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INTEGRATED REGULATORY REVIEW SERVICE (IRRS)

MISSION

TO

THE REPUBLIC OF KOREA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

Daejeon, Republic of Korea

KINS 한국원자력안전기술원 KOREA INSTITUTE OF NUCLEAR SAFETY

10 to 22 July 2011

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY

Integrated Regulatory Review Service

INTEGRATED REGULATORY REVIEW SERVICE (IRRS)
REPORT TO
THE REPUBLIC OF KOREA

Daejeon, REPUBLIC OF KOREA
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THE REPUBLIC OF KOREA

Mission date: *10 to 22 July 2011*
Regulatory body: *MEST & KINS*
Location: *KINS HQ in Daejeon, REPUBLIC OF KOREA*
Regulated facilities and *Nuclear power plants, Research Reactors*
Organized by: *International Atomic Energy Agency (IAEA)*

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The number of recommendations, suggestions and good practices is in no way a measure of the status of the regulatory body. Comparisons of such numbers between IRRS reports from different countries should not be attempted.

CONTENT

EXECUTIVE SUMMARY

At the request of the Government of the Republic of Korea, an international team of sixteen senior safety experts met representatives of the Nuclear Regulatory Bureau of the Korean Ministry for Education, Science and Technology (MEST), the Korean Institute for Nuclear Safety (KINS) and other organizations contributing to nuclear safety from 10 to 22 July 2011, in order to conduct an Integrated Regulatory Review Service (IRRS) Mission. The mission took place at the headquarters of KINS in Daejeon.

The purpose of this IRRS mission was to review the effectiveness of the Korean framework for safety as implemented by MEST and KINS. This IRRS mission was the first to be conducted after the occurrence of the TEPCO Fukushima Dai-ichi nuclear accident. Accordingly, special attention was given to the regulatory implications of the Fukushima accident in the Korean framework for safety, as part of a newly developed core IRRS module.

The review compared Korean nuclear standards against IAEA safety standards as the international benchmark for safety. The mission was also used to exchange information and experience between the IRRS Review Team members and the Korean counterparts in the areas covered by the IRRS.

The IRRS Review Team consisted of 16 senior regulatory experts and 1 observer from 14 IAEA Member States, 3 staff members from the IAEA and an IAEA administrative assistant. The IRRS Review Team carried out the review in the following areas: responsibilities and functions of the government; the global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body including the authorization, review and assessment, inspection and enforcement processes; regulations and guides; management systems; emergency preparedness and response; periodic safety review; and feedback of operating experience.

The IRRS mission also included the following Regulatory Policy Issues for discussion: response to the TEPCO-Fukushima Dai-ichi accident; independence of the regulatory body; transparency and openness; continued operation; and aging management of nuclear power plants. The thematic areas also covered were the periodic safety review and feedback of operating experience of nuclear power plants. The IRRS review addressed the Korean nuclear power plants and research reactors regulated by MEST and KINS. Additional IRRS core areas such as fuel cycle facilities, waste facilities, radioactive sources (medical and industrial) and decommissioning were not included in the scope.

The mission included observations of regulatory activities and a series of interviews and discussions with MEST and KINS staff and other organizations to help assess the effectiveness of the regulatory system. These activities included visits to: the Wolsong Emergency Center, the Kori nuclear power plant, and the KAERI research reactor site. The Wolsong emergency exercise was also observed by team members at the AtomCare Center, the Emergency Center at KINS Headquarters. Throughout the review of the various areas and policy issues, special consideration was given to the implications of Fukushima for the Korean Regulatory System. Team members observed the working practices during inspections carried out by MEST and KINS, including discussions with the licensee personnel such as plant managers.

MEST and KINS provided the IRRS Review Team with advanced reference material and documentation including the results of the self-assessment in all areas within the mission. Throughout the mission, the IRRS Review Team was extended full cooperation in regulatory, technical, and policy issues by all parties; in particular the staff of MEST and KINS provided the fullest practicable assistance.

In order to improve the effective independence of the regulatory body, the Korean government decided to establish a Nuclear Safety Commission (NSC) as an independent regulatory body completely separated

from MEST. KINS remains as a regulatory expert organization reporting to the NSC and MEST's role will be restricted to promoting the utilization of nuclear energy. Therefore the IRRS Team conducted the review of the current regulatory framework while acknowledging that the establishment of the NSC is expected to be carried out in October 2011.

The IRRS Review Team identified a number of good practices, made recommendations and suggestions that indicate where improvements are necessary or desirable to continue enhancing the effectiveness of regulatory functions in line with the IAEA Safety Standards.

The main observations of the IRRS Review Team were the following:

The Korean government, through the activities of MEST and KINS has implemented a technically capable and effective nuclear safety regulatory program. The status of KINS as an entrusted governmental corporation to function as a nuclear safety regulation body is unique. The Team's findings are based on the principle that the Korean current nuclear regulator is a combination of MEST and KINS.

Transition to a new regulatory framework has the potential to enhance regulatory independence, expertise and transparency; however implementation details have yet to be finalized. Therefore, the Team could not make a conclusion regarding the planned framework's effectiveness.

Korea's response to the accident at Fukushima has been prompt and effective. Communications with the public, development of actions for improvement and coordination with international stakeholders was of high quality. Further lessons learned should be adequately addressed.

Among the good practices identified by the IRRS Review Team are the following:

- The regulatory body of Korea has a clear and structured national approach for nuclear safety
- Korea strongly supports the global nuclear safety regime and provides training at national and international level
- KINS has a high level of technical competence and has implemented an effective human capital program
- KINS performs detailed and comprehensive safety assessment using a broad range of deterministic and probabilistic codes and methods
- KINS has a comprehensive integrated computerized information and data management system

The IRRS Review Team identified certain issues warranting attention or in need of improvement and believes that consideration of these would enhance the overall performance of the regulatory system.

- Transition to the new regulatory framework will require development of implementation details that will impact the effectiveness of the new framework. The areas requiring attention include:
    - clearly defining the roles and responsibilities of the organizations for both normal and emergency situations,
    - the selection criteria for members of the Commission,
    - establishment of an advisory committee to the NSC,
    - appropriate allocation of staff and resources, and
    - development of a management system for the new organization.
- The management system should be developed in the areas of resource management, as well as requiring descriptions of the internal safety culture, and organizational change management.
- Regulations and guides should be developed or updated to address decommissioning, management of spent fuel, quality assurance plan for licensing of research and test reactors and management of severe accidents.

- Enhancements to the licensing process are needed to clarify and strengthen the safety information in license amendments and assessment reports.

The IRRS Review Team findings are summarized in Appendix V and VI.

An IAEA press release was issued at the end of the mission.

I. INTRODUCTION

At the request of the Government of the Republic of Korea, an international team of sixteen senior safety experts met representatives of the Nuclear Bureau of the Korean Ministry of Education, Science and Technology (MEST), together with representatives of the Korean Institute for Nuclear Safety (KINS) from 10 to 22 July 2011, in order to conduct an Integrated Regulatory Review Service (IRRS) Mission to review the Korean nuclear regulatory framework and its effectiveness.

There was one preparatory mission in February 2011 carried out at KINS's Daejeon Headquarters to discuss the objective, purpose and consequently the preparations of the review as well as its scope in connection with the areas covered by MEST and KINS and selected safety aspects.

The IRRS Review Team consisted of 16 senior regulatory experts (15 reviewers and 1 observer) from 14 IAEA Member States, 3 staff members from the IAEA and an IAEA administrative assistant. The IRRS Review Team carried out the review of MEST and KINS in the following areas: responsibilities and functions of the Government; global nuclear safety regime; responsibilities and functions of the regulatory body; the management system of the regulatory body; the activities of the regulatory body including the authorization, review and assessment, inspection and enforcement processes; regulations and guides; emergency preparedness and response; periodic safety review; and feedback of operating experience.

This IRRS mission was the first to be conducted after the occurrence of the TEPCO Fukushima Dai-ichi nuclear accident. Accordingly, special consideration was taken for the regulatory implications of the Fukushima accident in the Korean framework for safety, as part of a newly developed core IRRS module.

In addition, policy issues were addressed, including: independence of the regulatory body, transparency and openness, continued operation and aging management. Two thematic areas were also covered, the periodic safety review, and operating experience feedback.

MEST and KINS prepared substantial documentation as advance reference material and a well prepared self-assessment. During the mission the IRRS Review Team performed a systematic review of all topics using the advance reference material, held interviews with management and staff from MEST and KINS, and performed direct observation of the working practices during inspections carried out by MEST and KINS.

All through the mission the IRRS Team received excellent and open co-operation from MEST and KINS, questions from the IRRS team members were fully answered, documents requested were presented and explained

II. OBJECTIVE AND SCOPE

The purpose of this IRRS mission was to conduct a review of the Korean nuclear regulatory framework and regulatory activities to review its regulatory effectiveness and to exchange information and experience in the areas covered by IRRS. The facilities and activities addressed the Korean IRRS review are nuclear power plants and research reactors regulated by MEST and KINS. Other facilities and activities that belong to the IRRS core areas such as fuel cycle facilities, waste facilities, radioactive sources (medical and industrial) and decommissioning were not included in the scope. The review was carried out by comparison against IAEA safety standards as the international benchmark for safety.

It is expected that the IRRS mission will facilitate regulatory improvements in the Republic of Korea and throughout the world from the knowledge gained and experiences shared by MEST and KINS and the IRRS reviewers and through the evaluation of the effectiveness of the Korean nuclear regulatory framework and its good practices.

The key objectives of this mission were to enhance nuclear safety and emergency preparedness:

- ✓ Providing MEST and KINS, through completion of the IRRS questionnaire, with an opportunity for self-assessment of its activities against international safety standards;
- ✓ Providing the Republic of Korea (MEST and KINS) with a review of their regulatory programmes and policy issues relating to nuclear safety and emergency preparedness;
- ✓ Providing the Republic of Korea (MEST AND KINS) with an objective evaluation of its nuclear safety and emergency preparedness regulatory activities with respect to international safety standards;
- ✓ Contributing to the harmonization of regulatory approaches among IAEA Member States;
- ✓ Promoting the sharing of experience and exchange of lessons learned;
- ✓ Providing reviewers from IAEA Member States and the IAEA staff with opportunities to broaden their experience and knowledge of their own field;
- ✓ Providing key staff with an opportunity to discuss their practices with reviewers who have experience of other practices in the same field;
- ✓ Providing the Republic of Korea (MEST and KINS) with recommendations and suggestions for improvement;
- ✓ Providing other States with information regarding good practices identified in the course of the review.

III. BASIS FOR THE REVIEW

A) PREPARATORY WORK AND IAEA REVIEW TEAM

At the request of the government authorities of the Republic of Korea, a preparatory meeting for the Integrated Regulatory Review Service (IRRS) was conducted in February 2011. The preparatory work for the mission was carried out by the IRRS IAEA Team Coordinator Mr Gustavo Caruso, the appointed Team Leader Mr William Borchardt and the Deputy Team Leader Mr Georg Schwarz.

MEST and KINS prepared for the mission based on the IAEA "Guidelines for the Preparation and Conduct of IRRS Missions, Edition 2010". For the preparation of the IRRS in Korea, MEST and KINS established organization charts, composed by MEST and KINS staff with key roles during all preparations and during the mission.

IRRS Preparation:

- ✓ August 2009: Formal request to the IAEA for IRRS mission
- ✓ November 2009: Receiving an IAEA confirmation letter for the Korea IRRS mission
- ✓ December 2009: Launching a self-assessment Task Force Team
- ✓ April 2010: Information meeting in Seoul
- ✓ October 2010: Confirmation of the Korea IRRS mission schedule (July 10 to 22, 2011)
- ✓ February 2011: IRRS Preparation Team (Korean IRRS Team Leader: Second Vice-Minister of MEST)
- ✓ February 2011: Preparatory meeting in Daejeon

Contacted persons from MEST and KINS during the IRRS preparation and IRRS Mission:

- Vice-Minister for Education, Science and Technology (MEST) Mr. Chang-Kyung KIM
- Senior Executive Managers:
  - Mr Jae Young Son, Director General of the Nuclear Regulatory Bureau at MEST
  - Mr Choul Ho Yun, President of KINS.
- Senior Executive Coordinators:
  - Mr Min Baek, Director of the Radiation Safety Division at MEST
  - Mr Sung Kyu Lee, Vice-President of KINS.
- Technical Coordinators:
  - Mr Kee Soo Jeon, Director of the IRRS Mission Team at MEST
  - Mr Youn Won Park, Director of the International Nuclear Safety Division at KINS.
- Liaison Officers:
  - Mr Min Baek, Director of the Radiation Safety Division at MEST
  - Mr Suk Ho Lee, Director of the Strategy and External Affairs Division at KINS.
- MEST and KINS Technical and support staff

The IRRS Review Team representatives had extensive discussions regarding MEST and KINS regulatory programmes and policy issues with the top management of MEST and KINS represented by Mr Min Baek and Mr Sung Kyu Lee.

The discussions resulted in the following areas to be covered by the IRRS mission:

- Nuclear power plants;
- Research Reactors
- Emergency preparedness and response;
- Selected policy issues.

MEST and KINS Management Staff made comprehensive presentations on the self-assessment results and other advanced reference material. IAEA presented the IRRS principles and methodology, including the self-assessment phase. This was followed by a discussion on the work plan for the implementation of the IRRS in Korea in July 2011.

The proposed IRRS Team composition (senior regulators from Member States to be involved in the review) was discussed and the size of the IRRS Review Team was confirmed. Logistics including meeting and work space, counterpart identification, lodging and transportation to accommodate site visits and observations were also addressed.

The MEST and KINS staff performed a self-assessment with the following objectives to improvement of effectiveness in nuclear safety regulation and enhancement public confidence in nuclear safety. The self-assessment was conducted to identify the strengths and weaknesses of Korean nuclear safety regulation in

comparison with the IAEA Safety Standards. Following the completion of the self-assessment, it was concluded that there are a number to be improved and also good practices identified. This self-assessment was included in the advance reference material for the review (Appendix VI).

B) REFERENCE FOR THE REVIEW

The most relevant IAEA safety standards used as review criteria are: GSR Part 1, Safety Requirements on Governmental, Legal and Regulatory Framework for Safety, GS-R-2, Preparedness and Response for a Nuclear or Radiological emergency and GS-R-3, Safety Requirements on The Management System for Facilities and Activities. The complete list of IAEA publications used as the reference for this mission is given in Appendix VII.

C) CONDUCT OF THE REVIEW

An opening IRRS Review Team meeting was conducted on Sunday, 10th July 2011 in Daejeon by the IRRS Team Leader and the IRRS IAEA Team Coordinator to discuss the general overview, the focus areas and specific issues of the mission, to clarify the basis for the review and the background, context and objectives of the IRRS and to agree on the methodology for the review and the evaluation among all reviewers.

In addition, IAEA Team Coordinator presented the new module on the IRRS "Regulatory implications from TEPCO Fukushima Dai-ichi Accident" to be applied for the first time during the IRRS mission in Korea.

The Technical and Organizational Liaison Officers were present at the opening IRRS Review Team meeting, in accordance with the IRRS guidelines. The reviewers also reported their first impressions of the advance reference material.

The IRRS entrance meeting was held on Monday, 11th July 2011, with the participation of MEST and KINS senior management and staff. Opening remarks were made by Mr Chang Kyung Kim, Vice-Minister of Education, Science and Technology, the IRRS Team Leader, Mr Bill Borchardt, and the IRRS Team Coordinator.

During the mission, a systematic review was conducted for all the review areas with the objective of providing MEST and KINS with recommendations and suggestions as well as identifying good practices. The review was conducted through meetings, interviews and discussions, visits to NPPs and direct observations regarding the national practices and activities.

The IRRS Review Team performed its activities based on the mission programme given in Appendix II.

The IRRS exit meeting was held on Friday 22th July 2011. The opening remarks at the exit meeting were presented by Mr Jae Young Son. The results of the IRRS mission were presented by Mr Bill Borchardt. The closing remarks were made by Mr Denis Flory, IAEA Deputy Director General of the IAEA Department of Nuclear Safety and Security, Mr Jae Young Son, Director General of the Nuclear Regulatory Bureau at MEST.

1. RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT

1.1. NATIONAL POLICY AND STRATEGY

Korea has established a structured system of policies and strategies for nuclear safety:

- The Nuclear Safety Charter is the top level document of the Korean National Policy and Legal Framework. It was enacted in 2001 and outlines the most important safety principles in a compact form. In particular, it assigns top priority to safety and the commitment to complement and continuously improve the nuclear safety-related legal system.
- The Nuclear Safety Policy Statement was enacted in 1994 and substantiates the Nuclear Safety Charter. It contains the five main regulatory principles to secure consistency, adequacy, and rationality of regulatory activities. In addition the Nuclear Safety Policy establishes eleven long term safety policies and emphasizes the central role of safety culture to improve safety.

The national safety policy and strategy are established primarily by the Government, and during the process, various comments are taken into account for a national consensus. Although the mentioned Policies are not legally binding and could be changed at any time by the Government, they have been very stable over the last decades.

In addition, the most important safety principles are enshrined in the AEA. The Atomic Energy Act states in Article 1 (Purpose) that the purpose of the Atomic Energy Act is "prevention of disaster resulting from radiation and to ensure safety of the general public". The AEA also has set up safety regulatory policy and implementation methods to assure safety during all stages associated with use of radioactive material as well as use of nuclear power, i.e., from construction to decommissioning of nuclear facilities. For those aspects relating to radiological emergency management and physical protection frameworks, the Act on Physical Protection and Radiological Emergency (APPRE) has been enacted. To provide compensation for those who suffer from nuclear damage, the Nuclear Liability Act (NLA) is in force.

The implementation of policies and strategies take place according to a two-stage planning:

- The AEA requires the Government to issue a Comprehensive Nuclear Energy Promotion Plan every 5 years to establish a basic direction for utilisation and safety control of nuclear energy and sector-specific tasks, and associated implementation plans. In 2010, MEST issued the first Comprehensive Plan on Nuclear Safety which, as the title suggests, focuses uniquely on the national safety strategy.
- The Annual Action Plan: concretizes the implementation of the Comprehensive Plan for Nuclear Safety on a yearly basis.

With its structured approach in the strategic area the Korean government sets out clear priorities for the further development of the legal framework and thus implements the graded approach in an exemplary manner on the strategic level.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1 para. 2.3 states that** *"National policy and strategy for safety shall express a long term commitment to safety. The national policy shall be promulgated as a statement of the government's intent. The strategy shall set out the mechanisms for*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	implementing the national policy."
GP 1	**Good Practice: Korea has a clear and structured national approach to set out in its policies and the corresponding implementation plans, with well-defined priorities for the further development of the legal framework.**

1.2. ESTABLISHMENT OF A FRAMEWORK FOR SAFETY

The legislative and regulatory framework in Korea for the safety of nuclear installations and radiological protection is based on a five-level system:

- Acts: at the uppermost level of the Korean legal framework, acts form the main legal provisions for the development and utilization of nuclear energy and the bases for safety regulation, authorisations and inspection of nuclear facilities. .
- Enforcement Decree of the Act: Particulars entrusted by the Act.
- Enforcement Regulation of the Act: Particulars entrusted by the Act and/or Decree and brief technical standards as delegated by the Act and/or Decree.
- Notice of the Minister: Details on technical standards procedures and format as delegated by the Act, Decree and/or Regulation.
- Regulatory Standards and Guidelines: Further particulars or interpretation of the Notice of the Minister, acceptable methods, conditions etc.

In the area of nuclear safety the following Acts are of importance:

- Atomic Energy Act (AEA): Matters related to development and utilisation of nuclear energy and safety regulation of nuclear facilities and related activities
- Act on Physical Protection and Radiological Emergency (APPRE): Protection of nuclear materials and facilities and establishment of radiological emergency measures
- Radioactive Waste Management Act (RWMA): Safety management of radioactive wastes
- Korea Institute of Nuclear Safety Act (KINS Act): Establishment of KINS with its authority and duty
- Nuclear Liability Act (NLA): Compensation for damage due to accidents during nuclear-related activities

The AEA is the most important of the Acts listed above for safety. The AEA is concretized using the Enforcement Decree, the Enforcement Regulation and the Notices of the MEST. In addition, to further elaborate on the above mentioned legally binding requirements, KINS develops non-binding documents: regulatory standards and regulatory guides, as well as guidelines for the safety review or inspection.

The team comes to the conclusion that the Korean legal framework provides the needed basis for the regulation of nuclear safety.

In the course of the mission the team learned that on 29 June 2011 the Korean National Assembly passed a bill with the aim of achieving clearer separation of the promotion of the use of nuclear energy and safety

regulation. The AEA will be split into two parts, and other related laws will be amended to provide for legal separation of responsibilities.

The team considers this legislative change as a positive step towards a more stringent separation of the promotion and the safety of nuclear energy. Its implications for the organisation and structure of the regulatory body are discussed in following sections of the report.

1.3. ESTABLISHMENT OF A REGULATORY BODY

In the current legal framework, the Ministry of Education, Science and Technology (MEST) is established as the regulatory body for nuclear safety in Korea in accordance with Article 22 of the Government Organisations Act. In February 2011 MEST's responsibilities in the area of promoting the utilization of nuclear energy and safety control were assigned to two different units within MEST. The Nuclear Regulation Bureau (NRB) is now in charge of nuclear safety regulation activities.

Part of the authority of the MEST may be delegated to other institutions. Based on Article 111 of the AEA the Korean Institute for Nuclear Safety (KINS) has been delegated most of the scientific and technical functions of the regulatory body with regard to safety. KINS is a governmental corporation established by the Korea Institute of Nuclear Safety Act (KINSA). The Korea Institute of Nuclear Nonproliferation and Control (KINAC) plays a similar role with regard to nuclear security and non-proliferation.

The third body within the Korean regulatory body is the Nuclear Safety Committee (NSC). The NSC is an advisory committee to the MEST. It plays a strong expert advisory role in deliberations and gives a second opinion on important safety matters.

The team concludes on this basis that Korea has established a regulatory body that is generally competent to fulfil the requirements of IAEA GSR Part 1. However the regulatory body in the team's view consists of the combination of MEST and the specialized institutions, and not MEST alone. The essential nuclear safety expertise and associated infrastructure resides with KINS. While MEST has the legal authority, its role is understood to be administrative.

As noted above the team was informed of new legislation which will change the regulatory framework. The new law will create an independent Nuclear Safety Commission, which will take over the mission, duties and responsibilities of MEST regarding safety and radioprotection. The new Nuclear Safety Commission will be established under the control of the President instead of the Minister of MEST. The mission, duties and responsibilities of KINS will be unchanged.

The proposed Nuclear Safety Commission will consist of from seven to nine members, including the Chairman and Vice Chairman who will be permanent members appointed by the President at the recommendation of the Prime Minister. The other members will be appointed by the President at the recommendation of the Chairman.

As the process is on-going, not all the details of this reorganisation are known. More detailed and formalized information would be needed to have a more precise position. Nevertheless, the team comes to the conclusion that the intended change has the potential to strengthen the regulatory framework for nuclear safety. The new Nuclear Safety Commission will have more competencies and resources available for nuclear safety matters than the minister of MEST and will therefore play a more prominent role in the regulatory processes. This fact should be considered when further developing the structure and the roles of the new organisation (see chapter 3 below).

1.4. INDEPENDENCE OF THE REGULATORY BODY

MEST has responsibilities in the areas of promoting the utilization of nuclear energy and of safety control. In particular, as noted above, MEST is responsible under the AEA for establishment of a comprehensive nuclear energy promotion plan for the utilization and safety control of nuclear energy. On the other hand MEST is responsible also for licensing and inspection of nuclear facilities and activities.

Since February of this year the two responsibilities are assigned to two different units within MEST. The aspects of promoting the utilization of nuclear energy are assigned to the Atomic Energy Bureau, whereas the Nuclear Regulatory Bureau is in charge of safety.

The various organizations responsible for nuclear safety in Korea are capable and dedicated. The team found no evidence that the dual responsibilities of MEST for promoting the utilization of nuclear energy and safety control has in any way diluted the strong national focus on high standards of nuclear safety. The team notes that the Nuclear Safety Committee, NRB and KINS have legal responsibilities uniquely for safety. However, the current provisions of the Atomic Energy Act which place promotion and safety control in the responsibility of a single ministry do not conform with the requirements of IAEA GSR Part 1.

The team considers that the new legislation passed earlier this year to create the Nuclear Safety Commission is a positive step to enhance the independence and effectiveness of the regulatory body in the Republic of Korea. Specific advantages include:

- De jure and de facto independence of the new regulatory body from entities responsible for promoting the use of nuclear energy in the state;
- Higher reporting level in the national government for the regulatory body, enabling direct access to the President and his cabinet for decisions on important matters.
- The qualifications for members of the Nuclear Safety Commission are set out in law which disbars any person who has a conflict of interest in a regulated nuclear activity.

On the other hand the team has identified a number of topics that should be considered when creating the new Commission:

- To be effectively independent the new Commission must be able to make its own opinion on the treated regulatory issues. This is only possible if some members, ideally the permanent members, have specific nuclear safety know-how.
- The Commission should make its decisions free from any undue influences that might compromise safety. In order to avoid the politicisation of the Commission's decision making, political or ideological affiliation should not be selection criteria for the members.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, para. 2.8 states that** *"To be effectively independent, the regulatory body shall have sufficient authority and sufficient staffing and shall have access to sufficient financial resources for the proper discharge of its assigned responsibilities. The regulatory body shall be able to make independent regulatory judgements and decisions, free from any undue influences that might compromise safety."*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
S 1	**Suggestion: In order to ensure the effectiveness, of the new Nuclear Safety Commission the selection criteria for the members should reflect the need of independence and nuclear safety competence within the Commission.**

1.5. PRIME RESPONSIBILITY FOR SAFETY

The team noted that the licensee's prime responsibility for safety is not explicitly regulated at the legislative level but is reflected at the policy level. One of the Safety Regulation Principles of the Nuclear Safety Policy states that "*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*."

On the legal level the safety responsibility of the licensees is defined principally through licensing, safety measures for operation and continuing regulatory oversight, and enforcement throughout all stages in the lifetime of a facility. This means the Korean regulator makes sure that the licensees take their safety responsibility. Under the statutory provisions for liability payments in the event of a nuclear accident, it is clear that the industry bears the liability.

1.6. COMPLIANCE WITH SAFETY REGULATIONS

Even though a person has obtained a construction permit or an operating license, that person can use the respective facility only when it meets the acceptance criteria of the regulatory body. Within this frame the Korean regulator makes sure that the licensees take their safety responsibility.

The safety responsibility also extends to the authorized party's employees, contractors, and others, against whom the regulatory body has authority to take enforcement action. Authorized parties are responsible for verifying that products and services supplied to them by employees and contractors in fact comply with applicable law.

The team concludes that the Korean legal framework provides for assuring that compliance with regulations and requirements does not relieve authorized parties of their prime responsibility for safety.

1.7. COORDINATION OF DIFFERENT AUTHORITIES WITH RESPONSIBILITIES FOR SAFETY WITHIN THE REGULATORY FRAMEWORK

In the legal and regulatory framework of Korea, all regulatory functions for safety of nuclear facilities are addressed by the Atomic Energy Act, and other related legislation under the jurisdiction of the MEST.

Nevertheless, the involvement of different governmental agencies such as the Ministries of Environment, Employment and Labour, etc., is inevitable in the regulatory process for nuclear facilities. The team was informed that the associated government agencies including MEST maintain a close cooperative system as governed by law. The activities of different agencies are coordinated at Cabinet meetings presided by the President of the Republic of Korea. In addition, the Ministry of Government Legislation assists in coordination among the different agencies.

At the practical level, the team observed a chart of the overall licensing process for a new Nuclear Power Plant that clearly delineates the steps and interfaces between the KHNP as applicant, the Ministry of

Knowledge and Economy as the agency responsible for nuclear energy development, and MEST/KINS as the safety regulator.

The team concludes that the government complies with the safety requirements of the IAEA in this respect.

1.8. COMPETENCE FOR SAFETY

Licensed staff

The Atomic Energy Act stipulates that only the relevant license holder approved by the Minister of the MEST can operate a reactor or handle nuclear fuel materials, radioisotopes or radiation generating devices. Licenses are issued to applicants who have engaged in the relevant fields with sufficient experience and successfully passed an examination administered by the MEST.

The training of the licensed staff is implemented following the relevant legal provisions of the AEA and the corresponding Presidential Decree. The education and training of licensed operators staff is provided for in the nuclear power education schools of the KHNP and the education/training centre located in each nuclear power plant area. The topics covered are: nuclear reactor operation principles and outlines; plant operation and system characteristics; plant instrumentation and control system; plant protection system; engineered safety features; radiation control and safety; technical specifications, etc.

The licensing examination of the reactor operating staff at the NPPs consists of a written and a practical examination organised by KINS. The practical examination is conducted by a committee composed of retired KHNP senior experts, university experts and KINS staff. The license certificate is issued by MEST. Reactor operator refresher training is legally required and has to be repeated every 3 years. It consists of a course of at least 5 days including simulator practical exercises.

Regulatory body

Internally, KINS maintains a high level of expertise by a comprehensive education and training programme for their staff. KINS operates its own training centre, namely the International Nuclear Safety School. This school provides education courses on nuclear safety targeting not only domestic regulatory staff but also safety regulatory staff of new entrant countries.

The International Nuclear Safety School provides training courses on the principles of nuclear safety regulation focusing on knowledge and technologies required for efficient job-performance skills for new employees., with relevant experience as well as for inexperienced employees. The training program includes concepts of nuclear safety, nuclear power plant systems, safety regulation systems, nuclear safety policies and legislation of nuclear energy, regulatory licensing procedures, concepts of radiation safety, national radiation emergency countermeasures, nuclear quality assurance, nuclear and radiation incident, and personnel ethics and leadership.

By opening a variety of international education/training courses for safety regulation staff of the world including Asia, the International Nuclear Safety School makes a considerable contribution to the improvement of international nuclear safety and at the same time helps invigorate global communications on nuclear regulatory technology.

R&D and Academic Institutions

Independent expertise is also ensured by establishing national research and development programmes according to the government’s strategic planning. The government levies a charge on all nuclear

electricity generation to pay for a Nuclear Energy Research and Development Fund. The nuclear safety research and the regulatory research are carried out by KAERI and KINS, respectively. KINS research focus on development of safety standards and regulatory requirements, while the KAERI research relate to development of computer codes, thermal hydraulic experiments, etc.

The "KINS-KAIST International Nuclear Safety Master's Degree Program" is designed to educate and train high-calibre students, through which they can grow to be nuclear safety leaders in their countries.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1 para. 2.38 states that** *"Development of the necessary competence for the operation and regulatory control of facilities and activities shall be facilitated by the establishment of, or participation in, centres where research and development work and practical applications are carried out in key areas for safety."*
GP 2	**Good Practice: The establishment of the International Nuclear Safety School which provides a large variety of training and education opportunities for members of the regulatory body as well as for students and other interested parties**

1.9. PROVISION FOR THE DECOMMISSIONING OF FACILITIES AND THE MANAGEMENT OF RADIOACTIVE WASTE AND SPENT FUEL

The practical implementation of decommissioning of facilities and the management of radioactive waste and of spent fuel is not part of the scope of this IRRS mission. The statements below are therefore limited to the implementation of the IAEA standards in national legislation. Additional discussions related to the topic can be found in chapter 6 and 9.

Decommissioning

There are no plans for shutting down or decommissioning any Korean NPPs for the moment. The research reactor units 1 and 2 and the uranium transformation facility are the only nuclear installations actually under decommissioning.

According to the Atomic Energy Act, the responsibility and duty for safe decommissioning of nuclear facilities basically rests with the licensee of the respective facility. In order to guarantee the financing of the decommissioning, the NPPs are obliged to set up a fund according to the Radioactive Waste Management Act. The amount to be accumulated in the fund is based on cost estimates of the decommissioning that have to be reviewed by MKE every two years.

If a licensee intends to decommission a nuclear facility, it has to submit a decommissioning plan to obtain advance approval from MEST prior to beginning the decommissioning works. The decommissioning plan will then pass an authorization process to confirm safety associated with decommissioning of facilities and its closedown.

The team has noted that the start of the decommissioning process is merely defined by the licensee and cannot be enforced by the regulatory body. There is also no legal obligation to prepare decommissioning plans prior to the decommissioning application to MEST.

The improvement of the regulation of decommissioning was included in the Comprehensive Nuclear Safety Plan of the years 2010-2014 and in the KINS action plan for the IRRS mission.

Radioactive Waste and Spent Fuel

The policy and strategy of the Government with respect to radioactive waste and spent fuel management are established on the basis of a Basic Plan for Radioactive Waste Management. To maintain continuity of the safety management responsibility, the legislation defines, for each management stage, the responsibility of license holders, either the producer of radioactive waste or the associated management licensee. In the case of a license revocation or a business closure, the license holder is required by law to take measures necessary to safely manage radioactive waste, and the MEST Minister may order him to take safety measures if deemed necessary.

The costs' associated with transport, storage, treatment and disposal of radioactive waste and spent fuel are covered by funds that are raised by fees of the producers of radioactive waste. Raising, usage, management and operation of the funds are prescribed in the Radioactive Waste Management Act.

Medium and low-level radioactive waste must be permanently disposed of, after managing it temporarily in a nuclear power plant site or radioisotope waste storage facility. A site for a facility for medium and low-level radioactive waste disposal was selected and MEST issued construction and operating permits in 2008. Construction work is underway with a target completion date in 2012.

Spent fuel is actually managed and temporarily stored on the sites of each nuclear power plant. The Korean Government is right now in the process of elaborating a long term plan for the management, intermediate storage and final deposit of the spent fuel.

The Korean ministry of Economy (MKE) is sponsoring R&D activities for safe transport and management of radioactive waste through the Radioactive Waste Management Fund. MEST provides support to R&D activities on safety standards for radioactive waste management through the Nuclear Technology Development Project financed by the Nuclear Energy Research and Development Fund.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1 para. 2.28** *"Decommissioning of facilities and the safe management and disposal of radioactive waste shall constitute essential elements of the governmental policy and the corresponding strategy over the lifetime of facilities and the duration of activities. The strategy shall include appropriate interim targets and end states."*
R 1	**Recommendation: The regulatory framework should require decommissioning plans for nuclear installations to be constructed and operated. These plans should be updated periodically**

1.10. PROVISION OF TECHNICAL SERVICES

Personal Dosimetry

Enterprises providing services for personal dosimetry have to be registered by MEST. They have to have a quality assurance program and relevant technical capabilities. KINS periodically verifies, by performing yearly inspections, the adequacy of the dosimeter reading quality system as well as the technical capability of the dosimeter reading service provider. The MEST may revoke the registration of the dosimeter reading service provider if it fails to meet the acceptance criteria.

The Korean Radioisotope Association (KRIA), as entrusted by the MEST according to the *Atomic Energy Act*, is responsible for maintaining the national registry of occupational radiation exposures and retraining of radiation workers.

Environmental Monitoring

KINS operates an Integrated Environmental Radiation Monitoring Network (IERNet) to automatically monitor environmental radioactivity over the whole territory. The IERNet system measures and manages space gamma dose rates in real time on a year-round basis. Through a main computer operated by a central radioactivity measurement centre of KINS, the measurement data from a total of 71 environmental radioactivity monitors installed around the country including mainland and islands are collected and managed through a wired/wireless communication network, and disclosed to the public through internet in real time.

In addition 12 local radioactivity measurement centres and KINS itself perform radiometric measurements on a variety of samples including water, soil, agricultural products and air dust filters. The data collected are managed with CLEAN, a web based information system radiological data.

Calibration of Equipment

Equipment has to be calibrated by an organization accredited Korea Laboratory Accreditation Scheme (KOLAS) which has been established by the Korean Agency for Technology and Standards (KATS),

2. GLOBAL NUCLEAR SAFETY REGIME

2.1. INTERNATIONAL OBLIGATIONS AND ARRANGEMENTS FOR COOPERATION

Korea has ratified the major international treaties and conventions for nuclear safety which are legally-binding (Nuclear Non-Proliferation Treaty, Convention on Physical Protection of Nuclear Material, Convention on Early Notification of a Nuclear Accident, Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Convention on Nuclear Safety, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management). In addition to the legally-binding international treaties and conventions, the Government has declared a policy of implementing various codes of conduct.

Regarding bilateral cooperation, the Government has signed nuclear energy cooperation agreements with 25 countries, and held the Joint Coordinating Committee Meetings at bilateral level with 12 countries including the U.S., Russia, Vietnam, the U.K., China, Chile, Canada, France, Australia, Kazakhstan, Japan and Thailand.

Korea is member of the International Nuclear Regulators' Association (INRA) and actively participates in the activities of the Asian Nuclear Safety Network (ANSN) of the IAEA and the Forum for Nuclear Cooperation in Asia (FNCA) for the enhancement of nuclear safety in the Asian Region. Korean delegations participate in the Commission on Safety Standards (CSS) of the IAEA and the four relevant subcommittees and in the six standing committees of the OECD/NEA, in the Multinational Design Evaluation Program (MDEP) and in international joint research projects under the auspices of OECD/NEA.

The first Operational Safety Review Team Mission (OSART) of the IAEA reviewed the Kori 1 nuclear power plant in the year1983. Since then Korea invited 5 further OSART-Missions, 2 Design Review Missions and 5 Review Missions on special topics including long-term operation and radioactive waste safety. Korea is also encouraging its own nuclear experts to participate in the international review missions

KINS also developed the Integrated Regulatory Infrastructure Support Service (IRISS) based on the IAEA safety standards in order to provide the tailored services to the countries embarking on the nuclear power plants, which is to respond to diverse demands of new entrants including the Jordan Nuclear Regulatory Commission (JNRC) and the Federal Authority for Nuclear Regulation (FANR) of the United Arab Emirates (UAE).

The International Nuclear Safety School (INSS) at KINS is another important instrument within the frame of international cooperation and support. The INSS plays the role of a hub for the international nuclear safety training courses under the cooperative arrangement with the IAEA. Last year, INSS provided training courses for about 200 foreign regulatory staff members from about 40 countries. The KINS-KAIST "International Nuclear Safety Master's Degree Program" is also open to nuclear safety experts from embarking nuclear countries.

The team recognizes that Korea invests a significant amount of resources in the area of international cooperation. KINS alone has dedicated 10 to 15 full-time employees exclusively to international activities. including part-time participations of experts in these activities, KINS effort amounts to 5 to 7% of the total.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, para 3.2 states that** *"The features of the global safety regime include: (e) Multilateral and bilateral cooperation that enhances safety by means of harmonized approaches as well as increased quality and effectiveness of safety reviews and inspections."*
GP 3	**Good Practice: Korea strongly promotes a global nuclear safety regime through multi or bi lateral actions, with countries having established nuclear programmes and those embarking on nuclear power, in technical, regulatory and research domains.**

2.2. OPERATING EXPERIENCE FEEDBACK

An Operating Experience Feedback (OEF) programme is required by the AEA and its supporting decrees and regulations Both the Utility and KINS undertake OEF. A well-resourced OEF team is maintained within the regulatory body to effectively undertake a broad range of OEF activities.

International Learning

KINS is proactive on the international front in looking for operational learning. It's OEF team, consisting of various experts and discipline specialists, analyses international events that are rated equal or higher than INES 2.

Information is also collected from a range of other sources worldwide, including the IAEA IRS data base, Generic Letters, Information Notice, Licensee Event Report (LER) of the U.S. NRC, OECD/NEA etc. Existing data collection and analysis systems cover not only operating nuclear power reactors, but also research reactors and international, as well as domestic experience gained during construction of new NPPs. The analysis results from these processes are provided to the competent departments and staff of the Regulatory Body, and are entered into the KINS Dissemination of Incidents and OE System (DIOS).

KINS regularly participates at international meetings relevant to the feedback of operating experience, such as the IRS meetings organized by the IAEA, the Working Group on Operating Experience (WGOE) of CNRA (Committee on Nuclear Regulatory Activities) of the OECD/NEA, and the RCOP-1 (Regional Cooperative Project-1; Feedback of Operational Experiences of NPPs in Northeast Asia). Furthermore design specific aspects are discussed with the countries operating the same type of reactors, through the "Regulators Group of Framatome PWRs" (FRAREG) for Framatome-designed reactors and the "CANDU Senior Regulators Meeting" (CSRM) for pressurized heavy water reactors.

Similar processes take place on behalf of the utility, based on the technical information provided by the IAEA, INPO and WANO. The insights and the resulting corrective actions of both organizations are readily discussed with one another. The final regulatory decision on a specific topic is then based on the results of these discussions.

National Operating Experience Feedback Process

MEST Notice 2009-37 (Regulation on Reporting and Public Announcement of Accidents and Incidents for Nuclear Power Utilization Facilities, Mest.Reactor.019) sets out the reporting criteria and time line that need to be applied by the licensee when reporting events to the regulator, which scopes both operational plants and those under construction. The level of discrimination of events to be reported to the regulatory body by the utility is set relatively high in line with the IAEA minimum requirement, but

this leads to a significant number of precursor events not being conveyed to the regulator body. This in turn places a high degree of reliance on the work of the individual NPP's and the utility in the broader sense, to review and analyze this data to identify any important trends, significant learning and associated corrective actions. Out of 460 Utility recorded events at Kori in 2010, only 16 required compulsory reporting to the regulator. However, the Team considered that the utility was giving full and proper attention not only to events that fulfill the legal criteria for reporting, but also to the much larger number of lower level events and near misses.

Events are officially reported to MEST in a prescribed standard format. Analysis of events is delegated to KINS, which identifies any corrective action required by the utility or its subcontractor. MEST will then advise the licensee accordingly, who in turn confirm that the work has been completed. Investigation of events by inspectors is normally commenced within 24 hours from the initial reporting and it was noted that KINS human factors specialists are involved in event investigations when required. The progress of corrective actions is monitored by a computer based Corrective Action Tracking System (CATS). This is maintained by KINS, with the utility reporting on a quarterly basis on the status of outstanding corrective actions. It was identified that there is no prioritization process for corrective actions; however KINS advised that, once the licensee had provided the programme for completion of the corrective action, if the timescale was unacceptable the utility would be asked to provide a revised programme.

Classification of events is undertaken, which allows KINS to trend the data, and the utility is subsequently informed about the results of the analysis. Since 2009 KINS has been using a number of databases to support its OEF work. A suite of Safety Performance Indicators is also provided on the KINS website. It was recognized that these are produced purely for public communication, as the targets are set at a high level; such that the information is of limited help in informing regulatory activities. Although further development work is planned, the Team believes that the way in which the data is presented and used in the OPIS, CATS, DIOS and other databases is good practice.

Evidence was observed of regulatory learning from experience as part of the OEF process. The initial review into the inadvertent containment spray event at Shin Kori 1 NPP on 17th September 2010 led to a number of lessons for the regulator being identified, including the need to focus on temporary plant configurations and the associated training of operators. However, it was noted that further work in this area was ongoing at the time of the mission and additional learning may result.

The team found that the results of operating experience is also taken into consideration in the process of regulatory review and inspection; considered in the development and revision of technical standards; and provided to the R&D department for its information and use. The sharing of operating experience is completed by the annual KINS organized "Nuclear Regulatory Information Conference" and the "Operating Experience Feedback Workshop" attended by all relevant industry stakeholders (MEST, KINS, utility, vendor, contractors and so on.) at which a rigorous review of these types of events and the associated learning is undertaken. Feedback is also given on the effectiveness of the OEF process by attendees at the workshop. In addition, the effectiveness of the whole OEF process is regularly reviewed by internal QA audits.

Finally, it is worth recognising that since 1999 KINS selects and awards excellence in regulatory activities via its "Annual Report of Best Regulatory Practices". This approach of selecting the best regulatory practices and sharing, disseminating them through the annual report is also considered to be one of the effective measures for practical and effective implementation of Requirements 15 (Sharing Operating Experience and Regulatory Experience) of GSR Part 1.

On the whole, the Team found that the key elements of IAEA Safety Guide NS-G-2.11 are being implemented and the foundation of a very good system has been established, recognizing that further evolution of the IT based systems is continuing; KINS is encouraged to continue its very good work in this area.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: NS-G- 2.11, Article 7.4 states that** "*For maximum impact and benefit, appropriate information relating to the feedback of operational experience should be disseminated to relevant bodies. This should occur at appropriate levels (e.g. the plant level, the operating organization level, and the national and international level). A list of possible recipients for different types of information should include: regulatory bodies, organizations with planned or ongoing nuclear programmes, technical support organizations in the nuclear field, vendor companies (including design firms, engineering contractors and manufacturers), research establishments and universities working in the nuclear field."*
(2)	**BASIS: GSR Part 1, Article 4.66 of Requirement 36 states that** *"The regulatory body shall establish, either directly or through authorized parties, provision for effective mechanisms of communication, and it shall hold meetings to inform interested parties and the public and for informing the decision making process. This communication shall include constructive liaison such as: ... (e) Making information on incidents in facilities and activities, including accidents and abnormal occurrences, and other information, as appropriate, available to authorized parties, governmental bodies, national and international organizations, and the public."*
(3)	**BASIS: NS-G-2.11 para 7.10. states that** "*Modern means of disseminating and sharing operational experience, such as CD-ROMs and other electronic media (local networks, email and the Internet), have been found to be particularly convenient. Technical meetings or seminars held on a periodic basis help to consolidate the information exchange"*
GP 4	**Good Practice: The regulatory body has developed and implemented a comprehensive OEF-system that is based around a number of effective initiatives including: collection and trending of data from a wide range of sources; well-populated and presented information databases; numerous key communication events; and close working with the licensees and other stakeholders on a national and international front.**

3. RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY

3.1. ORGANIZATIONAL STRUCTURE OF THE REGULATORY BODY AND ALLOCATION OF RESOURCES

The regulatory body of the Republic of Korea comprising MEST, NSC and KINS have responsibilities and roles established in the AEA giving an effective regulatory safety function. Each organization is bound by commitments to nuclear safety through the Nuclear Safety Policy Statement, Nuclear Safety Charter and the Comprehensive Nuclear Safety Plan which reflect accumulated knowledge and expertise in the state.

As discussed in previous chapters, the Government of Korea has passed legislation that will come into force in October 2011 which is intended to enhance the independence of the regulatory body through the establishment of a new Nuclear Safety Commission.

MEST

MEST is responsible for administration of the safety regulations of nuclear reactors, nuclear fuel cycle facilities, disposal facilities, nuclear materials, radioisotopes, and radiation generating devices pursuant to Article 22 of the Government Organization Act.

The Nuclear Regulatory Bureau within MEST is responsible for discharging the responsibilities and functions for safety regulation of nuclear reactors and related facilities throughout their life cycle, including selection of their sites, design, construction, commissioning, operation, and decommissioning.

Headed by the Director General, the NRB has five subordinate divisions and teams: the Nuclear Safety Division, IRRS Mission Team, Radiation Safety Division, Nuclear Emergency Team, and Nuclear Control Division. These divisions and teams are assigned the responsibilities for licensing, review and evaluation, inspection and enforcement, development of regulatory policies, safety regulation on radiation utilization, radiation protection, safety management of radioactive wastes, and establishment and management of preventive measures for radioactive disaster for nuclear power plants and other facilities.

The Nuclear Safety Division administers the Resident Offices at the sites of nuclear power plants (NPPs) under construction or in operation who carry out regulatory tasks such as routine inspections and investigation and reporting of any incidents. NRB has also instituted the Off-site Emergency Management Center Resident Office for coping with radiation emergencies.

Nuclear Safety Committee

The Nuclear Safety Committee (NSC) consists of the Minister of MEST as the chair and eight members who are appointed by the Minister in consultation with the Minister of the Ministry of Knowledge Economy (MKE).

The matters deliberated and decided by the NSC are as follows:

- Integration and coordination of the matters on nuclear safety control
- Matters on the regulation of nuclear reactors and materials
- Matters on the protection of hazards caused by radiation exposure during the utilization of nuclear energy
- Estimation and allocation plans of expenditures for nuclear safety control expenses

- Promotion of experimentation and research activities concerning nuclear safety control
- Fostering and training of researchers and engineers for nuclear safety control –
- Matters on the safety control of radioactive wastes
- Matters on the countermeasures for radiation disaster

The NSC has also created the Special Committee on Nuclear Safety (SCNS) to provide technical input its tasks. The SCNS consists of 25 experts, and operates five subcommittees for efficient operation and for strengthening its competence in specialized areas of nuclear safety.

The team discussed examples of the important role of the Nuclear Safety Committee in deliberation and decision making on matters important to nuclear safety, including safety assessment and authorisation. The team also noted some minor inconsistencies in the descriptions provided by counterparts regarding the organisation and functions of the Committee.

Korean Institute for Nuclear Safety (KINS)

KINS is a governmental corporation established by the KINS Act and led by Board of Directors and a President appointed by the Minister of MEST.

KINS is responsible for the technical nuclear safety regulatory tasks mandated by the AEA. Its major functions related to nuclear safety regulation are:

- Safety reviews in relation to the licensing and approval of nuclear installations
- Regulatory inspections during manufacturing, construction, and operation of nuclear facilities
- Research and development of the technical standards for safety regulation for nuclear facilities
- Management of license examinations for the handling of nuclear materials and radioisotopes and the operation of nuclear facilities
- Management of notifications relevant to licensing
- Quality assurance review and inspection
- Other tasks such as development of technologies for nuclear safety regulation, technical supports for developing policies and systems, technical supports for radiation protection, safety regulation information management, and monitoring and evaluation of environmental radioactivity

KINS operates an efficient regulatory organizational structure comprising the following six principal units under the President: the Nuclear Safety Headquarters; the Radiation & Radwaste Safety Headquarters; the International Nuclear Safety Division; the International Nuclear Safety School; the Strategy & External Affairs Division; and the Management Services Division.

The Nuclear Regulation Division in the Nuclear Safety Headquarters is responsible for KINS safety regulation activities for nuclear power plants. The tasks of safety assessment review and inspection are carried out through a “matrix management system” where a staff member is appointed as the project manager, and the manpower necessary to perform the project is drawn as necessary from seven specialist departments within the Nuclear Safety Headquarters. The specialist departments form a pool of technical experts for regulatory tasks. The Safety Research Division is responsible for development of the safety regulation technologies and the technical standards.

KINS has created an impressive IT infrastructure for knowledge management to support its regulatory activities. The chapter of this report on management systems gives more details about this IT infrastructure.

New Organisational Structure of the Regulatory Body

In comparison with the current organisation, the team has identified a number of topics that should be considered before the transition to the new structure of the regulatory body is carried out

- The new 7 to 9 member Nuclear Safety Commission will have more competencies and resources available for nuclear safety matters than the minister of MEST. The work of the Commission will likely create new duties and responsibilities on the secretariat that differ from those that NRB has now. The new Secretariat will have an important role in the legal and administrative processes required to support the Commission's decision-making as well as inter-ministerial coordination of the regulatory process.
- The actual regulatory processes are complex. NRB currently is often involved in regulatory actions for administrative reasons. The team noted as an example the divided responsibilities in NPP inspections. The creation of the Commission may add complexity. The new organization gives the opportunity to more clearly specify the role of the technical and administrative units of the regulatory body to avoid undue intervention of the Secretariat in decision making regarding safety. For example, delegation of authority for more complete fields of activity could simplify the regulatory process and decision making.
- The new Act allows for the establishment of an Advisory Committee to support the decision-making process of the Commission. The Advisory Body could be a source of technical competence to support the decision making process of the Commission.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: IAEA GSR Part 1 Req. 16 Organizational structure of the regulatory body and allocation of resources states that "***The regulatory body shall structure its organization and manage its resources so as to discharge its responsibilities and perform its functions effectively; this shall be accomplished in a manner commensurate with the radiation risks associated with facilities and activities.***"**
(2)	**BASIS: IAEA Safety Series GS-G-1.1, Para 3.4 of Organization And Staffing of the Regulatory Body For Nuclear Facilities states that** *"The regulatory body shall be structured so as to ensure that it is capable of discharging its responsibilities and fulfilling its functions effectively and efficiently. The regulatory body shall have an organizational structure and size commensurate with the extent and nature of the facilities and activities it must regulate, and it shall be provided with adequate resources and the necessary authority to discharge its responsibilities. The structure and size of the regulatory body are influenced by many factors, and it is not appropriate to require a single organizational model. The regulatory body's reporting line in the governmental infrastructure shall ensure effective independence from organizations or bodies charged with the promotion of nuclear or radiation related technologies, or those responsible for facilities or activities."*
R 2	**Recommendation: The Government of Korea should continue the process of clearly**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	defining the responsibilities within the new regulatory body and avoid overlaps between the Secretariat, KINS and the Advisory Committee. Resources and staff should be allocated commensurate with those responsibilities.

Management of Resources

The "Comprehensive Nuclear Safety Plan" developed by NRB in consultation with other relevant institution and experts sets out the national priorities for safety regulation for the period 2010 to 2014. Based on the Comprehensive Plan, the NRB establishes annual policy objectives, and execution and budget plans. MEST submits the budget plans to the Ministry of Strategy and Finance (MOSF) and after deliberation and adjustment at MOSF, the final allocation of budgets is decided by the National Assembly.

KINS establishes an annual one-year implementation plan supporting the five-year comprehensive nuclear safety plan and reports the results to MEST at the end of each year.

KINS has access to three sources of funding, namely: government appropriations, charges levied on nuclear operators, and funding for government-sponsored R&D.

KINS has allocated approximately 60% of its staff to work on Nuclear Power Plants according to an judgement that NPPs represent the greatest radiation risk to health and safety. Within nuclear power plant activities, consideration is given to inspection results and operating experience to focus regulatory resources on special issues, in addition to the objectives required by law.

The team concludes that the Korean regulatory body meets the requirements of the IAEA GSR-1 with respect to management of resources.

3.2. EFFECTIVE INDEPENDENCE DURING CONDUCT OF REGULATORY ACTIVITIES

The NRB, KINS and the Nuclear Safety Committee have mandates that are focused uniquely on safety. KINS has adequate resources to discharge its functions. The training and procedures of NRB and KINS staff emphasises the role and ethics of government officers and regulatory staff. The team was informed that few staff are recruited from NPP operators.

The team was impressed by the highly qualified staff of KINS who provide a substantial depth of technical competence to support independent regulatory decision-making on safety matters.

Communications on formal matters related to authorizations and enforcement take place between MEST and the NPP operators. A senior official of KHNP, the nuclear operator, told the team that he recognized the role of MEST as the legally empowered regulatory body.

The team concludes that the regulatory body meets the safety requirements of the IAEA for effective independence.

3.3. STAFFING AND COMPETENCE OF THE REGULATORY BODY

MEST

The NRB of MEST has a current staff of 46 persons, including those dispatched to the resident offices at the nuclear facility sites. NRB has to recruit most of its staff via the centralized government recruitment process following the rules of the Decree on Appointment of Public Officers. A limited number of

specialists have been employed by "special recruitment".

MEST trains its staff at the government Central Training Institute for the basic instruction on the job performance of public officials. Additional specialized training is organized on demand. No specific training is required for the MEST resident office staff at NPPs.

KINS

KINS has a highly educated staff population. Out of the complement of 418 staff, 186 have doctorate degrees, 159 have masters degrees, and 73 have bachelor degrees or lower. In contrast to MEST, KINS is not constrained by the government recruitment process and has therefore more flexibility in selecting the needed qualified staff.

In order to promote rigorous inspection of the nuclear facilities, KINS has significantly intensified the qualification requirements for inspectors in 2003. The training is carried out in KINS own International Nuclear Safety School (INSS) mentioned above. The INSS also offers refresher courses on a large variety of topics. In addition, KINS regularly selects some regulatory experts to dispatch to the international institutions and foreign regulatory bodies. In total KINS invests roughly 3%-5% of its working time in basic and refreshment training.

40% of KINS staff will reach their retirement age within the next ten years. KINS has proactively established a long-term plan for recruiting the needed experts, taking into account the staff fluctuations and of the number of coming nuclear facilities and activities subjected to regulation. KINS recruited 52 persons in 2010, and it is going to recruit 41 persons and 30 persons in 2011 and 2012, respectively, in preparation for mass retirements of engineer staff starting from 2012.

The systematic recruiting and training efforts of KINS complement the knowledge management system consisting of regulatory results, research results, education and training, and management of individual staff's job knowledge.

Although the KINS is confronted with a big drain of knowledge and expertise caused by the cumulative retirements, the team came to the conclusion that the recruitment, training and knowledge management processes in place are appropriate to cope with the challenge.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: IAEA GSR Part 1 Requirement 18: Staffing and competence of the regulatory body states that** *"The regulatory body shall employ a sufficient number of qualified and competent staff, commensurate with the nature and the number of facilities and activities to be regulated, to perform its functions and to discharge its responsibilities."*
(2)	**BASIS: Para 4.11 of GSR- Part 1 states that** *"The regulatory body has to have appropriately qualified and competent staff. A human resources plan shall be developed that states the number of staff necessary and the essential knowledge, skills and abilities for them to perform all the necessary regulatory functions."*
(3)	**BASIS: Para 4.12 of GSR- Part 1 states that** *"The human resources plan for the regulatory body shall cover recruitment and, where relevant, rotation of staff in order to obtain staff with appropriate competence and skills, and shall include a strategy to compensate for the departure of qualified staff."*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(4)	**BASIS: Para 4.13 of GSR- Part 1 states that** *"A process shall be established to develop and maintain the necessary competence and skills of staff of the regulatory body, as an element of knowledge management. This process shall include the development of a specific training programme on the basis of an analysis of the necessary competence and skills. The training programme shall cover principles, concepts and technological aspects, as well as the procedures followed by the regulatory body for assessing applications for authorization, for inspecting facilities and activities, and for enforcing regulatory requirements."*
S 2	**Suggestion: The new Nuclear Safety Commission should prepare human resources plans for the Secretariat that provides appropriate staff to enable the accomplishment of its administrative function in support of the Commission without undue burden.**
(1)	**BASIS: Para 4.13 of GSR- Part 1 states that** *"A process shall be established to develop and maintain the necessary competence and skills of staff of the regulatory body, as an element of knowledge management. This process shall include the development of a specific training programme on the basis of an analysis of the necessary competence and skills. The training programme shall cover principles, concepts and technological aspects, as well as the procedures followed by the regulatory body for assessing applications for authorization, for inspecting facilities and activities, and for enforcing regulatory requirements."*
GP 5	**Good practice: KINS has an effective practice to recruit successors 3 years before the actual retirement of experienced staff, in order to preserve knowledge and provide continuity.**

3.4. LIAISON WITH ADVISORY BODIES AND SUPPORT ORGANIZATIONS

As discussed in previous chapters, the Korean regulatory body has one independent advisory committee. The Nuclear Safety Committee advises the MEST and is organized pursuant to the Atomic Energy Act. The task of the NSC and its subcommittees is to provide the MEST with independent technical advice on decisions regarding major licensing issues. The team notes that the Government has drafted regulations that provide for an expert advisory committee for the new Nuclear Safety Commission.

A NSC review is not mandatory other than specified in the AEA. MEST usually requests the reviews for important regulatory decisions. The MEST regards the advice of the NSC as a very important input to the regulatory activities since its own technical competence is limited. The opinions or advice of the NSC are open to the general public.

With regard to other support organizations, the KINS can contract laboratories and consultants for specific technical advice when needed. Results of the contracted work are reviewed by KINS staff and any regulatory decisions are always taken by the regulatory body.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: IAEA GSR Part 1 Req 20 Liaison with advisory bodies and support organizations states that** *"The regulatory body shall obtain technical or other expert professional advice or services as necessary in support of its regulatory functions, but this*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	shall not relieve the regulatory body of its assigned responsibilities."
(2)	**BASIS: GSR- Part 1 Para 4.18 of states that** *"The regulatory body may decide to give formal status to the processes by which it is provided with expert opinion and advice. If the establishment of advisory bodies, whether on a temporary or a permanent basis, is considered necessary, it is essential that such bodies provide independent advice, whether technical or non-technical in nature."*
S 3	**Suggestion: The new Nuclear Safety Commission should establish an advisory committee, with similar capabilities as the existing Nuclear Safety Committee to support the decision-making process.**

3.5. LIAISON BETWEEN THE REGULATORY BODY AND AUTHORIZED PARTIES

Most of the regular meetings between MEST, KINS and the licensees take place at the diverse levels. There is daily contact between the resident inspectors and the respective plant management. In addition a lot of informal meetings are conducted in order to better understand the counterparts view.

In order to improve communications among the stakeholders (including the licensees), MEST and KINS hold official technology exchange meetings, such as the nuclear safety technology information meeting, the CANDU reactor. A communication mechanism is operated for briefing the licensees on the direction of regulation for the major safety issues and for discussing the methods of resolution by holding irregular information exchange meetings between the Vice President of the KINS (Chief of the Nuclear Safety Headquarters) and the senior executive of KHNP.

In case of different opinions in matters of regulatory decisions the licensees can request to state their opinions at the Nuclear Safety Committee. The licensees also have the right under the AEA to appeal certain decisions as noted in the chapter of this report on enforcement.

The team concludes that the regulatory body meets the IAEA safety requirements for liaison with authorized parties.

3.6. STABILITY AND CONSISTENCY OF REGULATORY CONTROL

According to legal and regulatory documents, MEST bears the authority of licensing and final regulatory decision for the licensees pursuant to the provisions of the AEA, and KINS is responsible for technical tasks for safety regulations entrusted to KINS.

The "Comprehensive Nuclear Safety Plan" mentioned in previous sections of the report contributes to stability of the regulatory system by presenting the government direction on safety priorities and regulatory activities.

The principles, requirements and criteria in the safety regulation processes including licensing reviews, regulatory evaluation, regulatory inspection, regulatory enforcement, etc. are set out in the legal and regulatory documents, guidelines and procedures. These documents are detailed and numerous.

Enactment and amendment of the regulatory processes are performed pursuant to the procedures stipulated in the applicable legislation, and the procedural requirements of the safety regulations are

stipulated in the "KINS Quality Management System Manual."

MEST announces the policies, principles, safety goals, and the criteria for the regulatory determination and decision to the directly interested parties through written notifications as well as to other licensees and the general public through press releases and/or internet website postings. KINS discloses nuclear safety information through the Nuclear Safety Information Centre (NSIC).

3.7. SAFETY RELATED RECORDS

Both NRB and KINS have a strict control of documents and records supported by advanced IT-tools. All regulatory documents are handled electronically and are retrievable. Since 2008 KINS has an advanced web based integrated information system MIDAS (Management of Information and Documents Access System). The system supports all regulatory tasks of KINS (see further Module 4).

MIDAS is a portal linked to 19 other information management websites which allows users to conveniently retrieve the records and data from the websites. An overview of the all the information management systems used by KINS for safety regulation is provided in the table below. Several of these systems are commented in other parts of the report.

Name of IT System	Main Functions
MIDAS (Management of Information and Documents Access System)	An integrated information system of the KINS regulatory tasks; a portal of the websites for nuclear facility regulation, radiation safety regulation, administration management, research management, knowledge management and data management
NSIC (Nuclear Safety Information Center)	Supply of comprehensive nuclear safety information such as the plant power information, plant incidents & troubles information and the background radiation monitoring network.
AtomCARE (Computerized technical Advisory system for Radiological Emergency)	Real-time collection and monitoring of plant safety information under normal conditions and incident information in an emergency; updated every 10 to 20 seconds
EMC (Earthquake Monitoring Center)	Operation of the NPP site earthquake monitoring network and the integrated earthquake monitoring system
SAFER (Nuclear Safety Regulation Supporting System)	A portal of websites for the guidelines, types, and years of regulatory review and inspection of nuclear facilities and the output of task performance for each nuclear facility
CATS (Corrective Action Tracking System)	Management of the incidents information of nuclear facilities, and management of corrective-action implementation information
DIOS (Dissemination of Incident and Operating experience System)	Collection and management of the incidents information home and abroad, and regulation-related operating experiences, and classification and dissemination of the collected operating experience information
SIMS (Safety Issues Management System)	A regulatory supporting system for managing the screening of the safety issues of nuclear facilities, the actions for resolving the issues, and the information of implemented measures

OPIS (Operational Performance Information System for NPP)	Provision of worldwide NPP operation information, making public the incidents information and the NPP operational safety performance index in Korea
KISOE (Korea Information System on Occupational Exposure)	Registration, management and utilization of occupational exposure records
WACID (Waste Comprehensive Information Database)	Management, analysis and making public of the information database related to radioactive wastes, spent fuels, etc.
RASIS (Radiation Safety Information System)	Provision of the performance of radiation safety regulation tasks, tracking and management of radioactive sources distribution, civil affairs for licensing applications, and related information
CLEAN (Computerized Local & Overall Country's Environmental Radioactivity Data Analysis Network)	Provision of the radioactivity information and reports from local and overall national monitoring centers, and the radioactivity cross-analysis tasks information
SIREN (System for Identifying Radiation in Environments Nationwide)	Real-time environmental radioactivity monitoring and analysis based on the electronic web map integrating IERNet, CAMSNet and RMSNet
• **IERNet** (Integrated Environmental Radiation Monitoring Network)	Early detection of abnormal radioactive situations resulted either from nuclear/radiation incidents home and abroad or nuclear tests.
• **CAMSNet** (Continuous Airborne dust radioactivity Monitoring System Network)	Remote monitoring of airborne dust radioactivity by using CDMA radio communication, and provision of web-based information sharing and alarm functions
• **RMSNet** (Regional Monitoring Stations Network)	Integrated management of environmental radioactivity data provided by12 regional monitoring stations in Korea
RTTC (Radiation Technical Troubleshooting Center)	Provision of information on radiation safety management and radiation licensing
RADWASTE (Radioactive Waste Disposal Facility Regulatory Information System)	Provision of information on safety reviews of medium- and low-level radioactive waste disposal facilities
RadLot (Radiation Source Location Tracking System)	Radiation source location tracking management for preventing possible loss/theft of sources and for early recovery of lost or stolen sources

3.8. COMMUNICATION AND CONSULTATION WITH INTERESTED PARTIES

KINS has developed and operated since November 2002 the Nuclear Safety Information Centre (NSIC) as the main tool of the regulatory body for providing information to stakeholders including the public. NSIC provides on-line information related to potential radiation risks from nuclear facilities and activities, in particular incident information, as well as information on regulatory task performance and regulatory decisions. The information available also includes data for evaluating safety performance of plants, operation information of plants, historical accident and incident data, data for emergency preparedness, and environmental radiation and radioactivity data for the entire country.

KINS provides the residents in neighbourhoods of NPP sites with real time information on the regional radiation level and the radioactivity concentration measured by the nationwide automatic environmental

radiation and radioactivity monitoring network.

The team however noted that the plant safety performance indicators tend to be uniformly "good". Such indicators cannot reveal trends in safety of plants and should not be allowed to lead to complacency.

In addition, KINS weekly provides nuclear safety information to academia, nuclear industries, non-governmental organizations, local governments and about 5,800 residents in the neighbourhoods of nuclear power plants via e-mail in webzine form, and furthermore regularly holds formal meetings with the regional residents.

General information is disclosed at regular informal talks with media, and the information on abnormalities and specific issues is disclosed immediately through a special press interview.

KINS regularly holds technology exchange meetings such as the nuclear regulatory information conference, the workshops on safety issues at the NPP sites, and the workshops on operating experience feedback for explaining the regulatory position and direction on the major safety issues to the stakeholders (including the licensees), and operates various official communication tools for open consultation on practical resolutions of the issues through technical discussion.

A special event called the "Nuclear Safety Inspection Day" has been held, raising the commitment for securing nuclear safety by all of the general public, the stakeholders and the regulatory bodies. The regulatory body also operates a program of nuclear safety experience classes to contribute to the public's understanding of importance of nuclear safety. More than 10,000 people have participated in 190 class sessions. Survey results show the program positively influences awareness and attitudes regarding the regulatory body. During the Fukushima accident, due to the neighbourhood with Japan, KINS was involved in providing information in response to a very large volume of enquiries from the public. A special website dedicated to the Fukushima accident was opened. The site was visited more than 3.5million times compared to 9,000 visits per year usually. Almost 600 inquiries from representatives of the National Assembly were received. 100 press releases were issued.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, R36: Communication and consultation with stakeholders states that** *"The regulatory body shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body.***"**
(2)	**BASIS: GSR Part 1 para 4.67 states that** *"The regulatory body, in its public informational activities and consultation, shall set up appropriate means of informing interested parties, the public and the news media about the radiation risks associated with facilities and activities, the requirements for protection of people and the environment, and the processes of the regulatory body. In particular, there shall be consultation by means of an open and inclusive process with interested parties residing in the vicinity of authorized facilities and activities."*
GP 6	**Good Practice: The "safety experience" training course of KINS dedicated to students/parents, teachers, opinion leaders has been shown to positively influence public understanding and acceptance of the regulatory body's activities.**

4. MANAGEMENT SYSTEM OF THE REGULATORY BODY

Introduction

The IAEA Safety Requirements publication GS-R-3, issued 2006, defines the requirements for establishing, implementing, assessing and continually improving a Management System that integrates safety, health, environmental, security, quality and economic elements. This integration aims to ensure that safety is properly taken into account in all the activities of an organization in order to ensure the protection of people and the environment. The requirements are applicable on Management Systems for industrial nuclear facilities and activities as well as for the regulatory body. GS-R-3 with its integrative and process based approach, emphasis on safety culture promotion and strong focus on continuous improvement can be seen as an evolution of the earlier concepts of Quality Assurance and Quality Management.

Documentation of the Management System

The Team reviewed the Management System manuals of MEST/NRB and KINS and examined a sample of underlying procedures and guides. Both manuals are focused on the nuclear safety regulatory activities of the respective organization and do not reflect all activities of the respective organization. NRB´s manual is newly decided (May 2011) and hence not fully implemented. KINS´ manual is an evolution of an initial version from 2001. Currently Revision 5 is in force which according to KINS has taken into account the requirements of GSR Part 1 and GS-R-3. Still the KINS manual is titled "Quality Management System Manual" which is an older concept not in line with integrated approach of GS-R-3. KINS assures that the title will be changed in the next revision.

NRB´s manual is applied on 11 jurisdictional core activities prescribed by the Atomic Energy Act, the Act on Physical Protection and Radiological Emergency and the Act on Atomic Energy Compensation for Damages. These core activities have been selected for their importance, complexity and interfaces between participating organizations. For other activities of NRB, such as rulemaking, performance in accordance with existing rules and regulations is considered sufficient. Since NRB is a part of MEST, administrative support is handled by MEST. For the defined core activities, processes have been developed and described in well-made graphic flowcharts. The Team noted some opportunities for improvements of the manual in line with the GS-R-3. The manual does not contain any overall map or narrative description of the processes and their interactions. NRB could also supplement the manual with an overview of the documentation hierarchy relevant for the Management System and more substantial information about how customer satisfaction and safety culture promotion is assured (see further below). Furthermore, NRB could insert references to detailed procedures about how the Management System is to be assessed, reviewed and improved.

The Team recognizes the large effort of NRB, over a short time, to develop a Management System showing the planned and systematic activities to deliver regulatory decisions on the basis of inputs from the Nuclear Safety Committee and KINS. However, in the view of the organizational changes decided by the National Assembly, the Korean government should consider to revise and supplement the current Management System with further core processes and support processes as needed for the complete activities of the new Nuclear Safety Commission and its Secretariat. This revised Management System, or at least the main parts of it, should be in place as soon as the new organization takes over responsibility. MEST informed the Team that there is an intention to make such a revision.

KINS´ Management System manual identifies nine basic processes which are needed for performing nuclear safety regulatory activities that are entrusted to KINS by Article 111 of the Atomic Energy Act (Delegation of Authority), Article 45 of the Act on Physical protection and Radiological Emergency, and its supporting work. On the identification of processes, the Team noted that, in order to make all activities of the organization process oriented, KINS should develop a process and adequate sub-processes also on resource management, which is currently not covered by the 9 basic processes. The Management System manual describes how the processes are to be developed and implemented, what they should cover and contain. Some opportunities for improvement of the manual in line with GS-R-3 were identified by the Team. The manual does not contain overall map or narrative description of the readymade processes and their interactions. The team noted that KINS has developed process descriptions for the basic processes and has a large number of underlying documentation in the form of 18 Process Standards (detailed provisions for a process or sub process approved by the minister of MEST) and about 100 procedures and guidelines. However, these types of documents are not described or referenced in the Management System manual. KINS could supplement the manual with an overview of the documentation hierarchy and more substantial information about how customer satisfaction and safety culture promotion is assured (see further below). Furthermore, KINS could insert references to detailed procedures about how the Management System is to be assessed, reviewed and improved.

Safety culture promotion

The Nuclear Safety Policy Statement from 1994 and the Nuclear Safety Charter from 2001 emphasize the importance of a strong safety culture and both NRB and KINS are highly aware of this issue. NRB has a short statement in its Management System manual basically saying that the Director General of NRB makes efforts to enhance the safety culture within the NRB and specialized nuclear safety institutions, and to promote safety culture of the nuclear facility operators. There are no descriptions of means to accomplish this.

One of the points in KINS´ quality policy is "Promotion and encouragement of safety culture which makes safety the first priority". The Management System Manual further includes a statement that the staff of KINS shall perform nuclear regulatory activities with the sense of responsibility, morality and commitment as clarified in a number of overarching policy documents. The safe and successful performance of activities shall be supported by the continuous improvement and supplementation of the Management System. The staff shall enhance a learning and questioning attitude related to their activities. Means to enhance this attitude are not mentioned. Until now KINS has mostly focused its efforts on safety culture promotion towards the licensee. In 2010, a special safety culture inspection was conducted at the headquarters of Korea Hydro and Nuclear Power Company (KHNP) and at 5 nuclear power units, 2 under operation and 3 under construction. Following the inspections, the regulatory body made several recommendations to improve the safety culture of the licensee, such as clarification of the task performance structure for the promotion of safety culture, improvement of a self-assessment method for effectiveness of safety culture, etc. KHNP is now working on this and is also preparing to host a Safety Culture Assessment Review Team (SCART) of IAEA that provides a peer review service of safety culture assessment. In response to the Comprehensive Nuclear Safety Execution Plan for 2010 and 2011, KINS is now planning a training program to more systematically enhance the safety culture of its own organization. As a result of the Fukushima accident, KINS also plans to make a safety culture self-assessment during 2011 (see further section 11.3).

Graded approach

The Korean regulatory system has a deterministic approach. There are legally required strict inspection procedures and schedules to be met notwithstanding the safety performance or the risk profile of the individual nuclear power plants. In cases of events, no matter the safety significance, a special inspection is made by the regulatory body. The graded approach is reflected in the strong focus of regulatory resources on the nuclear power plants which are the facilities with the highest potential risk for the environment. Most of the processes and the most detailed process standards and procedures deal with the regulation of the nuclear power plants. Furthermore, the activity planning of KINS takes into account the risk to the general public by selecting 10 strategic projects with safety priority to be elaborated during the coming year. This selection is done in a discussion at the top management level. If major events happen, such as the Fukushima accident, the tasks are rescheduled.

Management responsibility

GS-R-3 puts emphasis on the responsibility of all managers to demonstrate their commitment to the Management System and for senior management to develop organizational values and policies, clarify decision making and consider expectations of interested parties. Senior management is also responsible for the strategic planning and follow-up of the objectives that have been established. Ultimately, senior management is also responsible for the Management System and shall ensure that it is established, implemented, assessed and continually improved.

The Team found that these management responsibilities are adequately described in the Management System manuals of both NRB and KINS. The responsibilities for different working steps are also clearly defined in KINS´ process standards and process descriptions. The president of KINS establishes the management objectives and prepares the management plan annually. The objectives and plan are submitted to the Minister of Strategy and Finance for approval. The achievement of the management objectives and implementation of the plan are assessed annually in accordance with the Act on Public Organization Management (see further below).

Expectations of interested parties

NRB defines the public as its main customer and strives to satisfy the expectation of the public on nuclear safety and to promote the level of reliability on the nuclear regulatory activities by being attentive to the demand of the public. This is accomplished through an active information policy and a transparent decision making through the Nuclear Safety Committee. KINS selected customer satisfaction as one of the mid-term management objectives (2009-11) and it has an elaborated specification of its customers:

1. Providers of service value (KINS internal staff and external experts)
2. Users of service value (operators, foreign customers)
3. Affected by service value (Government, press, residents nearby the NPPs)
4. The general public

For these groups different means are used to satisfy their expectations. KINS is proud to have achieved the first place among 16 public organizations of the same category in the 2010 customer satisfaction survey administered by the Ministry of Strategy and Finance on the basis of the Act on Public Organization Management. This survey is conducted annually.

Organizational policies and values

The Korean government has issued two policy documents which, together with the Atomic Energy Act (AEA), guide the policies of both NRB and KINS: The Nuclear Safety Policy Statement in 1994 and the Nuclear Safety Charter in 2001. The Statement formulates five principles for nuclear safety regulation: independence, openness, clarity, efficiency and reliability. The Charter calls et al. for assuring the independence and fairness in nuclear regulation and to complement and improve the nuclear safety related legal system continuously.

The Management System manuals of both NRB and KINS include Mission, Vision and Policy Objectives. The missions are similarly formulated from the AEA: "To prevent a disaster resulting from radiation and to ensure the safety of the general public by the safety control of the production and utilization of nuclear energy".

NRB sets out the vision "establishment of global top 3 grade nuclear regulatory frameworks" as proclaimed by the Comprehensive Nuclear Safety Plan issued in May 2010, and repeats the five policy objectives of the Charter (see above).

Policy objectives for NRB are:

- Advancing nuclear regulatory framework
- Improving efficiency of regulation of nuclear facilities
- Enhancing capability of radiation protection and emergency preparedness
- Consolidating foundation of nuclear regulation
- Enhancing global leadership and safety culture

The vision of KINS for 2020 is "heart of global safety" and the strategic goals to achieve the vision are:

- Maintaining top class nuclear safety
- Leading global nuclear safety
- Innovation of customer service on nuclear regulation
- Advancement of management system

This vision and strategic goals have been translated to strategic projects in the medium term management plan (2009-11).

KINS still uses the terms "Quality Policy" and "Quality Goals" for its policy objectives. The policy calls for implementation of quality management and promotion of safety culture and the goals for number one customer satisfaction, securing practical regulatory capability and competency, inspiration of pride in KINS´ staff, and improvement of efficiency and reliability of nuclear safety regulation. In the opinion of the Team, the quality policy and goals need to be updated in view of the progress made over the last years, and the terminology should be brought in line with GS-R-3, 3.7.

Managing organizational change

According to GS-R-3, 5.28 and 5.29, organizational change shall be justified from a safety point of view, planned, controlled, communicated, monitored tracked and recorded to ensure that safety is not compromised. Translated to the regulatory side this essentially means not to compromise regulatory efficiency and effectiveness. Neither NRB nor KINS has established a process for managing organizational change in line with these requirements. Organizational changes are conducted in a planned manner but the current practices do not explicitly consider the possible impact on regulatory efficiency and effectiveness. The Team advises both organizations to supplement their Management System to cover these requirements.

Activity planning

NRB follows governmental rules in its mid and long term planning and reporting. These rules cover budgeting, human resource planning as well as regular reporting to the government. These processes are not included in NRB's Management System.

MEST has developed the First Comprehensive Nuclear Safety Plan for the period 2010 – 2014. This Master Plan gives the framework for annual and mid-term planning for NRB itself and for KINS. NRB's vision, policy objectives and fundamental directions and safety regulation are included in this Master Plan (see also Organizational policies). The Master Plan identifies objectives on nuclear safety regulation policy and priorities tasks and a detailed execution plan is attached as an annex.

The Team was informed that as all other governmental organizations MEST uses numerous performance indicators. Totally 98 indicators are assessed annually, of those ten are indicators for NRB activities The information on indicators is collected and assessed twice a year. Indicator values are also attached to reports to the President. Performance indicators are also used as basis for bonuses.

In GS-R-3 Chapter 3 on Management responsibilities there are several requirements on planning, resource allocation and follow-up of activities. The Team recommends NRB to consider including these activities in its Management System or at least to insert a clear reference to the related rules and other underlying documentation in connection with the further development of the system.

KINS has included planning and follow-up activities in its Management System manual as required by GS-R-3. The president of KINS and the relevant Minister of the Korean government sign the KINS´ annual management contract. More detailed guidance is given in the Management System manual chapter 3.4.2 Preparation of President's Management Contract which describes the planning process: Establishment of annual President's management objectives, Preparation of annual President's management plan and Procedure for preparation of President's management contract.

KINS' strategy for nuclear regulatory activities is based on MEST's Comprehensive Nuclear Safety Master Plan. KINS prepares its long term plan for 10 years and its strategy projects for 5 years. The organizational strategy is implemented by major projects. The strategic priority, which is given in the Comprehensive Nuclear Safety Plan, is the basis for resource allocation and management of the major projects. The annual plan, budget and detailed project plans are prepared by KINS in accordance with governmental 'Guidelines for Preparation of Management Plan'. Plans are submitted to MEST for approval. After approval KINS starts the finalization of the annual performance plan.

For follow-up of realization of the annual plan, KINS has developed a comprehensive set of direct and indirect performance indicators. These indicators are monitored systematically on a quarterly and annual basis. Measures of all indicators are in a database and they are also included in the annual report. Performance evaluation of organizational units and individuals is done by using Balanced Score Cards.

KINS reports all nuclear regulatory activities in its annual report to MEST. This report is also distributed to all staff members and all can express their opinion on the report and on the indicators. The Team recognizes the efforts KINS has put on developing such a comprehensive planning and monitoring system.

Human resources and knowledge management

General management activities of NRB are performed in accordance with Acts and other governmental rules. For human resource management the State Public Officials Act, The Ministerial Regulation on Personnel Management of the Ministry of Education, Science and Technology are applied. NRB prepares

the human resource plan as a part of the annual planning. The plan must be approved by the Ministry of Public Administration and Security before NRB can recruit new staff members.

KINS Management System manual describes responsibilities of managers for the provision of resources. It also describes the administrative routines for resource management and training (see also 3.3 and 7.6). Since resource management is a necessary prerequisite for carrying out the basic regulatory processes, KINS should develop resource management as a process within its Management System.

GS-R-3, 4.2 sets a requirement to manage information and knowledge as a resource. KINS uses the web based MIDAS portal for information management (see also below and 3.7) and for knowledge management purposes. All experts are encouraged to share their knowledge and experiences by posting it on MIDAS. The contributions are reviewed and graded for usefulness of the responsible managers and can also be graded by the readers. The most active contributors are rewarded.

Control of documents and records

As mentioned in section 3.7, both NRB and KINS have a strict control of documents and records supported by advanced IT-tools. All regulatory documents are handled electronically and are retrievable. Since 2008 KINS has an advanced web based integrated information system MIDAS (Management of Information and Documents Access System). The system supports all regulatory tasks of KINS and is designed to make the work process oriented. A whole working process is handled by MIDAS, from submission of an application by the licensee, over regulatory planning and resource allocation for the task, to monitoring of work progress and approval of the final product internally and by NRB. MIDAS acts as a portal with interfaces to a number of other documentation management and knowledge management systems. There are 19 different web based expert systems and databases connected to MIDAS for nuclear facility regulation, emergency preparedness, radiation safety regulation, administrative management, research management, knowledge management and data management (a full overview is provided in section 3.7). On these websites all necessary regulatory documentation can be found such as inspection plans, earlier inspection and review reports, basic safety information such as FSAR for all reactors, Technical Specifications, Emergency Procedures, SAMG etc. Also real-time collection and monitoring of plant safety information is provided. MIDAS is available for all technical staff. There are different levels of authorization for accessing and changing documents. For knowledge management, the staff can post articles or summaries of technical issues on the MIDAS knowledge management centre (see above). MIDAS also has features for collecting experiences and lessons learned. The Team was impressed with the different features of MIDAS and interfacing databases as demonstrated by KINS. Clearly MIDAS is a good example to other regulators of a tool to facilitate the regulatory work and at the same time have full control and accessibility of all documents and records.

Assessment, review and improvement

GS-R-3, chapter 6. sets requirements on assessment and improvement of the Management System: the effectiveness of the system shall be assessed, management at all levels in the organization shall carry out self-assessment, independent assessments shall be conducted regularly, a management system review shall be conducted at planned intervals and the causes of non-conformances shall be determined and remedial actions shall be taken to prevent their recurrence.

The NRB Management System manual chapters 5 “Assessment and improvement” and 3.3 “Review of management system” describe the how NRB meets the IAEA requirements. Chapter 5 introduces NRB’s actions on verification of process, assessment and improvement. Due the fact that NRB’s Management system is quite newly developed these actions have not yet been implemented. The Management System

manual is not yet sufficiently developed in the field of continuous improvement and should be supplemented to fully meet the GS-R-3 when the Management System is developed for the new Nuclear Safety Commission.

KINS´ Management System Manual chapter 6 "Assessment and Improvement" describes KINS' activities to confirm that all nuclear safety regulatory activities and their supporting work are effectively implemented according to the requirements in the Management System manual. Management review is described in the chapter 3.3 and chapter 2.5.1.3 describes the assessment of the effectiveness of the manual, process standards, guidelines and procedures.

Self-assessment is the responsibility of managers and process owners and shall be done once every three years. KINS has some detailed guidance on how such self-assessment should be conducted but this guidance is not referred in Management System manual.

For independent assessments KINS has established procedures for "Quality management assessment" which give detailed guidance on the assessment procedure and responsibilities of participants. Following this procedure KINS conducts a full scope management system audit twice a year. This audit can be divided into two parts, but it shall be finalized within a two months period. It is conducted by a team authorized by the president of KINS. The team has 9 members, 7 of them are members of the advisory committee, one is expert on the area that is audited and one is the "Quality Management Representative" who also leads the team.

All audit findings including suggestions and recommendations are reported annually to the president of KINS. The president in his annual management review assesses results and decides if there is need for further actions. Findings are also published on MIDAS.

Managers of audited units are responsible for corrective actions. Managers are also responsible for the realization of other improvement plans. The "Quality Management Representative" reviews the progress of corrective actions on a regular basis.

Managers and process owners are responsible for identification of potential non-conformances and opportunities for improvement. These should also be discussed at unit meetings on a regular basis. In order to enhance the continuous improvement process KINS has decided to develop a new module for improvement proposals within the MIDAS portal. The new module will be launched later this year.

The team was informed that KINS has a possibility to conduct focused audits in the case of urgent needs. Also it is possible to revise the annual audit plan. However none of these options is described in Management System manual and so far such audits have never been done.

The Team noted that the terminology used in the KINS manual is not fully consistent with GS-R-3. GS-R-3 requires Self-Assessment, in KINS manual this is covered with Effectiveness Assessment (2.5.1.3), GS-R-3 requires Independent Assessment which is covered by the KINS procedure 'Quality Management Assessment' and finally GS-R-3 requires Management Review which in KINS is covered partly with Management Review (3.3) and partly with 'Quality Management Assessment'. In the opinion of the Team the independent assessment procedure could be improved by increasing flexibility and including more ad hoc audits which more timely could assist the process owners to improve the performance of the processes under their responsibility.

The Team acknowledges the work KINS has done in developing and implementing such a comprehensive assessment procedure; however some opportunities for improvement were identified.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, Req. 19 states that** *"The regulatory body shall establish and implement a management system whose processes are open and transparent. The management system of the regulatory body shall be continuously assessed and improved".*
(2)	**BASIS: GS-R-3 Para. 2.1. states that** *"A management system shall be established, implemented, assessed and continually improved. It shall be aligned with the goals of the organization and shall contribute to their achievement. The main aim of the management system shall be to achieve and enhance safety by:* - *Bringing together in a coherent manner all the requirements for managing the organization;* - *Describing the planned and systematic actions necessary to provide adequate confidence that all these requirements are satisfied;* - *Ensuring that health, environmental, security, quality and economic requirements are not considered separately from safety requirements, to help preclude their possible negative impact on safety."*
(3)	**BASIS: GS-R-3 para 2.8. states that** *"The documentation of the management system shall include the following:* - *The policy statements of the organization;* - *A description of the management system;* - *A description of the structure of the organization;* - *A description of the functional responsibilities, accountabilities, levels of authority and interactions of those managing, performing and assessing work;* - *A description of the processes and supporting information that explain how work is to be prepared, reviewed, carried out, recorded, assessed and improved."*
(4)	**BASIS: GS-R-3 para 5.4. states that** *"The development of each process shall ensure that the following are achieved:* - *Process requirements, such as applicable regulatory, statutory, legal, safety, health, environmental, security, quality and economic requirements, are specified and addressed.* - *Hazards and risks are identified, together with any necessary mitigatory actions.* - *Interactions with interfacing processes are identified.* - *Process inputs are identified.*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	- *The process flow is described.* - *Process outputs (products) are identified.* - *Process measurement criteria are established."*
R 3	**Recommendation: The Korean government should provide for development of a Management System, to cover all activities of the new Nuclear Safety Commission and its Secretariat. This Management System should be in place, at least the main parts of it, as soon as the new organization takes over responsibility.**
R 4	**Recommendation: KINS should develop a process on Resource Management in order to achieve a fully integrated Management System.**
(1)	**BASIS: GS-R-3 para 2.8. states that** *"The documentation of the management system shall include the following:* - *The policy statements of the organization;* - *A description of the management system;* - *A description of the structure of the organization;* - *A description of the functional responsibilities, accountabilities, levels of authority and interactions of those managing, performing and assessing work;* - *A description of the processes and supporting information that explain how work is to be prepared, reviewed, carried out, recorded, assessed and improved."*
S 4	**Suggestion: KINS should revise its Management System Manual to include an overall description of the basic processes, how they relate to each other as well as a description of all types of documentation used within the Management System.**
(1)	**BASIS: GS-R-3 Para. 2.5. states that** *"The management system shall be used to promote and support a strong safety culture by:* - *Ensuring a common understanding of the key aspects of safety culture within the organization;* - *Providing the means by which the organization supports individuals and teams in carrying out their tasks safely and successfully, taking into account the interaction between individuals, technology and the organization;* - *Reinforcing a learning and questioning attitude at all levels of the organization;* - *Providing the means by which the organization continually seeks to develop and improve its safety culture."*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
S 5	**Suggestion: The new Nuclear Safety Commission and KINS should describe in their Management System Manuals what means they plan to use in order to ensure a common understanding of safety culture, to support individual and groups to carry out work in a safe way, to reinforce a learning and questioning attitude, and to continually develop and improve the safety culture**.
(1)	**BASIS: GS-R-3 Para 5.28. states that** *" Organizational changes shall be evaluated and classified according to their importance to safety and each change shall be justified."*
(2)	**BASIS: GS-R-3 para 5.29. states that** *"The implementation of such changes shall be planned, controlled, communicated, monitored, tracked and recorded to ensure that safety is not compromised."*
S 6	**Suggestion: The new Nuclear Safety Commission and KINS should supplement their Management Systems with a process or procedure for managing organizational change in order to ensure that regulatory efficiency and effectiveness are not compromised.**
(1)	**BASIS: GS-R-3 para 5.12. states that** *"5.12. Documents 10 shall be controlled. All individuals involved in preparing, revising, reviewing or approving documents shall be specifically assigned this work, shall be competent to carry it out and shall be given access to appropriate information on which to base their input or decisions. It shall be ensured that document users are aware of and use appropriate and correct documents."*
(2)	**BASIS: GS-R-3 para 4.2. states that** *"The information and knowledge of the organization shall be managed as a resource."*
GP 7	**Good practice: KINS has an excellent comprehensive integrated computerized information and data management system for establishing, maintaining and retrieving adequate records relating to the safety of facilities and activities (MIDAS and 19 additional information systems). This contributes considerably to improve effectiveness and efficiency of the regulatory performance.**

5. AUTHORIZATION

The scope of the IRRS mission to Korea covered nuclear power plants, and research and educational reactors. It did not extend to other nuclear applications such as fuel cycle and waste management facilities or industrial and medical applications. Thus in what follows authorization of reactor applications is discussed.

In most cases legal background of the regulatory supervision of nuclear power plant apply *mutatis mutandis* to research and educational reactors. Differences due to graded approach to the latter reactor types are discussed in subchapter 5.7 below.

NUCLEAR POWER PLANTS

5.1. LEGAL BASIS

The legal basis of authorization of nuclear facilities is primarily set by the Atomic Energy Act (AEA) supplemented by its Enforcement Decree (expanding the requirements in more details) and Enforcement Regulation (giving detailed instructions on the implementation of the Act and the Decree). The high level legal basis of nuclear safety is further detailed in regulations issued in the form of MEST Decrees. In case of authorization of nuclear facilities the most important such regulation is the Regulation on Technical Standards for Nuclear Reactor Facilities, Etc. It gives the technical requirements on the siting, construction, installation, operation and quality assurance of nuclear reactors and related facilities.

In certain cases Guidelines issued by KINS contribute to the regulations, occasionally filling up minor gaps in the legally binding requirements.

5.2. TYPES OF AUTHORIZATIONS AND REQUIREMENTS OF AUTHORIZATION

The AEA defines the types of permits and licenses as listed in the following subparagraphs

A. EARLY SITE APPROVAL

Early Site Approval is obtained in an optional licensing procedure in case the applicant wishes to reduce the review and assessment time period of a construction license.

Requirements concerning the contents of application for site approval (as defined in the Regulation on Technical Standards) pertain to geological features, location, meteorological conditions, hydrological conditions (including oceanography), manmade effects, emergency planning and possibility of multiple units.

B. CONSTRUCTION PERMIT

In order to start the construction of nuclear power plant a construction permit is to be obtained. If no Early Site Approval is obtained, the construction permit application shall contain details on the site of the plant. Construction Permit application include also Radiation Environmental Report and Preliminary Safety Analysis Report.

Construction Permit applications demonstrate the capability of the applicant to perform construction; the technical suitability of the unit to construct; conformance of the unit with the environmental requirements; and the existence of a QA program with a given contents. Requirements on technical suitability in turn

include those also required for the Early Site Approval, safety classes and standards, protection against design basis accidents, fundamental safety functions, various protection systems, systems and system components, fuel handling and storage, reactor components, basic design features, other instruments and devices, emergency preparedness, operational limits and conditions, etc.

C. STANDARD DESIGN APPROVAL

Standard Design License may be applied for and obtained for a reactor type which is intended to be constructed several times. Validity of a Standard Design License is 10 years. Amendment of such a license goes along the general line of license amendment. The first Standard Design License application in Korea was granted in 2002; construction of a reactor according to this License was initiated in 2003, and terminated in 2009.

The application for a Standard Design License shall demonstrate the technical suitability of the unit to be licensed and the conformance of the unit with the environmental requirements. Requirements on the technical suitability include the same items as in the case of the Construction Permit.

D. OPERATING LICENSE

An Operating License is needed for the operation of a nuclear power plant. Operation begins with the first fuel load. Operation is preceded by a pre-operational inspection period which continues after the fuel loading up to the beginning of the commercial operation. Operating License application include Technical Specifications, Radiation Environmental Report and Final Safety Analysis Report.

Applications for Operating Licenses need to demonstrate the technical capability of the applicant to operate a nuclear power plant; the suitability of the plant to satisfy the technical requirements on safe operation; conformance of the unit to satisfy environmental requirements when operating; and the existence of a QA program with a given contents. Requirements on technical suitability cover: radiation and fire protection and dose constraints, compliance with the technical specifications, operating organization, training, procedures, human factor management, operational experience feedback, shutdown operation, fuel management, testing, monitoring, inspection, maintenance, and radioactive waste management.

E. LICENSING OF PERSONNEL

Certain activities in a nuclear power plant require special licenses issued by the nuclear regulatory body. The AEA requires that in every nuclear power plant at least one license holder is to be present in every of the following positions: supervisor reactor operator, reactor operator, nuclear fuel material handling and supervisor of radiation handling.

F. DECOMMISSIONING PLAN APPROVAL

Prior to starting decommissioning of a nuclear power plant approval by the regulatory body of the Decommissioning Plan is required from the licensee.

The Decommissioning Plan shall contain information on method of decommissioning, decontamination, waste disposal, accident prevention, environmental impact analysis, QA program.

It is to be emphasized that decommissioning plans are neither in the design phase of a nuclear facility nor during operation required. This issue is further elaborated in Chapter 1.9 of this report.

In general terms a nuclear power plant is licensed in a two-step procedure, where the first step covers Construction License, the second the Operating License.

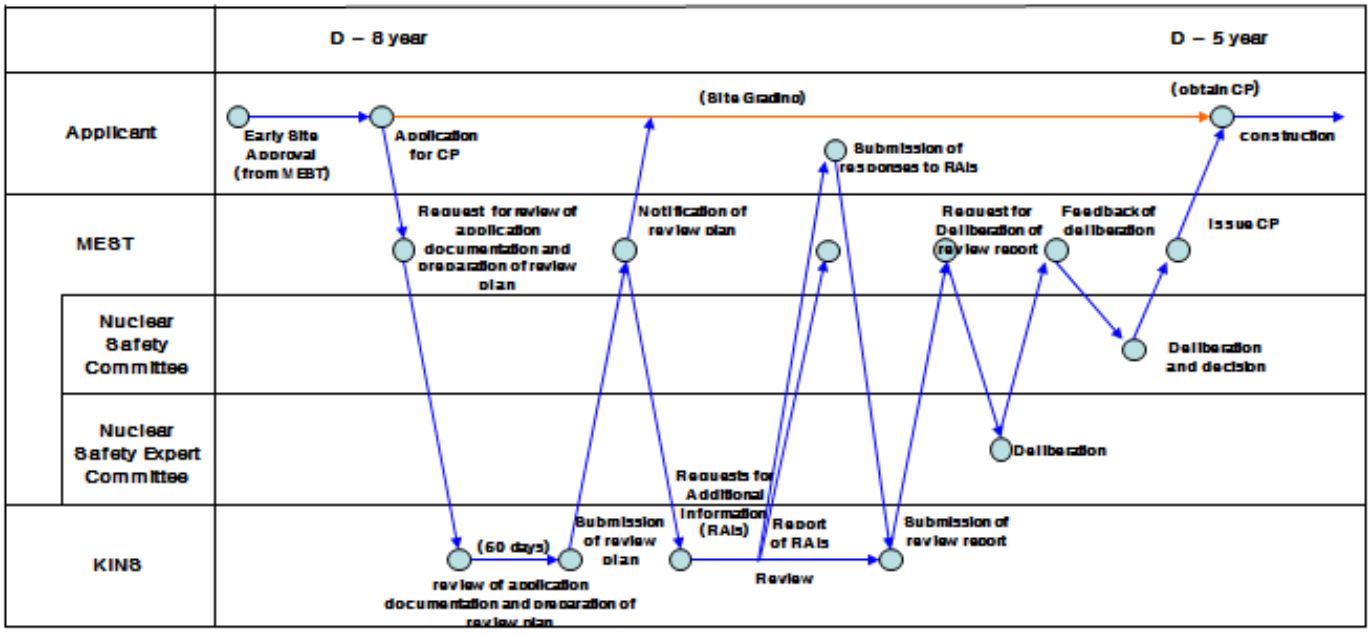
In case of research reactors (including also educational reactors) Construction and Operating Licenses are issued in a combined single-step procedure.

MEST/NRB does not directly license subcontractors. However, the regulation on Technical Standards Etc. clearly requires that the licensee make sure that all necessary qualifications shall be acquired and all quality and safety requirements shall be respected by any subcontractor.

Permission of restarting a nuclear power plant after fuel reload is given following a periodic inspection.

5.3. REGULATORY CONTROL FOR AUTHORIZATION

The typical process of an authorization is as follows. Applications for authorizations are submitted to the MEST/NRB for review and approval. MEST /NRB forwards the application to KINS for technical review. KINS overviews the application for completeness and prepares a review plan. The review plan and a possible request for supplementing the application with further data and information are sent to the applicant. The review is started by KINS and additional data are submitted by the applicant. The review report is sent to MEST/NRB. MEST/NRB requires a deliberation from the Nuclear Safety Expert Committee, then a decision from the Nuclear Safety Committee. In possession of this all, MEST/NRB issues the license to the applicant. The typical process of authorization is presented in the figure below.



Authorization process of a Construction License

The authorization process and its regulatory control are clearly defined in the underlying regulations and guides. The regulatory practice is particularly well organized, careful, and safety oriented.

5.4. CONDITIONS AND LIMITATIONS OF AUTHORIZATION

Limitation of authorization is set by time constraints. The time frame allowed by the regulations for processing the construction or operation license applications is 24 months each. In case of a Construction License application for a reactor having a Standard Design License this period is 15 months. No time limit is given for the review of a Standard Design Approval application.

It is to be mentioned here, that no specific timeframe exist in the regulations for license amendments (although also in this case a review plan is prepared and communicated to the licensee thus indicating the expected processing time). Time constraints for decision making by the regulatory body is not a requirement (moreover it is not preferred), however, since other decisions are bound to be taken within given time intervals, the regulation becomes more homogeneous if also license amendments are to be processed within a given period of time.

Authorization is conditioned by the full submittal of the documentation required in the review of and deliberation on the application. The documents to be submitted are clearly defined in the related regulations referred to in subchapter 5.1 above.

5.5. LICENSE AMENDMENTS AND RENEWAL

License amendments are of two main types. Amendments that affect those chapters of the Safety Analysis Report that either gives the technical specifications or describes the accident analysis results are considered major changes. In case of major changes license amendment assumes a process basically identical to the original licensing process.

In the opposite case, i.e. when none of the aforementioned chapters is affected by the modifications, the change is considered minor and a report on the change in minor matter shall be submitted. Minor changes still have two types. When data or items having no safety implications or effects are modified, the licensee is free to perform the change provided it notifies the regulatory body on the amendment. When the modifications may have safety implications the notification is to be made 30 day prior to initiating the modifications. In this case the regulatory body has the possibility to review the intended modifications and, in case of necessity, to intervene. In order to make this possible the licensee is bound to submit a safety assessment of the modification to be performed. MEST and KINS have demonstrated to the IRRS team via in practical cases the feasibility of this approach. However, the process as described above is defined in internal procedures, whereas no legally binding regulation exist for neither the need for a safety assessment, nor the necessity to wait for a confirmative answer from the regulatory body. Furthermore no stipulation exists for the case when MEST does not react on the notification from the licensee within 30 days.

5.6. TERMINATION OF LICENSE

License is terminated either when the design lifetime expires and no continued operation is initiated or when the license is revoked since certain conditions listed in the AEA are met. These conditions, among others, include fraudulent or illegal activities, unauthorized changes in the licensed status, non-compliances with the license conditions.

AEA also orders that if the temporary suspension of the licensed activity ”is likely to cause a grave inconvenience to the user or to be detrimental to the public interest, the Minister of Education, Science and Technology may impose a penalty surcharge … in lieu of the” suspension of the activity. In other words even if violation of safety would rightly call forth the suspension of the activity, financial penalty may replace the ultimate enforcement vehicle. Since suspension of the construction or the operating activity is meant to prevent continuation of construction/operation under the given circumstances, replacement of this measure by something what allows the continuation of the activities is hardly justifiable.

In summary the IRRS recognizes that the Regulatory body has established a well-organized, properly regulated and detailed, smoothly functioning process for the authorization and licensing of nuclear power plants and research reactors.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, para. 4.33 states that** *"Prior to the granting of an authorization, the applicant shall be required to submit a safety assessment, which shall be reviewed and assessed by the regulatory body in accordance with clearly specified procedures. The extent of the regulatory control applied shall be commensurate with the radiation risks associated with facilities and activities, in accordance with a graded approach."*
(2)	**BASIS: GSR Part 1, para. 4.39 states that** *"The regulatory body … shall inform the applicant, in a timely manner, of its decision, and to provide reasons and justification."*
R 5	**Recommendation: The Regulatory body should initiate the extension of the legal basis of the licensing process in order to ensure that:** **1. in case of the submittal of a report on a license amendment in minor matters, whenever the reported change has safety significance the licensee is required to submit a safety assessment on the possible consequences of the modifications,** **2. in case of the submittal of a report on a license amendment in minor matters, whenever the reported change has safety significance the licensee shall not commence to realize the modification prior to the answer to its notification from the regulatory body.**
(1)	**BASIS: GSR Part 1, para. 4.54 states that** *"The response of the regulatory body to non-compliances with regulatory requirements or with any conditions specified in the authorization shall be commensurate with the significance for safety of the non-compliance, in accordance with a graded approach.***"**
(2)	**BASIS: GSR Part 1, para. 4.55 states that** *"Enforcement actions by the regulatory body may include recorded verbal notification, written notification, imposition of additional regulatory requirements and conditions, written warnings, penalties and, ultimately, revocation of the authorization."*
(3)	**BASIS**: **GS-G-1.3, para, 5.12 states that** *"In the event of persistent or extremely serious non-compliance or significant contamination of the environment due to a serious malfunction or damage to the facility, the regulatory body should modify, suspend or revoke the authorization, depending on the nature and severity of the conditions at the facility. In considering the withdrawal of authorization, the regulatory body should give careful consideration to ensuring that activities vital to safety, even in a shutdown state, continue to be performed by a legally authorized operator."*
R 6	**Recommendation: The Regulatory body should initiate the process to modify the Atomic Energy Act in order to eliminate the option of replacing a suspension of the licensed activity by financial penalty when the safety violation would rightly call for**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	suspension of the activity.

RESEARCH REACTORS

There are two research reactors in operation in Korea; two more reactors are in various stages of decommissioning.

The HANARO reactor (High-flux Advanced Neutron Application Reactor), operated by the Korean Atomic Energy Research Institute is a 30 MW open-tank-in-a-pool type, light water cooled, light and heavy water moderated reactor facility used for experimental as well as for industrial applications. It has been put into operation in 1995.

AGN-201K (Aerojet General Nucleonics Model 201) is a 10 W power educational reactor with homogeneous LEU fuel operated by Kyung-Hee University. It has been donated to Korea by the USA after an operational period from 1967 to 1974 in Colorado State University. It restarted operation in Kyung-Hee University in 1982. Its power has been uprated from 0,1 W to 10 W in 2008.

KRR-I was a TRIGA MARK-II type open pool 250 kW reactor commissioned in 1962 and permanently shut down in 1995. It has been partly decommissioned, however it is meant to serve as a nuclear museum, and thus the internal parts of the reactor await decontamination.

KRR-II was a TRIGA MARK-III type open pool 2MW reactor commissioned in 1973 and permanently shut down in 1995. It is in the final phase of decommissioning.

5.7. GRADED APPLICATION TO RESEARCH REACTORS

Research reactors in certain cases are exempted from requirements valid for nuclear power plants. The most important such exemption is the single-step licensing procedure in which construction and operating licenses are granted in a single procedure. The license application includes a Radiation Environment Report, a Technical Specification, a Safety Analysis report and a Quality Assurance Program (for an exemption see below).

Research reactors of various powers are bound to comply with different requirements. Thus a reactor with a power less than 10 kW is not required to submit a Quality Assurance Plan when applying for the combined license. This exemption does not seem to be well grounded and raise certain doubts.

Due to the application of the NPP requirements on research reactors *mutatis mutandis* no stipulations exist on the regulatory handling of the safety implications posed by the experimental devices that are used in research reactors. Note that this is a lack in regulations only; since in practice Safety Review Guidelines of KINS contain requirements on that Safety Analysis Reports of the research reactors include the results of respective safety evaluations.

Korean regulation on emergency preparedness and release radiation monitoring in case of research reactors was formulated on the basis of the USA practice as described in the regulatory document NUREG-0849 on standard review plan for emergency planning of research reactors. The resulting regulation exempted research reactors of powers below 100 W from the preparation (and regulatory acceptance) of emergency plans as well as from the establishment of release monitoring systems. Furthermore, research reactors of power below 2 MW need not operate an emergency preparedness

organization and need not establish emergency support centers. These exemptions do not seem to be supported by analyses (and as a matter of fact are not in compliance with referenced NUREG guidance either). On the other hand, safety analysis valid for the AGN educational reactor (10 W power) shows indeed that the maximum hypothetical accident may not have effect on the environment.

In summary, graded approach to research reactors is justified and supported and many of the steps taken by the Korean regulatory body and regulation system are well established. Other issues related to the application of graded approach as in the case of the regulations on small research reactors do not fully comply with the requirements by IAEA.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-R-3, para. 1.9 states that** *"The main objective of the requirements for the management system is to ensure, by considering the implications of all actions not within separate management systems but with regard to safety as a whole, that safety is not compromised."*
(2)	**BASIS: GS-G-3.1, para. 2.20 states that** *"The organization should develop a management system that is appropriate to the stage in the lifetime and the maturity of the nuclear facility or activity."*
(3)	**BASIS: NS-R-4, para. 7.72 states that** *"Emergency plans shall be prepared for a research reactor facility to cover all activities planned to be carried out in an emergency. Emergency procedures shall be prepared by the operating organization, in accordance with the requirements of the regulatory body, and in co-operation, where necessary, with the appropriate governmental and local authorities or other bodies, to ensure the effective co-ordination of all site services and of external aid in an emergency. Emergency procedures shall be based on the accidents analysed in the SAR as well as those additionally postulated for the purposes of emergency planning."*
(4)	**BASIS**: **GS-R-2 para 1.10 states that** *"The types of practices and sources covered by these requirements include: fixed and mobile nuclear reactors; facilities for the mining and processing of radioactive ores; facilities for fuel reprocessing and other fuel cycle facilities; facilities for the management of radioactive waste; the transport of radioactive material; sources of radiation used in industrial, agricultural, medical, research and teaching applications; facilities using radiation or radioactive material; and satellites and radiothermal generators using radiation sources or reactors. The requirements also cover emergencies arising from radiation sources of an unknown or untraceable origin."*
(5)	**BASIS**: **GS-R-2 para 5.19 states that** *"The operating organization [of a facility or practice in threat category I, II, III or IV] shall prepare an emergency plan that covers all activities under its responsibility, to be adhered to in the event of an emergency. This emergency plan shall be co-ordinated with those of all other bodies having responsibilities in an emergency, including public authorities, and shall be submitted to the regulatory body."*
R 7	**Recommendation: The Regulatory body should initiate a change in the regulations in order to:**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	1) require a Quality Assurance Plan to be submitted when licensing a research reactor of any size. The requirements on the plan shall reflect the safety importance of the facility to be constructed in line with the graded approach, **2) require emergency preparedness organization and emergency preparedness plans for research reactors of any size. The organization and plan shall follow graded approach and shall be commensurate with the threat posed by the facility.**

6. REVIEW AND ASSESSMENT

6.1. ORGANIZATIONAL ASPECTS OF THE REVIEW AND ASSESSMENT PROCESSES

There are a number of documents to be reviewed by KINS in connection with various stages of the licensing as follows:

- Standard Design Documentation;
- Site Investigation Report;
- Preliminary Safety Analysis Report;
- Final Safety Analysis Report;
- Radiological Environmental Report;
- Quality Assurance Program for Construction;
- Quality Assurance Program for Operation;
- Technical Specifications for Operation;
- Explanatory Report on Technical Capability for Construction and Operation of Nuclear Reactor Facilities;
- Operating Guidelines, including the Emergency Operating Procedures;
- Life Evaluation Report for Major Equipment;
- Periodic Safety Review (PSR) Report;
- Documents relating to amendment of application documents for a construction permit or operating license for Amendment Approval;
- Topical Report;
- Decommissioning Plan.

Due to a relatively large number of operating reactors (21) of two different types (PWR and PHWR) and to the fact that several other (7) are under construction, the regulatory body should correspondingly deal yearly with large number of about 400-600 submissions with varying complexity. Majority of submissions are associated with Amendment Approvals and Notifications for Minor Changes. Much more complex submissions are associated with licensing of new plants, but also for Continued Operation or certain major amendments like for power uprating or replacement of steam generators.

Discussion was focused to examine how activities related to review and assessment are arranged by the regulatory body in particular taking into account the fact of sharing responsibilities between MEST and KINS in this matter. In accordance with the Article 311 (Approval, etc. of Rules for Entrusted Regulatory Activities) of Enforcement Decree of AEA and Rules for Entrusted Regulatory Activities KINS conducts safety reviews. With very few exceptions not requiring technical assessment, all submissions to MEST are forwarded to KINS. KINS first prepares a review plan which is confirmed in consultations with MEST. KINS performs review and assessment and the results are submitted to MEST. KINS has in place a system to agree on a final position regarding the results of review and assessment, a deliberation council, composed of senior specialists of KINS. Eventually, final decisions are taken under control of

MEST by its Nuclear Safety Committee. The reviewing role of KINS will remain the same also after organizational changes in MEST and establishment of the Nuclear Safety Commission.

There are legally imposed time limits (see chapter 5) for regulatory processes. The time limits seem to be adequate so that they do not impose any restrictions to the comprehensiveness of the review. In addition, there is sufficient flexibility to extend these time limits, if needed for quality of the review.

There is an electronic project management system MIDAS (see section 3.7) in place allowing also monitoring of the actual status of the review and assessment. The system is an important management tool, providing for on-line checking the status of individual tasks and indicating risks of project implementation.

Review and assessment activities are mainly performed by staff of the Technical Department and of Nuclear Regulation Division. In its 11 departments there are about 200 highly qualified people who can be involved in the review.

Any submission requiring review and assessment is managed as a project under control of a project manager (PM), who is an appointed expert from the Nuclear Regulation Division. PM coordinates the whole process of review and assessment and is responsible for high quality results to be achieved in timely manner. There are 11 PMs selected from the senior staff of the Nuclear Regulation Division (for each of 4 sites there is 1 manager for review and assessment and 1 for inspection tasks, and in addition there are 3 managers for new constructions). PM prepares the plan for the review and is responsible to distribute the review material to the right experts of KINS.

Most reviews are performed directly by KINS staff. Only exceptionally (in case of lacking manpower or special area of expertise needed) they may cooperate with universities or other institutions. However, in view of expected higher workload in the future KINS is seeking for possibility to enhance its review and assessment capacity by establishing a special research company, Nuclear Safety Evaluation (NSE) working exclusively for KINS. Since NSE is not a governmental organization, there will be more flexibility in hiring new people, including senior experts. There are adequate provisions in place to finance contractors' work in the area of review and assessment.

Review and assessment is performed in accordance with the annual plan based on information from the utilities. In case of unplanned situations the priorities are set up considering importance, urgency and safety issues associated with the matter, in special circumstances the KINS vice president sets up priority. The law prescribes for the construction and operating license the obligation KINS to inform the licensee within 60 days from the submission date about the review schedule, but KINS voluntarily applies this rule for all large licensing reviews.

Adequate management of the process and sufficient manpower available for the review and assessment is monitored through the relevant performance indicator (number of actions completed in timely manner). It was demonstrated by data of 2010 that practically all reviews (there were more than 600 of them) were completed in accordance with the established time schedule.

A specific case illustrating the process and outcomes of the review and assessment was discussed by IRRS mission more in detail. The example was the review and assessment performed in connection with 4 % reactor power uprate of Kori Units 3&4 and Yonggwang Unit 1&2 NPPs, submitted for the review in September 2005.

As a part of the review, two methodological documents have been developed: KINS/HR-742 Development of an Optimization Methodology of Safety Margin and Power Uprating, and KINS/HR-799 Development of Guidance and Standard Procedure for Power Uprate Regulation, latter meant to become a

standard review plan for power uprating of Korean NPPs. The review was performed in a systematic way, following the developed review plan and using methodology prepared by KINS. The submission as well as review itself was made very much in accordance with the US NRC methodology established in the guidance in the Office of Nuclear Reactor Regulation's Review Standard (RS)-001, "Review Standard for Extended Power Uprates". Foreign experts from a NRC's consulting company were invited to share their experiences. The review involved extended exchange of letters with the licensee mainly devoted to clarification of additional questions. Because of the complexity of the issue the review took about 2.5 years (there is no time limit for performance regulatory process in case of license amendment). It was demonstrated to the IRRS that all associated documentation and letters were systematically recorded, both electronically as well as in hard copies. An evaluation report has been prepared as a result of the review as a basis for subsequent assessment and decision made by the Nuclear Safety Committee of MEST. Development of methodological documents contributes to consistency in reviews of future submissions.

It can be concluded that the review and assessment in KINS is both organizationally and technically very well prepared and managed process.

6.2. REFERENCE DOCUMENTS FOR REVIEW AND ASSESMENT AND UTILIZATION OF LESSONS LEARNED

KINS carries out review and assessment to verify whether the submissions comply with the requirements specified in Article 12 (Standards for Permits) of the AEA, the Regulation on Technical Standards for Nuclear Reactor Facilities, and the Regulation on Technical Standards for Radiation Safety Control. In addition, KINS has developed safety review guidelines for each important review activity, and these guidelines are made available to the applicants or licensee in order to facilitate preparation of the submissions:

- Safety Review Guidelines for PWR Nuclear Power Plants: KINS/GE-N001 (see chapter 9 on availability of relevant guidance documents for PHWRs)
- PSR Review Guidelines for PWR Nuclear Power Plants: KINS/RR-139
- PSR Review Guidelines for PHWR Nuclear Power Plants: KINS/GE-N9
- Continued Operation Review Guidelines for PWR Nuclear Power Plants: KINS/GE-N8
- Continued Operation Review Guidelines for PHWR Nuclear Power Plants: KINS/GE-N11.

Furthermore, KINS developed the following internal review procedures that prescribe detailed procedures for performing review activities as a part of the KINS Quality Management System:

- KINS Procedure, Licensing Review Procedure for Nuclear Power Reactor and Related Facilities
- KINS Procedure, License Amendment Review Procedure for Nuclear Power Reactor and Related Facilities
- KINS Procedure, Periodic Safety Review Procedure for Nuclear Power Reactor and Related Facilities
- KINS Procedure, Topical Report Review Procedure.

In connection with methods for deterministic safety analysis, KINS technical guidelines, KINS/GT-N007-1 (Technical Guidelines for Conservative Evaluation of PWR ECCS Performance) and KINS/GT-N007-2 (Technical Guidelines for Best-Estimate Evaluation of PWR ECCS Performance) describe more in detail methodology of the analysis. The guidelines are in accordance with recently published IAEA Safety

Standards on safety assessment (GSR Part 4 and SSG-2). The KINS guidance KINS/GE-N001 (Safety Review Guidelines for Light Water Reactor Nuclear Power Plants) in Section 19.1 (latest update in December 2009) describes the methodology for PSA and specifies that a PSA should comprehensively cover internal events, external events, and events occurring during low power and shutdown conditions. Prompt incorporation of recent advancement in IAEA Safety Standards into Technical Guidelines was facilitated by active participation of KINS in development of Standards, in this particular case in development of SSG-2.

High attention is paid to continuous monitoring, evaluation and feedback from the review and assessment process in order to enhance its efficiency. KINS records the review and assessment results in accordance with the relevant Rules for Entrusted Regulatory Activities. When conducting a review and assessment for an authorization application, KINS develops a review report for each authorization activity (construction permit, operating license, amendment approval, or notification of a minor change). By maintaining and controlling various records including review results in MIDAS, KINS has made these documents readily available for the reviewers. Safety Evaluation Reports from previous cases provide sufficiently detailed source of information. Training of the KINS staff is also devoted to presentation of lessons learned from the reviews.

In addition the KINS publishes every year a book named "Good Practices (Best Regulation)" which contains selection of exceptional results of the regulatory works and findings (devoted to review and assessment area to large extent), separately for each of the departments. The book of 2010 with more than 200 pages was presented to the IRRS mission.

Technical consistency between new and operating reactors is a very important issue. In general, there are no substantial differences in review methodologies of existing and new reactors. Since both kinds of reactors are dealt with by the same experts, this fact facilitates continuity of the reviews and transfer of lessons learned. This transfer of lessons learned is further supported by sharing of information through the MIDAS system, internal discussions, internal training.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, 4.48. states that** *"The regulatory body shall record the results and decisions deriving from reviews and assessments, …. The results of reviews and assessments shall be used as feedback information for the regulatory process."*
GP 8	**Good Practice: In addition to enhancing efficiency of the review and assessment process by means of continuous monitoring, evaluation and feedback the KINS publishes every year a book of "Good Practices (Best Regulation)" which contains selection of exceptional results of the regulatory works and findings.**

6.3. COMMUNICATION WITH THE LICENSEE IN THE AREA OF REVIEW AND ASSESSMENT

There is a single licensee operating and constructing NPPs in Korea, which is the KHNP. Detailed guidance documents are available for the licensee (as described in section 6.2), which facilitate understanding of the regulatory requirements for format, quality and standards for submittals.

During the review, regular contacts are arranged between the licensee and KINS project manager. PM is assigned to manage all submittals from a given site. PM serves as a single contact point for the site,

communicates directly with the plant and is aware of all potential submissions from that plant. During the review process the regulatory body maintains open communication with the licensee through exchange of letters. There are frequently held case specific explanatory meetings between the licensee and KINS, initiated by both sides as needed. The KINS directly interacts with the licensee only, although the licensee gets support from his technical support organizations.

There are regular annual meetings held between the management of KINS and KHNP. In addition there are ad-hoc high level and working level talks between nuclear safety related institutions (last one held in June 2010) aimed at discussing the key safety issues. Another example of effective communication between the licensee and the regulator is the Research Team for Nuclear Power Earthquake Preparedness established after the earthquake at Kashiwazaki-Kariva NPP, and working since 2009 with the objective to verify seismic safety of Korean NPPs and provide for development of improvement measures.

Opinions of the industry are collected using a consultative group of experts participating in the high level and working level talks and technical group meetings.

All these communication channels provide for adequate feedback from the review and assessment activities to the licensee.

6.4. UPDATING OF REGULATIONS RELATED TO REVIEW AND ASSESSMENT

The issue addressed in the discussion was how advances in IAEA Safety Standards are reflected in updating the regulations and guides. The document describing the format and content of safety analysis report and the standard review plan was discussed in particular. The contents of the Preliminary and Final Safety Analysis Reports are specified in the Enforcement Regulation of the AEA, the standard review plan is covered by the Safety Review Guidelines KINS/GE-N001. These documents are derived from the equivalent US NRC documents, in particular Regulatory Guide 1.70, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, Revision 3 (1978) and of the US Standard Review Plan (NUREG 0800).

However, the existing legislative documents do not reflect comprehensively enough the recent developments in the IAEA Safety Standards, although progress in methods of safety assessment is adequately reflected in several internal KINS safety review guidelines. In particular, the requirement to address design extension conditions including sever accidents and to include PSA in the Safety Analysis Report are not covered by the current Enforcement Regulation, The Team supports the existing plans to include relevant requirements into the legislation at the earliest possibility. In the update of the Regulation it is also important to ensure that the level of detail of the safety analysis report provide for independent verification of safety assessment. IAEA Safety Requirements GSR Part 4 document was referred to as the relevant international standard reflecting the current of development and good practices in the area of safety assessment.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, Requirement 24 states that** *"The applicant shall be required to submit an adequate demonstration of safety in support of an application for the authorization of a facility or an activity."*
(2)	**BASIS: GSR Part 4, Requirement 15 states that** *"Both deterministic and probabilistic approaches shall be included in the safety analysis."*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(3)	**BASIS: GSR Part 4, art. 4.64 states that** *"The safety report has to document the safety assessment in sufficient scope and detail to support the conclusions reached and to provide an adequate input into independent verification and regulatory review…."*
S 8	**Suggestion: The regulatory body should initiate updating the Enforcement Regulation in order to extend the scope of the Safety Analysis report so that design extension conditions and PSA are adequately covered.**

6.5. PROVISIONS FOR INDEPENDENT SAFETY ASSESMENT BY THE LICENSEE

Referring to the IAEA Safety Requirements GSR Part 4, the IRRS mission reviewed whether adequate provisions are in place for independent verification of safety by the licensee as an important component of his prime responsibility for safety (Principle 1 of IAEA Safety Fundamentals). Safety assessment including safety analysis for NPPs in Korea is typically developed by KEPCO or KEPCO Nuclear Fuel companies, while the operating organization (the applicant) is KHNP. The issue of independent verification of the safety assessment by the operating organization is therefore relevant.

It was demonstrated that the obligation of the licensee to perform independent verification of safety features of the design including safety analysis is legally imposed by Article 70 of the Regulations on Technical Standards for Nuclear Reactor facilities (latest update of March 2008). Two examples of summary verification reports were presented to the IRRS mission: one on Independent Verification of the Vendor's Safety Analysis Report by Utility for FSAR of Shin Kori 3&4 units, another one on Assessment of the Safety Analysis Methodology by Utility regarding the best estimate methodology for ECCS performance analysis developed by Nuclear Engineering & Technology Institute. Safety Review Guidelines KINS/GE/N005, January 2004 on Safety Analysis Computer Codes and Methodologies for NPP specifies for the regulatory body as a part of his activity to check how the licensee performs his task of independent verification of safety.

It was therefore concluded that adequate provisions are in place for independent verification of safety assessment by the licensee.

6.6. USE OF COMPUTER CODES AND BEST PRACTICIES FOR SAFETY ANALYSIS BY THE LICENSEE

The issue of quality of computer codes used by the licensees or their contractors was discussed.

KINS regulatory guideline KINS/GE-N005 (Technical Guidelines for Safety Analysis Computer Codes and Methodology for Nuclear Reactor Facilities) stipulates that a verification & validation for the computer codes be performed to use for safety analysis of nuclear power plants to ensure that they properly perform their intended functions for specific phenomena and calculation purposes. Although there is no formalized procedure for certifying the codes, in reality the adequacy of all computer codes used for licensing was verified through the process of approval of the topical reports describing the codes and their validation. Approval of the topical reports is a recognized component of regulatory authorizations, and although it is not an obligatory step, it facilitates the approval of the results of the analysis and increases efficiency of review and assessment for repeating submissions.

MEST Notice 2010-04 (Criteria for Performance of Emergency Core Cooling System of Pressurized Light Water Reactor, MEST.Reactor.024) and subsequent KINS technical guidelines (KINS/GT-N007-1 and KINS/GT-N007-2) stipulate that deterministic safety analysis for licensing can be performed either in a conservative way or a best estimate way with evaluation of uncertainties. It was demonstrated during the mission that the advanced best estimate methods with evaluation of uncertainties are effectively used by the utility for deterministic safety analysis (e.g. in best estimate approach for LOCA Topical Report for ECCS Westinghouse 3 loop design, or on-going justification for steam generators replacement). In connection with the Probabilistic Safety Assessment, in spite of absence of specific legislative requirement the licensee submitted the PSA (Level 1 and 2) results for all operating nuclear power plants as required by the Policy on Severe Accident (2001) for all operating nuclear power plants.

It was demonstrated during the IRRS mission that good practices in safety analysis are incorporated in the KINS technical guidelines and these practices are followed by the licensee accordingly in spite of some gaps in the legislation.

6.7. ENSURING CONSISTENCY OF REVIEW AND ASSESMENT FOR VARIOUS DOCUMENTS

In connection with the licensing process for NPPs, in accordance with the AEA the KINS has to review two different licensing documents: Safety Analysis Reports and Radiological Environmental Reports. In general, these documents should contain similar information, in particular in the area of radiological impact of NPP operation on the environment. The issue was raised whether there can be inconsistent or conflicting information in two mentioned documents.

There are guidance documents available for development of both documents, namely Safety Review Guidelines for Light Water Reactors, KINS/GE-001 and Environmental Report Review Guidelines for Nuclear Power Plants, KINS/GE-N004. However, the methodologies for analysis of radiological consequences in both documents significantly differ. KINS explained that the over-conservative methodology in SAR is for determination of adequacy of the Engineered Safety Features and Siting, while the realistic methodology in RER is for the public dose in case of design basis accidents. In spite of this explanation, the Team shares the opinion that the Safety Analysis Report in connection to design basis accidents is unnecessarily over conservative. This is true both in terms of the source term to the environment as well as of the assumptions regarding dissemination of radioactive materials in the environment. For example, full core melting is assumed for design basis accidents in Safety Analysis Reports while 2 % of core inventory release is considered for the environmental report, assumptions on radioactivity material removal in the containment are also different. Regarding weather conditions, only 0.5 % most unlikely weather conditions are screened out for the safety report, and 50 % for the environmental report. Because of different assumptions the quantitative results presented in two documents for the same case may differ. Since both documents are publicly available such different information may be confusing for the public.

The reasons for different approaches used for determination of radiological effects in the above mentioned licensing documents were not completely clarified during the IRRS mission. It is believed that significant differences in methodologies of licensing documents for the same plant and for the same accident situations may be a source of confusion for the public and other interested parties.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 4, Requirement 22, art. 4.28 states that** *"There shall be consistency in the decision making process of the regulatory body and in the regulatory requirements themselves, to build confidence among interested parties."*
S 9	**Suggestion: The regulatory body should consider harmonization of approaches used for determination of radiological consequences in Safety Analysis Report and Radiological Environmental Report.**

6.8. RADIOLOGICAL ACCEPTANCE CRITERIA

Another issue related to review and assessment is associated with determination and use of legally established radiological acceptance criteria. For normal operation and transients the acceptance criteria consistent with the ICRP 60 recommendations are established, i.e. in terms of effective doses the limits are for plant radiation workers 20 mSv and 100 mSv for 1 and 5 years, respectively, and for public the limit is 1 mSv for 1 year. However, for design basis accidents (LB LOCA in particular) the acceptance criterion for the whole body dose is 250 mSv in 2 hours (similarly as in the US 10 CFR 100.11).

The value 250 mSv dose in 2 hours for licensing calculations for LB LOCA design basis accident (and 25 to 63 mSv for other DBAs) is considerably different than equivalent numbers currently used in some other countries, although it is understood that there is too large conservatism embedded in demonstration of compliance with the criterion. The compliance with the few mSv criterion is currently required for the Radiological Environmental Report, but the methodology for demonstration of the compliance allows realistic evaluation (see also previous section on consistency of the documents). The current DBA acceptance criterion is also larger than the dose for initiation of the off-site intervention measures (10 mSv for sheltering), while the necessity for such measures should be avoided for new reactors in accordance with the updated IAEA Safety Requirements for the design (SSR 2/1).

In addition, no acceptable radiological limits have been specified for design extension conditions, although it is required by the updated IAEA Safety Requirement for the design. The IAEA Safety Requirements allow for assessment of the design extension conditions using best estimate approach.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: SSR 2/1, Rev. NS-R-1, Rev 28b, art. 5.25 states that** *"A primary objective shall be to manage all design basis accidents so that they have no or only minor radiological impacts, on or off the site, and do not necessitate any off-site intervention measures. "* **and art. 5.26** *"The design basis accidents shall be analyzed in a conservative manner...."*
(2)	**BASIS: GSR Part 1, 4.43 states that** *"The regulatory body shall assess all radiation risks associated with normal operation, anticipated operational occurrences and accident conditions … to determine whether radiation risks are as low as reasonably achievable."*
(3)	**BASIS: GS-G-1.2, art. 3.25 states that** *"The safety objectives and regulatory requirements should cover, among other things: … — Criteria for assessing radiological risks to workers and the public."*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(4)	**BASIS: SSR 2/1, Rev. NS-R-1, Rev 28b, in Requirement 5 Radiation protection states that** *"The design of a nuclear power plant shall be such as to ensure that radiation doses to workers at the plant and to members of the public… remain below acceptable limits and as low as reasonably achievable in and following accident conditions."*
S 10	**Suggestion: In connection with licensing of new reactors the regulatory body should consider harmonization of licensing acceptance criteria and off-site intervention levels for design basis accidents and establish criteria for design extension conditions.**

6.9. REGULATORY APPROACH TO MANAGEMENT OF SEVERE ACCIDENTS

In accordance with the Policy on Severe Accident published by the regulatory body in 2001 the licensee should to: 1) establish probabilistic safety goals; 2) perform a Probabilistic Safety Assessment (PSA) for all operating nuclear power plants; 3) procure the capabilities to cope with severe accident; and 4) develop a severe accident management program.

In connection with the capabilities to cope with a severe accident, the licensee identified a number of ways to improve safety of the nuclear power plants, even though the legal requirement for the submission has not been established. The hydrogen igniters for hydrogen control during severe accidents were installed within the containment building during construction of Ulchin units 3 & 4, and thereafter all plants under construction have been equipped with hydrogen igniters for severe accidents. Additionally, Kori unit 1, the oldest plant in Korea, was also equipped with Passive Autocatalytic Recombiners during Continued Operation Permit pursuant to the regulatory requirements. All NPPs (except Ulchin unit 1 and 2 and Wolsong plants) are equipped with the hydrogen monitoring system powered by an AAC diesel generator or batteries. Implementation of these safety improvement measures has been verified by KINS and confirmed that the licensee adequately implemented the Severe Accident Policy in accordance with the implementation plan, and the capabilities to cope with severe accidents at operating nuclear power plants have been enhanced by establishment of severe accident management programs and facility improvement. Severe accident review guidelines KINS/GE-N001 (Safety Review Guidelines for Light Water Reactor Nuclear Power Plants) Section 19.2 have been developed (latest update in December 2009).

In accordance with the existing plans the follow-up measures are necessary including: a) establishment of a performance objective for NPPs for continued safety improvement with respect to severe accidents; b) development of legal requirements to evaluate severe accidents and submit a PSA for new nuclear power plants; c) preparation of regulatory requirements to revise nuclear power plant PSAs periodically; d) examination of whether severe accident mitigation facilities should be installed at existing nuclear power plants.

However, currently there are no legal obligations even for new NPPs to consider severe accidents in the plant design. Draft legislation has been developed, including consideration of severe accidents for new reactors. Some of the severe accident mitigation measures (such as hydrogen removal) are covered in the draft legislation; some others (like corium stabilization) are still under discussion.

The IRRS recommends the regulatory body to ensure that in finalization of the relevant legislation the IAEA Safety Standards, in particular the SSR 2/1 in the area of design extension conditions including severe accidents will be closely followed (see chapter 9 on this matter).

6.10. CAPABILITY FOR INDEPENDENT REGULATORY AUDIT CALCULATIONS

KINS has established and maintains exceptional capability for performing independent regulatory audit calculations. KINS has developed its own computer code system KINS-RETAS (derived from MARS code developed by KAERI) primarily applied to accident analysis of PWRs. A version of KINS-RETAS is also available for foreign users. Capability of KINS to perform independent calculations covers nearly whole spectrum of required analyses from calculation of fission product inventory,, through thermal-mechanical fuel behavior, neutronic and thermal hydraulic analysis of the reactor coolant system and containment both during the design basis as well as severe accidents, probabilistic safety assessment, up to the source term and radiological consequences in the NPP surroundings. KINS also developed its own KINS-REM methodology (KINS-Realistic Evaluation Methodology) for best-estimate analysis with quantification of uncertainties.

KINS also carries out the code validation activities in order to assure that his safety assessment is of high quality. The experimental data relevant for validation of codes are collected and the comparative calculations performed. The test matrix and essential parameters for validation are identified and applied.

As a part of review and assessment the KINS in cases of special interest performs its independent audit calculations, using independent computer codes and plant models. Several cases of such audit calculations were discussed more in detail during the mission. It was demonstrated that the audit calculations are properly selected and represent an important tool for high quality regulatory assessment. It is appreciated that the audit calculations are frequently performed using advanced methodology of best estimate analysis with quantification of uncertainties.

In order to enhance its own capability to perform independent analysis, KINS actively participates in many international projects, including BEMUSE (uncertainty evaluation), Halden project (nuclear fuel performance and human reliability issues), CABRI Water Loop Project (high burn-up fuel performance in RIA conditions). KINS frequently participates in international information exchange meetings; a number of presentations from such meetings were demonstrated to the IRRS mission. Participation in this kind of projects may be also utilized in the future for reconsideration of RIA and LOCA acceptance criteria.

In addition, KINS in its International Safety School provides opportunity for both national and foreign participants to improve their knowledge in nuclear safety matters, including safety assessment and use of computer codes for safety analysis. For example in 2010 four such courses were held: radiation Safety Analysis Code Course, Integrity of Nuclear Component Evaluation Code Course, PSA Course and MARS Safety Analysis Code Course.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-G-1.2, art. 3.38 states that** *"The regulatory body may decide to perform a limited number of audit calculations to check that the operator has justified a particular aspect of safety correctly, …"*
(2)	**BASIS: GSR Part 4, 4.71. states that** *"In addition, the regulatory body has to carry out a separate independent verification to satisfy itself that the safety assessment is acceptable and to determine whether it provides an adequate demonstration of whether the legal and regulatory requirements are met."*
GP 9	**Good Practice: KINS maintains and utilizes its internal capability for performing**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES
independent audit calculations by means of a number of deterministic and probabilistic computer codes including development and validation of such codes, and sharing the computer codes and relevant experience with other regulatory bodies.

6.11. INTERRELATION BETWEEN REVIEW AND ASSESMENT AND INSPECTIONS

Review and assessment and inspections are interrelated activities that are important for effectiveness and consistency of the regulatory role. Inspections in particular are among others aimed at verifying the compliance with the NPP design bases and monitoring that activities previously assessed are implemented accordingly. On the other hand the results of inspections can initiate in depth review and assessment of identified deviations.

In Korea, integration between the two regulatory functions is facilitated by the fact that all staff of the Nuclear Regulation Division involved in review assessment become after adequate working experience (2 years) and passing required examination empowered to perform regulatory inspections both in the plant as well as its suppliers. During the discussions a number of examples were presented demonstrating close interrelation and mutual benefit for both areas. Site audits aimed at demonstration whether actual installation is in line with the description, and participation in on-site tests during plant construction and commissioning is a regular practice. Authors of independent verification analyses for adequacy of sump strainers participated in relevant tests of the strainers in manufacturer's facilities and in the plant. Two examples were provided how observed inconsistencies between plant measurements and calculations (ex-core neutron flux, and cladding oxide thickness) initiated regulatory requirements to improve relevant computational models.

Based on the IRRS discussion it can be concluded that adequate provisions are in place for utilization of assessment and inspection activities in an integrated manner (see also Module 7 of this report for further information).

6.12. PERIODIC SAFETY REVIEWS

The Periodic Safety Review (PSR) system for NPPs was introduced to the legal framework of Korea in 2001, in accordance with the IAEA Safety Standard No. 50-SG-O12. Under this system, the licensee should evaluate safety of the NPP in an integrated manner, based on 11 factors such as 'actual physical condition of the nuclear reactor facilities at the time of assessment'.

The relevant legislative framework in Korea consists of: (a) the Atomic Energy Act (AEA) Article 23-3 (Periodic Safety Review); (b) the AEA Enforcement Decree Article 42-2 (Time, etc. for Periodic Safety Review), Article 42-3 (Details of Periodic Safety Review), Article 42-4 (Methods and Standards of Periodic Safety Review), and Article 42-5 (Reviewing and Processing Period of Periodic Safety Review Report); and (c) the AEA Enforcement Regulation Article 19-2 (Details of Periodic Safety Review) and Article 19-3 (Standards for Periodic Safety Reviews). For more detailed guidance KINS developed the 'PSR Review Guidelines for PWR Nuclear Power Plants (KINS/RR-139)' in 2002 and the 'PSR Review Guidelines for PHWR Nuclear Power Plants' (KINS/GE-N9) in 2007.

According the Enforcement Decree: (a) the licensee should perform a comprehensive safety assessment for each plant every 10 years starting from the day when the operating license was granted; and (b) the PSR report should be submitted to the MEST within one and a half years from the first day of the

following 10-year period after the operating license was initially granted. The MEST should then review the PSR report within 12 months.

Within the PSR the regulatory body requires the licensee to perform the review according to the up-to-date technical standards and criteria effective during the plant operation period, to identify the safety improvement items. Once the PSR is received from the licensee, the regulatory body assesses whether safety functions and safety margins are maintained despite aging phenomena and usually requires additional improvements. The final list of improvements is subsequently established in a series of meetings between regulatory body and the licensee. Afterwards the implementation plan for safety improvements is established within 3 months following the completion of the PSR report, with the implementation results to be semi-annually reported to the regulatory body. When the licensee submits the implementation report for each PSR every six months, the regulatory body asks expeditious implementation of safety improvement measures if found important during the review of the report.

In accordance with the legislation a total of 10 PSR evaluations have been completed as of January 2011, for 16 operating NPPs. Examples of safety improvements incorporated in the implementation plans include improvement of fire protection facilities, aging evaluation of structures and establishment of the aging management program, installation of alternating AC facility to cope with the station blackout, re-evaluation of probabilistic seismic hazard analysis, evaluation of the hydrological characteristics, improvements on the environmental impact evaluation and monitoring plan in environmental assessment, resolution of the sump clogging issue, qualification of the equipment.

A total of 211 items for safety improvement have been identified in the past through the PSR process. No NPP has been required to shut down because of a serious issue. As of January 2011, for 87 of the 211 safety improvement items appropriate follow-up actions have been completed and the remaining 124 items are in progress.

In contrast to the nuclear power plants, the existing regulations do not require Periodic Safety Reviews in case of research and educational reactors. The lack of PSR yields some deficiencies and inconsistencies in the regulation and in the regulatory supervision of these reactors (that shall in brief be mentioned as research reactors).

Review of the Self-Assessment report and interviews with the counterparts have revealed the issues for the IRRS team as below. The issues are followed by considerations on the positive results of the application of PSR:

- operational license of research reactors have no validity timeframe – (although a design lifetime is specified in the SAR) - PSR may result in a legally binding regular revision of the validity of the operating licence,
- there is no legally binding requirement on the revision of the Safety Analysis Reports of the research reactors – revision of the SAR shall be a part of PSR,
- Probabilistic Safety Analysis is not applied for research reactors – PSA is an obligatory part of PSR,
- the safety of research reactors is not reassessed at various later life-stages as required in paragraphs 7.108 and 7.109 of NS-R-4 – PSR shall ensure such a reassessment,
- at the moment neither self-assessments nor peer-reviews are required in case of the research reactors in the sense as given in paragraph 4.16, NS-R-4 – PSR shall replace these assessments.

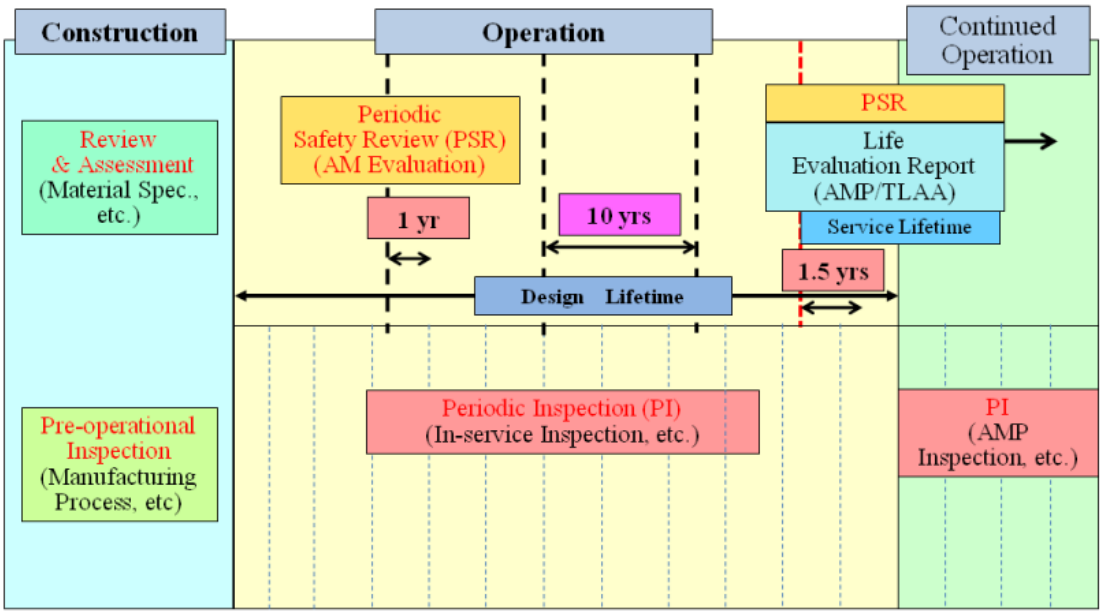
It was however noted that according to the Integrated Reactor Safety Plan introduced by the Nuclear Safety Committee in 2010 in the future the Periodic Safety Reviews shall also be applied to research reactors.

In 2003, the IAEA issued the 'Periodic Safety Review of Nuclear Power Plants (NS-G-2.10),' to replace the previous Safety Standard (50-SG-O12). In this new Safety Guide, the IAEA defines a total of 14 safety factors by subdividing two factors of the original 11 factors into five factors. Updating of the PSR process in Korea including incorporation of the new IAEA standard is in the advanced stage of the implementation. The re-definition principle of the PSR safety factors has been approved by the Nuclear Safety Committee in 2010 and Draft Amendment of the Periodic Safety Review regulation was completed in April 2011. It is therefore expected that the PSR amendment will be adopted at the time when the Nuclear Safety Commission will be newly established in October 2011.

Based on the current status and improvement actions already taken by the regulatory body the IRRS mission has been convinced that in the near future all necessary provisions will be in place to ensure full compliance with the IAEA Safety Standards in the PSR area. Final implementation of the provisions shall be verified by the follow-up IRRS mission.

6.13. AGING MANAGEMENT

Aging management oversight is closely related to periodic inspection, in-service inspection and PSR processes. Aging management provisions are considered since the design phase of the nuclear power plant.



Regulatory Framework for Aging Management

Initial licensing and periodic inspection

Article 15 of the *Regulation on technical standards for nuclear reactor facilities, Etc*. states that SSCs shall be designed to accommodate the effects of, and be compatible with the environmental conditions of normal operation, anticipated operational occurrences and design basis accidents and that aging

degradation caused by such environmental conditions shall be considered. The Team noted that this scope does not include conditions related to beyond design basis accidents.

At the review stage for the construction permit and the operating license, the licensee's safety analysis report (SAR) is reviewed to ensure materials for the SSCs are properly selected and the aging effects in the SSCs can be managed during the design life. KINS guideline (e.g. KINS/GE-N001, Safety review guidelines for PWR) provides the acceptance criteria and review procedures for this assessment. The Team noted that such guidance does not exist for PHWR and that no new PHWR unit is expected to be licensed in the near future.

Inspections during construction and pre-operational inspection (before fuel loading) give KINS opportunities to verify actual implementation of the main provisions described in the safety analysis report. KINS inspection guide KINS/GI-N02/03 (Pre-operational inspection guidelines for PWR) incorporates this topic. The Team noted that such guidance also exist for PHWR (last revision in 1994).

Once the installation is in operation, article 63 of the *Regulation on Technical Standards for Nuclear Reactor Facilities, etc*. requires the licensee to establish a testing, monitoring, inspection, and maintenance program for SSCs, considering the importance of SSCs to safety, and to monitor and evaluate the degree of degradation in materials and performance of safety-related SSCs due to aging so that any necessary measures can be taken.

Two MEST Notices, one specific to the pressure vessel, and another on detailed requirements for in-service inspection (ISI) in order to monitor and assess the degradation for performance and materials of safety-related equipment due to aging require KHNP to submit an ISI program for each nuclear installation in 10-year intervals. KINS checks, by periodic inspection during the planned overhaul outage, that the in-service inspection, surveillance, improvement and replacement of relevant equipment is performed to ensure effective aging management.

KINS is working on developing the regulatory basis for inspection on aging management for NPP in continued operation, by expanding current MEST Notice. KINS will therefore propose a revision of MEST Notice 2010-02 "*Regulation on items and method of periodic inspection for nuclear facilities*".

KINS review guidelines on PSR now include sections on the aging management of civil structures, both safety structures and safety related structures. As for PHWR, the Team noted that the Canadian standard CSA N-291, recently published, will be included as a reference for KINS review.

Periodic review

Aging effects on the SSCs are evaluated as part of the PSR, as specifically defined in article 42-3 of the *Enforcement decree of the Atomic energy act* and articles 19-2 and 19-3 of the *Enforcement regulation of the Atomic energy act.* For example, screening and classification of SSCs, for matters related to aging, as well as evaluation of degradation due to aging of relevant SSCs, are to be presented in each PSR report. It should however be noticed that information on measures to mitigate and programs to manage degradation due to aging of the SSCs are only required for PSR conducted 20 years after the date of the initial operating license of a NPP (article 19-2 4 (e)). KHNP does not currently use this exemption. The Team noted that this practice was adequate as such measures could be relevant since the beginning of NPP operation. Accordingly, the Team invites KINS and MEST to consider an update of the regulation to reflect actual practice, thus enhancing consistency with IAEA SSG2.2 requirement 14.

During PSR report assessment stage, KINS reviews the current aging management programs (AMPs), their effectiveness considering actual equipment conditions and test/maintenance records, and identifies,

necessary improvements. PSR reviews lead to the development of additional programs, as illustrated in the following table.

Example of safety improvement items from the PSR	
Safety Improvement	**Rationale**
Establishment of bolting integrity program	Prevention of coolant leakage
Implementation of alloy 600 program	Operating experience of damage in the dissimilar metal weld
Establishment of thermal aging embrittlement Program	Reduction of fracture toughness of cast austenitic stainless steel (CASS)
Establishment of a boric acid corrosion program	Operating experience of damage due to boric acid corrosion
Re-evaluation of fatigue analysis (including the fatigue monitoring program)	Failure in design to account for thermal stratification impact; Management of components (CUF > 1.0 or high fatigue usage factor)

As an example, the KINS safety evaluation report of Ulchin units 3 and 4 PSR (May 2010) was shown including excerpts dealing with ISI and aging management: they summarized the review area, the requirements and references used as a basis for the ISI, the results of the review and improvements identified. This report is transmitted to MEST and MEST notifies the licensee of any required improvements actions.

When the PSR is related to the authorization for continued operation, additional information has to be submitted by the licensee with regard to SSC aging and aging management (see section 6.14).

Kori Unit 1

In the process of authorizing the Kori Unit 1 continued operation, KINS reviewed the AMP, focusing on the 39 items listed in the MEST Notice. Although the KINS' conclusion was that the current AMP could effectively manage most of the aging effects identified for each SSC, KINS recommended 13 AMP items (such as one-time inspection) to be covered by new AMPs or revised AMPs (these additional items have been implemented). Following the recommendation of the IAEA SALTO peer review team (see chapter 6.14), the screening and evaluating for non-safety-related SSCs, which are not connected to safety-related piping or components were also performed. Furthermore, four general time-limited aging analysis (TLAAs) and seven plant-specific TLAAs were evaluated by KINS.

During the first planned overhaul outage conducted after the approval for continued operation of Kori Unit 1, a periodic inspection was performed by KINS, focusing on checking for proper implementation of the AMP. As a result, KINS made recommendations to KNHP, which were confirmed by MEST a few days later, to:

- Establish specific guidelines for plant in continued operation related to its aging management program (AMP);
    - periodic review of AMP;
    - review of AMP and, if necessary update, when design modifications are implemented;
    - update of AMP consistently with operating experience;
- Establish an implementation procedure for each AMP;
- Incorporate into the final safety analysis report (FSAR) the AMP provisions to confirm the adequacy of TLAA, for example fatigue monitoring program; and
- Incorporate into the FSAR relevant information related to operating experience and research results about AMP.

Although these recommendations were issued following Kori Unit 1 inspection, they are relevant as well to any plant under continued operation. Hence, KINS submitted to MEST early in 2011 an updated draft MEST Notice to incorporate these recommendations into a regulatory document. MEST has not yet made a decision on this draft.

Improving and sharing knowledge on aging phenomena

KINS actively takes part in numerous technical exchanges, both domestically and internationally through:

- community of practices within Korea, such as MAGIC (mechanical aging and integrity) or WISK (welding integrity study). KINS hopes that foreign stakeholders will participate in the future;
- international collaboration on aging (ASME, Japanese JNES…), including on research activities (OECD/NEA, US-NRC…).

The Team favourably considers the above mentioned activities.

Replacement of equipment and managing obsolescence

As part of mid and long-term maintenance program established for operational safety, equipment has been replaced or enhanced by KHNP, for example:

- replacement of numerous electrical cables (more than 4 km) at the Kori Unit 1.In 2013, vessel head and emergency diesel generators will be replaced;
- replacement of pressure and calandria tubes and feeder tubes, control console and other safety-related facilities of Wolsong Unit 1.

Until 2006, safety grade equipment had to be manufactured under a quality assurance program. However, sometimes, some manufacturer did not have a program so the licensee requested MEST and KINS to consider the possibility of implementing a “dedication program” similar to the one implemented in the USA. KINS developed a regulatory guide (which is now numbered 17-12) dealing with this program, which enables the licensee to demonstrate that standardized products (eligible to such program) actually meet quality assurance level of safety-grade equipment.

Impact of Fukushima accident

Following the special safety inspection, 50 improvements measures were identified. Among them, two are dealing with periodic inspections (6-1 and 6-2), one on ageing management program management (6-3), and three on extending to other plants provisions already implemented at Kori Unit 1 (6-4 to 6-6).

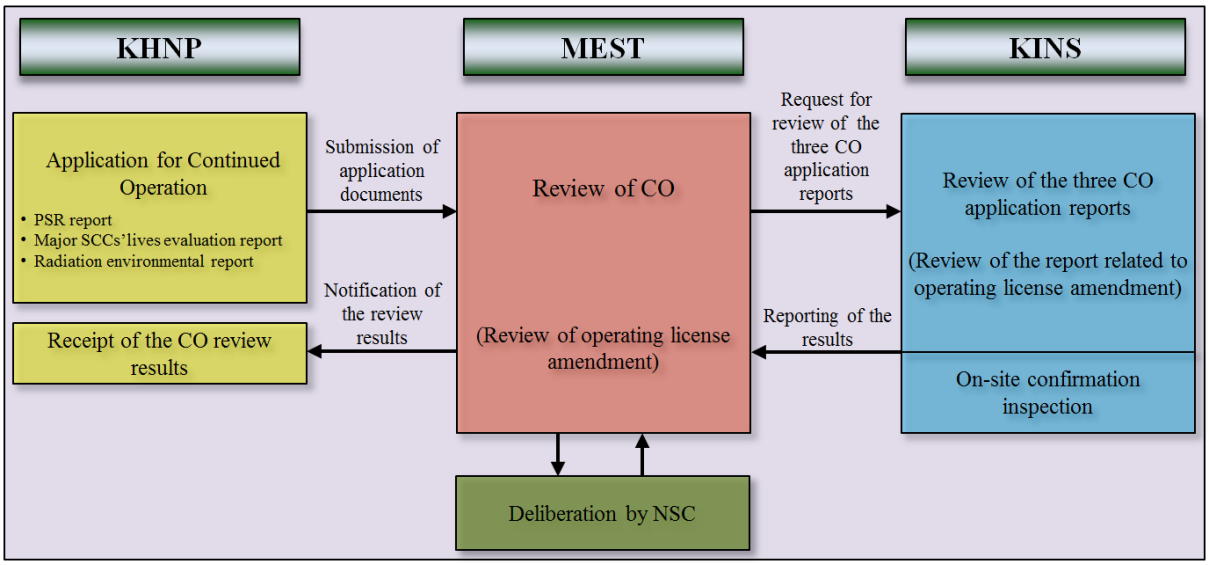
6.14. CONTINUED OPERATION

Nine plants out of 21 in operation in Korea are over the 20 year operation period (Kori Units 1 - 4, Yonggwang Units 1&2, Ulchin Units 1&2 and Wolsong Unit 1). The design life for NPPs of Korea, as established in the final safety analysis report (FSAR) of the NPPs, is as follows:

- 40 years for all PWR plants other than Kori unit 1;
- 30 years for all PHWRs.

The *Atomic Energy Act* stipulates that if the operator wants to continue operation of an NPP beyond its design life, in increments of 10 years (article the 42-2 (4) of the *Enforcement decree of the Atomic energy act*), a corresponding safety assessment report should be submitted to the regulatory authority. In addition, in cases where any changes to the contents of the existing operating license is deemed necessary following the regulatory review of the continued operation application, the licensee should then apply for an operating license amendment. This approach was found adequate by the Team.

The continued operation application timeframe, contents and methodologies are specified in *Enforcement decree of the Atomic energy act*.



The regulatory framework for continued operation of an NPP beyond design life was introduced in 2005, by amending and extending the existing regulations on PSR. When the PSR is related to the application for continued operation, according to article 42-2 (4) of the *Enforcement decree of the Atomic energy act*, the licensee assessment report, which consists of a "specific" PSR report (see after), should be submitted at least two years before the expiration date of the plant design life but not more than five years before that date. The same decree, in its article 42-2 (1) requires that the operator comprehensively assess the safety of the NPP every 10 years. There were extensive discussion between the Team and the regulatory body on the compatibility of PSR frequency and continued operation application timeframe. Several different explanations or interpretations were presented to IRRS team. These two extreme possibilities were expressed:

a) The guiding principle is that, once continued operation is on-going, the PSR rhythm will follow the continued operation rhythm. Hence, there is the potential that the next PSR occurs between 8 and 13 years ;

b) The 10 year frequency is maintained during the continued operation period and the timeframes of PSR and continued operation application are unified. KINS indicated that this was the current KHNP intent.

Finally, KINS and MEST confirmed that b) was the appropriate interpretation of the current regulations. Considering the confusion which occurred on this topic, the Team suggests that this position be included in KINS guidance. This could also be later clarified into the regulations.

In addition to the 11 items of a "normal" PSR (see chapter 6.12), two supplementary reports have to be included:

- Life assessments for major equipment considering the length of the continued operation period; and
- Analysis of the potential variation in the radiological impact on the environment since the issuance of the operating license.

The regulations explicitly require that the technical standards used as the basis of the assessment to reflect the latest operating experiences and research results be applied to the SSC life evaluation and the latest technical standards applied for the radiological environmental impact analysis.

The MEST Notice 2009-37 (*Guidelines for Application of Technical Standards for Assessment of Continued Operation of Nuclear Reactor Facilities, MEST.Reactor.035*) deals specifically with continued operation and its assessment. This notice specifies those evaluation items to be addressed, the applicable technical standards and the evaluation criteria.

Specific requirements related to PSR supporting application for continued operation	
Safety factor: incorporation of the latest operational experience and research findings	**Safety factor: Radiological environmental impact analysis based on the latest technical standards**
- scoping and screening analysis for the SSCs requiring aging management; - evaluation of the aging management programs; - life evaluation for the continued plant operation; and - requirements to account for research findings and operating experience.	- continued operation plan; - environmental impact; - plant status; - consequences resulting from the continued operation; - consequences of potential accidents; and - the environmental monitoring plan.

KINS developed the review guidelines for both the PSR report and the continued operation (see below). They are available on KINS' website. In addition, for PHWR, a "CANDU reactor council" (MEST, KINS, KAERI, KHNP, KOPCO E&C, KNFC, KEPRI) was established to discuss safety issues related to PHWR, cooperate and exchange information between relevant organizations regarding safety issues raised by long-term operation and design features. It has met four times up to now.

As per the MEST Notice 2009-37, items for the aging management program include a total of 39 items for a PWR (such as reactor vessel, steam generator tubes, containment building) and a total of 38 items for a PHWR (such as nuclear fuel channels, feeder pipes, steam generator tubes, containment building). However, the Team noted that systems covered are only those necessary to cope with design basis accidents. Systems necessary to manage beyond design basis accidents are out of the scope.

In addition, it also provides guidance on execution of site inspections used to confirm the adequacy of the contents and results of the corrective measures taken at the plant to meet the technical criteria for the continued operation evaluation.

The Team noted the benefits of the approach implemented in the area of regulations for In-service inspections for Articles 6 Clause 4 (2) 1 and 2 of MEST Notice Reactor.016, "*Regulation on In-Service Inspection of Nuclear Reactor Facilities*", which requires that the latest versions of relevant codes (1 year prior to the commencement of the inspection interval) for PWRs and PHWRs be implemented for the inspection interval of 10 years. This requirement brings continuous improvement in terms of the latest in-service inspection requirements during all phases of operations and continued operations. A table demonstrating the progression of standards over the years was provided for all Korean nuclear power plants from 1978 to 2012.

As for assessing an application for continued operation, KINS uses two review guidelines, KINS/GE-N8 (PWR plants, 2006) and KINS/GE-N11 (PHWR plants, 2007). These review guidelines (either for PWRs or PHWRs) consists of two chapters:

- Chapter 1, "General provisions," addresses the purpose, relevant rules and regulations and acceptance criteria, application scope, and the continued operation evaluation procedure;
- Chapter 2 "Contents" addresses general guidelines, establishment of evaluation scope, aging management programs, time limited aging analysis, incorporation of operational experience and research findings, and radiological environmental impact analysis.

In addition to these review guidelines, KINS also applies its review guidelines on PSR and the one on hydrogen control. However, in its continued operation guidelines, KINS references only its severe accident guidelines only in the hydrogen management topic, which is consistent with article 8 (8) of MEST notice, but is very restrictive.

The Team considers that KINS should cross-reference these specific guidelines in KINS/GE-N8 and KINS/GE-N11 so to explicitly ensure the comprehensiveness of assessment.

Two specific cases of regulatory review associated with the Continued Operation were discussed by the IRRS team.

Kori Unit 1

Kori Unit 1 (PWR type), the first NPP in Korea, started commercial operation in 1978. In preparation for continued operation, KHNP conducted significant plant upgrades including steam generators replacement and seismic reinforcement, and established an aging management program through a comprehensive assessment for aging degradation. On 16 June 2006, KHNP submitted an application to get approval for the continued operation of Kori Unit 1 beyond its design life, which expired on 18 June 2007.

KINS conducted a safety review for 18 months to assess the safety of continued operation, including verifications for PSR report, lifetime assessment reports for major equipment and radiological environmental assessment report. More than a 1000 questions were addressed to KHNP. On-site

inspection was performed by KINS from January to October 2007, including four team inspections. The inspections results were reported to MEST before MEST issued the authorization for continued operation, as part of the overall review report to MEST. In addition, the detailed internal report was prepared by KINS, but was issued after MEST authorized continued operation (report dated March 2008).

Supplementary to KINS review, the MEST in August 2007 invited the IAEA SALTO mission to conduct an independent review. Eight good practices and five improvements were identified. The follow-up IAEA mission took place in May 2010. The IAEA experts examined the implementation of the five follow-up mission items and confirmed its adequacy.

The (overall) review report presenting KINS assessment and inspection, as well as IAEA SALTO mission results, was issued in December 2007 and transmitted to MEST. KINS safety review confirmed that safety operation could be guaranteed for 10 more years beyond the original 30 year design life, on the basis that the overall safety had been enhanced through improvements made to major equipment such as seismic features and fire protection measures, and also through the addition of a hydrogen removal facility to better cope with severe accidents.

MEST approved the continued operation for 10 more years beyond its design life of 30 years in December 2007. ***Wolsong Unit 1***

Wolsong Unit 1 (PHWR type) design life expires on November 20, 2012. In relation to its submission, as the elongation of pressure tubes of Wolsong Unit 1 approaches to the prescribed limit, KHNP submitted an amendment to operating license mid-2007 to replace all of 380 pressure tubes. The MEST approved the replacement in December 2008 after KINS reviewed and confirmed the design and performance of new pressure tubes, the safety of replacement work, the appropriateness of radiation protection and radioactive waste management, and radiological environmental impact. The replacement of all of 380 calandria tubes, pressure tubes and feeder pipes occurred in April 2011 and Unit 1 was returned to full power mid-July 2011.

On 30 December 2009, KHNP submitted its application to get approval of the MEST for the continued operation of Wolsong Unit 1. Its review by KINS is on-going. The KINS review will in particular address two main issues, which are hydrogen control and technical specification, as well as lessons learned from Fukushima accident.

Special safety inspection following Fukushima accident

One specific area of this special safety inspection dealt with plant under continued operation. The special safety inspection process and results, including identified improvement measures, which are described in section 11. Among the 50 improvements measures identified for the plant under continued operation two deal with periodic inspections (6-1 and 6-2), there is one on aging management program management (6-3), and three on extending to other plants provisions already implemented at Kori Unit 1 (6-4 to 6-6).

7. INSPECTION

NUCLEAR POWER PLANTS

7.1. ORGANIZATION FOR INSPECTION

The Nuclear Safety Division (NSD) of the Ministry of Education, Science and Technology (MEST) is the regulatory body for the Republic of Korea's nuclear industry that is charged with overall authority for enforcement of nuclear safety matters. RSD has a relatively small number of personnel at its disposal and it relies heavily on the technical knowledge and expertise provided by the Nuclear Regulation Division (NRD) and 11 technical divisions of the Korea Institute of Nuclear Safety (KINS) to enable it to fulfill its regulatory duties, including the inspection of facilities and activities of authorized parties. This delegation of authority is permitted by legislation i.e. within the Articles of the Atomic Energy Act (AEA), the Enforcement Decree of the Energy Act, and the Korea Institute of Nuclear Safety Act.

Staffs from both organizations are certified by the Minister of Education, Science and Technology as Inspectors; but although they are each recognized as regulatory bodies in their own right, each undertakes a completely different role, as defined in legislation. KINS inspectors act as the technically competent experts and they complete all of the technical inspections activities on behalf of MEST. MEST inspectors perform a more administrative role, but have the regulatory powers of permissioning and enforcement at their disposal, which are exercised on advice from KINS.

The team recognizes that the two regulatory bodies work very closely together on inspection activities in an integrated and complementary manner. A view was considered about whether the enforcing body needs to be able to take intelligent ownership of the work and recommendations made to it by the technically competent regulatory body. However, as stated previously, the regulatory roles and responsibilities of each is fully defined in legislation and, on this basis, the Team has taken a view that this latter issue does not need to be pursued further. However the proposed changes to the regulatory framework in Republic of Korea and the new role of the Nuclear Safety Commission will have an impact on this. A Recommendation and Suggestion have been made in Sections 1 and 3 of this report that are intended to ensure that these proposals, when implemented, do not have a detrimental impact on nuclear safety regulation but further its robustness and effectiveness.

7.2. INSPECTION PROGRAMMES

Article 23-2 of the AEA of the Republic of Korea states that "... any operator of a nuclear power reactor shall undergo an inspection of the Minister of Education, Science and Technology for matters, etc. concerning the operation of the nuclear power reactor and related facilities ... under the conditions as prescribed by the Presidential Decree." The Decree sets out a range of required inspections:

- Pre-operational Inspections
- Periodic Inspections
- Quality Assurance Inspections
- Special Inspections
- Daily and Unannounced Inspections by the Resident Inspectors

The Enforcement Decree and Regulation of AET, and MEST Notices identify the scope and timing of the inspections for each type, defining a set of standard activities for each type that varies dependant only on the type of reactor and programme schedules are developed for each of these set of inspection activities. The MEST and KINS resident inspectors are tasked with the performance of the Daily and Unannounced Inspections. The remainder of the inspections are conducted by KINS headquarters staff in accordance with the delegated authority set out in legislation. A request from the utility to MEST triggers the production of the schedule for the Pre-Operational Inspection activities by KINS, which, if satisfactory, will culminate in the issuing of the appropriate licence by MEST. The Periodic Inspections are conducted primarily by KINS headquarters staff, and occur during each plant's overhaul (refuelling outage) typically performed every 18 months. KINS headquarters staff perform periodic Quality Assurance inspections of vendors and each licensed facility's quality assurance program. In the event of abnormal conditions at a licensed facility, KINS headquarters staffs are dispatched, depending on the significance of the event and typically within 24 hours of notification from the licensee, to follow-up and assess the event.

Daily inspections are undertaken by MEST and KINS resident inspectors to check and confirm the status of operational nuclear power plants and those under construction. These daily inspections are overseen out of the MEST Resident Inspector's office, with the MEST Senior Resident Inspector having supervisory responsibility of all resident inspection office activities. MEST Instruction and Inspection Guidelines specify the scope and periodicity (daily, weekly and monthly) of each activity. Daily inspection checklists are followed for both operational reactors and those under construction, and they include a wide variety of areas including staffing levels, documentation, plant parameters, logs, maintenance and testing, fire protection, configuration control, radiological protection & dose control and abnormal conditions. Daily and unannounced inspections are conducted by the KINS resident inspectors, who may be accompanied by the MEST inspector, and may take the form of document review, witnessing tests or plant walk downs.

In all cases it is the KINS inspectors who determine the technical adequacy of the licensed facility activities that they observe and inspect. Findings from KINS inspectors, whether from the residents or KINS headquarters, are always reported through MEST, who had the regulatory authority to require corrective action. The Team observed that there was no process in place for dealing with disputes where MEST disagreed with KINS inspector findings and recommendations. Whilst there was no evidence of such disagreements, the Team recommends that the new Nuclear Safety Commission should ensure a formal process is provided that allows satisfactory resolution of such potential disputes.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, Requirement 22 - Stability and consistency of regulatory control - states that** *"The regulatory body shall ensure that regulatory control is stable and consistent."* **Associated Article 4.26 states that** *"… The process shall ensure the stability and consistency of regulatory control and should prevent subjective decision making by the individual staff members …"*
R8	**Recommendation: The new Nuclear Safety Commission should recognize the current potential for conflict between technical and enforcing inspectors and ensure measures are introduced to reconcile these differences in an effective manner.**

The Enforcement Decree to the Atomic Energy Act requires licensees to submit to MEST details of all plant modifications that it is seeking to implement. An assessment of all nuclear safety related modifications is completed by KINS on MEST's behalf, including on-site inspections of those modifications. Where findings are made, they are included in a formal inspection report; otherwise the successful outcome is noted in the Resident Inspectors daily log.

7.3. SCOPE OF INSPECTIONS

Preoperational inspections begin at the early stage of site construction, when ground excavations commence. They are intended to confirm the adequacy of materials, components, systems and structures, as well as looking at the adequacy of construction related activities, processes, procedures and personnel competence. They provide assurance regarding the integrity of the primary and secondary systems, safe shutdown capability and will include oversight and inspection of cold and hot functional tests. Once the inspections are successfully completed, the Operating Licence is granted by the MEST minister and the licensee can proceed to core load, which is covered by the final stage of preoperational inspections.

Periodic inspections are undertaken to ensure that the performance of the nuclear power plant facility is being maintained to a similar standard to that achieved during the preoperational phase, and they are completed commensurate with the refuelling outage period. Satisfactory completion of which is necessary for restart permission to be granted by the MEST senior resident inspector. The periodic inspections focus on what are termed performance and operational capability type inspections. Examples of the former include core physics tests, emergency core cooling systems, S/G ECT, RCS flow rate, and containment isolations. Under the latter, KINS inspectors will look at areas such as organisation capability, training, human factors, procedures and operating experience.

A comprehensive programme of quality assurance inspections is undertaken by KINS to confirm the quality of components and equipment manufactured by vendors for the Korean nuclear programme. The prime contractor and associate subcontractors develop Quality Assurance Plans which KINS inspects against; it undertakes its inspection using the required fabrication, construction and manufacturing standards now set out in Korean KEPIC documents. The annual Quality Assurance inspection plan produced by KINS ensures that all major vendors to the Korean nuclear programme are subjected to a KINS QA inspection once in the 12-month period, including all overseas suppliers; this was considered as good practice by the inspection team and is recognized here.

It has already been mentioned that inspections are undertaken by KINS on a daily basis to a predefined scope and periodicity, and these are seen as important in providing assurance regarding the day to day safety performance of the licensee.

Special inspections are also undertaken should the need arise in relation to unexpected, unplanned or unusual events such as happened at Fukushima. The special inspections will focus on the topic of concern and will involve KINS site and headquarters staff as necessary.

During the observation of a number of KINS inspections on Kori and Shin Kori NPP sites, the team concluded that the inspection process was robust and to the benefit of nuclear safety; pre-inspection activities are completed to confirm system configurations, correct procedures and drawings being used, operator understanding, oversight of pre-job brief, checked design parameters of valves, tanks and pumps, test environment, and inspectors took photographic evidence of deficiencies to be included in the written

report. Inspection activities were attended by responsible managers and employees of KHNP and its subcontractors, with good cooperation between all parties. The opinion of the IRRS team was that KINS inspectors showed a high level of professionalism and knowledge of the procedures and inspection practices, with the results of the inspections being formally recorded and reported to MEST.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-G-1.3 – Article 2.4 states that** *"Regulatory inspection should include a range of planned and reactive inspections over the lifetime of the nuclear facility and inspections over relevant parts of the operators organization and contractors to ensure compliance with regulatory requirements"*
GP 10	**Good Practice: The annual Quality Assurance inspection plan produce by KINS ensures that all major vendors to the Korean nuclear programme are subjected to a KINS QA inspection at least once in the 12-month period, including all overseas suppliers.**

7.4. UTILIZATION OF INSPECTION RESULTS AND INSPECTION EXPERIENCE

Results of inspections, including findings, are identified in clear communications between KINS and MEST and include expectations for corrective actions. KINS inspections result in a request for broad-based corrective actions to be performed, and the licensee responds with specific actions taken or that will be taken to address the concern(s). Extensive use is made of databases within KINS to record issues, management information, corrective actions and operating experience. Planning and preparation for the Periodic Inspections will make use of this information from these databases to inform and focus some of the inspection activities, particularly where corrective actions are still to be completed.

To further encourage and improve cross site learning, MEST and KINS hold meetings between its resident inspectors and project managers 3 times a year. These events are used to share experiences and concerns across all of the nuclear plants and sites within the Korean nuclear programme.

7.5. RISK INFORMED INSPECTIONS AND GRADED APPROACH

The Periodic Inspection approach adopted by KINS has been subjected to a risk informed analysis. In 2006 KINS recognized it needed to enhance its inspections by ensuring they focused on risk significant safety systems and components in a graded approach, this was also intended to provide efficiency benefits. The initial analysis identified 19 areas for improved focus, however subsequent work has reduced this to 6 including: seismic, safety related electrical equipment, batteries, ECCS and fire protection. KINS's work has ensured that the Periodic Inspection programme is risk informed to a degree and the Team is satisfied that Periodic Inspections are a relatively robust and risk informed programme of inspection activities.

Although the utility categorizes systems with regard to their safety significance and resident inspectors are cognizant of this when undertaking their day to day inspection activities, there is no formal graded approach to the schedule of daily inspections, which constitute a significant proportion of the regulators assurance activities. The team believes that a risk informed approach needs to be applied to assist the

inspectors in targeting their activities, this is particularly important when work loads are high, which is increasingly likely with even more operational reactors coming on line. Sampling was in evidence e.g. reports reviewed instead of observing test, and they also use operational experience to inform the selection of a small number of inspections within a week.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, Requirement 29 states that** *"Inspections of facilities and activities shall be commensurate with the radiation risks associated with the facility or activity, in accordance with a graded approach."* **and Article 4.50 states that** "The regulatory body shall develop and implement a programme of inspections of facilities and activities, to confirm compliance with regulatory requirements ,,, In this programme it shall specify the types of regulatory inspection (including scheduled and unannounced inspections), and shall stipulate the frequency of inspections and the areas and programmes to be inspected in accordance with a graded approach."
(2)	**BASIS: GS-G-1.3, Article 3.14 states that** *"Inspections by the regulatory body should be concentrated on areas of safety significance. These are those SSC's and activities affecting safety or processes important to safety, which are identified as such in the safety documentation submitted by the operator or in the findings of the regulatory body's review and assessment …"*
R 9	**Recommendation: Daily inspection programmes should be reviewed by KINS to ensure they are founded on the safety significance of the structures, systems and components such that they are inspected in a graded and systematic manner.**

7.6. INSPECTOR TRAINING AND QUALIFICATION

MEST resident inspectors are each formally appointed by the MEST Minister. There are no specific nuclear training/education requirements for them to be appointed; only a general civil service certificate is required. It was noted that the term for each resident inspector is for up to 5 years. Regulatory inspectors having responsibilities in relation to the safety of facilities and activities within the nuclear industry should receive suitable industry specific nuclear training before formal appointment as a regulator, and this aspect is addressed in earlier sections of the report on responsibilities and functions of the regulatory body.

KINS inspectors' requirements for qualification include a basic qualification as an inspector (participation in several periodic and pre-operational inspections over the course of two years), and successful completion of a short training class in regulatory fundamentals. Assignment as a KINS resident requires further assessment by KINS management regarding the candidate's abilities and fitness to fulfill the position. According to Article 322 of the Enforcement Decree, KINS inspectors must possess an authorization from MEST in order to conduct inspections at all times. Inspectors receive formal endorsement to act in the role of inspector via certification from the MEST Minister. Assignments are typically for 2 years and can be extended for up to 5 years or more. Most KINS resident inspectors appear to opt to return to KINS headquarters following their initial term. KINS resident inspectors perform all technical inspections, including daily resident inspection.

Discussions with KINS management representatives confirm that KINS has an appraisal process for its inspectors. For KINS resident inspectors (currently 12) this involves a twice yearly assessment of each one covering character, technical knowledge, timeliness, regulatory impact and engineering achievement. It is undertaken by the head of the Regulation Management Department at KINS headquarters, but he utilizes formal feedback from the MEST senior resident inspector and KHNP. The process is limited, as there are no formal arrangements in place to confirm on a regular basis that the standard of site inspection being undertaken by the resident inspectors continues to be suitable and sufficient, by meeting the standards and expectations of the parent organization. To ensure that its site inspection and enforcement activities are being carried out in a suitable, consistent and effective manner, the Team suggests that KINS establishes a formal process to observe and assess the inspection methods and techniques of all of its inspectors on a regular basis.

It was noted that KINS Project Managers make frequent visits to site and observe their own staff undertaking project inspections on the site, but this only involves oversight of headquarters staff undertaking site work, not the resident inspectors.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-G-1.3, Article 6.1 states that** *"The regulatory body should have a system to audit, review and monitor all aspects of its inspection and enforcement activities to ensure that they are being carried out in a suitable and effective manner. It should be ensured by means of this system that any changes necessary in inspection and enforcement activities owing to improvements in methods are implemented."*
S 11	**Suggestion: The regulatory body should ensure it implements a formal process to observe and assess the inspection methods and techniques of all of its inspectors to ensure they are being conducted in a suitable, consistent and effective manner**.

RESEARCH REACTORS

The inspection types applied regularly for research reactors are identical to those for nuclear power plants, i.e. pre-operational inspection, Periodic Inspection and Quality Assurance inspection. Inspections are performed by the KINS staff on behalf of MEST/NRB.

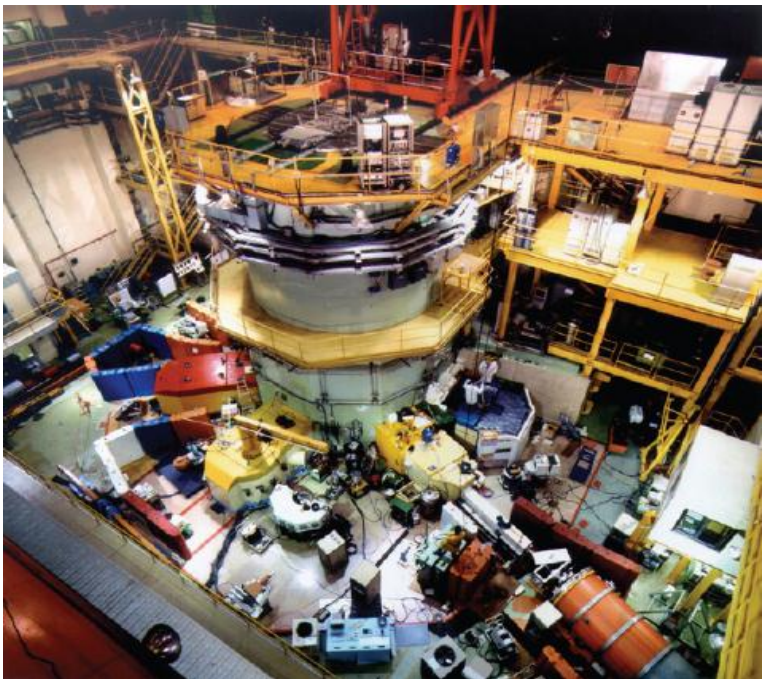
Pre-operational inspections are requested by the license prior to obtaining operation license. The inspection is meant to demonstrate that the research reactor is ready for operation. The inspection is expected to verify the suitability of the structural elements of the facility, the proper functioning of the major technological systems, cold and hot state functionality, fuel loading and startup and also that the system meets all requirements set by the regulatory body.

Periodic Inspections are performed once in every 24 months in both research reactors. The duration of such an inspection is four weeks and it is meant to demonstrate that the reactor and the important structures and components are maintained in the state corresponding to the design and that the facility meets all requirements set by the regulatory body. The objectives and scopes of the Periodic Inspections are set by a MEST Notice, the scope includes about 40 items.

Quality assurance inspections are performed according to the QA plan, once in every two years in every research reactor, and are meant to demonstrate that the QA requirements are met.

KINS staff for inspections are recruited by the Research Reactor Project Manager from the 11 expert groups in KINS according to the professional needs of the actual inspection. For activities related solely to research reactors are relatively rare, no permanent staff is dedicated to the research reactor safety from KINS. Examples of Periodic Inspections are given in the Chapter on enforcement of this report.

Besides the regular inspections special inspections may also be initiated if necessary.



The HANARO research reactor

8. ENFORCEMENT

NUCLEAR POWER PLANTS

8.1. ENFORCEMENT POLICY AND PROCEDURES

The enforcement policy for the Korean nuclear industry is enshrined in the legal framework whose primary piece of legislation is the Atomic Energy Act and it provides MEST with the legal authority for enforcement that it is able to exercise at its discretion. MEST is readily recognized by the utility in this role and during the mission the utility demonstrated a clear understanding of the different roles and authorities of both the regulatory bodies.

Enforcement covers a range of topics including verbal and written warnings, orders to curtail specific tasks, modification or revocation of license/construction permits and punitive penalties. In reviewing the legislation it is clear that MEST has all of these regulatory tools at its disposal, including the option of pursuing the dismissal or prosecution of individuals, with the potential for penal servitude, but KINS fulfils an essential role for MEST in ensuring that it is able to apply these tools in a targeted and proportionate manner. Procedures set out the process that should be followed by both MEST and KINS in gathering information, processing it and determining a particular course of regulatory action.

The team pursued the topic of criminal penalties to individuals and whether the threat of penal servitude is likely to be detrimental to the fostering of a strong safety culture, including the self-reporting of deficiencies and violations. The standard translation of the relevant Articles into English, originally provided to the Team, appears to have omitted some important matters. The translation subsequently provided highlights that it is only pursued if it is willful violation that has occurred and would not be pursued if an incident occurred as a result of pure negligence and this allayed any previous concerns.

The process for taking enforcement action is documented in MEST Notices and is dependent on the degree of enforcement that is considered necessary and the urgency of the situation. Legislation allows the MEST senior resident inspector to verbally order the utility to shutdown plant operations or to take other actions in an emergency situation. Otherwise, enforcement action is less immediate, with corrective actions tending to be decided and agreed upon after engagement and discussion between all parties. The team considered that this reflects the nature of enforcement within the Korean nuclear industry, which is based on a strong culture foundation of mutual cooperation and respect; this allows shortfalls and deficiencies to be addressed in a non-confrontational way. However, it was confirmed by MEST inspectors that more significant enforcement action would be taken if considered necessary. The bulk of the enforcement actions relate to the notification of inspection findings and the associated corrective actions, which have always been completed without conflict between the regulator and the regulated. Generally the MEST resident officer instructs the more minor cases of these, and the major ones are instructed by the MEST headquarters officer.

The team also followed-up on the longstanding of issue of PWR sump clogging, which was identified about 20 years ago in Sweden. It was confirmed that it had not been satisfactorily addressed yet in Korea, from 21 units in operation, only 3 of them have taken corrective action. For the remaining units the process is on-going with completion scheduled for 2014. KINS confirmed that it had looked at the

schedule provided by the utility to address this matter, and it had judged that it was satisfied with the programme and the 2014 completion date, indicating it was dealing with the matter in a proportionate manner.

In the cases where investigations conclude that a financial penalty should be levied on the utility within the legislative framework, a Penalties Council is convened to determine the appropriate level of fine. The Council is led by the head of MEST Nuclear Safety Bureau and is made up of members from KINS, MEST and its legal experts, but the final endorsement is from the MEST Minister who endorses the recommendation of the Council. The utility is required to attend to set out its case and justify its actions. The Council then sets the level of fine.

8.2. GRADED AND PROPORTIONATE APPROACH

Regulatory enforcement actions are based on a graded approach set out in the AEA and MEST Notices, generally related to the significance of the findings of the inspection activities, which are also undertaken in relation to abnormal events or occurrences. The tools can be applied to both operating reactors and those under construction. The inspection findings form is produced by KINS, and MEST will then issue it to the licensee. The associated enforcement action is graded dependent on the significance of the finding. Broadly three classifications are applied:

- High significance e.g. matters of violation of permit or license and matters that need to be rectified for the purpose of nuclear safety.
- Medium significance e.g. procedural violation.
- Low significance – recommendations for improvement not amounting to regulatory violation.

Within the higher significance band MEST is able to apply a further scale of penalties related to the degree of violation of the legal requirement. The AEA sets out a clear schedule of penalty surcharges that can be levied on the utility dependent on the breach of legislation or safety standard that has occurred. However, these appear quite small sums of money (max KRW 35M, plus an additional 50% at the discretion of the MEST Minister) when compared to the earnings potential of the utility and in the teams opinion are not considered large enough to act as a deterrent to future acts of non-compliance.

Although a range of strong, robust enforcement tools are available to MEST, the strongest have never been used. The strongest enforcement actions taken by the regulatory body for operational and constructional NPP's that were identified during the mission were: the delay of a number of NPP restarts; the letter recently written by MEST notifying the utility of the need for safety improvements post Fukushima; and a series of financial penalties ranging from KRW 15M to KRW 48M, associated with 8 different types of offence over the last 15 years.

8.3. APPEALS PROCESS

Where the utility or other parties do not agree with the enforcement action imposed by the regulatory body they have a right of appeal, as set out in the Articles to the AEA. However, the appeals process has never been implemented; the utility has complied with all levels of enforcement applied by the regulatory body without question. There has been some local discussion on timescales and scope content of corrective actions in relation to certain inspection findings, but these do not constitute appeals in the

purest sense, and again reflect the cooperative culture. Where a financial penalty is imposed, the route for appeal is via the Penalties Council.

8.4. IN DEPTH REVIEW OF SELECTED CASES

As part of its review of enforcement, the Team examined three incidents in relative depth, following up on the degree of enforcement action taken by the regulatory body. These included: (1) a reactor trip due to steam generator low level at Shin Kori Unit 1 on August 27, 2010; (2) inadvertent containment spray during commissioning operation at Shin Kori Unit 1 on September 17, 2010; and (3) a safety injection line thermal sleeve detachment at the Yonggwang Unit 5 in August 2003.

With regard to the August 2010 event at Shin Kori Unit 1, the event was the result of human error. A reactor operator partially closed the flow of the generator stator cooling water. Since the error did not result in any identified of Korean regulatory requirements, no further enforcement action was taken. However, corrective actions were implemented by the licensee.

For the September 2010 event at Shin Kori Unit 1, the event was also the result of human error. During commissioning activities, a reactor operator inadvertently manipulated a containment spray valve switch, following a test engineer's local equipment manipulation without control room approval, which directly caused the spray of reactor coolant into the containment, partial draining of the reactor pressure vessel, a slight increase in the fuel surface temperature, and exceeding the technical specification-allowed cool-down rate of the reactor coolant system. Reactor operators manually actuated high pressure safety injection to recover reactor inventory. The reactor remained in a shutdown condition during the Special reactive inspection, which lasted for approximately 30 days. Following the completion of the Special Inspection, KINS inspectors identified one high level violation that ultimately resulted in MEST imposing a 45 million KRW penalty on the utility, a relatively small financial penalty in the opinion of the team. The event was categorized as an INES Level 2 event.

The regulatory body had considered ordering the NPP to remain shut down after the initial post event shutdown period, but discounted this because it considered all the safety issues to have been satisfactorily addressed, allowing reactor operations to restart in October 2010. The team considered this a comparatively short period post the incident given the relative significance of the event, the contributing factors and the range of associated improvement issues. It is questionable whether they could have been fully addressed in such a short period of time, raising questions about the associated decision making and enforcement strategy. Consequently, it is recommended that a review should be undertaken of the enforcement strategy adopted for significant events, to determine whether there are any lessons to be learned and improvements required with regard to the associated regulatory decision making processes and enforcement strategies.

For the August 2003 event at Yonggwang Unit 5, the event was the result of an inadequate design review resulting in the inappropriate method being used to install thermal sleeves in the safety injection lines. This resulted in one of the thermal sleeves becoming detached due to flow induced vibration and dropping to the reactor lower support structure, damaging the reactor vessel cladding. As a result of the KINS inspection, MEST imposed a 25 million KRW penalty on the utility. The utility ultimately removed all such thermal sleeves from all other units of similar design.

The Team's impression is that all parties work together in the best interest of safety, to address particular shortfalls and deficiencies as expeditiously as possible, without having to use stronger formal enforcement action. This ability to achieve regulatory objectives in a cooperative environment, whilst having a range of more robust enforcement tools available, is seen as a positive feature of the regulatory approach in Korea.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1, para. 4.54 states that** *"The response of the regulatory body to non-compliances with regulatory requirements or with any conditions specified in the authorization shall be commensurate with the significance for safety of the non-compliance, in accordance with a graded approach."*
(2)	**BASIS: GSR Part 1, para. 4.55 states that** *"Enforcement actions by the regulatory body may include recorded verbal notification, written notification, imposition of additional regulatory requirements and conditions, written warnings, penalties and, ultimately, revocation of the authorization."*
S12	**Suggestion: The regulatory body should complete a review of its decision making processes that have been applied to significant events to determine whether the appropriate enforcement actions were taken and whether improvements are required to its decision making processes and associated enforcement strategies.**

RESEARCH REACTORS

Periodic inspections in the Korean research reactors have revealed serious non-compliances in 2005.

In the HANARO reactor of KAERI it was found that the equipment and devices as actually installed have shown marked difference from the status reflected in the Safety Analysis Report. The major non-conformances include deficiencies in the control system, omission of the compulsory notification of MEST/NRB on the modifications of the licensed status (including the reactor, the experimental devices, the radio-isotope production facilities, test facilities, etc.), deficiencies in the management of radioactive materials. Altogether 66 findings were identified by MEST/NRB.

The regulatory body took a number of enforcement measures such as:

- calling the licensee to establish an organization responsible for license documentation control and safety management as well as to implement a comprehensive plan for re-establishing a proper safety oversight,
- shortening the period of the Periodic Inspections from 24 months to 12 months,
- suspending the operating license for a period of 6 months

Follow-up inspection in 2007 has testified the rectification of the non-conformances revealed in the findings.

In the AGN-201 education reactor of the Kyung-Hee University the periodic inspection revealed that a power excursion test up to 20W had been performed without the approval from the regulatory body. At that time the licensed maximum power was 0,5 W and the test was meant to verify the possibility of a power uprate to 10 W.

The regulatory body suspended the operating license of the reactor for a two months period.

In summary, the Regulatory body has shown an exemplary strict and determined handling of the safety related non-conformances at the licensees.

9. REGULATIONS AND GUIDES

9.1. EXISTING REGULATIONS AND GUIDES

The higher level legislative framework is discussed in previous sections of this report.

As described below, the legal framework for regulations and guides in Korea is well established. The hierarchy of the various legally binding requirements and, more recently, the hierarchy of non-binding recommendations (KINS regulatory standards and regulatory guides) are clear. Numerous regulations and guides exist on a large spectrum of topics.

MEST and KINS Contribution to Development of Regulations and Guides

Some of the functions of MEST are to establish policies for nuclear safety and regulation and to establish technical standards and regulatory requirements. This is done, in practice, mostly by endorsing drafts developed by KINS, which are subsequently reviewed by the Nuclear Safety Committee.

KINS conducts nuclear safety regulation as entrusted by the MEST in accordance with the *Atomic Energy Laws*. KINS is involved in the development of nuclear safety regulation technology and provides technical support to the MEST for policy development.

Requirements for Design Basis Accidents and Beyond Design Basis Accidents (Severe Accidents)

The regulations require licensees to study design basis accident, using a deterministic approach (article 2 and 42 of *Regulation on technical standards for nuclear facilities etc.*). There are no requirements related to beyond design basis accidents (or the design extension conditions established in SSR-2.1), or for completion of PSA. However, a *Severe accident policy statement for NPPs* was issued in 2001 and licensees implemented this policy which encompasses development of PSA, severe accident management program, severe accident prevention capabilities and containment structural integrity in case of a severe accident. In this regard, the Team noted that the *Comprehensive plan on nuclear safety* includes plans to issue regulations on these topics along with lessons learned from Fukushima and that KINS has already developed some draft documents in support of this initiative. The Team suggests that the progress on this item be included in the follow up IRRS Mission and that it considers the various regulations, guides and licensing documents (safety analysis reports, etc.) impacted.

MEST Notices

There are currently 77 MEST Notices, among which 27 relate to nuclear installations, 18 on radioactive waste, and 32 on radiation safety. Since 2009, MEST notices are reviewed every five years, according to *Presidential Instruction* (No 248), to ensure that they are still adequate. For example, early this year, KINS proposed to MEST to update six MEST notices.

The ***Regulation on technical standards for nuclear facilities etc***. requires MEST notices to be issued to give more detailed requirements to support the regulations. The Team performed a sample test on some articles of this regulation:

- Art 4 (geological aspects, including earthquake): the MEST notice exists since 1983 and was last updated in 2009. It basically refers to US regulations for NPPs;
- Art 5 (low density population): the MEST notice exists since 1983 and was last updated in 2009. It basically refers to US regulations for NPPs;

- Art 6 (meteorological conditions): the MEST notice exists since 2003 and was last updated in 2009;
- Art 7 (flooding, including tsunami): the MEST notice exists since 2003 and was last updated in 2009;
- Art 90 (dry fuel storage):This particular article applies specifically to Nuclear Fuel Cycle Facilities. KINS drafted a notice and submitted it to MEST in 2007.

The ***Regulation on technical standards for nuclear facilities etc.*** includes a large number of articles (thus many technical requirements) dealing with NPP. There is, however, a lot less articles for research reactors and fuel cycle facilities: There is usually an article requiring provisions described for NPPs to be applied *mutatis mutandis* for these facilities and another one enabling MEST to waive the application of MEST notice if appropriately justified. As an example the Team investigated whether MEST notice 2009-37 (for location of a nuclear reactor) was applicable for fuel cycle facilities and research reactors. This notice refers to US regulatory guides established for power reactors. KINS confirmed that the MEST notice was not waived for HANARO research reactor, and that the application was waived by MEST for the fuel fabrication facility (authorized in 2002). However, there was no MEST letter formalizing this waiver: the Team understood that the waiver is implicitly imbedded in the review and approval process during licensing (process to obtain a licence). During that process, KINS reviews the safety analysis report submitted by the licensee to determine the adequacy of the location.

As part of the *Comprehensive plan on nuclear safety*, KINS is considering developing specific regulations for research reactors, by gathering the existing regulatory requirements, which are currently dispersed in several regulations, into a specific section.

KINS Standards and Guides

There are more than 50 KINS "master" inspection/review guides. For example, these are further detailed into about 300 guidance documents for PWR safety review guide (KINS is now engaged in a process of discriminating within its guidelines those which should become regulatory standards (i.e. including criteria) and those which should become regulatory guides (i.e. detailed guidance on means to assess the achievement of criteria).

According to the KINS policy, guides should be reviewed every three years. KINS endeavours to meet this policy, which seems largely implemented, with a few exceptions. For example, in 2010, KINS reviewed all of its guides relating to NPPs.

9.2. PROCESS FOR DEVELOPMENT OF REGULATIONS AND GUIDES

Overall Process

KINS rules are applicable to KINS regulatory activities. Under the KINS quality management system, KINS develops working procedures consistent with KINS rules. There is a specific KINS rule on the development and management of the standards to perform regulatory work (N°14-18, 2009), which is applicable for the development of (draft) regulations and guides. There is a dedicated department for the safety standards and a dedicated Technical Standard Committee, which encompass external experts (only ¼ of the 81 members are KINS staff) to review the technical standards (with seven subcommittees). The main steps of the process are:

1. develop a work plan for the development of the guide;
2. review of the plan by KINS' technical standard committee;

3. develop the draft guide, including gathering opinions from stakeholders;
4. review and approval by KINS' Technical Standard Committee;
5. report to the MEST (KINS is an entrusted body by MEST);
6. promulgation by KINS; and
7. notification to the licensee through a "public" letter.

As per regulations, the Nuclear Safety Committee (and its five specialized subcommittees), which advise MEST, also includes a wide range of experts external to KINS and MEST.

The MEST regulations and MEST Notices are issued by the Minister of MEST through a process of: proposal by the KINS, convergence of review opinions from internal and external stakeholders (including the licensees and other relevant Government departments). The convergence process is essentially performed through the Nuclear Safety Committee. The promulgated regulations are readily accessible through the website of the Korean Government (www.law.go.kr).

The Team noted that a well-established framework for regulations and guides exists, which now includes periodic review of existing regulations and guides. For example, since 2009, MEST Notices have to be reviewed every five years and KINS guides every three years. The first *Comprehensive plan on nuclear safety (2010-2014)* encompasses a specific task on developing and maintaining safety regulations and guides and several specific items are already identified.

Stakeholder Involvement

In addition to their participation in the Technical Standard Committee, stakeholder involvement should occur at step 3: article 8 of KINS rule 14-18, which explicitly deals with gathering the opinion of licensees and other stakeholders (which can be submitted to KINS through website or letter). This article is not currently fully implemented and it is not KINS' practice to involve the public at the drafting stage.

These opinions, as well as comparison with domestic and international standards, including IAEA Safety Standards, are communicated to KINS' Technical Standard Committee when the draft is submitted.

KHNP is also formally consulted on the final draft of the regulation/guide after it has been reviewed by KINS technical committee to get the final formal position of KHNP on this draft.

It is recognized that the recent development of the "SCALE" data base system (http://scale.kins.re.kr), which is a web-based system, is a good approach to allow for access for the public and other stakeholders to published regulations and guides and to provide them a means to comment and provide feedback. This feedback will then be used as input for the next revision of the document.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-R part 1 Requirement 34 states that** *"The regulatory body shall notify interested parties and the public of the principles and associated criteria for safety established in its regulations and guides, and shall make its regulations and guides available."*
(2)	**BASIS: GS-R part 1 4.61 states that** *"The government or the regulatory body shall establish, within the legal framework, processes for establishing or adopting, promoting and amending regulations and guides. These processes shall involve consultation with interested*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	parties in the development of the regulations and guides, with account taken of internationally agreed standards and the feedback of relevant experience. *Moreover, technological advances, research and development work, relevant operational lessons learned and institutional knowledge can be valuable and shall be used as appropriate in revising the regulations and guides."*
GP 11	**Good Practice: KINS Technical Standard Committee plays a key role in reviewing draft comments by giving expert opinions. A significant number of external experts allow for broader stakeholder input. As per regulations, the Nuclear safety committee also includes a wide range of experts outside the Regulatory body.**
S 13	**Suggestion: Although stakeholder involvement is encompassed in the drafting process for regulations and guides, general public involvement should be enhanced, especially by making them aware of the drafts being developed well before they are submitted to KINS Technical standard committee.**

9.3. RELATION TO THE IAEA SAFETY STANDARDS

IAEA safety standards and publications are sometimes explicitly referred to in Korean regulations and guidance. They are systematically considered when developing draft regulations and guides (see Chapter 9.2).

Since 2002, KINS performed several comparisons between IAEA safety standards and Korean regulations and guides, to enhance consistency.

Recently, KINS performed such comparisons with:

- IAEA DS413: against Korean regulations and guides; and
- IAEA DS414: against Korean regulations (following an earlier comparison on NS-R-1 started in 2009).

Some discrepancies, which should be addressed, have been identified in the Korean regulations and guidance framework as follows for:

- DS 413 (to become SSR-2.2) on operation of NPP, KINS identified shortcomings in the some areas such as for safety culture, interface between safety and security, and decommissioning.
- DS414 (to become SSR-2.1) on design of NPP, KINS identified some shortcomings in some areas such as for detailed descriptions (e.g. definition of safety functions), operational experience feedback and PSA, interfaces between safety and security, and design extension conditions

KINS subsequently advised the Team that the rule-making for the detailed regulations and guides for decommissioning of nuclear power plant are delayed due to its low priority compared to decommissioning of research reactors. It is recognized there is legislation related to the authorization process for decommissioning, for example, when the decommissioning plan is to be submitted; however, the Team emphasized that it should happen earlier. Furthermore, detailed regulations on decommissioning

are still under development. This is recognized in the *Comprehensive Plan on Nuclear Safety*, which includes a specific task on that topic. See Chapter 1 for additional discussion related to this topic.

KINS presented a summary table of the initial comparison, for PWRs, of 36 IAEA safety standards (requirements and guides, i.e. about 7600 articles) with Korean regulations and guides. This table presents information on the comparison both on the level of detail and on the conservativeness. The results are heterogeneous.

This comparison, which is considered to be preliminary screening by KINS was performed within the KINS research division. KINS intends to complete a more detailed comparison by 2014. As a consequence, the current preliminary results have not yet been communicated to MEST.

The results of this comparison as they become progressively available will be an input to the KINS process of periodic revision of regulations and guides.

The process for prioritization of the review activities and resulting implementation actions was discussed with KINS and although the current processes are not formalized, it is clear that KINS considers factors such as gaps in requirements, conservatism, and implications from Fukushima. KINS had decided that the review of DS 413 and 414 was crucial, to review as early as possible, and 13 action items are already identified as a result. KINS should formalize a method for prioritization under the new Presidential Nuclear Safety Commission and the Team suggests that this item be included in the follow up IRRS Mission.

As per PHWR, KINS reviewed in 2010 the applicable regulations and guides. As there are many common points with regulations and guides applicable to PWR and as there are no current plans in Korea to build new PHWRs, KINS decided it was not a priority to perform a similar comparison exercise as the one performed for PWR. It was noted that MEST Notice 024 (*Standards for performance of emergency core cooling system of pressurized light water reactor*) only applies to light water reactors and that there is no corresponding MEST Notice for PHWRs. Subsequently, KINS provided information demonstrating an exception to this MEST Notice for PHWR and the additional measures that were taken through approval of the design manual to reach an equivalent safety level to that which was found in the MEST Notice. The Team considers that KINS should continue to ensure regulations and guides for PHWR are reviewed and developed as appropriate.

When drafting standards or guides, Article 7 of KINS rule 14-18 explicitly requires that the development plan includes references of relevant international standards. Article 9 of this rule also requires a comparison with the domestic and international standards.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-R part 1 Requirement 33 states that** *"Regulations and guides shall be reviewed and revised as necessary to keep them up to date, with due consideration taken of relevant international safety standards and technical standards and of relevant experience gained."*
GP 12	**Good Practice: The drafting process for regulations and guides explicitly includes identification then comparison to domestic and international standards, including IAEA safety standards. Since nearly a decade, there have been several comparison exercises between Korean regulations and guides and IAEA safety standards, in an effort to improve harmonisation with those standards.**

10. EMERGENCY PREPAREDNESS AND RESPONSE

10.1. BASIC RESPONSIBILITIES

The arrangements for emergency response actions both within and outside nuclear power plants are dealt with through the regulatory process, which is led by the Ministry of Education, Science and Technology (MEST) with shared responsibilities of other national agencies having involvement in the general emergency management framework. This framework plan is developed for 33 different types of emergencies, each of which is led by the competent national authority. The response to radiation emergency is one of these 33 emergencies; this arrangement fits into the concept of all-hazard emergency management approach. MEST is fully responsible for leading and coordinating all activities of the Korean Government relating to emergency preparedness and response in accordance with the relevant laws such as the "Atomic Energy Act" (AEA) of 1958 and the "Act on Physical Protection and Radiological Emergency" (APPRE) of 2004. Through regulatory activities such as review and inspection based upon the laws relating to emergency preparedness and response, and associated regulations and guides, MEST and the Korea Institute of Nuclear Safety (KINS) ensure that appropriate protective actions can be taken in a rational, effective and timely manner where a nuclear or radiological emergency occurs at a nuclear power plant or other nuclear facilities (research reactor, nuclear fuel cycle facility, radioactive waste management facility, and so on). MEST is responsible for regulating the licensees' on-site emergency planning and for the offsite planning, as well.

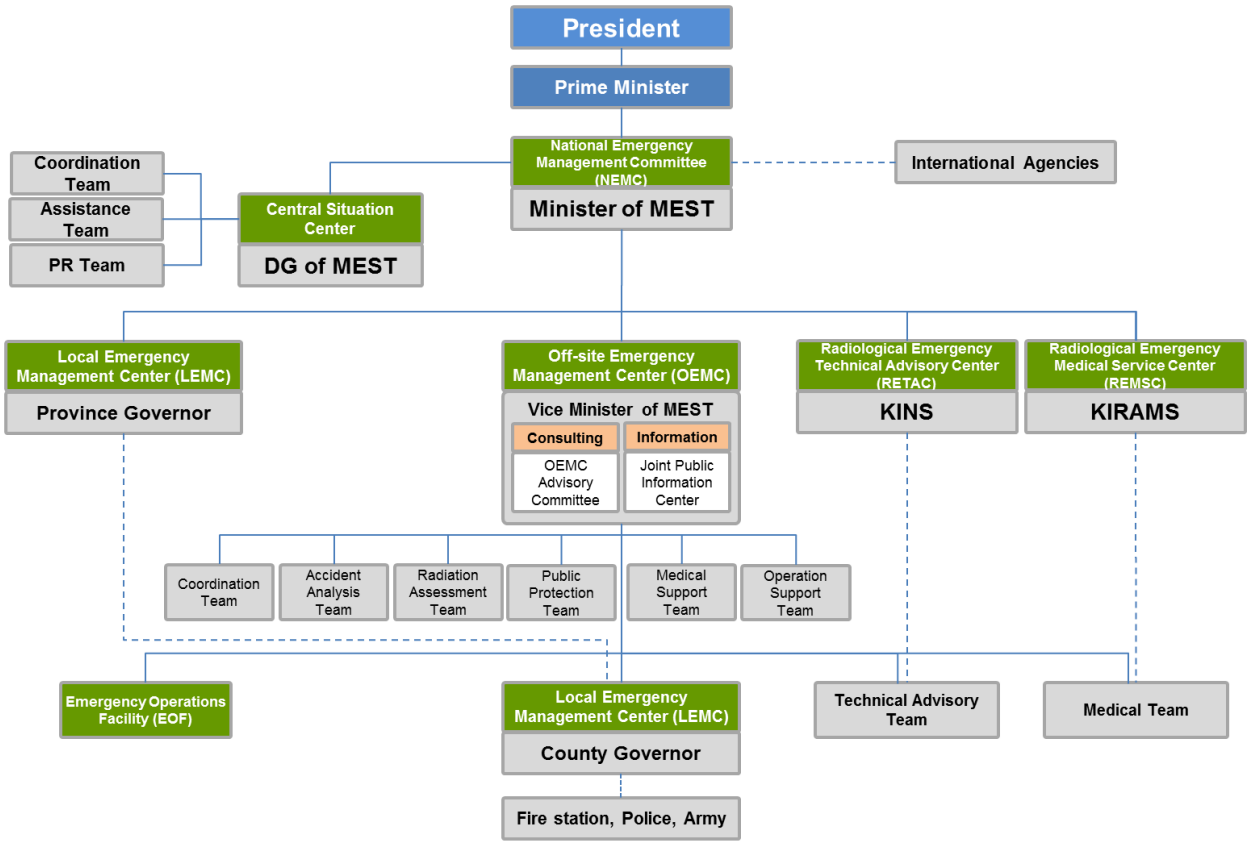


Fig.10-1. National Radiation Emergency Response Framework of the Republic of Korea

MEST is the National Competent Authority according to the Conventions [19], KINS serves as the National Warning Point, with 24/7 coverage.

The functions of the different national authorities and agencies are clearly defined in the National Radiological Emergency Plan (NREP) pursuant to APPRE. In addition, local governments have also prepared their corresponding Local Radiological Emergency Plans (LREPs) and the nuclear licensees have their Radiological Emergency Plans (REPs), respectively.

According to APPRE the MEST regular inspection should cover the "maintenance of preparedness against radiological disasters" at the facility of the licensees.

Korea uses the threat categorization approach according to the IAEA Safety Standards Series No. GS-R-2 [3]. They use 5 categories with the same definition of the threats as recommended by GS-R-2. During the interviews the counterpart presented the results of their threat assessment, taking the most significant sources of threat into consideration.

While most of the radiation sources have been categorized in accordance with GS-R-2 and the adopted preparedness measures (with special regards to the requirement for emergency plans) complied with the international recommendations the low-power (10W) KHU training reactor was licensed with an emergency plan according to AEA before enacting of APPRE (2004). KINS made reference to a Safety Analysis Report that would justify, in their interpretation, omitting the submission of the emergency plan. This approach was contended by the IRRS team. The legal situation that made this exemption from the obligation possible was discussed also in connection with the authorization process of the research reactors (Module 5.7) and was addressed in that respect, as well. It is the opinion of the team that the proposed changes in the legal documents would eliminate the unjustified exemption in any case.

10.2. FUNCTIONAL REQUIREMENTS

Establishing Emergency Management and Operations

Among the functional requirements, GS-R-2 [3] sets a strong requirement for the establishment of emergency management and operations. The country shall make arrangements to coordinate the emergency responses of the entire off-site response organization with the on-site response to include a command and control system for the local and national response to any nuclear or radiological emergency.

The general scheme of the National Radiological Emergency Response system is outlined in Fig. 10-1. The emergency organization of Korea consists of: 1) the Central Safety Management Committee which is chaired by the Prime Minister; 2) the National Emergency Management Committee (NEMC) and the Off-site Emergency Management Center (OEMC) run by MEST; 3) Local Emergency Management Center (LEMC) run by the local government; and 4) Emergency Operations Facility (EOF) of the nuclear licensee. In addition, KINS establishes a Radiological Emergency Technical Advisory Center (RETAC) and provides technical support on radiation emergency preparedness and response, and the Korea Institute of Radiological and Medical Sciences (KIRAMS) operates the national radiation emergency medical service system by setting up the Radiological Emergency Medical Service Center (REMSC). The responsibilities and duties, advisory/technical support and cooperation framework, decision-making process, emergency contact and communication means, and so on for each organization that participates in the national emergency organization are prescribed in detail in the APPRE and its subsequent regulations.

MEST has adopted an approach of rendering the nuclear licensee to prepare in advance the procedures that need to be activated at each nuclear facility in case of an emergency in terms of radiation emergency plan, emergency operating procedures, or severe accident management guidelines, and so on, and then to implement the procedures during an emergency situation. The routine regulatory and administrative processes such as prior authorization are not unconditionally suspended during an emergency. However, the AEA and other nuclear-related legislations prescribe that the nuclear licensee first takes priority safety measures and then reports the result to the regulatory body, where radiation hazard occurs or may occur. In addition, it is practically assured from a legal or institutional standpoint that routine regulatory and administrative provisions can be suspended for timely response in case of an inevitable emergency situation by having the Minister of MEST (i.e., the head of the Regulatory Body) fully in charge of the national radiation emergency organization.

The functioning of emergency management and operation was well demonstrated during the observed Integrated Emergency Exercise at the Wolsong Nuclear Power Plant (Unit#4), on 12-13 July 2011.

Identifying, Notifying and Activating

In the case where a nuclear or radiological emergency occurs at a nuclear facility, it is reported to MEST (in parallel to KINS) and the local government through the nuclear licensee. When a radiological accident occurs in a place other than a nuclear facility, it is reported to MEST through a person who has discovered it or a relevant organization that has been notified of the accident. The specific procedures on this kind of emergency notification are prescribed in the MEST Notices No. 2009-37 (Notice on Radiological Emergency Preparedness for Nuclear Licensee, MEST.Radiation.003) and No. 2009-37 (Regulations on Reporting and Public Announcement of Accident and Incident for Nuclear Power Utilization Facilities, MEST.Reactor.019).

In the event of a nuclear or radiological emergency inside or outside of Korea, the emergency is communicated through MEST and KINS, which have been designated as the National Competent Authority (NCA) and the National Warning Point (NWP), respectively, in accordance with the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. They are available 24/7.

The licensee is responsible for the initial classification of the emergency, within the shortest time after its occurrence. The emergency classification system adopted in Korea is basically corresponding to the system recommended by GS-R-2. The most severe emergency is termed ‘Red Emergency’, corresponding to a General Emergency (release can be reasonably expected to exceed PAG exposure levels); the second is the “Blue Emergency”, corresponding to Site Area Emergency (no expected release exceed PAG exposure except near site boundary); “White Emergency” corresponding to a Facility Emergency (expected release limited to a small fraction of PAG exposure levels).

Upon the classification of the emergency the licensee immediately activates its response plans for the necessary actions on the site. The off-site emergency management is the responsibility of the Off-site Emergency Management Centers (OEMCs) that are located outside the EPZ (typically 8-10 km from the NPP), beside the Emergency Operation Centre of the Facilities (EOF). In these OEMCs representatives of the different agencies involved in the off-site emergency response are present and the decision-making is aided by several technical and IT support systems. The OEMC has seven working groups (or teams). As a consulting organization to support the decision making of the head of the OEMC, an OEMC Advisory Committee is formed. On the other hand, the Joint Public Information Center is established as one of the working groups to disseminate accurate and consistent information on radiation disasters.

The decision about the necessary off-side actions are made by the head of the OEMC, who is a designated employee of the MEST (in this case the vice-minister of MEST), as requested by APPRE.

Taking Urgent Protective Action

This requirement of the GS-R-2 focuses on the priorities of radiation emergency preparedness and response. During response life-saving, preventing the occurrence of severe deterministic effects and reasonably reducing the risk of stochastic effects are the priorities. The main requirements for preparedness are associated with the facilitation of these response priorities, requiring that:

- The country adopts national intervention levels for taking urgent protective actions in accordance with the relevant international standards;
- Arrangements are in place for effectively making and implementing decisions on urgent protective actions to be taken off the site;
- Arrangements are in place to ensure the safety of all persons on the site in the event of a nuclear or radiological emergency.

In connection with the control of a nuclear or radiological disaster caused by an accident, the OEMC which is led by MEST has the authority to determine the urgent public protective actions. Article 15 (Standards for Determination of Urgent Public Protective Actions, etc.) and Addendum Table 4 (Standards for Determining Urgent Public Protective Actions) of the Enforcement Regulation of the APPRE prescribe in detail the decision-making criteria on urgent public protective actions with respect to those aspects such as: sheltering and evacuation depending on the expected dose level, distribution of iodine prophylaxis, temporary relocation logistics and permanent settlement, and so on.

Based on the interviews and the reviewed documents the response objectives in Korea are fully in accordance with the requirements of GS-R-2. These protective actions are regularly exercised and evaluated during the emergency drills in the facilities regulated by the MEST.

Korean category I facilities (NPPs) use the concept of emergency planning zones (EPZ) (typically 8-10 km radius around the facility), without clearly defining the precautionary action zone (PAZ) and the urgent protective action planning zone (UPZ), as recommended by GS-R-2 [3]. For practical purposes, however, the operational emergency plans of the licensees contain actions to be performed in a "keyhole" area within the EPZ which can be identified as the PAZ of the international standards. However this practice is not firmly based on any regulatory requirement.

Regarding the national intervention levels Korea uses General Intervention Levels (GILs) that are mentioned in the Field Manual for Crisis Response in Nuclear Safety Area (2010-09-14). These GILs are in full compliance with the recommended values of the international standards (GS-R-2). The application of these GILs is tested and evaluated during emergency exercises.

The arrangements for the protection of the on-site personnel are in place and the safety standards are in compliance with the international standards (e.g. 250 mSv guidance value for volunteering emergency workers in life-saving action).

Providing Information and Issuing Instructions and Warnings to the Public

As described above MEST has a system to activate its own emergency organizations such as the NEMC and the OEMC. Within this system the tasks for providing information and issuing instructions and warnings to the public is the responsibility of the "Joint Public Information Center" which is operated as a

working group beside the head of the OEMC (see Fig. 10-1). This high-level team is to provide accurate and consistent information on nuclear or radiological disasters and other related matters.

According to the MEST Notice 2009-37 the right of the public to get timely, consistent and truthful information must be guaranteed. Beside the traditional ways of mass communication a special website is available for the dissemination of the relevant information (http://nsic.kins.re.kr/nsic/index.j).

Protecting Emergency Workers

For the general case, as mentioned above, the arrangements for the protection of the on-site personnel are in place and the safety standards are in compliance with the international standards (e.g. 250 mSv guidance value for volunteering emergency workers in life-saving action).

As for special circumstances MEST prescribes through Article 14 (Limitation of Radiation Dose in Emergencies) of the MEST Notice No. 2009-37 (Standards for Radiation Protection, etc., MEST.Radiation.001) that: 1) the effective dose and the skin equivalent dose are allowed up to 0.5 Sv and 5 Sv, respectively, for a person engaged in such inevitable emergency works as dealing with accidents to prevent the spread of damage; and 2) the dose limitation is not applied for life-saving emergency works.

Excellent dosimetric equipment and services are available to guarantee that emergency workers' doses are properly monitored (TLD and electronic dosimeters). In order to effectively and systematically manage radiation exposure to the emergency personnel of the local government, the nuclear licensee, and other emergency related organizations, the Regulatory Body has developed and put into operation the "Korea Information System on Occupational Exposure" (KISOE, http://kisoe.kins.re.kr).

Protective equipment is also available in sufficient quantity, should there be any need for their use.

Assessing the Initial Phase

The decision-making criteria for urgent actions to protect the public, as well as the specific details of the public protective actions are prescribed in the APPRE and its subsequent regulations. In the event of an emergency, the Regulatory Body determines the public protective actions by applying the general intervention levels (GILs), and decides upon the operational intervention levels (OILs), which are applicable in the early stage of response, in the "Crisis Response Manual". In addition, the Regulatory Body provides consulting to the local government when it performs a mid- to long-term radiological impact assessment, or formulates a restoration plan and the "General Post-radiological Disaster Measures". The Regulatory Body supervises and supports the local government so that the OILs will be applied when establishing or executing the long-term restoration measures. The National Radiological Emergency Plan prescribes how the nuclear licensee should establish and implement safe treatment and management strategies for radioactive waste such as radioactively contaminated materials generated during an emergency situation, and the Regulatory Body oversees and controls the safe management of the radioactive waste.

The established initial OILs agree with those recommended by the IAEA documents (TECDOC-955 [20]) and MEST has the authority to revise these values, if necessary.

Taking Long Term Protective Actions

The "Crisis Response Manual" defines values for restriction of foodstuffs intake for different radionuclides. In addition, the Regulatory Body provides consulting to the local government when it

performs a mid- to long-term radiological impact assessment, or formulates a restoration plan and the "General Post-radiological Disaster Measures".

The values given in the referred document are in line with those recommended by the international standards [3].

Mitigating the Non-Radiological Consequences

The issue of dealing with the non-radiological consequences is in the scope of MEST. Various means and methods are in use for the dissemination of verified information and for addressing the problems generated by fear, anxiety and circulation of rumors. Among others the following communication channels are available (and actually were used during the Fukushima emergency):

- website (www.kins.re.kr) with up-to-date information on the actual emergency (1.8 million visits in March, because of Fukushima);
- dedicated telephone numbers for counseling and personal inquiries;
- meeting with the press (press conferences, 9 were held on Fukushima);
- press releases;
- public hearings;
- explanatory articles;
- TV, radio, newspapers;
- expert workshops aired on TV;
- booklets, leaflets, brochures, educational materials

The Ministry of Public Health and the Ministry of Public Administration and Safety also have roles in mitigating non-radiological consequences of a radiation emergency and the response thereof. The three main issues are as follows:

- public communication, in general;
- preventing ungrounded rumors and allegations;
- medical and psychological intervention.

Conducting Recovery Operations

The Regulatory Body provides consulting and support to the local government when it establishes the restoration plan and the post-radiological disaster measures which are based upon the mid- to long-term radiological impact assessment. Section 3 (Posterior Measures, etc.) of Chapter III of the APPRE stipulates the followings:

- Article 41: Mid- to Long-Term Radiological Impact Assessment and Damage Restoration Plan, etc.;
- Article 42: Implementation of Post-Radiological Disaster Measures, etc.; and
- Article 43: Disaster Investigation, etc.

In other words, MEST (NEMC) and KINS (RETAC) consult with the local government (LEMC) when it assesses a mid- to long-term radiological impact and formulates a restoration plan. MEST also consults with the metropolitan city mayor/provincial governor when it formulates the General Post-radiological Disaster Measures. The Measures include the followings:

- Investigation of radioactive material concentration or radiation dose in the area where a radiological disaster has occurred and other necessary areas;
- Medical checkup of residents, etc., medical counseling in consideration of their psychological impact and other necessary medical services;
- Public relation regarding the impact caused by radioactive materials and ways to overcome damage; and
- Other matters for the prevention of the spread of a radiological disaster and restoration from damage.

10.3. REQUIREMENTS FOR INFRASTRUCTURE

Organization

The system of national, local community and facility level emergency response organisations involved in the emergency response is well established and fully functional.

MEST is fully responsible for leading and coordinating all activities of the Korean Government relating to emergency preparedness and response in accordance with the relevant laws such as the "Atomic Energy Act" (AEA) and the "Act on Physical Protection and Radiological Emergency" (APPRE).

The Minister of Ministry of Education, Science and Technology (MEST) establishes the "National Radiological Emergency Plan" pursuant to Article 18 (Formulation of a National Radiological Emergency Plan, etc.) of the APPRE. This Plan constitutes a part of the national level disaster management system in accordance with the "Framework Act on the Management of Disasters and Safety" and the "Framework Act on Civil Defense". The head of the local government in charge of a radiological emergency planning zone formulates the "Local Radiological Emergency Plan" in accordance with the National Radiological Emergency Plan, and submits it to the Minister of MEST. Details of this procedure are provided in Article 19 (Formulation of a Local Radiological Emergency Plan, etc.) of the APPRE. On the other hand, the nuclear licensee prepares its own Radiological Emergency Plan and obtains approval from the Minister of MEST as per Article 20 (Radiological Emergency Plan of a Nuclear Licensee) of the APPRE.

Logistical Support and Facilities

The Regulatory Body clearly specifies the responsibilities, authorities and roles of each position in the emergency response organizations including NEMC, OEMC, RETAC, and others. In addition, MEST and KINS designate experts who are well-qualified to perform the roles of the positions and establish advisory and technical support groups for specific areas so that emergency response can be effectively and efficiently implemented. By setting up the "Radiological Emergency Central Situation Center" at the MEST Headquarters and the "Radiological Emergency Technical Advisory Center Situation Room" at the KINS Headquarters, MEST and KINS have arranged that the preliminary or full-scale emergency organizations can be quickly established and operated depending on the class of emergency.

In order to secure and maintain practical capabilities for emergency preparedness and response, MEST periodically implements emergency exercises and drills. Through these measures, the Regulatory Body

assesses and ascertains the coping capacity based on the Radiological Emergency Plans inside and outside of the nuclear facility, maintains the capabilities of the emergency response personnel, and initiates recommendations in appropriate areas requiring improvement as necessary. The Regulatory Body also has established the OEMCs in five different regions, located so that they encompass all the nuclear power plants and major nuclear facility sites scattered throughout the country, and dispatched emergency officials and personnel to the OEMCs even during normal situations. The Regulatory Body confirms the effectiveness of the licensees' Radiological Emergency Plans through daily inspections thereon and also continues to maintain the prompt operability of the site emergency response centers and facilities in the event of an emergency.

The Regulatory Body has set up and implemented the "National Radiological Emergency Plan", the "Radiological Emergency Technical Advisory Plan" and the associated procedures such as an emergency response manual in consideration of the IAEA Safety Standards GS-R-2 [3] and GS-G-2.1 [12]. Moreover, so as to efficiently implement technical support activities for protection of the public and the environment in a nuclear or radiological emergency of a nuclear power plant, the "Atomic Computerized Technical Advisory System for a Radiological Emergency" (AtomCARE) was developed and is in operation. Through the AtomCARE system, any nuclear or radiological emergency and its consequences can be quickly verified and assessed, and subsequently, comprehensive management of the information related to public protective actions is also made possible. The AtomCARE system, which is under continuous improvement per the 1st "Emergency Preparedness Development Program" (2010 to 2014), is effectively applied as an analytical tool and computer program for assessment of radiation risks and subsequent decision-making in an emergency situation. Fig. 10-2 shows the overall structure of the AtomCARE.

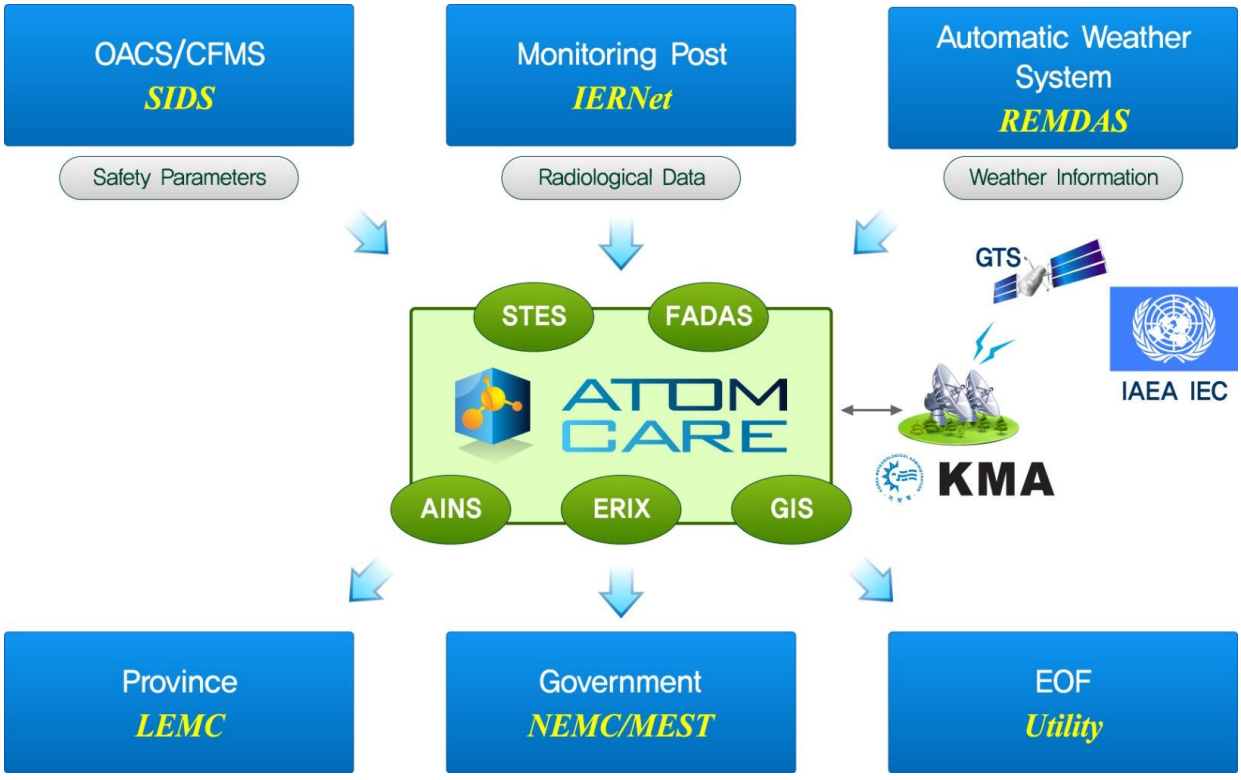


Fig. 10-2. Atomic Computerized Technical Advisory System for the Radiological Emergency (AtomCARE)

OACS: Operator Aid Computer System
CFMS: Critical Function Monitoring System
SIDS: Safety Information Display System
IERNet: Integrated Environmental Radiation Monitoring Network
REMDAS: Radiological Emergency Meteorological Data Acquisition System
AINS: Automatic Information Notification System
STES: Source Term Estimation System
KMA: Korea Meteorological Administration
GTS: Global Telecommunication System
LEMC: Local Emergency Management Center
NEMC: National Emergency Management Committee
EOF: Emergency Operations Facility
FADAS: Following Accident Dose Assessment System
GIS: Geographic Information System
ERIX: Emergency Response Information eXchange system

In order to protect public health from radiation through early detection of domestic or foreign radiological emergencies and furthermore to preserve the environment, KINS operates 71 radiation monitoring posts/stations located throughout the country in accordance with the "Monitoring Program for Nationwide Environmental Radioactivity", and thereby monitors and evaluates the environmental radiation and radioactivity throughout Korea. Moreover, KINS is also running a variety of monitoring networks for environmental radiation and radioactivity, such as Integrated Environmental Radiation monitoring Network (IERNet), Continuous Airborne dust radioactivity Monitoring System Network (CAMSNet), Computerized Local and overall country's Environmental radioactivity data Analysis Network System (CLEAN), Swedish Automatic Unit for Noble gas Acquisition (SAUNA), and Radioactive Airborne Dust Archive (RADA). By developing the "System for Identifying Radiation in Environments Nationwide" (SIREN) that integrates all the monitoring networks, as well as a program linking the monitoring results from the various networks, the capability of KINS to early detect a domestic or foreign nuclear or radiological emergency has been further improved. The SIREN interconnects the measurement results of various radiation and radioactivity from different monitoring networks, thereby being effectively used for persistent monitoring of the environmental radioactivity on the entire national territory before and after an emergency situation and used as an early detection system for abnormal situations.

The Regulatory Body is equipped at the central situation rooms in the headquarters and the OEMCs with such facilities as video conferencing system, dedicated telephones, general telephones, satellite communications, faxing facsimiles, and web-based Emergency Response Information Exchange (ERIX) system, and also employ radiation emergency mobile command and control center vehicles, mobile environmental radiation monitoring vehicles, and rotorcraft as needed for aerial exploration. Additionally, the dedicated internet lines and the ERIX system are effectively utilized as a stable communication system for emergency response. So that the aforementioned emergency response facilities can maintain the proper quality and capability, maintenance activities (such as testing and calibration) are periodically performed on the instruments, equipment, and communication systems. Periodic communication drill is also carried out in collaboration with domestic and foreign emergency response organizations. Further, it may be noted that the emergency response facilities and equipment are subject to a quality assurance program that is included in the emergency response field manual of RETAC.

Training, Drills and Exercises

The initial and refresher training for radiation emergency staff of KINS, nuclear licensees, local governments and emergency-related organizations are conducted as per the legal requirements, and KINS inspects radiation emergency education of the nuclear licensee along with the institutions designated to conduct such education. By participating in a variety of domestic and international technical workshops and conferences, the radiation emergency staff of the Regulatory Body is actively engaged in the exchange of specialized technology, thereby improving their competence. For the sake of ascertaining the practical and responsible coping capability of radiation emergency staff and improving the weak points identified, emergency exercises are held, in which on-site and off-site emergency preparedness organizations must participate, as follows:

- Unified radiological emergency exercise of all relevant parties together with central government: every five years;
- Integrated radiological emergency exercise led by local government: at each site more than once in four years;
- On-site radiological emergency exercise of all emergency-related organizations of a nuclear licensee: more than once a year for every two units of nuclear power plants;
- Drills of relevant emergency-related organizations of a nuclear licensee: more than once a quarter for every two units of nuclear power plants; and
- Initial exercise for new nuclear facilities.

The Regulatory Body is also enhancing and maintaining the capability to cope with an emergency situation beyond the national boundary by periodically taking part in the ConvEx-1, 2, 3 for implementation of the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency as an evaluator, controller or player, and periodically observed the national emergency exercises conducted by the NRC (Nuclear Regulatory Commission) in USA, the CEA (Alternative Energies and Atomic Energy Commission) in France, the Situation and Crisis Center (SCC) of Rosatom in Russia, Japan and the National Nuclear Security Administration (NNSA) in China.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-R-2 para 5.25 states that** *"Adequate tools, instruments, supplies, equipment, communication systems, facilities and documentation (such as procedures, checklists, telephone numbers and manuals) shall be provided for performing the functions specified in Section 4. These items and facilities shall be selected or designed to be operational under the postulated conditions (such as the radiological, working and environmental conditions) that may be encountered in the emergency response, and to be compatible with other procedures and equipment for the response (such as the communication frequencies of other response organizations), as appropriate. These support items shall be located or provided in a manner that allows their effective use under postulated emergency conditions."*
GP 13	**Good Practice: The operation and continuous enhancement of AtomCARE and the development of a Nationwide Integrated Management System for Environmental Radiation / Radioactivity Monitoring is a good example of integrating information and data gathering systems into an effective and efficient national emergency response organization.**

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GS-R-2 para 4.83 states that** *"Arrangements shall be made for: providing useful, timely, truthful, consistent and appropriate information to the public in the event of a nuclear or radiological emergency; responding to incorrect information and rumors; and responding to requests for information from the public and from the news and information media."*
(2)	**BASIS: GS-R-2 para 4.96 states that** *"Arrangements shall be made for responding to public concern in an actual or potential nuclear or radiological emergency. Preparations shall include arrangements for promptly explaining any health risks and what are appropriate and inappropriate personal actions for reducing risks. These arrangements shall include monitoring for and responding to any related health effects and preventing inappropriate actions on the part of workers and the public. This shall include the designation of the organization(s) with the responsibility for identifying the reasons for such actions (such as misinformation from the media or rumours) and for making recommendations on countering them. How these recommendations are to be included in the national emergency response shall be specified."*
GP 14	**Good Practice: The Regulatory body has implemented an exemplary outreach program, including the integration of volunteering experts and first responders (U-REST), as well as raising the awareness and understanding of the population regarding the issues of nuclear and radiological emergencies.**
(1)	**BASIS: GS-R-2 para 4.48 states that** *"For facilities in threat category I or II arrangements shall be made for effectively making and implementing decisions on urgent protective actions to be taken off the site… (a) The specification of off-site emergency zones44 for which arrangements shall be made for taking urgent protective action. These emergency zones shall be contiguous across national borders, where appropriate, and shall include: (i) A precautionary action zone, for facilities in threat category I, for which arrangements shall be made with the goal of taking precautionary urgent protective action, before a release of radioactive material occurs or shortly after a release of radioactive material begins, on the basis of conditions at the facility (such as the emergency classification) in order to reduce substantially the risk of severe deterministic health effects. (ii) An urgent protective action planning zone, for facilities in threat category I or II, for which arrangements shall be made for urgent protective action to be taken promptly, in order to avert doses off the site in accordance with international standards."*
R 10	**Recommendation: Emergency planning zones should be defined in accordance with the IAEA Requirements (GS-R-2) (PAZ and UPZ instead of the EPZ).**

11. REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT

This module brings together the information accumulated by the Team on Fukushima implications during the course of the mission and contains the views and conclusions of the team for each of the standard modules of the IRRS.

In particular, this module includes discussions on the following policy issues:

- Policy issue 0: Report of the Korean Government, Response to the Fukushima Daiichi Nuclear Accident.
- Policy issue 1: Independence of the Regulatory Body
- Policy issue 2: Transparency and Openness

11.1. ACTIONS TAKEN BY THE REGLATORY BODY IN THE AFTERMATH OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT

A. IMMEDIATE ACTIONS TAKEN BY THE REGLATORY BODY

Following the Fukushima accident, the Korean government set up an effective response led by a Prime Ministerial Task Force which coordinated actions by the regulatory body and other relevant government departments and agencies. The Government assigned clear responsibilities to departments and agencies involved in the response. MEST and KINS were put on full alert to protect the public from potential radiological impacts.

From 18:40, 11 March 2011, KINS and KIRAM operated a 24-hour emergency response centre under the oversight of MEST. The actions for monitoring and analysis of radioactivity in the environment appear to have been effective. The national network of 71 unmanned stations and 12 regional centres were used to take air, water and soil samples at increased frequency. Analysis of meteorological data was taken into account. Measures were taken in ports and airports to check for possible contamination. The contamination of food and tap water was also monitored.

MEST and KINS ensured communication with the general public through various media, including national newspapers and the Internet portals most frequented in Korea. Namely, MEST and KINS opened a special webpage accessible on KINS's homepage on 12 March 2011, and also opened several dedicated telephone lines to answer public inquiries. Radiation measurements from the environmental monitoring network were made publicly available on the KINS web site. The web site received a huge increase in public interest with millions of hits being recorded. The regulatory body posted around 70 sets of Q&As on health hazards arising from radioactivity on the most frequented Internet portals. The regulatory body also provided hundreds of press releases and interviews, and responded to numerous questions from representatives of the National Assembly.

Interactions with the international community were pursued. KINS sent two experts to Japan to support JNES. Additionally, KINS held two meetings in Tokyo with Japanese experts to discuss Fukushima implications, respectively on 11-13 April 2011 and 14-15 June 2011.

B. TECHNICAL ISSUES CONSIDERED IN THE LIGHT OF THE FUKUSHIMA ACCIDENT

KHNP proactive self-assessment

The Korean utility KHNP carried out voluntary inspections from 16 March 2011 to 18 March 2011 and identified about 5 subject areas (consisting in 21 measures) for improvement, including the installation of waterproof doors, supplementary emergency power generators and hydrogen recombiners.

The Special Safety Inspection (SSI) Process and Scope

KINS organized a targeted Special Safety Inspection (SSI), and a team composed of 37 KINS staff and 36 external experts stemming from various different organizations, including academia, industry and research institutes was brought together to undertake the work.

The purpose of the SSI was to examine the safety of Korean NPPs and to identify needed safety improvements in the light of the Fukushima accident. The assumed scenario which was investigated mirrored the Fukushima accident: an earthquake followed by a tsunami which resulted in a loss of electrical power and subsequently to a severe accident. Accordingly, areas for improvement were promptly identified.

The SSI undertook three week inspection from 23 March 2011 to 15 April 2011, followed by two weeks for review and technical discussion of improvement items between KINS and KHNP. The SSI covered all 21 operating nuclear power plants, the HANARO research reactor and fuel cycle facilities.

The scope of the SSI consisted in the six following areas:

- Area 1: Design of structures and equipment against earthquakes and coastal flooding;
- Area 2: Integrity of electrical power, cooling, and fire protection systems in case of inundation;
- Area 3: Counter measures against severe accidents;
- Area 4: Emergency response and emergency medical systems;
- Area 5: Long-term in-service plants;
- Area 6: Research reactors and nuclear fuel cycle facilities.

The SSI first checked whether design basis requirements were matched. According to the results of the special safety inspection, MEST concluded that Korean operating NPPs, the HANARO research reactors and nuclear fuel cycle facilities are safely designed and operated considering the current design basis earthquake and tsunami.

Findings of SSI to improve Korean nuclear safety

Following the completion of the Special Safety Inspection, a total of 100 items were initially suggested for discussion both by the SSI team and the licensee KHNP, and were subsequently optimized after the technical exchange process. As a result of this exchange KINS and MEST, established a list of 50 actions to improve the Korean nuclear safety in the light of the Fukushima accident (see table in Annex 3). As regards nuclear power plants in operation, around 70% of the total items for improvement were identified by KHNP during its proactive self-assessment. The other improvement items concerning nuclear power plants in operation were suggested by the SSI team. The scope of the SSI also included research reactors, ageing management and fire protection measures, thus additional items for improvement were suggested by the SSI team.

Among the 50 items for improvement, the Team considers that opportunities to identify some of these may have existed in the past, for example, as part of the standard PSR process. On the other hand Fukushima has increased the priority of pending improvements, such that they are enforced in a very timely manner.

The result of the SSI was discussed and agreed in the 44th meeting of the Nuclear Safety Committee (May 6, 2011). Following that meeting, MEST notified KHNP and other stakeholders the need to implement relevant improvements according to a two phased approach; short term actions should be completed within 2 years while mid/long-term actions should be completed within 5 years. MEST requested implementation plans from KHNP to be sent by 6 July 2011; these plans are now under review

C. OTHER ISSUES CONSIDERED IN THE LIGHT OF THE FUKUSHIMA ACCIDENT

The Special Safety Inspection was focused on technical issues. Other regulatory issues, including those pertaining to regulatory systems, effective independence of the regulator, regulatory frameworks, or safety culture, which were already identified as lessons learned from the Fukushima accident, were not addressed by the Special Safety Inspection.

Consideration of implications of the Fukushima accident on the regulatory system

The accident of Fukushima accelerated the further improvement of the independence of the regulatory body in Korea.The Korean government decided to change the organization of the regulatory system, by installing a new Nuclear Safety Commission, which will report directly to the President. This upcoming evolution is seen by the Korean government as a further step to formally separate promotion and oversight of nuclear energy and to enhance the effective independence of the regulatory body.

In preparing for the detailed implementation of the organizational change, the Team considers that opportunities to effectively address the regulatory lessons learned from the Fukushima accident should be systematically identified. Findings identified in chapter 3 should support this process.

Besides, a draft manual to efficiently respond to accidents at neighboring countries was prepared after the Fukushima accident and is being reviewed by relevant organizations under the supervision of MEST.

CONCLUSION [1]
The Team considers that the prompt and well-coordinated response of the Korean government, its regulatory body and the licensees to the Fukushima accident is commendable. In particular, public concerns were addressed by significant communication involvement and a prompt Special Safety Inspection was performed. The Team recognizes that these efforts were carried out in difficult circumstances, considering that the geographical proximity of Japan exacerbated general anxiety.

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
(1)	**BASIS: GSR Part 1 Requirement 8 states that** *"The government shall make provision for emergency preparedness to enable a timely and effective response in a nuclear or radiological emergency."*
(2)	**BASIS: GSR Part 1 Requirement 36 states that** *"The regulatory body shall promote the establishment of appropriate means of informing and consulting interested parties and the*

RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES	
	public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body."
GP15	**Good Practice: The Korean national response to the Fukushima accident was well-coordinated and addressed key areas in a short timeframe. In particular, national environment radiation monitoring was reinforced, contamination of goods and people was monitored at airports and harbors, public concerns were addressed by significant communication involvement, and cooperation with Japan was conducted through staff support and technical meetings.** **The swift launch of the Special Safety Inspection process led to the prompt identification of first measures to improve safety. As part of the response to the implications of the Fukushima accident, the exceptional involvement of external experts in the Special Safety Inspection further enhanced the transparency and further reinforced the credibility of the inspection process, while promoting information sharing with interested parties.**

11.2. PLANS FOR UP-COMING ACTIONS TO FURTHER ADDRESS THE REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT

The Korean government, MEST and KINS, already established plans for up-coming actions to be taken to further address the implications of the Fukushima accident, according to a three phased approach.

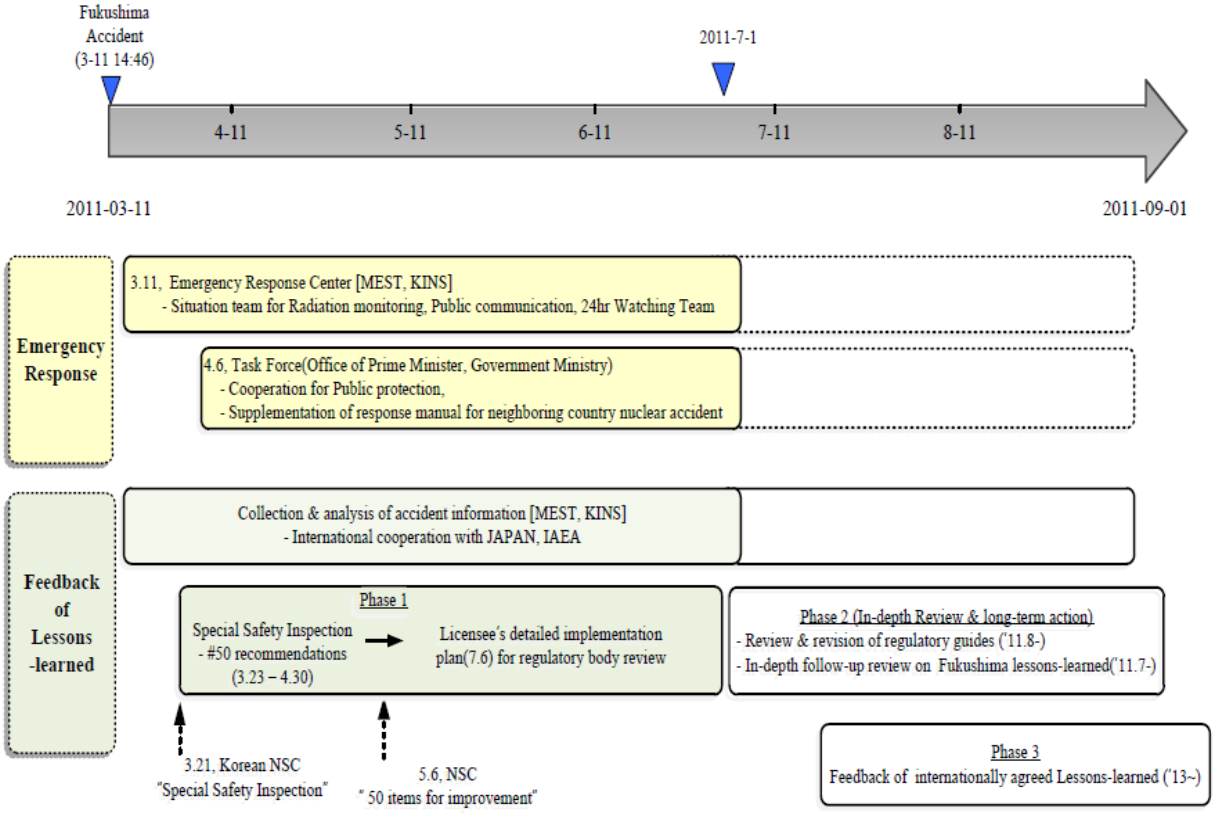


Fig: Summary phasing of the Korean response to the implications of the Fukushima accident

Follow-up on the Special Safety Inspection for operating plants:

The licensees have been requested by MEST to submit implementation progress reports on the 50 items for improvements every six months. These reports will be independently reviewed by KINS. Adequacy of the execution of improvement measures will be checked by KINS through site inspection for operating installations.

As regards necessary license amendments related to the implementation of the improvements, KINS considers that it will have sufficient resources to process them timely. KINS underlined that the improvements are scheduled over several years, which will enable KINS to adjust human resources if needed.

The submission of implementation progress reports by KHNP every six months, which will then be independently reviewed by KINS, is considered as an adequate process by the Team. This process is also judged appropriate to ensure a timely and effective implementation

Further investigations to follow-up on Special Safety Inspection:

The Korean regulatory body recognized that, further detailed, systematic and, whenever appropriate, quantitative assessments still need to be conducted by the licensee and reviewed by KINS in order to ensure the adequacy and completeness of the findings of the Special Safety Inspection in the light of the Fukushima accident. The Team confirms that an additional analysis of the technical implications and lessons to be learned of the Fukushima accident, including a systematic approach to address beyond design basis accidents, would be valuable to follow-up SSI findings. As KINS intends to do, inputs and approaches applied in foreign countries could be considered. As the prime responsibility for safety lies with the licensee, the regulatory body should request that KHNP perform the relevant assessments.

Conversely, the Team considers that it would be valuable that the experience gained in Korea be put into the attention of the nuclear community for consideration in responding to the implications of the Fukushima accident. Annex 3 summarizes the 50 items identified for improvement.

Further addressing implications of the Fukushima accident on regulatory functions

The Team considers that the current on-going implementation of the new Korean regulatory organization is an opportunity to effectively address the regulatory lessons already learned from the Fukushima accident. The National Comprehensive Plan for Nuclear Safety provides a tool that could be supplemented as appropriate to reinforce the vision and priorities for safety over the several coming years, in the light of the Fukushima accident.

With the support of the newly established Nuclear Safety Commission, the follow-up IRRS mission should perform a thorough review of the regulatory system to consider its effectiveness in the light of the lessons learned from the Fukushima

Reviewing and revising regulation and guides in the light of the Fukushima accident

The regulatory body has plans to perform a complete review of regulations and guides in the light of the Fukushima accident and to subsequently revise them as appropriate. This process should be completed by 2015.

While conducting these plans, KINS will monitor and intends to take into account what happens at the international level (evolution of IAEA safety standards, European stress tests results…).

Safety culture

A policy statement on safety culture by the Government is being prepared and is expected to be issued in 2011. Already before the Fukushima accident, KINS suggested that KHNP invite a SCART mission to review its programme for safety culture assessment. This mission is now being prepared. The Team considers these measures as a good opportunity to address, among other topics, lessons which will be learnt from the Fukushima accident.

Taking into account foreign experience feedback

In parallel, in-depth follow-up review will start through a research project in order to feedback the lessons learned from the accidents in Japan at the Fukushima plants to the Institutes and NPPs in Korea.

In a later step (phase 3), taking into account information published by the international community (e.g. IAEA inspection results, EU stress test results and the similar actions carried out in the USA and in Japan), KINS will determine whether additional improvements are needed.

CONCLUSION [2]

The Team concludes that the findings of the Special Safety Inspection are valuable first steps in a process which will last for many more years, as additional analysis is completed and further lessons are learned from the Fukushima accident worldwide.

The Team considers that it would be valuable for the experience gained in Korea from the implementation of the safety improvement programme to be brought to the attention of the nuclear community for consideration in responding to the implications of the Fukushima accident.

As intended by KINS, the Team considers that the regulatory body should request that in the light of the Fukushima accident, KHNP perform further relevant assessments, including a thorough review of design basis provisions, and define and conduct a systematic approach to address beyond design basis accidents. As intended, international approaches could be considered.

11.3. SIGNIFICANCE OF REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA ACCIDENT ACROSS REVIEWED AREAS

Note: ***The significance of Fukushima implications was considered as part of the review of each IRRS module. The review conclusions below and the plans presented by Korea to further address Fukushima issues in the coming years should be included in the scope of the follow-up IRRS mission to be invited by Korea.***

Module 1: Responsibilities and Functions of the Government

The legislative and regulatory framework in Korea for the safety of nuclear installations and radiological protection is based on a clear hierarchical system that clearly allocates all responsibilities. The interfaces of all authorities involved, are specified for routine and emergency situations.

The accident of Fukushima accelerated the further improvement of the independence of the regulatory body in Korea. On 21 June 2011 the National Assembly passed a bill with the aim of achieving clearer separation of the promotion of the use of nuclear energy and safety regulation.

Also as a result of the analysis of the Fukushima accident, two improvement measures (PSR and severe accident) have been identified to enhance the current nuclear safety policy. This should be an opportunity to give this policy a more formal regulatory status to PSA and design extension conditions, including severe accidents.

CONCLUSION [3]
The Team did not identify elements regarding the responsibilities and function of the government, which would raise particular concern in the light of the Fukushima accident. **However, the Team considers that the establishment of an effectively independent regulatory body is an opportunity to effectively address the regulatory lessons learned from the Fukushima accident.**

Module 2: Global Nuclear Safety Regime

Korea has ratified the major international treaties and conventions in the area of nuclear safety and, emergency preparedness and actively promotes the .multilateral and bilateral cooperation on-going to enhance safety by means of harmonized approaches, in particular regarding emergency response and accident management.

The operators of NPPs and the regulatory body of Korea systematically analyze international operational experience feedback and derive and enforce the adequate improvement measures. An in-depth follow-up review will start (through a research project) to feedback the lessons learned from the accidents in Japan at the Fukushima plants to the Institutes and NPPs in Korea.

In a later step taking into account information published by international community (e.g. IAEA inspection results, EU stress test results and the similar actions carried out in the USA and in Japan), KINS will determine whether additional improvements are needed.

CONCLUSION [4]
The Team did not identify elements regarding the Global Nuclear Safety Framework which would raise particular concern in the light if the Fukushima accident. It is important that operators of NPPs and the regulatory body systematically analyze international operational experience feedback in the light of the Fukushima accident and derive and enforce the adequate improvement measures.

Module 3: Responsibilities and Functions of the Regulatory Body

The various organizations responsible for nuclear safety in Korea are capable and dedicated. The team found no evidence that the dual responsibilities of MEST for promoting the utilization of nuclear energy and safety control has in any way diluted the strong national focus on high standards of nuclear safety. The team notes that the Nuclear Safety Committee, NRB and KINS have legal responsibilities uniquely for safety and have adequate powers to take decisions in emergency situations. Nevertheless, the involvement of different governmental agencies such as the Ministries of Environment, Employment and Labour, etc., is inevitable in the regulatory process for nuclear facilities. The team was informed that the associated government agencies maintain a close cooperative system as governed by law.

Effective communications were established with KHNP regarding short term inspections and actions to

confirm the safety of Korean plants.

The Korean Government and the regulatory bodies took highly effective actions to inform interested parties and the public in a transparent manner.

CONCLUSION [5]
The Team did not identify elements regarding the responsibilities and functions of the regulatory body which would raise particular concern in the light of the Fukushima accident. The Team considers that the environmental radiation monitoring programme and the communication to the public and interested parties were carried out in an exemplary manner.

Module 4: Management System of the Regulatory Body

Several actions taken by KINS after the Fukushima accident will improve the effectiveness of the management system even if only one change of the system itself was initiated.

Self-assessment, management system review, independent assessment and continuous improvement

KINS has established a special task force to assess which actions the Korean regulator should take on the basis on lessons learned on Fukushima accident. The main purpose is to assess the "stress tests" of the nuclear power plants and consider new requirements on the licensee. But also internal KINS activities will be assessed after the team has finished its task.

At the time of the Fukushima accident KINS had already established its audit plan for this year. It has not been revised to assess any activities related to the Fukushima accident response but such issues will be taken into consideration when establishing the detailed programs for the audits.

Timely actions taken

Shortly after the Fukushima accident a big meeting was held at KINS chaired by the KINS´ President. In those discussions it was recognized that public communications needed to be improved, especially the risk communication to the public. A work was immediately initiated to revise the public information process of the Management System. Two months after the Fukushima accident, KINS issued a new revision of the communication process. Before the accident the name of the process was Public Relations and its main objective was to give the Korean people information about KINS´ regulatory work. After Fukushima the process was renamed Public Communications and the objective is now to respond to the information requests of the public.

CONCLUSION [6]
The Team concludes that the KINS´s Management System was responsive to experiences from the Fukushima accident response. Actions were initiated immediately to remedy a weakness of the system. As intended by KINS, further assessments should be made and actions should be taken if necessary, even if the established audit plan will not be revised to explicitly address the Fukushima regulatory response issues.

Module 5: Authorization

A general lesson to be learned from the Fukushima accident is that siting and design of newly built reactors need stricter and more careful considerations than before. Selection of new sites need to take into

account the need for an even higher protection against external events, whereas the design shall take into account revised requirements on the protections against design basis, some beyond design basis and certain severe accidents.

Consistent with IAEA Safety Guide on licensing, the Korean regulatory body has the authority to reject a site proposed by an applicant on the basis of safety concerns. This can be done if an (optional) Early Site Approval is requested, or when the Construction Permit is submitted to the Regulatory body.

KHNP voluntarily decided to apply the relevant improvement measures (33 items out of 50) to plants under construction. Adequacy of these improvements will be reviewed by the regulatory body as part of the on-going licensing of such plants. As requested by MEST, KHNP will report on implementation progress every 6 months.

For operating power plants, the licensee will need to make an application for amendments, which will be reviewed by KINS. The construction of two APR 1400 reactors (Shin-Kori 3 and Shin-Kori 4) was recently completed. KINS will review the operating license application and check that the above mentioned improvement measures are completely included.

For the two APR 1400 reactors to be constructed (Shin Ulchin 1 and Shin Ulchin 2), a construction permit process will be applied instead of the Standard Design Approval; KINS will review the application for the construction permit and will check that the above mentioned improvement measures are completely included.

KINS recognizes that the Standard Design Approval concerning the APR 1400 reactor needs to be reviewed in the light of the Fukushima accident.

The Team confirms that the permits for new plants and those under construction as well as the Standard Design Approval should be revisited to assess its adequacy in the light of the Fukushima accident and should be revised as appropriate.

The Team welcomes the decision from the regulatory body that the two new builts shall go along the lines of the general two step authorization procedure instead of the pre-established Standard Design Approval process.

CONCLUSION [7]
The Team concludes that, in the light of the Fukushima accident, importance of the site selection procedure might be further emphasized if Early Site Approval were a compulsory part of the authorization process of a new nuclear plant. The Team supports the deliberation of the regulatory body to review the Standard Design Approval process and also encourages that similar review be conducted in case of the Construction Permit and Operational License.

Module 6: Review and Assessment

During the discussion on implications of Fukushima accident in the area of review and assessment it was recognized that the near term safety improvements included in the implementation plans should be followed by more general long term actions aimed at updating the whole review and assessment process, including determination of initiating events and hazards, specification of acceptance criteria and methodologies for demonstration of compliance with the criteria, including both deterministic and probabilistic methods of safety assessment. Systematic reassessment of safety margins (robustness of the design) for both existing and future plants is needed, including comprehensive assessment of defence in

depth, consideration of low probability beyond design basis accidents (in particular extreme external hazards), consideration of combination of events and common cause failures, assessment of cliff edge effects, severe accident management issues for single-unit and for multi-unit sites, consideration of extended loss of ultimate heat sink, loss of essential power supply, hydrogen management, adequate post-accident monitoring, and safety of spent fuel storages. Not only nuclear power plants but also other nuclear installations with significant sources of radioactive material should be addressed in the long term.

There are several specific actions to be considered in the future in connection with the determination of initiating events, acceptance criteria and methods for safety assessment:

- Enhancement of methods for determination of site specific extreme events, in particular external hazards
- Reconsideration of existing design basis regarding the extreme external natural hazards, with examination of the likelihood of extreme events which are beyond design bases
- Review of whether the protection provided against the impact of extreme events in design basis and beyond design basis is adequate with sufficient margins (using thermal-hydraulic analyses, fragility analysis, structural mechanics, review of fault sequences that could occur following extreme events, assessment of robustness of the design for maintaining safety functions)
- Integrated use of deterministic and probabilistic approaches for safety assessment, with significantly enhanced scope of the PSA approach
- Suggestion of areas where improvement of the protection can be achieved
- Assessment of adequacy of emergency procedures and severe accident management guidelines for extreme events and development of enhanced accident management strategies.

CONCLUSION [8]
The Team concludes that, in accordance with the existing plans, the near term safety improvements should be followed by more general long term actions aimed at updating the whole review and assessment process, including the determination of initiating events and the magnitude of external hazards, specification of acceptance criteria and methodologies for demonstration of compliance with the criteria. The Korean regulatory body is ready to actively participate in the development of internationally harmonized review methodologies.

Module 7: Inspection

KINS undertook a programme of site inspection activities immediately following the accident at the Fukushima Dai-ichi plant on March 11, 2011, to identify where improvements where necessary at each operating facility. The scope of these Special Safety Inspections included:

- The adequacy of the design of each plant to withstand natural hazards.
- The adequacy of severe accident prevention and mitigation strategies.
- The effectiveness of the emergency response system in place.

The Special Safety Inspection identified a total of 50 long and short term improvements. Each plant submitted a detailed implementation plan for the improvements and committed to providing a progress report every six months regarding the status of the improvements. The Team noted that the post-Fukushima review was not introspective, in that it did not assess whether changes were necessary for either of the two prime nuclear safety regulators, with a view to improving the regulation of the nuclear industry.

With regards to the scope of the current inspection programmes, the Team found them to be comprehensive; however, there is a need to look at the daily inspection programme to ensure that it is risk informed and this is recognized in the main body of the report.The improvements and enhancements that are being implemented as a result of the lessons from Fukushima will be subject to a separate inspection programme produced and conducted by KINS, this programme had still to be produced at the time of the mission.

CONCLUSION [9]
The Team considers the approach by the regulatory inspection functions to be prompt, well defined and an effective way of identifying the initial set of safety improvements post a significant event. Future inspection activities should look to focus on the improvements being implemented in a targeted and systematic manner. Finally, an introspective review of the inspection function and the need for associated improvements should be completed; considering specific learning in this area.

Module 8: Enforcement

MEST has requested the utility to produce and implement an improvement plan to address the 50 post Fukushima recommendations for all of its NPP sites: Site management views the letter from

MEST/Nuclear Safety Committee regarding Fukushima improvement plans to be almost like an order. The site management believes that improvement plan can be implemented by 2015. Some, if not all improvements, will require modifications and accompanying license amendments. Full schedule for completion of improvements is still being produced.

In case of the implementation of the Fukushima improvement plan, the regulatory authority has a legal mechanism under Articles 29 and 30 of the AEA to order that work be done, as "measures for the safe operation of the reactor". However, KINS approach will be to work with the utility to ensure it produces a mutually acceptable schedule. Where delays are encountered the utility will submit an application justifying the extended time for implementation.

CONCLUSION [10]
The nature of the relationship between regulator and licensee in Korea is based on mutual cooperation and respect; this enables regulatory objectives to be achieved with the minimal amount of confrontation. However, the team concludes that improvement plans to address the implications of the Fukushima accident can be adequately enforced by the regulatory body with the enforcement tools at its disposal if required.

Module 9: Regulations and Guides

Among the 50 improvements items identified during the SSI, some clearly relate to regulations and guides. For example improvement items 4-5 and 4-6 (see Annex) address severe accident management.

As a consequence KINS has plans:

- to draft new regulations and to develop guides on severe accident (including low power severe accidents) and multi-unit accidents;
- to develop guides on portable diesel generators and batteries; and
- to conduct research projects to determine whether current regulations or guides should be updated for defining the design basis for earthquakes and tsunamis (research program is expected to start in March 2012).
- to consider the needs for additional regulations or guides on accidents effecting several units at the same sites;
- to consider weather additional regulations or guides for other extreme external natural hazards (extreme weather conditions …) and man made hazards (cyber-security, airplane crash …)

While conducting these plans, KINS will monitor and intends to take into account what happens at the international level (evolution of IAEA safety standards, European stress tests results…).

The Team performed a limited sampling of the regulatory requirements and KINS review guidelines against some specifically identified IAEA requirements relevant to the Fukushima accident.

CONCLUSION [11]
The Team considers that updating the legal requirements to include provisions for severe accident management, as well as probabilistic safety assessment, should receive a high priority. As part of its action plan, KINS recognized the need to perform a comprehensive review of the content of Korean regulation and guides in the light of the Fukushima accident, by 2015. The Team considers that this process is adequate and that updates should be prioritized according to their safety significance.

Module 10: Emergency Preparedness and Response

Based on the information received from the counterpart during the mission there are a number of improvement steps planned to be executed in Korea to enhance the country's capabilities to respond to emergencies like the one in Fukushima Daiichi. The following planned measures are supposed to serve the mentioned objectives:

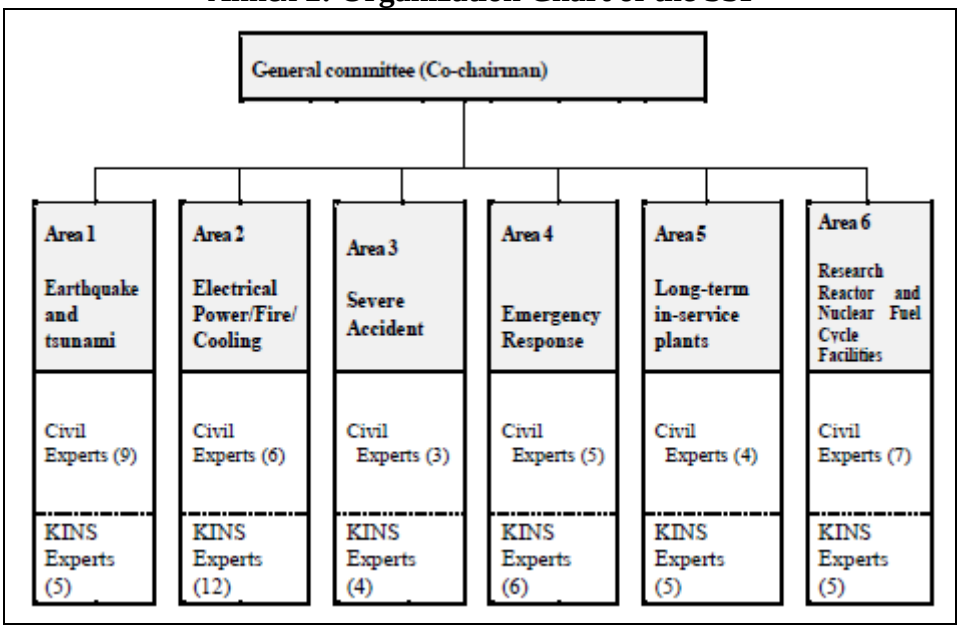
- Securing additional protective equipment in preparation for prolonged emergency;
- Securing countermeasures for protecting maintenance workers;
- Reinforcing education and training for severe accidents;
- Reinforcing radiological emergency exercises;
- Amending the emergency plan to include combined emergency of both large-scale natural disaster and nuclear accident;
- Amending the information disclosure procedure in the event of a radiation emergency;
- Reinforcing the environment monitoring for devising a means for securing necessary information in the event that there is a prolonged loss of electrical power;
- Segregation of duties between relevant central and local organizations, etc.;
- Reinforcing the performance of emergency alarm facilities;
- Adequate identification and forecast of effect of released radioactive materials;
- Evaluating protective measures for residents who live beyond the emergency planning zone.

CONCLUSION [12]
The Team concludes that Korea has an adequate improvement plan to address implications of the Fukushima accident in the area of Emergency Preparedness and Response; a time schedule for implementation should be defined and agreed by the regulatory body and relevant national organizations.

Annex 1: Main Inspection Points for SSI

Major Inspection Points of SSI	
Topic	**Major Inspection Points**
Extreme natural disasters	- Adequacy of the plant design and facilities against natural hazards - Design against earthquake and seismic capacity - Design against coastal flooding and inundation protection capability
Prevention of severe accidents	- Adequacy of power supply and cooling functions - Power system and emergency power supply - Cooling capability in case of SBO and inundation
Mitigation of severe accidents	- Adequacy of countermeasure capabilities against severe accidents - Facilities, guidelines, and strategies against severe accidents
Emergency response	- Adequacy of emergency response - Emergency response to multi-units accidents - Facilities, systems, and infrastructure for the protection of local residents and workers

Annex 2: Organization Chart of the SSI



Annex 3: 50 items to improve Korean nuclear safety after the Fukushima accident

Aera	Improvement
Design of structures and equipment against earthquakes	(1-1) Installing an automatic seismic trip system (1-2) Improving the seismic capacity of the safe shutdown system (1-3) Investigation and study on the maximum potential earthquake for NPP sites (1-4) Improving the seismic capacity of the main control room (i.e., the earthquake occurrence alarm window) (1-5) Improving the seismic capacity of the entrance bridge of Wolsong nuclear power plant
Design of structures and equipment against coastal flooding	(2-1) Extension of the height of the sea wall for the Kori site (2-2) Installation of waterproof gates and discharge pumps. (2-3) Investigating of NPP sites and study on the design basis sea water level (2-4) Enhancement of sea water intake capability and reinforcement of facilities in preparation for coastal flooding
Integrity of electrical power, cooling, and fire protection systems in case of inundation	(3-1) Securing the availability of a portable electric power generator vehicle and batteries, etc. (3-2) Upgrading design basis of AAC diesel generator (3-3) Fastening the spare transformers with anchor bolts and modifying the fuel injection port of emergency power supply system (3-4) Improving the management of switchyard facilities (3-5) Ensuring countermeasures against loss of the spent fuel pool cooling function (3-6) Preparing measures of the inundation prevention and restoration of the ultimate heat sink (3-7) Preparing countermeasures for damage of the outdoor tank (3-8) Preparing countermeasures for inundation of the main steam safety valve room and the emergency water pump room (3-9) Improving the fire protection plan and reinforcing cooperation systems (3-10) Improving fire protection facilities and response capability of plant firefighting team (3-11) Introducing a performance-based fire protection design.

Counter measures against severe accidents	(4.1) Installation of passive hydrogen removal equipment (4.2) Installation of filtered vent system or depressurizing facilities in the containment buildings (4.3) Installation of reactor injection flow paths for emergency cooling water injection from external sources (4-4) Reinforcing education and training for severe accidents (4-5) Revision of the Severe Accident Management Guidelines to enhance effectiveness (4-6) Development of Low-Power Shutdown Severe Accident Management Guidelines
Emergency response and emergency medical systems	(5-1) Securing additional radiation protection equipment for protecting residents near NPP (5-2) Amending the emergency plan to include such events as a simultaneous emergency at multiple units (5-3) Securing additional protective equipment in preparation for prolonged emergency (5-4) Securing additional equipment of emergency medical institutes (5-5) Reinforcing radiological emergency exercises (5-6) Devising a means of securing the necessary information in case of a prolonged loss of electrical power (5-7) Securing countermeasures for protecting maintenance workers (5-8) Improving the emergency response facilities (5-9) Amending the information disclosure procedure in the event of a radiation emergency (5-10) Evaluating protective measures for residents who live beyond the emergency plan zone (5-11) Reinforcing the performance of emergency alarm facilities
Long-term in-service plants	(6.1) Drastically reinforcing the safety inspections, such as regular inspections (6.2) Reinforcing the in-service inspection of the main components and pipes (6.3) Establishing and implementing an integrated management method for the aging management program (6.4) Reinforcing the management of the performance parameter of the main active components

	(6-5) Installing a fatigue monitoring system to reinforce quantitative fatigue management (6-6) Reinforcing the integrity of the pressurizer lower head. (6-7) Increasing the reliability of shutdown-inducing equipment. (6-8) Evaluating the adequacy of human resources (6-9) Increase the reliability of on-site power supply system. (6-10) Reinforcing the quality assurance on purchasing components important to safety
Research reactors and nuclear fuel cycle facilities	(7-1) Evaluating the seismic capacity and improving the main control room (7-2) Re-evaluating the site's inundation depth for HANARO and auxiliary facilities. (7-3) Amending the radiological emergency plan to reflect complicated radiological emergency conditions.

IRRS KOREA 2011 REVIEW TEAM

APPENDIX I – LIST OF PARTICIPANTS

INTERNATIONAL EXPERTS:		
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APPENDIX II – MISSION PROGRAMME

IRRS MISSION PROGRAMME		
Sunday, 10 July 2011		
IRRS Opening IRRS Review Team Meeting		
14:00 - 18:00	- Opening Remarks by the IRRS Team Leader (Mr. Borchardt) - Self-introduction of all Attendees - Introductory words by Liaison Officer. - Presentation on the IRRS Methodology and Reporting (Mr. Caruso) - Presentation Mission conduct/review (Mr. Borchardt) - First Impression from experts arising from the Advanced Reference Material (ARMS)	IRRS Review Team MEST counterparts KINS counterparts
Monday, 11 July 2011		
IRRS Entrance Meeting		
09:00 - 11:20	Opening Remarks by Vice Minister of MEST (Mr. Kim) Opening Remarks by the IRRS Team Leader (Mr. Borchardt) Self-Introduction of the IRRS Review Team Self-Introduction of the MEST/KINS counterparts Conclusion of IAEA Ministerial conference on Fukushima by Mr. Caruso Briefing by MEST Director (Mr. Baek) on: - Roles and responsibility of the regulatory body - Structure of the regulatory body - Regulatory activities - Fukushima accident response - Future regulatory framework Introduction of working arrangements by Head IRRS Mission Team (Mr. Do) Closing remarks by the IRRS Team Leader (Mr. Borchardt)	IRRS Review Team MEST counterparts KINS counterparts
13:15 - 17:00	Interview of NRB DG (Mr. Son) Module Discussion/Interviews (Module 1, 4, 5, 6, 7, 9 and 10)	IRRS TL, DTL IRRS Review Team MEST counterparts KINS counterparts
17:15 - 18:00	Daily IRRS Team debrief and MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts

Tuesday, 12 July 2011		
Daily Discussions / Interviews (Travel to site visits)		
09:00 - 10:15	Policy Issue 0 – Fukushima presentation by KINS Director (Mr. Sung)	IRRS Review Team MEST counterparts KINS counterparts
10:30 - 12:00	Interview of NSC Member Module Discussion/Interviews (Module 6, 7, 10 and Policy Issue 0)	IRRS TL, DTL IRRS Review Team MEST counterparts KINS counterparts
12:15 -	Site visit to Wolsong OEMC Briefings/interviews with OEMC staff	Mr. Zombori Mr. Cortes Carmona MEST counterparts KINS counterparts
13:00 - 16:45	Interview with VP of KHNP Module Discussion/Interviews (Module 3, 4, 6, 7, 8, 9, and 11B)	IRRS TL, DTL IRRS Review Team MEST counterparts KINS counterparts
17:00 - 17:45	Daily IRRS Team debrief and MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts
Wednesday, 13 July 2011		
Daily Discussions / Interviews (Travel to sites and ongoing visits)		
09:00 - 12:00	Module Discussion/Interviews (Module 1, 4, 6 and Policy Issues 1& 3)	IRRS Review Team MEST counterparts KINS counterparts
08:00 -	Site visit to KORI NPP site: - Interview of resident inspectors - Interview of KHNP Senior Leadership Site visit to KAERI RR (HANARO) site: - Interview of KAERI senior managers - Observation of inspection by KINS Ongoing site visit at Wolsong (OEMC): - Observation of emergency drill	Mr. Cameron Mr. Foy Ms. Persic Mr. Rovny Mr. Lux Mr. Zombori Mr. Cortes Carmona
13:00 - 16:45	Module Discussion/Interviews (Module 4, 7, 8, 11A and Policy Issues 2 & 4)	IRRS Review Team MEST counterparts KINS counterparts
17:00 - 18:15	Daily IRRS Team debrief and MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts

Thursday, 14 July 2011		
Daily Discussions / Interviews (Ongoing site visit)		
09:00 - 12:00	Module Discussion/Interviews (Module 1, 4, 5, 9, 10 and 11A)	IRRS Review Team MEST counterparts KINS counterparts
08:00 -	Ongoing site visit at KORI NPP site: Observation of inspection at • Kori NPP • Shin-Kori NPP	Mr. Cameron Mr. Foy Ms. Persic Mr. Rovny
13:00 - 16:45	Module Discussion/Interviews (Module 3, 4, 5, 6, 10, 11A and Policy Issue 0)	IRRS Review Team MEST counterparts KINS counterparts
17:00 - 18:15	Daily IRRS Team debrief and MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts
Friday, 15 July 2011		
Daily Discussions / Interviews		
09:00 - 12:00	Module Discussion/Interviews (Module 2, 8, 11B, Policy Issue 2 and follow up discussions)	IRRS Review Team MEST counterparts KINS counterparts
13:00 - 16:45	Follow up on all Module Discussions/Interviews	IRRS Review Team MEST counterparts KINS counterparts
17:00 - 18:15	Daily IRRS Team debrief and MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts
Saturday, 16 July 2011		
Report Writing		
09:00 - 18:00	IRRS Review Team Meeting and Report writing	
Sunday, 17 July 2011		
Social Event		
08:00 - 20:00	Social Event	
Monday, 18 July 2011		
Daily Discussions		
09:00 - 12:00	Follow up on all Module Discussions/Interviews	IRRS Review Team MEST counterparts KINS counterparts
13:00 - 14:30	Follow up on all Module Discussions/Interviews	IRRS Review Team MEST counterparts KINS counterparts
14:45 - 18:15	IRRS Team Meeting on Draft Mission Report Daily IRRS Team debrief and MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts

Tuesday, 19 July 2011		
Daily Discussions		
09:00 - 12:00	Follow up on all Module Discussions/Interviews	IRRS Review Team MEST counterparts KINS counterparts
13:00 - 15:45	IRRS Team Meeting on Draft Mission Report	IRRS Review Team
16:00 - 18:15	IRRS Team Meeting on Draft Mission Report Daily IRRS Team debrief and MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts
Wednesday, 20 July 2011		
Review of Mission report and, mission report handover		
09:00 - 11:30	IRRS Team Meeting on Draft Mission Report	IRRS Review Team
11:45 - 12:00	Draft Mission Report handover to MEST/KINS	IRRS Review Team MEST counterparts KINS counterparts
13:00 - 17:45	Preparation of Executive Summary	IRRS Review Team
18:00 - 18:30	IRRS MEST/KINS status meeting	IRRS Review Team MEST counterparts KINS counterparts
Thursday, 21 July 2011		
Plenary Session and Preparation for the exit meeting		
09:00 - 12:00	IRRS Team Meeting on Draft Mission Report	IRRS Review Team
13:00 - 18:00	IRRS Review Team and MEST/KINS discussion on Draft Mission Report	IRRS Review Team MEST counterparts KINS counterparts
Friday, 29 October 2010		
EXIT MEETING and PRESS CONFERENCE		
09:00 - 12:00	IRRS Exit Meeting followed by Press Conference	IRRS Review Team MEST counterparts KINS counterparts

APPENDIX III – SITE VISITS

SITE VISITS	
1.	Site Visit to KORI NPP – UNIT 3
2.	Site Visit to SHIN-KORI NPPs - UNIT 2 &3 (UNDER CONSTRUCTION)
3.	Site Visit to WOLSONG (OEMC) – EMERGENCY EXERCISE OBSERVATION
4.	Site Visit to KAERI (HANARO) RESEARCH REACTOR

APPENDIX IV – LIST OF COUNTERPARTS

	IRRS EXPERTS	MEST Lead Counterpart	KINS Lead Counterpart	MEST/KINS Support Staff
1.	**RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT**			
	Richard W. Borchardt Gustavo Caruso Georg Schwarz Ian Grant Jean-Christophe Niel	Baek Min	-	Im Si Woo (MEST) Lee Tai Yong (MEST) Park Youn Won (KINS) Chang Hyun Sop (KINS) Kim Sang Wong (KINS) Chung Yun Hyung (KINS) Do Kyu Sik (KINS)
2.	**GLOBAL NUCLEAR SAFETY RÉGIME**			
	Richard W. Borchardt Gustavo Caruso Georg Schwarz Ian Grant Jean-Christophe Niel	Baek Min	Park Youn Won	Bae Seok Hee (MEST) Lee Tai Yong (MEST) Lee Jin Ho (KINS) Hah Yeon Hee (KINS) Cheong Jae Hak (KINS)
3.	**RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY**			
	Richard W. Borchardt Gustavo Caruso Georg Schwarz Ian Grant Jean-Christophe Niel	Baek Min	Na Seong Ho	Im Si Woo (MEST) Lee Tai Yong (MEST) Chang, Hyun Sop (KINS) Chung Yun Hyung (KINS Jo Jong Chull (KINS)
4.	**MANAGEMENT SYSTEM OF THE REGULATORY BODY**			
	Erik Jende Annakaisa Koskinen	Baek Min	Yang Sung Ho	Im Si Woo (MEST) Lee Tai Yong (MEST) Bae Koo Hyun (KINS) Lee Jea Hang (KINS) Chung Ku Young (KINS)

	IRRS EXPERTS	MEST Lead Counterpart	KINS Lead Counterpart	MEST/KINS Support Staff
5.	**AUTHORIZATION**			
	Jiang Guang Ivan Lux	Jeon Kee Soo	Oh Sung Hun	Im Si Woo (MEST) Kim Suk Joon (MEST) Kim In Goo (KINS) Auh Geun Sun (KINS) Chung Ku Young (KINS)
6.	**REVIEW AND ASSESSMENT**			
	Jozef Misak Jiang Guang Ivan Lux	Jeon Kee Soo	Oh Sung Hun	Im Si Woo (MEST) Kim Suk Joon (MEST) Woo Sweng Woong (KINS) Suh Nam Duk (KINS) Chung Yeon Ki (KINS)
7.	**INSPECTION**			
	Ivan Lux Mark Foy Juraj Rovny Andreja Persic Jamnes Cameron	Baek Min	Song Seon Ho	Chae Hee Yeon (MEST) Jung Hyoun Duck (MEST) Kim Se Won (KINS) Lee Woo Ho (KINS) Chung Yeon Ki (KINS)
8.	**ENFORCEMENT**			
	Ivan Lux Mark Foy Juraj Rovny Andreja Persic Jamnes Cameron	Baek Min	Yang Chae Yong	Chae Hee Yeon (MEST) Kim Suk Joon (MEST) Kim Weol Tae (KINS) Choi Kang Ryong (KINS)
9.	**REGULATIONS AND GUIDES**			
	Fabien Feron Lisa Love-Tedjoutomo Guillaume Bouyt	Baek Min	Choi Young Hwan	Chu Ho Seong (MEST) Lee Deok-Jae (MEST) Kim Kyun Tae (KINS) Ha Jong Tae (KINS)

	IRRS EXPERTS	MEST Lead Counterpart	KINS Lead Counterpart	MEST/KINS Support Staff
				Choi Kang Ryong (KINS)
10.	EMERGENCY PREPAREDNESS AND RESPONSE			
	Alejandro Cortes Carmona Peter Zombori	Kang Ho Sung	Park Won Jae	Park Sung Won (MEST) Lee Sae Yul (KINS) Lee Jongseong (KINS) Cho Dae Hyung (KINS) Cheong Jae Hak (KINS)
11A	PERIODIC SAFETY REVIEW			
	Jozef Misak Jiang Guang	Jeon Kee Soo	Auh Geun Sun	Chu Ho Seong (MEST) Kim Suk Joon (MEST) Moon Chan Ki (KINS) Kim Hong Key (KINS) Jo Jong Chull (KINS)
11B	OPERATING EXPERIENCE FEEDBACK			
	Mark Foy Juraj Rovny Andreja Persic Jamnes Cameron	Baek Min	Lee Durk Hun	Chae Hee Yeon (MEST) Kim Min Chull (KINS) Lee Kyung Won (KINS) Koo Bon Hyun (KINS)

POLICY ISSUE DISCUSSIONS			
PI 0 – Fukushima Regulatory Issues			
Guillaume Bouyt **Fabien Feron** **Lisa Love-Tedjoutomo**	**Baek Min**	**Sung Key Yong**	**Kang Jeong-Whan (MEST)** **Lee Sae Yul (KINS)** **Hwang Sun Chul (KINS)** **Yun Ju Yong (KINS)** **Kim Sang Jae (KINS)** **Kim Hyung Tae (KINS)**
PI 1 – Independence of the Regulatory Body			
Richard W. Borchardt **Gustavo Caruso** **Georg Schwarz** **Ian Grant** **Jean-Christophe Niel**	**Baek Min**	**-**	**Im Si Woo (MEST)** **Lee Tai Yong (MEST)** **Park Youn Won (KINS)** **Chang Hyun Sop (KINS)** **Do Kyu Sik (KINS)**
PI 2 - Transparency and Openness			
Richard W. Borchardt **Gustavo Caruso** **Georg Schwarz** **Ian Grant** **Jean-Christophe Niel**	**Baek Min**	**-**	**Im Si Woo (MEST)** **Lee Tai Yong (MEST)** **Hwang Sun Chul (KINS)** **Lee Kye Hwi (KINS)** **Hah Yeon Hee (KINS)** **Choi Kang Ryong (KINS)**
PI 3 - Continued Operation			
Fabien Feron **Lisa Love-Tedjoutomo** **Guillaume Bouyt**	**Baek Min**	**Oh Sung Hun**	**Chu Ho Seong (MEST)** **Lee Deok-Jae (MEST)** **Moon Chan Ki (KINS)** **Kim Yong Beum (KINS)** **Jo Jong Chull (KINS)**
PI 4 - Aging Management			
Fabien Feron **Lisa Love-Tedjoutomo** **Guillaume Bouyt**	**Baek Min**	**Chung Hae Dong**	**Chu Ho Seong (MEST)** **Lee Deok-Jae (MEST)** **Kim Yong Beum (KINS)** **Chung Yeon Ki (KINS)**

RESEARCH REACTORS			
Ivan Lux	**Baek Min**	**Shin Dae Soo**	**Chu Ho Seong (MEST)** **Park Jun Sang (KINS)** **Chung Ku Young (KINS)**

APPENDIX V – RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICES

AREA	R: Recommendations S: Suggestions GP: Good Practices	Recommendations, Suggestions or Good Practices
1. RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT	R 1	The regulatory framework should require decommissioning plans for nuclear installations to be constructed and operated. These plans should be updated periodically
	S 1	In order to ensure the effectiveness of the new Nuclear Safty Commission the selection criteria for the members should reflect the need of independence and nuclear safety competence within the Commission.
	GP 1	Korea has a clear and structured national approach to set out in its policies and the corresponding implementation plans with well-defined priorities for the further development of the legal framework.
	GP 2	The establishment of the International Nuclear Safety School which provides a large variety of training and education opportunities for members of the regulatory body as well as for students and other interested parties
2. GLOBAL NUCLEAR SAFETY REGIME	GP 3	Korea strongly promotes a global nuclear safety regime through multi or bi lateral actions, with countries having established nuclear programmes and those embarking on nuclear power, in technical, regulatory and research domains.
	GP 4	The regulatory body has developed and implemented a comprehensive OEF-system that is based around a number of effective initiatives including: collection and trending of data from a wide range of sources; well-populated and presented information databases; numerous key communication events; and close working with the licensees and other stakeholders on a national and international front.
3. RESPONSIBILITIES AND FUNCTIONS OF THE	R 2	The Government of Korea should continue the process of clearly defining the responsibilities within the new regulatory body and avoid overlaps between

AREA	R: Recommendations S: Suggestions GP: Good Practices	Recommendations, Suggestions or Good Practices
REGULATORY BODY		the Secretariat, KINS and the Advisory Committee. Resources and staff should be allocated commensurate with those responsibilities.
	S 2	The new Nuclear Safety Commission should prepare human resources plans for the Secretariat that provides appropriate staff to enable the accomplishment of its administrative function in support of the Commission without undue burden.
	S 3	The new Nuclear Safety Commission should establish an advisory committee, with similar capabilities as the existing Nuclear Safety Committee to support the decision-making process.
	GP 5	KINS has an effective practice to recruit successors 3 years before the actual retirement of experienced staff, in order to preserve knowledge and provide continuity.
	GP 6	The "safety experience" training course of KINS dedicated to students/parents, teachers, opinion leaders has been shown to positively influence public understanding and acceptance of the regulatory body's activities.
4. MANAGEMENT SYSTEM OF THE REGULATORY BODY	**R 3**	The Korean government should provide for development of a management system, to cover all activities of the new Nuclear Safety Commission and its Secretariat. This management system should be in place, at least the main parts of it, as soon as the new organization takes over responsibility.
	R 4	KINS should develop a process on Resource Management in order to achieve a fully integrated Management System.
	S 4	KINS should revise its Management System Manual to include an overall description of the basic processes, how they relate to each other as well as a description of all types of documentation used within the Management System.

AREA	R: Recommendations S: Suggestions GP: Good Practices	Recommendations, Suggestions or Good Practices
	S 5	The new Nuclear Safety Commission and KINS should describe in their Management System Manuals what means they plan to use in order to ensure a common understanding of safety culture, to support individual and groups to carry out work in a safe way, to reinforce a learning and questioning attitude, and to continually develop and improve the safety culture.
	S 6	The new Nuclear Safety Commission and KINS should supplement their Management Systems with a process or procedure for managing organizational change in order to ensure that regulatory efficiency and effectiveness are not compromised.
	GP 7	KINS has an excellent comprehensive integrated computerized information and data management system for establishing, maintaining and retrieving adequate records relating to the safety of facilities and activities (MIDAS and 19 additional information systems). This contributes considerably to improve effectiveness and efficiency of the regulatory performance.
5. AUTHORIZATION	**R 5**	The Regulatory body should initiate the extension of the legal basis of the licensing process in order to ensure that: 1. in case of the submittal of a report on a license amendment in minor matters, whenever the reported change has safety significance the licensee is required to submit a safety assessment on the possible consequences of the modifications, 2. in case of the submittal of a report on a license amendment in minor matters, whenever the reported change has safety significance the licensee shall not commence to realize the modification prior to the answer to its notification from the regulatory body.
	R 6	The Regulatory body should initiate the process to modify the Atomic Energy Act in order to eliminate the option of replacing a suspension of the licensed activity by financial penalty when the safety violation would rightly

AREA	R: Recommendations S: Suggestions GP: Good Practices	Recommendations, Suggestions or Good Practices
		call for suspension of the activity.
	R 7	The Regulatory body should initiate a change in the regulations in order to 1. require a Quality Assurance Plan to be submitted when licensing a research reactor of any size. The requirements on the plan shall reflect the safety importance of the facility to be constructed in line with the graded approach, 2. require emergency preparedness organization and emergency preparedness plans for research reactors of any size. The organization and plan shall follow graded approach and shall be commensurate with the threat posed by the facility.
6. REVIEW AND ASSESSMENT	**S 7**	The regulatory body should initiate updating the Enforcement Regulation in order to extend the scope of the Safety Analysis report so that design extension conditions and PSA are adequately covered.
	S 8	The regulatory body should consider harmonization of approaches used for determination of radiological consequences in Safety Analysis Report and Radiological Environmental Report.
	S 9	In connection with licensing of new reactors the regulatory body should consider harmonization of licensing acceptance criteria and off-site intervention levels for design basis accidents and establish criteria for design extension conditions.
	GP 8	In addition to enhancing efficiency of the review and assessment process by means of continuous monitoring, evaluation and feedback the KINS publishes every year a book of “Good Practices (Best Regulation)” which contains selection of exceptional results of the regulatory works and findings.
	GP 9	KINS maintains and utilizes its internal capability for performing independent audit calculations by means of a number of deterministic and

AREA	R: Recommendations S: Suggestions GP: Good Practices	Recommendations, Suggestions or Good Practices
		probabilistic computer codes including development and validation of such codes, and sharing the computer codes and relevant experience with other regulatory bodies.
7. INSPECTION	**R 8**	The new Nuclear Safety Commission should recognize the current potential for conflict between technical and enforcing inspectors and ensure measures are introduced to reconcile these differences in an effective manner.
	R 9	Daily inspection programmes should be reviewed by KINS to ensure they are founded on the safety significance of the structures, systems and components such that they are inspected in a graded and systematic manner.
	S 10	The regulatory body should ensure it implements a formal process to observe and assess the inspection methods and techniques of all of its inspectors to ensure they are being conducted in a suitable, consistent and effective manner.
	GP 10	The annual Quality Assurance inspection plan produce by KINS ensures that all major vendors to the Korean nuclear programme are subjected to a KINS QA inspection at least once in the 12-month period, including all overseas suppliers.
8. ENFORCEMENT	**S 11**	The regulatory body should complete a review of its decision making processes that have been applied to significant events to determine whether the appropriate enforcement actions were taken and whether improvements are required to its decision making processes and associated enforcement strategies.
9. REGULATIONS AND GUIDES	**S 12**	Although stakeholder involvement is encompassed in the drafting process for regulations and guides, general public involvement should be enhanced, especially by making them aware of the drafts being developed well before they are submitted to KINS Technical standard committee.

AREA	R: Recommendations S: Suggestions GP: Good Practices	Recommendations, Suggestions or Good Practices
	GP 11	KINS Technical Standard Committee plays a key role in reviewing draft comments by giving expert opinions. A significant number of external experts allow for broader stakeholder input. As per regulations, the Nuclear safety committee also includes a wide range of experts outside the Regulatory body.
	GP 12	The drafting process for regulations and guides explicitly includes identification then comparison to domestic and international standards, including IAEA safety standards. Since nearly a decade, there have been several comparison exercises between Korean regulations and guides and IAEA safety standards, in an effort to improve harmonisation with those standards
10. EMERGENCY PREPAREDNESS AND RESPONSE	**R 10**	Emergency planning zones should be defined in accordance with the IAEA Requirements (GS-R-2) (PAZ and UPZ instead of the EPZ).
	GP 13	The operation and continuous enhancement of AtomCARE and the development of a Nationwide Integrated Management System for Environmental Radiation / Radioactivity Monitoring is a good example of integrating information and data gathering systems into an effective and efficient national emergency response organization.

	GP 14	The Regulatory body has implemented an exemplary outreach program, including the integration of volunteering experts and first responders (U-REST), as well as raising the awareness and understanding of the population regarding the issues of nuclear and radiological emergencies.
11. REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT	**GP 15**	Good Practice: The Korean national response to the Fukushima accident was well-coordinated and addressed key areas in a short timeframe. In particular, national environment radiation monitoring was reinforced, contamination of goods and people was monitored at airports and harbors, public concerns were addressed by significant communication involvement, and cooperation with Japan was conducted through staff support and technical meetings. The swift launch of the Special Safety Inspection process led to the prompt identification of first measures to improve safety. As part of the response to the implications of the Fukushima accident, the exceptional involvement of external experts in the Special Safety Inspection further enhanced the transparency and further reinforced the credibility of the inspection process, while promoting information sharing with interested parties.

APPENDIX VI – CONCLUSIONS ON THE REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT

AREA	NO.	CONCLUSION
ACTIONS TAKEN BY THE REGLATORY BODY IN THE AFTERMATH OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT	**C 1**	The Team considers that the prompt and well-coordinated response of the Korean government, its regulatory body and the licensees to the Fukushima accident is commendable. In particular, public concerns were addressed by significant communication involvement and a prompt Special Safety Inspection was performed. The Team recognizes that these efforts were carried out in difficult circumstances, considering that the geographical proximity of Japan exacerbated general anxiety.
PLANS FOR UP-COMING ACTIONS TO FURTHER ADDRESS THE REGULATORY IMPLICATIONS OF THE TEPCO FUKUSHIMA DAI-ICHI ACCIDENT	**C 2**	The Team concludes that the findings of the Special Safety Inspection are valuable first steps in a process which will last for many more years, as additional analysis is completed and further lessons are learned from the Fukushima accident worldwide. The Team considers that it would be valuable for the experience gained in Korea from the implementation of the safety improvement programme to be brought to the attention of the nuclear community for consideration in responding to the implications of the Fukushima accident. As intended by KINS, the Team considers that the regulatory body should request that in the light of the Fukushima accident, KHNP perform further relevant assessments, including a thorough review of design basis provisions, and define and conduct a systematic approach to address beyond design basis accidents. As intended, international approaches could be considered.

AREA	NO.	CONCLUSION
1. RESPONSIBILITIES AND FUNCTIONS OF THE GOVERNMENT	**C 3**	The Team did not identify elements regarding the responsibilities and function of the government, which would raise particular concern in the light of the Fukushima accident. However, the Team considers that the establishment of an effectively independent regulatory body is an opportunity to effectively address the regulatory lessons learned from the Fukushima accident.
2. GLOBAL NUCLEAR SAFETY REGIME	**C 4**	The Team did not identify elements regarding the Global Nuclear Safety Framework which would raise particular concern in the light if the Fukushima accident. It is important that operators of NPPs and the regulatory body systematically analyse international operational experience feedback in the light of the Fukushima accident and derive and enforce the adequate improvement measures.
3. RESPONSIBILITIES AND FUNCTIONS OF THE REGULATORY BODY	**C 5**	The Team did not identify elements regarding the responsibilities and functions of the regulatory body which would raise particular concern in the light of the Fukushima accident. The Team considers that the environmental radiation monitoring programme and the communication to the public and interested parties were carried out in an exemplary manner.
4. MANAGMENT SYSTEM OF THE REGULATRY BODY	**C 6**	The Team concludes that the KINS´s Management System was responsive to experiences from the Fukushima accident response. Actions were initiated immediately to remedy a weakness of the system. As intended by KINS, further assessments should be made and actions should be taken if necessary, even if the established audit plan will not be revised to explicitly address the Fukushima regulatory response issues.

AREA	NO.	CONCLUSION
5. AUTHORIZATION	**C 7**	The Team concludes that, in the light of the Fukushima accident, importance of the site selection procedure might be further emphasized if Early Site Approval were a compulsory part of the authorization process of a new nuclear plant. The Team supports the deliberation of the regulatory body to review the Standard Design Approval process and also encourages that similar review be conducted in case of the Construction Permit and Operational License.
6. REVIEW AND ASSESSMENT	**C 8**	The Team concludes that, in accordance with the existing plans, the near term safety improvements should be followed by more general long term actions aimed at updating the whole review and assessment process, including the determination of initiating events and the magnitude of external hazards, specification of acceptance criteria and methodologies for demonstration of compliance with the criteria. The Korean regulatory body is ready to actively participate in the development of internationally harmonized review methodologies.
7. INSPECTION	**C 9**	The Team considers the approach by the regulatory inspection functions to be prompt, well defined and an effective way of identifying the initial set of safety improvements post a significant event. Future inspection activities should look to focus on the improvements being implemented in a targeted and systematic manner. Finally, an introspective review of the inspection function and the need for associated improvements should be completed; considering specific learning in this area.

AREA	NO.	CONCLUSION
8. ENFORCEMENT	**C 10**	The nature of the relationship between regulator and licensee in Korea is based on mutual cooperation and respect; this enables regulatory objectives to be achieved with the minimal amount of confrontation. However, the team concludes that improvement plans to address the implications of the Fukushima accident can be adequately enforced by the regulatory body with the enforcement tools at its disposal if required
9. REGULATIONS AND GUIDES	**C 11**	The Team considers that updating the legal requirements to include provisions for severe accident management, as well as probabilistic safety assessment, should receive a high priority. As part of its action plan, KINS recognized the need to perform a comprehensive review of the content of Korean regulation and guides in the light of the Fukushima accident, by 2015. The Team considers that this process is adequate and that updates should be prioritized according to their safety significance.
10. EMERGENCY PREPAREDNESS AND RESPONSE	**C 12**	The Team concludes that Korea has an adequate improvement plan to address implications of the Fukushima accident in the area of Emergency Preparedness and Response; a time schedule for implementation should be defined and agreed by the regulatory body and relevant national organizations.

APPENDIX VII – MEST/KINS REFERENCE MATERIAL USED FOR THE REVIEW

[1] IRRS Questions and Answers:

- *Module 1: Responsibilities and Functions of the Government*
- *Module 2: Global Nuclear Safety Regime*
- *Module 3: Responsibilities and functions of the Regulatory Body*
- *Module 4: Management System of the Regulatory Body*
- *Module 5: Authorization*
- *Module 6: Review and Assessment*
- *Module 7: Inspection*
- *Module 8: Enforcement*
- *Module 9: Regulations and Guides*
- *Module 10: Emergency Preparedness and Response*
- *Module 11a: Periodic Safety Review*
- *Module 11b: Feedback of Operating Experience*

[2] References to Modules

Module 1: Responsibilities and Functions of the Government

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *Act on Physical Protection and Radiological Emergency*
5. *Enforcement Decree of the Act on Physical Protection and Radiological Emergency*
6. *Enforcement Regulation of the Act on Physical Protection and Radiological Emergency*
7. *Regulation on Technical Standards for Nuclear Reactor Facilities, etc.*
8. *Regulation on Technical Standards for Radiation Safety Control, etc.*
9. *Nuclear Liability Act*
10. *Act on Indemnity Agreement for Nuclear Liability*
11. *Enforcement Decree of the Nuclear Liability Act*
12. *Korea Institute of Nuclear Safety Act*
13. *Enforcement Decree of Korea Institute of Nuclear Safety Act*
14. *Radioactive Waste Management Act*
15. *Enforcement Decree of the Radioactive Waste Management Act*
16. *Enforcement Regulation of the Radioactive Waste Management Act*
17. *Government Organization Act*
18. *State Public Officials Act*
19. *Electric Utility Act*
20. *Government Finance Act*
21. *Framework Act on Civil Defense*
22. *Framework Act on Environmental Policy*
23. *Industrial Safety and Health Act*
24. *Medical Services Act*
25. *Framework Act on the Management of Disasters and Safety*
26. *Rules for Entrusted Regulatory Activities*
27. *Nuclear Safety Policy Statement*
28. *Nuclear Safety Charter*
29. *Policy on Severe Accident of Nuclear Power Plants*
30. *The 1st Comprehensive Nuclear Safety Plan (2010 ~ 2014)*

31. *Comprehensive Nuclear Safety Implementation Plan in 2011*
32. *KINS Code of Ethics*

Module 2: Global Nuclear Safety Regime

1. *The Republic of Korea Fifth National Report for the Convention on Nuclear Safety, 2010*
2. *2009 Safety and Operational Status of Nuclear Power Plants in Korea, KINS/ER-035, Vol. 10, 2010*

Module 3: Responsibilities and functions of the Regulatory Body

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *Act on Physical Protection and Radiological Emergency*
5. *Nuclear Liability Act*
6. *Act on Indemnity Agreement for Nuclear Liability*
7. *Government Organization Act*
8. *Government Finance Act*
9. *Framework Act on the Management of Charges*
10. *Official Information Disclosure Act*
11. *Korea Institute of Nuclear Safety Act*
12. *KINS Rule (Rules for Expert Utilization)*
13. *KINS Rule (General Rules for Entrusted Regulatory Activities)*
14. *KINS Rule (Rules of Nuclear Safety Information Disclosure)*
15. *Presidential Decree: Organization of the Ministry of Education, Science and Technology and its Subordinate Offices*
16. *MEST Ordinance: Enforcement Regulation of Organization of the Ministry of Education, Science and Technology and its Subordinate Offices*
17. *Regulations on Management of National Research and Development Projects*
18. *MEST Rule of Human Resource Management*
19. *Nuclear Safety Policy Statement*
20. *MEST Notice No. 2009-37 (Regulations on Reporting and Public Announcement of Accident and Incident for Nuclear Power Utilization Facilities, MEST.Reactor.019)*
21. *MEST Notice No.2009-37 (Standards for Radiation Protection, etc., MEST.Radiation.001)*
22. *Rule Making and Amendment Procedures*
23. *White Book on Nuclear Safety*
24. *The Republic of Korea Fifth National Report for the Convention on Nuclear Safety*
25. *KINS Quality Management System Manual*
26. *The 1st Comprehensive Nuclear Safety Plan (2010 ~ 2014)*
27. *The Code of Conduct for Officers of the Ministry of Education, Science and Technology*
28. *KINS Code of Ethics*
29. *Website of MEST (Ministry of Education, Science and Technology, http://www.mest.go.kr)*
30. *Website of KINS (Korea Institute of Nuclear Safety, http://www.kins.re.kr)*
31. *Website of INSS (International Nuclear Safety School, http://soar.kins.re.kr)*
32. *Website of NSIC (Nuclear Safety Information Center, http://nsic.kins.re.kr/nsic)*
33. *Website of KISOE (Korea Information System on Occupational Exposure, http://kisoe.kins.re.kr)*
34. *Website of WACID (WAste Comprehensive Information Database, http://wacid.kins.re.kr)*
35. *Website of RASIS (RAdiation Safety Information System, http://rasis.kins.re.kr/rasis)*
36. *Website of OPIS (Operational Performance Information System for nuclear power plant, http://opis.kins.re.kr)*
37. *Website of AtomCARE (Computerized technical Advisory system for a Radiological Emergency, http://care.kins.re.kr)*

38. *Website of IERNet (Integrated Environmental Radiation monitoring Network, http://iernet.kins.re.kr)*
39. *Website of EMC (Earthquake Monitoring Center, http://emc.kins.re.kr)*
40. *Website of MIDAS (Management of Information and Data Access System, http://midas.kins.re.kr)*
41. *Website of SAFER (Nuclear Safety Regulation Supporting System, http://safer.kins.re.kr)*
42. *Website of CATS (Corrective Action Tracking System, http://rtracer.kins.re.kr/cats)*
43. *Website of DIOS (Dissemination of Incident and Operating experience System, http://rtracer.kins.re.kr/dios)*
44. *Website of SIMS (Safety Issues Management System, http://rtracer.kins.re.kr/sims)*
45. *RADiation source LOcation Tracking system (RADLOT)*
46. *IAEA, Fundamental Safety Principles, No. SF-1*
47. *IAEA, Organization and Staffing of the Regulatory Body for Nuclear Facilities, No. GS-G-1.1*
48. *IAEA, Occupational Radiation Protection, No. RS-G-1.1*

Module 4: Management System of the Regulatory Body

1. *Atomic Energy Act*
2. *Act on Physical Protection and Radiological Emergency*
3. *MEST Nuclear Safety Management System Manual*
4. *IAEA TECDOC-1090 Quality Assurance within Regulation Bodies*
5. *ISO 9001-2000 Quality Management System*
6. *KINS Quality Management System Manual*
7. *Korea Institute of Nuclear Safety Act*
8. *Nuclear Safety Charter*
9. *Nuclear Safety Policy Statement*
10. *KINS Mission Principle*
11. *KINS Code of Ethics*
12. *KINS Customer Service Charter*
13. *KINS Rules for Entrusted Regulatory Activities 14-01-15 (Specific Rules on Safety Review for Nuclear Reactor and Related Facilities)*
14. *Licensing Review Procedure for Nuclear Power Reactors and Related Facilities*
15. *Safety Review Guidelines for PWR Nuclear Power Plants, KINS/GE-N001*
16. *MEST Instruction No.84 (Regulation on Nuclear Power Inspector Certificates and Their Management)*
17. *KINS Rule for Education and Training*
18. *KINS Procedure for Quality Management Assessment*

Module 5: Authorization

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *Act on Physical Protection and Radiological Emergency*
5. *Enforcement Decree of the Act on Physical Protection and Radiological Emergency*
6. *Enforcement Regulation of the Act on Physical Protection and Radiological Emergency*
7. *Regulation on Technical Standards for Nuclear Reactor Facilities, etc.*
8. *Regulation on Technical Standards for Radiation Safety Control, etc.*
9. *KINS Rules for Entrusted Regulatory Activities - 14-01-15 (Specific Rules on Safety Review for Nuclear Reactor and Related Facilities)*
10. *KINS Procedure (Licensing Review Procedure for Nuclear Power Reactors and Related Facilities)*
11. *Safety Review Guidelines for LWR Nuclear Power Plant, KINS/GE-N001*

Module 6: Review and Assessment

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*

3. *Enforcement Regulation of the Atomic Energy Act*
4. *Regulation on Technical Standards for Nuclear Reactor Facilities, etc.*
5. *MEST Notice No.2010-04 (Criteria for Performance of Emergency Core Cooling System of Pressurized Light Water Reactor, MEST.Reactor.024)*
6. *MEST Notice No.2010-05 (Regulation on Preparation of Explanatory Report on Technical Capability for Construction and Operation of Nuclear Reactor Facilities, MEST.Reactor.037)*
7. *KINS Regulatory Guide 8.22 (Cyber Security for I&C System)*
8. *KINS Quality Management System Manual*
9. *KINS Rules for Entrusted Regulatory Activities - 14-01-15 (Specific Rules on Safety Review for Nuclear Reactor and Related Facilities)*
10. *KINS Safety Review Guideline*
    - *Safety Review Guidelines for PWR Nuclear Power Plants, KINS/GE-N001*
    - *PSR Review Guidelines for PWR Nuclear Power Plants, KINS/RR-139*
    - *PSR Review Guidelines for PHWR Nuclear Power Plants, KINS/GE-N9*
    - *Continued Operation Review Guidelines for PWR Nuclear Power Plants, KINS/GE-N8*
    - *Continued Operation Review Guidelines for PHWR Nuclear Power Plants, KINS/GE-N11*
11. *Accident Analysis Computer Codes and Methodology Review Guidelines for Nuclear Reactor Facilities, KINS/GE-N005*
12. *KINS Procedure*
    - *Licensing Review Procedure for Nuclear Power Reactor and Related Facilities*
    - *License Amendment Review Procedure for Nuclear Power Reactor and Related Facilities*
    - *Periodic Safety Review Procedure for Nuclear Power Reactor and Related Facilities - Topical Report Review Procedure*
13. *Technical Guidelines for Conservative Evaluation of PWR ECCS Performance, KINS/GT-N007-1*
14. *Technical Guidelines for Best-Estimate Evaluation of PWR ECCS Performance, KINS/GT-N007-2*

Module 7: Inspection

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *Regulation on Technical Standards for Nuclear Reactor Facilities, etc.*
5. *MEST Notice No. 2009-37 (Regulation on Management of Inspection Findings from Nuclear Power Utilization Facilities, MEST.Reactor.010)*
6. *MEST Notice No.2009-37 (Regulations on Reporting and Public Announcement of Accident and Incident for Nuclear Power Utilization Facilities, MEST.Reactor.019)*
7. *MEST Notice No.2009-37 (Detailed Requirements for Quality Assurance of Nuclear Reactor Facilities, MEST.Reactor.026)*
8. *MEST Notice No.2010-26 (Regulations on Pre-operational Inspection for Nuclear Reactor Facilities, MEST.Reactor.027)*
9. *MEST Notice No.2010-02 (Regulation on Items and Method of Periodic Inspection for Nuclear Reactor Facilities, MEST.Reactor.034)*
10. *MEST Notice No. 2010-05 (Regulation on Preparation of Explanatory Report on Technical Capability for Construction and Operation of Nuclear Reactor Facilities, MEST.Reactor.037)*
11. *MEST Instruction No.84 (Regulation on Nuclear Power Inspector Certificates and Their Management)*
12. *MEST Instruction No.85 (Nuclear Power Plant Resident Office Operation Regulation)*
13. *KINS Rules for Entrusted Regulatory Activities*
14. *KINS Quality Management System Manual*
15. *KINS Inspection Guideline*
    - *Pre-Operational [Facility] Inspection Guidelines for PWR Nuclear Power Plants, KINS/GI-N02*

- *Pre-Operational [Performance] Inspection Guidelines for PWR Nuclear Power Plants, KINS/GI-N03*
- *Quality Assurance Inspection Guidelines for Construction and Operation of Nuclear Power Utilization Facility, KINS/GI-N013*
- *Periodic Inspection Guidelines for Nuclear Power Reactor and Related Facilities, KINS/GI-N01*

16. *KINS Procedure*
    - *Pre-operational Inspection Procedure for Nuclear Power Reactor and Related Facilities*
    Periodic Inspection Procedure for Nuclear Power Reactor and Related Facilities
    - *Quality Assurance Inspection Procedure for Construction and Operation of Nuclear Reactor Utilization Facilities*
    - *Quality Assurance Inspection Procedure for Production of Major Components of Nuclear Reactor Facilities*
    - *Event Investigation and Disclosure Procedure for Nuclear Power Reactor and Related Facilities*
17. *Quality Assurance Inspection, KINS/AR-653, Vol. 12*
18. *Quality Management Assessment Report, KINS/ER-142, Vol. 2*
19. *Quality Management Assessment Report, KINS/ER-142, Vol. 3*

Module 8: Enforcement

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *MEST Notice No. 2009-37 (Regulation on Management of Inspection Findings from Nuclear Power Utilization Facilities, MEST.Reactor.010)*
5. *MEST Instruction No. 85 (MEST Nuclear Power Plant Resident Office Operation Regulation)*
6. *KINS Quality Management System Manual*

Module 9: Regulations and Guides

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *Regulation on Technical Standards for Nuclear Reactor Facilities, etc.*
5. *MEST Notice No. 2010-28 (Guideline for Application of Korea Electric Power Industry Codes as Technical Standards of Nuclear Reactor Facilities, MEST.Reactor.021)*
6. *KINS Rules for Entrusted Regulatory Activities*
7. *KINS Quality Management System Manual*

Module 10: Emergency Preparedness and Response

1. *Act on Physical Protection and Radiological Emergency*
2. *Enforcement Decree of the Act on Physical Protection and Radiological Emergency*
3. *Enforcement Regulation of the Act on Physical Protection and Radiological Emergency*
4. *Nuclear Liability Act*
5. *Enforcement Decree of the Nuclear Liability Act*
6. *Act on Indemnity Agreement for Nuclear Liability*
7. *Enforcement Decree of the Act on Indemnity Agreement for Nuclear Liability*
8. *MEST Notice No. 2009-37 (Standards for Radiation Protection, etc., MEST.Radiation.001)*
9. *MEST Notice No. 2009-37 (Regulation on the Inspection for Radiological Emergency, MEST.Radiation.021)*
10. *.MEST Notice No. 2009-37 (Regulation on the Education for Radiological Emergency, MEST.License.007)*
11. *.MEST Notice No. 2009-37 (Standards for Establishment, etc. of Radiological Emergency Plan for Nuclear Licensee, MEST.Radiation.003)*
12. *MEST Notice No. 2009-37 (Regulation on Reporting and Public Announcement of Accidents and*

Incidents for Nuclear Power Utilization Facilities, MEST.Reactor.019)

13. *Field Manual for Crisis Response in Nuclear Safety Area (Release of Radioactivity)*
14. *Field Manual for the Initial Response against Radiological Accident and Terrorism*

Module 11a: Periodic Safety Review

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *The Republic of Korea Fifth National Report for the Convention on Nuclear Safety, 2010*
5. *The 11th NSC meeting minutes*
6. *The 39th NSC meeting minutes*
7. *PSR Review Guidelines for PWR Nuclear Power Plants, KINS/RR-139*
8. *PSR Review Guidelines for PHWR Nuclear Power Plants, KINS/GE-N9*
9. *IAEA, Periodic Safety Review of Nuclear Power Plants, No. NS-G-2.10*
10. *IAEA, Periodic Safety Review of Operational Nuclear Power Plants, No. 50-SG-O12*
11. *The 1st Comprehensive Nuclear Safety Plan (2010 ~ 2014)*

Module 11b: Operating Experience Feedback

1. *IAEA Convention on Nuclear Safety*
2. *IAEA, Governmental, Legal and Regulatory Framework for Safety, No. GSR Part 1*
3. *IAEA, A System for the Feedback of Experience from Events in Nuclear Installations, No. NS-G-2.11*
4. *MEST Notice No. 2009-37 (Regulation on Reporting and Public Announcement of Accidents and Incidents for Nuclear Power Utilization Facilities, MEST.Reactor.019)*
5. *Website of OPIS (Operational Performance Information System for nuclear power plant, http://opis.kins.re.kr)*
6. *Website of CATS (Corrective Action Tracking System, http://rtracer.kins.re.kr/cats)*
7. *Website of DIOS (Dissemination of Incident and Operating experience System, http://rtracer.kins.re.kr/dios)*
8. *Electronic Functional Analysis and Simulation Tool (e-FAST)*
9. *Three-dimensional Functional Analysis and Simulation Tool (t-FAST)*
10. *Proceedings on OEF Workshop (2003 ~ 2010)*

Policy Issue 1: Independence of the Regulatory Body

1. *Atomic Energy Act*
2. *Act on Physical Protection and Radiological Emergency*
3. *Nuclear Liability Act*
4. *Korea Institute of Nuclear Safety Act*
5. *Enforcement Decree of Korea Institute of Nuclear Safety Act*
6. *Radioactive Waste Management Act*
7. *Enforcement Decree of the Radioactive Waste Management Act*
8. *Enforcement Regulation of the Radioactive Waste Management Act*
9. *Government Organization Act*
10. *State Public Officials Act*
11. *Electric Utility Act*
12. *Government Finance Act*
13. *Rules for Entrusted Regulatory Activities*
14. *Nuclear Safety Policy Statement*
15. *Nuclear Safety Charter*
16. *Policy on Severe Accident of Nuclear Power Plants*
17. *The 1st Comprehensive Nuclear Safety Plan (2010 ~ 2014)*
18. *Comprehensive Nuclear Safety Implementation Plan in 2011*

19. *KINS Code of Ethics*

Policy Issue 2: Transparency & Openness

1. *Atomic Energy Act*
2. *Enforcement Regulation of the Atomic Energy Act*
3. *Nuclear Safety Policy Statement*
4. *Nuclear Safety Charter*
5. *The 1st Comprehensive Nuclear Safety Plan (2010 ~ 2014)*
6. *The MEST Notice No. 2009-37 (Regulation on Reporting and Public Announcement of Accidents and Incidents for Nuclear Power Utilization Facilities, MEST.Reactor.019)*
7. *Official Information Disclosure Act*
8. *Administrative Procedures Act*
9. *Act on Assistance to Electric Power Plants-Neighboring Areas*
10. *Website of NSIC (Nuclear Safety Information Center, http://nsic.kins.re.kr)*

Policy Issue 3: Continued Operation

1. *Enforcement Decree of the Atomic Energy Act*
2. *Enforcement Regulation of the Atomic Energy Act*
3. *MEST Notice No. 2009-37 (Guidelines for Application of Technical Standards for Assessment of Continued Operation of Nuclear Reactor Facilities, MEST.Reactor.035)*
4. *Continued Operation Review Guidelines for PWR Nuclear Power Plants, KINS/GE-N8*
5. *Continued Operation Review Guidelines for PHWR Nuclear Power Plants, KINS/GE-N11*
6. *IAEA, Expert Mission on Continuous Operation Programme/Activities of Kori Unit 1 in Korea*

Policy Issue 4: Aging Management

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *Regulation on Technical Standards for Nuclear Reactor Facilities, etc.*
5. *MEST Notice No. 2009-37 (Material Surveillance Criteria for Reactor Pressure Vessel, MEST. Reactor.014)*
6. *MEST Notice No. 2009-37 (Regulation on In-Service Inspection of Nuclear Reactor Facilities, MEST.Reactor.016)*
7. *MEST Notice No. 2010-02 (Regulation on Items and Method of Periodic Inspection for Nuclear Reactor Facilities, MEST.Reactor.034)*
8. *MEST Notice No. 2009-37 (Guidelines on Application of Technical Standards for Assessment of Continued Operation of Nuclear Reactor Facilities beyond Design Life, MEST. Reactor.035)*
9. *KINS Safety Review Guideline*
   - *Safety Review Guidelines for PWR Nuclear Power Plants, KINS/GE-N001*
   - *PSR Review Guidelines for PWR Nuclear Power Plants, KINS/RR-139*
   - *PSR Review Guidelines for PHWR Nuclear Power Plants, KINS/GE-N9*
   - *Continued Operation Review Guidelines for PWR Nuclear Power Plants, KINS/GE-N8*
   - *Continued Operation Review Guidelines for PHWR Nuclear Power Plants, KINS/GE-N11*
10. *ASME Code Section III, Appendix W, Environmental Effects on Components*
11. *ASME Code Section XI, Rules for In-service Inspection of Nuclear Power Plant Components*
12. *KEPIC MI, In-service Inspection of Nuclear Power Plants*

Research Reactors

1. *Atomic Energy Act*
2. *Enforcement Decree of the Atomic Energy Act*
3. *Enforcement Regulation of the Atomic Energy Act*
4. *Act on Physical Protection and Radiological Emergency*

5. *Enforcement Decree of the Act on Physical Protection and Radiological Emergency*
6. *Enforcement Regulation of the Act on Physical Protection and Radiological Emergency*
7. *Regulation on Technical Standards for Nuclear Reactor Facilities, etc.*
8. *The 1st Comprehensive Nuclear Safety Plan*
9. *Safety Review Guideline for Research or Education Reactor, KINS/GE-N10*
10. *Nuclear Safety Policy Statement*
11. *MEST Notice No. 2009-37 (Standard Format and Content of Technical Specifications for Operation, MEST.Reactor.003)*
12. *MEST Notice No.2009-37 (Regulation on Reporting and Public Announcement of Accidents and Incidents for Nuclear Power Utilization Facilities, MEST.Reactor.019)*
13. *MEST Notice No.2010-32 (Regulation on Survey and Evaluation of Environmental Radiation in Vicinity of Nuclear Power Utilization Facilities, MEST.Reactor.007)*
14. *MEST Notice No. 2009-37 (Standards for Establishment, etc. of Radiological Emergency Plan for Nuclear related Enterprisers, MEST.Radiation.003)*
15. *MEST Notice No. 2009-37 (Regulation on Management of Inspection Findings from Nuclear Power Utilization Facilities, MEST.Reactor.010)*
16. *Inspection Guideline for HANARO, KINS-GI-019*
17. *Inspection Guideline for Education Reactor, KINS-GI-N020*
18. *Inspection Guideline for Decommissioning of Research Reactor, KINS-GI-N022*

APPENDIX VIII – IAEA REFERENCE MATERIAL USED FOR THE REVIEW

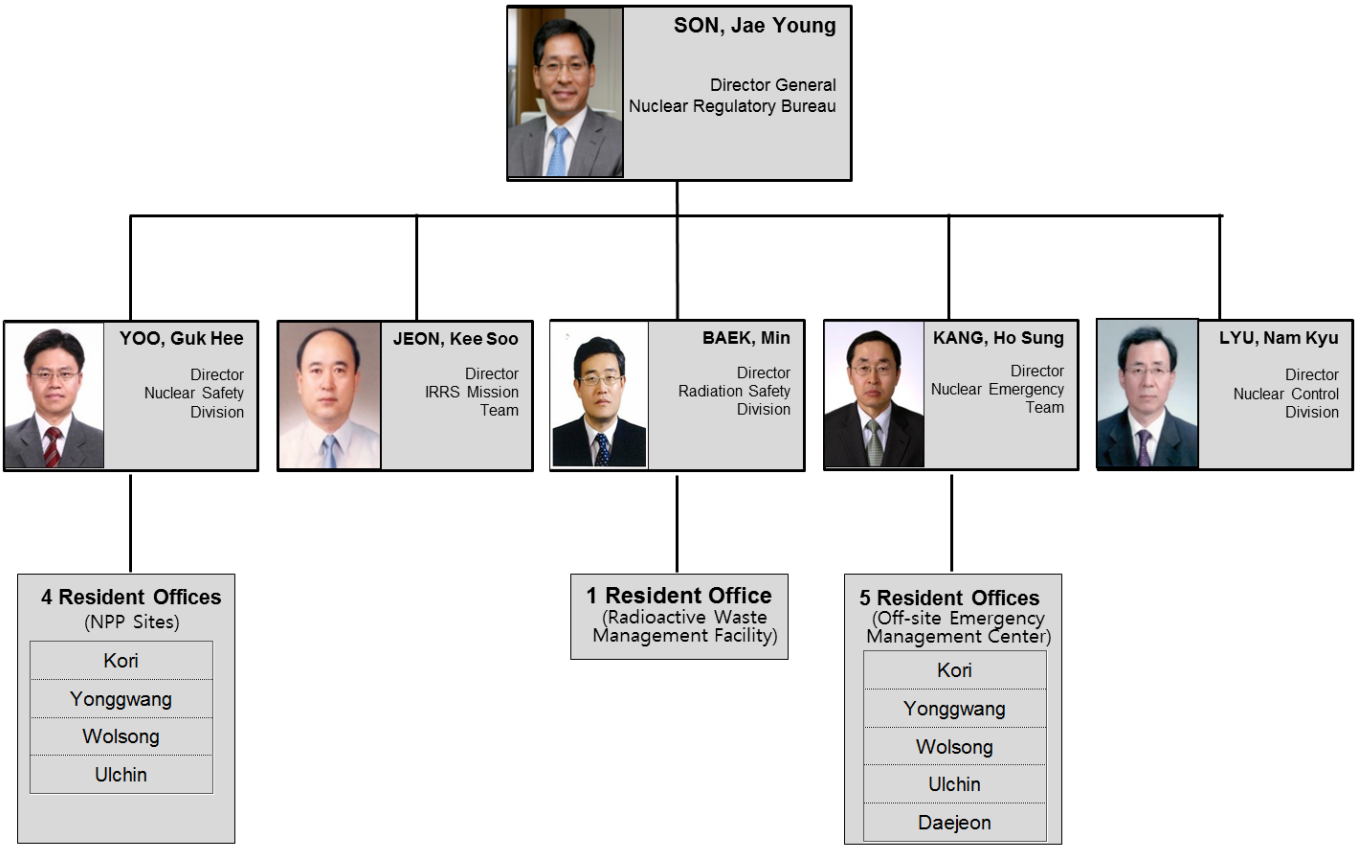
1.	**IAEA SAFETY STANDARDS SERIES No. SF-1** - Fundamental Safety Principles
2.	**IAEA SAFETY STANDARDS SERIES No. GSR PART 1** - Governmental, Legal and Regulatory Framework for Safety
3.	**IAEA SAFETY STANDARDS SERIES No. GS-R-2 -** Preparedness and Response for a Nuclear or Radiological Emergency
4.	**IAEA SAFETY STANDARDS SERIES No. GS-R-3 -** The Management System for Facilities and Activities
5.	**IAEA SAFETY STANDARDS SERIES No. NS-R-1 –** Safety of Nuclear Power Plants: Design
6.	**IAEA SAFETY STANDARDS SERIES No. NS-R-2 –** Safety of Nuclear Power Plants: Operation
7.	**IAEA SAFETY STANDARDS SERIES No. NS-R-4 -** Safety of Research Reactors
8.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.1 -** Organization and Staffing of the Regulatory Body for Nuclear Facilities
9.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.2 -** Review and Assessment of Nuclear Facilities by the Regulatory Body
10.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.3 -** Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body
11.	**IAEA SAFETY STANDARDS SERIES No. GS-G-1.4 -** Documentation for Use in Regulatory Nuclear Facilities
12.	**IAEA SAFETY STANDARDS SERIES No. GS-G-2.1 -** Arrangements for Preparedness for a Nuclear or Radiological Emergency
13.	**IAEA SAFETY STANDARDS SERIES No. GS-G-3.1 -** Application of the Management System for Facilities and Activities
14.	**IAEA SAFETY STANDARDS SERIES No. GS-G-3.2 -** The Management System for Technical Services in Radiation Safety
15.	**IAEA SAFETY STANDARDS SERIES No. RS-G-1.3 -** Assessment of Occupational Exposure Due to External Sources of Radiation
16.	**IAEA SAFETY STANDARDS SERIES No. RS-G-1.4 -** Building Competence in Radiation Protection and the Safe Use of Radiation Sources
17.	**IAEA SAFETY STANDARDS SERIES No. NS-G-2.10 -** Periodic Safety Review of Nuclear Power Plants Safety Guide
18.	**IAEA SAFETY STANDARDS SERIES No. NS-G-211 -** A System for the Feedback of Experience from Events in Nuclear Installations Safety Guide

19. **INTERNATIONAL ATOMIC ENERGY AGENCY** - Convention on Early Notification of a Nuclear Accident (1986) and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1987), Legal Series No. 14, Vienna (1987).

20. **INTERNATIONAL ATOMIC ENERGY AGENCY** - Generic Assessment Procedures for Determining Protective Actions during a Reactor Accident, IAEA-TECDOC-955, IAEA, Vienna (1997).

APPENDIX VIIII – ORGANIZATIONAL CHARTS

MEST (NRB)



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