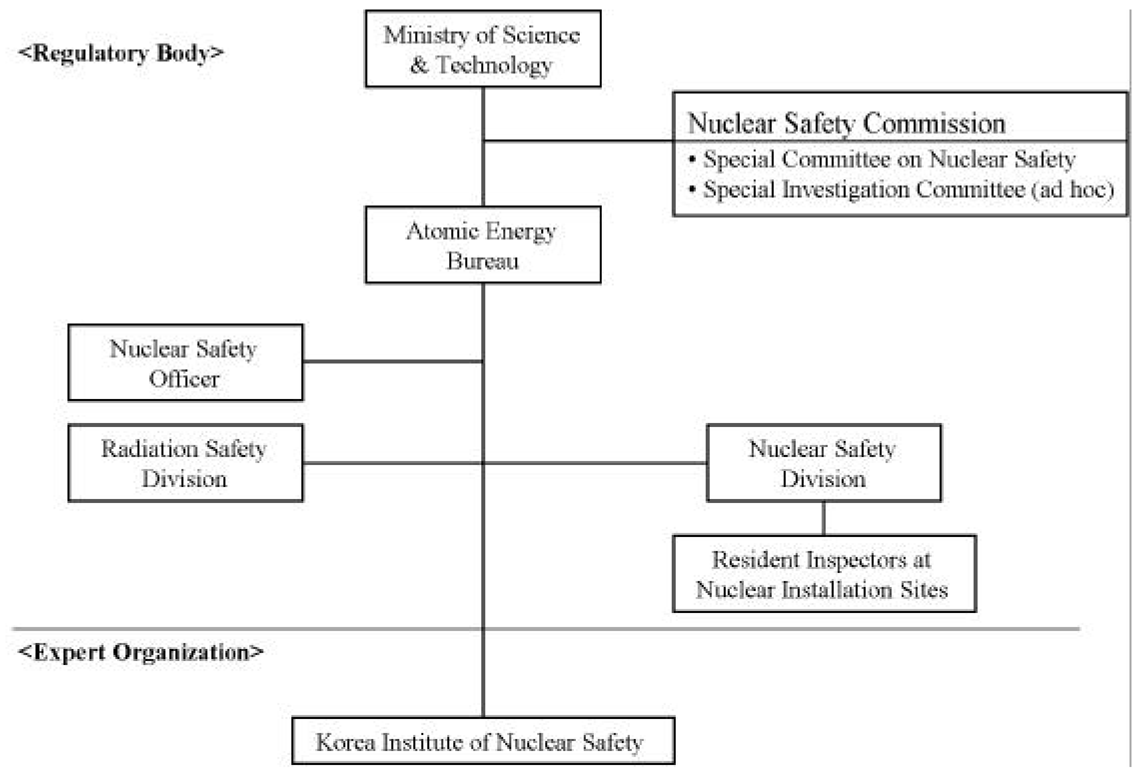


Figure II.2-3 Nuclear Safety Regulatory System

Ⅱ.2.3 Licensing System and Safety Assessment

The licensing procedures of nuclear installations consist of two steps, the construction permit and the operating license, pursuant to the Atomic Energy Act, and the early site approval system is established as a line in the chain of construction permit. as shown in Figure II.2-4.

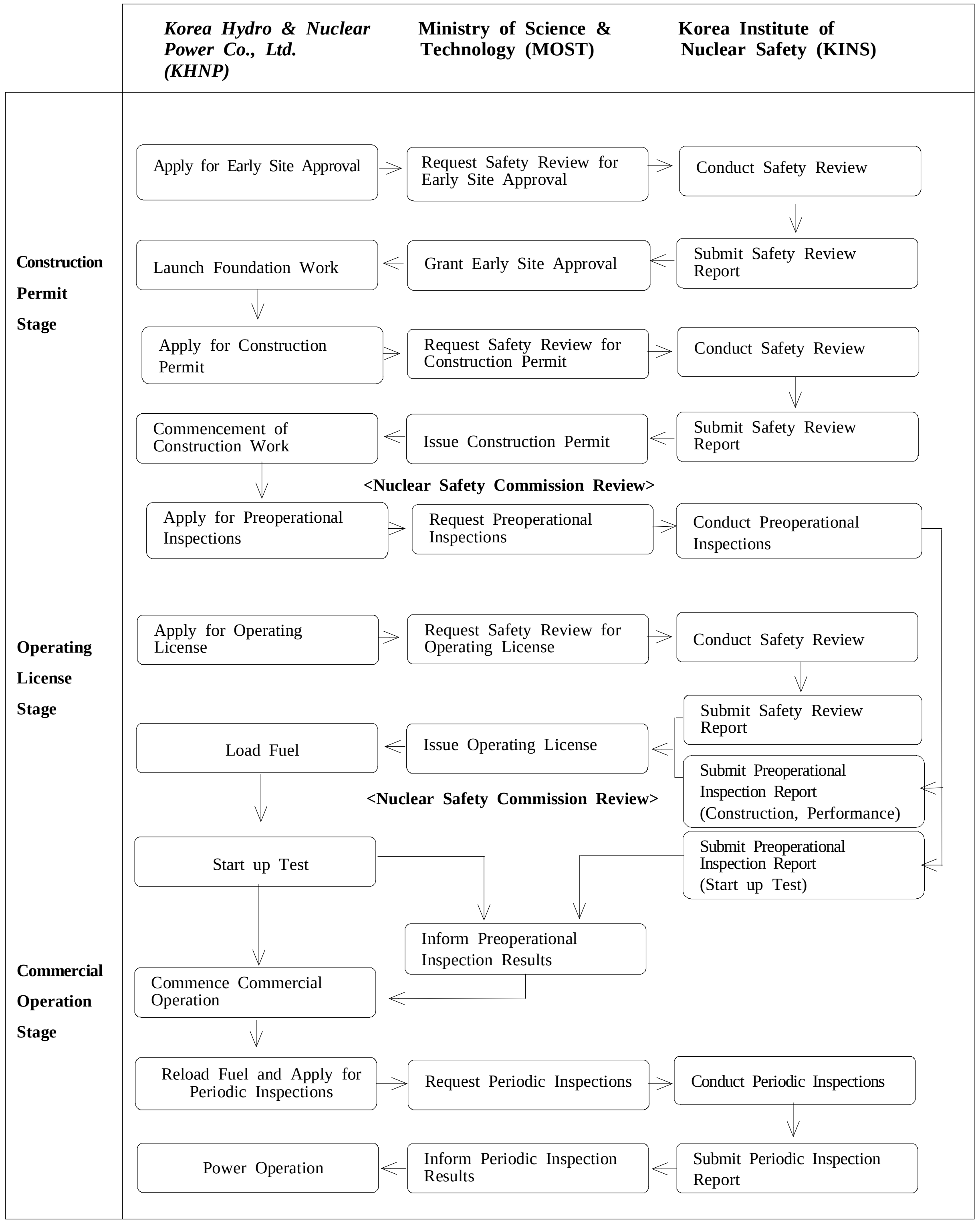


Figure II.2-4. Licensing Process for Nuclear Installations

Standard Design Approval

For the standard design of the NPPs which have enhanced level of safety, the regulatory effectiveness has been improved by setting up a new licensing system, i.e. the Standard Design Approval (SDA) System. The SDA system will ensure the validation of approved standard design without imposing additional regulatory requirements during certain period of time by the law and will basically exculde safety review for the portions of NPPs referencing approved standard design.

Early Site Approval

In order to begin limited construction work on a proposed site before the construction permit is issued, an applicant for early site approval shall file an application for approval accompanied by a site survey report and a radiological environmental report with the Minister of Science and Technology. Based on the results of the safety review by 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 a nuclear site and the radiological impacts on the environment surrounding the nuclear installation. MOE is in charge of reviewing non-radiological environmental impacts.

Construction Permit for Nuclear Installation

In order to obtain a construction permit for nuclear installation, the applicant shall file an application for a construction permit accompanied by the radiological environmental report, the preliminary safety analysis report, and the quality assurance program for design and construction with the Minister of Science and Technology. Basing on the results of the safety review by KINS of the application for a construction permit, the Minister will issue a construction permit after deliberation by the Nuclear Safety Commission.

The safety review of the application for a construction permit is conducted to confirm that the site and the preliminary design of the nuclear installation are in conformity with the relevant regulatory requirements and technical guidelines. It includes safety reviews of the principle and concept of reactor facility design, the implementation of the regulatory criteria in due course, the evaluation of the environmental effects resulting from the construction, and a proposal for minimizing those effects.

The radiological environmental report to be filed together with the application for a construction permit as well as for early site approval should contain the public's opinion from the area surrounding the nuclear installation through a public hearing, if necessary.

Operating License for Nuclear Installation

To obtain an operating license for a nuclear installation, the applicant shall submit to the Minister of Science and Technology the application for an operating license accompanied by the operational technical specifications, the final safety analysis report, the quality assurance program for operation, and the radiological emergency plan. Based on the results of the safety review by KINS of the application for an operating license and the results of pre-operational inspections, the Minister will issue the operating license after deliberation by the Nuclear Safety Commission.
The safety review of the application for an operating license is conducted to confirm that the final design of the nuclear installation is in conformity with the relevant regulatory requirements and technical guidelines and that the nuclear installation may continue to operate throughout its lifetime.

Amendment to Operating License for Nuclear Installation

In order to make modifications to the specifics for which the operating license has been given, such as a change in the operational technical specifications or in the design that affects or may affect the safety of operating nuclear installations, it is necessary to obtain approval from the Minister of Science and Technology for an amendment to the operating license. The approval for an amendment to the operating license is the same in procedure as the application for an operating license. A safety review is to be conducted for the parts whose safety is affected or may be affected by the amendment to the operating license.

Approval for Decommissioning of Nuclear Installation

In case that the operator intends to decommission a nuclear installation, the operator shall prepare a decommissioning plan and obtain prior approval from the Minister of Science and Technology. A safety review for approval of the application is to be conducted by KINS for the radiation protection during decommissioning, the radiological impacts on the environment surrounding the nuclear installation after decommissioning, and the proposal for minimizing the impacts.

Ⅱ.2.4 Regulatory Inspection

Regulatory inspections for a nuclear installation under construction or in operation include ***the pre-operational inspection for the construction of nuclear installations, the periodic inspection for operating nuclear installations, the quality assurance audit, the daily inspection by resident inspectors, and the special inspection, pursuant to the Atomic Energy Act***. The general procedure for each inspection is schematically described in Figure II.2-5.

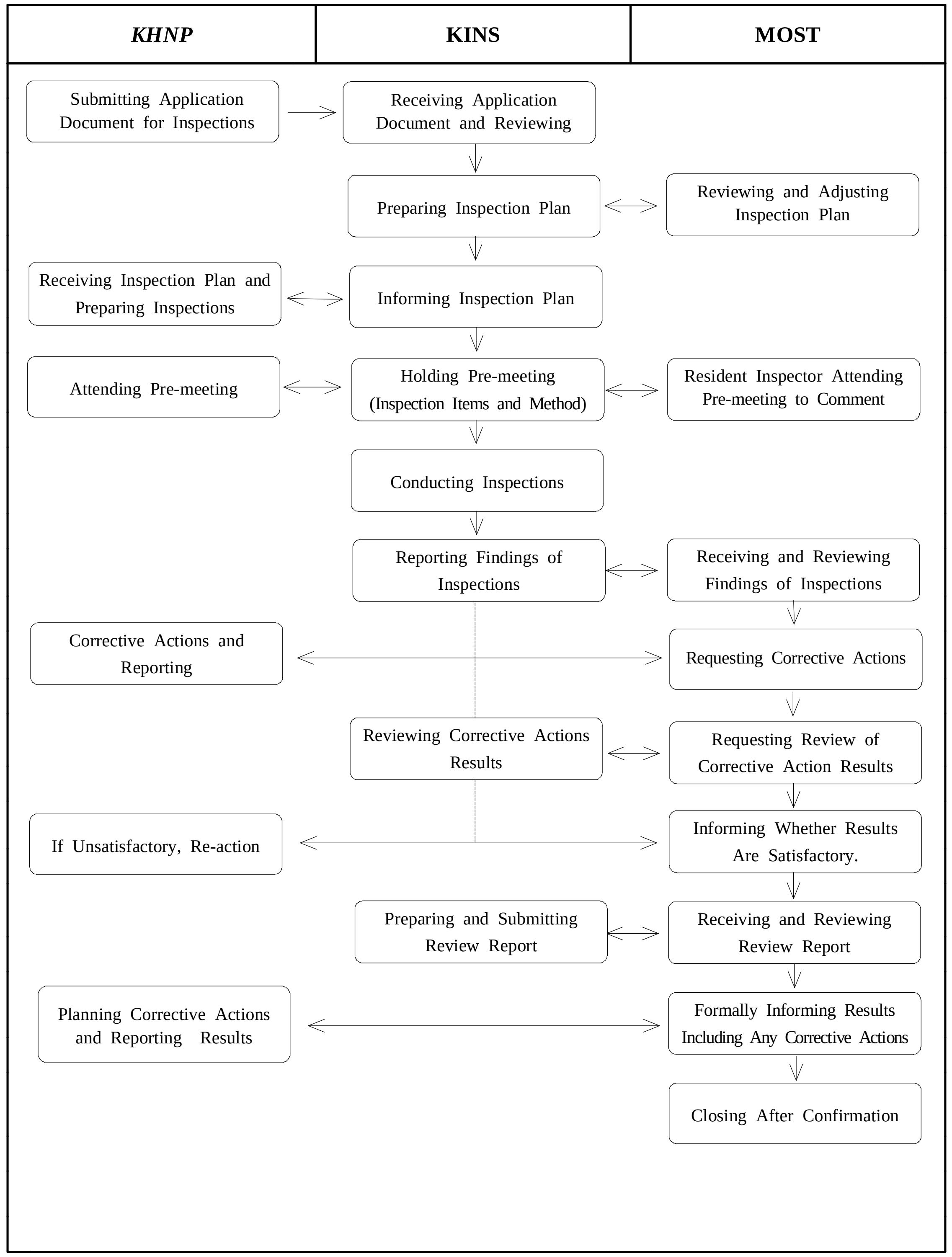


Figure II.2-5. Regulatory Inspection Process for Nuclear Installations

Pre-operational Inspection for the Construction of Nuclear Installations

The pre-operational inspection for the setup of nuclear installations is conducted to verify whether the nuclear installation is properly constructed in conformity with the conditions of the construction permit and whether the constructed nuclear installation may be operated safely throughout its lifetime. It is conducted for the construction and the performance of the facilities by means of a document inspection and a field inspection.

Periodic Inspection for Operating Nuclear Installations

The periodic inspection for an operational nuclear installation is conducted to verify whether the nuclear installation is properly operating in conformity with the conditions of the operating license; to verify whether the installation can still withstand pressure, radiation and other operating environments; and whether the performance of the installation maintains license based conditions. It is performed by means of a document inspection and a field inspection during the period of refueling outage for a PWR, and during periodic maintenance for a PHWR.

Quality Assurance Audit

The quality assurance audit is conducted to verify whether all activities affecting quality at every stage of the design, construction and operation of a nuclear installation are being performed in conformity with the quality assurance program approved by the regulatory body. It is conducted periodically for operational nuclear installations.

Daily Inspection by Resident Inspectors

The main purpose of the daily inspection is to daily check the nuclear installations under construction or in operation. It includes a field inspection on the surveillance tests, an investigation on the measures taken when the reactor reached an abnormal state, and a verification of the adequacy of the operator's activity regarding the radiation control.

Special Inspection

The special inspection includes an examination of important safety issues, if any, and an in-depth field investigation for the prevention of any potential accident.

Ⅱ.2.5 Enforcement

In case that the safety review results of the construction permit application meet the relevant requirements, the Minister of Science and Technology will issue a construction permit. The Minister may impose minimum conditions therein, if judging that it is necessary to secure safety. If any violation is found as a result of the 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 Minister of Science and Technology is authorized to order the operators to submit the necessary documents on their business and to complement any submitted documents. The Minister may also conduct a regulatory inspection to verify that the documents are in conformity with field conditions and order the operator to take corrective or complementary measures, if any, as a result of the inspection.

The Minister of Science and Technology may order the revocation of the permit (or license) or the suspension of business within a period of not more than one year, in cases where the installer or operator of a nuclear installation falls under one of the followings:

- where the installer or operator has modified any matters subject to the permit (or license) without approval,
- where the installer or operator has failed to meet the criteria for permit (or license),
- where the installer or operator has violated an order of the Minister of Science and Technology to take corrective or complementary measures as a result of the regulatory inspections for the construction or operation of a nuclear installation, and
- where the installer or operator has violated any of the permit (or license) conditions or regulations on safety measures in the operation of a nuclear installation.

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

Ⅱ.3 Regulatory Body (Article 8)

Ⅱ.3.1 Mandates and Duties of Regulatory Body

The primary mission of MOST is to ensure adequate protection of the public health and the environment against radiation hazards that may accompany the peaceful use of nuclear energy. It includes the following major functions:

- to establish policies for nuclear safety and regulation,
- to review and assess safety information of nuclear installations,
- to issue, amend or revoke licenses for the construction and operation of nuclear installations,
- to conduct regulatory inspections,
- to establish technical standards and regulatory requirements,
- to take necessary enforcement actions, 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 the appropriate emergency response capabilities,
- to ensure that the records of occupational radiation exposure are maintained,
- to assure the qualifications of radiation workers,
- to provide nuclear safety information for the public, and ***strengthen international cooperation for the enhancement of the public 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.

Ⅱ.3.2 Authority and Responsibility of Regulatory Body

The authority of 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 installations, and to take the necessary enforcement actions, where 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, where such delegation is directly essential to the performance of the body's regulatory responsibilities,
- to obtain such documents and opinions from public or 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 installation licensed or under review.

MOST assumes the responsibility to develop the acceptance criteria for constructing and operating nuclear installation, to develop technical standards for operational safety measures, and to ensure compliance at every stage of the siting, design, construction, commissioning, operation, and decommissioning of nuclear installations.

Ⅱ.3.3 Structure and Resources of Regulatory Body and Supporting Organizations

Ministry of Science and Technology (MOST)

As shown in Figure II.3-1, the Nuclear Safety Commission, under the jurisdiction of the Minister of Science and Technology, 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 on a vertical organization under the Minister.***

The Atomic Energy *Bureau* consists of *4 divisions: the Nuclear Policy Division, the Atomic Energy Cooperation Division, the Nuclear Safety Division, and the Radiation Safety Division. In the Atomic Energy Bureau, a nuclear safety officer assists and advises the Director General of the Bureau in the matter of nuclear safety regulation and radiation safety management. The staff participating in nuclear activities totals 55, of which 35 persons are responsible for safety regulation. The functions of 2 divisions in charge of the safety regulation of nuclear installations are as follows:*

- Nuclear Safety Division
  - to establish the basic policy on nuclear safety,
  - to coordinate and control the activities of nuclear safety regulation,
  - to establish the technical standards of nuclear safety,
  - to issue permits for facilities related to reactor and nuclear materials,
  - to issue licenses for manufacturing parts and/or components related to nuclear safety,
  - to compensate for nuclear damage,
  - to support and foster regulatory expert organizations, and
  - to issue and control the licenses for reactor operators and senior reactor operators.

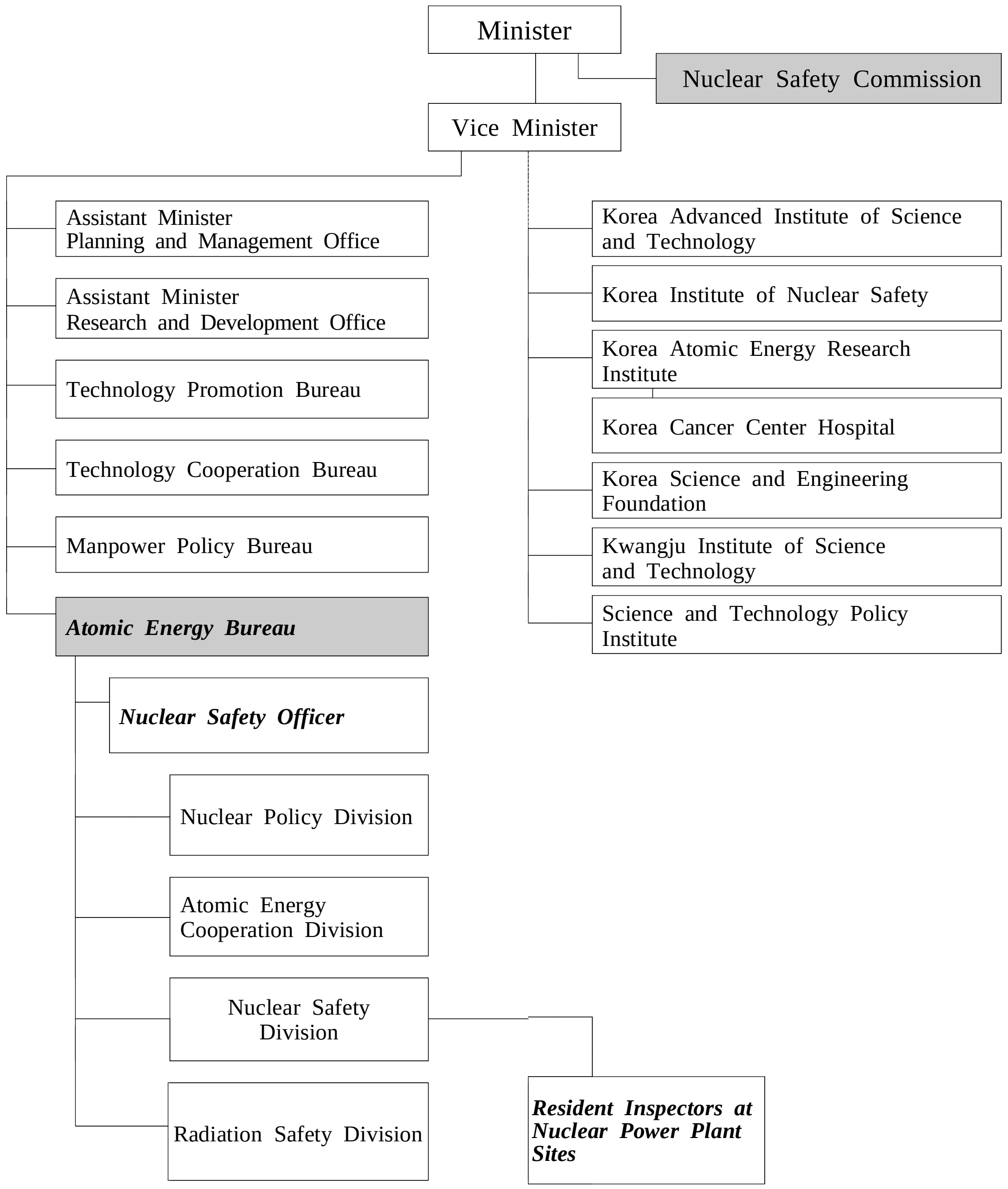


Figure II.3-1 Organization Chart of the Ministry of Science and Technology

- ***to carry out inspections for the quality and performance of materials and equipments, etc. in the construction of reactors and nuclear materials-related facilities***
- ***To carry out the inspections relevant to the operation of reactors and nuclear materials-related facilities, and the supervision of facility security***
- ***To study and develop the systems pertaining the quality assurance of nuclear -related facilities, and materials and equipments***
- ***To superintend the resident inspectors of nuclear installations***

- Radiation Safety Division
  - to license and supervise the use of radioisotopes and radiation generating devices,
  - to regulate the transport, treatment, and disposal of nuclear material and radioactive waste,
  - to formulate and coordinate protective measures against radiation hazards,
  - to direct and supervise the evaluation of radiological environmental impact around nuclear installations,
  - to control the licenses of radioisotope supervisors,
  - to register and control service provision business, and
  - to monitor and control the national environmental radiation
  - ***to formulate and coordinate radiation protection measures***
  - ***to formulate and coordinate radiological emergency plans as well as to manage and evaluate radiological emergency exercises***

- Office of Resident Inspectors
  - to conduct daily inspections for nuclear installations.

Nuclear Safety Commission(NSC)

The Nuclear Safety Commission is established under the jurisdiction of the Minister of Science and Technology 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 matters:

- consolidation and coordination of matters concerning nuclear safety control,
- matters concerning the regulation of nuclear materials and reactors,
- matters concerning the protection against hazards due to radiation exposure,
- matters concerning the plan for estimation and allocation of expenditures for nuclear safety control,
- matters concerning the formulation of tests and research for nuclear safety control,
- matters concerning the fostering and training of researchers and engineers in the area of nuclear safety control,

- matters concerning the safety management of radioactive waste,
- matters concerning the measures against radiation accidents, and
- other matters deemed important by the chairman.

The Nuclear Safety Commission, which is chaired by the Minister of Science and Technology, consists of 7 members including 6 members appointed or commissioned by the Minister. In order to strengthen nuclear safety regulation activities, MOST increased the membership of the Nuclear Safety Commission from 5 7 to 7 9 in 2001. Any person engaged in the operation of nuclear installations shall not be commissioned to be a member of the Commission.

The Commission organizes 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 4 Sub-committees: the Reactor System Sub-committee, ***the Radiation Environment Sub-committee, the Site and Structure Sub-committee,*** and the Regulatory Policy Sub-committee. The Nuclear Safety Commission may also organize and operate the Special Investigation Committee if any nuclear and/or radiation accidents occur.

Korea Institute of Nuclear Safety (KINS)

KINS was established in December 1981 and initially operated under the name of "Nuclear Safety Center" as an internal organization of KAERI. It started functioning as an independent expert organization in February 1990, according to the "Korea Institute of Nuclear Safety Act", and conducts matters on nuclear safety regulation as entrusted by MOST in accordance with the Atomic Energy Laws. Its major functions relevant to nuclear safety regulation are as follows:

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

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

and the monitoring and evaluation of environmental radioactivity.

KINS consists of 6 divisions, and 30 offices and teams as shown in Figure II-3-2, and operates the Advisory Committee on Nuclear Safety, a consultative body for technical matters on safety regulations, which is composed of experts from KINS and various other organizations. As of September 31, 2001, the staff of KINS numbers 301, of which 249 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, KINS has concluded agreements with China, Germany, France, Japan, Romania, Spain, UK, and USA (in alphabetic order) to make bilateral cooperation in the radiological emergency preparedness as well as to increase the technique and know-how of nuclear safety regulation through international collaboration with regulatory agencies in the cited countries.

KINS, an expert organization which 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 Nuclear Training Center, under the control of KAERI and as entrusted by MOST according to the Atomic Energy Laws, performs the retraining of persons designated to take responsibility for handling nuclear fuel materials and radiation safety control.

Korea Radioisotope Association (KRIA)

KRIA, as entrusted by MOST according to the Atomic Energy Laws, is responsible for maintaining the national registry of occupational radiation exposures.

Ⅱ.3.4 Position of Regulatory Body in Governmental Structure

MOST, the nuclear safety regulatory body, has complete authority and responsibility for the safety regulations, including the issuance of permits and licenses for nuclear installations and it is free from the intervention of other Ministries in the area of safety regulation. The Minister who joins the Atomic Energy Commission as an ex officio member is involved in making decisions on major national policies related to the development and utilization of nuclear energy.

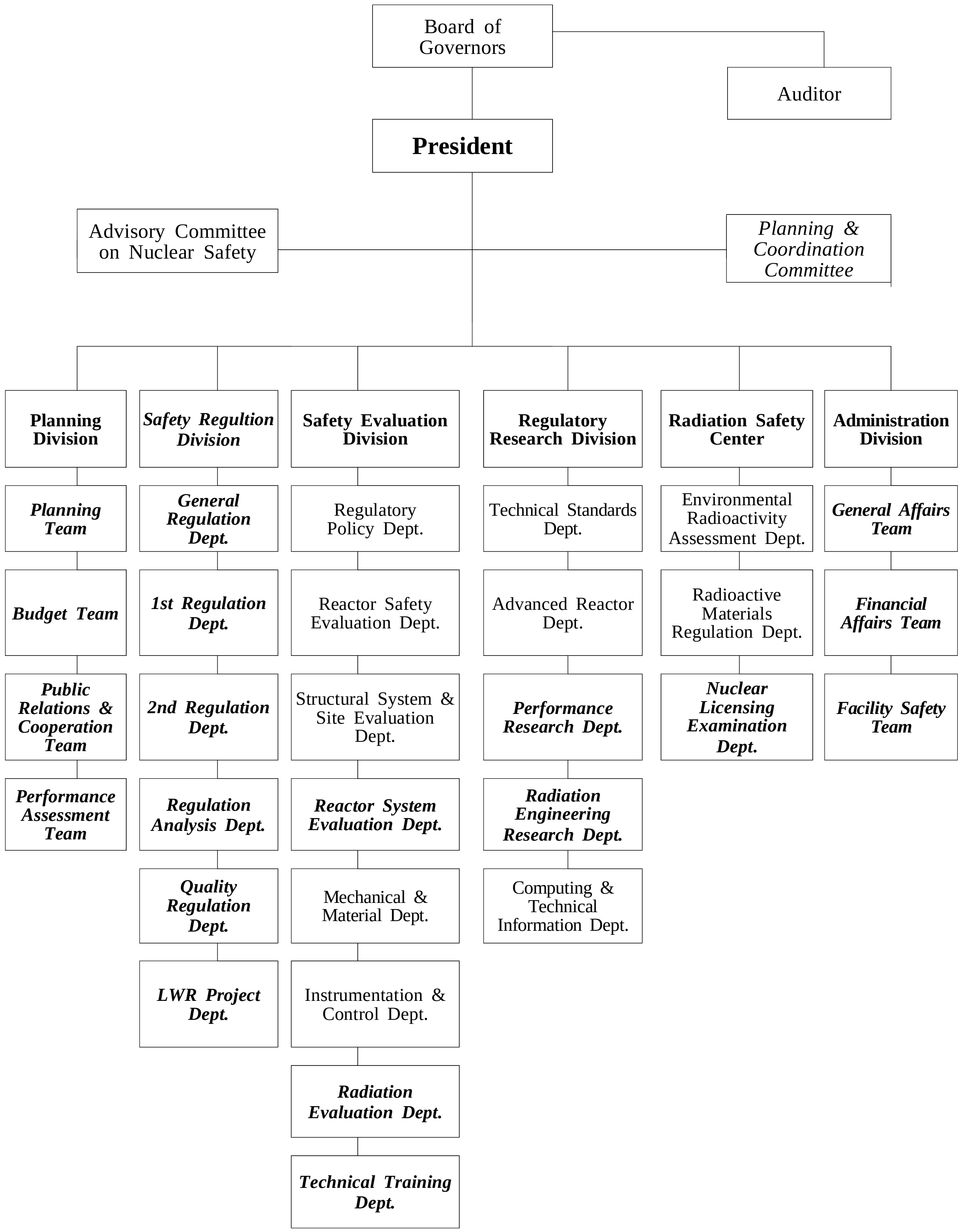


Figure II.3-2 Organization Chart of the Korea Institute of Nuclear Safety

Ⅱ.3.5 Relationship of Regulatory Body to Organizations Responsible for Promotion and Utilization of Nuclear Energy

MOCIE is responsible for the promotion and utilization of nuclear energy and for formulating and implementing the National Long-term Electricity Supply Plan. MOST performs the regulatory functions for the construction and operation of nuclear installations, thus maintaining a separation of safety regulations from MOCIE. MOST also operates the Nuclear Safety Commission, an independent deliberative organization, to enhance the objectivity and unbiasedness in safety regulations.

Ⅱ.4 Responsibility of License Holder (Article 9)

Ⅱ.4.1 Responsibility of License Holder

The holder of a construction permit assumes the responsibility to construct a nuclear installation as approved at the time when the construction permit was issued. The holder also assumes the responsibility to comply with the conditions imposed on the construction permit by the regulatory body.

The holder of an operating license assumes the responsibility to operate a nuclear installation as approved at the time when the operating license was issued. The holder also assumes the responsibility to comply with the conditions imposed on the operating license by the regulatory body.

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

Ⅱ.4.2 Mechanism for Regulatory Body to Ensure that License Holder Will Meet Its Primary Responsibility for Safety

The Minister of Science and Technology, in accordance with the Atomic Energy Act, assumes the responsibility to verify by means of regulatory inspections described in Section Ⅱ.2.4, that the installer or operator of nuclear installations comply with the permit or license conditions during construction or throughout the lifetime of the installations. 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 installation.

The installer of a nuclear installation shall undergo pre-operational inspections from MOST to verify that the nuclear installation is constructed as previously approved. After passing the inspections, the installer can commence operation. The operator of a nuclear installation shall undergo periodic inspections from the Minister of Science and Technology to assure that the performance of the nuclear installation maintains conformity with the technical standards as prescribed in the relevant provisions, and that other performances including the resistance to pressure and radiation maintain the same state as they were when passing the pre-operational inspection.
If the installer or operator of a nuclear installation has failed to meet the permit or license conditions, the Minister of Science and Technology may order the revocation of the permit or license or the suspension of the business for a given period. If the performance of the nuclear installation does not meet the standards or if safety measures for the operation of the nuclear installation are unsatisfactory, the Minister may order the operator to take corrective actions or to suspend the operation of the nuclear installation.

C. General Safety Considerations

Ⅱ.5 Priority to Safety (Article 10)

Ⅱ.5.1 Safety Policy

As mentioned in Section Ⅰ.1.2, the Minister of Science and Technology declares in the "Statement of Nuclear Safety Policy" that the major premise is to secure safety in the utilization and development of nuclear energy, and all organizations and people engaged in nuclear activities have to thoroughly adhere to the principle of "priority to safety".

In the "Comprehensive Promotion Plan for Nuclear Energy" established in accordance with the Atomic Energy Act, MOST again emphasizes that securing safety is prerequisite to the development and utilization of nuclear energy, as a basic direction of nuclear energy policy, and that the best efforts for enhancing nuclear safety must be made.

The nuclear safety policy manifests the Government's intention to make the utmost efforts for the prevention and mitigation of nuclear accidents. The consequences of nuclear accidents are intensified because of the geographical and demographical characteristics of Korea, such as small land areas and a high population density.

Ⅱ.5.2 Safety Culture and its Development

In the "Statement of Nuclear Safety Policy", the Minister of Science and Technology has proposed, as a basic principle, to develop the safety culture presented by IAEA, recognizing that human factors are just as important as technical factors are in contributing to the safety of nuclear installations, through lessons learned from the accidents of TMI and Chernobyl nuclear power plants.

The Minister of Science and Technology established, in the Comprehensive Promotion Plan for Nuclear Energy, a program by organizations to promote safety culture and formulated a basic plan to develop and apply the criteria for evaluating safety culture.

Ⅱ.5.3 Commitment to Safety

Declaration of Nuclear Safety Charter

The Korean Government declared 'Nuclear Safety Charter' in the occasion of 7th

Nuclear Safety Day in September 6, 2001 through the deliberation of Nuclear Safety Commission to confirm that nuclear safety has first and foremost priority over promotion of nuclear industry, to encourage the workers in nuclear field to have a sense of mission and responsibility for assuring nuclear safety, and also to contribute to public confidence in nuclear safety. The Charter is attached in Annex C.

License Holder's Endeavor for Safety

Since KEPCO declared in April 1990 that it will regard the establishment of safety culture as a philosophy in the construction and operation of nuclear installations, it has tried to put this principle into philosophy. KEPCO also established in April 1996 the "Staff's Ethics" describing the supreme rules and values which all staff should adhere to in order to achieve the "promotion of electric power culture", and KHNP, a subsidiary of KEPCO, continues on the Staff's Ethics of KEPCO. One of the clauses in the Staff's Ethics concerns the securing of safety. It clearly shows that all staff should make utmost efforts to preserve the public health and welfare by securing the safety of electric power installations and by preventing accidents. As a concrete practice, it emphasizes securing safety through the reformation of safety consciousness and the institutionalization of the principle of "priority to safety".

Meanwhile, "2004 Long-term Strategy and Management Plan" was established in January 1995 in order to secure the safety of nuclear installations and to promote safety culture. This Plan includes three basic strategies: The first one is to establish a complete management system on radiation safety, the second is to prevent human errors and enhance operating technology, and the third is to develop safety culture campaigns for nuclear installations. Utility's strong will to improve the safety of nuclear installations was also expressed by implementing the Plan mentioned above.

Ⅱ.5.4 Regulatory Control

MOST recognizes that the complete understanding of safety culture is more important than anything else for securing nuclear safety. Therefore, KINS has developed indicators for the safety culture evaluation based on the IAEA Guidelines. MOST encouraged the licensees to perform self-assessment of their safety culture, while KINS, reaching the 10th anniversary of its foundation, made public "the Mission Statement" and "Code of Conduct" in February 2000 as a part of efforts to establish safety culture in regulatory organizations, and exerts its utmost to promote the nuclear utility's activities for nuclear safety culture and settle it in Korea(Refer to Annex D).

Ⅱ.5.5 Voluntary Activities and Good Practices Related to Safety

Holding of Events Commemorating the "Nuclear Safety Day"

In 1994, the Government designated the 10th of September as the "Nuclear Safety Day". Various events emphasizing nuclear safety have been held by the governmental initiative for the purpose of having workers engaged in all nuclear-related organizations recognize the importance of nuclear safety and solidify their commitment to nuclear safety. Among those events, there are technical seminars on nuclear safety and public relation activities for the people. The Government also awards appropriate prizes to organizations and individuals having any distinguished achievement for securing safety. This is done to encourage relevant organizations and employees to recognize the importance of nuclear safety and to further contribute toward nuclear safety.

In the 7th Nuclear Safety Day held in 6th September 2001, MOST declared the "Nuclear Safety Charter" and other particulars on those events were described in Annex E.

Consideration of Enhancing Safety in Performance Evaluations of Nuclear Installations

KHNP leads the operating organization to safely operate nuclear installations by considering activities which enhance safety as a performance index of each nuclear installation. In those areas difficult to evaluate by indexes, like safety culture, the performance evaluation could be conducted through by comparatively evaluating to what extent the management of each operating organization makes an effort to promote safety culture. Based on the results of the performance evaluation, KHNP encourages individuals and operating organizations by effectively adjusting incentives to each operating organization.

Evaluations on the Safety Culture of Employees

In order to promote the principle of "priority to safety", KHNP evaluated the safety culture of each nuclear installation by using the safety culture indicators developed by KINS as described in Section Ⅱ.5.4. KHNP developed new self-assessment indicators on the basis of the aforementioned indicators in 1997, and evaluated the safety consciousness of employees in all nuclear installations, reflecting the results into operational management and training programs.

Nuclear Safety Technology Information Meeting

The Nuclear Safety Technology Information Meeting is annually held under the auspices of KINS to share up-to-date information on nuclear safety and regulations between regulatory organizations and industries. Emphasis is laid on the greater mutual recognition of the importance of nuclear safety through discussions on nuclear safety issues.

Ⅱ.6 Financial and Human Resources (Article 11)

Ⅱ.6.1 Financial and Human Resources of Licensee/Applicant

KEPCO, the owner of all the power plants in Korea, transacted the reorganization of electric power industrial structure to divide its power generation sector into 6 subsidiary companies, in view of promoting efficiency in electric power business and maximizing the effect of services for the people with the introduction of competitive system. The power generation sector was separated into 5 thermal power generation companies (namely, South-eastern, Southern, Central, Western, and East-western Power Generation Corporation) and a hydraulic and nuclear power company, and will be privatized step by step. KHNP will remain as a public entity so that the safety may not be jeopardized in pursuit of the profit.

KHNP, a company which took all nuclear power-related installations and employees of KEPCO, is composed of the headquarters having 3 divisions and 10 offices, and the branches having 4 nuclear power site divisions, 2 hydro power generation plants, and 3 special branches. Details of KHNP organization is shown in Figure II.6-1. With assets worth about 17.6 trillion won, this Company has the personnel of 6,200 or so. Among 6,200 employees, the persons engaged in the construction and operation of nuclear installations number approximately 5,700.

Each nuclear installation of KHNP consists of various sections for generation control, maintenance control, radiation safety control, reactor core management, chemistry and quality control, as shown in Figure II.6-2.

In the headquarter of KHNP, the Nuclear Review Board is placed for deliberating and making decision on nuclear safety. The Plant Nuclear Safety Committee (PNSC) is organized in each nuclear installation to advise the plant manager on the matters concerning nuclear safety.

Ⅱ.6.2 Financing of Safety Improvements

The Government performs research and development to enhance safety as part of the Long-term Nuclear Energy Research and Development Program for the purpose of maintaining safe operation of nuclear installations and preparing for changes in regulatory standards resulting from the advancement of nuclear technology and environmental changes. To continuously perform research and development and to secure financial resources, the Atomic Energy Act stipulates specifics on the promotion of nuclear research and development programs and on the foundation of a nuclear research and development fund.

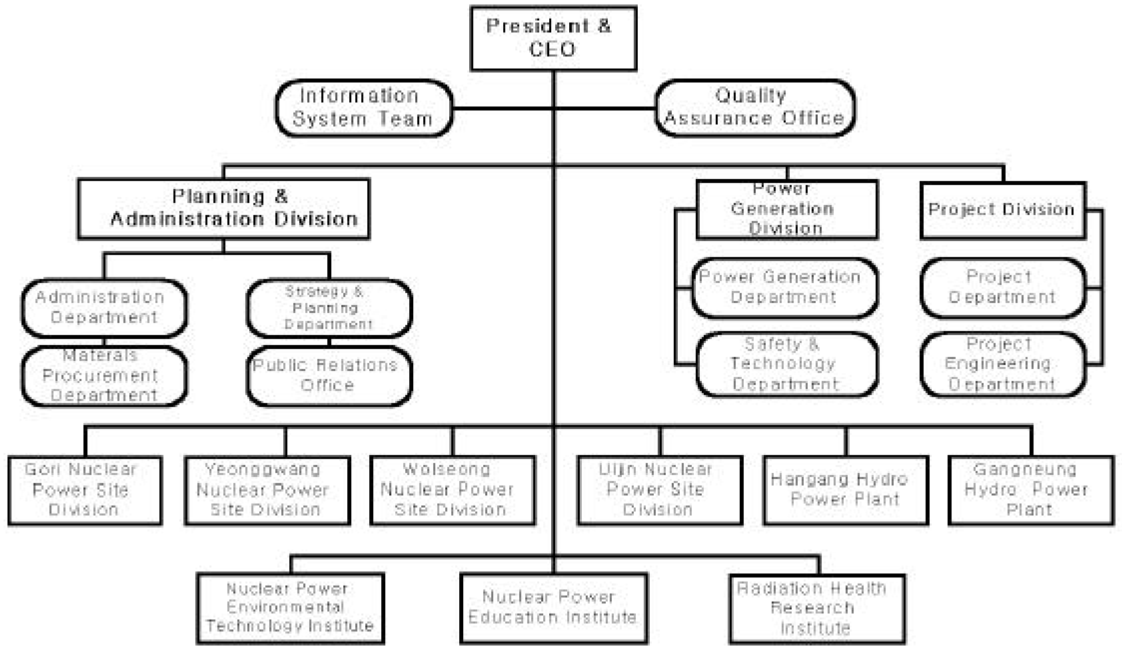


Figure II.6-1 Nuclear Related Organization Chart of Korea Hydro & Nuclear Power Corp.

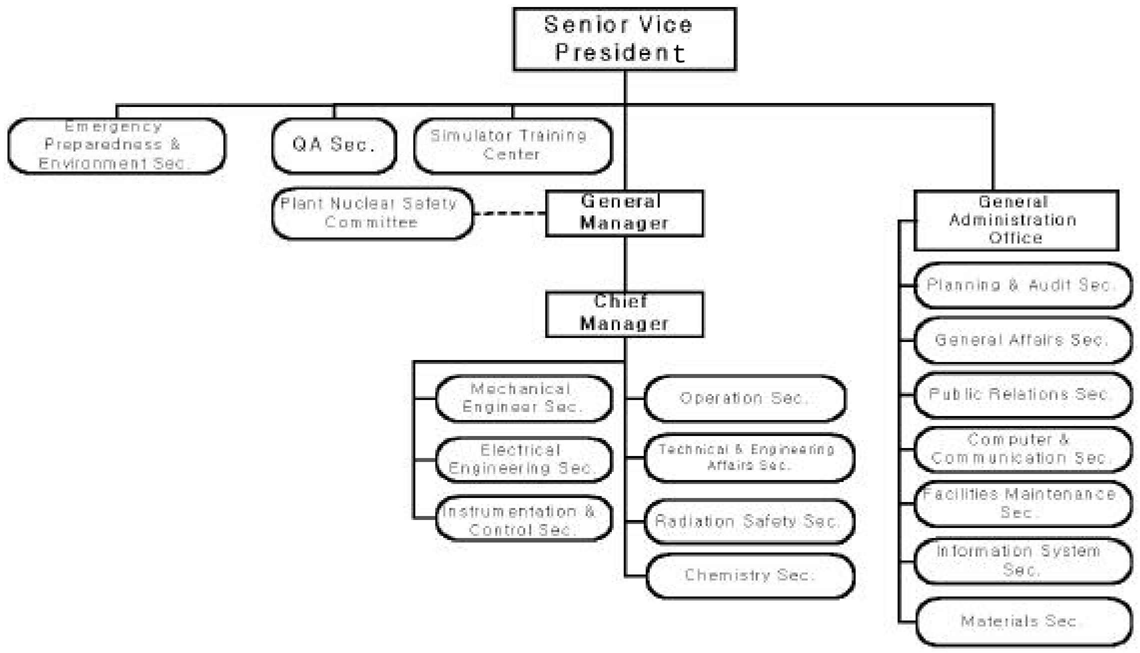


Figure II.6-2 Operating Organization Chart for Each Nuclear Installation Site

The nuclear research and development fund consists of the fee borne by the utility of nuclear installations. The fee is fixed at 1,200 won per MWh (1 USD per MWh) of nuclear power generation. The total budget estimated for the research and development program during the period from 2002 to 2006 amounts to around 1.55 trillion won (1.2 billion USD) and that consists of a nuclear R&D fund and a government subsidy amounting to 1.21 trillion won (1 billion USD) and a private investment amounting to 0.34 trillion won (0.28 billion USD). The fund of nuclear safety research will be gradually increased importance of nuclear safety to considering.

Additionally, KHNP is implementing a technology enhancement project utilizing the Electric Industry Fund borne by the Electricity Business Act to develop practical core technology for the construction, operation and management of nuclear installations.

KHNP is replacing and/or reinforcing its facilities under the Mid- and Long-term Maintenance Program established for operational safety. As an example of investments in nuclear installations for the enhancement of safety, KHNP completed, in 1998, replacing steam generators, process control systems, reactor protection systems, plant monitoring systems, and field instruments in order to enhance the safety of Kori Unit #1, the oldest nuclear installation in Korea.

Furthermore, KHNP resolved the Y2K problems of all nuclear power plants, and replaced reactor control rod guide tube supporting pins and nuclear fuel top nozzle spring screws with new ones, while safety assessment for the power operated valves of all plants is under way. Up to now, safety assessments and relevant proper measures have been completed for some 45% of all valves. To be prepared for any disqualification of the plant safety-graded component manufacture or discontinuance of manufacture, KHNP is in process of developing a quality verification program (named Dedication Program) to secure the substitution of standardized products for safety-graded ones.

Ⅱ.6.3 Financial and Human Provisions for Decommissioning Program and Radioactive Waste Management

The Electricity Business Act stipulates that the operator of nuclear installations shall deposit the back-end cost for the purpose of decommissioning nuclear installations and permanently disposing of radioactive waste. According to this, KHNP estimates the cost of decommissioning nuclear installations on the basis of the installation capacity and the price index of productivity, and reserves it after equally dividing it by years over the lifetime of installations.

The cost for the treatment of radioactive waste originated from nuclear installations, volume reduction, improvement of facilities, securing on-site storage capacity and on-site transportation is included in the maintenance cost of nuclear installations.

***KHNP organized the Radiation Safety Team to take charge of the overall radioactive waste management project under the Safety & Technology Office* in its head office, and placed the *Radiation Management Section* responsible for radioactive waste treatment and storage in each nuclear installations.**

The Nuclear Environment Technology Institute provides technical support for the construction and operation of radioactive waste management facilities and the management of spent fuel, while the service company such as the Korea Plant Service and Engineering Co., Ltd. (KPS), etc. provides the required support for the maintenance and management of radioactive waste disposal facilities in nuclear installations.

Ⅱ.6.4 Qualification, Training, and Retraining of Personnel

The Atomic Energy Act stipulates that only the relevant license holder approved by the Minister of Science and Technology can operate the reactor or handle nuclear fuel materials, radioisotopes or radiation generating devices. The licenses are classified as follows:

- a license for senior reactor operator,
- a license for reactor operator,
- a license for senior nuclear fuel material supervisor,
- a license for nuclear fuel material supervisor,
- a license for radioisotope supervisor,
- a license for radioisotope supervisor in medical use, and
- a license for senior radiation safety supervisor.

Licenses are issued to applicants who have engaged in the relevant fields with sufficient experience and successfully passed an examination administered by MOST. ***The license holders employed by KHNP total 1,371 as shown in Table Ⅱ.6-1. At regular intervals, the license holder must take a refresher course that KAERI, KHNP or KRIA holds by types of license. Technical specification specifies the qualifications of nuclear employees, and prescribes that all nuclear employees shall meet the specified qualifications.***

The Atomic Energy Act stipulates that the operator of a nuclear Installation shall provide employees with educational and training opportunities. Accordingly, KHNP, an operator of nuclear installations, provides employees with professional experiences by annually improving the educational program. The educational program consists of two categories, basic training and developing training, as shown in Table Ⅱ.6-2.

KHNP conducts the Operator Refresher Training of 4 weeks twice a year for reactor operators rotating in a six-group three-shift system. The major contents of the program consist of nuclear safety culture, simulator excercise, technical specifications, and a case study of incidents and accidents.

The Nuclear Power Education Institute of KHNP is functionally operated for the purpose of nurturing nuclear expert manpower. This Institute is fully equipped with a simulator and various mock-up equipment including steam generator, fuel-reloading facility, and reactor coolant pump to enhance the maintenance capability of the personnel. At each nuclear installation site, the training center (Yonggwang, Wolsong, and Ulchin) is equipped with a simulator.

Table Ⅱ.6-1 License Holders Employed in Reactor Facilities

(as of December 31, 2000)

Category / Field	*Type of License*	*Number of Holders*
Reactor	***Reactor Operator***	***702(441)***
	Senior Reactor Operator	***847(728)***
	Subtotal	***1,549(1,169)***
Radioisotope	***Radioisotope Supervisor***	***3,427(128)***
	Senior Radioisotope Supervisor	***646(55)***
	Radioisotope Supervisor in Medical Use	***797***
	Subtotal	***4,870(183)***
Nuclear Fuel Material	***Nuclear Fuel Material Supervisor***	***6***
	Senior Nuclear Fuel Material Supervisor	***31(19)***
	Subtotal	***37(19)***
Total		***6,456(1,371)***

※ The figures in parentheses correspond to the number of license holders employed by KHNP

Table Ⅱ.6-2 Training System of Employees in Nuclear Installations

(Unit: week)

Phase		Basic Training	Developing Training	Training Course
New Recruits		3 11 13		■ Introductory Course ■ Nuclear Fundamental Course
Primary and Intermediate Training for Employee	Opera-tion	16	8 10 1	■ On Job Training (OJT) ■ Refresher Training Course ■ Course for MCR Operator Candidate ■ Licensed Operator Requalification Course
	Engi-neering	16	3 4	■ OJT ■ Developing Courses for Engineering Staff
	Main-tenance	16	3 1 2	■ OJT ■ Developing Courses for Maintenance Staff ■ Special Courses for Maintenance Expert
Management and Supervisor	Assis-tant Manager		2 1 4	■ Assistant Manager Courses ■ Supervisor Courses ■ Shift Technical Adviser (STA) Course
	Manag-er		1 1	■ Manager Courses ■ Plant Manager Course

Ⅱ.7 Human Factors (Article 12)

Ⅱ.7.1 Prevention, Detection, and Correction of Human Errors

Reflection of Human Factor Engineering in Design

The details of human factor engineering design shall be described in the safety analysis report, which is to be filed to obtain construction permit and operating license, in accordance with the Atomic Energy Laws. The principles for human engineering are consistently applied to any modifications to the design of nuclear installations in operation.
The human factor engineering design is performed through 4 stages, namely, the Stage of Human Factor Engineering Application Planning, the Stage of Operating Experience Review, the Stage of man-machine interface design, Verification & Validation of the Design. The facilities subject to human engineering design include the main control room, safety parameter display system, remote shutdown control room, and so on.
KINS conducts a safety review for the safety analysis report submitted by KHNP, an applicant for construction permit, and field inspections to verify whether human engineering is properly reflected in the design.

Korea Human Performance Enhancement System (K-HPES)

For the purpose of improving the human performance of employees in nuclear installations, KHNP has formulated and operated since February 1990 the Human Performance Enhancement System (HPES). The HPES operational management procedures are based on the HPES procedures of the Institute of Nuclear Power Operation (INPO). To analyze more accurately the root causes of human factors, KHNP completed the development of the K-HPES(Ⅰ) in October 1993, of which the analysis procedure is reinforced in consideration of Korean working environments, and currently applies it to all nuclear installations. ***Additionally, KHNP developed CAS(Computer Aided System)-HPES which reduces time for analysis as well as deviations that might be caused by the analyzer's views. The CAS-HPES is currently applied to the analysis of events and accidents which occur in nuclear installations.***

Installation and Utilization of Simulators at Each Site

To reinforce the reactor operator's capability to cope with accidents and to prevent human errors, KHNP installed a simulator at each nuclear installation site as shown in Table Ⅱ.7-1, and utilizes it for various operator training.

Table Ⅱ.7-1 Status of Simulator Installations

	Simulator 1	Simulator 2	Simulator 3	Simulator 4	Simulator 5	*Simulator 6*
Station	Kori Units 1 & 2	Kori Units 3 & 4 ; Yonggwang Units 1 & 2	Ulchin Units 1 & 2	Yonggwang Units 3 & 4 ; Ulchin Units 3 & 4	Wolsong Units 1, 2, 3 & 4	***Ulchin Units 3 & 4***
Manufacturer	Samsung, Hyundai (Korea)	Westinghouse (USA)	Thomson (France)	Samsung, Hyundai (Korea)	CAE (Canada)	***KHNP, Samsung (KOPEC)***
Reference Plant	Kori Unit 2 PWR 2 Loops	Yonggwang Units 1 & 2 PWR 3 Loops	Ulchin Units 1 & 2 PWR 3 Loops	Yonggwang Units 3 & 4 PWR 2 Loops	Wolsong Unit 2 PHWR 2 Loops	***Ulchin Units 3 & 4*** ***PWR 2 Loops***
Date of Installation	***July*** 1998	December 1986	February 1990	April 1997	December 1996	***October 2001***
Place of Installation	Nuclear ***Power*** Education Institute (Kori)	Nuclear ***Power*** Education Institute (Kori)	Ulchin Site	Yonggwang Site	Wolsong Site	***Ulchin Site***

Establishment of a System for the Feedback of Operating and Maintenance Experience

KHNP prepared and now implements a procedure to share the important domestic and overseas operating and maintenance experiences, and to reflect them in the operation of nuclear installations. Since December 1999, This Company also has been promoting the effective utilization of the foreign technical information provided by IAEA, INPO, etc. as well as of its domestic operating experience through the establishment of the KHNP Nuclear Information System (KONIS). KHNP, which

publishes an accident or incident report or a report of operating and maintenance experience including near misses in the related nuclear installations, and distributes them to all nuclear installations and nuclear-related organs, periodically holds relevant workshops.

Ⅱ.7.2 Managerial and Organizational Issues

KHNP changed in 1992 the reactor operator's working system of all nuclear installations from a five-group three-shift to a six-group three-shift. This was done to minimize human errors of reactor operators by reducing their work load and consolidating the educational and training programs. A six-group three-shift working system is three groups rotating in turns and three groups having education, day-offs and performing routine jobs. Routine jobs consist of the evaluations of and surveillance tests for safety-related systems of nuclear installations.

Ⅱ.7.3 Role of Regulatory Body and Operator

MOST, a regulatory body, establishes a regulatory policy for enhancing human performance, and provides strategic support to encourage excellent manpower to engage in nuclear power fields. MOST encourages the operator to improve nuclear installations with respect to human engineering through licensing formalities and regulatory inspections for nuclear installations. MOST also devises institutional measures to incorporate human engineering into the design of nuclear installations. For example, MOST systematically enforced the post-TMI action to all operating nuclear installations through an administrative order. MOST has also devised institutional measures to evaluate the suitability of human factors from the beginning of the design stage, by adding a new chapter (Chap. 18) on human engineering to the preliminary safety analysis report submitted for a construction permit of a nuclear installation. It has been applied to nuclear installations constructed after 1988.

KINS performed from 1989 to 1994 the safety review and regulatory inspection of a detailed control room design review (CRDR), as a post-TMI action, in order to reflect the element of human engineering in all operational nuclear installations. KINS recommended KHNP to correct human engineering discrepancies that were identified as a result of the safety review. KINS also has recommended through the safety review to consistently apply the principles of human engineering to items requiring modifications in the design of control room identified afterwards.

KHNP worked out measures to prevent recurrence of similar events by analyzing the root causes of any event involving human errors, and distributes the analysis report so as to prevent similar events in other nuclear installations. Thus, KHNP now reflects it into the relevant educational courses of the Nuclear Education Institute, and requests the designer of nuclear installations to reflect it into the design.

Ⅱ.8 Quality Assurance (Article 13)

Ⅱ.8.1 Quality Assurance Policies

The Atomic Energy Act stipulates that the installer and operator of nuclear installations shall 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, and maintenance of the nuclear installations.

According to this provision, the applicant for a construction permit or an operating license shall file a quality assurance program manual for the construction or operation of a nuclear installation, accompanying an application for construction permit or operating license, with the Minister of Science and Technology for approval. They must comply with the quality assurance program during the construction and operation of nuclear installations.

Ⅱ.8.2 Quality Assurance Program

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), and the KINS Guidelines stipulate 18 criteria for the quality assurance program as follows:

①organization, ②quality assurance program, ③design control, ④procurement document control, ⑤instructions, procedures, and drawings, ⑥document control, ⑦control of purchased material, equipment, and services, ⑧identification and control of materials, parts, and components, ⑨control of special processes, ⑩inspection, ⑪test control, ⑫ control of measuring and test equipment, ⑬handling, storage, and shipping, ⑭ inspection, test, and operating status, ⑮nonconforming materials, parts, or components, corrective action, quality assurance records, and audits.

A comprehensive assessment for the adequacy, effectiveness and practicability of a quality assurance program is performed by KINS during the process of safety review in accordance with the Atomic Energy Laws, and the safety review guidelines and the quality assurance guidelines for nuclear installations, as prepared by KINS.

Ⅱ.8.3 Methods of Implementing and Assessing Quality Assurance Programs

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

All contractors involved in nuclear projects, including design, manufacturing, construction, and maintenance, are required to perform quality-related activities in accordance with regulatory requirements. All contractor's quality-related activities are verified by KHNP and subject to the safety review and regulatory inspection of KINS.

The assessment for the implementation and effectiveness of the quality assurance program is periodically conducted by KHNP to verify whether quality assurance activities are being properly implemented by KHNP itself, the contractor and sub-contractor, in accordance with the quality assurance program. The method of assessing the implementation of a quality assurance program includes quality control inspection, quality assurance audit, quality assurance trend analysis, and effectiveness assessment for the quality assurance program.

- 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 the internal organizations and external contractors considering the characteristics of 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 investigation of the causes for non-conforming items and corrective actions that are identified during the quality control inspection and quality assurance audit.
- Effectiveness Assessment for a quality assurance program is periodically conducted by the quality assurance organization to maintain the quality assurance program suitable for the features of nuclear installations. Major considerations given to the assessment for quality assurance programs include, inter alia, 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 the 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 resulted from the assessment 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 assessment of effectiveness.

Ⅱ.8.4 Regulatory Control Activities

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

In order to encourage voluntary and active quality assurance activities from the licensees, KINS has developed the "Guidelines for the Assessment of Licensee's Quality Assurance Activities", and is carrying out a distinctive regulation by class, after quantifying the results of the regulatory inspections of the quality assurance activities of the licensees. ***Under the "Quality Assurance Auditor Qualification System" for regulatory personnel, which was established by KINS, the 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), KINS developed Quality Assurance Program for regulatory bodies to improve trust toward the public and fairness of regulatory activities, and is developing the Quality Assurance Guideline for regulatory activities necessary to implement it.

Ⅱ.9 Assessment and Verification of Safety (Article 14)

Ⅱ.9.1 Licensing Procedure and Safety Analysis Report

Pursuant to the Atomic Energy Act, the licensing procedure for nuclear installations, as described in Section Ⅱ.2.3, consists of two stages : the construction permit(CP) and the operating license(OL).
The applicant for ***a standard design approval,*** a construction permit or an operating license shall conduct comprehensive and systematic safety assessments to ensure that the public and the environment are protected from potential radiation hazards which may accompany the construction and operation of nuclear installations.

If the licensee intends to construct reactors of the same design, it can obtain a standard design approval, which would substantially reduce the CP and OL review process by exempting the scopes already reviewed in the process.
He must submit a standard design safety analysis report, a preliminary or final safety analysis report together with a radiological environmental assessment report to the Minister of Science and Technology, depending on the license that he wishes to obtain.

The safety analysis report includes results of the entire safety assessment of nuclear installations, such as the design features of structures, systems and components of nuclear installations, structural integrity, evaluation of system performance, human engineering, design basis accidents, radiation protection, and site characteristics.

Technical Specifications and Quality Assurance Programme which have been independent reports, are newly added to safety analysis report and become a part of it.
The contents of the safety analysis report are prescribed in the Enforcement Regulation of the Atomic Energy Act, and applied to all types of reactors, as shown in Table Ⅱ.9-1. The probabilistic safety assessment has been conducted by applicant or operator not as regulatory requirement but as voluntary measure. It has been conducted not only for new plants but also for operating plants.

The radiological environmental assessment report includes an assessment of the radiological effects on the public and environment, and as prescribed in the Enforcement Regulation of the Atomic Energy Act, it includes the following items:

- the environmental state of all areas around the nuclear installation and its site,
- the estimation of radiological impacts on surroundings due to the construction and operation of nuclear installations,
- a radiological environmental monitoring program to be implemented during the construction and operation of nuclear installations, and

- the radiological environmental impacts resulting from accidents which may occur during the operation of nuclear installations.

Further details are described in the Notice No. 98-10 of the Minister of Science and Technology, as titled "Guideline Concerning the Preparation of a Report on Radiological Environmental Assessment.

Table Ⅱ.9-1 Contents of Safety Analysis Reports of Nuclear Installations

	Contents
General Items	1. Introduction and General Plant Description 2. Site Characteristics 3. Design of Structures, Components, Equipment, and Systems 4. Reactor 5. Reactor Coolant System and Connected Systems 6. Engineered Safety Features 7. Instrumentation and Controls 8. Electric Power 9. Auxiliary Systems 10. Steam and Power Conversion System 11. Radioactive Waste Management 12. Radiation Protection 13. Conduct of Operations 14. Initial Test Program 15. Accident Analyses ***16. Technical Specifications*** ***17. Quality Assurance Programme*** 18. Human Factor Engineering
Others	• Probabilistic Safety Assessment (PSA)

Ⅱ.9.2 Continued Monitoring and Periodic Safety Review

1) Safety Assessments Using Deterministic Method

Safety Assessment for Reload Core

KHNP conducts a safety evaluation for the reload core of all PWR installations at every refueling. The reload safety evaluation includes the design of reload core, power capability, accident evaluation, any modification to technical specifications, and acceptability of peaking factors. KINS, as entrusted by MOST, conducts regulatory inspections to ensure the safety of reload core.

Periodic Inspections and Assessments for Nuclear Installations

To assess the safety and continuous operability of nuclear installations, KHNP carries out overall safety inspections including In-Service Test (IST) and In-Service Inspection (ISI) during the planned preventive maintenance period of 20 month intervals.

Separately from the safety inspections by KHNP, KINS conducts a periodic regulatory inspection for operational nuclear installations. The Minister of Science and Technology determines whether or not to allow the reactor to reach criticality by comprehensively assessing the safety and performance of nuclear installations with the result of a regulatory inspection.

The details of the overall safety inspections performed by KHNP, and the periodic regulatory inspections by KINS are described in Sections Ⅱ.9.3 and Ⅱ.9.4.

Monitoring and Assessment of Safety-related Parameters

KHNP conducts a continued monitoring and assessment for the safety-related parameters listed below, ***and the data on the unplanned reactor scrams and the capacity factor is shown in Table II.9-2 :***

- unplanned reactor scram,
- actuation and failure of safety-related systems,
- human actions against all incidents including human errors, and
- tendency and practices of all maintenance including periodic maintenance.

Table Ⅱ.9-2 Some Parameters of Nuclear Installations (1/2)

(a) Reactor Scrams at Nuclear Installations

연도	Kori				Yonggwang				Ulchin				Wolsong				Average	Total	Operating Unit
	K-1	K-2	K-3	K-4	Y-1	Y-2	Y-3	Y-4	U-1	U-2	U-3	U-4	W-1	W-2	W-3	W-4			
78	17																17	17	1
79	13																13	13	1
80	8																8	8	1
81	7																7	7	1
82	4																4	4	1
83	9	5											4				6	18	3
84	7	5											4				5.3	16	3
85	8	15	4	-	-	-	-	-	-	-			3				7.5	30	4
86	4	4	9	4	7	-	-	-	-	-			5				5.5	33	6
87	3	5	5	4	5	3	-	-	-	-			1				3.7	26	7
88	1	0	1	3	2	2	-	-	2	-			2				1.6	13	8
89	3	3	0	1	1	2	-	-	0	1			2				1.4	13	9
90	2	0	3	3	2	1	-	-	3	3			1				2.0	18	9
91	11	1	0	2	1	2	-	-	3	1			3				2.7	24	9
92	4	1	0	4	1	3	-	-	1	0			1				1.7	15	9
93	1	2	3	3	0	2	-	-	1	1			1				1.6	14	9
94	2	1	1	1	1	0	-	-	0	2			1				1.0	9	9
95	2	2	1	0	2	2	3	-	2	1			1				1.6	16	10
96	2	1	1	0	1	1	0	5	3	1			3				1.6	18	11
97	2	2	1	0	1	2	1	5	4	5			0	4			2.3	27	12
98	0	2	2	0	0	0	0	0	1	0	0		2	2	2		0.8	11	14
99	1	2	2	0	1	5	1	1	1	0	1	0	1	1	0	0	1.1	17	16
00	1	0	1	1	0	0	0	2	1	1	1	1	0	0	0	0	0.6	9	16
계	112	51	34	26	25	25	5	13	22	16	2	1	35	7	2	0		376	

Table Ⅱ.9-2 Some Parameters of Nuclear Installations (2/2)

(b) Capacity Factors of Nuclear Installations

연도	Kori				Yonggwang				Ulchin				Wolsong				Average
	K-1	K-2	K-3	K-4	Y-1	Y-2	Y-3	Y-4	U-1	U-2	U-3	U-4	W-1	W-2	W-3	W-4	
78	46.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46.3
79	61.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61.3
80	67.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67.4
81	56.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56.3
82	73.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73.5
83	63.6	80.4	-	-	-	-	-	-	-	-	-	-	61.9	-	-	-	66.6
84	66.3	76.9	-	-	-	-	-	-	-	-	-	-	66.8	-	-	-	70.1
85	65.5	70.1	89.7	-	-	-	-	-	-	-	-	-	94.4	-	-	-	78.7
86	67.9	73.7	71.7	94.2	88.2	-	-	-	-	-	-	-	79.7	-	-	-	78.1
87	94.0	79.7	73.0	73.7	75.2	95.9	-	-	-	-	-	-	92.9	-	-	-	81.5
88	45.8	83.6	76.7	74.1	77.6	78.6	-	-	40.8	-	-	-	79.4	-	-	-	73.0
89	56.5	94.4	82.6	77.3	81.0	71.6	-	-	65.2	45.8	-	-	91.0	-	-	-	76.2
90	72.1	81.0	85.9	78.1	86.5	74.9	-	-	78.5	70.3	-	-	85.9	-	-	-	79.3
91	89.9	84.9	74.2	79.6	84.0	84.2	-	-	91.7	84.2	-	-	91.1	-	-	-	84.4
92	74.8	84.0	84.3	83.1	86.8	80.6	-	-	88.0	88.9	-	-	86.8	-	-	-	84.5
93	78.7	78.1	89.1	85.5	84.5	86.9	-	-	87.7	90.0	-	-	100	-	-	-	87.2
94	66.5	87.5	82.1	93.2	103	89.4	-	-	86.2	86.8	-	-	82.6	-	-	-	87.4
95	82.2	95.3	76.1	91.4	78.6	73.6	100	-	90.4	92.5	-	-	83.7	-	-	-	87.3
96	77.0	86.9	99.1	83.5	84.6	95.6	76.6	86.6	89.7	96.6	-	-	81.0	-	-	-	87.5
97	78.9	86.1	75.8	87.8	103.9	83.5	87.0	81.7	85.9	88.8	-	-	102.1	97.1	-	-	87.6
98	77.6	87.5	86.5	105.3	89.1	75.5	89.0	101.2	96.0	92.8	103.7	-	78.5	83.6	98.5	-	90.2
99	85.2	87.1	90.5	89.0	84.5	84.3	89.1	91.8	89.4	97.9	83.5	-	82.8	90.8	82.0	103.0	88.2
00	92.3	91.3	100.8	91.3	87.6	88.3	86.2	85.3	88.1	83.5	88.1	82.3	79.6	89.3	100	91.5	90.4
평균	71.6	83.9	83.3	85.6	86.4	83.0	88.0	89.7	85.4	88.2	89.6	84.7	85.0	90.2	93.8	95.9	84.4

In order to minimize the radiological impacts on nearby residents and surrounding environment following the operation of nuclear installations, KHNP sets the limits of radioactive effluent release and controls the release to the environment. KHNP also continuously monitors the effect on the environment. According to the environmental radiation monitoring program, and periodically collects and analyzes environmental samples, continuously checking the environmental radiation level with the environmental radiation monitoring system. Basing on the data, KHNP evaluates the off-site dose to the population every month. The details of the radioactive material release and the environmental radiation monitoring system are described in Section Ⅱ.10.2.

2) Probabilistic Safety Assessment (PSA)

KHNP conducts probabilistic safety assessments for pre-operational and operational nuclear installations, continuously improving the safety of reactor installations on the basis of the results. Several examples of implementing the result of PSA are given as follows :

- ***For the improvement of the capability to cope with station blackouts, Kori Unit #1, #2, #3 and #4, Yonggwang Unit #1 and #2, and Ulchin Unit #1 and #2, that is, for the PWR-type nuclear installations KHNP is conducting the detail design to add an alternate alternating current (AAC).***
- ***As for Yonggwang Unit #3, #4, #5 and #6, and Ulchin Unit #3, #4, #5 and #6, that is, of CE-type PWR, KHNP improved the reliability of auxiliary feed water system, and installed an additional AAC in order to enhance a capability of coping with station blackouts. A safety depressurization system was also installed to heighten the depressurization capability of reactor system.***
- ***As for Ulchin Unit #3, #4, #5 and #6, and Yonggwang Unit #5 and #6, KHNP modified the design of reactor cavity, and installed hydrogen ignitors in order to enhance a capability of coping with severe accidents, further to all the improvements made at Yonggwang Units #3 and #4,. KHNP also provided a penetrator for containment exhaust filter.***
- In case of Wolsong Unit #1, #2, #3, and #4, that is, PHWR-type installations, KHNP installed hydrogen ignitors, except for Wolsong Unit #1, and improved and reinforced a part of equipments with a seismic design for the pump buildings of an emergency water supply system in order to increase safety against earthquakes.

For the purpose of enhancing the capability of coping with severe accidents, KHNP continues establishing an accident management plan for nuclear installations.

The result of a probabilistic safety assessment indicates that the core damage frequency (CDF) by types of reactor, as shown in Table II.9-3, satisfies the safety targets recommended by the IAEA, CDF of 10^{-4}/R・Y for an operating nuclear

installation and 10^{-5}/R・Y for a newly constructed one. No nuclear installations with vulnerabilities were found that may seriously affect safety.

Table Ⅱ.9-3 Core Damage Frequency of Nuclear Installations

Station Name	**Review Scope**	**CDF(/RY)1)**
Kori Units 1 & 2	***Level 2 PSA***	***In progress***
Kori Units 3 & 4	Level 1 PSA	8.03×10^{-5}
Yonggwang Units 1 & 2	Level 1 PSA	7.24×10^{-5}
Yonggwang Units 3 & 4	Level 2 PSA	8.35×10^{-6}
Ulchin Units 1 & 2	***Level 2 PSA***	planned
Ulchin Units 3 & 4	Level 2 PSA	8.25×10^{-6}
Wolsong Unit 1	***Level 2 PSA***	***In progress***
Wolsong Units 2, 3 & 4	Level 2 PSA	***8.02×10^{-5}***
Yonggwang Units 5 & 6	***Level 2 PSA***	***7.43×10^{-6}***
Ulchin Units 5 & 6	***Level 2 PSA***	***In progress***

Note : 1) Internal events were considered.

3) Periodic Safety Review

The Nuclear Safety Commission resolved to take up the periodic safety review implementation plan covering the basic directions, the method of implementation, and the selection of nuclear power plants subject to the periodic safety review and its legislation in the 11th committee meeting of December 21, 1999. The policy basically aims to introduce and enforce a comprehensive and systematic safety assessment system including the operating experience in and outside Korea, the general safety activities of utility, and the aging effect, that are essential to secure safety during the lifetime of operating nuclear plants. According to this project, the periodic safety review must be implemented every 10 years from the date of licensing of operation, and by the operator of the plant, and its result is to be examined by a regulatory organ. Additionally, it is feasible to modify the criteria for periodic safety review on the basis of 11 safety factors specified in the Guidelines on Periodic Safety Review provided by IAEA, and adjust the detailed scope of safety review according to the number of years of operation.

Concerning the selection of units subject to this periodic safety review and its legislation, it is a rule to carry out a periodic safety review preferentially for older power plants. Among them, as for Kori Unit #1 which has run for more than 20 years, PSR has already begun in 2000, and PSR will be performed for Wolsong Unit #1, Kori Unit #2, etc.

Following the decision of Nuclear Safety Commission, KHNP undertook a periodic safety review from May 2000, after submitting a plan for Kori Unit #1 of a demonstration plant to MOST, and now intends to complete this review by November 2002. Wolsong Unit #1 started a periodic safety review in May 5 2001 and will complete the review by June 2003, while the periodic safety review for operating nuclear plants which have run more than 10 years is planned to complete by the end of 2006.

Ⅱ.9.3 Verification Program

Preventive Maintenance

KHNP carries out preventive maintenance to prevent any failure by preserving the operating condition and performance of nuclear installations within the design limits, in accordance with the provisions referred to in the guide for operational technique of each nuclear installation. The current methods for preventive maintenance are classified into daily surveillance and verification, periodic preventive maintenance, predicted maintenance and planned preventive maintenance, etc.

KHNP systematically manages the information on preventive maintenance by using a computer program named "Power Unit Maintenance System for Nuclear-VersionⅡ" which is developed by KHNP to ensure accuracy and reliability of information control. Such information includes intervals of preventive maintenance, equipment history, trend analysis, and reflection of results.

In-Service Inspection (ISI) and In-Service Test (IST)

Pursuant to the Enforcement Decree of the Atomic Energy Act and the Notice of the Minister of Science and Technology, KHNP submits an ISI program for each nuclear installation at 10-year intervals with the said Minister, and conducts necessary inspections. The Enforcement Decree of the Act and the Notice No. 98-15 of the Minister of Science and Technology (titled "Regulation Concerning In-Service Inspection and In-Service Test for Reactor Facilities") stipulate that the ISIs shall be conducted in accordance with Section Ⅺ (Rules for In-service Inspection of Nuclear Power Plant Components) of the ASME Boiler & Pressure Vessel (B & PV) Code for PWR and in accordance with CAN/CSA-N285.4 (Periodic Inspection of CANDU Nuclear Power Plant Components) for PHWR.

The Notice of the Minister of Science and Technology prescribes that Section Ⅺ of the ASME B & PV Code or Section IST of ASME OM Code shall be applied to both PWR and PHWR. Pumps must undergo several tests for operating parameters including pressure, flow rate and temperature, along with the analysis of the result of tests being made to ascertain any change in reference values of the parameters, in accordance with the provisions specified in Subsection IWP of Section Ⅺ or Subsection ISTB of Section IST. As for valves, it includes the leakage test, the actuation test, and the position indicating test, together with analysis of the result of tests being performed to ascertain any change in reference values, in accordance with the provisions specified in Subsection IWV of Section Ⅺ or Subsection ISTC of Section IST.

Aging Process Evaluation

KHNP conducts aging process evaluations of major components, systems, and structures through the preventive maintenance program and the ISI and IST programs. The data collected through the ISIs and ISTs are used as reference data for aging mitigation programs or maintenance programs.

As for the reactor pressure vessel, the variation in the impact absorption energy and the nil-ductility transition temperature is periodically examined through specimen surveillance. The welding parts of the reactor pressure vessel, steam generator, pressurizer, and major pipes are examined by ultrasonic inspection to identify the existence of any flaws or the possibility of any crack growth. The steam generator tubes and the turbine rotors are inspected during planned preventive maintenance to identify the existence of any flaws or the possibility of any crack growth. As for major rotating machines, valves, and heat exchangers, the existence of performance degradation is checked and evaluated through the ISTs. The performance degradation of snubbers, thickness thinning of pipes, corrosion levels of underground laid materials, and so on are continuously monitored and evaluated.

KHNP is in process of carrying out lifetime management program for Kori Unit #1, the oldest nuclear installation in the country, as a part of the mid- and long-term nuclear research and management plan. KHNP has already performed the 1st stage of life assessment and economic assessment for 13 main equipments such as reactor pressure vessel, etc., and now conducts the 2nd stage of a detailed life assessment and the formulation of an aging control plan for 12 equipments and groups.

Further to this, KEPRI makes studies of technologies controlling field aging degradation, aging management and life assessment procedure, time-limited aging analysis technique, equipments & systems degradation monitoring technique, and economic assessment technique, etc., in order to manage the life of long-time operated nuclear power plants. Additionally, for the life management of Wolsong Unit #1 which is a PHWR-type plant,

KHNP carries out researches in the life assessment and the replacement plan for main equipments, the establishment of a feeder pipe thinning control plan, and the development of a real-time thinning monitor. A project is afoot to gradually initiate and expand the study of life management as well as the periodic safety review for other nuclear installations.

Safety Assessment for Motor Operated Valves

KHNP conducts a design-based safety assessment for safety-related motor operated valves from the year of 1999 up to date. Through this safety assessment it is feasible to select the worst operating condition expected in the design-based conditions, and make a related test to ascertain the properness of switch set points, with the result of checking full opening or full closing function, that is, a safety function proper to motor operated valves. As for the valves hard to test under the design-based conditions, a safety verification can be made by a substitute method. Any proper corrective action is necessary to secure safety for the valve wanting in a safety function as a result of safety assessment.

Additionally, KHNP formulated and now implements a program to check whether the thermal binding and the pressure locking of safety-related power operated gate valve does hinder the safety function of gate valve. The examination of the valve

configuration, and the system design condition permit to select a valve expected to have the vulnerability to thermal binding and pressure locking, and valve functionality is secured through tests or analyses with the proper corrective measures, if necessary.

With regard to the safety assessment for all safety-related motor operated valves and power operated gate valves, a safety assessment for a specified number of valves every refueling outage period is preferentially being carried out, and may be completed by June 2005. In case of the valve for which is completed a safety assessment, it is planned to check the periodic verification of valve operability during the lifetime of plant, according to the plan for periodic verification program.

Development of Dedication Program

By way of preparedness against any disqualification for nuclear quality assurance or any production discontinuance of the plant safety-graded component manufacturer, KHNP is currently developing a quality verification program to assure the substitution of standardized products by safety-graded ones.
This program will permit to determine the essential properties which any component should possess as a safety one through the analyses of safety function and breakage type for the components of main equipments, and to verify them with tests and inspections.

Ⅱ.9.4 Regulatory Control Activities

As part of the regulatory control activities for the safety assessment and verification of nuclear installations, safety reviews and regulatory inspections are conducted at the design and construction stage to verify whether the nuclear installation is designed in conformity with regulatory requirements and technical standards. In the case of operating nuclear installations, periodic inspections are conducted to confirm whether the safety regulatory requirements and limiting conditions for operation are complied with. KINS carries out these safety reviews and inspections, as entrusted by the Minister of Science and Technology in accordance with the Atomic Energy Act.

At the stage of the construction permit, the suitability of a site and the safety of proposed designs are, as major matters, subject to safety reviews. At the stage of the operating license, the integrity of facilities, the operating method of installations, and the plan for emergency response are, as major matters, subject to safety reviews.

The regulatory inspection is classified into the pre-operational and the periodic inspection. The objective of those inspections is to verify whether the installer or operator of nuclear installations properly implements the relevant requirements and licensing basis conditions. KINS conducts regulatory inspections of the safety and performance of each nuclear installation during the planned outage every 20 months. The facilities and items subject to regulatory inspections for PWR and PHWR are described in Table II.9-4 and Table II.9-5.

Meanwhile, in order to legislate the periodic safety review system for checking the safety of nuclear power plants which have run for more than 10 years, MOST amended the Atomic Energy Act in 2001, and also revised the Enforcement Decree and the Enforcement Regulations of the same Act reflecting necessary particulars for the enforcement of this amended Act.

KINS is now in process of developing a detailed guideline for an examination on the periodic safety review report to be submitted by the utility.

Table II.9-4 Facilities and Items Subject to Periodic Inspection for PWR

Facilities	Items Subject to Inspection
Reactor (including Fuel)	- Used Fuel Assembly Integrity - Zero Power Reactor Physics Test - On-Power Reactor Physics Test
Reactor Coolant System	- ISTs of Safety Class 1, 2, and 3 Systems - Steam Generator Eddy Current Test - Reactor Coolant Flow Rate Measuring Test - Reactor Coolant System Leakage Test
Instrument and Control System	- Engineered Safety Feature (ESF) Response Time Measurement - Reactor Protection System Response Time Measurement - Control Rod Drop Time Measurement - Control Rod Position Indication System Functional Test - ESF Slave Relay Actuation Test - Safety-related Instrumentation Calibration - Seismic Monitoring System - Digital Metal Impact Monitoring System - Emergency Shutdown Pannel - Fire Detection and Alarm System
Fuel Handling and Storage System	- Fuel Transfer Facilities - Spent Fuel Pool Cooling and Purification System
Radioactive Waste Management System	- Radioactive Waste Management System - Ventilation System Filter Functional Test - Water Chemistry Management
Radiation Control System	- Health Physics Plan and Implementation - Radiation Measuring and Monitoring System - Environmental Radiation Monitoring System - Meteorological Monitoring System
Reactor Containment System	- Integrated Leak Rate Test of Containment Building - Local Leak Rate Test of Containment Building - Containment Isolation System - Containment Spray System - Containment Combustible Gas Control System
Reactor Safety System	- Residual Heat Removal System - Emergency Core Cooling System - Auxiliary Feedwater System - Refueling Water Storage Tank
Emergency Power Supply System	- Emergency Diesel Generator Test - Battery and Battery Charger Test
Other Reactor Safety Related System	- Component Cooling Water System - Nuclear Service Water System - Compressed Instrument Air System - Snubber - Chemical and Volume Control System - Essential Chilled Water System - Fire Protection System - Seismic Class Structure Integrity - Heating, Ventilation, and Air Conditioning

Table II.9-5 Facilities and Items Subject to Periodic Inspection for PHWR

Facilities	Items Subject to Inspection
Reactor	- Reactor Criticality - Flow Rate of Fuel Channel - Fuel Channel Elongation - Power Distribution of Fuel Channel
Reactor Coolant System	- ISIs of Safety Class 1, 2, and 3 Systems - Steam Generator Eddy Current Test - Primary Heat Transport (PHT) Pump - PHT System Liquid Relief Valve Stroking Time Test - Feeder Grayloc - Degasser Condenser Relief Valve Test - Shutdown Cooling System - D_2O Feed Pump
Instrument and Control System	- PHT System Functional Test - Shutoff Rod Drop Test - Shutdown System # 1 Functional Test - Shutdown System # 2 Functional Test - Calibration of Safety-related System Instrumentation - Seismic Monitoring System - Fire Detection and Alarm System
Fuel Handling and Storage System	- Fueling Machine - Spent Fuel Pool Cooling and Purification System - Spent Fuel Discharge and Emergency Cooling System
Radioactive Waste Management System	- Radioactive Waste Management System - Ventilation System Filter Functional Test - Water and D_2O Chemistry Management
Radiation Control System	- Health Physics Plan and Implementation - Radiation Measuring and Monitoring System - Environmental Radiation Monitoring System - Meteorological Monitoring System
Reactor Containment System	- Integrated Leak Rate Test of Containment Building - Containment Local Leak Rate Test - Containment Isolation Valve Closing Time Test
Reactor Safety System	- Emergency Core Cooling System - Emergency Water Supply System - Special Safety System Poised State - Auxiliary Feedwater System
Emergency Power Supply System	- Standby Diesel Generator Test - Emergency Power Supply System - Battery and Battery Charger Test
Other Reactor Safety-related System	- Recirculating Cooling Water System - Raw Service Water System - Moderator System - Compressed Instrument Air System - Main Steam Safety Valve Test - Safety Class 1, 2, and 3 Pump and Valve Test - Fire Protection System - Annulus Gas System - Snubber - Differential Settlement of Containment Building - Seismic Class Structure Integrity - Calandria Vault Light Water Leak

Ⅱ.10 Radiation Protection (Article 15)

Ⅱ.10.1 Laws, Regulations, and Requirements

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

- provisions on protective measures against radiation hazards that keep the radioactive material release and the occupational radiation exposure to be as low as reasonably achievable (ALARA),
- provisions on safety measures relating to operations stipulating the necessary actions to be taken for protecting human bodies, materials, the public, and the environment from radiation hazards which may accompany the operation of nuclear installations,
- criteria for the registration of a business related to the personnel dosimetry service for any person who is employed in, or who has access to nuclear installations, and
- training requirements for the workforce involving radiation exposure.

The Enforcement Decree of the Atomic Energy Act specifies the detailed requirements for implementing the basic matters on radiation protection referred to in the Act, while the Enforcement Regulations of the Act includes the detailed procedure and method for executing the Enforcement Decree.

- ***radiation dose limits related to radiation protection (The dose limits defined by this regulation are as shown in Table II.10-1)***
- ***detailed regulations to minimize the exposure of the workers engaged in radiation work, the persons who have frequent access to nuclear installations, and the population living around the said installations***
- detailed provisions necessary for implementing protective measures against radiation hazards, such as the action to be taken for the radiation overexposure accident, and relevant reporting,
- ***detailed provisions necessary for implementing the radiological control measures such as criteria and access control of radiologically controlled area,***
- ***detailed provisions on the criteria for the registration related to a license for personnel dosimetry service.***

The Notice No. 2001-2 of the Minister of Science and Technology (titled "Criteria for Radiation Protection, etc.) amended in 2001, prescribes technical requirements, for example, the condition of radioactive effluent release and the application of dose limits affecting radiation protection.

Table Ⅱ.10-1 Dose Limits

Category	*Occupational*	*Frequent Access Personnel & Transport Worker*	General Public
Effective Dose	100 mSv in a consecutive five-year period, subject to a maximum effective dose of 50 mSv in any single year	12 mSv per year	1 mSv per year
Equivalent Dose			
- The Lens of the Eye	150 mSv per year	15 mSv per year	15 mSv per year
- The Skin, Hands, and Feet	500 mSv per year	50 mSv per year	50 mSv per year

1) "consecutive five-year period" means the period for every 5 years 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 over 1 mSv to a single year is acceptable within the limit of not exceeding 1 mSv per year on the average of values for five years.

※ Concerning the person who proves to be pregnant among radiation workers and the person who restrictively or temporarily uses any radioactive isotope among the public, it is necessary to comply with the standards prescribed and notified by the Minister of Science and Technology.

Ⅱ.10.2 Implementation of Laws, Regulations, and Requirements

1) Radiation Exposure Control and Reduction

Implementation of ALARA in the Design and Construction of Nuclear Installations

KHNP incorporates the following radiation protection principles in the design and construction of nuclear installations, 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 the shield 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 installations, and
- appropriate zone classification and access control.

Criteria for Radiation Exposure Control

KHNP established a target dose limit for radiation workers at 80% of the legal limit, as shown in Table Ⅱ.10-1, and controls radiation doses to maintain 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 they are expected to be additionally exposed above the target value, unless the approval of the plant manager is given or any proper measure is taken.

Management of Radiation Work

KHNP prescribes in the procedures 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 issuance of the radiation work permit, the radiation control personnel is to evaluate the expected dose in consideration of the working environment and conditions, and if necessary, to further impose any special conditions on the worker.

Dose Reduction

KHNP establishes and operates target values for reducing occupational radiation exposure according to classified categories, such as the annual collective dose, collective dose during planned preventive maintenance period, and the job-specific collective dose. KHNP prescribes in the procedures that any radiation work shall be conducted following the plan, as established before undertaking the work. It is also prescribed that the ALARA Committee shall be held from the planning stage to estimate and evaluate the radiation level and the expected collective dose, and to further evaluate ALARA performance more than once a year, in respect of major maintenance work, design modification, and replacement of equipment. When conducting radiation work, the technique for reducing doses shall be described in the radiation work procedure or the radiation work permit. It is required for radiation workers to utilize the technique after evaluating the application result of the technique to any past work. Trends of radiation exposure of radiation workers in nuclear installations are shown in Table II.10-2.

Personnel Dosimetry Service and Inspection for Dosimeter

All the persons engaged in personnel dosimetry service, including KHNP, transact personnel dosimetry services with an approval of the Minister of Science and Technology, and monthly distribute, collect, and reads thermoluminescence dosimeters (TLDs). ***The result should be notified to the individuals and reported to the Government on a quarterly basis, and the calibration and the performance verification for the said reader are conducted every 6 months. TLD periodically undergoes a standardized performance inspection and a periodic inspection which meet the international criteria in order to secure objectivity and reliability in the personnel dosimetry.***

Radiation Protection Training

KHNP prescribes in the procedure that radiation workers and the personnel having access to nuclear installations shall take appropriate radiation protection training courses. Workers acquire basic knowledge and handling skills needed for radiation work through training. The curriculum is classified into the following courses:

- a course for personnel of temporary access,
- a course for personnel of occasional access,
- a course for radiation workers,
- a refresher course,
- a course for any offenders, and
- a course for managers.

Table II.10-2 Exposure Dose of Radiation Workers in Nuclear Installations

Unit: Collective Dose (man-Sv/yr), Average Individual Dose (mSv/yr)

Dose for Plant	Year	1995	1996	1997	1998	1999	2000
Kori Units 1 & 2	Collective Dose	1.38	3.00	2.50	4.56	2.62	1.73
	Average Individual Dose	1.20	2.15	1.87	2.31	1.69	1.21
Kori Units 3 & 4	Collective Dose	4.03	2.31	3.04	1.85	2.42	1.29
	Average Individual Dose	2.50	1.79	2.17	1.42	1.51	0.90
Yonggwang Units 1 & 2	Collective Dose	3.83	1.66	0.95	3.17	2.05	2.32
	Average Individual Dose	2.54	***1.30***	0.84	2.43	1.54	1.52
Yonggwang Units 3 & 4	Collective Dose	0.06	0.68	0.69	0.61	1.01	0.94
	Average Individual Dose	***0.04***	0.45	***0.50***	0.45	0.74	0.70
Wolsong Units 1 & 2	Collective Dose	2.17	2.99	1.23	2.87	2.77	1.81
	Average Individual Dose	1.48	1.73	0.74	2.17	2.15	1.37
Wolsong Units 3 & 4	Collective Dose	-	-	-	0.14	0.64	0.40
	Average Individual Dose	-	-	-	0.11	0.49	0.40
Ulchin Units 1 & 2	Collective Dose	1.37	1.07	1.62	1.27	0.82	2.15
	Average Individual Dose	1.09	0.94	1.44	1.20	0.82	1.64
Ulchin Units 3 & 4	Collective Dose	-	-	-	0.03	0.36	0.74
	Average Individual Dose	-	-	-	0.02	0.28	0.52

The training duration is assigned differently for each course in consideration of the speciality of each course. Educational subjects include fundamentals of radiation protection, health effects of radiation, access procedure to the controlled area, and emergency preparedness. Additional subjects include radiation exposure control, contamination control, waste management, and the use of instruments and protective equipment. The 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, the personnel will be qualified.

2) Requirements for Radioactive Effluent Release

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

The dose constraints for gaseous effluent on the exclusion area boundary by a unit of nuclear power plant, which are specified in the Notice of the Minister of Science and Technology, are as follows:

- air absorbed dose by gamma rays : 0.1 mGy/yr
- air absorbed dose by beta rays : 0.2 mGy/yr
- effective dose from external exposure : 0.05 mSv/yr
- skin equivalent dose : 0.15 mSv/yr
- ***organ equivalent dose from internal exposure to particulate radioactive substance, H-3, C-14, and radioiodine : 0.15 mSv/yr***

The dose constraints for liquid effluents on the exclusion area boundary by a unit of nuclear power plant are as follows :

- effective dose: 0.03 mSv/yr
- organ equivalent dose from internal exposure: 0.1 mSv/yr

The annual dose constraints on the exclusion area boundary per site where multiple units are operating, are as follows:

- ***effective dose: 0.25 mSv/yr***
- ***thyroidal equivalent dose: 0.75 mSv/yr***

According to this, KHNP discharges gaseous or liquid effluents into the environment after confirming that the released effluents is less than the prescribed discharge limits. The trend of annual release of liquid and gaseous effluents is

shown in Table II.10-3.

Table II.10-3. The trend of annual release of liquid and gaseous effluents

Unit : TBq

Types of Effluents \ Year		1996	1997	1998	1999	2000
Kori Units 1 & 2	Liquid	3.83E-04	1.06E-04	2.05E-05	4.51E-06	1.36E-05
	Gaseous	4.49E+00	4.80E+00	9.90E-01	1.73E+00	4.16E-01
Kori Units 3 & 4	Liquid	4.18E-05	1.44E-06	Less than LLD	Less than LLD	9.14E-07
	Gaseous	1.54E+00	1.97E+00	2.26E+00	1.77E+00	1.33E+00
Yonggwang Units 1 & 2	Liquid	5.65E-05	1.24E-05	Less than LLD	Less than LLD	6.84E-08
	Gaseous	5.47E+00	4.23E+00	6.49E+00	6.74E+00	3.42E+00
Yonggwang Units 3 & 4	Liquid	1.59E-04	3.39E-06	Less than LLD	Less than LLD	1.95E-05
	Gaseous	1.14E-02	5.03E-03	7.86E-03	1.09E-02	7.98E-03
Ulchin Units 1 & 2	Liquid	2.57E-04	Less than LLD	Less than LLD	Less than LLD	2.17E-05
	Gaseous	2.15E-01	6.83E-01	6.04E-02	4.54E-02	3.25E+00
Ulchin Units 3 & 4	Liquid	-	-	Less than LLD	Less than LLD	8.23E-06
	Gaseous	-	-	1.09E-02	1.80E-01	5.34E-02
Wolsong Units 1 & 2	Liquid	Less than LLD	Less than LLD	Less than LLD	Less than LLD	2.13E-04
	Gaseous	3.23E+03	6.03E+01	1.01E+02	6.19E+01	3.92E+01
Wolsong Units 3 & 4	Liquid	-	-	Less than LLD	Less than LLD	7.62E-05
	Gaseous	-	-	6.03E+01	4.22E+01	1.37E+01

LLD: Low Limit of Detection

Assessment of Radiation Doses to the Population around Nuclear Installations

The radiation dose to and its effect on the population around nuclear installations 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.

3) Environmental Radiation Monitoring

KHNP conducts environmental radiation monitoring activities including the installation and operation of the TLD posts and environmental radiation monitors, and the analysis of the radioactivity of environmental samples, in accordance with the Notice No. 96-31 of the Minister of Science and Technology (titled "Regulation Concerning the Survey of Environment around Nuclear-related Installations and the Impact Assessment").

The environmental radiation monitors are installed at about 10 stations within a 30 km radius of nuclear installations, in consideration of topography, population distribution, and atmospheric dispersion factors, and continuously monitor the gamma exposure dose rate 1 m above the ground. The monitoring system status and the radiation dose levels can be confirmed, on real time basis, in the environmental radiological laboratory and the main control room where the monitors are connected on-line. TLDs are installed at about 40 posts for measuring and assessing quarterly the cumulative gamma radiation dose within a 30 km area around nuclear installations.

The sampling points in the neighboring environment are selected with due consideration of population distribution, meteorological condition, and geographical features of the area within 30 km. The samples are, inter alia, air particulates, land samples (soil, pine needles), water samples (seawater, underground water, precipitation), seabed samples (sediment, benthos), and food samples (milk, fishes and shellfish, cereal, egg, seaweed). ***The revised parts were also indicated in italics in the table II.10-4.***

Table Ⅱ.10-4 Environmental Radiation Monitoring in the Vicinity of Nuclear Installations

Sample			Monitoring Items	Sampling Frequency	Analysis of Frequency	No. of Locations (No. of Samples)			
						Kori	Wolsong	Young-gwang	Ulchin
Air	Air Dose Rate		Gamma ray dose rate (ERM)	Continuous	Continuous	12	10	10	10
			Gamma ray dose rate (Portable)	Monthly, ***Quarterly***	Monthly, ***Quarterly***	49 (***512***)	30 (120)	***30 (120)***	24 (***84***)
			Gamma ray dose rate (TLD)	Continuous	Quarterly	43 (172)	42 (168)	43 (172)	43 (172)
Land	Air	Particulates	Gross -β	Continuous	Weekly	10 (520)	10 (520)	10 (520)	10 (520)
		Iodine	I-131		Weekly	10 (520)	10 (520)	10 (520)	10 (520)
		Particulates	γ-nuclides		Monthly	10 (120)	10 (120)	10 (120)	10 (120)
		CO2	C-14		Monthly	-	2 (24)	-	-
		Moisture	H-3		Biweekly	-	10 (240)	-	-
	Drinking Water		H-3, γ-nuclides	Quarterly	Quarterly	3 (12)	4 (16)	***2 (8)***	3 (12)
	Ground Water		H-3, γ-nuclides	Quarterly	Quarterly	3 (12)	4 (16)	2 (8)	3 (12)
	Surface Water		H-3, γ-nuclides	Monthly	Monthly	3 (36)	4 (48)	2 (24)	3 (36)
	Precipitation		Gross-β, H-3, γ-nuclides	Monthly	Monthly	3 (36)	7 (84)	***4 (48)***	3 (36)
	River Sediment		γ-nuclides	Quarterly	Quarterly	4 (16)	3 (12)	2 (8)	3 (12)
	Soil		γ-nuclides	Semiannually	Semiannually	10 (20)	10 (20)	10 (20)	10 (20)
			Sr-90			3 (6)	3 (6)	3 (6)	***4 (8)***
	Milk		***γ-nuclides***	Monthly	Monthly	2 (24)	2 (24)	2 (24)	2 (24)
			Sr-90	***Monthly***	***Quarterly***	***2 (8)***	***2 (8)***	***2 (8)***	***2 (8)***
			C-14, ***H-3***	Quarterly	Quarterly	-	1 (4)	-	-
	Crops & Vegetables		γ-nuclides	***Harvesting Season***	***Semi-annually***	3 (14)	4 (14)	***5 (12)***	2 (16)
			Sr-90			2 (8)	2 (8)	2 (8)	2 (16)
			C-14, ***H-3***			-	***3 (10)***	-	-
	Pineneedle		γ-nuclides	Semiannually	Semiannually	7 (14)	4 (8)	5 (10)	4 (16)
			Sr-90			2 (4)	2 (4)	2 (4)	2 (4)
	Meat & Eggs		γ-nuclides	Semiannually	Semiannually	2 (4)	2 (4)	2 (4)	2 (4)
			C-14			-	1 (2)	-	-
Sea	Sea Water		Gross-β, H-3	Monthly	Monthly	11(132)	4 (48)	6 (72)	3 (36)
			γ-nuclides		Quarterly	11 (44)	4 (16)	6 (24)	3 (12)
			Sr-90		Quarterly	2 (8)	2 (8)	2 (8)	2 (8)
	Sea Sediment		γ-nuclides	Semiannually	Semiannually	9 (18)	4 (8)	4 (8)	3 (6)
			Sr-90			2 (4)	2 (4)	2 (4)	2 (4)
	Fish & Shellfish		γ-nuclides	Semiannually	Semiannually	3 (12)	3 (12)	5 (18)	3 (12)
			Sr-90			2 (8)	2 (8)	2 (8)	2 (8)
	Benthos Indicator		γ-nuclides	Semiannually	Semiannually	4 (8)	3 (6)	3 (10)	3 (6)
	Seaweeds		***γ-nuclides***	Semiannually	Semiannually	***5 (11)***	3 (6)	4 (8)	3 (6)
			Sr-90			2 (4)	2 (4)	2 (4)	***3 (6)***

Ⅱ.10.3 Control Activities

The safety regulatory activities for radiation protection are classified into safety reviews, regulatory inspections, and development of technical standards. In the safety review, items are examined regarding ALARA assurance of radiation exposure to workers, source term assessment, characteristics of radiation protection design, dose assessment health physics program, and the appropriateness of equipment. The regulatory inspection confirms whether or not the radiation monitoring system in nuclear installations is appropriately operated. It also confirms that any personal exposure to radiation is maintained as low as reasonably achievable (ALARA) by checking the health physics program, the procedures for the radiation exposure control, the ALARA program, and the radiation work management.

KINS, entrusted by MOST, installs and operates the nation-wide environment radiation monitoring network in addition to the above safety regulatory activities. KINS measures the radioactivity in airborne dust, fallout, rainwater, livestock products, farm products, soil, drinking water, milk, and background radiation levels throughout the nation. This enables to properly respond and quickly detect any abnormal situations or symptoms in environmental radioactivity. The nationwide environmental radiation monitoring network, as shown in Figure Ⅱ.10-1, consists of an environmental radiation monitoring center in KINS, local monitoring stations situated at ten cities of large population, monitoring posts located in Ulnongdo and Baekryongdo, monitoring posts around four nuclear installation sites, and a monitoring network connected with military monitoring post. KINS has yearly conducted national and international inter-comparisons on environmental radioactivity measurements for conducting quality control of environmental radiation monitoring.

There are some important issues on safety regulatory activities, such as the reduction of dose limits and the more active application of the ALARA principle.
KINS had conducted a five year mid- and long-term research project since July 1992, for incorporating ICRP 60 into relevant national laws and regulations under the initiative of MOST.
KINS made an amendment of the Atomic Energy Laws in August 1997 by partly reflecting the concept of ICRP 60 therein.
The major contents of the amendment are the reduction of dose limits for radiation workers and the general public and the introduction of an internal exposure assessment system, etc., following the abolishment of the maximum permissible dose concept. The amendment has put in force by the legal revision of 1998. Meanwhile, the rest part is to be extensively introduced from the year of 2003 with the formulation and application of a stepwise enforcement plan.

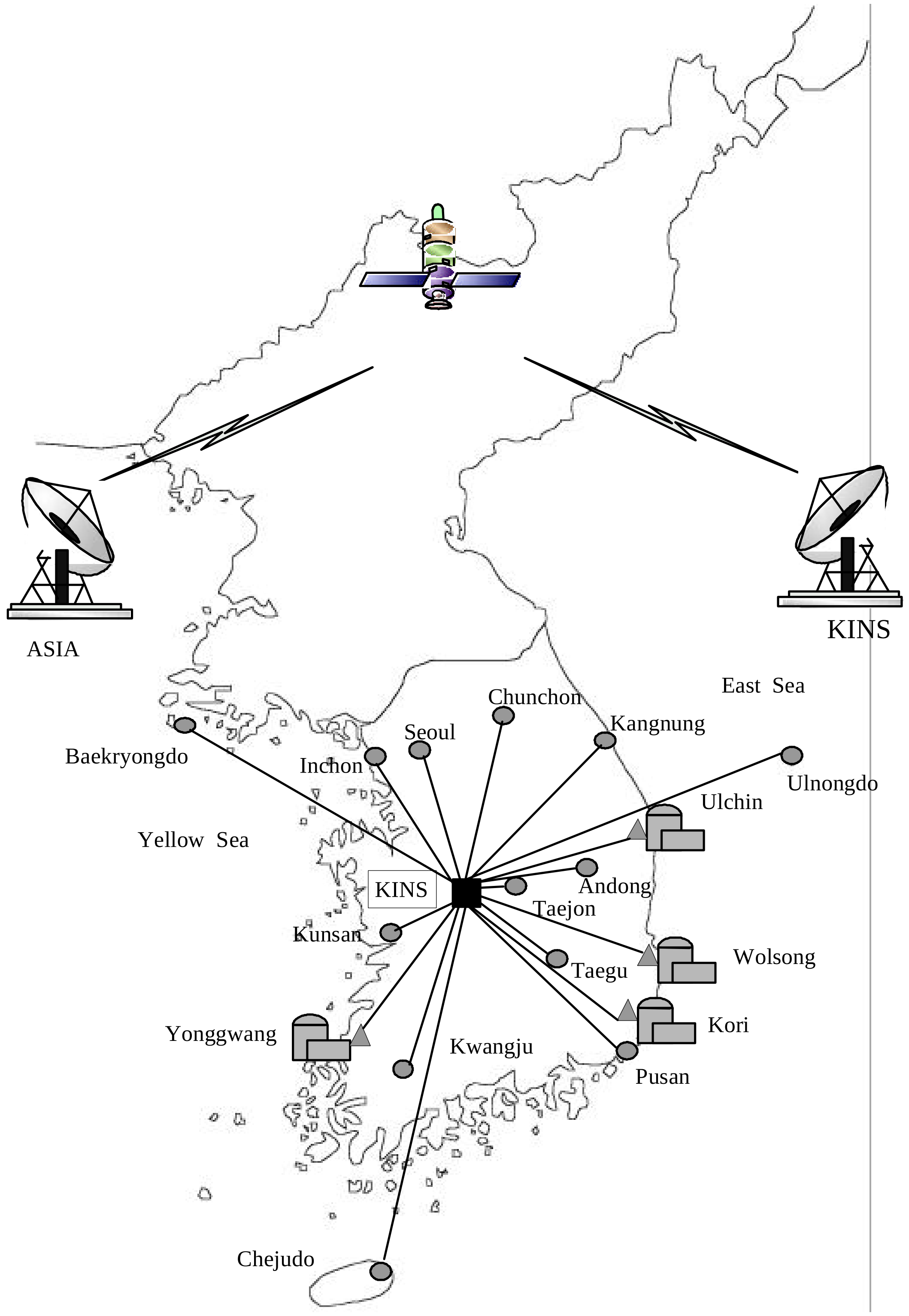


Figure Ⅱ.10-1 National Environmental Radiation Monitoring Network

Ⅱ.11 Emergency Preparedness (Article 16)

Ⅱ.11.1 Laws, Regulations, and Requirements

Radiological emergency preparedness is based on the Atomic Energy Act and the Basic Law of Civil Defense which stipulates a national preparation against radiological accidents. Under the Basic Law of Civil Defense, MOST is responsible for formulating a master plan every 5 years and an yearly implementation plan based on the master plan. The local governments and agencies concerned shall yearly make a detailed implementation plan, according to the master plan and the yearly implementation plan.

The Atomic Energy Act prescribes that, as a part of the safety measures for the operation of nuclear installations, an applicant for an operating license shall submit a radiological emergency plan to MOST for approval. The detailed criteria for formulating radiological emergency plans are referred to in the Notice No. 96-4 of the Minister of Science and Technology (titled "Criteria for the Formulation and Implementation of Radiological Emergency Plan by the Power Reactor Operator"). ***The same Notice, which had been formulated in 1996, was revised mainly for the particulars of environmental measurement laboratory in August 1998. It contains the following :***

- the organization for emergency response,
- the cooperation system with off-site emergency preparedness organizations,
- the emergency classification and the emergency action level,
- the emergency response facilities and equipments,
- the of an accident and its consequences,
- the protective measures including medical activities,
- the reentry and recovery, and
- the emergency training and exercises
- ***the public education and information***
- ***the responsibility for the maintenance and management of emergency plan***

From the year of 2000, it become feasible to continuously check and complement the capability of coping with emergencies, covering the radiological emergency response facilities of nuclear power plant, according to legislation of regulatory body's periodic inspection for radiological emergency response facilities.

Ⅱ.11.2 Implementation of Emergency Preparedness Measures

The national radiological emergency plan (the master plan and the yearly implementation plan of MOST) consists of 5 parts, namely, the establishment of

emergency response organization, emergency classification and response, protective measures, emergency response facilities and equipments, and emergency training and exercises, as shown in Table Ⅱ.11-1.

Table Ⅱ.11-1 Elements of National Radiological Emergency Plan

Titles	Contents
1. Emergency Response Organization	● Emergency organization ● Assignment of responsibility ● Recovery planning
2. Emergency Classification and Response	● Types of emergencies considered in radiological disaster control ● Emergency classification system ● Emergency responses according to incident phases ● Notification ● Strengthening of the radiological disaster control system
3. Protective Measures	● Emergency planning zone ● Alerting the population ● Sheltering and evacuation ● Medical support ● Food and water control ● Access control ● Public information
4. Emergency Facilities and Equipment	● Reinforcement of emergency installations ● Funding and technical assistance
5. Training and Exercises	● Emergency training ● Emergency exercises

Classification of Emergency Situations

Radiological emergencies at nuclear installation site are classified into white emergency (alert), blue emergency (site area emergency), and red emergency (general emergency) according to the severity of accident. The emergency action levels are based on the conditions of nuclear installations, the instrument indications, and the on-site and off-site radiation levels.

- White Emergency: Events are in progress or have occurred which involve an actual or potential substantial degradation of the safety level of nuclear installations. The release of radioactive material is expected to be limited within the structures of the nuclear installation, demanding the alertness of off-site emergency preparedness organizations.
- Blue Emergency: Events are in progress or have occurred which involve actual

or likely major failures of plant functions needed for the protection of the public, requiring the activation of off-site emergency response organizations.

- Red Emergency: Events are in progress or have occurred which involve actual or imminent substantial core degradation or melting with the potential for loss of containment integrity, thus anticipating a large release of radioactive material, and requiring protective measures for the population in the vicinity of the nuclear installation.

If any accident occurs in nuclear installations, the operator shall immediately report the emergency situation to the Minister of Science and Technology and the local government, in accordance with the Notice No. 96-25 of the Minister of Science and Technology (titled "Regulation concerning the Report on the Incidents and Accidents of Nuclear-related Installations").

Radiological Emergency Response Scheme

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 KINS-Technical Support Center, and the KEPCO-Emergency Operation Center as shown in Figure II.11-1.

The national government has a responsibility to control and coordinate the countermeasures against radiological disaster. The Local Response Headquarters, established by the provincial governments concerned, deploys actions to protect the people and properties under their jurisdiction.

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

KINS is in charge of providing technical advice on radiological emergency response, dispatching technical advisory teams to the affected site, initiating emergency operation of 17 nation-wide environmental radioactivity monitoring stations in accordance with the Nationwide Environmental Radioactivity Monitoring Plan, offering radiation monitoring cars, and monitoring the response activities of the operator.
KINS also developed and currently operates the Computerized Technical Advisory System for the Radiological Emergency (CARE) in order to effectively provide various technical supports for the public and environment protection in radiological emergencies. CARE permits not only the rapid verification and evaluation of radiological emergencies and radiation impacts but also the comprehensive management of an information about several measures to protect the public. Tts configuration is represented in Figure II.11-2.

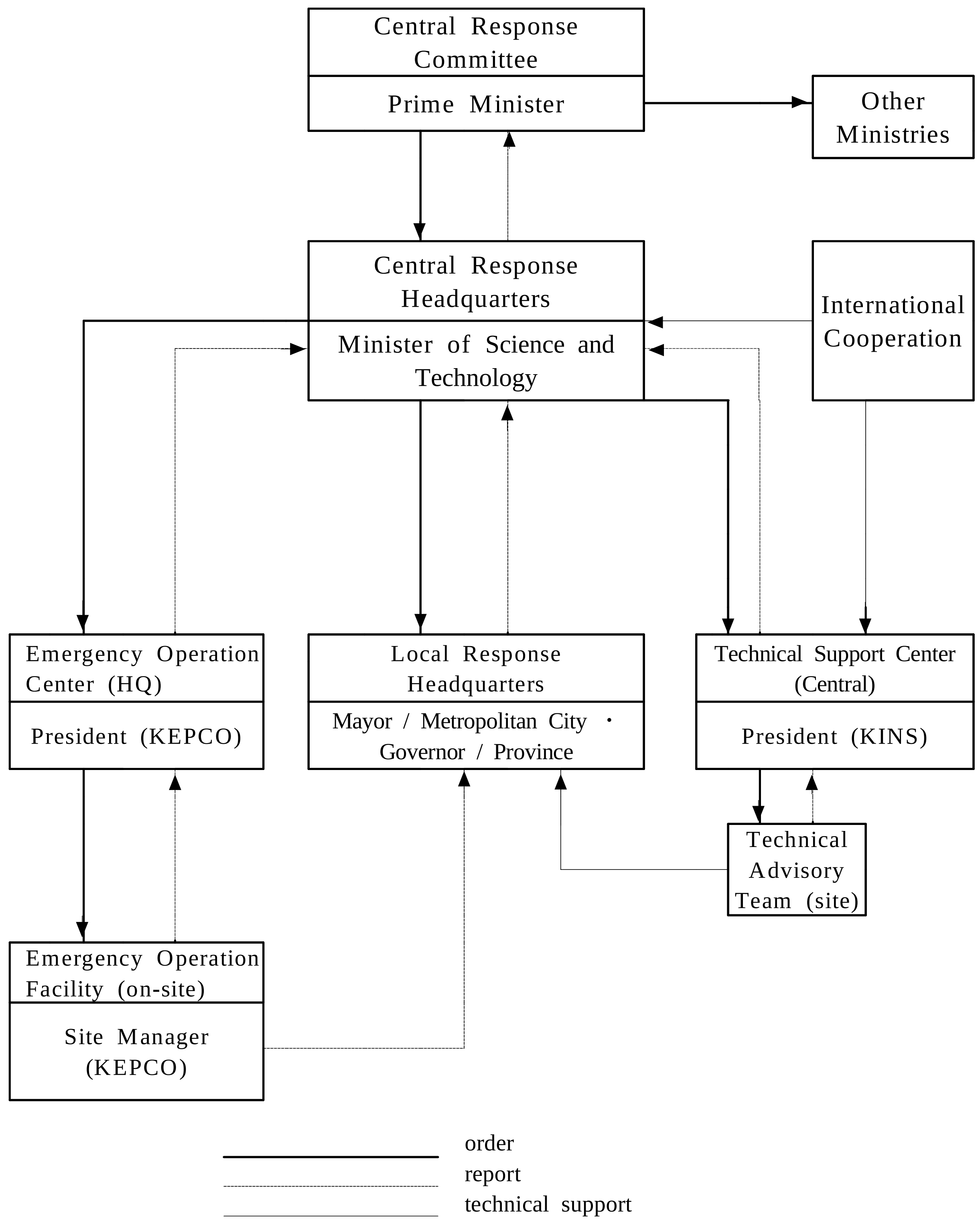
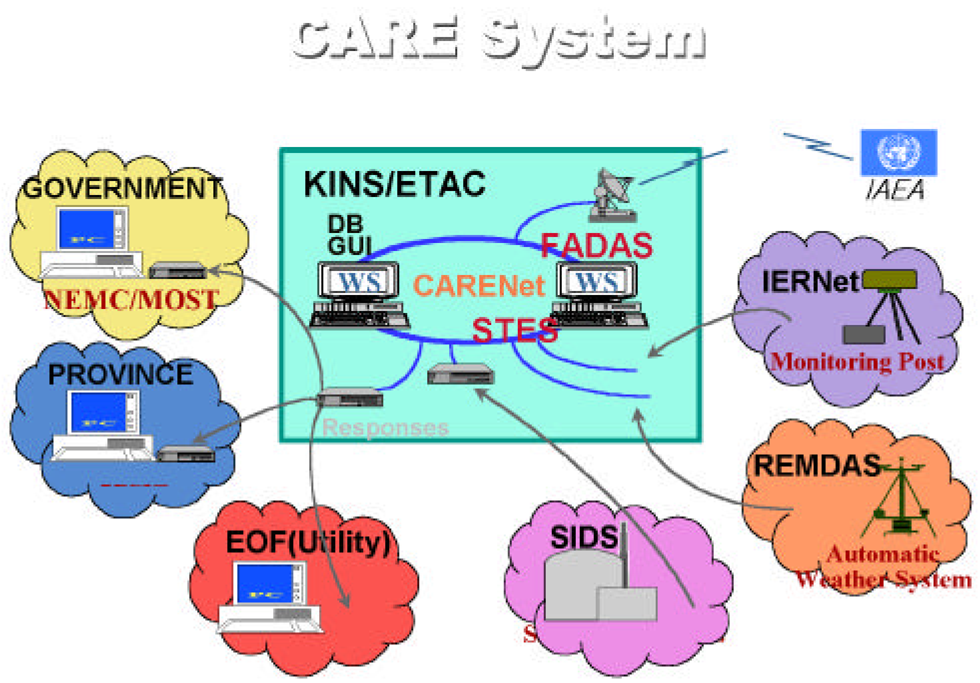


Figure Ⅱ.11-1 National Radiological Emergency Response Scheme



NEMC : National Emergency Management Commission

SEMC : Site Emergency Management Committee

SIDS : Safety Information Display System

REMDAS : Rediological Emergency Management Data Acquisition System

IERNet : Integrated Environmental Radiation Network

FADAS : Following Accident Dose Assessment System

STES : Source Term Evaluation System

GUI : Graphic User Interface

DB : Database

WS : Workstation

EOF : Emergency Operation Facility

Figure II.11-2 Computerized Technical Advisory System for the Radiological Emergency (CARE)

Protective Measures

In order to make the emergency plan immediately executable at the early phase of the accident, an emergency planning zone (EPZ) is designated for the area at a radius of 8-10 km from the nuclear installation. Intensive emergency plans such as evacuation plan are required for an EPZ. For the areas outside the EPZ, comprehensive plans are worked out. For the evacuation and indoor sheltering of the population within the EPZ, the local government designates and secures, beforehand, public establishments by regions as facilities for evacuation and indoor sheltering. These facilities are chosen in consideration of the estimated number of persons, distance, and time required for evacuation. The local government gives directions for evacuation and indoor sheltering when an accident occurs. ***Considering the special aspects of radiological accident, the local government and the nuclear installation operator must jointly alert the population living within a radius of 2km from the nuclear installation.***

The operators of nuclear installations are responsible not only to report emergency situations to the organizations concerned, but also to provide the local government with advice and consultation on protective measures at the early phase of the accident.

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. In order to prevent the thyroid exposure from radioactive iodines, the Headquarters retains potassium-iodide for emergencies and maintains a distribution system.

KHNP made an agreement with designated hospitals near the site of nuclear installation for emergency medical service, and established the Radiation Health Research Institute which conducts researches activities and incorporate th results into radiation and health physics. The institute also provides the radiological emergency medical service and the medical examination for nuclear workers and inhabitants in the nearby area.

The Director of the Local Response Headquarters has a responsibility to decide on the measures to control the ingestion of contaminated foodstuffs. The Director of the Central Response Headquarters and the operator of the nuclear installation shall give utmost support to the Director of the Local Response Headquarters in making decisions on relevant measures. In order to secure a stable life of the population, it is necessary for the local headquarters to devise short-term food substitute, secure an emergency water supply system, and take long-term response against a prolonged emergency.

Measures for Publicity

The national government and the local governments have provided information to the public in the vicinity of the nuclear installation on nuclear disasters, evacuation routes, sheltering centers, emergency communication, and protective action guides through pamphlets and civil defense education.

Emergency Facilities and Equipments

The operator of nuclear installations must prepare emergency response facilities such as the Emergency Preparedness Center, the Technical Support Center (TSC), the Operational Support Center (OCS). The Safety Parameter Display System (SPDS) is provided to the TSC. The operator is also required to set up the Plant Data Acquisition System through which information is provided to MOST and KINS.

The operator of nuclear installations shall keep and manage the equipments required by each emergency organization for the measurement and analysis of radioactivity. The operator also provides off-site emergency organizations with radioactivity measuring and analyzing equipment to perform an emergency response.

Ⅱ.11.3 Training and Exercises

The operator of nuclear installations shall periodically conduct repeated training and exercises for emergency personnel to qualify them by providing thorough knowledge of emergency duties. The Nuclear Training Center of KAERI and the Nuclear Education Institute of KHNP operate training courses on emergency preparedness for personnel involved in an emergency response. The head of the local government formulates and implements an independent training program, considering the specialty of radiological accidents, to the personnel engaged in an emergency response.

Emergency exercises are held, in which on-site and off-site emergency preparedness organizations must participate, as follows:

- full-scale exercises, in which all on-site and off-site emergency organizations shall participate, are held at the nuclear installation site once or more every 3 years,
- small-scale exercises, in which all emergency units in nuclear power stations of two units shall participate, are held every year,
- drills, in which each emergency unit in a nuclear installation shall participate, are held every quarter, and
- for newly constructed nuclear installations at a site where other nuclear installations are in operation, an initial exercise is held to demonstrate the ability

of emergency response before the rated thermal output reaches 5%.

According to the above regulations, full-scale exercises were held at Kori nuclear power site and Yonggwang nuclear power site, along with small-scale exercises of four times in 2000.

Ⅱ.11.4 International Arrangements

The notification of an accident and the request of assistance from international organizations and nations concerned, are made in accordance with the procedures specified in the "Convention on the Early Notification of Nuclear Accidents" and the "Convention on the Support in Nuclear Accidents or Radiological Emergencies".

MOST and the US Nuclear Regulatory Commission (USNRC) maintain a radiological emergency cooperation scheme, by mutual consent, pursuant to the "Arrangement between USNRC and MOST for the Exchange of Technical Information and Cooperation in Regulatory and Safety Research Matters". Between MOST and the Ministry of Trade and Industry, and the Science and Technology Agency of Japan, there are inter-governmental agreements to maintain an early notification network to provide prompt notification when a nuclear accident occurs..

D. Safety of Installations

Ⅱ.12 Siting (Article 17)

Ⅱ.12.1 Licensing Process and Regulatory Requirements

The procedure for the site selection of nuclear installations is described in Section Ⅱ.2.3. It is stipulated in the Atomic Energy Act that the siting of nuclear installations shall conform to the technical requirements prescribed by the Enforcement Decree of the same Act in such a way that it does not present any impediment to the protection of people properties and the environment against radiation hazards. As for technical standards entrusted by the same Act, ***the Enforcement Regulation Concerning the Technical Standards of Reactor Facilities, etc., provides 7 items: restriction on location and practicability of emergency preparedness plan, geology and earthquake, meteorology, hydrology and oceanography, man made hazard, and construction of multiple units.***

The Notice No. 2000-8 of the Minister of Science and Technology (titled "Technical Standards of the Location, Structure and Equipment of Reactor Facilities") amended in 2000, stipulates that the relevant safety requirements set by USNRC and IAEA shall be applied, mutatis mutandis, to the regulatory requirements for siting.

The Atomic Energy Act also stipulates that an exclusion area shall be established to protect human bodies, materials, and the public from radiation hazards that may result from the construction and operation of nuclear installations. Access or residence of the public shall be restricted accordingly.

It is also prescribed in the Environmental Impact Assessment Act to verify and evaluate non-radiological environmental impacts on the natural environment, the living environment, and the social and economic environments due to the construction and operation of nuclear installations.

Ⅱ.12.2 Plan for Implementing Regulatory Requirements

KHNP shall perform safety assessments, under the provisions of the Atomic Energy Act, including the preliminary site surveys and the detailed site surveys for a proposed site. When applying for early site approval, KHNP must prepare a radiological environmental report and a site survey report, filing them with the Minister of Science and Technology. The said Minister issues an early site approval on the basis of the results of the safety review by KINS.

Location of Site, practicability of emergency preparedness plan and Exclusion Area

For confirming the suitability of a site, it is essential to conduct a site survey and an assessment regarding the geographical and geological conditions, the present and future estimated population density, and public facilities in low population zone. Assessments are also performed regarding the adequacy of the exclusion area boundary distance, the low population zone distance, the distance between the site and the population center, and the feasibility to take proper protective actions in an emergency.

In accordance with the Atomic Energy Act, KHNP establishes an exclusion area within a specified radius from the site, as shown in Table Ⅱ.12-1. In establishing the exclusion area boundary distance, 700 m was applied to a site with PWRs, at the initial stage, to be consistent with the exclusion area boundary distance applied to Kori Unit 1 on the basis of dose calculations. In the case of the site with PHWRs introduced from Canada, 914 m has been established as the exclusion area boundary distance in accordance with Canadian practices. In the case of new nuclear installations, such as Yonggwang Units 5&6 and Ulchin Units 5&6, a boundary distance of 560 m has been adopted on the basis of dose calculations and newly developed technical standards. The exclusion area boundary distance has to be set up in such a way that an individual located at any point on the exclusion area boundary for 2 hours immediately following onset of the radioactive material release would not receive a total radiation dose to the whole body in excess of 0.25 Sv or a total radiation dose in excess of 3 Sv to the thyroid from iodine exposure.

Table Ⅱ.12-1 Exclusion Area Boundary Distance of Nuclear Installations

(unit : meter)

Station Name	Reactor Types	Exclusion Area Boundary Distance
Kori Units 1, 2, 3 & 4	PWR	700
Yonggwang Units 1, 2, 3 & 4	PWR	700
Ulchin Units 1, 2, 3 & 4	PWR	700
Wolsong Units 1, 2, 3 & 4	PHWR	914
Yonggwang Units 5 & 6	PWR	560
Ulchin Units 5 & 6	PWR	560

Nearby Industrial Facilities

An appropriate survey is conducted in respect of locations of nearby industrial facilities, accident probability, and the distances in relation to transport routes of nearby industrial, military, and transports facilities. If nearby industrial facilities are found to have potential impacts on nuclear installations, appropriate measures must be taken.

As for an airport within close proximity to a site, it is essential to survey the distance between the airport and the nuclear installation, the probability of an aircraft accident, flight frequencies, and air ways, and then to evaluate the feasibility of measures to prevent an airplane collision with the nuclear installation.

Meteorology, Hydrology and Oceanography

Appropriate surveys and analysis are conducted regarding the average and extreme values of meteorological conditions and the local meteorological conditions necessary for the site selection and safety design of the nuclear installation. Appropriate analyses are also conducted regarding the potential influence of a nuclear installation on local meteorological conditions and on the topography of the site and surrounding area.

Appropriate evaluations and analyses are conducted concerning hydrological features of the site that might affect safety-related structures. These features include floods, ground water systems, surges, tsunami, and dam failure. The results are then reflected in the design of the nuclear installation. The flood history and the maximum flooding of streams and rivers are surveyed. Based on the survey, assessments are conducted regarding any potential effects from flooding or heavy rainfall, and any potential water disaster that might affect safety-related structures in the nuclear installation due to dam failures near the site. Evaluations are also conducted regarding minimum water levels.

Geology, Earthquake, and Geotechnical Engineering

Various surveys and analyses are conducted for the area within a radius of 320 km from a nuclear installation in such fields as topography, geology, geological structure, stratigraphy, geological tectonics and seismology. As for the area within a radius of 1 km to 8 km from the nuclear installation, a more detailed investigation is conducted in specific fields of topography, geology, stratigraphy, and geological history by using geological engineering and geophysical techniques.
It is essential to verify whether any geological disaster, for example, settlement or collapse has occurred at the site and in the area adjacent thereto, and to analyze the seismicity of the site. The results are to be reflected in the design of the nuclear

installation. It is also necessary to investigate the stability of the foundation under static and dynamic load conditions, and then to evaluate whether or not the foundation holds a sufficient bearing capacity within the allowable extent of subsidence of each structures. The foundation is to be reinforced to meet the designed criteria, if necessary.

External Events Considered in the Probabilistic Safety Assessment

In conducting a probabilistic safety assessment of a nuclear installation, risk is evaluated in consideration of any external events causing functional loss of the systems, such as earthquake, fire, typhoon, or flood. In this evaluation, the instruments and structures that may be damaged from any external event are identified and the core damage frequency is estimated in consideration of damaged instruments and structures.

Ⅱ.12.3 Activities to Maintain Continued Safety Acceptability of Nuclear Installations in Consideration of Site-related Factors

Monitoring and Evaluation of Non-radiological Environmental Impacts

In order to verify how the operation of nuclear installations affects the environment, KHNP conducts a periodic survey on the biological, chemical, and physical states in accordance with the guidelines for monitoring the environment around a nuclear installation. Within a radius of 8 km from the nuclear installation, the oceanic environment is investigated at more than 10 different locations, while within a radius of 10 km the land environment is investigated at more than 3 different locations.

Meteorological and Seismological Observation

KHNP makes consecutive meteorological observations to provide sufficient meteorological data to evaluate potential radiation doses to the public, due to any release of radioactive materials during normal operation or any accident of the nuclear installation. KHNP also monitors any seismism by seismic monitors, so that when any earthquake occurs, effects on the safety-related equipment can be promptly evaluated.

Conduction of Epidemiological Census

In order to identify radiological effects on site personnel and on the population near nuclear installations, KHNP took an epidemiological census of all site personnel and the population living within a radius of 3 5 km from the nuclear installation.

To ensure the accuracy and reliability of such census results, the population is classified into two groups: one for the population living in an area of 20 km from the nuclear installation and the other for the population living in remote areas of more than 20 km away. Each group is then divided into two subgroups: one for the population living in rural areas and the other for those living in cities. The census results of each subgroup are then compared with alternate subgroups.

Environmental Radioactivity Monitoring, Control of Radioactive Effluent and Dose Evaluation

The environmental radioactivity monitoring, the control of radioactive effluents and the dose evaluation are described in detail in Sections Ⅱ.10.2 and Ⅱ.10.3.

Ⅱ.12.4 International Arrangements

The Republic of Korea has not concluded any specific international agreements with foreign countries on site selection, since the Republic of Korea is a peninsula and isolated from neighboring countries. The Republic of Korea has, however, concluded agreements with foreign countries on radiological emergency preparedness, as described in Section Ⅱ.11.4.

Ⅱ.13 Design and Construction (Article 18)

Ⅱ.13.1 Licensing Procedure and Regulatory Requirements

The licensing procedure for the design and construction of nuclear installations is described in Section Ⅱ.2.3.

The criteria for a construction permit of nuclear installations are specified in the Atomic Energy Act as follows:

- Technical capability necessary for the construction of nuclear installations shall be secured.
- The location, structures, and components of nuclear installations shall conform to the technical standards provided in the Ordinance of MOST in such a way that there may not be any impediment to the protection of human bodies, materials, and the public against radiation hazards caused by radioactive materials or materials contaminated by them.
- There shall not be any impediment to the protection of the public health and the environment against danger or injury due to radioactive materials which may accompany the construction of nuclear installations.

The technical requirements for the location, structure, and equipment of reactor facilities consist of 45 articles in the Enforcement Regulation Concerning the Technical Standards of Reactor, etc. amended in 2001. The specific regulatory requirements are prescribed in the Notice No. 2000-8 of the Minister of Science and Technology (titled "Technical Standards of the Location, Structure, and Equipment of Reactor Facilities")

Ⅱ.13.2 Implementation of Defense-in-depth Concept

In order to assure the safety of nuclear installations, KHNP applies a multi-barrier concept based on the defense-in-depth principle, to the design and operation of nuclear installations. The following basic concepts are considered in order to implement the defense-in-depth principle:

- Securing sufficient design margins,
- Fail-safe concept,
- Interlock concept,
- Securing independency, redundancy, and diversity,
- Multiple barriers concept, and
- In-service testability.

Irrespective of the reactor type, all systems, components, and structures of a nuclear installation are designed in consideration of the following internal and external events at the stage of siting, as specified in the Atomic Energy Laws:

- Internal events: Loss of coolant accident, main steam and high energy line breaks, internal scattered material (missile) caused by a rotor, fire, flooding, and so on.
- External events: Earthquakes, floods, typhoons, inflammables, poisonous gas, other anticipated man-made disasters, and so on.

The nuclear installation is designed by applying the defense-in-depth principle as a safety design concept against internal and external events as mentioned above. Its major contents are as follows:

- A sufficient safety margin is secured in the design so that the probability of any design basis accident is minimized. Safety facilities are designed in terms of independency, redundancy, and diversity so that the consequences of accidents are minimized.
- Nuclear installations are designed so that even if any abnormal state occurs in the nuclear installation, due to any failures of equipment, operator errors, or combination thereof, the reactor protection system operates automatically by detecting the abnormal state and initiates the operation of the reactor shutdown system in order to prevent the abnormal state to proceed into a severe accident.
- Nuclear installations are designed so that the nuclear installation has multiple barriers, such as the fuel pellet, the fuel clad, the reactor vessel, the reactor coolant pressure boundary, and the containment building to prevent the release of any radioactive materials into the environment.

Ⅱ.13.3 Prevention and Mitigation of Accidents

The followings are reflected in the design of nuclear installations to prevent any accident from occurring:

- The reactor core is designed so that in the power operating range, the net effect of the prompt inherent nuclear reactivity characteristics tends to compensate for a rapid increase in reactivity. The reactor core is also designed to assure that power oscillations which can result in conditions exceeding specified acceptable design limits are not possible or can be readily suppressed.
- The reactor coolant pressure boundary is designed to have an extremely low probability of abnormal leakage and gross rupture. If any leakage of the reactor coolant takes place, it is promptly detected to prevent against proceeding to a severe accident. It is also designed to permit periodic inspection and testing to

assess the structural integrity and leak-tightness.
- The emergency core cooling system (ECCS) is designed to automatically provide abundant emergency core cooling following any loss of reactor coolant at a rate such that any fuel damage that could interfere with continued effective core cooling is prevented. Even if the off-site power is lost, the necessary power is to be supplied from emergency diesel generators installed in the nuclear installation. The residual heat removal system is also installed to remove the core decay heat.

The reactor protection system is installed to sense accident conditions and maintain the reactor in a safe state by automatically initiating the operation of the reactor shutdown system and the engineered safety features. The reactor protection system is designed with redundancy, diversity, and independence to assure that no single failure of any equipment or channel of the system results in loss of the intended safety functions.

The followings are considered in the design of nuclear installations to mitigate any accidents including a severe accident:

- The reactor containment is designed so that if any accident occurs, the radioactive material released from the reactor coolant pressure boundary is confined and reduced over a long period. A system is installed in the containment to control the concentration of any combustible gas as it accumulates inside. The safety features including the containment spray system are reflected in the design to lower the pressure inside the reactor containment and to eliminate radioactivity.
- The Emergency Response Facility (ERF) is installed so that if any radioactive material is accidentally released outside the nuclear installation, the radioactive effect on nearby the population and the contamination to the environment are minimized. The ERF consists of the Technical Support Center (TSC), the Operating Support Center (OSC), and the Emergency Operating Facility (EOF). The Safety Parameter Display System (SPDS) is installed in the main control room, in the TSC, and in the EOF, so that major safety parameters are promptly recognized.

The main control room is designed so that even if any serious accident occurs, the operator can safely remain to take the necessary post-accident actions. It is possible in the control room to monitor the operating parameters, the radioactivity inside and outside the reactor containment, the radiation releasing passage, and the radioactivity around the nuclear installation in order to sense the accident conditions and to take appropriate actions.

Ⅱ.13.4 Application of Proven Technologies

Korea has a basic principle that technologies incorporated in a design shall be duly proven by experience or qualified by testing or analysis. All nuclear installations under construction and in operation in Korea were designed with technologies proven by operating experiences inside or outside of the country.

Ⅱ.13.5 Operation in Consideration of Human Factors and Man-Machine Interface

The Atomic Energy Act stipulates that the main control room, the safety parameter display system, and the remote control room shall be designed so that the results of analyzing and evaluating the human factors are reflected therein in order to maximize the safety and efficiency of nuclear installations. According to this provision, the contents of analyzing the feasibility and suitability of the human engineering design are included in the preliminary safety analysis report and in the final safety analysis report accompanying an application for a construction permit and an operating license, respectively. The major contents of the analysis are as follows:

- In the design of the main control room, human factors are considered so that the man-machine interface is suitable for the safe operation of nuclear installations. The major factors are: working space in the main control room, environment around the working space, alarm and control facility, visual indicating facility, auditory signal facility, nameplates and their positioning, and layout of distributing boards.
- In the design of the safety parameter display system, the human engineering principle is considered so that the system continuously provides important safety information and the reactor operators easily recognize the information by installing it in convenient places.
- The remote control room is designed in consideration of man-machine interface so that the reactor can be safely shutdown.

Ⅱ.14 Operation (Article 19)

Ⅱ.14.1 Licensing Procedure and Regulatory Requirements

The permit and licensing procedures for operating a nuclear installation are referred to in Section Ⅱ.2.3.

The criteria for an operating license for a nuclear installation is specified in the Atomic Energy Act as follows:

- Technical capability***(organization, structure, education & training, qualification)*** necessary for the operation of nuclear installations shall be secured.
- The performance and the technical specifications of nuclear installations shall conform to the technical requirements, as prescribed by the Ordinance of MOST, in such a way that there may not be any impediment to the protection of human bodies, materials and the public against radiation hazards caused by the radioactive materials.
- There shall not be any impediment to the protection of the public health and the environment against danger and injury due to radioactive materials which may accompany the operation of nuclear installations.
- ***The substance of a quality assurance program is to meet the criteria provided in the Ordinance of MOST.***

The technical requirements in the Enforcement Decree consist of 8 articles regarding the performance of nuclear installations and 10 articles regarding the operational technical specifications. The specific regulatory requirements are prescribed in the Notice No. 83-3 of the Minister of Science and Technology (titled "Criteria for the Preparation of Operational Technical Specifications")

Ⅱ.14.2 Safety Analysis and Commissioning Program for Authorization of Initial Operation of Nuclear Installations

In order to obtain initial authorization to operate a nuclear installation, the operator shall obtain a construction permit and an operating license from the regulatory body according to licensing procedure provided in the Atomic Energy Act. Following this, KHNP conducts comprehensive and systematic safety assessments of nuclear installations and prepares a preliminary safety analysis report and a final safety analysis report from the results of the safety assessments. KHNP submits the reports to MOST. The reports are reviewed by KINS, as entrusted by MOST. KINS conducts a pre-operational inspection to verify whether or not the nuclear installation is constructed in conformity with the permit conditions. The safety analysis reports, the safety assessments and the pre-operational inspection for issuing the construction permit and the operation license are described in detail in Sections Ⅱ.2.3, Ⅱ.2.4, and Ⅱ.9.1.

KHNP formulates and implements a commissioning program to verify that the instruments and components of the reactor coolant system can be operated in compliance with the design. The commissioning program includes the following tests: cold functional test, hot functional test, initial fuel loading test, hot functional test after loading fuel, initial critical test, low power reactor physics test, power ascension test, and initial operation test.

Ⅱ.14.3 Operational Limits and Conditions

The Atomic Energy Act stipulates that the operator of a nuclear installation shall submit an operational technical specifications accompanying the application for an operating license, so as to establish requisite conditions for the safe operation, and the technical specifications prescribe the details on technical guidelines. In the said specifications, operational limits and conditions for the safety operation of nuclear installations, limiting safety system settings, and surveillance requirements are specified with a classification according to operational modes and systems.

The Standard Technical Specification for CE and W/H type nuclear power plants were developed and will be used by the end of 2001, and those of CANDU and Framatome type plants are under development. It is outlined in Table Ⅱ.14-1.

The operational limits and conditions are established with sufficient safety margins through the accident analysis in the safety analysis report, as stated above.

Ⅱ.14.4 Operation, Maintenance, Inspection, and Testing Procedures

In accordance with the Enforcement Regulation Concerning the Technical Standards of Reactor, etc., KHNP, an operation of nuclear installations, prescribes in the operational technical specifications that the written procedures listed below should be prepared, observed, managed and periodically examined, and conducts the operation, maintenance, inspection and testing of nuclear installation, basing on the relevant specifications.

- Administrative Procedure,
- ***General Operating Procedure,***
- ***System Operating Procedure,***
- Surveillance and Test Procedure,
- Maintenance Procedure,
- Chemistry and Radio-chemistry Control Procedure,

- Radiation Protection and Control Procedure, and
- Refueling, Security Planning, Emergency Planning, ODCM, and Fire Protection Procedure.

The procedures related to the safety of nuclear installations are to be deliberated by the Plant Nuclear Safety Committee (PNSC) and implemented after obtaining approval from the plant manager. The operational technical specifications prescribe that the same process shall apply in case that any change to the approved procedures is to be made.

Table Ⅱ.14-1 Major Contents of Standard Technical Specification

Part	*Items*	*Major Contents*
Part 1. Operation of Nuclear Installation	*Use and Application*	• *Definition of Terminology, Logical Connect, Limiting Conditions, Surveillance Frequency, etc.*
	Safety Limits	• *Safety Limits*
	Limiting Conditions for Operation and Surveillance Requirements	• *Reactivity Control System* • *Power Distribution Limits* • *Instrumentation* • *Reactor Coolant System* • *Emergency Core Cooling System* • *Containment System* • *Plant System* • *Electrical Power System* • *Refueling Operations*
	Design Characteristics	• *Site, Reactor core, Fuel Storage, etc.*
Part 2. Radiological Environment Control	*Radiation Protection*	• *Reactor Installation Protection* • *Radiation Safety Control* • *Radiation Detection Instrumentation Management*
	Management of Radioactive Materials, etc.	• *Radioactive Waste Management* • *Gaseous and Liquid Effluents Monitoring System* • *Transportation, Storage, Handling, and Security of Nuclear Materials*
	Environmental Protection	• *Environmental Protection from Reactor Facilities*
Part 3. Management Control	-	• *Organization and Responsibility* • *Patrol and Check of Reactor Facilities* • *Emergency Operator's Action* • *Programs and Manuals* • *Reporting Requirement*

Ⅱ.14.5 Procedures Responding to Anticipated Operational Occurrences and Accidents

The classification of anticipated operational occurrences and accidents is based on those developed by the American Nuclear Society. The classifications are as follows:

- Condition Ⅰ (Normal Operation),
- Condition Ⅱ (Incidents of Moderate Frequency),
- Condition Ⅲ (Infrequent Incidents), and
- Condition Ⅳ (Limiting Faults).

Incident response procedures based on event classification are as follows:

- Alert Action Procedure: Procedure describing the measures suited to an alarm
- Abnormal Operating Procedure: Procedure responding to events for Condition Ⅰ and Ⅱ events.
- ***Emergency Operating Procedure: Event-based and Symptom-oriented procedure to cope with Condition III and IV, and design bases accidents***
- Severe Accident Management Guide: Accident management guide to link the Emergency Operating Procedure with the Emergency Plan. ***KHNP developed SAMG for Korean standard nuclear plant, and on this basis, is currently preparing a plant-specific SAMG.***

Ⅱ.14.6 Engineering and Technical Support

In order to secure safety over the lifetime of nuclear installations, the following organizations provide engineering and technical support to KHNP:

- Korea Power Engineering Co. (KOPEC): Comprehensive design engineering works including design of nuclear installations, project management, and a whole range of engineering services for construction.
- Korea Nuclear Fuel Co. (KNFC): Design and fabrication of nuclear fuel and relevant research and development activities.
- Korea Plant Service and Engineering Co. (KPS): Maintenance of electric power installations, general activities on relevant research and development, labor service, and equipment development.
- ***Doosan Heavy Industries Co. (DHICO): Construction of various power generating facilities including nuclear installations***
- Korea Atomic Energy Research Institute (KAERI): Research and development on nuclear energy and nuclear safety technology, and establishment of policies and related work.

Additionally, KEPCO and KHNP, a subsidiary of KEPCO have internal technical support organizations and systems under its control. The Electric Power Research Institute of KEPCO is in charge of comprehensive research and development in all areas of electric technology, while the Nuclear Environment Technology Institute (NETEC) of KHNP is responsible for supporting several affairs related to the securing of radioactive waste management techniques and radioactive waste disposal sites, and the preparation of spent fuel management measures.

Under the contract of emergency recovery services with Westinghouse Electric Co., GEC Alstome Co., Atomic Energy of Canada, Ltd., ***Framatome Co., and Giemens Co.*** KHNP receives international technical support and consultation for field works and emergency recovery of nuclear installations introduced from abroad.

Ⅱ.14.7 System of Reporting Incidents to Regulatory Body

The Atomic Energy Act stipulates that the organizations concerned in nuclear activities shall immediately take all necessary safety actions and report such actions to the Minister of Science and Technology for the following cases:

- if radiation hazards occur,
- if any failure occurs in nuclear installations,
- if there is any danger in nuclear installations or radioactive materials due to earthquakes, fires or other disasters,
- ***if Radiation Generating Devices and the radioactive material under possession is stolen, lost, or destroyed by a fire or any other incidents, or***
- if the radioactive material in transportation or packing leaks or is destroyed by a fire or any other incidents.

The Notice No. 96-25 of the Minister of Science and Technology (titled "Regulations Concerning the Report on the Incidents and Accidents of Nuclear-related Installation") stipulates in detail the incident reporting system. It includes the objects, means and procedures for reporting, and the classification of incidents. The classification of incidents is based on the International Nuclear Event Scale (INES) of IAEA.

Ⅱ.14.8 Collection, Analysis, and Exchange of Operating Experience

Domestic and foreign operating experiences related to safety, cases of incidents, and the results of safety-related research are to be reflected in nuclear installations through an administrative order of the Minister of Science and Technology, or through recommendations made during regulatory inspections by resident inspectors or inspectors of KINS. KHNP submits a report on the implementation of the administrative orders or the recommendations to MOST for review of its suitability.

A typical example is the post-TMI action items, which have been enforced to be reflected in all nuclear installations.

In cases that it is found necessary to modify nuclear installations or to change organizations or administrative matters on the basis of the results of self-assessments of domestic and foreign operating experiences, KHNP files with MOST a safety assessment report related to the modifications and changes. Entrusted by MOST, KINS reviews the report. All procedures necessary for the operation of nuclear installations must be deliberated by the Plant Nuclear Safety Committee (PNSC) and approved by the plant manager. To incorporate new technology, operating experiences, and necessary information, the procedures are examined and supplemented every 2 years.

Regulatory body organized a "Nuclear Power Plant Event Scale Evaluation Committee" and operates it for systematic assessment and feedback of safety related operating experiences. In addition, Regulatory body provides the basis and means to effectively utilize the cause and resolution of the reactor scram by developing the Nuclear Event Evaluation Database (NEED). NEED consists of such data as the time of reactor scram, title of event, reactor and generator outputs before reactor scram, summary of event and a watch code. It also includes recovery time, International Nuclear Event Scale (INES) and its basis, and a method of reactor shutdown in order to link with the IAEA-INES database. The records of NEED are updated annually.

KHNP formulates and implements the "Procedures for Controlling Operating and Maintenance Experience in Nuclear Installations" for the purpose of efficiently exchanging experience in operation and maintenance of nuclear installations among nuclear installations. KHNP also formulates and implements the "Procedures for Utilization and Control of Technological Information" to efficiently utilize the operating experience of foreign nuclear installations.

KHNP has joined the Institute of Nuclear Power Operation (INPO) and the World Association of Nuclear Operators (WANO) to promote information exchange and mutual cooperation among operators of nuclear installations. KHNP has also become a member of Westinghouse Owner's Group (WOG), Framatome Owner's Group (FROG), CANDU Owner's Group (COG) and Combustion Engineering Owner's Group (CEOG). KHNP concludes technical agreements with foreign electric power companies to mutually exchange relevant technologies and experience.

Regulatory body currently develops the Nuclear Plant Analyzer (NPA) which permits the quantitative analysis of operating events collected to establish and enforce the nuclear plant operating experience feedback system on a national scale. NPA, a tool of analyzing the status and operational progress of any nuclear power plants under normal operation, abnormal operation, transients and accidental

circumstances, is the nuclear plant simulator designed to make the interactive manipulation of equipments possible through the Graphic User Interface. In Korea, there are 16 nuclear plants now in operation, of 4 types of reactor, namely, KSNP(Korean Standard Nuclear Plant), CANDU, FRAMATOME, W/H. The development of NPA for KSNP which commands a majority of domestic nuclear plants in operation is completed in the 1st project year of 2000.(Refer to Annex G)

Ⅱ.14.9 Minimization, Treatment, and Storage of Radioactive Waste

The gaseous and liquid radioactive waste management systems are designed with reliability and diversity in collecting and treating radioactive waste generated during normal operation and anticipated operational occurrences. The gaseous and liquid effluents to the environment are to be discharged in conformity with the principle of ALARA and the requirements of radioactive effluents release as described in Section Ⅱ.10.2. The monitoring system continuously operates to detect the radioactivities of the effluents.
These systems are designed so that such release can be automatically interrupted or to be circuitously controlled if the radioactivity exceeds a alarming set point of monitoring system.

The solid radioactive waste management system treats compactible solid waste with a super compactor to reduce its volume, while it treats other waste matters by stabilizing or solidifying with paraffin or cement according to their property. In case of spent resin, it is common to dry the resin and to pack the dried resin in a High Density Poly-Ethelene(HDPE) container. The conditioned waste is stored in a temporary storage building to reduce the radiation level before being transferred to a disposal site.

For the spent fuel management of PWRs, the normal spent fuel storage rack in some nuclear installations has been replaced with a high density storage rack, or an additional high density storage rack is installed in a vacant space of the storage pit. For PHWRs, dry storage canisters are installed within nuclear installation sites. The amount of discharged spent fuel is reduced by employing long-term fuel cycle.

Ⅲ. Planned Activities to Improve Safety

Ⅲ.1 Implementation of Periodic Safety Review

In order to rectify any vulnerability in safety due to the aging of operating nuclear installations and to ensure a high level of safety commensurate with that of new installations, MOST made the legislation of a periodic safety review system in January 2001 to establish an integrated and comprehensive safety review system in addition to the existing safety assessment and inspection for operating nuclear installations described in Section II.9.

The periodic safety review is to be repeatedly conducted every 10 years for the basic items of 11 safety factors including equipment qualification, aging, safety performance, etc. that are specified in a guide prepared by IAEA. Kori Unit #1 which is the oldest nuclear installation in Korea and Wolsong Unit #1 entered upon the periodic safety review on May 2000 and May 2001 respectively, while the safety review for the plants which have run for not less than 10 years among the rest is to be completed by the end of 2006.

Ⅲ.2 Legislation for ICRP 60

MOST plans to implement the 1990 recommendations of ICRP (ICRP 60) step by step and in harmony with national circumstances for the improved radiation protection of workers, the public and the environment.

Under the financial support and initiatives of MOST, KINS formulated a project as part of the Long-term Research and Development Programs to implement ICRP 60. KINS had conducted necessary studies from 1992 to 1997. The schedule of the implementation is as follows:

- *Most of ICRP 60 are legislated through the amendment of the Atomic Energy Laws by the beginning of 2001.*
- *Full implementation of ICRP 60 is to be completed by 2003.*

Ⅲ.3 Regulatory Use of Risk Information

In the Policy Statement on Nuclear Safety issued in 1994, it is declared that risk-informed regulation be introduced to current regulation system. Since then, KINS has continued research and development in parallel with trial applications

regarding the regulatory use of risk information, and, as a result, confirmed that both safety and efficiency in nuclear regulation can be improved. Consequently, early in 2000, KINS has launched a program to develop regulatory framework, methodologies, and guides which direct the use of risk information in nuclear regulation on the whole including nuclear power plants and the other radiation facilities.

The program consists of 3 areas and fifteen individual tasks including the general guide for the regulatory use of risk information, in-service test, in-service inspection, quality assurance program, regulatory inspection, technical specifications, PSA standardization, training program, and so on. A task force team has been formed to execute and integrate this program effectively and periodic progress review meeting is held quarterly. Currently, for each task, extensive reviews on technical status and expected impact on existing regulation have been completed, and implementation technologies and guides are under development.
Also, in order to reflect licensee opinions and schedule in this program adequately, KINS organized and is operating a council for risk-informed regulation and application (CRIRA) which consists of PSA representatives from nuclear-related organizations such as utility, research institute and vendor.
In addition, a relevant training program for regulatory staff is prepared and will be implemented, and internet homepage is operated for public relation as well as for information exchange. (http://www.kins.re.kr/RIR/KINS-RIR_Home.html)

IV. Measures taken for the Recommendations of the First Review Meeting

IV.1 Introduction

The summary report adopted at the First Review Meeting contains descriptions on general background of this meeting and the information about Contracting Parties which participated. It describes observations on the achievement of the general objectives of the review process, external factors of special interest, the legislative and regulatory framework, the regulatory body, the safety of nuclear installations and emergency preparedness. And final conclusions were also given.

Particularly, observations on the safety of nuclear installations were described for areas such as existing nuclear installations, financial and human resources, assessment and verification of safety, and radiation protection.

This chapter summarizes each item in the report and describes relevant actions or measures taken by Korea for the recommendations which were found in each observation.

IV.2 Background of the First Review Meeting and Observations

This Review Meeting was held in accordance with Article 20 of the Convention on Nuclear Safety. 45 Contracting Parties participated, the United States of America, who was not full Contracting Party at that time, attended only the final plenary session and OECD/NEA attended as an observer. National Reports were submitted six months before the Review Meeting and written questions and comments were exchanged. Contracting Parties organized into 6 country groups met for six days and discussed each other's National Report.

The Contracting Parties noted that the Convention entails themselves' commitment to a continuous learning and improving process. They agreed that this first Review Meeting could be regarded as a base-line for future meetings. They also observed that the National Reports were in most cases of high quality and provided ample information on steps and measures to implement the obligations of the Convention. They were all given reasonable opportunity to discuss the National Reports and to seek clarification of the Reports. The Review Meeting had also proved to be of value to Contracting Parties without nuclear power reactors. The Contracting Parties furthermore observed that the self-assessment process had already initiated steps and measures to improve implementation of their obligations.

IV.3 External Factors of Special Interest

15. Several external factors and circumstances, which could affect nuclear safety, were observed. Such factors included:

- *Deregulation of electricity markets and associated ownership changes and increased competition;*
- *Maintaining competence in industry, regulators and research institutions, especially in countries with small nuclear programmes, or where phasing out nuclear power is part of the national energy policy, or where the use of nuclear power is reduced for other reasons;*
- *Lack of sufficient economic resources in some countries.*

Contracting Parties were invited to provide further information in their next National Reports on developments with regard to these factors and circumstances.

<u>Measures</u>

- *According to the restructuring plan of electricity industry in Korea, KEPCO, separated its non-nuclear generation parts into 5 subsidiaries. Nuclear generating part of KEPCO also was separated into one subsidiary, KHNP. The ownership of KHNP has not changed and will remain a subsidiary of KEPCO for the foreseeable future.*
- *While other 5 non-nuclear power subsidiaries will be privatized gradually according to the restructuring plan, KHNP will remain subsidiary of KEPCO taking into consideration the safety aspects of nuclear power generation, especially for the concern on the pursuit of the economy over safety to survive the competitive market, when it is privatized.*

Category	Hydraulic & Thermal Power					Hydraulic & Nuclear Power
	South-eastern Power Generation Corp.	Central Power Generation Corp.	Western Power Generation Corp.	Southern Power Generation Corp.	East-western Power Generation Corp.	
Total Capacity (Mw)	7,165	7,993	7,946	7,875	7,500	18,251

** The above capacity is the value covering nuclear power plants under construction.*

** The total capacity includes those of nuclear power plants under construction.*

IV.4 Legislative and Regulatory Framework (Articles 4, 7, 9-10)

16. The legislative framework is well established in most countries.

__Measures__

- *Not applicable as the legislative framework of Korea has been properly established.*

17. Contracting Parties with political changes were invited to provide information demonstrating that there are no gaps as a result of the transition and that the new national system is complete and consistent.

__Measures__

- *Not applicable to Korea as it has no political change after the First Review Meeting*

18. Contracting Parties who started their nuclear program some decades ago are requested to provide information on legislative updatings in next National Report.

__Measures__

- *We duly described the particulars of the decrees amended after the submittal of the first National Report.*

IV.5 Regulatory Body (Article 8)

19. For some countries questions were raised as to the effective independence, administrative position, and the human and financial resources of their Regulatory Bodies.

__Measures__

- *Not applicable to Korea as it has no problem related to regulatory body.*
- *However, the members of the Nuclear Safety Commission increased from 5-7 to 7-9 in order to strengthen regulatory function, and that the regulatory staff of KINS increased in 2000. Responding to the growing regulatory demands, a plan to recruit personnel was set up and is under implementation.*

20. It was noted that it would be desirable to improve the "de jure" independence of the regulatory body.

__Measures__

- *Not applicable to Korea, since MOST, responsible for nuclear safety regulation, is independent of MOCIE which is responsible for promoting nuclear program, in "de jure" sense.*

21. Special attention should be given to the human and financial resources. The focus is especially needed in those countries where the salaries offered to staff in the regulatory body is very low as compared to the salaries offered to staff of equivalent levels in the industry.

__Measures__

- *The salaries of the staff in the regulatory body are not lower than that of nuclear industry workers and there is no problem for the financial resources of the regulatory body, as it is secured in accordance with the Atomic Energy Act.*

22. Although no preferable strategy between prescriptive and risk based regulation was identified, some countries have agreed to review their experience and report at the next Review Meeting.

__Measures__

- *In 2000, KINS has launched a program to develop regulatory framework, methodologies, and guides which direct the use of risk information in nuclear safety regulation, which are described in this National Report.*

23. It was noted that there is an interest in continuing an exchange of experience on the regulatory actions to be taken to address management issues relevant to nuclear safety.

__Measures__

- *Not applicable to Korea, as it has no pending management issues relevant to nuclear safety.*

24. The importance of international co-operation was emphasized as a way to share common experiences and exchange of information. In particular, international peer reviews were considered as very effective tools for the support of regulatory improvement programmes.

Measures

- Korea has concluded many agreements to cooperate with other foreign regulatory bodies for developing regulatory technologies on nuclear safety, and are vigorously participating in related activities. Detailed information is given in Annex.

25. It was noted that some Contracting Parties are implementing quality assurance systems in relation to the activities performed by the regulatory body. An interest in continuing an exchange of experience on this topic was expressed.

Measures

- A scheme for applying this quality assurance system to the regulatory body is in formulation and is described in this report.

26. Some countries emphasized how a clear, open and proactive policy of providing information to the public on regulatory requirements, decisions and opinions, contributes to the establishment of an independent, competent and credible regulatory body.

Measures

- MOST, a regulatory body, always opens regulatory information about safety regulation activities to the public through its Internet homepage, so as to enhance public confidence in nuclear safety.
- An annex is prepared to give a detailed explanation of the fact that MOST designated September 10 as 'Nuclear Safety Day' on September 10, 1995, and has held regular annual events under the supervision of the Prime Minister with a view to promoting the understanding of the persons concerned in industry, education, and research, and the environmental groups about the securing of nuclear safety as well as with a view to encouraging the workers in nuclear field to have a proactive attitude in assuring nuclear safety.
- At the 7th 'Nuclear Safety Day' held in September 9, 2001, MOST declared 'Nuclear Safety Charter' to confirm that nuclear safety has first and foremost priority over promotion of nuclear industry, to encourage the workers in nuclear field to have a sense of mission and responsibility for assuring nuclear safety and to contribute to public confidence in nuclear safety.

27. Contracting Parties would welcome additional information in the next National Reports regarding:

- "De jure" and "de facto" status of regulatory bodies;
- Experience gained in implementing different regulatory strategies;
- Actions taken to monitor safety management;
- Implementation of modern quality assurance systems for regulatory activities;
- International co-operation on a bilateral and multilateral basis among regulatory bodies.

Measures

- Explanations on these items were included in corresponding paragraphs of 20, 22, 23, 24 and 25 of this chapter.

IV.6 Existing Nuclear Installations (Article 6 and others)

28. Many countries have carried out or are carrying out detailed assessments of the safety status of their existing nuclear power plants. These assessments can be in the form of critical self-assessments with outside assistance, peer reviews, or in-depth evaluations involving experts from other countries or international bodies. Some countries require periodic safety reviews as part of their regulatory process.

Measures

- Periodic Safety Review (PSR) was incorporated in the Atomic Energy Acts and is currently being implemented to all nuclear installations.
- Besides the PSR, probabilistic safety assessments of all nuclear installations are to be completed by 2007.

29. Probabilistic analysis has been used in several countries to identify and prioritize safety upgrades. Several countries have significant safety improvements still to be implemented. Special attention should be given to the safety level reached after the improvements, and the subsequent assessment for licensing of continued operation.

Measures

- The regulatory periodical inspection and safety assessment on nuclear installations have found no safety vulnerability which may require a shutdown of nuclear installations. In fact, KHNP continues to increase safety as a part of safety improvement activities, based on the results of probabilistic safety assessment and operating experience of overseas nuclear power plants.

30. Measures for severe accident management are in various stages of development and implementation in many countries. Further information on these measures in the next National Reports would be welcomed.

Measures

- *MOST issued the Severe Accident Implementation Plan in 2000, and instructed KHNP and KINS to implement the Plan, and the 'Severe Accident Policy for Nuclear Power Plants' was decide to formulate by the Nuclear Safety Commission in August 29, 2001. The basic direction of the Plan has the gist of 4 points, namely, the establishment of safety goal, the conduct of probabilistic safety assessment and the formulation of available measures to improve safety, the assurance of the capabilities of preventing and mitigating severe accidents, and the establishment of severe accident management program. In order to implement the Plan, KHNP currently carries out a probabilistic safety assessment, through which available means to improve the accident prevention and mitigation capabilities could be assessed, and develops a guide (procedure ?) for severe accident management, while KINS is developing the related guidelines and criteria necessary to review this guide.*

31. The availability of financial resources varied between the countries with safety improvement programmes under way. Some countries had adequate financing provisions in place, while others indicated that difficulties existed in obtaining the required financial resources.

Measures

- *In Korea, there is no problem in the operation and maintenance of nuclear installations, and the fund for safety enhancement program is legally secured in accordance with the 'Comprehensive Promotion Plan of Nuclear Energy'.*
- *Additionally, in 1999, a supplementary budget of about 6 billion won (50 million USD) was expended on safety improvements in the fields of periodic safety review, heavy water reactor, and environmental radioactivity.*

32. It was observed that several safety improvement programmes used technology imported from sources different than those which provided the original design, and that in such cases, special attention to compatibility was required.

Measures

- *Not applicable to Korea*

33. It was noted that some plants designed to earlier standards would have safety levels significantly lower than those designed to present standards. In this connection, it was pointed out that it would be necessary to adopt the measures provided for in Article 6. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installations as soon as practically possible.

Measures

- *With the ability of a self-judgment on safety, Korea continues to conduct safety inspections, and make improvements in safety, based on operating experience and know-how of overseas nuclear power plants.*
- *The periodic safety review is in process or is planned for all nuclear installations running for 10 years or more, while probabilistic safety assessment is to be completed by 2007 for some nuclear installations which have undergone no probabilistic safety assessment. We plans to formulate and carry out necessary measures for safety improvement, grounding on the results of periodic safety review and probabilistic safety assessment.*

34. Further and more detailed information on the status of the safety improvement programmes would be welcomed in the next National Reports. A statement on whether the original workplan and schedule have been implemented would also be appreciated.

Measures

- *Concerning the safety improvement program, it is described in the overall part of the 2nd National Report, particularly, in Chapter III.*

IV.7 Financial and Human Resources (Article 11)

35. It was noted that a sound economic basis of the nuclear utility owning and operating the plant is a prerequisite for financing an effective safety programme. In the present changing energy market in many countries, it is important that utility management as well as regulatory bodies understand the potential effects on safety of severe financial constraints.

Measures

- *The understanding of the potential effects of utility management as well as regulatory body on safety of severe financial constraint is firm(추가한 부분임)*
- *In Korea, financial resources for the improvements of nuclear safety are secured by laws, even if there is any restructuring of the domestic power industry.*

36. For countries with an expanding nuclear programme, adequate planning for human resources at the utility and the regulatory body must take place, especially if there is a diversity of reactor designs.

Measures

- *A plan is afoot to build additional 12 nuclear plants by 2015, of which 4 units are now under construction. According to this plan, we formulated a scheme of recruiting reactor operator and regulatory staff, and currently implement it.*

37. Potential safety issues linked to the stagnation or shrinking of nuclear programs were identified, such as:
  - *Decrease of the global national nuclear technology knowledge base;*
  - *Retirement of many people who contributed to the design and start up of nuclear power plants and the difficulty of attracting young people into the nuclear energy field;*
  - *Changes in national energy policy, may also require special measures to counteract loss of motivation and loss of personnel;*
  - *Obsolescence of equipment;*
  - *Decrease in the number of certified manufacturers; and*
  - *Decrease of capacity to support nuclear safety internationally.*

Measures

- *Not applicable to Korea as it continues to expand nuclear program. However, the safety issues described above are thoroughly followed and proper measures are being taken.*

IV.8 Assessment and Verification of Safety (Article 12-14 and 17-19)

38. Contracting Parties identified a number of significant developments and trends. The following areas were considered of particular interest.

Measures

- *This paragraph dose not need any actions.*

39. Probabilistic Safety Analyses (PSA) are increasingly being used. The Meeting noted that a proper balance between PSA and deterministic approaches is essential.

Measures

- *In Korea, the two methods are properly being used together, as detailed in the first National Report.*

40. In many countries Periodic Safety Reviews (PSR) are conducted on a regular basis, ten years being a typical interval. The PSR often includes a re-evaluation of the site characterization, a seismic re-evaluation, consideration of other external factors and an ageing management programme, in addition to the usual update of the safety analysis and a review of operating experience.

Measures

- *The PSR for Kori Unit #1 begun in May, 2000 and legislation for it was conducted in January, 2001, and PSR for Wolsong Unit #1 started in May 2001. PSRs for plants which have run for more than 10 years, are to be completed by the end of 2006, while PSRs for plants which have run for under 10 years will start after 10 years from the day of obtaining operating license, and will be conducted every 10 years.*

41. Operational experience feedback systems, incorporating information on international experience, are present in all countries.

Measures

- *A procedure for the operating experience feedback system was established and a Nuclear Plant Analyzer (NPA) for Korean standard nuclear power plant was developed in 2000. Demonstration of the NPA was made in 2001. This is described in this report.*

42. External peer reviews of operational performance (IAEA, WANO, etc.) are widely used and the implementation of their recommendations is in some cases monitored by the regulatory body.

Measures

- *The IAEA OSART inspection on Younggwang Units #1 and #2 had been conducted in 1997. A Follow-up Visit to the two units was made in October 1999 for a week.*
- *For 2 weeks from November 5, 2001 to November 16, 2001, the WANO Peer Review on Younggwang Units #3 and #4 was carried out with regard to 6 areas of organization and administration, operation, maintenance, technical support, radiation protection, and operating experience.*

43. Most countries make efforts to continuously review and update the safety case. Results on a more comprehensive safety analysis would be welcomed in the next National Reports.

Measures

- *A full detail of this matter is given in the first National Report.*

44. Activities are taking place in most countries to improve safety culture. Special initiatives in some countries to promote safety culture were reported.

Measures

- *There have been special regulatory initiatives for safety culture in Korea, such as the declaration of 'Statement of nuclear safety policy', the designation of 'Nuclear Safety Day' and the declaration of 'Nuclear Safety Charter'. Information on these are given in Annexes in this report.*

45. Many countries are revising their Quality Assurance programmes based on best international practices.

Measures

- *The Korean Government is also carrying out related activities in accordance with the international practices.*

46. New subjects for safety assessment are emerging, such as the introduction of software based safety systems, etc., requiring new assessment tools.

Measures

- *A regulatory guide on Digital I&C and plans are being developed to complete the 1st stage of such development by the end of 2001 and to start its 2nd stage in 2002, continued till 2006.*

47. It was noted that in some cases the containment function at existing nuclear power plants would not meet current standards. Therefore, additional information would be welcomed in the next National Reports regarding evaluation of the performance and efficiency of the confinement function at existing nuclear power plants. Such information should cover evaluation of the original design basis, impact of ageing, modifications with regards to the original design, and, finally, evaluation of its capability to cope with events beyond the design basis, including severe accidents.

Measures

- *Licensees to construct nuclear power plants are required to submit the results of Level 2 PSA and Accident Management Plan, by which the design safety including the performance of containment against severe accident is reviewed before operating license is permitted. Moreover, the regulatory authority gave licensees currently operating nuclear plants an administrative instruction to complete both Level 2 PSA and to establish Accident Management Plan.*

48. Other topics on which additional information would be welcomed in the next National Reports include Probabilistic Safety Assessments, Periodic Safety Reviews and updating of safety analysis reports.

Measures

- *Information was included in corresponding paragraphs of 39, 40 and 43.*

IV.9 Radiation Protection (Article 15 and 19(viii))

49. The ALARA principle is implemented in all countries with regard to doses and releases. The recommendation in ICRP 60 is already applied or is planned to be applied by all countries.

Measures

- *ALARA principle is being implemented in Korea and legislation for ICRP-60 was conducted as described in chapter III of this report.*

50. Contracting Parties would welcome additional data in the next National Reports on the evolution of trends in collective doses and effluent releases.

Measures

- *Radiation exposure of the workers employed in nuclear plants : Notwithstanding the additional operation of new plants, the total radiation exposure dose is on a decreasing trend after 1998.*

※ *Average radiation dose per year / per unit of plant for the last 5 years*

Category	1996	1997	1998	1999	2000
Number of Units in Operation	11	12	14	15	16
Total Radiation Dose	11.708	10.029	14.500	12.684	11.394
Average Radiation Dose / Unit	1.06	0.84	1.04	0.85	0.71

☞ *Total radiation dose : man-Sv, Average radiation dose : man-Sv/unit*

- *Effluents of gaseous radioactive materials : The gaseous radioactive materials emitted from all nuclear power plants do not affect the environment and the population, and its amount is on a gradually decreasing trend.*

※ *Effluents of gaseous radioactive materials and impacts on the population in the last 5 years*

Category	1996	1997	1998	1999	2000
Emitted Radioactivity	3.21E+03	7.20E+01	1.71E+02	1.15E+02	6.14E+01
Radiation Dose of Population	6.90E-03	7.90E-03	4.79E-03	8.76E-03	1.03E-02
Percentage to ICRP recommendation (%)	0.69	0.79	0.479	0.88	1.03

☞ *Units : Emitted radioactivity(TBq), Radiation dose of population(mSv), Radiation Dose recommended by ICRP(1mSv)*

- *Effluents of liquid radioactive materials : The liquid radioactive materials discharged from all nuclear power plants do not affect the environment and the population, and its amount is on a gradually decreasing trend.*

※ *Effluents of liquid radioactive materials and Impacts on the population in the last 5 years*

Category	1996	1997	1998	1999	2000
Discharged Radioactivity	9.00E-01	1.20E-01	2.05E-05	4.51E-06	3.53E-04
Radiation Dose of Population	7.37E-04	5.95E-04	7.06E-04	6.37E-04	7.88E-04
Percentage to ICRP recommendation (%)	0.0737	0.0595	0.0706	0.0637	0.0789

☞ *Units : Discharged radioactivity(TBq), Radiation dose of population(mSv), Radiation Dose recommended by ICRP(1mSv)*

IV.10 Emergency Preparedness (Article 16 and 17(iv))

51. Integrated emergency response plans are in place in all countries with a nuclear power programme. Response plans are tested at varying frequencies. Many countries without nuclear power plants have also developed extensive monitoring and response capabilities. It was observed that bilateral agreements with neighbouring countries regarding emergency preparedness should be completed, in those cases where nuclear installations are located in the vicinity of national borders. In the next National Reports, information would be welcomed on improvements made from the results of national and international exercises.

Measures

- *MOST and KINS make a close cooperation with the US Nuclear Regulatory Commission, the China Radiation Institute, and the Organization for Economic Cooperation and Development (OECD) under the cooperative agreements for international radiation emergency plan.*

IV.11 Final Conclusion

In this chapter, measures taken for the recommendations of the first Review Meeting were described.

In summary, Republic of Korea, as a contracting party that promotes nuclear power program and continues to construct nuclear power plants, has been endeavoring to assure nuclear safety as follows:

- *It established proper legislative and regulatory framework, securing human and financial resources for regulatory body and also promoting QA for regulatory activities.*

- *Under the restructuring process of electricity industry in Korea, KHNP will remain as a subsidiary of KEPCO, a government invested corporation, in consideration of the safety aspect of nuclear power generation and adequate funds for the enhancement of safety is secured.*

- *It formulated severe accident policy to secure capability to cope with accidents* *and probabilistic approach as well as deterministic approach is adopted in safety assessment and also the framework for regulatory use of risk information is being established.*

- *Legislation for Periodic Safety Review has been conducted and life management program, operating experience feedback system and containment performance assessment program are implemented.*

- *It made efforts for the public confidence in nuclear safety such as the declaration of nuclear safety policy statement & nuclear safety charter, designation of nuclear safety day and the introduction of information release system which contribute to the promotion of nuclear safety culture.*

- *ALARA principle is being implemented and ICRP-60 recommendation is applied step by step and network for radiological emergency response was established. International cooperation for it is also being strengthened.*

At the first Review Meeting, participating contracting parties recognized Korea's dedication for the implementation of obligations of the Convention. We conclude that the objectives pursued by the Convention on Nuclear Safety has been attained successfully.

ANNEXES

Annex A. List and Data on Nuclear Installations

Table A-1. Reactor Facilities in Operation

(As of September 2001)

Station Name	Reactor Type	Capacity (MWe)	Operator (Owner)	NSSS Supplier	Start of Construction (month/year)	Initial Criticality (day/month/year)	First Power (day/month/year)	Commercial Operation (day/month/year)
Kori Unit 1	PWR	587	*KHNP*	WH	8/71	10/6/77	26/6/77	29/4/78
Kori Unit 2	PWR	650	*KHNP*	WH	7/78	9/4/83	22/4/83	25/7/83
Kori Unit 3	PWR	950	*KHNP*	WH	6/79	1/1/85	22/1/85	30/9/85
Kori Unit 4	PWR	950	*KHNP*	WH	6/79	26/10/85	15/11/85	29/4/86
Wolsong Unit 1	PHWR	678.7	*KHNP*	AECL	6/77	21/11/82	31/12/82	22/4/83
Wolsong Unit 2	PHWR	700	*KHNP*	AECL/KHIC/KAERI	10/91	27/1/97	1/4/97	1/7/97
Wolsong Unit 3	PHWR	700	*KHNP*	AECL/KOPEC/ KHIC	8/93	15/2/98	25/2/98	1/7/98
Wolsong Unit 4	***PHWR***	***700***	**KHNP**	***KHIC/KOPEC/AECL***	***2/94***	***10/4/99***	***21/5/99***	***1/10/99***
Yonggwang Unit 1	PWR	950	*KHNP*	WH	10/80	31/1/86	5/3/86	25/8/86
Yonggwang Unit 2	PWR	950	*KHNP*	WH	10/80	15/10/86	11/11/86	10/6/87
Yonggwang Unit 3	PWR	1,000	*KHNP*	KHIC/KAERI/ ABB-CE	6/89	13/10/94	30/10/94	31/3/95
Yonggwang Unit 4	PWR	1,000	*KHNP*	KHIC/KAERI/ ABB-CE	6/89	7/7/95	18/7/95	1/1/96
Ulchin Unit 1	PWR	950	*KHNP*	FRAMATOME	1/81	25/2/88	7/4/88	10/9/88
Ulchin Unit 2	PWR	950	*KHNP*	FRAMATOME	1/81	25/2/89	14/4/89	30/9/89
Ulchin Unit 3	PWR	1,000	*KHNP*	KHIC/ABB-CE	5/92	21/12/97	6/1/98	11/8/98
Ulchin Unit 4	***PWR***	***1,000***	**KHNP**	***KHIC/ABB-CE***	***7/93***	***14/12/98***	***28/12/98***	***31/12/99***

Table A-2. Reactor Facilities under Construction

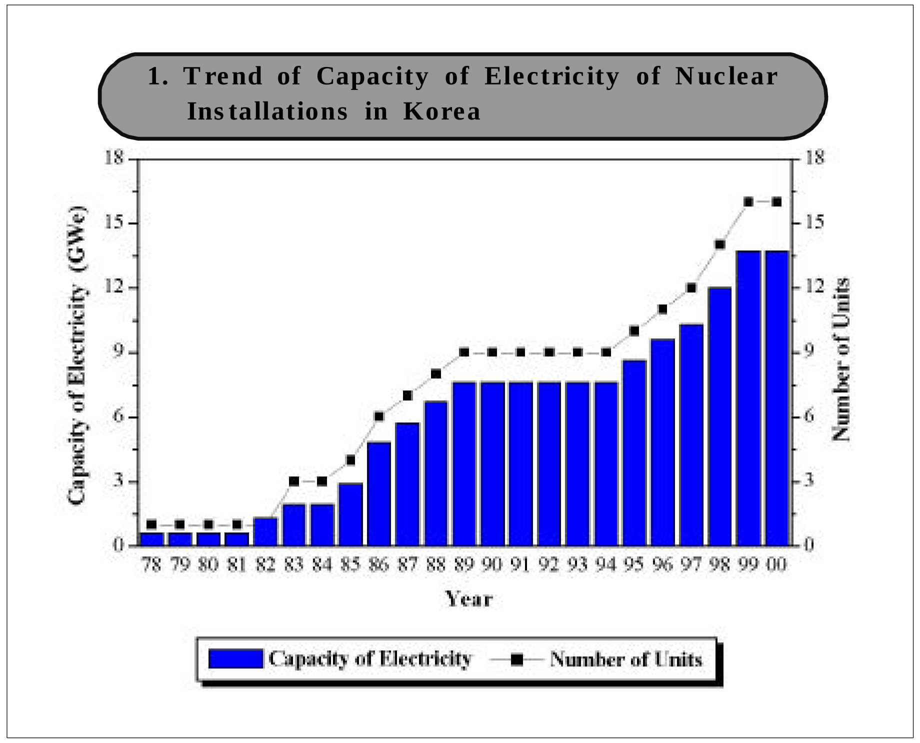
(As of September 2001)

Station Name	Reactor Type	Capacity (MWe)	Operator (Owner)	NSSS Supplier	Start of Construction (month/year)	Initial Criticality (day/month/year)	First Power (day/month/year)	Commercial Operation (day/month/year)
Yonggwang Unit 5	PWR	1,000	*KHNP*	*DHICO/KOPEC*	*9/96*	-	-	-
Yonggwang Unit 6	PWR	1,000	*KHNP*	*DHICO/KOPEC*	*9/96*	-	-	-
Ulchin Unit 5	PWR	1,000	*KHNP*	*DHICO/KOPEC*	*1/99*	-	-	-
Ulchin Unit 6	PWR	1,000	*KHNP*	*DHICO/KOPEC*	*1/99*	-	-	-

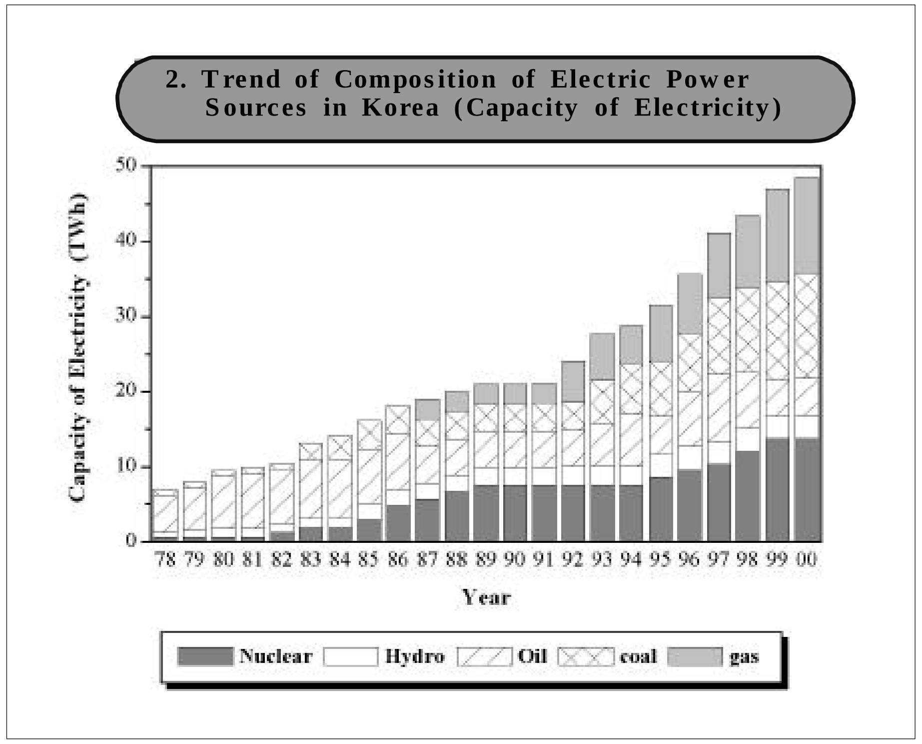
Note) Glossary of Terms

ABB-CE : Asea Brown Boveri-Combustion Engineering
AECL : Atomic Energy of Canada, Limited
KAERI : Korea Atomic Energy Research Institute
DHICO : Doosan Heavy Industries Co.
KHNP : Korea Hydro & Nuclear Power Co.
KOPEC : Korea Power Engineering Co.
WH : Westinghouse Electric Co.

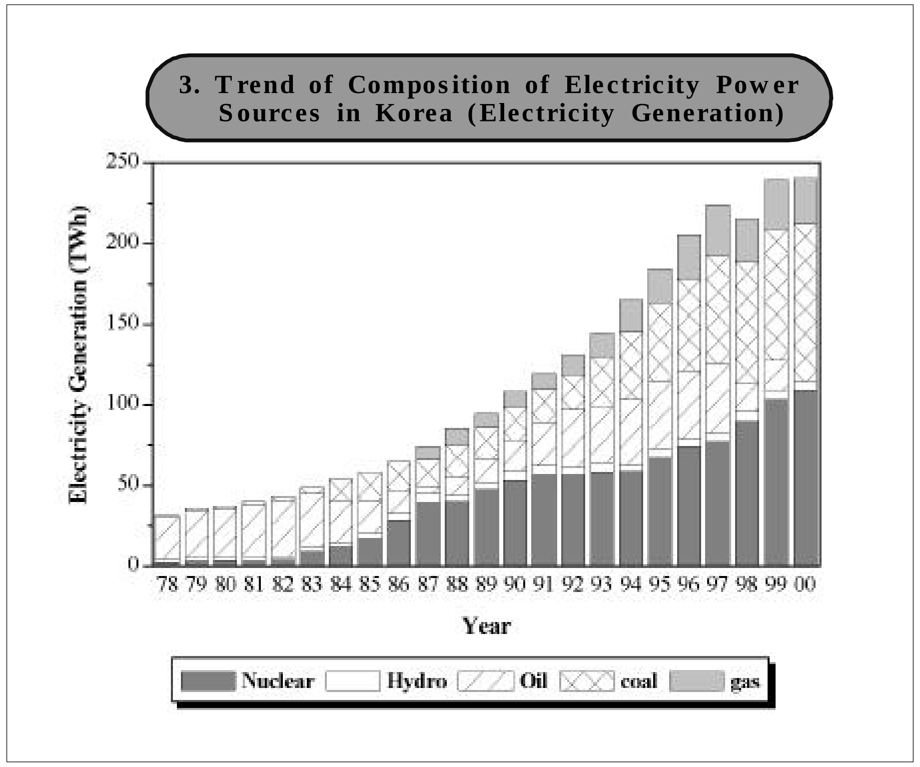
Figure A-1. Status of Nuclear Installations



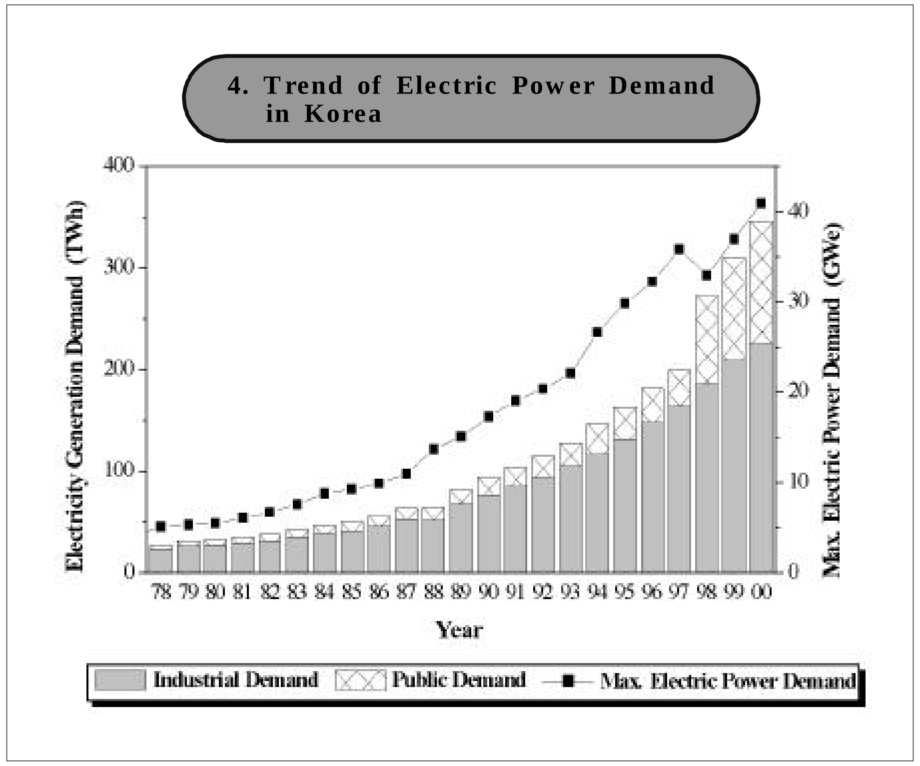
Source: White Paper on Nuclear Power, Ministry of Commerce, Industry and Energy and Korea Hydraulic and Nuclear Power Corp., Aug. 2001.



Source: White Paper on Nuclear Power, Ministry of Commerce, Industry and Energy and Korea Hydraulic and Nuclear Power Corp., Aug. 2001.

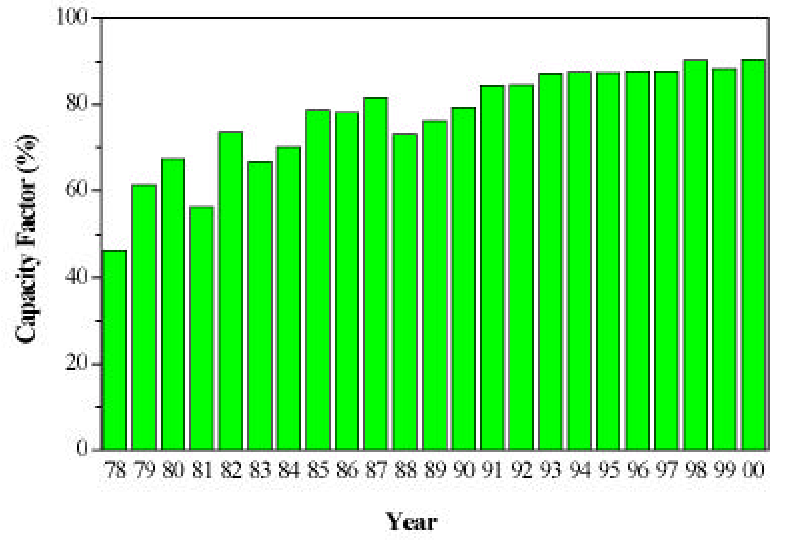


Source: White Paper on Nuclear Power, Ministry of Commerce, Industry and Energy and Korea Hydraulic and Nuclear Power Corp., Aug. 2001.



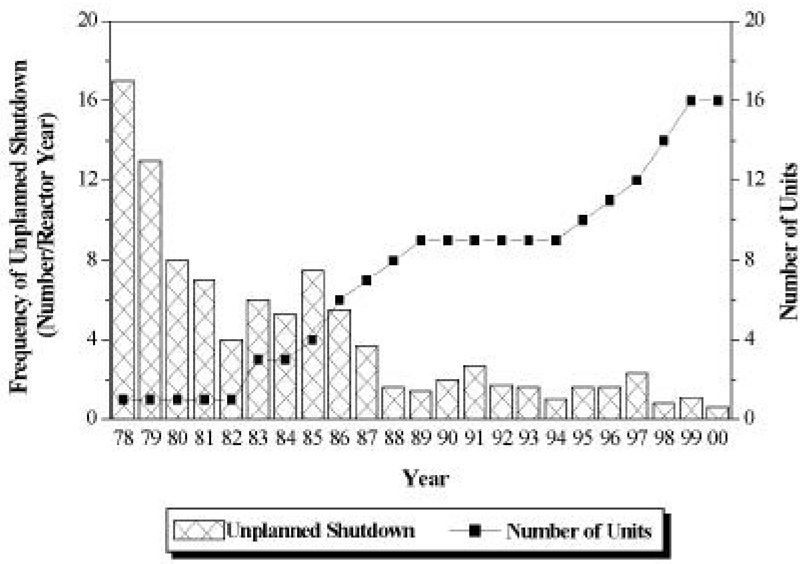
Source: White Paper on Nuclear Power, Ministry of Commerce, Industry and Energy and Korea Hydraulic and Nuclear Power Corp., Aug. 2001.

5. Trend of Capacity Factor of Nuclear Installations in Korea



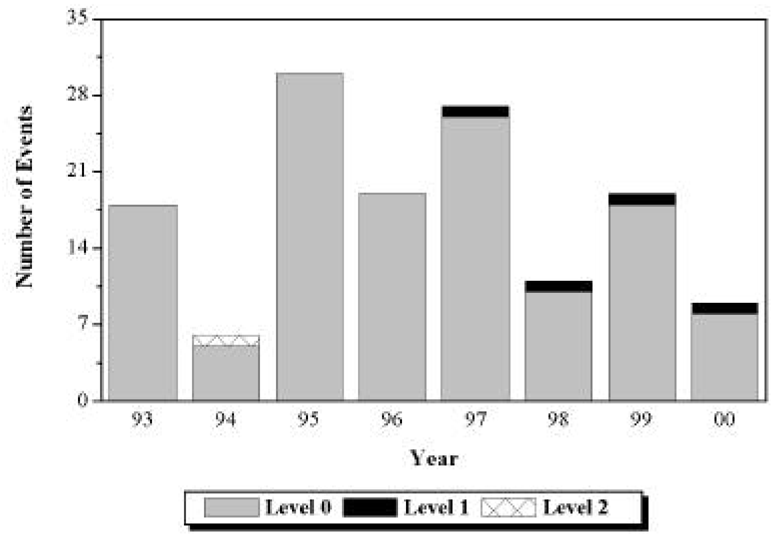
Source: White Paper on Nuclear Power, Ministry of Commerce, Industry and Energy and Korea Hydraulic and Nuclear Power Corp., Aug. 2001.

6. Trend of Frequency of Unplanned Shutdown of Nuclear Installtions in Korea



Source: White Paper on Nuclear Power, Ministry of Commerce, Industry and Energy and Korea Hydraulic and Nuclear Power Corp., Aug. 2001.

7. Results of Event Scale Evaluation by INES



Source: White Paper on Nuclear Power, Ministry of Commerce, Industry and Energy and Korea Hydraulic and Nuclear Power Corp., Aug. 2001.

Annex B. 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 the growing public concern for nuclear safety and 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 titled, "Directions of Long-term Nuclear Energy Policy toward 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 first priority in the development of nuclear power, and organizations and individuals engaged in nuclear power activities should adhere to safety principles as top priority.

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

These days, nuclear safety is not a matter for one country but a world-wide 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 a 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, 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 whole stages of design, construction, operation and maintenance of nuclear power plants, but also by the spread 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 development to achieve technical expertise of regulatory activities and will ensure regulatory independence and fairness by minimizing any undue pressure and interference.

Nuclear utilities establish management policies, giving a 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 any concealment 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 will be achieved through sound safety policies and full understanding of safety culture by the 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 in nature an overall responsibility for ensuring the protection of public health and the environment from radiation hazards which 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 system in order to achieve safety goals on a government level. To effectively regulate, 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 by the other organizations and systems involved in the development of nuclear energy. It also ensures that the regulatory organization acts on its own objective, technical judgment without any political interference and influence from external sources.

The regulatory organization should maintain an extensive program of research and sufficient staff resources to review and audit the licensee's submittals so that it can independently verify the validity of the 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 the regulatory process. To accomplish this, the Government extends an opportunity to the public to participate in the regulatory processes and publicizes related information under the principle titled, "Openness and Democratization of Nuclear Administration".

However, the 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 the 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 about the 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 regulation is expected, the Government informs the licensee of the regulatory policies and provides guidance in advance and establishes regulatory practices to minimize the licensee's trials and errors 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 is any unreasonable act or technical standard, the licensee should communicate its view with the regulatory organization in order to initiate any 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 sufficient staff that are capable in performing regulatory activities which are closely connected with many technical areas, and the 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 the 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 which 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 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 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 safety assurance system, each organization prepares its "Implementation Program of Safety Culture" and a 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 the 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 the existing nuclear power plant. For the nuclear power plants in operation, maintenance, repair, inspection, and monitoring

of the 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 the 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 the nuclear power plants are promptly found and reflected in the policy. Operating record and accident and failure data are analyzed to determine the factors which affect the safety of the nuclear power plants, and efficient safety supplement 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 ones. In addition, design and operational safety of nuclear power plants are achieved through the measures in order to minimize human errors.

- 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 the individual exposure dose, introduction of radiation protection standards based on the new ICRP 60 recommendations is being favorably reviewed.

- In response to the 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 can not be achieved in a day, but rather it is 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 the 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 C : Nuclear Safety Charter

Recognizing that the peaceful use of nuclear energy contributes to national development and improvement of the quality of the people's life, and confirming that protection of the people and preservation of the environment through safe control of nuclear energy have the first and foremost priority over others, we pledge ourselves:

1. To maintain the highest standards of safety in the use of nuclear energy;

1. To release information regarding nuclear safety promptly and transparently;

1. To reflect the public opinion in formulating nuclear safety policies;

1. To assure the independence and fairness in nuclear safety regulation;

1. To strengthen research and development of technologies on nuclear safety;

1. To abide sincerely by national laws and international agreements on nuclear safety;

1. To complement and improve the nuclear safety-related legal system continuously;

1. To promote nuclear safety culture and incorporate it in our workplace.

September 6, 2001

Annex D : KINS(Korea Institute of Nuclear Safety) Mission Statement and Code of Conduct

Mission Statement

The KINS's mission is to protect public health, safety and the environment from radiation hazards that might be incidental to 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 clients are 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 the 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 a clear regulatory decision without any undue delay.*
- *KINS shall pursue effectiveness and rationality in safety regulation.*
- *KINS shall endeavor for establishment of the 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 the nuclear safety is a matter of international concern, KINS shall maintain close cooperative relationship with international agencies and foreign institutes.*

February 11, 2000

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 production and use of nuclear energy. For this, recognizing the importance of our mission and responsibility, we are committed to exerting every effort for public trust, and at the same time, we shall hereby establish this Code of Conduct to be observed fundamentally and 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 works.

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 result therof.

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 as acquired or known in connection with performance of our duty.

Article 6. Security of Expertise
We shall secure the 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 working situation. Also, we shall perform our work in the 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 and suggestion for solution 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 E. Events on Nuclear Safety Day

As a result of international efforts to enhance nuclear safety after a grave accident occurred at the Chernobyl Nuclear Power Plant in the former USSR in April 1986, the Convention on Nuclear Safety was agreed in September 1994, and came into force from October 1996.

From the fact that the Chernobyl nuclear accident was due to a human error, the International Atomic Energy Agency (IAEA), and the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation & Development (OECD) take the lead in the proposal and implementation of regulatory strategies for safety culture with a view of inculcating the workers engaged in nuclear installations with a sense of safety.

In Korea, the Ministry of Science and Technology institutionalized the 'Nuclear Safety Day' of September 10 every year, and holds regular annual events to inspire a safety consciousness into the workers engaged in nuclear power industry. Through those events, MOST intends to promote the safety of nuclear installations and extensively announce the Government's will for nuclear safety management activities in first consideration of safety, with a view to increasing the public's understanding and reliability for the safety of nuclear power plant.

For this, each of nuclear installations appoints the Safety Week to hold a variety of safety-related events such as the safety pledging rally, the special lecture on safety, the seminar on human errors, etc., that enable the workers engaged in nuclear installations to find a new view on safety. Additionally, in order to help the public's understanding for nuclear safety, nuclear installations show their safety-related activities to the public through many programs, for example, the people's participation in environmental sampling and sample analysis, the opening of reactor facilities to the public, the people's visit on radioactive waste disposal work, etc.

On the Nuclear Safety Day every year, a commemorative ceremony is held under the supervision of the Prime Minister and in the presence of nearly 500 persons

engaged in nuclear power industry, including the Minister of Science and Technology, and the preparation of commemorative events is made by the participation of 22 private organizations inclusive of the Korea Hydro & Nuclear Power Co. (KHNP), centering around the Korea Institute of Nuclear Safety (KINS) which is a nuclear regulatory expert organization. The Government also heightens the level of rewards every year to awaken the people to the significance of nuclear safety, with a result that, in 2000, 37 men of merit for nuclear safety received many kinds of prizes such as orders or medals for merit, the Presidential Citation, the Citation of the Prime Minister, the Citation of the Minister of Science and Technology, and the Nuclear Safety Award.

Meanwhile, diverse events including academic meetings, seminars, etc. are held after a commemorative ceremony every year, and a forum on the subject of the '21C Nuclear Environment and Safety' is held in the presence of the government officials in charge, and the persons concerned in nuclear industry, education, and research, journalists, the persons related to environmental institutions. Mr. Domaratzki, Deputy Secretary-General of IAEA, attended on an event for the 'Nuclear Safety Day' in 1999, where he delivered a special lecture on the subject of 'Is nuclear technology safe at present? Is it more safe in the future?'

The nuclear-related agencies and organizations hold varied events on a national scale to increase the public's understanding and recognition for nuclear power and the safety of nuclear plants during the Week that has the 'Nuclear Safety Day', and particularly in 2000, the 'National Highschool Student Nuclear Homepage Contest' and a cyber nuclear quiz competition for the first time.

Besides, a joint radiological emergency preparedness drill and a street campaign for the publicity of nuclear safety were held at Yonggwang Nuclear Plant and in all the major cities including Seoul, respectively, and main nuclear installations are specially open for the public's visit. A special lecture on nuclear safety also was given to approximately 4,000 students, teachers, housewives, and officials all over the country, while an essay contest was held at Ulchin Nuclear Plant.

The object of the aforesaid events is to increase a safety consciousness of the whole nuclear power industry, and the recognition of the world at large for nuclear safety.

At the 7th 'Nuclear Safety Day' held in September 9, 2001, MOST declared 'Nuclear Safety Charter' to confirm that nuclear safety has first and foremost priority over promotion of nuclear industry, to encourage the workers in nuclear field to have a sense of mission and responsibility for assuring nuclear safety and to contribute to public confidence in nuclear safety.

Through the continuous holding of events commemorating the 'Nuclear Safety Day', the Korean Government intends to announce its firm will in the first consideration of nuclear safety, enhance the people's reliability, and establish safety culture by infusing a safety consciousness into the workers engaged in nuclear power industry.

Annex F. Resolution of Y2K Problems

From the recognition that the Y2K problems may affect nuclear power plants which employ many types of digital-based equipments, MOST issued a regulatory action (dated July 29, 1998) on the nuclear licensees in regard of systematic measures to be taken by stages in order to thoroughly resolve every Y2K problem for the equipments of nuclear plants.

In accordance with this regulatory action, the licensees had carried out stepwise activities for problem solution, and submitted the results of activities to regulatory body at each step, such as initial assessment, detailed assessment, and remediation & verification step. KINS had evaluated those submittals according to Y2K resolution guidelines, and also performed the site audit for all nuclear power plants to evaluate the effectiveness of measures licensees were taking to identify and correct Y2K problems at their facilities. In this process, the licensees claimed to take complementary measures for 105 items in the field of nuclear power plant, and lastly reviewed and verified the properness of complements and rectifications.

Meanwhile, obtaining the data and experiences required to cope with domestic Y2K problems through a visit to many countries which had provided the necessary technology for domestic major nuclear plants, regulatory body and licensees participated in the international Y2K workshop supervised by the international organizations related to nuclear plants to grasp the actual state of other countries' Y2K problem solution, and made a diversified review on the project for the solution of domestic Y2K problems, according to the result of a discussion about pending issues at the said workshop.

The solution of problems in 108 Y2K-non-compliant equipments was completed by the end of June 1999. In order to systematically and rapidly surmount any abnormal situation that may be encountered during the year changes from 1999 to 2000, KINS developed a computer program (MIDSAY) for a real-time monitoring of essential Y2K-related information of nuclear power plant, and worked out a Y2K Contingency Plan of a regulatory level.

It is verified that every domestic nuclear plant was normally operated with no Y2K problem, as a result of monitoring and checking the operational state of nuclear plant by the Emergency Response Support Headquarters established and run for the period of the year change to 2000 and the period of leap-year identification, according to KINS Y2K Contingency Plan. As above, the reason why domestic nuclear plants could successfully surmount the millennium bug without mishap is that under the systematic and practical regulation policy, the nuclear licensees did ıt spare rts to solve Y2K problems and draw up the Plan for Emergency ɪsponse, while KINS carried out a strict and depth evaluation, analysis and check ȷor the progress of the licensees' implementation of a stepwise Y2K problem solution program.

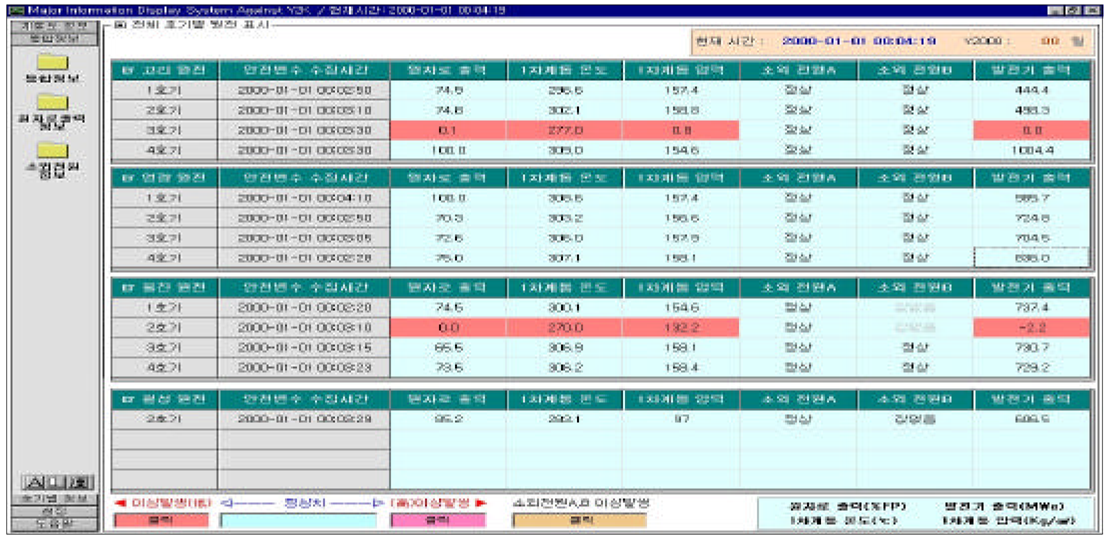


Fig. F-1. MIDSAY - Status of domestic nuclear power plants after entry into the year of 2000 (Kori Unit #3 · Ulchin Unit #2 : under O/H)

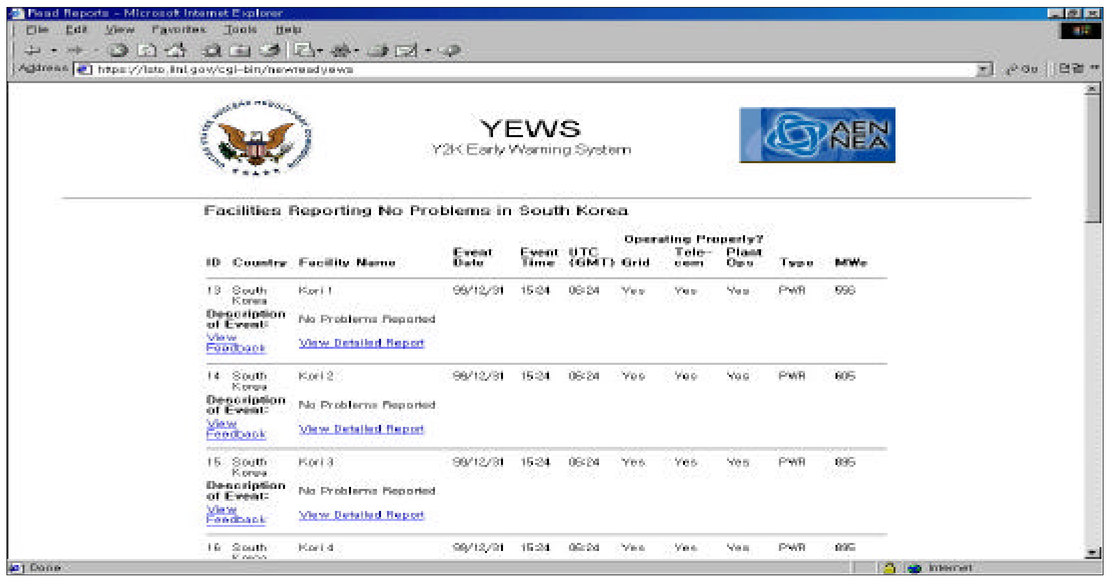


Fig. F-2. YEWS No Problem Report - Right after entry into the year of 2000 (Korean nuclear power plants)

Annex G. Development of Nuclear Plant Analyzer

1 Configuration of NPA

As shown in Fig. G-1, NPA consists of three large parts. Process Model, the central part of them, is capable of precisely computing the thermo-hydraulic behavior of nuclear plant and the nuclear reaction of reactor core, and the model for each system is modularized so as to easily analyze, correct, and modify the model. The detailed configuration of this Process Model is as represented in Fig. G-2.

Simulation Executive, a simulation control program, functions to execute each system model and manage the database necessary to such execution, and enables the Process Model to be linked with the User and the Graphic User Interface. It has a function not only to store the data value of diverse operational circumstances but also to output the data value of the operational circumstances desired.

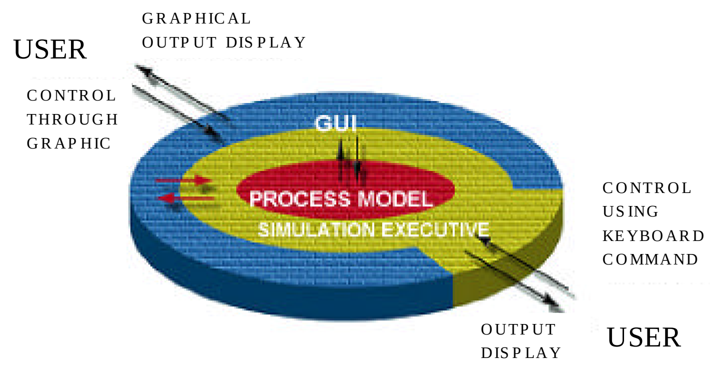


Fig. G-1. Configuration of NPA

The outermost Graphic User Interface enables the user to employ various functions of the simulation executive program, and the method of executing the program through graphic screen. Each graphic screen of the Graphic User Interface is build up for the main systems of nuclear plant, that helps user understand the behavior of nuclear plant during simulation and execution of any function related to database management and the change of any operational state of simulation with menu bar or related button during the operation of NPA. Fig. G-3 represents the screen for each main system of NPA.

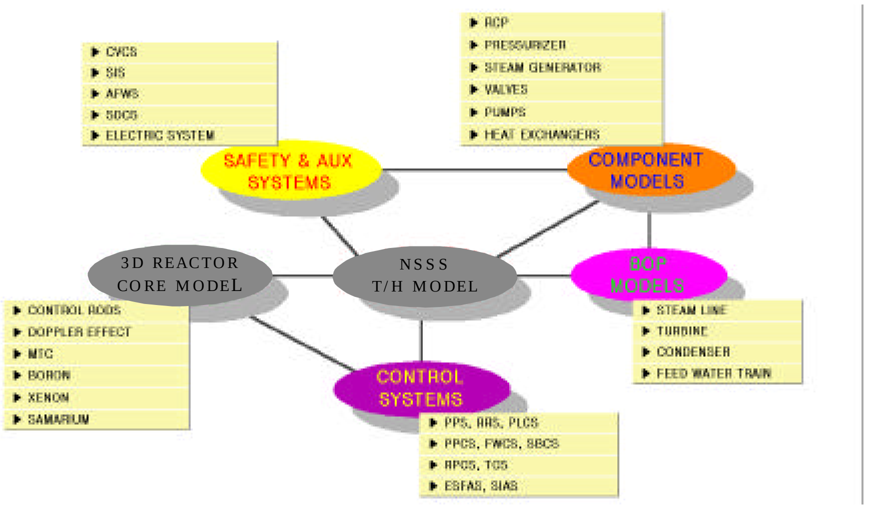


Fig. G-2. Configuration of NPA Process Model

2 Function of NPA

NPA for KSNP is designed to provide various simulation functions for the user's convenience. With the development of computer technology, it is possible to make faster simulation than real time and provide the function of an easier input and output through the improved Graphic User Interface. NPA has several functions of Run, Freeze, Snapshot and Backtract, provided by a full-scope simulator in general, together with a list of 52 main malfunctions. The main functions of NPA for KSNP are as follows:

o Simulation Control
- *Run, Freeze*
- *Real time, Fast time*
- *Snapshot*
- *Backtrack*
- *Reactor trip / Turbine trip bypass, etc.*

o Analysis
- *Reset*
- *Pre-determined malfunctions (52 in total)*
- *Setting-up of setpoint*
- *Change of operational variables, etc.*

o User Support
- *Sequence of event*
- *Main variables transition graph*

- *Alarm (Main systems, Reactor trip, ESFAS)*
- *Provision of the digital value of real-time simulation variables*
- *Print of current screen*

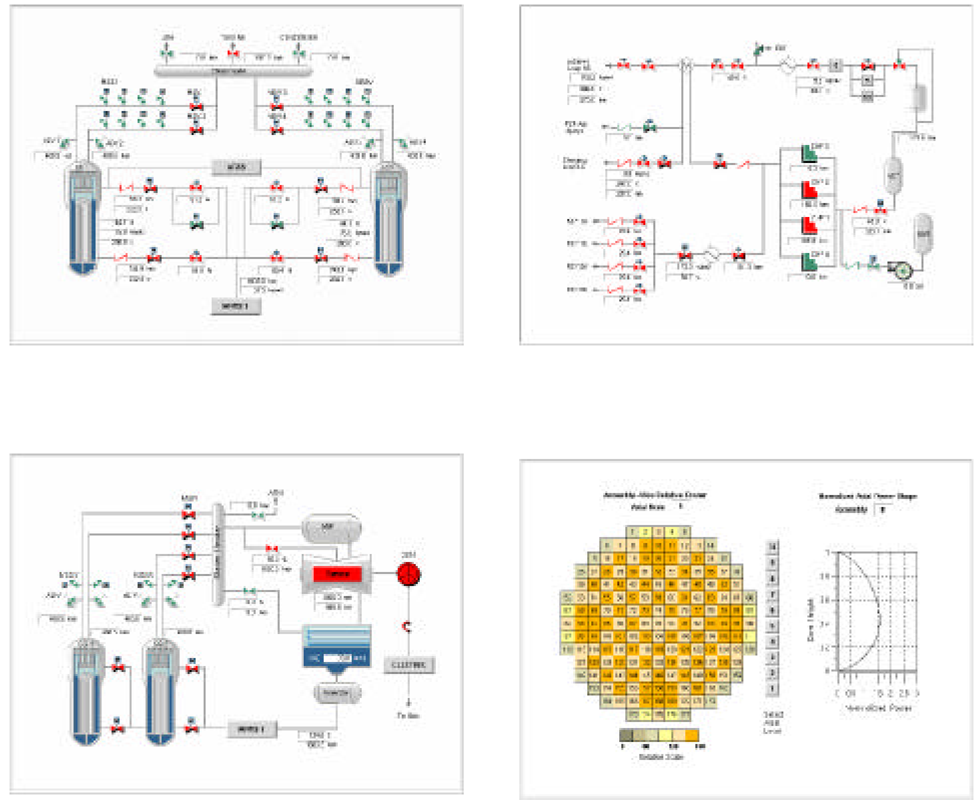


Fig. G-3. Mimics of Main Systems

3. Scope of NPA Simulation

NPA, capable of modeling all the main systems of KSNP and simulating diverse operational areas, has a function of displaying the result of simulation through graphs. The scope of its simulation is as follows:

o Normal Operation
- *Steady state*
- *Power change*
- *Heatup and Cooldown*

o Abnormal Operation
- *Reactor or Turbine trip*
- *Natural circulation and Cooldown*

- *Performance-related design bases events*

o Accidental Circumstances
- *Total loss of feedwater flow*
- *Safety-related design bases events(SBLOCA, SGTR, MSLB, etc.)*

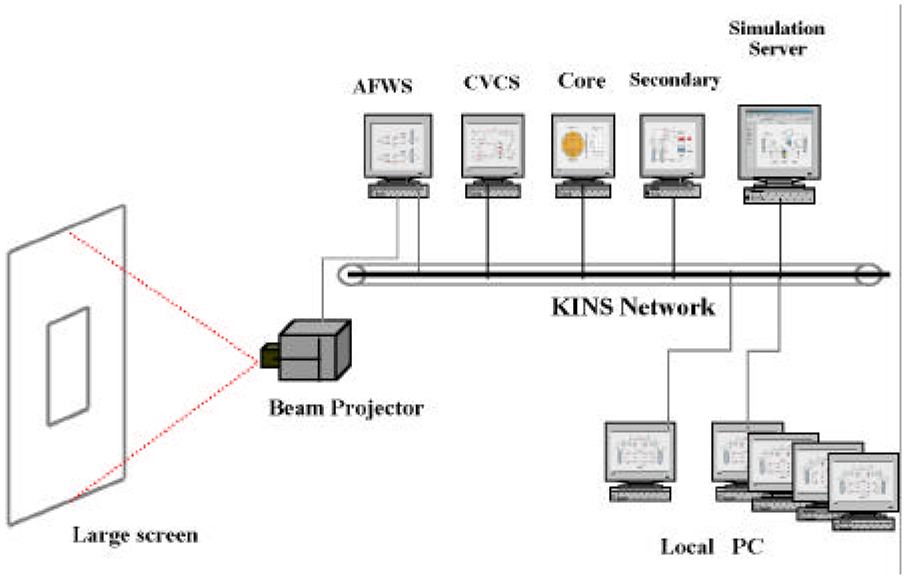


Fig. G-4. Configuration of NPA System

4. NPA Development Environment and System Configuration

The NPA Program is designed to be run in the SUN Workstation as a client-server system, and to display the screen of each main system with 4 units of Pentium PC. This Program is running in two modes, namely, Analysis Mode and Training Mode, and if running in the latter, an Instructor screen and several Student screens are made up. Additionally, NPA which is developed in the concept 'Client-Server' can execute an analysis through any independent computer linked with KINS Network, and enables about 10 users to analyze each event at a time. The overall configuration of NPA System is as found in Fig. L-4.

5. Application of NPA

The function of NPA becomes expanded with the remarkable progress of computer simulation technology, and the scope of application also is on the widening trend. Therefore, KINS NPA can be applied to various fields as follows:

o Quantitative analysis of the data collected from nuclear plant operating experience

o Safety analysis for nuclear plants through system and component analysis

o Validation and verification of an emergency operating procedure

o Education and training of regulatory personnel and outside trainees

o Support of the emergency exercises of each nuclear plant, etc.

Annex H. List of Safety-related Reports

H-1 Domestic References

1) Atomic Energy Commission, Directions of Long-term Nuclear Energy Policy toward the Year 2030, July 1994

2) Ministry of Science and Technology (MOST), Nuclear Safety Policy Statement, September 1994

3) **MOST, *Comprehensive Nuclear Promotion Plan for Nuclear Energy (2002-2006), June 2001***

4) ***MOCIE, 5th Long-term Electricity Supply Plan (1999-2015), December 1999***

5) ***MOST, White Paper on Nuclear Safety, September 2001***

6) ***Ministry of Commerce, Industry and Energy (MOCIE) / Korea Hydro & Nuclear Power Co., White Paper on Nuclear Development, August 2001***

7) Korea Institute of Nuclear Safety, 1997 Annual Report on Operational Aspects of Nuclear Power Plants in Korea, April 1998

8) **Korea Institute of Nuclear Safety, *Annual Reports on Operational Aspects of Nuclear Power Plants in Korea, 1998, 1999, 2000,***

H-2 Foreign References

1) International Atomic Energy Agency (IAEA), IAEA OSART Mission to Kori Nuclear Power Plant (Units #3 & #4), NENS/OSART/87/5, March 1987.

2) IAEA, IAEA OSART Mission to Wolsong Nuclear Power Plant (Unit #1), NENS/OSART/89/27, October 1989.

3) IAEA, Report of the Design Review Mission to Wolsong Nuclear Power Plant(Unit #2), ROK/9/025-17, July 1992.

4) IAEA, IAEA OSART Mission to Ulchin Nuclear Power Plant (Units #1 & #2), NENS/OSART/94/72, January 1995.

5) IAEA, Report of the Design Review Mission to Ulchin Nuclear Power Plant (Units #3 & #4), TC Project ROK/0/008, September 1995.

6) ***IAEA, IAEA OSART Mission to Yonggwang Nuclear Power Plant (Units #1 & #2) and Follow-up Visit Report, NSNI/OSART/96F/99***