

## **Policy Issue 0**

# **Report of the Korean Government Response to the Fukushima Daiichi Nuclear Accident**

This special report provides a succinct summary of the emergency response activities and the results of special safety inspection for all operating nuclear power plants of the Republic of Korea as conducted by the Korean Government following the accident occurred at Fukushima Daiichi Nuclear Power Station in Japan.



# ACRONYMS

AAC DG	Alternative Alternating Current Diesel Generator
AtomCARE	Computerized Technical Advisory System for a Radiological Emergency
DBA	Design Basis Accident
BDBA	Beyond Design Basis Accident
CFMS	Critical Function Monitoring System
EDG	Emergency Diesel Generator
EPS	Emergency Power Supply system for CANDU
ERMS	Environmental Radiation Monitoring System
EOF	Emergency Operation Facility
FANR	UAE Regulatory Body
HPGe	High Purity Germanium Detector
IERNet	Integrated Environmental Radiation Monitoring Network
IMEF	Irradiated Materials Examination Facility of HANARO Research Reactor
LOOP	Loss of Offsite Power Event
MDEP	Multinational Design Evaluation Program
NSC	Nuclear Safety Committee
KAERI	Korea Atomic Energy Research Institute
KEPCO	Korea Electric Power Corporation
KEPCO ENC	KEPCO Engineering & Construction Co.
KEPCO KPS	KEPCO Plant Service Co.
KHNP	Korea Hydro & Nuclear Power Co.
KINAC	Korea Institute of Nonproliferation and Control
KINS	Korea Institute of Nuclear Safety
KIRAMS	Korea Institute of Radiological & Medical Sciences
KMA	Korea Meteorological Administration
MCA	Multi-Channel pulse height Analyser
MCR	Main Control Room
MDA	Minimum Detectable Activity
MEST	Ministry Of Education, Science and Technology
NISA	Nuclear and Industrial Safety Agency of JAPAN
NPP	Nuclear Power Plant
NPS	Nuclear Power Station
OBE	Operating Basis Earthquake
OSC	Operating Support Center
RPV	Reactor Pressure Vessel
SAMG	Severe Accident Management Guideline
SBO	Station Blackout

SFP	Spent Fuel Pool
SPDS	Safety Parameter Display System
SSE	Safety Shutdown Earthquake
SSI	Special Safety Inspection
TEPCO	Tokyo Electric Power Company
TLD	Thermo – Luminescence Dosimeter
TSC	Technical Support Center
JNES	Japan Nuclear Energy Safety Organization
MOFAT	Ministry of Foreign Affairs and Trade
MIFAFF	Ministry for Food, Agriculture, Forestry and Fisheries
KFDA	Korea Food and Drug Administration
MLTM	Ministry of Land, Transportation and Maritime Affairs
MKE	Ministry of Knowledge Economy
NFRDI	National Fisheries Research and Development Institute
WANO	World Association of Nuclear Operators

# **POLICY ISSUE 0: Fukushima Regulatory Issues**

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## **I. Overview**

Around 14:46 on March 11 (Friday) of the year 2011, a magnitude 9.0 earthquake struck off the northeastern coast of the Tohoku District of Japan. As a result, the following 11 (out of 14 nuclear power plant units located near the epicenter) automatically tripped: Fukushima Daiichi Nuclear Power Station (NPS) Units 1, 2, and 3; Fukushima II NPS Units 1, 2, 3, and 4; Onagawa NPS Units 1, 2, and 3; and Tokai Daini Unit 2. Fukushima Daiichi Units 4, 5, and 6 were in a shutdown state for periodic inspection.

Due to the earthquake and subsequent tsunami, Fukushima Daiichi NPS Units 1, 2, 3, and 4 lost both the offsite power and emergency diesel generators (EDGs), resulting in a long-term station blackout (SBO). It has been assessed that the reactor cores of Fukushima Daiichi NPS Units 1, 2 and 3 overheated and melted due to loss of reactor cooling, and as a consequence, the reactor pressure vessels were damaged. The pressure of the containments subsequently increased, and hydrogen explosions occurred in the reactor buildings because of the hydrogen generated by the reaction of fuel cladding with water in a sequence of Units 1, 3, 2, and 4. The outer walls of the reactor buildings were damaged in those processes, and as a result, a large amount of radioactive materials was released to the environment, causing environmental radioactivity impact even on the countries near Japan, such as Korea.

The Korean Government established a task force(T/F) under the supervision of the Prime Minister's Office, and has been responding to the Fukushima Daiichi nuclear accident at the government level. In particular, the Ministry of Education, Science and Technology (MEST) and Korea Institute of Nuclear Safety (KINS), being the nuclear safety regulatory body of the Republic of Korea, set up an emergency response situation team on March 11, and have continuously been operating the situation team to perform emergency response activities.

As public concern over the safety of domestic operating nuclear power plants increased because of the occurrence of the Japanese Fukushima Daiichi nuclear accident, a Special Safety Inspection was performed for all operating nuclear power plants of Korea, after identifying inspection items based on an analysis of the Fukushima Daiichi accident.

During the period of March 23 to April 30, 2011, the inspection team, composed of experts from the industry, academia, and research institutes, examined Korean NPP capabilities to cope with or respond to severe accidents and emergency situations caused by natural disasters such as a large earthquake or tsunami. As a follow-up measure, adequate implementation of the improvement items identified from the safety inspections will be persistently verified, and the lessons gained through more in-depth analysis or cooperation with Japan, and international organizations, etc. will be incorporated in the future to further improve safety of domestic nuclear power plants.

## **II. Fukushima Daiichi Nuclear Accident of Japan**

### **II.1 Exact Account of the Fukushima Daiichi Nuclear Accident and Consequences**

Following the occurrence of the earthquake at 14:46, March 11, 2011, all the offsite power of the Fukushima Daiichi NPS was lost and accordingly the emergency diesel generators (EDGs) automatically got started. However, the EDGs of Fukushima Daiichi Units 1, 2, 3, 4 and 5 were all stopped with subsequent loss of all batteries due to the tsunami. As a result, a station blackout (SBO) occurred in these units, and so, the temperature of the reactor cores and the pressure of the containments rapidly increased due to loss of core cooling functions. A series of hydrogen explosion took place because of the accumulation of hydrogen that was generated by fuel cladding material reaction with water in the sequence of Unit 1 (15:36, March 12), Unit 3 (11:01, March 14), and Unit 2 (06:10, March 15). In the case of Units 5 and 6, the hydrogen explosion accident was prevented by making a ventilation hole in the upper area of the reactor buildings, and a stable state at each unit has been maintained by availability of an EDG.



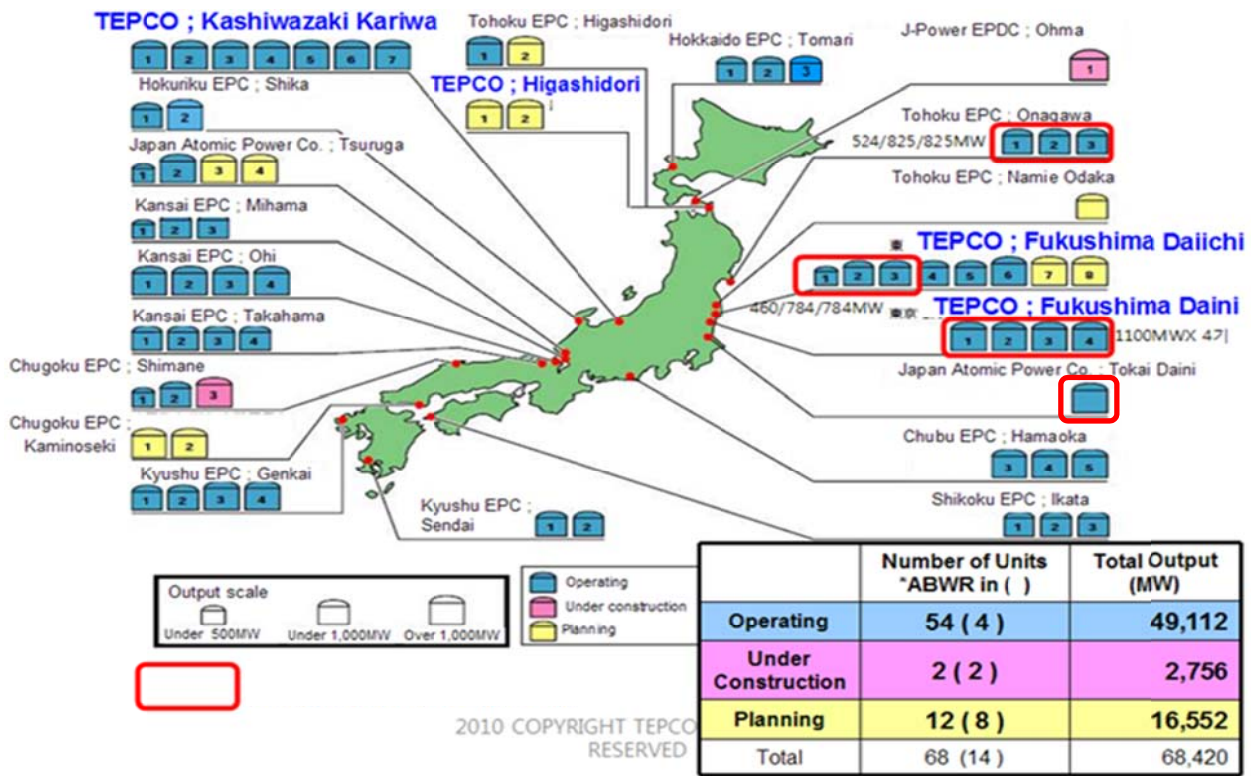


Fig. PI0-2. Status of Japanese Nuclear Power Stations

### II.1.1 Damage to Fukushima Daiichi Nuclear Power Station

According to the information collected thus far with regard to core and containment states and re-criticality potential, it is judged that most of the nuclear fuels of reactor cores in Fukushima Daiichi Units 1, 2 and 3 melted and relocated to the bottom of the reactor pressure vessels (RPVs) at the early stage of the accident. The RPVs might have been damaged in view of the fact that the water levels of reactors do not increase even though coolant is continuously injected to the cores. The operators of Fukushima Daiichi Nuclear Power Station and the Japanese regulatory body also indicated that the penetration tubes in the lower parts of the reactors were damaged, resulting in an external release of corium (i.e., melted core materials). The possibility of core re-criticality seems to be almost zero in consideration of the low concentration of nuclear fuels and the inclusion of control rod materials in the corium. The integrity of the containments apparently is not maintained in view of the fact that radioactively contaminated water continues to be discharged to the turbine buildings.

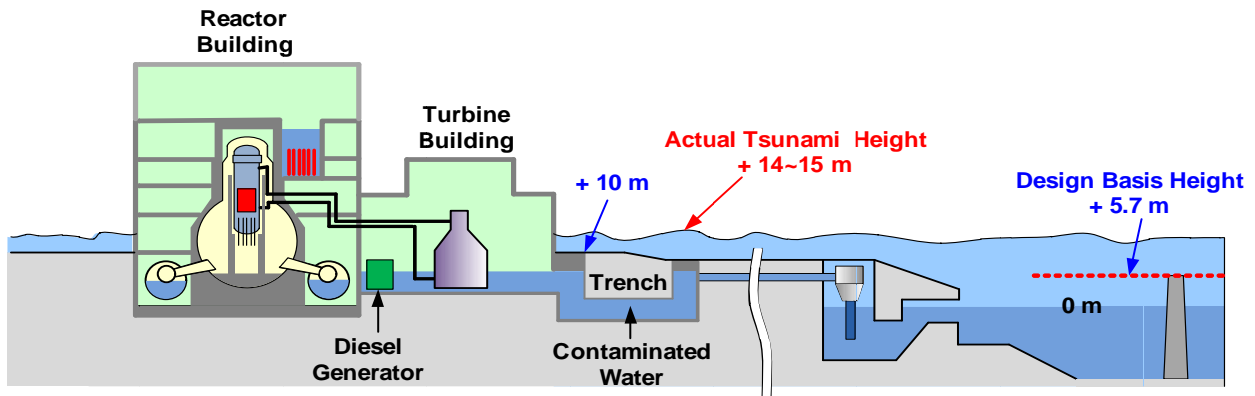


Fig. PI0-3. Submergence of Structures and Equipment of Fukushima Daiichi Units 1~4 due to the Tsunami Onslaught



Fig. PI0-4. Aerial View of Fukushima Daiichi Nuclear Power Station Following the Accident

### **II.1.2 Initial Response to the Radiological Emergency and Environmental Impact**

Tokyo Electric Power Company (TEPCO) reported an emergency in accordance with Article 10 of the Nuclear Disaster Countermeasure Act at 15:42 of March 11 when a station blackout (SBO) took place. On the same day, the Japanese Government declared a radiological emergency at 19:03, and ordered an evacuation of about 1,900 people living within a radius of 2 km from Fukushima Daiichi Unit 1. Upon deterioration of the accident conditions, the evacuation order was expanded on March 12 to the residents within a radius of 20 km from Unit 1, and a radius of 10 km from Unit 2. Most radiation monitors were damaged due to the natural disaster, and therefore, the radiological impact on the people and environment could not be accurately estimated in the early stage of the accident. Later it was verified by the on-spot investigation and specimen analysis that neighboring areas have been seriously contaminated by radiological materials.

At present the amount of radioactive materials directly released to the atmosphere is not so much because of the relatively stable cooling of the reactor cores. However, minimizing and treating the persistent release of the liquid radioactive wastes generated by the fresh water injection for reactor cooling has become a major issue.

### **II.2 Accident Recovery**

TEPCO developed a roadmap to deal with the nuclear accident, and under that plan, are implementing the following measures to bring the nuclear power station into a stable controlled state within approximately 9 months: 1) cooling of the nuclear reactors and spent fuel pools; 2) isolation and mitigation of released radioactive materials; 3) monitoring and reduction of the environmental radiation impact; 4) aftershock measures; and 5) improvement of the work environment. However, they are apparently confronting hardships in restoration work due to considerable damage to the nuclear plants and serious radiological contaminations, even now several months following the onset of the accident.

### **II.3 Lessons from the Accident**

The report submitted by Japan to the IAEA points out that a total 28 specific lessons have been learned from the Fukushima Daiichi nuclear accident in 5 different areas. Phrased as directives, these 5 areas are: 1) strengthen preventive measures against severe accidents; 2) enhance response measures against severe accidents; 3) enhance nuclear emergency response; 4) reinforce safety infrastructure; and 5) raise awareness of safety culture.

Following the Fukushima Daiichi disaster, domestic and foreign nuclear safety experts also suggested similar lessons as presented by Japan. The lessons referred to by those experts thus far are summarized below, and additional lessons are expected to be obtained by an in-depth investigation and analysis in the future.

- Complementing Nuclear Plant Facilities
  - Strengthening emergency power systems and ECCS performance
  - Complementation of facilities to prevent and cope with severe accidents, including hydrogen removal systems

- Strengthening electric power sources and cooling functions for SFPs
- Complementation of instrumentation survivability during severe accidents
- Need for securing ultimate heat sink under any circumstances
- Improving passive core cooling safety systems
- Enhancement of Response Capabilities against Extreme Disasters and Severe Accidents
  - Securing capabilities to respond to extreme natural disasters
  - Complementing completeness of the procedures to deal with severe accidents
  - Inclusion of severe accidents themselves into the scope of design basis accidents
  - Coping with multi-unit accidents due to common-cause failures within a single site
- Nuclear Safety Regulation Infrastructure and Public Acceptance
  - Need for upgrading independence and technical expertise of nuclear safety regulatory body
  - Focus on securing safety of new reactors as well as operating reactors
  - Establishment of an international cooperation network at nuclear accidents
  - Establishment of an information exchange and cooperative system on nuclear accidents
  - Enhancement of effectiveness of the command and management system to cope with nuclear accidents
  - Improvement of public communication during an emergency
  - Establishment of safety culture and enhancement of public understanding

### **III. Emergency Response of the Korean Government**

#### **III.1 Activities of the Emergency Response Organizations**

In order to respond to the accident situations that occurred at Fukushima Daiichi Nuclear Power Stations, the Republic of Korea as the closest neighboring country of Japan established an emergency response organizational structures at the governmental level. The Ministry of Education, Science and Technology (MEST) and Korea Institute of Nuclear Safety (KINS), being the regulatory body of Korea, set up an emergency operation center and have been put on full alert to protect the general public from potential radiological impacts. The Korean Government established a task force under the supervision of the Prime Minister's Office in order to control radiological emergency response capabilities of various government agencies, and a total 8 meetings have been held thus far. The roles of various pertinent agencies are coordinated through this task force, and each agency operates a necessary sub-organization with active support to the main agency, i.e., MEST, where necessary (Fig. PI0-5). Following each agency's report to the task force with respect to the countermeasures to be taken under its jurisdiction, a consensus was reached between the task force and the respective agency in developing effective and consistent measures. The specific responses of the government agencies to the Fukushima Daiichi accident are as follows:

- Responsive strategy upon the up-rating of the INES scale for the Japanese nuclear accident to Level 7 (MEST)
- Plan to hold open forums on nuclear safety (MEST)
- Plan to publish a P.R brochure "Comprehensible Nuclear Energy" (MEST)
- Countermeasures and responses to the Japanese nuclear power plant accident (Ministry of Foreign Affairs and Trade)
- Safety management measures for agricultural/animal/fishery products (Ministry for Food, Agriculture, Forestry and Fisheries)
- Plan to control import of Japanese foods (Food and Drug Administration)
- Plan to operate a marine monitoring and control system for detection of materials radiologically contaminated due to the Japanese NPPs (Ministry of Land, Transportation and Maritime Affairs)
- Report on the status regarding the Japanese nuclear accident (Meteorological Administration)

- Progress status of SSI and future plans (Safe Environmental Policy Administration of the Prime Minister's Office)
- Main issues regarding continued operation of Kori Unit 1 and associated responses (Ministry of Knowledge Economy)

A draft manual to efficiently respond to accidents at neighboring countries like the one occurred at Fukushima Daiichi NPPs has been developed under the supervision of MEST, based on the contents discussed at the meetings of the task force of the Prime Minister's Office. At present the opinions of each agency with respect to the draft manual are being collected. In parallel with the Government's response, KINS keeps close watch on any abnormality of operating nuclear power plants of Korea and now runs an around-the-clock radiological emergency response headquarters instituted 18:40 of March 11 in connection with the Japanese earthquake. The emergency response organization of KINS is headed by the president of KINS, and consists of 7 teams including the emergency response integration team. (refer to Figures 3-1-2 and 3-1-3, and Table PI0-1).

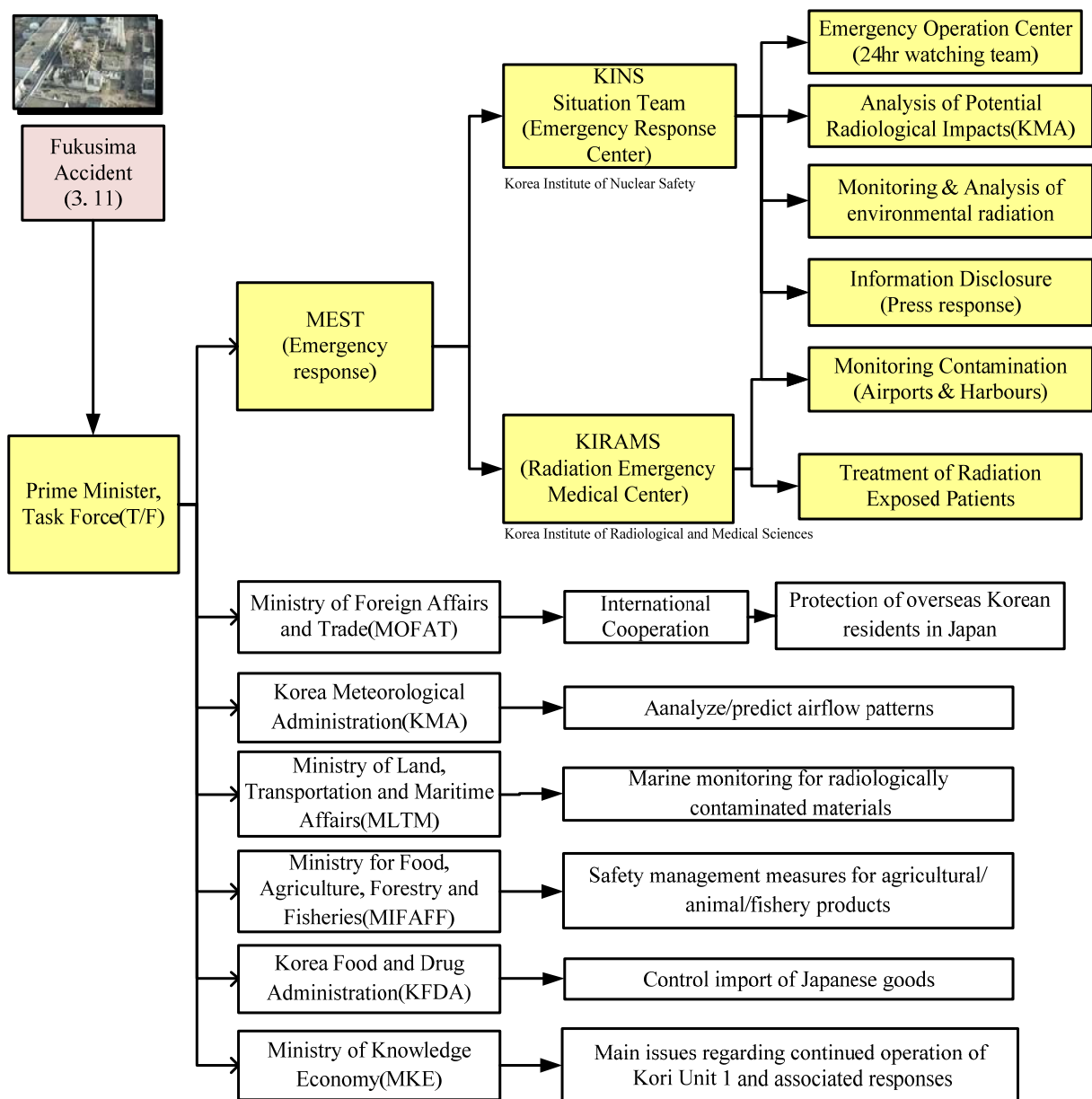


Fig. PI0-5. Response of Korean Government on the Fukushima I Accident

And Korea Institute of Radiological and Medical Sciences (KIRAMS), which is in charge of a medical treatment in the national radiological emergency system, set up a radiation emergency medical center for the contamination monitoring and treatment of the patients exposed by radiation.

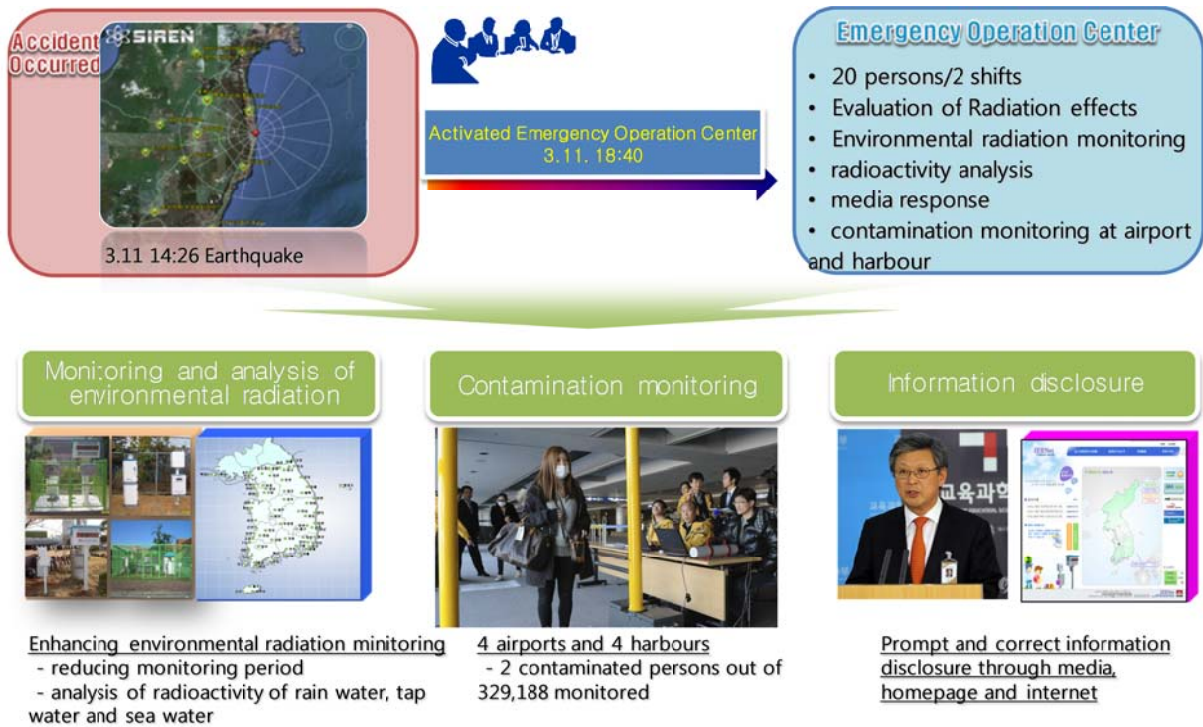


Fig. PI0-6. Major Emergency Response Activities of KINS Following the Fukushima Daiichi Nuclear Accident

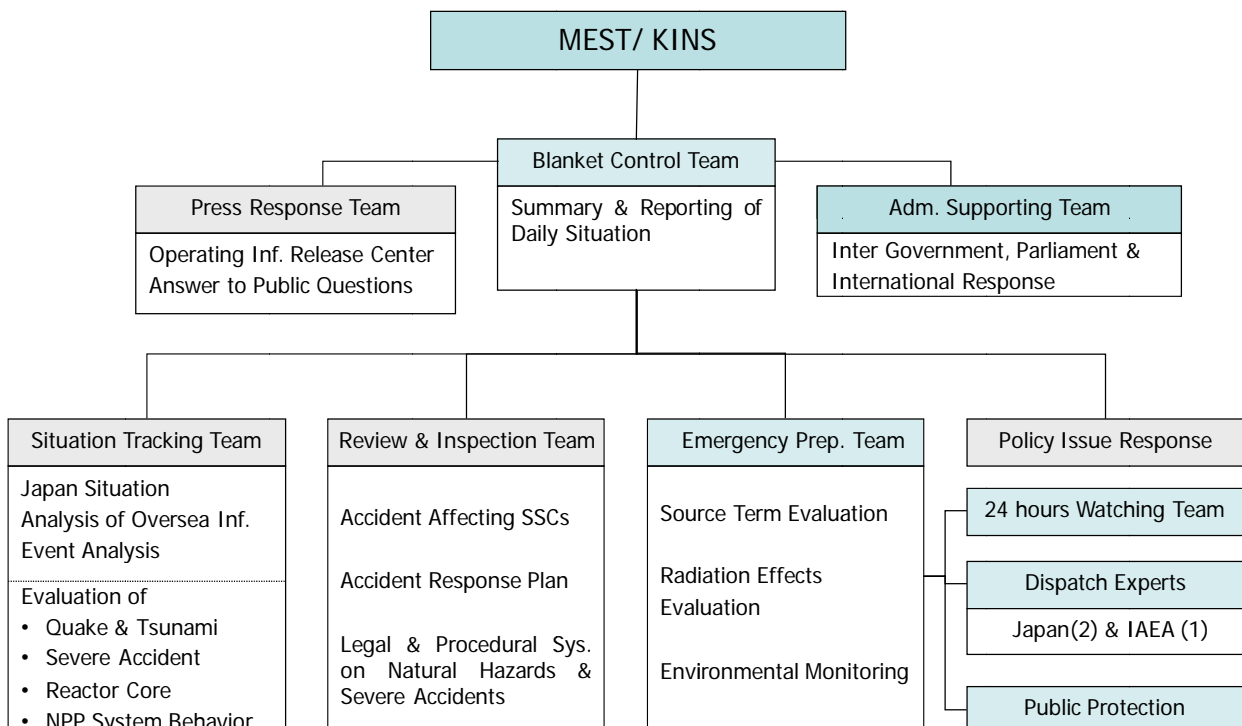


Fig. PI0-7. Emergency Response Organizational Structure of KINS to Cope with the Fukushima I Accident

Table PI0-1. Role of the KINS Emergency Response Entities Concerning the Fukushima Daiichi Nuclear Accident

Entity	Role
Head	- Direction and control of the activities of the emergency response headquarters
Radiological Emergency Integration Team	- Preparation and support to the headquarters operation - Correspondence with organizations inside or outside of KINS - Synthesis and fine-tuning of information on the accident situation and response activities - Report, notification and dissemination of the accident situation
Situation Technical Support Team	- Operation of AtomCARE and the situation room facilities - Operation of the video conference system - Computer support
Radioactivity Assessment Team	- Assessment of radiological impact and dose rate prediction - Collection of meteorological and accident information
Environmental Monitoring Team	- Operation of the national environmental radioactivity monitoring network - Environmental radioactivity monitoring and impact assessment
Media Team	- Collection of news and media information - Response to mass media and assistance to reporters - Response to civil request
Administrative Support Team	- Budget, supply, communication, power sources and document control necessary to run the headquarters operation - Procurement and provision of transportation means required by the site or headquarter - Administrative support for coordination with other emergency response organizations
Airport contamination monitoring Team	- Monitoring contamination of people entering Korea - Decontamination and transfer to hospital where necessary

### III.2 Activities for Public Protection

From the earliest phases of the Japanese accidents, MEST and KINS shared information everyday with pertinent agencies on the status of the Japanese nuclear reactors, results of measuring environmental radioactivity throughout Korea (with help from the Ministry of Land, Transport and Maritime Affairs), daily meteorological data (with help from the Meteorological Administration), results of contamination monitoring at airports and harbors, etc. The information was also accurately disclosed to the general public through the mass media. MEST and KINS have been doing their best by still maintaining the emergency response system for public health and environmental protection.

Following the Fukushima Daiichi accident, MEST and KINS reduced the monitoring period for ambient dose rates from 15 minutes to 5 minutes at the 71 unmanned measurement centers of the country, and are disclosing the results through the internet in real time. Since the time when the inflow of radioactive materials into Korea was confirmed, the analysis period for ambient radioactive materials was reduced from monthly to daily with a sample analysis every precipitation event(every rain, every snow, etc.). Radioactivity analysis was also carried out for tap water, land, seawater and marine life, and the radiological impact on Korea was evaluated. Efforts were made to set the general public at ease by disclosing these results.

As the contamination of Japan continues to get more serious, a contamination monitoring system has become necessary for all people entering Korea from Japan. Therefore, a contamination monitoring was carried out for those who were admitted into Korea from Japan through airports or harbors, starting from March 17 and running till June 8.

In collaboration with the Korea Atomic Energy Research Institute(KAERI), Korea Institute of Radiological & Medical Sciences(KIRAMS), and Korea Institute of Nonproliferation and Control(KINAC), KINS, the leading agency, performed the monitoring through portal monitors of the gate type at the international airports (Incheon, Gimpo, Gimhae, Jeju) and harbors (Busan, Donghae, Jeju, Gwangyang), and contamination monitoring was conducted on those requesting it. A total of approximately 300,000 travellers were monitored, and two persons out of these were found to have been contaminated and so were decontaminated.

In view of the growing public interest as to whether domestic foodstuffs were contaminated by radioactivity, the Ministry of Food, Agriculture, Forestry and Fisheries and the Food and Drug Administration tried to protect the public health by confirming that some samples of the agricultural and marine products of Korea, and all those products imported from Japan are free from any significant contamination.

The Ministry of Foreign Affairs and Trade set up an emergency headquarters to respond to the Japanese accident, and performed protective actions for Korean people residing in Japan and Korean tourists to Japan by means of an emergency response team dispatched to the country. KINS provided technical support to the Korean Government for the public protection. As per requests from the National Emergency Management Agency, KINS also dispatched a radiation expert to Japan in order to support the rescue activities of the Agency by performing education on radiation safety and contamination monitoring. To check safety of the workers at the Embassy of the Republic of Korea in Japan and at the same time to address the concerns of Korean residents in Japan over the accident, KINS dispatched radiological experts to the Korean Embassy sequentially as follows:

- First (March 20 ~ April 7)
- Second (April 5 ~ April 28)
- Third (May 11 ~ June 3)



Fig. PI0-8. A Briefing Session on the Nuclear Accident and Radiological Impact at the Korean Consulate General in Tokyo (Time: 17:30 ~ 19:00, March 22, Participants: Representatives of the Federation of Korean Residents in Japan, the Consulate Staff)



Fig. PI0-9. A Briefing Seminar on the Fukushima Daiichi Nuclear Accident and Radiological Impact for Korean Residents in Japan (Time: 15:00 ~ 16:30, April 1, Place: Korean Embassy in Tokyo, Participants: About 50)

### III.3 Nationwide Territory Monitoring of Environmental Radiation/Radioactivity

#### III.3.1 National Monitoring System

The environmental radiation/radioactivity monitoring of Korea consists of two major parts, which are environmental radiation monitoring around nuclear power facilities and the nationwide territory monitoring. Nuclear facility operators mainly perform environmental radiation/radioactivity monitoring in accordance with Article 104-6 (Environmental Preservation) of the Atomic Energy Act followed by inspection and confirmation of the government. The Government also conducts nationwide monitoring and evaluation of impact of overall environmental radiation and radioactivity to the country as per Article 104-7 (Nationwide Environmental Radioactivity Monitoring) of the same Act.

In connection with the environmental radioactivity monitoring around the nuclear facilities, the licensee establishes and implements its own monitoring plan. The implementation results are then reported to the pertinent government agency, i.e., MEST, as per MEST Notice No. 2010-32 (Regulation on Environmental Radiation Monitoring and Impact Analysis of the Area around Nuclear Power Utilization Facilities). The Korea Institute of Nuclear Safety (KINS), entrusted by MEST with these duties, independently carries out environmental monitoring programs to evaluate if the environmental monitoring of the licensee was appropriate.

The sampling locations, analysis items and frequency (depending on sample type) for environmental monitoring are determined based on the population density around the facilities, the predicted maximum concentration of radioactive depositions, meteorological conditions, marine conditions, geography, bearing, atmospheric dispersion factors and so on. In addition, the design characteristics based on types of facilities and radionuclides types discharged to the environment are also considered.

The national territory environmental monitoring program is performed with two different schemes (the normal and the emergency programs). The 12 regional radioactivity monitoring stations of Korea conduct monitoring tasks according to the normal monitoring plan. In case of an emergency, the central monitoring station (KINS) obtains information relevant to the radiological accident and then predicts its potential consequences. A monitoring plan is accordingly established and implemented based on the type of the radiological accident. At each regional monitoring station, radioactivity concentrations of airborne dust, fallout, rainwater and drinking water are measured which allow any radiological change in the environment can be promptly detected at early stage of a radiological emergency. The measurement period can be flexibly set depending on a given situation so that the monitoring objective can be accomplished.

KINS collects and manages the monitoring information from the 71 unmanned radiation monitoring posts of the country as well as the 12 regional radioactivity monitoring stations, and provides their results to the public in real time through a webpage, <http://iernet.kins.re.kr> (see Fig. PI0-10). KINS also operates a national environmental radiation automatic monitoring network (the IERNet: Integrated Environmental Radiation Monitoring Network) for an effective monitoring of environmental radiation over the whole country. The IERNet system contains measurement results of the ambient gamma dose rates, which are automatically measured real-time ambient gamma dose rates taken every 15 minutes at the 71 posts (Fig. PI0-11).



Fig. PI0-10. Homepage of the National Environmental Radiation Automatic Network

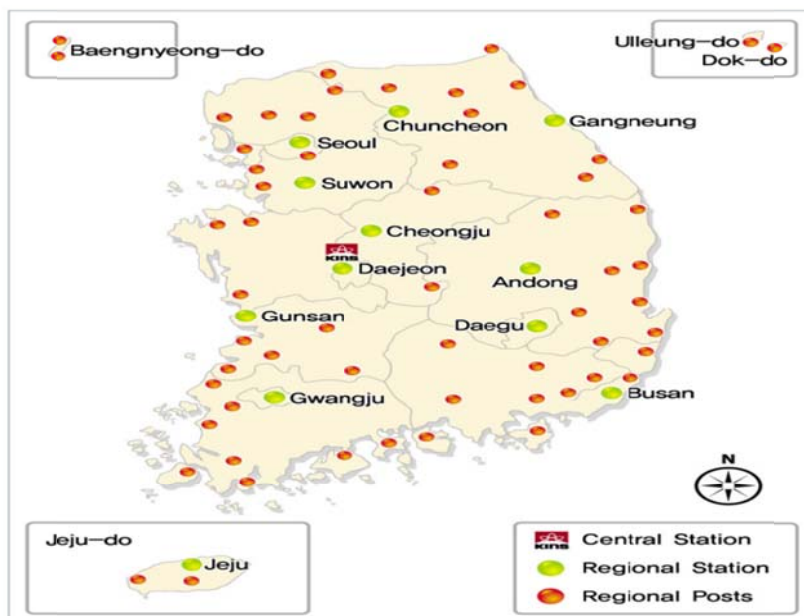


Fig. PI0-11. The status of installed National Environmental Radiation Automatic Network (IERNet)

Since 1993, KINS has carried out marine environmental radioactivity monitoring for the coastal areas around the country. Under this program, KINS has been collecting seawater samples and conducting analysis of its radioactivity twice a year at 20 specific locations on the sea that were determined with the cooperation with the East Sea, West Sea and South Sea Fisheries Laboratories of the National Fisheries Research and Development Institute since 1995.

Table PI0-2. Environmental Radiation/Radioactivity Monitoring Program of Korea

Surveillance Items		Monitoring Period	Investigation Scope
Monitoring Nuclides	Target Samples		
Ambient Gamma Dose Rates (TLD) Cumulative Ambient Dose	Ambient Dose	Continuous, Real time Quarterly	Nationwide territory
Gross Beta	Airborne dust Rainwater Drinking Water	Daily Every Rainfall Weekly	Regional monitoring stations
Gamma Isotope	Airborne dust, Fallout, Rain Soil, River sediment, ground Water Seawater (Surface water, Milk) Rice, Cabbage, etc. Submarine Sediments, Marine Life	Monthly Biannually Quarterly (Biannually, Monthly) Annually Biannually	12 Regional monitoring stations Around Nuclear Utilization Facilities, Easter/Western/Southern Coasts
<sup>90</sup> Sr	Soil, River Soil, Seawater, Submarine Sediments Milk	Annually Biannually	Areas Around Nuclear Utilization Facilities, Easter/Western/Southern Coasts
Pu and U Isotopes	Soil, River Soil	Annually	Areas Around Nuclear Utilization Facilities, Easter/Western/Southern Coasts
Pu Isotope	Seawater, Submarine Sediment, Marine Life	Annually	ditto
<sup>3</sup> H	Atmosphere, Pine Needle, Milk, Rainwater Seawater (Intake and discharge)	Monthly Quarterly	Areas Around Nuclear Utilization Facilities, Central monitoring center (KINS)
<sup>3</sup> H	Seawater	Annually	Easter/Western/Southern Coasts
<sup>14</sup> C	Atmosphere, Pine needle, Milk	Monthly	Areas Around Nuclear Utilization Facilities
[Remarks] ① Monitoring of radioactive contamination for each surveillance item at a reference sampling point for comparison ② Multiple places to monitor <sup>3</sup> H and <sup>14</sup> C in the atmosphere and pine needles for Wolsong nuclear power plant site ③ Multiple places (distance-wise) to monitor <sup>3</sup> H for Wolsong nuclear power plant site ④ Monitor <sup>3</sup> H and <sup>14</sup> C in milk from a ranch around Wolsong nuclear power plant site ⑤ Monitor soil, river sediment (U) and surface water around Daeduk research site			

### III.3.2 Post-Accident Environmental Radiation/Radioactivity Monitoring

After occurrence of the Japanese earthquake followed by the associated tsunami on March 11, 2011, MEST and KINS set up an emergency response team, and subsequently the monitoring period of the national environmental radiation automatic network was shortened to 5 minutes from 15 minutes. As the public concern regarding the Fukushima nuclear accident increased, the network was expanded to 71 posts by installing an automatic environmental radiation monitor on in Dok-do Island, which is the easternmost point of land of the national territory of Korea.

On March 28, artificial radioactive nuclides such as <sup>131</sup>I, presumably resulting from the Fukushima nuclear accident were detected for the first time in airborne dust and rainwater samples. A Stepwise Environmental Radioactivity

Monitoring Strengthening Program was then established with the normal monitoring system transformed to a national territory environmental radioactivity emergency monitoring system.

As KINS confirmed a domestic inflow of radionuclides due to the Japan nuclear accident, the environmental radioactivity monitoring periods were shortened. The monitoring period for airborne dust in the atmosphere was shortened from weekly to daily. In the case of rainwater, samples were collected every rainfall for radioactivity analysis. To evaluate radioactive contamination of tap water, radioactivity analysis for tap water from 23 districts has been being conducted twice a week since April 2. On April 4, radioactivity analysis for surface soil sample collected from 12 regional radioactivity monitoring stations was performed to urgently check potential radioactivity contamination of the national territory.

In response to the public concern about potential inflow of radionuclides through the East, West or South Seas, KINS analyzed radioactive nuclides in seawater samples and marine organisms (for example 14 kinds of fish, 6 kinds of shellfish, 3 kinds of seaweed) from 12 coastal sea stations and 11 ocean stations. In April, radioactivity investigation was performed for 25 of surface seawater samples, 19 of deep seawater samples, and 17 kinds of marine organisms in cooperation with the National Fisheries Research and Development Institute and the Fisheries Resource Agency. It is known that in Japan, over 10 thousand tons of contaminated water that was stored in the waste treatment facility of Fukushima Daiichi NPS was discharged into the Pacific Ocean in early April. As radioactive materials are spilled into the Pacific Ocean, KINS has established and is running a Marine Radioactivity Continuous Alert Monitoring Program to evaluate domestic marine inflows until August.

The results of radioactivity analysis performed by KINS for entire environmental samples of the country were reported through the mass media. The daily radioactivity analysis result was posted on the KINS homepage and provided to relevant organizations. The status of environmental radioactivity analysis performed in response to the Fukushima Daiichi nuclear accident until the end of May 2011 is described in Table PI0-3.

Table PI0-3. Analysis Status of Environmental Radioactivity in Response to the Fukushima Daiichi Nuclear Accident (as of May 31, 2011)

Sample type	Atmosphere	Rainwater	Tap water	Soil	Seawater	Marine organisms			Total
						Fish	Shellfish	Seaweed	
No. of samples	791	274	414	12	77	39	13	10	1,630

In response to the Japan Fukushima Daiichi nuclear accident, the intensified environmental radioactivity monitoring program in addition to the national environmental radioactivity monitoring and marine radioactivity investigation tasks normally conducted by KINS is as summarized in Table PI0-4. Airborne dust in the atmosphere, rainwater and soil samples at the 12 of regional radioactivity monitoring stations were taken and analyzed throughout the country.

In the case of tap water, the monitoring has been intensified as shown in Table PI0-4 by performing gamma radionuclide analysis for tap water taken biweekly (i.e., Monday and Thursday) from 23 water treatment facilities within the country. The tap water sample collection spots of Fig. PI0-12 were selected in consideration of the population densities of metropolitan cities and provinces.

Table PI0-4. Intensified Environmental Radioactivity Monitoring Program in Response to the Fukushima Daiichi Nuclear Accident

Sample type	Investigation Place	Intensified Monitoring	Monitored Nuclides
Atmosphere	12 regional Radioactivity monitoring stations	Monthly→Weekly→Daily	Gamma-Emitting Nuclides such as $^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$
Rainwater	12 regional Radioactivity monitoring stations	Monthly→Every Rainfall	Gamma-Emitting Nuclides such as $^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$
Tapwater	23 Water Treatment Plants of the Country	Weekly (Gross beta) → Biweekly (Mon, Thurs) Gamma Analysis	Gamma-Emitting Nuclides such as $^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$
Soil	12 regional Radioactivity monitoring stations	Biannually→Urgent Contamination Investigation	$^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$ , $^{239+240}\text{Pu}$
Seawater	Surface Seawater (12)	Normal Biannually (April, August)	$^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$ , $^{239+240}\text{Pu}$
	Upper Layer Seawater (21), Deeper Layer Seawater (6)		
Marine organisms	Fish	Normal Biannually (April, August)	Gamma-Emitting Nuclides such as $^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$
	Shellfish		Gamma-Emitting Nuclides such as $^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$
	Seaweed		Gamma-Emitting Nuclides such as $^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$

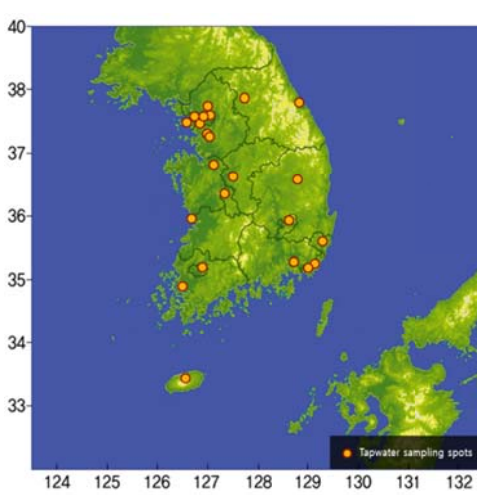
	City Sample Location		Provincial Sample Locations	
	Metro-Politan City	Sample Collection Locations	Province	Sample Collection Locations
 <p>&lt;Tapwater sample spots&gt;</p>	Seoul	Junggu District Office	Gyunggi	Uijongbu City Hall
		Yangchun District Office		Gyunggi Institute of Health & Environment
		Geumcheon District Office		Suwon monitoring station
		Seoul monitoring station		Chuncheon monitoring station
	Busan	Busan Water Treatment Plant, North Business Office	Gangwon	Gangneung monitoring station
		Busan monitoring station	Chungbuk	Chungju monitoring station
	Daegu	Daegu monitoring station	Chungnam	Cheonan City Hall
	Incheon	Incheon Institute of Health & Environment	Jeonbuk	Gunsan monitoring station
	Gwangju	Gwangju monitoring station	Jeonnam	Mokpo City Hall
	Daejeon	Daejeon monitoring station	Gyungbuk	Andong Monitoring station
Ulsan	Ulsan Institute of Health & Environment	Gyungnam	Gyungnam Institute of Health & Environment	
		Jeju	Jeju monitoring station	

Fig. PI0-12. Total 23 Tap Water Sample Collection Spots in Korea

Concerning marine radioactivity, a radioactivity analysis is performed by collecting seawater and marine organism every month in accordance with the Marine Radioactivity Continuous Alert Monitoring Program which was established to intensify marine radioactivity monitoring for the Eastern, Western, and Southern Seas. Fig. PI0-13 through PI0-15 show the marine sample collection spots following the Fukushima Daiichi accident. In March, KINS directly visited these spots to collect seawater and marine life. Since April, the marine samples are being procured with the help of the National Fisheries Research and Development Institute and the Fisheries Resource Agency.

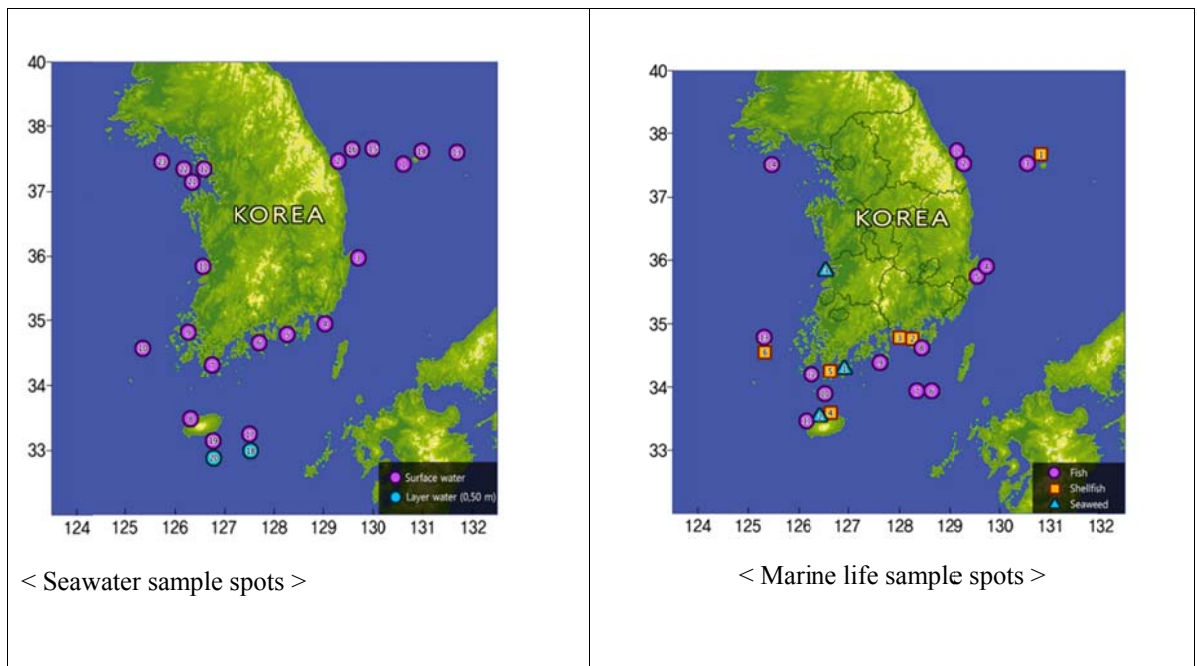


Fig. PI0-13. Seawater and Marine Life Sample Collection Spots (March)

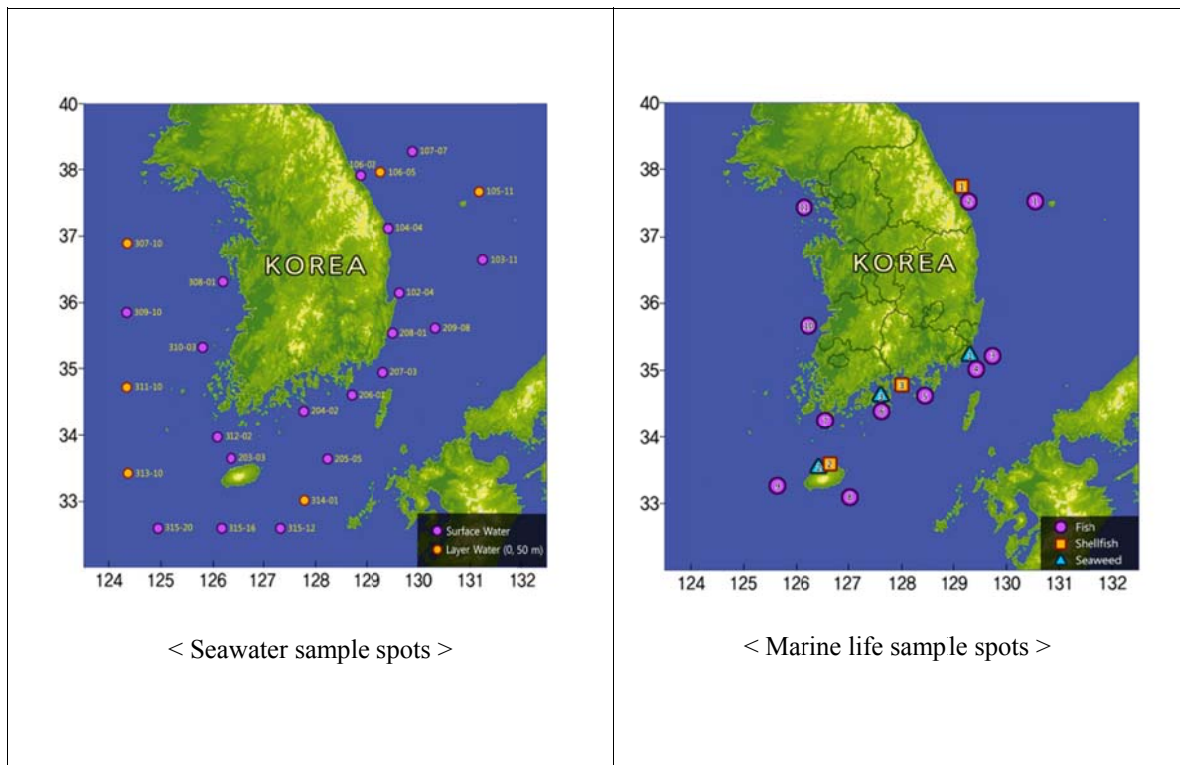


Fig. PI0-14. Seawater and Marine Life Sample Collection Spots (April)

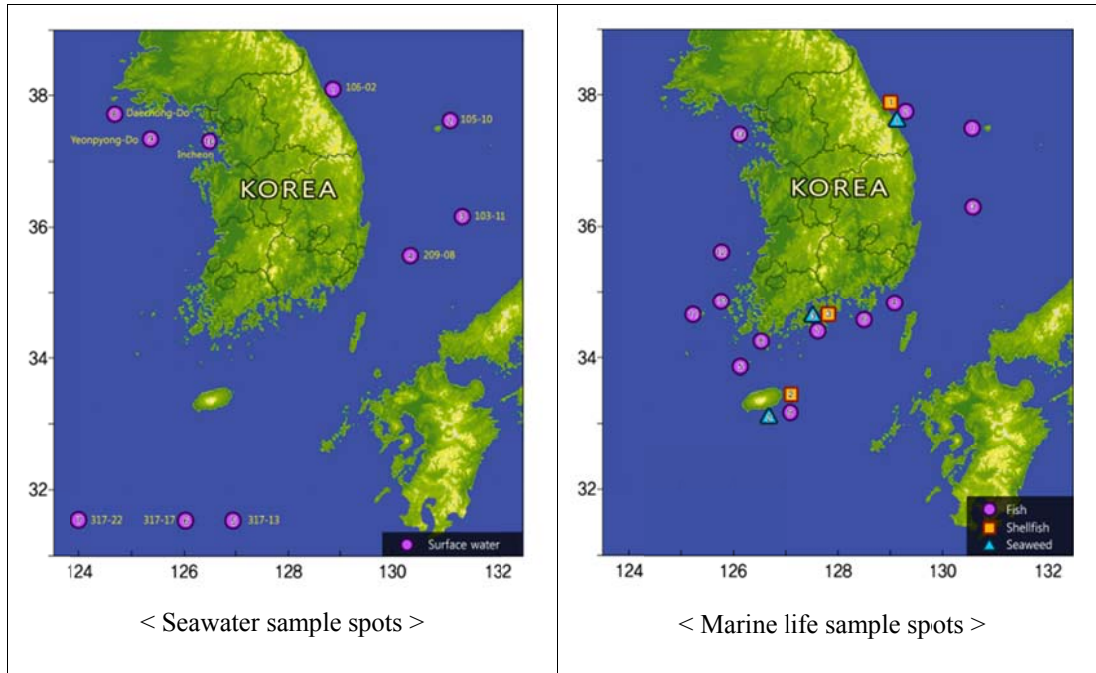


Fig. PI0-15. Seawater and Marine Life Sample Collection Spots (May)

The main nuclides, (for which primary focus was placed in the radioactivity investigation of domestic environmental samples in response to the Fukushima Daiichi accident), were  $^{131}\text{I}$ ,  $^{137}\text{Cs}$ , and  $^{134}\text{Cs}$ . Artificial gamma nuclide analysis was performed for these nuclides using the HPGe (High Purity Germanium Detector) system, and  $^{239+240}\text{Pu}$  analysis was also additionally carried out using MC-ICP-MS (Multi Collector- Inductively Coupled Plasma - Mass Spectrometry). The methods used by KINS to preprocess environmental samples for radioactive nuclide analysis are shown in Table PI0-5.

Table PI0-5. Preparation of Environmental Samples for Radioactive Nuclide Analysis

Sample Type	Gamma Nuclide Analysis ( $^{131}\text{I}$ , $^{137}\text{Cs}$ , $^{134}\text{Cs}$ , etc.)		Plutonium Analysis ( $^{239+240}\text{Pu}$ )
	Sample preparation Method	Measurement Vessel	( $^{239+240}\text{Pu}$ )
Airborne dust in the Atmosphere	Direct Measurement	U8 Vessel	
Rainwater, Tapwater	Direct Measurement	Rainwater: Marinelle Vessel (1L) Tapwater: Marinelle Vessel (2L)	
Soil	Drying and Sieving (2mm)	U8 Vessel	Chemical separation after incineration and Acid Extraction
Seawater	Cs : AMP (Ammonium Phosphomolybdate) absorption after Filtering	U8 Vessel	Chemical separation after iron precipitation.
	$^{131}\text{I}$ : Direct Measurement	Marinelle Vessel (2L)	Chemical separation after iron precipitation.
Marine organism	Cleaning and Drying	Marinelle Vessel (1L)	

Gamma emitting nuclides were analyzed using the High Purity Germanium (HPGe) detector and the Multi-Channel pulse height Analyzer (MCA) with excellent separation capability ( $\sim 1.8$  keV at 1.33 MeV) as shown in Fig. PI0-16. The measurement time for radioactivity was set in consideration of the measurement objective, i.e., MDA (Minimum Detectable Activity), for each target sample in order to quickly evaluate the contamination of radioactive materials for a large quantity of samples.

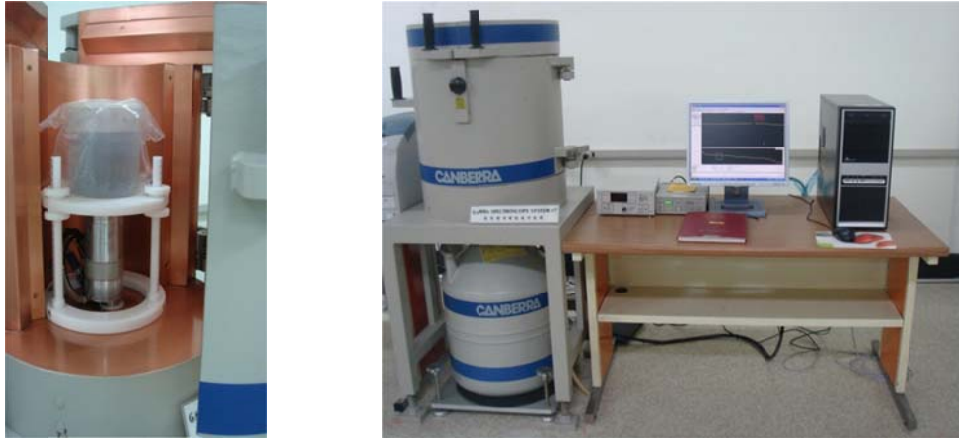


Fig. PI0-16. HPGe Detector and MCA System

### III.3.3 Monitoring Results

The environmental gamma dose rates of Korea that are monitored through the National Environmental Radioactivity Automatic Monitoring Network (IERNNet) normally ranges between 50 and 300 nSv/h depending on the specific area and natural phenomena. According to the radioactivity monitoring results following the Fukushima Daiichi accident, no outliers were detected which exceeded the normal range. Therefore, it is judged that the impact of the Fukushima Daiichi accident on Korea is negligible in terms of radiation dose.

Following the Fukushima Daiichi accident, detailed analysis of radioactive nuclides (i.e., gamma radionuclides) was carried out after collecting samples of airborne dust in the atmosphere of 12 regional radioactivity monitoring stations throughout the country on a daily basis, and rainwater samples after every rainfall. Minute amounts of  $^{131}\text{I}$ ,  $^{137}\text{Cs}$ ,  $^{134}\text{Cs}$ , etc. were detected, presumably due to the consequence of the Fukushima nuclear accident. However, those radioactive nuclides have not been detected since April 26, and as a result, there appears to be no more impact of the nuclear accident on Korea. Fig. PI0-17 and PI0-18 show a daily change of radioactivity concentration in airborne dust of the atmosphere and in rainwater.

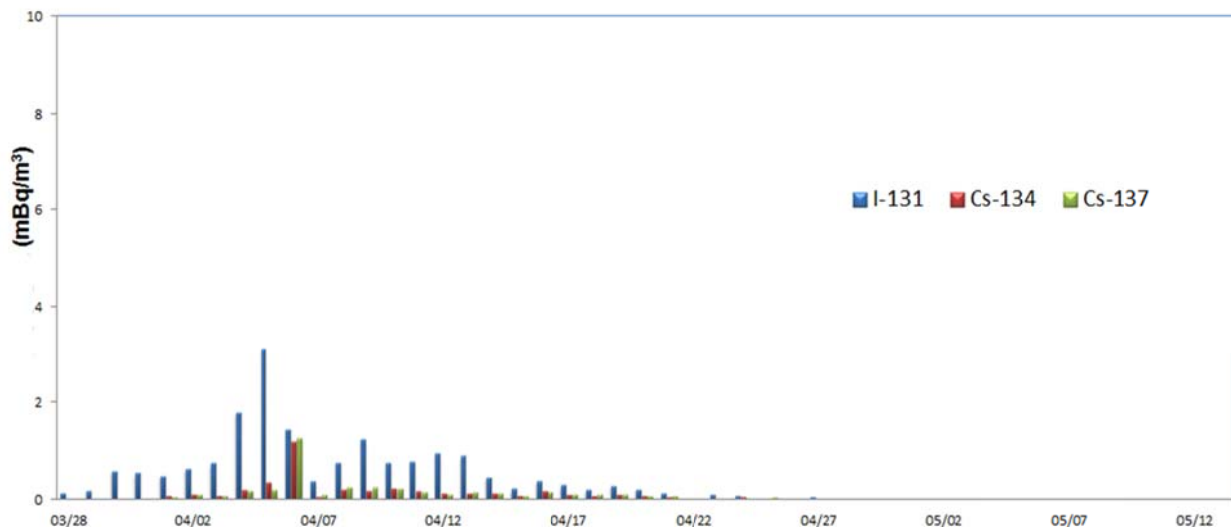


Fig. PI0-17. Daily Changes of Radioactivity Concentration in Airborne dust of the Atmosphere

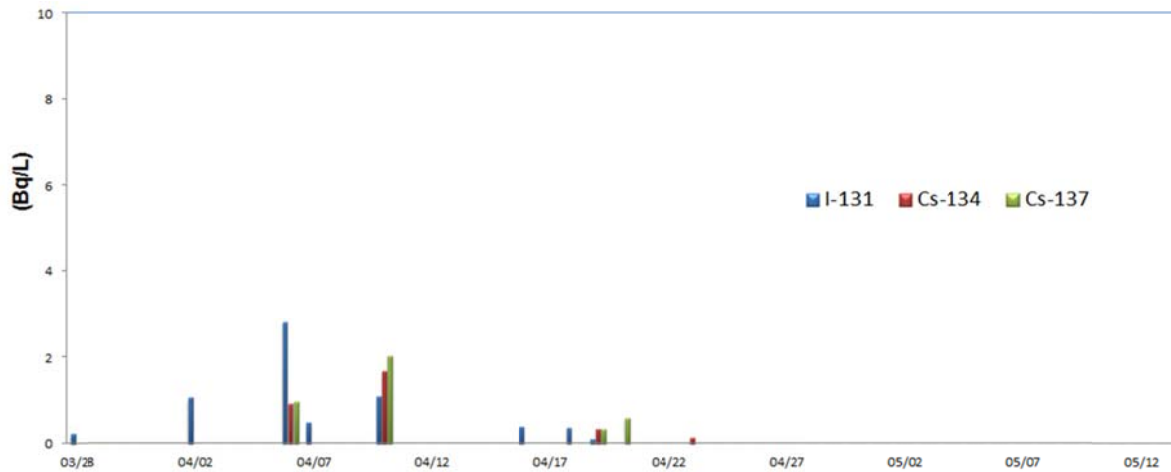


Fig. PI0-18. Daily Changes of Radioactivity Concentration in Rainwater

Table PI0-6 shows the analysis status of radioactivity concentrations in the domestic environmental samples that were monitored in response to the Japanese nuclear accident. In the case of airborne dust in the atmosphere,  $^{131}\text{I}$  was detected in Gunsan City on April 6 with a maximum concentration of  $3.12 \text{ mBq/m}^3$ , and  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  were detected in Busan City on April 7 with a maximum concentration of  $1.19 \text{ mBq/m}^3$  and  $1.25 \text{ mBq/m}^3$ , respectively. In the case of rainwater,  $^{131}\text{I}$  was detected in Jeju City on April 7 with a maximum concentration of  $2.81 \text{ Bq/L}$ , and  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  were detected in Jeju City on April 11 with a maximum concentration of  $1.67 \text{ Bq/L}$  and  $2.02 \text{ Bq/L}$ , respectively. Since April 26, artificial radioactive nuclides have not been detected in the samples of airborne dust in the atmosphere and rainwater. With respect to tap water, an analysis was performed 18 times so far as of May 31, but  $^{131}\text{I}$  and  $^{137}\text{Cs}$  were not detected. The results of 3 times of sampling and analysis for marine environmental samples (i.e., seawater and marine organisms) indicated the normal level of radioactivity. According to the results of radioactivity analysis for soil,  $^{131}\text{I}$  was not detected, but  $^{137}\text{Cs}$  and  $^{239+240}\text{Pu}$  were detected at very low level that had normally been detected and originated from atmospheric nuclear tests mainly 1950's-1960's.

For early detection of radioactivity in case of a domestic or foreign nuclear accident, the total number of unmanned environmental radiation monitors are going to be expanded from the present 71 monitors to 120 starting with the installation of a monitor at Dokdo Island (on April 1, 2011). The regional radioactivity monitoring stations also are going to increase from the present 12 centers to 16 by installing more monitoring stations at overpopulated areas. When a nuclear accident occurs within or outside of Korea, the environmental radioactivity monitoring periods will be shortened to protect the public health and the monitoring results will be transparently disclosed. For effective inter-agency response to a nuclear accident in neighboring countries, an integrated manual for pertinent government agencies is being developed so that the emergency response framework for a radioactivity release accident can be improved. Furthermore, the Korean Government plans to persistently discuss matters with neighboring countries through diplomatic channels so that exchange of accident-related information, dispatching of domestic experts to the accident site, and collaborative investigation and response could efficiently be realized in the event of a nuclear accident in a neighboring country.

Table PI0-6. Analysis Status of Radioactivity Concentrations in the Domestic Environmental Samples in Response to the Fukushima Daiichi Nuclear Accident (as of May 31, 2011)

Sample	Investigation Date	No. of Investigation Places	Investigation Result	Remark* (Normal Level)
Atmosphere	3.28~5.31	12	<sup>131</sup> I : ND~3.12 mBq/m <sup>3</sup> (4.6) <sup>134</sup> Cs : ND~1.19 mBq/m <sup>3</sup> (4.7) <sup>137</sup> Cs : ND~1.25 mBq/m <sup>3</sup> (4.7)	<sup>131</sup> I : ND <sup>134</sup> Cs : ND <sup>137</sup> Cs : ND~7.55 μBq/m <sup>3</sup>
Rain water	3.28~5.31	12	<sup>131</sup> I : ND~2.81 Bq/L (4.7) <sup>134</sup> Cs : ND~1.67 Bq/L (4.11) <sup>137</sup> Cs : ND~2.02 Bq/L (4.11)	<sup>131</sup> I : ND <sup>134</sup> Cs : ND <sup>137</sup> Cs : ND~12.3 mBq/L
Tap water	4.2~5.31 (Total 18)	23	Artificial radioactivity : ND	Artificial radioactivity : ND
Soil	4.4	12	<sup>137</sup> Cs : ND~16.0 Bq/kg <sup>239+240</sup> Pu : ND~0.537 Bq/kg	<sup>137</sup> Cs : ND~252 Bq/kg <sup>239+240</sup> Pu : 0.18~1.85 Bq/kg
Sea water	3.26~4.6 4.9~5.5 5.12~5.31	23 44 10	<sup>131</sup> I : ND <sup>134</sup> Cs : ND <sup>137</sup> Cs : ND~2.49 mBq/kg <sup>239+240</sup> Pu : ND~0.0258 mBq/kg	<sup>137</sup> Cs : ND~4.50 mBq/kg <sup>239+240</sup> Pu : ND~0.0366 mBq/kg
Marine organisms (Fish, Shellfish, Seaweed)	3.27~3.31 4.21~5.4 5.13~5.30	23 17 19	Fish <sup>131</sup> I : ND <sup>134</sup> Cs : ND <sup>137</sup> Cs : ND~0.253 Bq/kg  Shellfish <sup>131</sup> I : ND <sup>134</sup> Cs : ND <sup>137</sup> Cs : ND  Seaweed <sup>131</sup> I : ND~0.236 Bq/kg <sup>134</sup> Cs : ND <sup>137</sup> Cs : ND	Fish <sup>137</sup> Cs : ND~0.184 Bq/kg  Shellfish <sup>137</sup> Cs : ND~0.107 Bq/kg  Seaweed <sup>131</sup> I : ND~1.76 Bq/kg <sup>137</sup> Cs : ND~0.107 Bq/kg

\*) ND : Non-Detected

\*\*) References

1. Seawater, marine life: Marine Environmental Radioactivity Investigation (2005-2010)
2. Seaweed (<sup>131</sup>I): Environmental Radiation Investigation and Evaluation Report for Areas Surrounding Nuclear Power Utilization Facilities (2008-2009)
3. Soil: National Environmental Radioactivity Investigation (1997)

### III.4 Public Communication Activities

#### III.4.1 Overview

The people and mass media of Korea, the closest country to Japan, showed a great interest in the accident of the Japanese nuclear power plants. In order to respond to the explosive interest of the public and mass media, MEST and KINS opened a special webpage dedicated to the Japanese nuclear accident within the KINS homepage on March 12. Through this webpage, reliable information about the evolving events was promptly posted as precisely as possible. Situation call lines to respond to inquiries of the public were also set up with 5 KINS staff responded to the questions from the public via these lines. In addition, the results of the environmental radiation measurements were disclosed in real time through several main domestic portal sites where the public often visit (i.e., Naver, Daum, and Nate). MEST and KINS are also trying to actively provide information to the press by establishing a team to respond to the press, distributing the press release, holding press conferences, giving interviews, helping to resolve inquiries and collect news, etc.

#### III.4.2 Activities

The public interest in radioactivity further increased as a result of media attention on the Japan's nuclear accident. MEST and KINS accordingly set up special webpages within KINS and NSIC homepages, and also addressed public inquiries through several dedicated telephone lines which were installed in the radiological emergency response headquarters. The special webpages provide information on the status of the events at Fukushima Daiichi plant, the daily results of domestic radioactivity analysis, what residents should do in a radiological emergency situation, questions and answers, etc., with updates every day as necessary. The general public posed very diverse questions through the telephones and homepages, including the possibility of a radioactivity rain, responsive measures in case of a radiation exposure, use of imports from Japan, and so on. KINS promptly addressed their concerns with correct information. The total number of inquiries through the telephones was 8,696 from March 12 through May 31, and the number of inquiries through the homepages was 575 during the same period. Normally KINS receives about 130 inquiries through homepages a year, and thus, the number of public inquiries considerably increased. The development of the question-and-answer sessions in the homepages in connection with the events at Fukushima Daiichi plant is shown in Fig. PI0-19, with the main contents summarized in Table PI0-7.

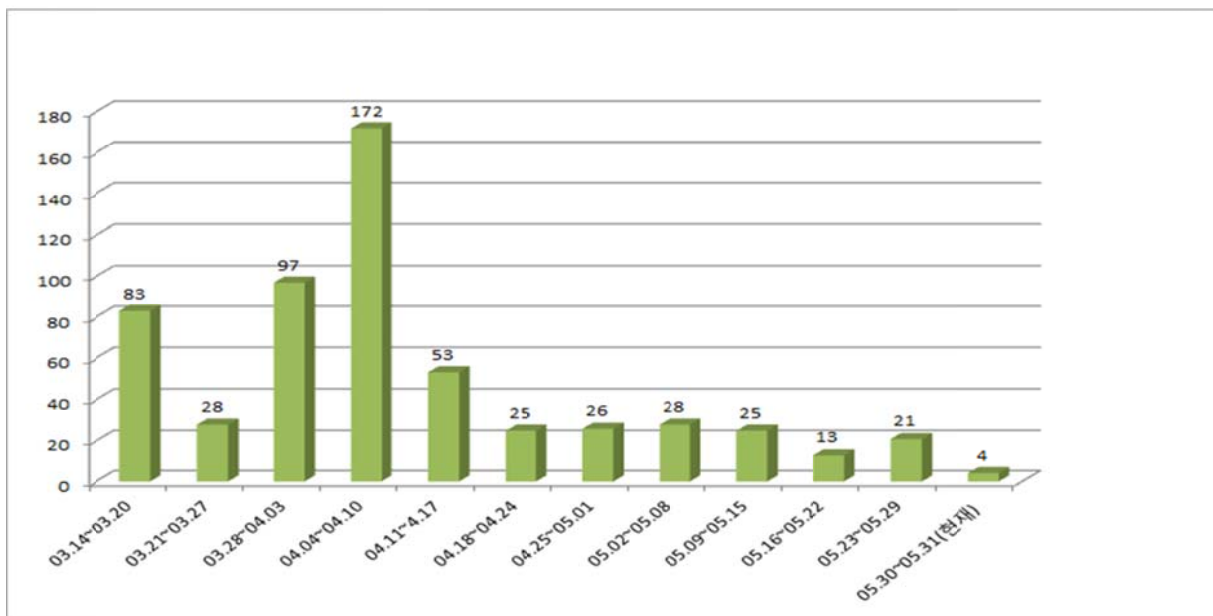


Fig. PI0-19. The Number of Question-and-Answer Sessions in the Homepages

Table PI0-7. Main Contents of the Public Inquiries

Content	Number of Inquiries
Health hazard due to potential radioactivity included in the atmosphere or rainwater	164
Results of national radioactivity detection and real-time dose rates (calculation method, analysis method, causes of detection, differences with press reports, etc.)	116
Basic information on radioactivity and nuclear energy (units, characteristics, X-ray, etc.)	114
Import and export of products of Japan (detection criteria, treatment methods, etc.)	83
Japan's nuclear power plants / Status of radioactive contaminations	34
Expected results and potential measures in the case of a domestic nuclear accident	31
Simulation results of foreign meteorological agencies	15
Request for reference materials (App development, etc.)	12

The people showed the greatest interest in domestic environmental dose rates in connection with the Japan's nuclear accident. This fact is manifested itself in the considerable jump in click rates of the homepage through which KINS provides updated information every 15 minutes (reduced to every 5 minutes following the accident). The yearly total clicks from 2004 to 2010 averaged about 8,845. However, this year the total clicks as of May 31 reached 3,595,860, with as many as 1,973,771 only during March. In view of such high interest, MEST and KINS made utmost efforts to ease the public and keep them from panicking by posting the results of real-time environmental radiation measurement results in the main domestic portal sites (i.e., Naver, Daum, and Nate) that the people most frequently visit. In collaboration with the Korea Institute of Radiological & Medical Science (KIRAMS), Korea Meteorological Administration, Ministry of Foreign Affairs and Trade as well as other experts, MEST and KINS have provided since March with 21 about 70 sets of questions and answers in the first largest portal site of the country, i.e., 'Knowledge-iN' with regard to such topics as health hazard from radioactivity or criteria for radioactive contaminations.

Spokespersons and experts of the Government, KINS and other relevant organizations endeavored to present correct information to the public through press interviews, contribution of a number of articles to newspapers, and so on. KINS and KIRAMS tried to avoid public misconceptions about radiation by advertising in 6 major newspapers of Korea since April 5, 2011 under the title of "We inform you for a correct understanding of radiation." Pamphlets entitled "Radiation in our life -- here are the facts" were also distributed.

Additionally, KINS enabled the public to ask questions through text messaging by establishing a mailbox (1661-4770) for them in the Nuclear Safety Calling Center (868-0777) which has been in operation earlier.

The Korea Food & Drug Administration and KIRAMS also tried to ease the public's concerns about radiation by distributing press release copies, answering public phone calls, etc. Several societies and science organizations such as the Korean Association for Radiation Protection, Korean Academy of Science and Technology, Korean Federation of Science and Technology Societies and so on endeavored to transmit correct information on radiation by hosting open forums, seminars, and so on with respect to the Japanese events at Fukushima Daiichi.

### III.4.3 Responses to the Press

The primary interest of the press and public about Japan's nuclear accident was health consequences of the radioactivity release due to the accident. However, joint responses and cooperation efforts among pertinent organizations were

necessary because the public showed interest in diverse topics.

A meeting among the government agencies, which have a responsibility to respond to the press concerning nuclear safety, was held under the supervision of the Policy, Public Relations and Planning Department of the Prime Minister's Office on April 1, 2011. Based on the decisions made at the meeting, a network of pertinent organizations was established in each of the following areas: 1) safety of radioactive materials; 2) safety of domestic nuclear power plants; and 3) food safety. The Ministry of Education, Science and Technology, Ministry of Knowledge Economy, and Korea Food & Drug Administration are responsible for each of these areas, respectively. The organizations involved in the network are: Ministry of Land, Transport and Maritime Affairs; Ministry for Food, Agriculture, Forestry and Fisheries; Ministry of Environment; Ministry of Health and Welfare; Meteorological Administration; Ministry of Information and Culture; Korea Institute of Nuclear Safety; Korea Hydro and Nuclear Power Company; Korea Nuclear Energy Foundation; and so on. Through this networks, consistent responsive strategies, public relation messages (e.g., "one-voice" strategies), and so on were established or developed.

Upon declaration of the emergency situation at the Japanese Fukushima Daiichi NPS by the Japanese Government at 19:03, March 11, 2011, the Korean media showed a great interest in Japan's nuclear accident. On March 12, MEST and KINS immediately established and continued to operate a situation team to respond to the press. This situation team is composed of a spokesperson, a press response team (2 persons), and a press monitoring team (3 persons). To answer technical questions from the press, a KINS staff was assigned to each technical area. The situation team was operated after forming an organizational structure with the spokesperson and press response team as the center.

As the events at the Japanese nuclear power plant unfolded, the situation team responded to interview requests, inquiries, requests to cover news from television news broadcasts, newspapers, news magazines, local media, and so on. Since the Japanese accident, KINS has had communications with the mass media as follows:

- Interviews and lectures: 160 times
  - Television news broadcast 68; radios 48; newspapers 42; lectures 2
- Assistance and cooperation to cover news: 200 times
  - 52 days (3.11~4.30) \* 4 times per day on the average; shooting pictures of the situation room with provision of reliable and accurate information
- Press conferences: 9 times
- Distribution of press release copies: 104 times

The interest of the press and public regarding the Japanese nuclear accident changed over time, and therefore, a timely press response was necessary in view of the increasing interest. The press monitoring team established in the situation room performed around-the-clock monitoring and analysis. Based on the monitoring results, the press response team coordinated and ascertained the schedules for press conferences, and tried to present correct information by frequently distributing press release copies and truth-clarification materials. Table PI0-8 shows the main messages transmitted to the press on specific dates.

KINS established a press briefing room in its emergency response headquarters for the convenience of the reporters, and also tried to share various information such as trends in media coverage among the staff; this sharing was accomplished by posting it on the KINS intranet.

In order to keep the people of Korea from panicking and to resolve the public concerns and questions, KINS distributed press release materials such as environmental radioactivity monitoring and inspection results, corrections of the incorrect press releases, and so on, from Mar. 16 to now, as shown in Table PI0-9.

The interest areas of the press and public are as follows in terms of topics:

- Status of the Japanese nuclear accident and its expected situation in the future: reactor types, accident ratings, causes of hydrogen explosion, responses of the Japanese government and utility, etc.
- Possibility of radioactive contamination of the people entering Korea from Japan, and potential transfer of radioactive contamination to Korean residents
- Safety of foodstuff and industrial products imported from Japan
- Directions of winds at the accident site of Japan

- Possibility of domestic radioactive contamination in the atmosphere, seawater, soil, etc. due to the Japan's accident, with particular interest in rainwater
- Radioactive contamination measurement and related procedures in the import and export industries
- Radiation effects on pregnant women and infants
- Treatment methods following radiation exposure and foods helping treatment (seaweed, salt, etc.)
- Location of domestic environmental monitoring networks and the central operating body
- Countermeasures for Korean people and students residing in Japan, and for Korean visitors to Japan
- What to do in case of an actual domestic radiological emergency
- Safety of operating nuclear power plants in Korea: heightened interest in aged nuclear such as Kori Unit 1, for which continued operation has been allowed
- Potential cooperation with Japan and international organizations: increased interest in dispatching domestic nuclear experts to Japan and collaboration with Japan.

Table PI0-8. Main Messages Transmitted to the Press

Date	Main Message
3. 15	“The impact on our country will not serious even though the radioactivity release from the Japanese nuclear power plant will worse.”
3. 22	“We will regard the Japanese accident as an opportunity to further upgrade domestic nuclear plant safety.”
3. 29	“Detection of radioactive materials at 12 local measurement centers throughout the country -- Will not pose a health risk to the general public.”
3. 30	“A bare possibility of domestic Plutonium inflow -- No impact on health and environment.”
3. 31	“We will inspect radioactive materials in seawater, soil and tap water.”
4. 4	“Unnecessary to feel concern about domestic inflow of the radioactivity from Japan -- The preconditions used in the diffusion model of a Norwegian institute of atmospheric research are different from the actual situation.”
4. 6	“Very low possibility of direct inflow of radioactive materials and of radioactive rainfall -- Will intensify radioactivity monitoring of domestic ocean to ease public concerns.”
4. 7	“According to the inspection of radioactive materials in Jeju Island area, the impact of the Japan's nuclear accident on Korea is not large.”
4. 13	“As per the inspection results for plutonium in seawater and marine life, almost no impact of the Japanese nuclear accident on the Eastern, Western and Southern Seas of Korea -Will operate a constant radioactivity monitoring system to relieve the concerns public.”

Table PI0-9. Distribution Status of Press Releases and Contents

Item	Topic	Distribution Date	Specific Contents	Number of Press Releases
Environmental Radioactivity Monitoring	Domestic Intensification of Environmental Radioactivity Monitoring	3.16	Inspection of radioactivity contamination for airline passengers from Japan	6
		3.28	Detection of Xenon nuclear radiation in Korea	
		3.28	Detection of radioactive materials in 12 local measurement centers throughout the country	
		3.31	Stepwise intensification program for environmental radioactivity	
		4.1	Intensification of real-time environmental radioactivity monitoring (addition of Dok-do Island site)	
		4.6	Countermeasures for potential domestic inflow of Japan's radioactive releases	
	Results of Environmental Radioactivity Monitoring	3.28~	Results of daily environmental radioactivity inspections (in the atmosphere and rainwater)	66
		4.7	Results of the emergency radioactivity monitoring in Jeju Island area	1
		4.4~	Results of radioactivity analysis for tap water at 23 water treatment plants throughout the country	17
		4.13~	Results of radioactivity analysis for seawater and marine life samples	3
		4.25	Results of radioactivity analysis for soil samples	1
Others	Dispatching of Domestic Experts	3.18~	Korean rescue workers dispatched to Japan for radiation protection support	5
			Support for overseas Korean residents in Japan	
			Support for settlement of the Japanese nuclear accident (dispatched to IAEA)	
			Dispatch of Korean experts to Japan as part of the IAEA expert team	
	Clarification Materials	3.20~	Correction of incorrect press releases about domestic radiation effects due to the Japan's accident	5
<b>Total Number of Press Releases: 104</b>				

#### III.4.4 Lessons learned from the Mass Communication Activities

A great deal of experience and lessons were obtained in connection with the Fukushima Daiichi nuclear accident, especially from a perspective of public communication. The main lessons gained are as follows:

- The public were found to have much more specific, realistic, and diverse questions than the experts thought. It is necessary to prepare 'Frequently Asked Questions (FAQ)' in anticipation of emergency situations by performing a detailed analysis of the public questions.
- For a wide communication with the public in case of an emergency, it is necessary to take advantage of social networks, which are increasingly used of late.
- As the public are interested in diverse technical areas, it is necessary to establish a systematic response organization by designating persons who will be responsible for each specific area

- In anticipation of a variety of questions that may exceed the task scope of a nuclear regulatory body, it is necessary to develop a list of experts and associated networks in special fields such as meteorology, food or medicine
- It is necessary to secure well-trained experts to respond to the press in case of an emergency
- To help journalists understand the basic knowledge about radiation and nuclear energy, it is necessary to develop and distribute a fact book

### **III.5 Response to the International Community**

#### **III.5.1 Overview**

After the accident of Fukushima Dai-ichi nuclear power plants, the public and press of Korea have showed considerable interest in the accident and the Korean government has taken prompt and active measures to cope with the accident since Korea is the closest neighboring country to Japan. The Korean Government supplied the Japanese Government boric acid, for controlling the accident, and has dispatched radiation safety experts to the Embassy of the Republic of Korea in Japan to promptly collect the accident-related information and provide technical consulting. A couple of Korea-Japan expert meetings were held in Japan for the assessment of impact of the Fukushima accident on the Korean Peninsula, information collection, and opinion exchange. Korea also has dispatched nuclear safety experts to the Japan Nuclear Energy Safety Organization (JNES) for a joint analysis of the accident and speedy information exchange. Through these activities, the cooperation between Korea and Japan has been strengthened.

In addition, Korea has sent domestic experts to the radiological impact analysis team and the international fact-finding expert mission of IAEA to support the accident response activities of the international organization. By participating in the international experts meetings, ministerial-level meetings, and summit meetings after the Fukushima accident, Korea has actively cooperated with the international organizations and community.

#### **III.5.2 Cooperation with Japan**

In connection with the Fukushima accident, the cooperation for prompt information sharing and emergency response among neighboring countries became an issue. Thus, Korea has made every effort to collect information and to intensify collaboration with Japan by diversifying cooperation channels and methods

With the request from the Japanese Government following the accident, the Korean Government provided 52 tons of boric acid to Japan.

Through the diplomatic channel after the accident, MEST and KINS suggested to the Japanese Government that Korea would send Korean nuclear safety experts to Japan. Upon the acceptance of this suggestion by the Japanese Government, KINS has dispatched nuclear safety experts to JNES (refer to Table PI0-10, Fig. PI0-20 & PI0-21). This has paved the way for a more intimate cooperation between Korea and Japan, such as sending liaison officers from a very early stage of an emergency.

In view of the public concerns and interest about the Fukushima Daiichi nuclear accident, the Korean Government asked the Japanese Government to provide information on the status and progress of the accident to Korea and hold Korea-Japan expert meetings. As a result, the following first Korea-Japan expert meeting was held in Tokyo on 11-13 April 2011 and relevant information was exchanged and accident mitigation activities and follow-up measures were discussed.

- Korea Side: a total of 10 experts and government officials including 1 MEST staffer, 4 KINS staffers, and 2 KAERI staffers, and 3 staffers from the Embassy of the Republic of Korea in Japan
- Japan Side: a total of 16 experts and government officials from Ministry of Foreign Affairs (MOFA), Ministry of Education, Culture, Sports, Science, and Technology (MEXT), Ministry of Health, Labor, and Welfare (MHLW), Ministry of Agriculture, Forestry, and Fisheries (MAFF), NISA, and JNES

- Main Content: Information exchange on the current status of the Fukushima accident, Japan's response strategies, radiation monitoring, and food safety
- Follow-Up Measure: Dispatch of liaison personnel of KINS to JNES for more efficient information exchange

And the following second Korea-Japan expert meeting was held in Tokyo on 14-15 June 2011 where the follow-up measures and future plans of both countries were reported, information about the Fukushima accident was exchanged, comments on the Japanese national report prepared for the IAEA Ministerial Conference on Nuclear Safety were given by the Korean experts, and further collaboration between Korea and Japan was discussed.

- Korea Side: a total of 9 experts and government officials including 1 MEST staff, 7 KINS staff, 1 staff from the Embassy of the Republic of Korea in Japan
- Japan Side: a total of 22 experts and government officials from Ministry of Foreign Affairs (MOFA), Ministry of Education, Culture, Sports, Science, and Technology (MEXT), NISA, and JNES
- Main Contents: Information exchange on the activities taken by both countries, future plans, and the progress of the Fukushima accident and comments by the Korean experts on the Japanese national report prepared for the IAEA Ministerial Conference on Nuclear Safety (questions, answers, and comments)
- Follow-Up Measures: Further enhancement of the function of Early Notification System for an emergency situation and measures such as dispatching liaison personnel in case of a nuclear accident

### **III.5.3 Cooperation with International Community**

In order to actively support the accident investigation and impact assessment of IAEA, Korean experts provided technical consulting on radiation impact analysis by participating in the radiation impact analysis team of IAEA, and also performed a preliminary assessment on the Fukushima accident by taking part in the fact-finding expert mission of IAEA (see Table PI0-10).

In the Nuclear Safety Convention fifth review meeting, Korea presented its safety investigation plan for operating nuclear power plants in connection with the Fukushima accident, and exchanged information with participating countries especially to derive preliminary lessons learned from the accident. Subsequently Korea disseminated information on actions taken in Korea following the Fukushima accident at the important international meetings including MDEP steering committee meeting, INRA meeting, ANSN steering committee meeting, INSAG meeting, G20 nuclear safety ministerial-level meeting, NEA Forum on Fukushima accident, and IAEA Ministerial conference on Nuclear Safety (refer to Table PI0-11).

In the fourth summit meeting of Korea, Japan and China held in Tokyo on 22 May 2011, it was decided to strengthen practical cooperation through the Top Regulator's Meeting among the three countries which was established in 2008. It was also agreed to start discussion on establishing an early notification framework in case of emergency and exchanging experts, and to contemplate on exchange of information regarding the analysis and forecast of air flow trajectory on a real time basis in case of a nuclear accident.

So as to fulfill the duty as a nuclear export country for the UAE (United Arab Emirates) nuclear regulatory body (FANR), KINS provided its action plan for operating nuclear power plants in connection with the Fukushima accident. KINS also continues to support FANR by sharing regulatory technologies and experiences (Fig. PI0-22).

Through the accident of the Fukushima Daiichi nuclear power plants, it has been reaffirmed that prompt information sharing and response among neighboring countries are of utmost importance in order to protect public health and facilitate public acceptance of nuclear energy. To that end, the early accident notification framework should be strengthened with the international organizations including IAEA as the center, and international cooperation especially among neighboring countries should be further enhanced.

Table PI0-10. Status of Experts Dispatch

Dispatched Experts (or Meeting)	Date	Place	Activity
<b>Korea-Japan Expert Meeting and Experts Dispatch to JNES</b>			
The First Korea-Japan Expert Meeting	April 11-13	Japan	Discussion on information exchange concerning the Fukushima Dai-ichi nuclear accident and cooperative methods
The Second Korea-Japan Expert Meeting	June 14-15	Japan	Discussion on information exchange concerning the Fukushima Dai-ichi accident and cooperative methods
Yongjin Cho (KINS)	May 18- June 30	JNES	Identification of the post-accident status, information exchange, performance of the task as a liaison officer
Cheol Sheen (KINS)	July 5- August 31	JNES	Identification of the post-accident status, information exchange, performance of the task as a liaison officer
IAEA Expert Team			
Changkyu Kim (KINS)	April 2-17	IAEA	Performance of the task as part of the radiation impact analysis team of IAEA
Kyeyong Sung (KINS)	May 23- June 2	Japan	Performance of the task as part of the accident investigation team of IAEA

Table PI0-11. Status of Participation in International Meetings

Name of Meeting	Date	Place	Activity
The Nuclear Safety Convention fifth review meeting	April 4-14	IAEA	Status of nuclear safety regulation, presentation of the Korean' plan to inspect operating nuclear power plants, exchange of relevant information
MDEP steering committee	April 27-29	NEA	Activity in the design review group and issue review group; response of each member country to the Fukushima accident
The 28th INRA (International Nuclear Regulators Association) Meeting	May 16-18	Sweden	Response status of Japan and other member countries following the Fukushima accident, information exchange and support measures in case of a nuclear accident
The 13th ANSN (Asian Nuclear Safety Network) steering committee	May 18-20	Austria	Strengthening of regulatory capabilities of member countries, emergency cooperation between neighboring countries in the aftermath of the Fukushima accident
The 4th summit meeting of Korea, Japan and China	May 22	Japan	Intensification of practical cooperation through a TRM among the 3 countries, establishment of early notification system in case of an emergency, expert exchange
INSAG (International Nuclear Safety Group) meeting	May 29- June 3	Austria	Status of IAEA response and future plan in connection with the Fukushima accident
G20 Nuclear Safety Ministerial meeting	June 7	NEA	Expansion and intensification of the existing international conventions on nuclear safety, strengthening of IAEA role
NEA forum on the	June 8	NEA	Presentation of countermeasures by each country

Fukushima accident	Dai-ichi			following the Fukushima accident; emergency and responsive measures to enhance nuclear safety
IAEA Conference on Nuclear Safety	Ministerial	June 19-22	Austria	Adoption of a joint declaration statement to step-up international nuclear safety framework; presentation of Korean response to the Fukushima accident



Fig. PI0-20. the First Korea-Japan expert meeting (4.11)



Fig. PI0-21. the Second Korea-Japan expert meeting (6.14)



Fig. PI0-22. Topical Meeting on Severe Accident between KINS and UAE FNAR

(Date: March 29-31, Place: Main conference room of KINS, Participants: about 30 people from KINS, FANR, TSO, KEPCO, KEPCO E&C, and KHNP)

## **IV. Special Safety Inspection of Nuclear Power Plants in Korea**

### **IV.1. Overview**

Due to the severe accidents at Fukushima DAI-ICHI nuclear power plants (NPPs) in Japan, caused by the great earthquake on Mar.11, 2011, public concern about the safety of domestic NPPs has greatly increased. The government convened the 43th Nuclear Safety Committee (NSC) on Mar. 21, 2011, and decided to conduct a comprehensive special safety inspection (SSI), based on the recommendation of the NSC, on the nuclear facilities in Korea. The SSI was performed from Mar. 23 through Apr. 30, 2011 to conform the mitigating capabilities against severe accidents resulting from huge earthquakes and tsunamis that go beyond expectation, such as those occurred in Fukushima, and to derive any items for improvement needed.

The NPP utility, KHNP voluntarily performed a self - inspection on earthquake and tsunami preparedness of NPP from Mar. 16 to Mar. 18, 2011. The utility's inspection has focused on safety of NPP's design against anticipated maximum earthquake and tsunami, probability of SBO by flooding, probability of loss of cooling function due to loss of heat sink, and probability of loss of the integrity of containment. Through the self - inspection, KHNP confirmed safety of structural design of NPPs and were identified some items to be improved for enhancing safety of NPPs in the worst natural disasters, in view of the accident at the NPP's in Fukushima. KHNP plans to implement these items for improvement to NPPs and also actively review Fukushima's post actions of IAEA, IAEA, and WANO etc. and reflect them to NPPs.

During the SSI, activities were focused on confirming if the nuclear facilities were adequately designed for responding to natural disasters, for preventing and mitigating severe accidents assuming the worst accident scenario resulting from natural disasters, and establishing a proper emergency response system for severe accidents. The inspections was performed by various experts from industries, academic circles, and research institutes as well as inspectors from Korea Institute of Nuclear Safety (KINS) for three weeks - Kori site (Mar. 28-Apr. 1), Wolsong site (Apr. 4-6), Ulchin (Apr.7-9), Yonggwang site (Apr. 11-13), and research reactors and the nuclear fuel cycle facilities (Apr. 14 and 15). Opinions from the local governments, the civil environment monitoring organizations, and the residents in the vicinity of the sites were reflected in advance into the inspection scope.

### **IV.2 SSI Scope and Areas**

In the SSI, adequacy of the plant design and configuration, operation procedures, the accident management guidelines, and emergency preparedness plan of the plants were preferentially checked over the Design Basis Accidents (DBAs) and Beyond Design Basis Accidents (BDBA) considered in Safety Analysis Reports. Furthermore, the SSI focused on verifying the defense-in-depth functions and the operability of the plant facilities by assuming the scenario of "earthquake → tsunami → power loss → extreme severe accident" with reference to the causes of the Fukushima accidents. The objects of the inspection include commercial NPPs, research reactors and nuclear fuel cycle facilities, and the emergency medical institutions.

The followings items were selected as the common points for SSIs of commercial NPPs:

Table PI0-12. Major Inspection Points of SSI

Defense-In-Depth Functions	Major Inspection Points
Extreme natural disasters	<ul style="list-style-type: none"> <li>· Adequacy of the plant design and facilities against natural hazards</li> <li>- Design against earthquake and seismic capacity</li> <li>- Design against coastal flooding and inundation protection capability</li> </ul>
Prevention of severe accidents	<ul style="list-style-type: none"> <li>· Adequacy of power supply and cooling functions</li> <li>- Power system and emergency power supply</li> <li>- Cooling capability in case of SBO and inundation</li> </ul>
Mitigation of severe accidents	<ul style="list-style-type: none"> <li>· Adequacy of countermeasure capabilities against severe accidents</li> <li>- Facilities, guidelines, and strategies against severe accidents</li> </ul>
Emergency response	<ul style="list-style-type: none"> <li>· Adequacy of emergency response</li> <li>- Emergency response to multi-units accidents</li> <li>- Facilities, systems, and infrastructure for the protection of local residents and workers</li> </ul>

The scope of the SSI consists of the following 6 areas and 27 inspection items deduced on the basis of the inspection points as stated above:

- (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

Four areas (area 1 to 4) were common inspection scopes for all operating plants. As for long-term in-service plants over 20-years operation, the inspections confirming equipment integrity against aging degradation have been performed in addition to other checks.

As for the research reactors and the nuclear fuel cycle facilities of Area 6, the adequacy of measures against inundation caused by heavy rain and fire, and adequacy of the discharge control of radioactive materials have been confirmed.

The goal for improvement in each area has been established as a target of the inspection. Although the goals are beyond the current design and functional requirements, they have been suggested in order to guarantee the safety margin of plants as large practically as possible during large-scale disasters such as an earthquake and/or tsunami.

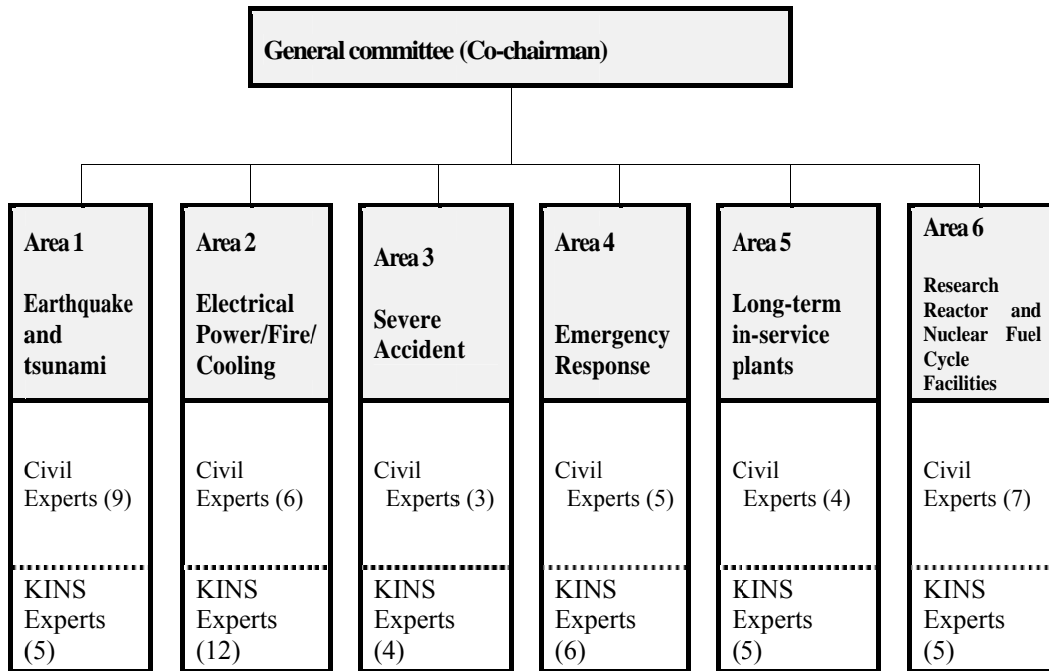


Fig. PI0-23. Organization of the SSI team for nuclear power plants in Korea

After the SSIs were completed, the team provided presentations to the residents and civil representatives of each plant site for briefing the SSI results and the follow-up action plan (May 27-Jun. 30) as an effort to relieve the residents who are concerned about nuclear accidents in the aftermath of the Fukushima accident. Through the presentations, the team explained the inspection results, and also heard various opinions and suggestions from the residents regarding to nuclear safety. The Korean government plans to continue its effort in communications with the public.



Fig. PI0-24. Photos of presentation explaining the SSI results to the residents near the Kori site

## IV.3 Inspection results and items for improvement

### IV.3.1 Design of structures and equipment against earthquakes

#### 1) Current status

The maximum ground acceleration of the Safe Shutdown Earthquake (SSE) of operating plants was determined to be 0.2g based on the maximum potential earthquake, with a safety margin. The maximum potential earthquake was estimated by taking into account the geologic and seismic characteristics within 320km from the center of the plant site. The maximum ground acceleration of the SSE for new plants (Shin Kori Units #3 and #4) is 0.3g. A seismic monitoring system is installed and operated at each plant. Each plant must be shut down manually according to the abnormal operating procedure when an earthquake stronger than the Operating Basis Earthquake (OBE) (0.1g) occurs, and then the integrity of structures and equipment is checked.

#### 2) Detailed inspection area

The followings items were major areas for confirming the safety of the structures and equipment against an earthquake:

- Seismic capacity of Seismic Category I structures and equipment
  - Maintenance of structures and equipment
  - Effect of design change or additionally installed facilities on the existing facilities
  - Adequacy of the anchorage of equipment, and the potential of interference between the major equipment and adjacent facilities
- Operability of the seismic monitoring system
  - Operability of the seismic monitoring and alarm system
  - Adequacy of the data input in the seismic monitoring system as shutdown criteria in the event of an earthquake
- Adequacy and feasibility of corresponding measures upon the occurrence of an earthquake
- Measures for securing extended margin against strong earthquakes exceeding the design earthquake (SSE)

#### 3) Inspection results

It was assured that the major structures and equipment are managed so as to maintain the same status as that at the time of the plant construction through periodic testing, inspection and maintenance, and are secured with integrity against the design earthquake, and that design changes and additionally installed facilities are designed not to affect the integrity of the existing facilities. It was also assured that aging management on the anchorage of the major equipment is being properly performed according to the relevant operation procedure and separation between the major equipment and adjacent facilities is sufficiently maintained to prevent interferences.

It was verified that the seismic monitoring systems are managed properly through the monthly channel check, the semi-annual functional test, and calibration during the scheduled overhaul period, and that alarm systems and the uninterruptible power supplies meet the relevant requirements. It was also confirmed that the operating basis earthquake (OBE), which is used as the criteria for the plant shutdown, is one half of the design earthquake or SSE so that it meets the relevant requirements. It was also verified that necessary measures such as plant shutdown and seismic response analysis upon the occurrence of an earthquake are implementable with the relevant abnormal operating procedures.

However, in view of the great earthquake in eastern Japan, some items to be improved have been derived through the SSI to secure extended safety margins under the assumption of the occurrence of a strong earthquake that exceeds the design basis.

#### 4) Items for improvement

While the safety of the major structures and equipment at the plants in Korea is secured under the current design earthquake, as a result of the inspection, five items have been identified for achieving the goals for improvement.

<Goals for improvement>  
- Securing a safe shutdown capability even in case of an earthquake beyond design basis

- (1-1) Installing an automatic seismic trip system
  - Installing systems needed to automatically trip the plants when detecting an earthquake above a specified seismic level (0.18g) (applied to all plants)
- (1-2) Improving the seismic capacity of the safe shutdown systems
  - Upgrading the seismic capacity of the safe shutdown systems to the design earthquake level of advanced NPPs (0.3g) in preparation for an earthquake exceeding the design basis (all plants)
- (1-3) Investigation and study on the maximum potential earthquake for NPP sites
  - Conducting a comprehensive reassessment of the maximum potential earthquake at NPP sites (all plants)
- (1-4) Improving seismic capacity of equipment in the main control room (MCR)
  - Improving the seismic capacity of the seismic alarm window in the MCR (all plants)
  - Preventing of ceiling and lighting equipment from dropping and fixing of office appliances to protect the operator in the MCR (applied to Kori Unit 1 to 4)
- (1-5) Improving the seismic capacity of the entrance bridge to the Wolsong site
  - Enhancing the seismic capacity of the entrance bridge near the back gate to the Wolsong site (applied to Wolsong Unit 1 to 4)

#### **IV.3.2 Design of structures and equipment against coastal flooding**

##### 1) Current status

In Korea, the design basis sea water levels (probable maximum and minimum sea water levels) are estimated by evaluating the maximum tsunami and storm surge. The probable maximum sea water level is determined by combining the high tide level, the maximum sea water level caused by a tsunami or a storm surge (using the higher sea level from either a tsunami or a storm surge), and the height of wave run up. The probable minimum sea water level is determined by combining the low tide level and the minimum sea water level caused by a tsunami, a storm surge, etc. (using the lower sea level from either a tsunami or a storm surge).

##### 2) Detailed inspection area

The following items were major areas for confirming the safety of the structures and equipment against coastal flooding:

- Adequacy of plant design against tsunami and storm surge
  - Adequacy of site elevation in preparation for coastal flooding (considering an earthquake, storm, etc.)
  - Resistant capability of safety-related structures against coastal flooding
  - Capability of the intake structure to provide sufficient cooling water under low water level
- Measures for securing enhanced margin against coastal flooding exceeding the design basis

##### 3) Inspection results

The probable maximum sea water level of the plant site was conservatively estimated by combining the height of high tide level, the maximum sea water level caused by a tsunami or storm surge, and wave run up. There is a very rare possibility of the inundation of structures because the maximum possible sea water level is much lower than the site elevation (including the sea wall). (Refer to Table PI0-13)

Table PI0-13. Probable maximum sea water levels at plant sites and freeboard (meters)

Site	Expected maximum coastal flooding		Maximum probable sea water level	Site elevation*	Freeboard
	Storm	Earthquake			
Kori	2.5	0.3	7.2	7.5 (Kori #1·#2)	0.3
				9.5 (Kori #3·#4)	2.3
Wolsong	2.0	0.5	7.2	12	4.8
Yonggwang	2.3	-	8.4	10	1.6
Ulchin	0.9	3.0	5.7	10	4.3

\* Kori #1·2: site elevation 5.8m + sea wall 1.7m

The probable minimum sea water levels were also conservatively calculated by combining the low tide level and minimum sea water level caused by a tsunami or storm surge. It means that sea water intake is available even in minimum sea water level condition caused by a tsunami or storm surge because the bell mouse of the intake pump is lower than the probable minimum sea water level. As a result, it was confirmed that the inundation of structures is not probable even in case of the design basis probable maximum sea water level condition, and the function of water intake is maintained even for a probable minimum sea water level as well.

However, in view of the great earthquake in eastern Japan, the measures to be taken have been derived through SSI to secure enhanced safety margin under the assumption of severe coastal flooding beyond the design basis.

#### 4) Items for improvement

The structures of NPPs in Korea are free from inundation when viewed against the probable maximum sea water level, and are designed to be capable of seawater intake even at the probable minimum sea water level. However, under the assumption of severe coastal flooding beyond the design basis, four measures have been identified for achieving the goals for the improvements as a result of inspection.

##### <Goals for improvement>

- Securing the inundation prevention capability of major safety-related facilities even for coastal flooding exceeding design basis
- Securing the ultimate heat sink even for tsunami or storm surge exceeding the design basis

- (2-1) Extension of the height of the sea wall for the Kori site
  - Extension of the sea wall height for the Kori site, whose freeboard is relatively low, to increase the height level equivalent to other sites (10m) (Kori site)
- (2-2) Installation of waterproof gates and discharge pumps
  - Installing seismically designed waterproof gates and waterproof discharge pumps in the structures containing emergency power systems and major safety systems for inundation protection. (including the inundation protection measures on penetrations such as ventilation louver or openings, etc.) (all plants)
- (2-3) Investigation and study on the design basis sea water level of NPP sites
  - Investigation and study on the design basis sea water level with enough conservatism in input data that was used to evaluate and determine the existing design basis sea water level. (consideration of conservatism : simultaneous occurrence of seismic gaps, super typhoon, and so on.) (all plants)
- (2-4) Enhancement of sea water intake capability and reinforcement of facilities in preparation for coastal flooding
  - Enhancement of intake capability of component cooling sea water pumps (rearranging the bell mouse location of the

intake pumps and maintaining the minimum sea water level by installing a submerged dam), which should be based on the results of improvement item (2-3), (all plants)

- Moving the warehouse keeping spare parts and replacements to a safe place that is away from inundation in the event of severe coastal flooding (Kori Units #1 and #2)

### IV.3.3 Integrity of electric power, cooling, and fire protection systems inundation

#### 1) Current Status

The electric power facilities are designed to consist of two physically and electrically independent trains in accordance with the relevant regulatory requirements. There are two physically separate transmission lines from the grid for minimizing the probability of the simultaneous failure of the offsite power systems upon the design basis accidents and the effects from natural disasters during operation.

In addition, all plants have two emergency diesel generators (EDG) installed to cope with a loss of offsite power event (LOOP). There is one alternative alternating current diesel generator (AAC DG) per 2 or 4 units to cope with a station blackout (SBO) event. The battery systems are designed to have the independency, redundancy, and testability according to the requirements for insuring their safety functions even upon single failure.

Table PI0-14. Installation status of AAC diesel generators

Plants	AAC DG (number, capacity)	Installation year
Kori units #1~#4	1 (5,500kW)	2006
Yonggwang units #1~#2	1 (5,500kW)	2010
Yonggwang units #3~#6	2 (6,500kW)	during construction
Ulchin units #1~#2	1 (5,500kW)	2010
Ulchin units #3~#6	1 (7,000kW)	during construction
Wolsong units #1~#4	2 (2,000kW)	during construction
Shin Kori Units #1~#2	1 (7,200kW)	during construction

The electrical power systems are designed not to be inundated in case of design basis tsunami or floods pursuant to the regulatory requirement. An EDG is capable of supplying electrical power to the affected plant for seven days in case of LOOP event, and for eight hours by an AAC DG in case of a SBO event. The battery systems have the capability to supply sufficient electrical power to the connected electrical loads in case of a DBA occurrence as designed.

The nuclear service cooling water systems are designed to have redundant and independent trains pursuant to the regulatory requirement. Even if one train is out of service, cooling function can be maintained using the other train. The spent fuel pool has various cooling water sources such as the Refueling Water Storage Tank (RWST) and the Condensate Storage Tank (CST) to prevent a loss of the cooling function.

Periodical evaluation for fire hazard analysis is performed every 10 years to confirm the safe shutdown capability even during fire accidents pursuant to the regulatory requirement. In addition, the fire protection program has been established and implemented to prevent and extinguish fires and to secure the safe shutdown capability.

## 2) Detailed inspection area

To confirm the capabilities of the electrical power, cooling, and fire protection systems that are essential for preventing and mitigating severe accidents caused by inundation, the following areas have been checked.

- Adequacy of electric power systems against design basis earthquake and tsunami
  - EDG, AAC diesel generators, batteries, etc.
- Adequacy of cooling systems against design basis earthquake and tsunami
  - Nuclear service cooling water system, spent fuel pool cooling systems, etc.
- Measures to secure the functions of electric power systems against beyond design basis earthquakes and tsunamis
  - Adequacy of the restoration plans upon loss of power sources due to an earthquake
  - Restoration measures upon the inundation of emergency power sources and connected system, and battery capacity, etc.
  - Adequacy of the location of electric power supply connections that may be vulnerable to inundation
- Measures to secure the functions of cooling systems against beyond design basis earthquake and tsunami
  - Securing the function of the ultimate heat sink
  - Maintaining the long-term loss of cooling functions of the spent fuel pool
  - Integrity of the cooling water sources installed outside and the storage tanks containing toxic substances
  - Adequacy of the fire protection facilities and the emergency response capability of firefighting organization

## 3) Inspection results

It is not likely that the design basis earthquake and tsunami would flood the electric power sources. It has been confirmed that the emergency power sources are capable of coping with a LOOP event for seven days and that the AAC diesel generator is capable of supplying emergency power for 8 hours in case of a SBO event. It has also been assumed that the batteries have the capability to supply sufficient electrical power to the connected electric loads in case of a design basis accident.

Nuclear service cooling water (i.e. sea water) system is capable of maintaining safety related functions even on the assumption that one train is out of service in either normal operation or in accident conditions. It was confirmed that the facilities to prevent the loss of cooling functions are in place, even in abnormal conditions such as intake clogging by debris.

It was confirmed that the spent fuel pool cooling system maintains the ability to remove the decay heat of spent fuel in the design basis accidents, and diverse cooling water sources, such as the RWST and the CST and the like, are secured to deal with long-term loss of cooling function in the spent fuel pool.

It was also confirmed that the RWST and the CST installed outside on ground level are designed as seismic category I safety related components. Likewise, facilities that collect and process the toxic solution discharged from the storage tanks containing chemical substances (sulfuric acid, caustic soda, ethylene-amine, and so on) were installed and have been well managed.

Fire protection facilities were designed and installed according to fire protection and nuclear regulatory requirements. It was assured that fire protection facilities maintain their fire extinguishing functions through integrated detailed verification pursuant to fire protection regulations. Initial fire suppression system is verified to be adequate since an initial fire brigade and the headquarters' firefighting team was organized to cope with fire occurring at the site.

However, through the SSI, some measures to be taken for improvement have been identified in this area for guaranteeing enhanced safety margin of electrical and cooling systems even in case of the worst situation such as site inundation by a large tsunami and simultaneous shutdown of electric power supply to multiple units.

#### 4) Items for improvement

##### <Electric Power Systems >

The emergency power supply systems are installed at the units and site against loss of onsite and offsite electrical power accidents as a design basis. However, the following measures to be taken have been identified for achieving the improvement goals upon SBO events exceeding the design basis, such as the simultaneous outage of the power supply to multiple units.

<Goals for improvement>

- Securing the essential electric power sources to monitor the reactor core states upon SBO accident caused by the beyond design basis external hazards.
- Securing alternative electric power sources within 2 hours after SBO.

- (3-1) Securing the availability of a portable electric power generator vehicle and batteries, etc.
  - Equipping with one vehicle-mounted portable emergency power generator and batteries (including charger and cables) per site, and placing them in a safe location away from inundation to cope with the long-term SBO caused by site inundation. Securing temporary connections for portable electrical power sources (all plants)
- (3-2) Upgrading design basis of AAC diesel generator
  - Upgrading the AAC diesel generator's design basis (increasing capacity, diversifying its cooling methods, ensuring one-day fuel storage) (all plants)
- (3-3) Fastening the spare transformers with anchor bolts and modifying the fuel injection ports of emergency power supply systems
  - Fastening spare transformers with anchor bolts to prevent damage and / or floating away of spare transformers owing to a large earthquake or tsunami (all plants)
  - Repositioning the injection port of the fuel storage tank of the emergency power supply system (EPS) to a position higher than the ground surface in Wolsong site, where the injection port was originally installed in a position lower than the ground surface (Wolsong plants)
- (3-4) Improving the management of switchyard facilities
  - Clarifying the responsibility for managing switchyard facilities and establishing the procedure for quick restoration following the loss of offsite power through the cooperation of KEPCO. (all plants)

##### <Cooling Systems >

The nuclear service cooling water system and the spent fuel cooling system are designed for performing sufficient cooling functions in case of a design basis accident. However, four items have been identified to improve for the purpose of achieving the following goals during the event of external hazards beyond design basis accidents

<Goals for improvement>

- The function of the spent fuel pool cooling shall be restored within 4 days upon occurrence of beyond design basis external hazards
- The function of the nuclear service cooling water system (i.e. ultimate heat sink) shall be restored within 2 hours upon occurrence of beyond design basis external hazards

- (3-5) Ensuring countermeasures against loss of the spent fuel pool cooling function
  - Preparing a supplementary method of installing a connection point for supplying water by using a fire vehicle in preparation for loss of cooling pump and heat exchanger (all plants)
- (3-6) Preparing measures of the inundation prevention and restoration of the ultimate heat sink
  - Waterproofing of electrical components such as the motors and power cabinets of nuclear service cooling water (i.e. sea water) pumps to prevent damage from large storms and tsunami (all plants)
  - Securing spare parts for the motor and establishing restoration procedures for loss of function (all plants)

- (3-7) Preparing countermeasures for damage of outdoor tanks
  - Installing wall barriers to cope with potential damage to various cooling water tank and chemical substances tank caused by an earthquake and/or tsunami (all plants)
- (3-8) Preparing countermeasures for inundation of the main steam safety valve room and emergency water pump room
  - Preparing measures for potential inundation of the main steam safety valve room (Wolsong Units #2 to #4) and the emergency water pump room (Wolsong site), which are on the ground level and vulnerable from flooding and external damage (Wolsong site)

**<Fire protection>**

Three measures to be taken for improvement have been identified through SSI for achieving the following goals for protection against a fire outbreak resulting from external hazards exceeding design basis:

<Goals for improvement>  
 - Reinforcing the internal and external firefighting teams and cooperation systems.

- (3-9) Improving the fire protection plan and reinforcing cooperation systems
  - Improving the fire protection plan, (i.e., simplifying the requesting process for the support of external firefighting teams, improving access control, establishing effective cooperation systems during fire mobilization, and measures for large fire, etc.) (all plants).
  - Reinforcing cooperation systems between the internal and external fire stations of the plant, and reinforcing the firefighting capability of the adjacent 119 emergency centers and regional team (all plants).
- (3-10) Improving fire protection facilities and response capability of plant firefighting teams.
  - Securing alternative water sources, capable of having ties with the fire trucks, in preparation for lack of firefighting water sources in a plant due to tsunami (all plants).
  - Maintaining the minimum numbers of experts to operate chemical fire trucks owned by plant firefighting team (All plants).
- (3-11) Introducing a performance-based fire protection design.
  - Improving current fire protection design concept into performance-based design taking into account the plant characteristics for the optimization of fire suppression based on fire frequency and effects (all plants).

**IV.3.4 Countermeasures against severe accidents**

1) Current status

The severe accident prevention and mitigation measures for Korean NPPs have been executed in accordance with the Policy on Severe Accidents enacted in Aug. 2001 by MEST and the NSC. The Policy has contributed to improvements on safety over severe accidents by forcing the utility to perform Probabilistic Safety Assessment (PSA) and to develop Severe Accident Management Guideline (SAMG) for operating plants, which have led to enhancement of the prevention and mitigation capability to severe accidents. In addition, the Policy states the submission of the PSA and SAMG during operational licensing for the plants under construction, 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-type hydrogen removal system (Passive Autocatalytic Recombine) during Continued Operation Permit pursuant to the regulatory requirements. All NPPs (except Ulchin unit #1 / #2 and Wolsong plants) are equipped with the hydrogen monitoring system powered by an AAC diesel generator or batteries.

Table PI0-15. Hydrogen control system in operating plants (As of Jun. 2011)

Kori#1	Kori#2-#4, Yonggwang#1~#4, Ulchin#1-#2	Wolsong#1	Wolsong#2-#4	Yonggwang#5-#6, Ulchin#3-#6
Passive Autocatalytic Recombine (34) for DBA & severe accident	Thermal Recombine for DBA	None	Igniter (44) for severe accidents	- Thermal Recombine for DBA, - Igniter (8~20) for severe accidents

※ Passive Autocatalytic Recombiner (PAR) can be operated without electric power

## 2) Detailed inspection area

The SSI has been performed to check the capability of coping with severe accidents at the NPP's in Korea by assuming the occurrence of a loss of the cooling functions for the reactor due to a combined accident such as the SBO and the loss of ultimate heat sinks. Detailed inspection areas are as follows;

- Adequacy of facilities preventing and mitigating severe accidents
  - Hydrogen control, reactor coolant system depressurization and cooling capability, containment building depressurization capability, etc.
  - Equipment survivability of measuring instruments and devices under severe accident conditions.
- Adequacy of severe accidents strategies and accident management plans
  - Applicability and practicality of the SAMG
  - Management capability for severe accidents
- Adequacy of reactor cooling strategies in the event of SBO
  - Adequacy of strategies for feeding water to steam generators and a reactor core

## 3) Inspection results

It has been verified that facilities against severe accidents have continuously been supplemented at the operating plants as well as the plants under construction according to the Policy on Severe Accidents (Aug. 2001), and the operator's capability of responding to severe accidents has been increased by developing the Severe Accident Management Guidelines (SAMG).

Since an abnormal procedure using the turbine/diesel-driven auxiliary feed water pumps to feed water in to steam generators is provided, the reactor core is supposed to maintain its cooling functions for a certain period of time after an SBO. Electrical power for components and instruments for use during severe accidents can be supplied for more than 2 hours. Current strategies in SAMGs regarding the cooling of the reactor core, hydrogen control, and water spray and ventilation of the containment building were established on the condition that a power source is available. Similar to the Pressurized Water Reactor (PWR), the SAMG for Heavy Water Reactors (CANDU) has also been established on the basis that the power is available.

Some measures to be taken for improvement have been deduced through SSI for guaranteeing an enhanced safety margin even in the worst case of reactor core meltdown caused by combined incidents such as the long-term SBO and the loss of ultimate heat sink.

## 4) Items for improvement

Six measures to be taken have been identified for achieving the following improvement goals upon the severe accidents which can be caused by combined events exceeding the design basis.

<Goals for improvement>

- Preventing severe accidents from external hazards beyond design basis.
- Securing the cooling functions by achieving reactor depressurization and cooling to prevent reactor core melt.
- Securing the instrumentation function for severe accident management.
- Protecting against containment failure and control of radioactive material releases.

- (4-1) Installation of passive hydrogen removal equipment
  - Installation of passive hydrogen removal equipment that can be operated without power supply (all plants except Kori unit #1).
  - Installation of on-line hydrogen monitoring system inside the containment buildings (applied to: Ulchin #1 / #2, Wolsong #1 to #4)
- (4-2) Installation of filtered vent system or depressurizing facilities in the containment buildings.
  - Installing filtered vent or depressurizing facilities to prevent the overpressure of a containment building during severe accidents (all plants).
- (4-3) Installation of reactor injection flow paths for emergency cooling water injection from external sources .
  - Installing primary and secondary injection flow paths in the primary and secondary systems for emergency cooling water injection in preparation for prolonged loss of cooling functions (all plants).
- (4-4) Reinforcing education and training for severe accidents
  - Reinforcing the operator training of SAMGs with tools simulating various severe accident scenarios and phenomena. Extension of the training time from 8 hours per two years to 10 hours per year (all plants).
- (4-5) Revision of the Severe Accident Management Guidelines to enhance effectiveness
  - Assessment of the validity and applicability of In-Vessel Retention / Ex-core Reactor Vessel Cooling strategy with revision of mitigation guidelines if necessary (all plants)
  - Assessment of equipment survivability with consideration of long-term SBO events, and development of procedure to supply power in case of severe accidents. (all plants).
- (4-6) Development of Low-Power Shutdown Severe Accident Management Guidelines
  - Developing the "Low-Power Shutdown Severe Accident Management Guidelines" through assessing low-power shutdown severe accident risks (all plants).

#### **IV.3.5 Emergency Response and Emergency Medical Systems**

##### 1) Current Status

The radioactive emergency response for NPPs is implemented according to the radioactive emergency plan that was prepared and approved based on "The Act on Physical Protection and Radiological Emergency (APPRE)." On-site and off-site emergency response facilities are appropriately located and equipped and operability is checked periodically.

The exercises for checking the effectiveness of the radiation emergency plan and related procedures and for improving the emergency responding capability are performed as follows: the onsite emergency exercise at NPP--once a year; the integrated emergency exercise organized by the local government--once every four years; and the unified emergency exercise organized by the central government--once every five years.

Table PI0-16. Radiological Emergency Exercises in Korea

	Unified Emergency Exercise	Integrated Emergency Exercise	On-site Emergency Exercise	Drill
Organizer	Central government (every 5 years)	Local government (every 4 years per site)	NPP (every year per 2 unit plant)	NPP (every quarter per 2 unit plant)
Range of participation	Nation-wide emergency responding organization	All local Emergency responding organizations	Power plant Emergency organization	Power plant working group

About 400 emergency medical staff and a total of 22 radiological emergency medical institutes, with the Korea Institute of Radiological & Medical Sciences (KIRAMS) as the center, primary medical institutes around NPPs and secondary medical institutes in cities and provinces, are designated and operated for the national radiological emergency medical system. Potassium Iodide for consumption by approx. 120,000 people are kept in the areas adjacent to the NPP's (KHNP and local governments), and the local governments adjacent to NPP's keep approx. 61,700 gas masks.

Table PI0-17. Radiological Emergency Medical Institutes

Division	No. of Institutes	Role
Primary radiological emergency medical institute	9	Initial medical response (classifying injuries and first aid/decontamination)
Secondary radiological emergency medical institute	12	Medical treatment for excessive radiation exposure, burns, and serious trauma
Korea Institute of Radiological & Medical Sciences(KIRAMS)	1	Medical treatment for acute radiation syndrome and internal contaminated person

## 2) Detailed inspection area

The emergency response organization is found well established for each unit of NPPs. However, the followings were investigated for confirming the response capabilities against the worst-case scenario where a radiological emergency occurred simultaneously at multiple units, combined with natural disaster.

- Emergency plan related to emergency action level, procedure and organization
  - Whether the plan adequately secures the criteria and procedure for declaring an emergency, organizing emergency organization, activating emergency organization, and securing the command and control system.
  - Whether the management criteria for emergency recovery workers and the number of radiation protection workers are appropriate.
- Emergency response facilities and equipment
  - Emergency response facilities of the NPP and the local government.
  - Emergency alarm facilities in and outside of the station.
  - Securing the status of protective appliances such as protective clothing and radiation monitors.
- Operating status of systems for protecting residents in case of an emergency
  - SPDS and environmental radiation monitor
  - Cooperation with environmental radiation-monitoring center in case of site area emergency or general emergency.
  - Need for the additional installation of environmental radiation monitors.
  - Information disclosure procedure.
- Emergency medical systems
  - On-site response manual for emergency patients.
  - Contents of training course for emergency personnel and training records, maintenance records for response

- facilities, equipment, goods, and medicine for emergency responses.
- Exercise for confirming emergency response ability
  - Status of conducting exercise such as scenarios and records of exercise

### 3) Inspection results

The criteria and procedures for declaring emergency, emergency organization, and securing the command and control system and functions, duties and activating time of the emergency response organization, etc., are clearly laid out and have been implemented accordingly. Those provisions described in emergency plans, such as the protective measures for residents, sheltering and evacuation of personnel within the power plant, protective measures for thyroid, access control in an emergency, limitation of food intake and agreement with the designated radiation emergency medical treatment hospital, and so on fulfill related criteria. Preparations for prolonged emergency, such as supporting other NPP's headquarters, shift operating plan and manpower support plans have properly been established according to the shift organizing and operating procedure.

Emergency response facilities such as TSC (Technical Support Center), OSC (Operating Support Center), and EOF (Emergency Operation Facility) are secured and managed properly so that they can be activated quickly to respond in case of an emergency. Each emergency operation facility (EOF and the like) is equipped with emergency response equipment and checked periodically.

Major operating variables are provided to related emergency response organizations such as MEST and KINS through the CFMS (Critical Function Monitoring System) and the SPDS (Safety Parameter Display System), which are supplied with electrical power from battery (2-10 hours' capacity) in case of station blackout.

Audible emergency alarms are installed and operated properly for protection of residents living within 2km around each NPP. Communication tools, including a dedicated telephone network and a satellite phone, are equipped for emergency telecommunication with related organizations in and outside of the station

There are contract provisions for emergency maintenance with maintenance workers from KEPCO KPS in case of a radiation emergency. Currently, emergency preparedness education and emergency exercise are conducted for some maintenance workers who have been designated as emergency preparedness personnel.

The ERMS (Environmental Radiation Monitoring System) installed on the shoreline around the NPP contains a battery with a capacity of 4 hours in case of the loss of electrical power.

The primary and secondary emergency medical institutes for each NPP are properly organized and operated.

Local governments around NPP, KIRAMS, and emergency medical institutes have facilities and medicine for radiation-contaminated patients. Regional emergency medical response exercises are conducted every year with the emergency medical institutes of the region as the center, so that proper emergency medical response can be executed in case of a real emergency.

In addition to current radiation emergency plans and the emergency response systems, some areas of improvement have been identified for enhancing current emergency response system to respond effectively to simultaneous emergencies at multiple units, as in the accidents at the nuclear power plants in Fukushima.

### 4) Items for improvement

11 measures to be taken have been identified for achieving the following goals of improvement, even in regard to simultaneous emergency situations at multiple units.

<p>&lt;Goals for improvement&gt;</p> <ul style="list-style-type: none"><li>- Securing emergency response ability in consideration of natural hazards that go beyond the design basis.</li><li>- Maintaining the emergency response function even in the event of a simultaneous emergency at multiple units.</li></ul>
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- (5-1) Securing additional radiation protection equipment for protecting residents near the NPP :
  - Securing additional potassium iodide (KI), an increase from 120,000 portions to 500,000 portions and gas masks from 60,000 EA to 480,000 EA for protecting residents near NPPs in preparation for large accidents (applied to: all NPPs).
  - ※ (Securing basis) Increasing the population basis from residents within 10km around an NPP to population within 16km around an NPP.
- (5-2) Amending the emergency plan to include such events as a simultaneous emergency at multiple units :
  - include emergency response organization that can be implemented at simultaneous natural disaster emergencies at multiple units.
- (5-3) Securing additional protective equipment in preparation for a prolonged emergency
  - Securing additional protection equipment such as protective clothing and gas mask filters at more than 200% of the current inventory and storing them in a secure place that will not flood (applied to: all NPPs).
- (5-4) Securing additional equipment of emergency medical institutes
  - Secure additional emergency medical treatment facilities and medical equipment and designate more emergency medical institutes for quick initial medical treatment in case of radiation emergency.
- (5-5) Reinforcing radiation emergency exercises:
  - Develop a practical scenario including natural disaster, such as earthquake and tsunami, and utilize for emergency exercise and further increasing emergency response capabilities through unannounced blind exercises. (applied to: all NPPs).
- (5-6) Devising a means for securing necessary information in the event that there is a prolonged loss of electrical power.
  - Reinforcing the electrical power equipment of CFMS and SPDS to provide the necessary safety variables of the power plant as needed to protect residents (applied to: all NPPs).
  - Establishing inundation prevention measures for environment monitors near nuclear power plants in case of major tsunami and securing additional emergency electrical power in preparation for prolonged loss of electrical power (applied to: all NPPs).
- (5-7) Securing countermeasures for protecting maintenance workers:
  - amend the emergency plan to include the maintenance workers from KPS in the emergency organization so the workers can attend emergency prepared education and emergency exercises. (applied to: all NPPs).
  - Preparing standardized procedures (deciding on urgent radiation work and approval procedures) so that there is no confusion in protecting the workers who are performing urgent radiation work (applied to: all NPPs).
- (5-8) Improving the emergency response facilities:
  - Improve the seismic capacity of TSC and OSC (applied to: Kori NPP) and anti-inundation ability (applied to: Kori NPP, Yonggwang Units #1, #2) in preparation for tsunami and earthquakes that exceed site elevation.
  - Secure the proper area for TSC and OSC (applied to: Kori NPP, Ulchin Units #1, #2, Wolsong NPP) and emergency electrical power (applied to: all NPPs).
- (5-9) Amending the information disclosure procedure in the event of a radiation emergency:
  - Amend the radiation emergency plan and its related manual (risk response manual) so that concrete information (real-time information disclosure list, radiation contamination, and a guide to protecting residents) and the period of information disclosure provided to the press, people, and residents are included (applied to: all NPPs).
- (5-10) Evaluating protective measures for residents who live beyond the emergency plan zone:
  - Evaluate protective measures for residents, who live outside the emergency plan zone (EPZ), considering the simultaneous emergency at multiple units (applied to: all NPPs).
- (5-11) Reinforcing the performance of emergency alarm facilities
  - Securing emergency electrical power for the alarm facilities that have been installed in order to protect staff and

residents who reside within 2km of the power plant in preparation for natural hazards that go beyond the design basis (applied to: all NPPs).

#### IV.3.6 Long-term in-service plants

##### 1) Current Status

Nine plants with over 20 years of operation period such as Kori Units 1 - 4, Yonggwang Units 1&2, Ulchin Units 1&2 and Wolsong Unit 1 were inspected in this area in terms of confirmation of aging effect. The integrity change due to aging of safety-related piping as well as the reactor vessel has been confirmed through the long-term in-service inspection program. Also, the performance of the active components (pumps and valves) has been confirmed through the in-service test program and plant technical specification. In particular, the in-depth inspection has been additionally performed for the Kori Unit 1, which is the oldest long-term in-service plant in Korea, to check the causes of an unplanned shutdown, human factor management, and activities of quality control and assurance as the significant concerns of the public increased.

##### 2) Detailed inspection area

The following items have been checked for the long-term in-service plants.

- Adequacy of the aging management program.
- Monitoring the aging of the reactor vessel, steam generator, safety-related piping and support, and emergency diesel generator
- Adequacy of in-service management for the active component (pumps and valves)

##### 3) Inspection results

The aging effects of the SSCs under long-term operation are evaluated according to the Enforcement Regulation of the Atomic Energy Act (Details of Periodic Safety Review). The Surveillance Test monitors the radiation embrittlement of the reactor vessel and is conducted appropriately according to MEST Notice No. 2009-37 (Material Surveillance Criteria for Reactor Pressure Vessel, MEST.reactor.014). In-service inspections for reactor vessel welds, upper head penetrations, pressure tubes of heavy water reactors, and the major components and piping systems such as those in the reactor coolant system, etc. are conducted appropriately according to MEST Notice No. 2009-37 (Regulation on In-Service Inspection of Nuclear reactor Facilities, MEST.Reactor.016). Also, the performance tests for the active components (pumps and valves) are conducted appropriately according to the in-service test program and technical specifications established by MEST Notice No. 2009-37 (Regulation on In-Service Test of Safety-related Pumps and Valves, MEST.reactor.033).

The old plants had been designed in accordance with less strict safety criteria than the ones applied to newly constructed plants. The probability of aging of the systems and equipment is also relatively high. This means that the accidents at these plants may lead to the catastrophic situation with relatively high probability. Therefore, some measures to be taken have been identified through SSI to prevent the safety margin reduction and to archive quality improvement of SSCs in the plants.

##### 4) Items for improvement

Ten measures to be taken have been identified for achieving the following goals for enhancing safety and preventing the reduction of the safety margin due to the aging of long-term operating NPPs.

<Goals for improvement>

- Preventing the deterioration of safety margins due to aging.
- Preventing the reactor shutdown by reinforcing the maintenance quality of long-term in-service NPPs.

##### ○ (6-1) Reinforcing regulatory safety inspections

- Establishing and implementing mitigation measures and management plans for aging, and confirming adequacy

- during periodic inspections (Kori #1 to #4, Yonggwang #1 & #2, Ulchin #1 & #2, and Wolsong #1).
- Adding new inspection items such as "monitoring the lifetime of the main components" that are related to the continued operation to the existing periodic inspection items. If necessary, extending the inspection period ( Kori #1).
- (6-2) Reinforcing the in-service inspection of the main components and pipes.
    - Reducing the inspection period of the reactor vessel beltline welds (from 10 years to 5 years) ( Kori #1).
    - Expanding the in-service inspection scope for class-1 piping (from 25% to 50%). ( Kori #1)
  - (6-3) Establishing and implementing an integrated aging management program
    - Establishing and implementing an integrated aging management program including processes of establishment, revision, and implementation (Kori Unit #1).
    - Installing a dedicated organization in charge of the aging management program (Kori Unit #1).
  - (6-4) Reinforcing the management of the performance parameters of the main active components
    - Analyzing the trend of performance parameters of safety-related pumps and valves (Kori #1 & #2, Ulchin #1 & #2, Yonggwang #1 & #2, Wolsong #1 to #4).
  - (6-5) Installing a fatigue monitoring system to reinforce quantitative fatigue management
    - Installing a fatigue monitoring system in long-term in-service plants, and reinforcing quantitative fatigue management (Kori #2, #3, #4, Yonggwang #1 & #2, Ulchin #1 & #2).
  - (6-6) Reinforcing the integrity of the pressurizer lower head.
    - Reinforcing the fatigue integrity of the pressurizer lower head, which is caused by reactor coolant's inflow and outflow (Kori #2, #3, #4, Yonggwang #1 & #2, Ulchin #1 & #2).
  - (6-7) Increasing the reliability of shutdown-inducing equipment.
    - Reflecting past fault experience and the root causes for faults to the preventive maintenance program to increase the reliability of shutdown-inducing equipment (all NPPs).
    - Reinforcing education and training for workers in the service companies and subcontractors to prevent human errors and to secure maintenance service quality, (all NPPs).
  - (6-8) Evaluating the adequacy of human resources
    - Securing proper human resource at site for operation and maintenance (Kori Units #1, #2).
  - (6-9) Increase the reliability of on-site power supply system.
    - Modifying the design of electrical bus system to separate the safety bus from non-safety bus for preventing the interference of non-safe bus.(Kori Unit #1)
  - (6-10) Reinforcing the quality assurance on purchasing components important to safety
    - Reinforcing the quality requirements in the purchase specification is to avoid using defective parts that could induce the reactor shutdown (all plants)

#### **IV.3.7 Research reactor and nuclear fuel cycle facilities**

##### 1) Current Status

The HANARO research reactor consists of a reactor building and stack designed against around an earthquake of 0.2g. A radiological emergency plan has been established, so potential earthquake and emergency responses have been prepared. HANARO is not located in a coastal area, so tsunami damage is not an issue. The radiological emergency plans for nuclear fuel processing facilities were established, and radiological emergency alarm criteria were classified in terms of the event type.

##### 2) Detailed inspection area

The following items have been covered through SSI for the research reactors and the nuclear fuel cycle facilities:

- Adequacy of emergency plan against earthquake, inundation, and fire.
- Adequacy of the emergency plan and related manuals regarding the event of an earthquake.

### 3) Inspection results

The reactor building and stack are seismically designed based on the design earthquake (0.2g), and integrity is secured for the design earthquake. The HANARO reactor building, the IMEF (Irradiated Materials Examination Facility), the PIEF (Post Irradiation Examination Facility), and the nuclear waste processing buildings are confirmed to be maintained properly. The absence of leaks in the HANARO reactor fuel pit, working pit, and spent fuel pool was checked. The firefighting and fire responding systems were assured to be appropriate even in case of a loss of fire extinguishing water supply systems due to an earthquake.

The emergency criteria issuing "White-level" has been established for the HANARO research reactor in case of external hazard (earthquakes, etc.). The number of staff in charge of the emergency preparedness is 4 during normal conditions, but over 200 staffs are designated as working staff in radiological emergency conditions. Thus, the composition of emergency organization and system are appropriate.

The measures to be taken have been identified for an effective response against earthquakes and heavy rain that exceed the design basis for the research reactors and the nuclear fuel cycle facilities that are located inland.

### 4) Items for improvement

Three items for improvement have been identified for achieving the following goals for responding to external hazards that exceed the design basis:

<p>&lt;Goals for improvement&gt;</p> <ul style="list-style-type: none"> <li>- Preventing radiation discharge due to external hazards and fire.</li> <li>- Improving the effectiveness of emergency response.</li> </ul>
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- (7-1) Evaluating the seismic capacity and improving the main control room
  - Evaluating the seismic capacity of the HANARO reactor building and stack for earthquakes beyond design basis.
  - Preventing ceiling and lighting equipment from collapsing, and fixing office appliances to protect the operators in the reactor control room in case of an earthquake.
- (7-2) Re-evaluating the site's inundation depth for HANARO and auxiliary facilities.
  - Estimating the possible maximum rainfall considering the change of rainfall intensity according to recent global climate change and reevaluating the site's inundation depth at HANARO (improving if necessary).
- (7-3) Amending the radiological emergency plan to reflect complicated radiological emergency conditions.
  - Evaluating complicated radiological emergency conditions (simultaneous accidents at multiple facilities and a radioactive materials release) and reflecting these into the radiological emergency plan (HANARO and fuel processing facilities).

## IV.4 Action plan

The government executed first the special safety inspection for the NPPs that are under commercial operation and also for the research reactors and the nuclear fuel cycle facilities after the accidents at the Fukushima plants. The results of the inspection indicate that the NPPs in Korea are safely designed and operated against the worst earthquake and tsunami anticipated in the surveys and the researches to date. However, the government has identified a total of 50 long- and near-term measures to be taken for guaranteeing a cold shutdown of the NPPs even in the worst natural hazards in view of the accident at the Fukushima plants. The execution of measures for improvement was decided on at the 44<sup>th</sup> Nuclear Safety Commission (May 6, 2011). The licensee shall submit the detailed implementation plan regarding the improvements within two months, and the progress report every six months thereafter (See Table PI0-18). The government will review the implementation plan and its result submitted by the licensees, and will verify the adequacy of the execution for improvement through site inspection and validation. The government will also apply the 50 measures for improvement to the NPPs that are currently under construction, and will also confirm the adequacy of the

execution of these items for improvement through review and inspection during the period of licensing.

As the Phase 2, the government will start the measures for enhancing the safety regulation standards and guides for the NPPs that are currently under operation and those under construction in view of the accidents in Fukushima, beginning from Aug. 2011. In parallel, in-depth follow-up review will start in July 2011 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

The action plan in the Phase 3 will review the IAEA inspection results, EU stress test, and those in the U.S. and Japan. It will additionally adopt the measures for improvement identified amongst the international community. Furthermore, the government will continuously identify and apply the items to be improved through the long-term research on severe accidents and active participation in cooperative research programs.

The safety inspection has provided the moment for drastically enhancing the safety of at nuclear facilities in case of combined accidents resulting from natural hazards by identifying items for improvement and performing the appropriate follow-up actions. This has also contributed to the improvement of trust of the general public nationally and abroad by executing the safety-oriented policies for the nuclear plants.

Table PI0-19 shows the comparison between the items for improvement from the SSI of the NPPs in Korea and the nine items suggested by the IAEA IRRS.

Table PI0-18. List of items for improvement of NPPs in Korea from SSI

Item No.	items for improvement	Action <sup>**</sup>
1-1	Installing an automatic seismic trip system	short-term
1-2	Improving the seismic capacity of the safe shutdown system	mid- & long-term
1-3	Investigation and study on the maximum potential earthquake for NPP sites	mid- & long-term
1-4	Improving the seismic capacity of the main control room (i.e., the earthquake occurrence alarm window)	mid- & long-term
1-5	Improving the seismic capacity of the entrance bridge of Wolsong NPP	short-term
2-1	Extension of the height of the sea wall for the Kori site	short-term
2-2	Installation of waterproof gates and discharge pumps	mid- & long-term
2-3	Investigating and research study on the design basis sea water level of NPP sites	mid- & long-term
2-4	Enhancement of sea water intake capability and reinforcement of facilities in preparation for coastal flooding	mid- & long-term
3-1	Securing the availability of a portable electric power generator vehicle and batteries, etc.	mid- & long-term
3-2	Upgrading design basis of AAC diesel generator	mid- & long-term
3-3	Fastening the spare transformers with anchor bolts and modifying the fuel injection port of emergency power supply system	short-term
3-4	Improving the management of switchyard facilities	mid- & long-term
3-5	Ensuring countermeasures against loss of the spent fuel pool cooling function	short-term
3-6	Preparing measures of the inundation prevention and restoration of the ultimate heat sink	mid- & long-term

3-7	Preparing countermeasures for damage of the outdoor tank	mid- & long-term
3-8	Preparing countermeasures for inundation of the main steam safety valve room and the emergency water pump room	mid- & long-term
3-9	Improving the fire protection plan and reinforcing cooperation systems	short-term
3-10	Improving fire protection facilities and response capability of plant firefighting team	mid- & long-term
3-11	Introducing a performance-based fire protection design	short-term
4-1	Installation of passive hydrogen removal equipment	mid- & long-term
4-2	Installation of filtered vent system or depressurizing facilities in the containment buildings.	mid- & long-term
4-3	Installation of reactor injection flow paths for emergency cooling water injection from external sources	mid- & long-term
4-4	Reinforcing education and training for severe accidents	short-term
4-5	Revision of the Severe Accident Management Guidelines to enhance effectiveness	short-term
4-6	Development of Low-Power Shutdown Severe Accident Management Guidelines	short-term
5-1	Securing additional radiation protection equipment for protecting residents near NPP	short-term
5-2	Amending the emergency plan to include such events as a simultaneous emergency at multiple units	short-term
5-3	Securing additional protective equipment in preparation for a prolonged emergency	short-term
5-4	Securing additional equipment of emergency medical institutes	mid- & long-term
5-5	Reinforcing radiological emergency exercises	short-term
5-6	Devising a means of securing the necessary information in case of a prolonged loss of electrical power	mid- & long-term
5-7	Securing countermeasures for protecting maintenance workers	short-term
5-8	Improving the emergency response facilities	mid- & long-term
5-9	Amending the information disclosure procedures in the event of a radiation emergency	short-term
5-10	Evaluating protective measures for residents who live beyond the emergency plan zone	mid- & long-term
5-11	Reinforcing the performance of emergency alarm facilities	mid- & long-term
6-1	Drastically reinforcing the safety inspections, such as regular inspections	short-term
6-2	Reinforcing the in-service inspection of the main components and pipes	short-term
6-3	Establishing and implementing an integrated management method for the aging management program	short-term
6-4	Reinforcing the management of the performance parameter of the main active components	short-term
6-5	Install a fatigue monitoring system to reinforce quantitative fatigue management	mid- & long-term

6-6	Reinforcing the fatigue integrity of the pressurizer lower head	short-term
6-7	Increasing the reliability of shutdown-inducing equipment	short-term
6-8	Evaluating the adequacy of operators	mid- & long-term
6-9	Increasing the reliability of station power supply systems	mid- & long-term
6-10	Reinforcing the quality assurance on purchasing components important to safety	short-term
7-1	Evaluating the seismic capacity and improving the main control room	short-term
7-2	Re-evaluating the site's inundation depth for HANARO and additional facilities	short-term
7-3	Amending the radiological emergency plan to reflect complicated radiological emergency conditions	short-term
<b>Total</b>	<b>50</b>	

※ short-term: to be finished in 2012, mid- & long-term: to be finished in the years 2013-2015

Table PI0-19. Comparison between items for improvement from SSI for Korean NPPs and the 9 items from the IAEA

IAEA 9 items	Items for improvement
1. Nuclear power plant design against external events	<p>(1-1) Installing an automatic seismic trip system</p> <p>(1-2) Improving the seismic capacity of the safe shutdown system</p> <p>(1-3) Investigation and study on the maximum potential earthquake for NPP sites</p> <p>(1-4) Improving the seismic capacity of the main control room (i.e., the earthquake occurrence alarm window)</p> <p>(1-5) Improving the seismic capacity of the entrance bridge of Wolsong nuclear power plant</p> <p>(2-1) Extension of the height of the sea wall for the Kori site</p> <p>(2-2) Installation of waterproof gates and discharge pumps.</p> <p>(2-3) Investigating of NPP sites and study on the design basis sea water level</p> <p>(2-4) Enhancement of sea water intake capability and reinforcement of facilities in preparation for coastal flooding</p> <p>(3-1) Securing the availability of a portable electric power generator vehicle and batteries, etc.</p> <p>(3-2) Upgrading design basis of AAC diesel generator</p> <p>(3-3) Fastening the spare transformers with anchor bolts and modifying the fuel injection port of emergency power supply system</p> <p>(3-4) Improving the management of switchyard facilities</p> <p>(3-6) Preparing measures of the inundation prevention and restoration of the ultimate heat sink</p> <p>(3-7) Preparing countermeasures for damage of the outdoor tank</p> <p>(3-8) Preparing countermeasures for inundation of the main steam safety valve room and the emergency water pump room</p> <p>(3-9) Improving the fire protection plan and reinforcing cooperation systems</p> <p>(3-10) Improving fire protection facilities and response capability of plant firefighting team</p> <p>(3-11) Introducing a performance-based fire protection design.</p>
2. Offsite response to emergency situations (i.e., station blackout)	<p>(5-5) Reinforcing radiological emergency exercises</p> <p>(5-10) Evaluating protective measures for residents who live beyond the emergency plan zone</p> <p>(5-11) Reinforcing the performance of emergency alarm facilities</p>
3. Emergency management and preparedness following worst case accident scenarios	<p>(4-5) Revision of the Severe Accident Management Guidelines to enhance effectiveness</p> <p>(4-6) Development of Low-Power Shutdown Severe Accident Management Guidelines</p> <p>(5-2) Amending the emergency plan to include such events as a simultaneous emergency at multiple units</p> <p>(5-8) Improving the emergency response facilities</p>

4. Safety consideration for the operation of multi-units at the same nuclear power plant site and nuclear power plant design against external events	(3-1) Securing the availability of a portable electric power generator vehicle and batteries, etc. (5-2) Amending the emergency plan to include such events as a simultaneous emergency at multiple units (5-10) Evaluating protective measures for residents who live beyond the emergency plan zone
5. Cooling of spent fuel storage in severe accident scenarios	(3-5) Ensuring countermeasures against loss of the spent fuel pool cooling function
6. Training of nuclear power plant operators for severe accident scenarios	(4-4) Reinforcing education and training for severe accidents (5-5) Reinforcing radiological emergency exercises
7. Radiological monitoring following a nuclear power plant accident involving a radiological release	(5-6) Devising a means of securing the necessary information in case of a prolonged loss of electrical power
8. Public protection emergency actions	(5-1) Securing additional radiation protection equipment for protecting residents near NPP (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 (5-10) Evaluating protective measures for residents who live beyond the emergency plan zone
9. Communications in emergency situations	(5-8) Improving the emergency response facilities (5-9) Amending the information disclosure procedure in the event of a radiation emergency (5-11) Reinforcing the performance of emergency alarm facilities

## V. Lessons learned from the Fukushima Accident

The imperative lessons learned from the emergency responses and SSI of Korean government in response to the accidents of Fukushima is as follows:

- 1) Enhancement of the response capabilities for natural hazards that exceed the design basis.
  - Prevention of power loss caused by inundation.
  - Reassessment of seismic facilities and enhancement of seismic standards.
- 2) Supplement of the strategies for preventing and mitigating severe accidents.
  - Facilities for preventing hydrogen explosions.
  - Reassessment of the guidelines, and enhancement of training for severe accidents.
  - Installation of facilities for filtered vent and depressurization in the containment building.
  - Measures for guaranteeing the flow path of the cooling water in case of long-term SBO.
- 3) Supplement of the capabilities emergency response and emergency medical systems.
  - Ensuring response capabilities for natural hazards that exceed the design basis.
  - Improvement of emergency response facilities (TSC and OSC), and enhancing response exercises.
  - Additional supply of emergency equipment, including that at the emergency medical institutes.
- 4) Information disclosure and enhancement of international cooperation.
  - Improvement of procedures of information disclosure upon radiation emergency.

- Information disclosure and enhancement of cooperation with neighboring countries.
- Improvement of trust of the general public and the risk communication plan.

In reflection of the items for improvement identified in the "National Report of Japan" and the inspection results of IAEA such as 1) improving safety culture and 2) ensuring independence, transparency, and objectiveness of the regulatory body, the Korean government is in the process of establishing the Nuclear Safety Commission under the direct control of the president for ensuring the independence of the regulatory body.

Furthermore, to resolve the concerns of the general public about the potential events and failures at NPP's, the Korean government (MEST) decided to take the following actions by the resolution at the NSC on May 6, 2011.

- To increase the duration of periodic regulatory inspection and increase the number of inspection items to thoroughly deal with the safety concerns related to the continued operation of Kori unit 1.
- To improve the restarting procedures: Permit of reactor restart only after confirmation of safety by the regulatory body in all cases of unexpected reactor shutdown.
- To enhance participation of residents near the site in activities related to the safety of NPPs, and to enhance communications with residents by allowing them to observe regulatory inspections upon receipt of their request.

## **VI. Conclusions and Future Plans**

In Fukushima, severe accidents took place due to natural disasters that exceeded the design basis of the plants involved. These accidents have raised concerns about nuclear safety and radioactive damage amongst citizens in Japan as well as people around the world. In particular, Korea, as a nation neighboring Japan, became very sensitive about radioactive safety. The Korean government made its best efforts to protect its own citizens, by analyzing the severe accidents that took place at the plants in Fukushima, Japan on Mar. 11, 2011, and evaluating the effects of radiation on Korea as a result of these accidents. The government also tried to provide reliable information to the general public through the mass media. In addition, the government positively participated in the international cooperation responding to the accidents in order to contribute to joint international efforts. The Korean government also executed a comprehensive SSI to relieve the general public's concerns about the safety of NPPs in Korea, and to confirm the safety margin at the NPPs against similar accidents.

### 1) Emergency response to the accidents at Fukushima

- (The government's response) MEST and KINS shared information about the accident situations in Japan, the measurement results of the environmental radioactivity throughout the country, the meteorological data (from the Meteorological Agency), and the contamination monitoring results at the airports and the seaports with the competent ministries and institutions on a daily basis. They are committing their best endeavors to protecting the general public and the environment by keeping the emergency response system active. In addition, the government is developing "A Response Manual for Accidents in Neighboring Countries" (to be completed in July 2011) for more effective response to accidents at nuclear facilities in neighboring countries.
- (Environment monitoring) Immediately after the accidents on Mar. 11, 2011, both MEST and KINS operated the Korean emergency response team, and intensified the environmental surveillance program by reducing the monitoring interval of the national automatic radiation monitoring network connecting the 71 locations in Korea and also by increasing the analysis frequencies for radioactivity in the atmosphere, airborne particles, and rainwater. The government is analyzing radioactivity in tap water also, and will establish and operate a permanent monitoring program for marine radioactivity by Aug., 2011. In addition, the government plans to expand the locations for the national automatic monitoring of environmental radiation to 120 for the early detection of radioactivity in the case of the occurrence of nuclear accidents either nationally or abroad.
- (Communication with the general public) The government installed a team for communicating with the general public and the mass media as a systematic and positive response to the increased concerns among the general public about the accidents in Japan and the potential effects from the accidents. The team provided the general public with information regarding occurrence, development and mitigation of the accidents, the situation of the

disaster prevention activities, and the effects of the accidents on Korea.

- (International cooperation) The Korean government convened two conferences of experts from Korea and Japan in Japan, and dispatched experts to the Japan Nuclear Energy Safety Organization (JNES) for grasping the accident situations and for seeking possible cooperation with Japan. In addition, the government participated in the international meetings that were convened after the accidents (MDEP Steering Committee, INRA, INSAG, G20 Nuclear Safety Cabinet Meeting, and IAEA Cabinet Meeting) for active international cooperation. Furthermore, the government tried to seek for opportunities for practical cooperation measures, such as strengthening the functions of the Nuclear Safety Regulatory Manager Meeting (TRM), establishing early emergency notification, system and measures for air current analysis and predictive information sharing at the 4th Summit Meeting of Korea, China, and Japan. The government will further strengthen its international cooperation in consideration of the lessons learned from the accidents of Fukushima.

## 2) Comprehensive SSI of operating nuclear facilities in Korea

- (Inspection scope) The Inspection scope includes 27 items in six areas of earthquake/tsunami, power/cooling system, severe accident, emergency response, long-term in-service plants, and the research reactor/nuclear fuel cycle facilities. Experts from industry, academia, research institutions, and KINS participated in the inspection.
- (Inspection results) The SSI of the nuclear facilities indicates that the NPPs in Korea are safely designed and operated in preparation against the worst earthquake and tsunami predicted in the surveys and research as so far. In the meantime, the government identified 50 near- and long-term actions and measures to be taken for enhancing nuclear safety, and the government plans to implement these items for improvement in the next five years.

The prompt response to the accidents in Fukushima and the SSI of the nuclear facilities in Korea were successful in relieving the general public's concerns about the safety of nuclear facilities, and in enhancing perceptions of reliability in the international community. Although the necessity for the further review of the policy for nuclear power in Korea has been raised by some people after the accidents in Fukushima, there is no official change yet in the national policy that NPPs will be operated continuously with considerably enhanced nuclear safety.

The government plans to enhance the safety of the NPPs in operation, as well as under construction, based on the results of the SSI of the NPPs in Korea and the action plans. The government will initiate measures for improving the safety regulation standards and guides for the NPPs that are currently under operation and those under construction from Aug. 2011. In parallel, in-depth follow-up review will start in Jul. 2011 through a research project to feedback the lessons from the accidents in the Fukushima plants.

The government will also continuously cooperate with international communities and other countries for applying the lessons from the accidents that took place in Fukushima. In particular, the government will make continued efforts to reflect the recommendations from international communities and other countries' inspection results and implement experience into the NPPs in Korea.