Convention on Nuclear Safety
National Report of Japan
for the Second Extraordinary Meeting

July 2012

Government of Japan

Convention on Nuclear Safety
National Report of Japan for the Second Extraordinary Meeting

Contents

A Introduction

A1 Outline of Japan's Efforts After the Accident

The 2011 off the Pacific coast of Tohoku Earthquake occurred on March 11, 2011 (hereinafter referred to as "the earthquake on March 11") and the resulting tsunami (hereinafter referred to as "the tsunami on March 11") hit flaws in measures for nuclear safety in Japan, causing the loss of total AC power sources at Units 1 to 4 of the Fukushima Dai-ichi Nuclear Power Station (NPS) of Tokyo Electric Power Co. (TEPCO) (hereinafter referred to as "Fukushima Dai-ichi NPS"), leading to core melts at Units 1 to 3 and the large release of radioactive materials to the environment.

The units of Fukushima Dai-ichi NPS were stabilized at temperatures below 100C° and reached a condition equivalent to cold shutdown by December 2011, with a stable supply of cooling water and a significant reduction of radioactive releases to the environment. However, many systems are still temporary and their reliability needs to be improved. In addition, there remains a large amount of contaminated water and radioactive waste, along with many issues to be tackled with, including fuel removal, in implementing the decommissioning tasks smoothly. Decommissioning will take several decades and efforts using the latest knowledge should be made. Even now, a considerable number of evacuees are not able to return home. The government is doing its utmost.

Reflecting that we were unable to prevent such a serious outcome, we are working through bringing a resolution to the situation. It is our responsibility to gain lessons to the maximum extent possible. We would like to express our sincerest gratitude for all the help and support that have been extended to us from various nations and international organizations after the accident.

The investigations of the accident have been under way by an " Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company" (hereinafter referred to as "the government Investigation Committee"). The interim report was issued in December 2011.

The Nuclear and Industrial Safety Agency (NISA), as the nuclear safety regulatory organization, reflects on the failure to prevent common cause failures due to the tsunami, leading to the loss of total power supply, and a further critical situation, together with insufficient protection against severe accidents. Determining that the lessons learned from the accident should contribute to nuclear safety from now, NISA has compiled technical knowledge so far available along the accident sequence from its occurrence through various phases. On March 28, 2012, NISA developed 30 safety measures that should be reflected into the future regulations. (Reference A-1)

It is considered that these efforts helped clarification of the causes and progress of the accident. Verification of the cause and characteristics of the accident has been under way by the National Diet of Japan's Fukushima Nuclear Accident Independent Investigation Commission (hereinafter referred to as the "National Diet Investigation Commission") and other organizations at the time of preparation of this report. These activities will provide new findings in the future. The more detailed investigations on the status of the damaged reactor cores as well as structures, systems and components, which are difficult to access for direct examination due to high radiation doses, will be started, making use of knowledge

accumulated both domestically and internationally.

Given the number of nuclear power stations sited in Japan, it is necessary to confirm their safety immediately. Therefore, based on the safety issues that were gradually identified regarding the accident, NISA directed the operators of the other nuclear power stations to take various safety measures.

First, on March 30, 201, NISA directed the operators to take measures against flooding and to deploy power supply vehicles and an alternate water injection system to help safety emergency actions that allow stable cooling of the core and others even if a tsunami equivalent to that which hit Fukushima Dai-ichi NPS strikes the plant and triggers a station blackout and a loss of the ultimate heat sink function. On May 6, 2011, NISA confirmed the implementation of these precautions. (Reference A-2)

Second, NISA issued directives in July 2011 to conduct the comprehensive safety assessments, so-called stress tests, on all Japan's nuclear power plants. The assessments consist of two steps.

The primary assessment focused on the nuclear power plants which are under their planned periodic inspections and ready to restart, judges whether the restart of the plants is allowable. It evaluates to what extent the plants can withstand a beyond-design-basis earthquake or tsunami without causing core damage.

The secondary assessment takes into account the implementation status of the stress tests in Europe and examination by the government Investigation Committee, covering all the nuclear power plants including those in operation and those evaluated in the primary assessment. The comprehensive safety assessment is carried out to determine the limit of functionality of radioactive material confinement in the case of core damage, as well as to identify any vulnerability of the entire facility to make continuous improvement, with an aim of judging the continued operation of the plants. (Reference A-3)

The stress test processes were reviewed by the IAEA mission team consisting of international experts in January 2012. (Reference A-4)

The stress tests on the nuclear fuel cycle facilities will be evaluated in the future.

Reflecting the failure to prevent the accident at Fukushima Dai-ichi NPS (hereinafter referred to as the "Fukushima Dai-ichi accident"), Japan is now in the process of reforming its nuclear safety regulations. Among others, preparation is under way to establish a new regulatory organization responsible for nuclear safety for the purpose of separating nuclear regulation and promotion and integrating the related administrative activities. Examinations had been continuously made at the Advisory Committee for Prevention of Nuclear Accidents by experts in order to also respond to the lessons learned from the Fukushima Dai-ichi accident and the recommendations and suggestions of the Integrated Regulatory Review Service (IRRS) of the IAEA conducted in 2007, and the relevant bill was submitted to the Diet. After discussions between the government and opposition parties, in order to create further independent nuclear regulation authority, a new bill was submitted to the Diet and passed on 20th June. The Act was promulgated on 27th June. At the same time, focus will be placed on reforming the safety regulation system including legislation of severe accident measures and the introduction of a backfitting program. Together with this reform, various types of engineering review will be conducted to organizationally make use of the findings obtained

from the review results in a new system, with the aim of continuously enhancing nuclear safety.

In the nuclear emergency preparedness and response area, the introduction of the Precautionary Action Zone (PAZ) and strengthening of the risk management system will be undertaken.

In recognition that it is our responsibility to provide the international community with accurate information regarding the accident, we have provided national governments and international organizations with accident information and received various IAEA mission teams. In particular, we developed and submitted two reports in June and September 2011 to the IAEA, explaining the accident sequence identified up to that time, actions taken to deal with the Fukushima Dai-ichi accident and those affected, and lessons learned from the accident. Since then, we have disseminated additional information on the accident on various occasions including the IAEA International Experts' Meeting held in March 2012. This report explains the actions taken after the accident and is also placed as a part of providing information under the framework of the Convention on Nuclear Safety. We hope this will contribute to enhance nuclear safety all over the world.

We will continuously commit ourselves to deal with the accident and proceeding with investigation and verification of the accident, and will release additional information and the results of analysis on the accident to the world, preparing for "the Fukushima Ministerial Conference on Nuclear Safety" scheduled for December 2012 in Japan.

The major factor that aggravated the accident is that the people involved in nuclear power generation in Japan had not seriously addressed the latest knowledge about tsunami and international standards and best practices for nuclear safety including severe accident measures, and adequate preparation has not been made in the aspects of the systems, organizations, human resources, equipment and operation. We will definitely correct these flaws through the actions mentioned above. In addition, people in all levels involved in nuclear power generation will maintain and improve their technical skills, while maintaining close relations with the international community, and continue to review and enhance nuclear safety to regain trust at home and abroad.

A2 Purpose and Structure of the Report

This report describes the activities taken in Japan after the Fukushima Dai-ichi accident including the review and measures mentioned above for the purpose of peer review by the Contracting Parties at the Second Extraordinary Meeting of the Convention on Nuclear Safety scheduled for August 2012. According to the guidelines for the National Reports, the actions taken by the regulator and operators by the end of June of 2012 in response to the accident were explained in the sections of Chapter B (B-1 to B-6) including the information contained in the above-mentioned reports based on the following six topics:

- External events
- Design issues
- Severe accident management and restoration (on-site)
- National organizations
- Emergency preparedness, emergency response and post-accident management

(off-site)

- International cooperation

This report was compiled by NISA in cooperation with the government organizations including the Cabinet Secretariat (the Task Force for the Reform of Nuclear Safety Regulations and Organizations), the Cabinet Office (the Nuclear Safety Commission and the Nuclear Damage Liability Facilitation Fund Section), the Ministry of Foreign Affairs, the Ministry of Education, Culture, Sports, Science and Technology, the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, the Ministry of the Environment and the Team in Charge of Assisting the Lives of Disaster Victims of Nuclear Emergency Response Headquarters, as well as the Federation of Electric Power Companies and the Japan Nuclear Energy Safety Organization.

B Report on Individual Topics

B1 External Events

B1.1 Topic Analysis

The earthquake and tsunami on March 11 significantly affected many nuclear power plants. Among others, at Fukushima Dai-ichi NPS, the measured seismic ground motion exceeded the design-basis standard seismic ground motion Ss, causing damage to switching yard equipment and the destruction of a pylon due to the collapse of an embankment, which led to a station blackout.

Because the tsunami significantly exceeded the previously estimated height and insufficient protective measures against a beyond-design-basis massive tsunami were in place, total AC power supplies including emergency power supply systems and sea water pumps at Units 1 to 4 were flooded over a wide range and damaged, causing loss of the ultimate heat sink and cooling functions, resulting in a serious accident that ended up with core melts at Units 1 to 3 and a large release of radioactive material.

(Table B1.1) Comparison of the maximum response acceleration observed on the lowest basement of reactor buildings of each unit and the maximum response acceleration calculated from the basic design ground motion Ss

Observation Point (the lowest basement of reactor buildings)		Observed Data Maximum Response Acceleration (gal)			Maximum Response Acceleration Against Basic Earthquake Ground Motion (gal)		
		NS direction	EW direction	UD direction	NS direction	EW direction	UD direction
Fukushima Dai-ichi NPS	Unit 1	460*	447*	258*	487	489	412
	Unit 2	348*	550*	302*	441	438	420
	Unit 3	322*	507*	231*	449	441	429
	Unit 4	281*	319*	200*	447	445	422
	Unit 5	311*	548*	256*	452	452	427
	Unit 6	298*	444*	244	445	448	415
Fukushima Dai-ni NPS	Unit 1	254	230*	305	434	434	512
	Unit 2	243	196*	232*	428	429	504
	Unit 3	277*	216*	208*	428	430	504
	Unit 4	210*	205*	288*	415	415	504

*Recording was interrupted approximately 130-150 seconds after recording started.

In order to analyze the factors that led to the inappropriate estimates of earthquake and tsunami and possible effects of a beyond-design-basis earthquake and tsunami on facilities, along with the Headquarters for Earthquake Research Promotion (ERPHQ) and the Nuclear Safety Commission (NSC), NISA has investigated the events while receiving review by outside experts at the public meeting. The findings on the earthquake on March 11 obtained so far indicated that a fault slip occurred that was larger than the conventional estimate of a trench type earthquake; a strong seismic ground motion occurred due to a combination of movements of the seismic segments in a wide range of areas; and a huge crustal seismic deformation that impacted an extended area of stress fields occurred, which induce further activity.

For the tsunami on March 11, it has been identified that a combination of a long-period wave generated by the oceanic interpolate earthquake with a short-period and great

amplitude tsunami generated along the trench axis further increased the height of the tsunami.

Based on these new findings on the earthquake and tsunami, the NSC reviewed the Regulatory Guide for Reviewing the Seismic Design of Nuclear Power Reactor Facilities (hereinafter referred to as “Regulatory Guide for Reviewing Seismic Design”) and developed a draft revision. At the same time, NISA is examining approaches to the seismic safety evaluation and tsunami evaluation methods. If additional findings are obtained by investigation, they will immediately be incorporated into NISA’s seismic safety evaluation of nuclear facilities or the evaluation of tsunami effects on them, while paying attention to research and study activities by related organizations.

B1.2 Activities by Operators for External Events

The Japan Society of Civil Engineers issued the “Tsunami Assessment Method for Nuclear Power Plants in Japan” in February 2002 as means to calculate tsunami heights. Japanese electric utilities determined to apply this to tsunami assessment and reconsidered their tsunami estimates. For example, TEPCO changed the estimated tsunami height at Fukushima Dai-ichi NPS from 3.1 m to 5.7 m (the maximum height at Unit 6). TEPCO made equipment arrangements based on the revised tsunami estimates using the Tsunami Assessment Method, but the tsunami on March 11 considerably exceeded them. TEPCO performed trial calculations in the light of the views of the Headquarters for Earthquake Research Promotion (ERPHQ) publicized in 2002, which pointed out that “there is a possibility that an earthquake of about M8.2 could occur at anywhere along the trenches from Sanriku to Boso.” Considering that this lacked in specific evidence, TEPCO took it as a future research subject.

For the Jogan tsunami that hit the coastal areas of Tohoku in 869, TEPCO conducted trial calculations using the wave source model proposed by Satake, et al (2008). TEPCO investigated the tsunami deposits but did not complete development of the wave source model. In addition to these activities, TEPCO asked experts at the Japan Society of Civil Engineers to deliberate the views of the Headquarters for Earthquake Research Promotion (ERPHQ) as well as the Jogan tsunami. Besides, TEPCO said that they explained to NISA about the result of the trial calculation of Jogan tsunami using the wave source model proposed by Satake, et al. (2008) in September 2009. In addition, they said that on March 7, 2011, they had made presentation to NISA on another “trial calculation based on a wave source model along the trench of Fukushima”. The former and the latter calculation results showed that tsunami about 8-9 m high and more than 10 m high could be generated, respectively. TEPCO considered the estimated tsunami heights were obtained under hypothetical conditions, and that they would not actually occur. TEPCO did not take any measures despite these results.

After the accident, the operators assessed the effects of the earthquake and tsunami on March 11 on facilities at Fukushima Dai-ichi and Dai-ni NPSs and Onagawa NPS of Tohoku Electric Power Co. (hereinafter referred to as “Onagawa NPS”) and Tokai Dai-ni NPS of the Japan Atomic Power Company (hereinafter referred to as “Tokai Dai-ni NPS”) in accordance with NISA’s directive. In addition, in response to the government-ordered stress tests, they are evaluating whether the important safety facilities and components have sufficient safety margins against a beyond-design-basis earthquake, tsunami and others, and what extent the safety margins were increased owing to the emergency safety measures undertaken so far.

B1.3 Activities by the Regulator for External Events

B1.3.1 Activities before the Earthquake and Tsunami on March 11

In September 2006, the NSC revised the Regulatory Guide for Reviewing Seismic Design, incorporating the latest scientific technical knowledge about the seismology and seismic technology at the time and improvements and advancement of seismic design technology. The revised guide focused on enhancing the methods to develop geological surveys and standard seismic ground motion studies and a review of seismic classification. NISA directed the operators on September 19, 2006 to assess the seismic safety of the existing nuclear power plants in the light of the revised this Regulatory Guide (the seismic backcheck) and report the results to NISA. Later, the seismic ground motion exceeding the standard seismic ground motion was observed at Kashiwazaki-kariwa NPS of TEPCO during the Niigataken Chuetsu-oki Earthquake in 2007. NISA issued additional directives to the operators to implement assessment taking into account the knowledge obtained from the earthquake. As it was expected to take time for the seismic backcheck that would involve geological investigation, NISA allowed the operators to carry out a review of the standard seismic ground motion and important buildings and components ahead of other reviews as an interim evaluation, if the work for the seismic backcheck was estimated to be time consuming. The tsunami assessment was accepted to be included in the final evaluation, which meant the tsunami assessment got left behind. The interim report, which touched upon Fukushima Dai-ichi NPS, was submitted before March 11. However, the final report including the tsunami assessment had not been submitted by that day.

Many nuclear plants did not complete their seismic backchecks at this time.

B1.3.2 Evaluation of the Earthquake and Tsunami on Nuclear Power Plants taking into account Knowledge of the 2011 off the Pacific coast of Tohoku Earthquake

In the accident, the beyond-design-basis earthquake and tsunami caused simultaneous loss of total AC power and DC power for a prolonged time and loss of cooling functions of the reactors, resulting in a serious situation that led to damage of the cores and the release of a massive amount of radioactive materials into the environment. The NSC reconsidered the Regulatory Guide for Reviewing Seismic Design, and proposed their amendment proposals to this Regulatory Guide in March 2012. In the proposed amendment, the measures against tsunami, which were traditionally treated as measures against an event accompanied with an earthquake, are addressed as an independent topic and provisions necessary for tsunami assessment are established. (Reference B1.3.2-1)

NISA thoroughly analyzed the earthquake and tsunami on March 11 and conducted a study and review to reflect the findings into the safety regulations on nuclear power plants, while holding public advisory meetings with external experts and seeking their views. NISA developed an interim report in February 2012, based on the following review results, emphasizing the need to individually incorporate them into the seismic backcheck (Reference B1.3.2-2):

(1) In the assessment of seismic ground motion of a trench type earthquake, the factors with their maximum level (specification of fault slip and asperity - an area with faults firmly stuck and generates stronger seismic wave than the surrounding areas) should be reviewed in considering uncertainty. In addition, the directivity effect (the amplitude

of seismic waves in the direction of rupture propagation becomes stronger) should be also considered;

(2) The interaction of a fault 5 km or more away from other faults was denied empirically, but it should be re-examined, considering the stress conditions and uncertainty;

(3) Specific evaluation and utilization methods for approaches to evaluation of the estimated tsunami height need to be further examined and reviewed; and

(4) In the wave power evaluation, the design assumption of the pressure with three times as high as hydrostatic pressure is basically conservative; however, it may lead to underestimation depending on the conditions of coastal topography, and therefore individual evaluation is necessary.

NISA continues its investigation and aims at incorporating newly acquired results into the future seismic backchecks and safety reviews.

B1.3.3 Restart of Seismic Backcheck Based on Knowledge of the 2011 off the Pacific coast of Tohoku Earthquake

The NSC required NISA to investigate the following issues in the light of findings obtained from observatory records of the earthquake on March 11, its aftershocks and relatively big earthquakes triggered by them, as well as the seismic activities that have more actively occurred in the areas which had been conventionally seen as almost inactive places such as Tohoku and Kanto areas, which were thought to be induced by the earthquake on March 11 and the generation of normal fault earthquakes such as the one occurrence at Hamadori, Fukushima on April 11, 2011:

- In the wake of the earthquake on March 11, great crustal movements were observed and a broad range of the stress fields were affected. Based on these conditions, it should be investigated if the fault, displaced terrain, lineament and others that each licensee has already studied could correspond to a fault necessary to be considered in seismic design.
- In the wake of the earthquake on March 11, if any earthquake occurred at the place where seismic activities was low in the past, or around the non-capable faults that have not been thought necessary to consider in seismic design in the vicinity of the site, the seismic assessment of the earthquake should be conducted.
- Based on these investigations, if there is any faults that could affect the site, seismic ground motion assessment should be conducted.

Along with the review mentioned in B1.3.2, NISA determined to restart the seismic backcheck at the end of October 2011, taking into account the knowledge including the interaction of hypocenters, the effect of the combination of a tsunami triggered by an interpolate earthquake and a tsunami around the trench axis on the tsunami height and reactivation of a fault that had not been deemed active. On November 11, 2011, NISA directed the operators to conduct evaluation in the light of the knowledge obtained from the earthquake and tsunami on March 11, in addition to the issues left pending in the past seismic backcheck.

NISA also directed them to identify the capable faults requiring investigation from the viewpoint of a possible interaction and report the results to NISA on January 27, 2012. In response to the reports submitted by most of the operators following this directive by February 29, 2012, NISA issued “Advisers’ comments and NISA’s view against operators’ report regarding the Interaction of capable faults around sites of NPSs” on March 28, 2012, and

determined to further investigate the interaction of active faults. For the criteria on tsunami safety evaluation, specific review on the evaluation methods that will form bases of evaluation is also under way. The Central Disaster Prevention Council estimated Tonankai and Nankai earthquakes to be a maximum strength of M9.0 to 9.1 and massive tsunami accompanying them. Based on these estimates, future backchecks should consider interpolate earthquakes and tsunami.

B1.3.4 Interim Report on Evaluation and Impact on Reactor Buildings, etc. of TEPCO's Fukushima Dai-ichi and Fukushima Dai-ni NPSs

NISA evaluated whether the significant seismic safety facilities and components at Fukushima Dai-ichi and Fukushima Dai-ni NPSs were in a condition to maintain their safety functions during and just after the earthquake on March 11 and the current seismic resistance performance of the reactor buildings of Fukushima Dai-ichi NPS. After holding public meetings to hear the views from external experts and receiving their review, NISA released the interim report in February 2012. (Reference B1.3.4)

For the safety functions during and just after the earthquake on March 11, calculation results of the main seven components - (1) insertion performance of control rods, (2) core support structures, (3) residual heat removal system pump, (4) residual heat removal system piping, (5) reactor pressure vessel, (6) main steam system piping, and (7) reactor containment – to evaluate possible effects of the accident, were below the acceptable seismic criteria. Therefore, it was considered that they were in a condition that could maintain their safety functions during and just after the earthquake.

To evaluate important seismic components and piping (Seismic Class S) other than the seven main components, Unit 5 of Fukushima Dai-ichi NPS was selected because it had experienced beyond the design basis seismic ground motion. As a result, except some piping and piping supports, the calculation results of the Seismic Class S components and piping satisfied the acceptable criteria. It was considered that they were in a condition that could maintain their safety functions during and just after the earthquake. According to the field investigation conducted on the piping and piping supports that exceeded the acceptable criteria, no significant damage was found out. It was estimated that they had been in a condition that could keep their safety functions after the earthquake. From now, detailed analysis on seismically important components other than the seven main components in the other units will be undertaken.

On the other hand, it is necessary to ensure that all units of Fukushima Dai-ichi NPS still maintain their seismic resistance capability under the current conditions (with the building walls collapsed because of hydrogen explosions, etc.). According to the seismic evaluation conducted on the reactor buildings based on the current damage conditions, it was considered that an earthquake that might occur in the future would not destroy the seismic walls nor would lead to ripple effects on the significant seismic safety systems. In addition, detailed local evaluations using a 3D analysis method were performed on Units 3 and 4 of Fukushima Dai-ichi NPS, the upper structures of whose buildings were damaged in a complicated ways, particularly focusing on the spent fuel pools. It was confirmed that they have seismic margins against the seismic ground motion for the seismic evaluation, even if the rigidity of floors and walls is decreased due to explosion, fire and a temperature increase in the pool water. Reinforcement of the bottom of the spent fuel pool at Unit 4 of Fukushima Dai-ichi NPS was completed, which was confirmed effective. Walkdown in Unit 4 was

conducted, since its contamination level was lower than that of Units 1 to 3 of Fukushima Dai-ichi NPS. The inspection confirmed that leaks from the pool or major damage of fuel and fuel racks in the pool were not observed and the surface of the pool water was parallel to the base of the building. Walkdown in the Unit 4 pool are being regularly conducted now.

B1.3.5 Impact of Aging Degradation Caused by the Accident at TEPCO's Fukushima Dai-ichi NPS

NISA evaluated the potential effects of aged equipment on the outbreak or expansion of the Fukushima Dai-ichi accident. As a result, in February 2012, NISA concluded that the effects including low cycle fatigue due to seismic ground motion were within acceptable limits, and that it was highly unlikely that aging degradation had incurred loss of equipment functions including the seismic safety significant equipment in the wake of the seismic ground motion and caused the outbreak and expansion of the Fukushima Dai-ichi accident.

However, this conclusion was a result of the analysis using a past technical evaluation on aging, because field investigation is still difficult under the current conditions. If new findings are available in the future through field confirmation or other means, additional examination will be conducted.

B1.3.6 Emergency Safety Measures in Response to the Accident at TEPCO's Fukushima Dai-ichi NPS and Safety Measures Based on Technical knowledge of the Accident

NISA directed the operators of the emergency safety measures on March 30, 2011 to prevent the occurrence of serious conditions such as core damage and to attain cold shutdown if an earthquake and tsunami equivalent to that of March 11 generates and triggers loss of the total AC power supply and ultimate heat sink function.

NISA demanded that operators deploy power supply vehicles and pumps for alternate water injection, to take measures against inundation for buildings to cope with tsunami equivalent to the one that hit Fukushima Dai-ichi NPS and to develop procedures for short-term measures, and to take protective measures such as full-fledged watertight arrangements for equipment and construction of seawalls for mid- and long-term measures. After receiving the reports from the operators on implementation of these measures, NISA evaluated and verified them in May 2011. Implementation of the mid- and long-term measures will be continuously reviewed strictly. (Reference A-2)

Regarding the technical knowledge (review results will be mentioned later) of the Fukushima Dai-ichi accident, it was estimated, based on the evaluation of the plant parameters showing the operating status of cooling function, that the significant safety equipment had been generally in a condition that can maintain its safety function just after the outbreak of the earthquake till the tsunami attack, though it is uncertain at present whether it was damaged due to the earthquake and caused minor leaks or not. In addition, based on the facts that were identified at the moment in relation to the outbreak and development of the accident, NISA established "30 safety measures" which were considered necessary to be reflected into the future regulations. In response to the accident in which the submerged station electric systems and cooling systems lost their functions, in "30 safety measures", the need to take actions such as installation of the station electric systems and cooling systems in different locations, inundation protection and reinforcement of the ultimate heat sink in the case of accident is emphasized. (Reference A-1)

B1.3.7 Comprehensive Assessments for Safety of Existing Power Reactor Facilities

From the experience of the Fukushima Dai-ichi accident, the NSC considered it would be important to conduct comprehensive assessments on the robustness of the existing power reactor facilities against the beyond-design-basis external events. On July 6, 2011, the Commission released the report “Regarding the Implementation of the Comprehensive Assessment for the Safety of Existing Nuclear Power Reactor Facilities Taking into Account the Accident at the Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co., Inc.,” and asked NISA to undertake the comprehensive assessment on safety of power reactor facilities. (Reference B.1.3.7-1)

At nuclear power plants in Japan, actions such as the emergency safety measures mentioned above are being carried out, so as to enable nuclear power plants to reach cold shutdown without the risk of the situation deteriorating into a more serious condition even if an earthquake and tsunami equivalent to those of March 11 should occur. The implementation of these measures has been verified by NISA. On the other hand, as for the restart of nuclear power plants after periodic inspection, verification of safety by NISA did not appear to be well understood by the public, including local residents. Therefore, in July 2011, the government at the ministerial level decided to undertake the stress tests based on those conducted in European countries as a means for safety evaluation, using new procedures and rules with the aim of further improving safety of nuclear power plants and securing the peace of mind and trust of the public. (Reference B.1.3.7-2)

According to the decision, the stress tests on nuclear power plants are a two-step assessment. The primary assessment is to determine the acceptability of the restart of a nuclear power plant that has stopped operation for a periodic inspection. On July 21, 2011, NISA released a evaluation methodology of the two-step stress tests and their implementation plan and, with verification of the NSC, directed the operators to conduct the tests on July 22, 2011. (Reference A-3)

The primary assessment “will evaluate the degree to which safety margins are secured for the significant safety structures, systems and components against the beyond-the-design basis events. The assessment will be implemented from the perspective of the degree to which safety margins are secured against the allowable limit and other related value. The assessment will also indicate the effectiveness of the measures taken to secure safety against the beyond-the-design basis events from the defense-in-depth perspective. These processes will confirm whether a certain level of higher safety margins has been added to the required safety standards.” NISA received reports on the result of the primary assessment from 22 plants as of June 30, 2012, including Units 3 and 4 of Ohi NPS and Unit 3 of Ikata NPS, on which NISA has completed its evaluation. The NSC validated the NISA’s evaluation on Units 3 and 4 of Ohi NPS and compiled its views. (References B.1.3.7-3 and 4)

In the secondary assessment “the safety margin (bearing ability) will be assessed by evaluating the intensity of an event that a nuclear power plant can withstand without facing a risk of significant fuel damage in the case of beyond-the-design basis events. Additionally, the effectiveness of the measures to prevent significant fuel damage will be indicated from the defense-in-depth perspective. At the same time, a cliff-edge effect will be identified to find out potential vulnerabilities. These processes will yield a comprehensive assessment of the robustness of existing power reactor facilities against beyond-the-design basis external events”.

In January 2012, the IAEA review mission team reviewed NISA's directives and review process for the stress tests, and concluded that they were generally consistent with the IAEA safety standards. The IAEA team also identified the issues that would enhance overall effectiveness of the stress test process including the secondary assessment and other regulatory activities and made the recommendations. Regarding seismicity in particular, the IAEA team recommended to "ensuring that the seismic safety margin assessment includes system walkdowns for checking the completeness of the basic safety-function success path and the seismic/flood capability walkdowns for the identification of interactions and collecting as-built and as-operated information to be used in safety margin calculations." (Reference A-4)

NISA takes the IAEA recommendations including seismic issues seriously and will start to implement them from whatever possible.

B2 Design Issues

B2.1 Topic Analysis

The reason why this accident escalated was that the sea water pumps and electric systems were extensively inundated and damaged by the tsunami as a common cause, which led to the loss of total AC power supply, and as a result, safety functions including cooling function were lost. However, it must be said that the significant problems that caused these situations were the absence of the regulatory requirements for design to assume and prevent such situations or to limit further progress of the accident and sufficient voluntary efforts of the operators. At present, a large number of systems and components are difficult to inspect on site and the situation of the melted and dropped down cores cannot be directly inspected because Units 1 to 4 of Fukushima Dai-ichi NPS are still contaminated with radioactive materials, and these restrictions have obstructed progress of elucidation of the event. Under such circumstances, NISA has developed 30 items in the 5 fields, which include the measures to ensure the external power supply, the measures to ensure the on-site electric equipment, the measures to ensure the cooling and water injection systems, the measures to prevent containment damage and hydrogen explosion and the measures to ensure instrumentation and control systems, for the purpose of reflecting them in the future regulations, based on the fact-finding to date, such as plant parameters after the earthquake, and the technical knowledge extracted from the external experts' opinions about what type of events had actually occurred, which have been presented at the public advisory meeting.

B2.1.1 Impact on Safety Functions Caused by the Earthquake

The external power supply to Fukushima Dai-ichi NPS was disrupted by the earthquake on March 11. However, on-site emergency power supply and cooling systems actuated immediately after the earthquake, and the functions of "stop," "cool" and "contain" are assumed to have worked successfully because it is judged unlikely that damage to impair the basic safety functions had occurred according to the data showing the plant behavior immediately after the earthquake.

As is stated in B1.3.4, the results of the seismic response analysis based on the observation records of the earthquake satisfied the acceptable criteria as far as the major systems with the safety significant functions are concerned. As a result of internal investigation carried out in Unit 5, as the representative unit, no crack that might affect the structure of the building or deformation of the component and piping was observed. Although it cannot be confirmed if there is damage such as very small leaks concerning Units 1-4, the major systems with the safety significant functions are considered to be basically able to maintain their required safety functions even after the earthquake. No particular objection has been made at the government Investigation Committee and the Independent Investigation Commission on the Fukushima Dai-ichi accident that carried out independent investigation of the accident.

B2.1.2 Loss of Safety Functions due to Tsunami as Common Cause Failure

On the other hand, all the sea water cooling pumps installed on the seaward side of TEPCO's Fukushima Dai-ichi NPS and most of the emergency diesel generators, switchgears and batteries installed on the basement floors of the turbine buildings near the sea were simultaneously flooded or inundated and lost their functions due to flooding of the buildings by

the subsequent strike of the gigantic tsunami. The emergency diesel generator of Unit 6 is an air-cooled type, and the switch gear was not submerged. Therefore, power supply for Units 5 and 6 were secured by electricity accommodation. Loss of the electric equipment functions was fatal in preventing the accident progress because many of the safety systems related to the “cool” function were driven by electricity. The loss of DC power supply in Units 1, 2 and 4 resulted in the loss of function of the measuring instruments, making it impossible for the operators to understand the status of the reactors and doubling difficulties in the subsequent accident response.

B2.1.3 Loss of Core Cooling Functions

Although the isolation condensers, as a passive cooling system, were installed in Unit 1 of Fukushima Dai-ichi NPS, they did not perform successfully because the fail-safe function worked on the loss of DC power supply, closed the isolation valve and stopped power supply required to operate the condensers. As a consequence, it became impossible to promptly cool down the reactor and maintain the water level. In Units 2 and 3, although the reactor water level was maintained approximately for 2 or 3 days by the actuated reactor core isolation cooling system (RCIC) or the high pressure coolant injection system (HPCI), which were driven by the steam turbine, they failed to sufficiently depressurize the reactor and to shift to the alternative low pressure water injection, while the water level was still maintained. At Unit 2, a pressure drop could not be confirmed in spite of the attempts to vent. The operators also failed to promptly depressurize the reactor after the reactor core isolation cooling system stopped because of the difficulty they faced in operation of opening the main steam relief valve due to lack of battery storage. Alternative water injection by fire engines was also delayed. As a result, the reactor cooling function was assumed to be lost. On the other hand, water was injected into the reactor of Unit 3 for a while by the RCIC, followed by the HPCI. However, the reactor pressure decreased because they controlled the flow rate of the HPCI to save power from the DC power supply. Under these circumstances, they tried to manually stop the HPCI to switch to the alternative water injection by the fire extinguishing system. However, they failed to open the main steam safety relief valve, which resulted in the loss of reactor cooling function. Consequently, the cores were damaged at Units 1 to 3. Unit 4 was under periodic inspection and the fuel had been removed from the reactor pressure vessel (RPV). In Units 5 and 6 in which AC power supply was secured, were successfully reached to the cold shutdown condition.

B2.1.4 Loss of Containment Functions and Hydrogen Explosions

Under the extremely high temperatures associated with core damage, a substantial amount of hydrogen was generated by the reaction between zirconium of the fuel cladding and water, and then released to the primary containment vessels (PCVs) with steam. It is assumed that the radioactive materials and steam containing hydrogen leaked to the reactor buildings because the confinement function of the gaskets at the top flange were degraded and could no longer resist to the pressure due to heat under the influence of core damage in addition to high pressure.

Moreover, in Units 1 and 3 of Fukushima Dai-ichi NPS, it cannot be denied that a certain amount of hydrogen flowed back to the reactor buildings through the standby gas treatment system (SGTS) connected to the above-mentioned systems and the ventilation system of the building because SGTS was failed to be isolated when PCVs were vented. This is considered

to be the process how hydrogen accumulated in the reactor buildings of Units 1 and 3 and finally exploded.

Steam containing hydrogen and radioactive materials were also leaked to the reactor building of Unit 2. Although accidental opening of the blow-out panel prevented the explosion, a substantial amount of radioactive materials was considered to be released.

In Unit 4, which was under periodic inspection, it is considered that although the fuel was removed from the pressure vessel, hydrogen released from Unit 3 when it was vented flew back through the pipes of the SGTS and the venting system, accumulated in the reactor building and exploded.

B2.1.5 Loss of Instrumentation and Control Functions

Furthermore, the loss of power supply due to the earthquake and tsunami significantly impaired the lighting, communication, instrumentation, monitoring and other functions, making it impossible to speedily secure communication tools required for prompt and correct accident response and information collection, which is also considered one of the causes to significantly obstruct the works to mitigate the progress of the accident.

B2.2 Activities by Operators for Design Issues

Although operators had worked hard to reduce risk of nuclear disaster by reflecting the knowledge such as operating experiences of their own plants and other companies in the systems/operations of the nuclear power plants, these efforts did not turn out to be effective in preventing this accident.

On the other hand, construction of seismic isolated buildings and the deployment of fire engines, based on the lessons learned from the damage caused by the Nigataken Chuetsu-oki Earthquake in 2007, had certain effects on the emergency response for this accident. However, a facility that can serve as a command base, such as a quake-proof office building, has not been constructed in all the nuclear power plants in Japan because the corresponding countermeasures are left to the companies' voluntary response.

After the accident, operators immediately took emergency safety measures, based on the direction of NISA, in order to prevent core damage even if total of three functions of AC power, cooling by seawater, cooling of spent fuel storage pool were lost by tsunami. Concerning the measures requiring a long time to complete, such as the installation of the air-cooled emergency generators and the coastal levee, the implementation plan was reported to NISA as medium- and long-term measures.

TEPCO implemented countermeasures against tsunami for the electric systems in preparation for recurrence of tsunami because electric systems such as the switchyard of the Fukushima Dai-ichi NPS were damaged by the earthquake and the tsunami on March 11.

The Japan Nuclear Technology Institute established by Japan's nuclear industry analyzed the course of the events and the accident cause, and extracted the lessons learned in order to clarify the policy of the entire industry, and developed various measures that can contribute to further upgrading the safety of the nuclear power plants as recommendations. The operators are now actively carrying out these measures.

Moreover, the operators are examining, planning and implementing the measures for the plant systems included in 30 safety measures that NISA proposed as the technical knowledge of the accident at Fukushima Dai-ichi.

B2.3 Activities by the Regulator for Design Issues

B2.3.1 Emergency Safety Measures Based on the Accident at TEPCO's Fukushima Dai-ichi NPS

NISA directed the operators to take emergency safety measures to prevent serious situations including core damage and to bring the units to cold shutdown even in the case of a station blackout due to the earthquake and the tsunami of the same magnitude of those that struck the Fukushima Dai-ichi NPS.

On May 6, 2011, NISA received the implementation status report of all the nuclear power plant except Fukushima Dai-ichi NPS, and confirmed that emergency safety measures are properly taken in all nuclear power plants in Japan except the Fukushima Dai-ichi and Dai-ni and the Onagawa NPSs. NISA confirmed that emergency safety measures were properly taken in the Onagawa and the Fukushima Dai-ni NPSs on June 1, 2011 and November 28, 2011, respectively. Specifically, NISA confirmed that the operators have taken short-term measures such as developing emergency response programs and power supply cars for securing of power supply systems in emergencies and fire pumps for alternate water injection, measures to prevent flooding, securing of water sources, developing of response procedures in time of emergency, and implementing drills. Some of these measures were included in the requirements of the technical criteria. Besides these, the operational safety program was revised so that the response procedures in time of accident shall be developed.

Moreover, securing of spares such as sea water pump motors, the installation of air-cooled emergency generators, and protective actions against tsunami including the introduction of watertight doors and structures, and the installation of sea walls and tide embankments are required by the emergency safety measures as medium- to long-term measures. NISA will check if each operator has a program for proper implementation of these measures. (Reference A-2)

Concerning the Fukushima Dai-ni NPS, NISA checked the implementation status of the countermeasures from the viewpoints that the necessary measures should be taken in order to maintain the cold shutdown status.

B2.3.2 Ensuring Reliability of External Power Supply at Nuclear Power Plants, etc.

External power supply was lost at the Fukushima Dai-ichi and Tokai Dai-ni NPSs by the earthquake on March 11. Again, on April 7, 2011, external power supply was temporarily lost at the Higashidoori NPS of Tohoku Electric Power Co. and the Rokkasho Reprocessing Plant of the Japan Nuclear Fuel Ltd. due to the earthquake that occurred off the coast of Miyagi prefecture on the same day. Although NISA had not requested to take special measures to secure external power supply so far , in light of the fact that external power supply was lost at multiple sites, aiming at further upgrading the reliability of external power supply, it directed the operators on April 15, 2011 to examine how they should respond to secure the reliability of external power supply and report the results to NISA. NISA evaluated and verified the contents of the reports submitted by each operator on June 7, 2011. (Reference B2.3.2-1) NISA evaluated and verified the response of the Fukushima Dai-ni NPS for securing the reliability of external power supply on November 28, 2011. NISA will strictly check the implementation status of the various measures considered by each operator.

Considering the fact that the electrical systems including switchyards lost their functions by the collapse of and damage to equipment, NISA also directed each operator to assess the

impact of potential collapse and damage of equipment and to report back to NISA the implementation status of their countermeasures developed on the basis of the assessment results. In response to this direction, the operators submitted the interim reports on the implementation status to NISA on July 7, 2011.

Subsequently, TEPCO reported on January 19, 2012 that the electric equipment related to the switchyard of the Fukushima Dai-ichi NPS, etc. was damaged beyond a design basis ground motion at the switchyard caused by the 2011 off the Pacific coast of Tohoku Earthquake. Based on this report, NISA gave an additional direction to TEPCO and other operators to perform seismic safety evaluation and to take countermeasures for earthquakes that may occur in the future. Each operator reported the implementation program of the seismic safety evaluation on February 17, 2012. NISA will strictly examine the results of the seismic safety evaluation immediately upon receipt of the report from each operator.

B2.3.3 Review of Basic Design Principles Based on the Accident at TEPCO's Fukushima Dai-ichi NPS

This accident resulted in the serious situations including the reactor core damage and the release of a substantial amount of radioactive materials to the environment due to the prolonged simultaneous loss of total AC power and DC power supply and the loss of reactor cooling function caused by the earthquake and tsunami. Taking into account the serious situation, the NSC considered if the Regulatory Guide for Reviewing Safety Design of Light Water Nuclear Power Reactor Facilities should be or should not be reviewed and re-organized the basic principles of the measures for the loss of total AC power supply and the loss of ultimate heat sink, which are the most urgent issues. (Reference B2.3.2-2)

B2.3.4 Technical Knowledge of the Accident at TEPCO's Fukushima Dai-ichi NPS

It is the responsibility of the regulatory body to extract as many lessons as possible from this accident and to contribute to future nuclear safety. As mentioned in B1.3.6, NISA reorganized and analyzed the facts that had been found out to date regarding the occurrence and the progress of the accident as deeply as possible from the engineering perspective following the accident sequence, and systematically extracted the technical knowledge at each phase of the accident, and examined the direction of the necessary measures that should be taken mainly in terms of systems and procedures.

Specific points to be considered encompass the off-site power supply systems (transformer stations, switchyards, etc.), on-site electric equipment (emergency power supply systems, etc.), cooling systems (core cooling systems, component cooling systems, etc.) and systems related to the confinement function (PCVs, venting systems, etc.) and command, communication and instrumentation and control systems (communication systems, in-core instrumentation system) during the Fukushima Dai-ichi accident. The scope of the accident sequence that should be examined includes the events that occurred during the period starting from the occurrence of the earthquake to the release of radioactive materials to the off-site environment due to the core damage and the loss of confinement function.

Although investigations have not sufficiently progressed to completely understand the situation of the melted and dropped down cores because of the difficulties of inspecting a large number of systems and components due to remaining radiological contamination, the "Safety Measures on 30 Items" were issued in March 2012 for the following 5 fields, after reviewe by external experts at a series of 8 public advisory meetings starting in October 2011.

(Reference A-1)

1) Measures to ensure external power supply (4 measures): Prevention of the prolonged loss of external power supply due to earthquake, etc.
2) Measures to ensure on-site electric equipment (7 measures): Prevention of the loss of function of on-site power supply due to a common cause and enhancement of emergency power supply.
3) Measures to ensure cooling and water injection systems (6 measures): Prevention of the loss of function of cooling and water injection.
4) Measures to prevent containment failure and hydrogen explosion (7 measures): Prevention of damage of containment vessel at an early stage and prevention of uncontrolled release of radioactive materials.
5) Measures to ensure instrumentation and control systems (6 measures): Drastic enhancement of the function to monitor the plant status and maintain plant management.

NISA presumes that these measures will serve as a foundation when it examines the technical requirements under the new regulatory framework. However, these measures were developed by a bottom-up approach based on the events that had occurred during the Fukushima Dai-ichi accident caused by the loss of total AC power supply due to the combination of earthquake and tsunami as the initiating event. Therefore, it is necessary to more systematically examine and re-organize the measures by a top-down approach, including the severe accident responses that cover wider range of initiating events, in addition to comparison of the relationship among these measures and the degree of their importance, and consideration for further safety improvement of the system as a whole. It is also necessary to develop design guidelines, etc. before actually applying these measures in regulations.

B2.3.5 Comprehensive Assessments for Safety of Existing Power Reactor Facilities

As stated in B1.3.7, the stress test for nuclear power plants is performed in two steps consisting of primary and secondary assessments pursuant to the framework decided at the ministerial level in July 2011. In the primary assessment, the duration of cooling in different types of events, identification of the cliff edge and the effects of the emergency safety measures in the case of the loss of total AC power and the loss of ultimate heat sink have been evaluated. (Reference A-3)

<Primary Assessment>

NISA has completed the review of the primary assessment reports on Ohi Units 3 and 4, and Ikata Unit 3, proposed by the respective operators (As of June 30, 2012). (Reference B1.3.7-3)

The primary assessment of the stress test is to be carried out by the operators according to the assessment approach and the implementation program developed by NISA and confirmed by the NSC. The results of the primary assessment submitted by operators are to be first confirmed by NISA and then validated by the NSC. (Reference B1. 3. 7-1)

In the course of NISA's review, it is confirmed that "the core damage that occurred at the Fukushima Dai-ichi NPS will never occur at the power plants, even in the case of the earthquake and the tsunami of the same scale that struck Fukushima Dai-ichi NPS."

<Secondary Assessment>

NISA has not received the secondary assessment reports of the nuclear power plants from any of the operators (as of June 30, 2012).

In the same way as the primary assessment, the secondary assessment of the stress test is to be performed by the operators in accordance with the assessment approach and the implementation program developed by NISA and confirmed by the NSC. The results of the primary assessment are to be first confirmed by NISA and then validated by the NSC.

B2.3.6 Judging Criteria for Safety on the Restart of Nuclear Power Plants

The "Judging Criteria for Safety on the Restart of Nuclear Power Plants" were decided at the ministerial level on April 6, 2012, as follows:

Criterion (1)

The following safety measures have already been implemented to prevent station blackout due to earthquake and tsunami:

1) Measures to protect on-site power supply systems.
2) Measures to protect cooling and water injection systems.
3) Measures to prevent containment failure.
4) Measures to protect control and instrumentation systems.

Criterion (2)

The national government has confirmed that "the core damage that occurred at the Fukushima Dai-ichi NPS will never occur at the power plants, even in the case of the earthquake and the tsunami of the same scale that struck Fukushima Dai-ichi NPS, by maintaining cooling of the reactor core and the spent fuel pit or the spent fuel pool."

Criterion (3)

The operators have specified clear-cut plans to implement measures to achieve further safety and reliability concerning the following matters. Moreover, the operators themselves have surely adopted a proper management system to find out the necessary steps to ensure safety and to make continuous efforts to implement such steps in addition to the prompt application of new regulations to be developed by a new regulatory authority that will be established in the near future.

1) The matters on which further improvements are requested by NISA after its review on the results of the stress tests (primary assessment).
2) 30 safety measures presented in NISA's report, "Technical Knowledge of the Accident at Fukushima Dai-ichi NPS of TEPCO".

In these criteria, the criterion (2) is intended to confirm that fuel damage will never occur even if a plant is struck by an earthquake and tsunami beyond assumptions, like the one causing the Fukushima Dai-ichi accident, and this is related to the primary assessment of the stress test. On the other hand, the criterion (3) is intended to confirm the plan to implement the measures for further upgrading the safety within a fixed period of time, the prompt application of new regulations and the management system to make voluntary efforts to ensure safety. This criterion is also concerned with the response to the matters on which further improvements are requested by NISA after its review on the primary assessment results of the stress test.

As mentioned in B1. 3. 7, the NSC has already compiled their views on the primary assessment of Units 3 and 4 of Ohi NPS. On April 13, 2012, the government at the ministerial level confirmed the compliance of the units with the applicable criteria, and that the safety was

ensured.

Then the government moved to take actions towards a restart of operation, including a series of explanations to the host municipal and prefectural authorities to gain their understanding. They accepted restarts of Units 3 and 4 on June 16, 2012, followed by the related ministers' final decision on the restarts. Preparatory work for restarts after completing the periodic inspection is under way now at Units 3 and 4.

Focusing on the restart, NISA developed a special surveillance system on June 16, 2012 in which a "constant surveillance and emergency response system" was established at the Off-site Center for Ohi NPS to enhance the peace and safety of the local residents through making better arrangements for prompt and appropriate emergency response in case of accident.

B3 Severe Accident Management and Restoration (On-Site)

B3.1 Topic Analysis

B3.1.1 Severe Accident Management

In Japan, the probability of a severe accident was considered to be too low to occur in reality from an engineering point of view before the Fukushima Dai-ichi accident. Thus, it had not been subject to the regulations and the measures had been left to the operators' voluntary efforts. The operators had implemented the probabilistic safety assessment and had promoted to establish accident management (AM) measures in response to the request of the (then) Ministry of International Trade and Industry. Fukushima Dai-ichi NPS had been no exception to this rule, and had accordingly taken AM measures. However, these AM measures had not adequately assumed external events, particularly the common cause failure that causes the unavailability of a wide range of electrical systems due to tsunami that caused the Fukushima Dai-ichi accident. The AM measures that had been developed in advance did not sufficiently function in the severe situation, and failed to prevent core-melt and the subsequent large scale release of radioactive materials.

Moreover, there had not been sufficient efforts in Japan to collect information on the trends and the research results of the international organizations as well as the countries in Europe and the U.S., including the measures against the potential situations that may lead to core damage (severe accident measures) that have been advanced in Europe and the U.S. through the experiences of the Three Mile Island (TMI) accident, the Chernobyl accident and the synchronized terrorist attacks on September 11, 2001 and to make use of such information in the regulatory activities.

B3.1.2 Restoration

To maintain post-accident safety at Fukushima Dai-ichi NPS, measures have been carried out, such as circulating water for cooling of the damaged cores, water circulation for cooling of the spent fuel pools, treatment and leakage prevention of high-level radioactively contaminated water, prevention of a hydrogen explosion by injection of nitrogen gas into the PCVs and restoration of the power supply systems lost by the accident. Also, such major safety systems provided with redundancy and diversity had been installed so that their required functions are maintained by their standby systems. Concerning the Fukushima Dai-ichi NPS as a whole, the completion of Step 2 of the "Roadmap towards settlement of the accident at the Fukushima Dai-ichi Nuclear Power Station, TEPCO" (hereinafter referred to as "Roadmap towards Settlement of the Accident") was declared in December 2011 as it was confirmed after the investigation by the experts that the reactors had reached "the cold shutdown condition," which is defined as a condition in which the release of radioactive materials to the off-site environment is significantly reduced and controlled. In response to this declaration, a medium- to long-term roadmap is to be developed for the Fukushima Dai-ichi NPS to promote activities aiming at its future decommissioning and NISA will play a part in promoting successful implementation of the roadmap from the standpoint of safety regulator.

On the other hand, because a leakage of high-level radioactively contaminated water still frequently occurs in the site, and the large number of facilities for water injection and waste storage are temporary construction, it is necessary to implement certain actions to maintain the plant's safety on a medium- to long-term basis. Therefore, on March 28, 2012 NISA

directed TEPCO to develop a specific implementation program for the matters of the first priority, for example, improvement of the reliability of the major safety systems by replacing the temporally-installed facilities with the permanent one.

Upon receipt of NISA's direction, TEPCO developed and proposed the implementation program to NISA on May 11, 2012. Continuous improvement will be done by reflecting the items included in the submitted gram in the medium- to long-term roadmap receiving the experts' reviews.

In parallel to enhancing robustness of the safety systems, the actions required for the preparation for decommissioning will be taken on a medium- to long-term basis, which include removal of the fuel from the spent fuel pools of Units 1 to 4, and removal of the fuel debris from the RPVs and PCVs of Units 1 to 3.

In addition, the progress status of the above-described implementation program as well as the lessons and knowledge obtained from the experience will continue to be shared with the international community to promote international discussions on efficient decommissioning strategies and effective utilization of the knowledge and techniques from abroad to the future decommissioning activities.

B3.2 Activities by Operators for Severe Accident Management

Operators in Japan had implemented AM measures as voluntary efforts based on the policy decided by the NSC and the request made by (then) the Ministry of International Trade and Industry (MITI) in response to the NSC's policy. However, taking into account the Fukushima Dai-ichi accident, TEPCO's response and preparedness to the scenario resulting in the loss of total AC power due to the earthquake and the tsunami as a common cause event were insufficient. Also, it must be said that the actions by operators to voluntarily promote severe accident measures for nuclear power plants beyond what was directed by the national government, by actively collecting, assessing and incorporating the new knowledge, was also insufficient.

Following the Fukushima Dai-ichi accident, operators took immediate measures concerning severe accident management such as securing emergency ventilation / air conditioning system facilities and communication facilities in case of total AC power loss, arrangement of emergency equipment and materials including protective clothes, reservation of radiation control personnel, countermeasures against hydrogen explosions, preparation of heavy machinery to dispose of debris caused by tsunami and the securing of power sources based upon the directive of NISA, and submitted to NISA the results of their implementation in June 2011.

Also the operators are currently making efforts to follow the suggestions stated in the technical knowledge of the accident at Fukushima Dai-ichi NPS of TEPCO developed by NISA in March 2012, which include enhancement of alternative water injection function in time of a severe accident, preventing damage of the PCV from excessive pressure and temperature, and prevention of hydrogen explosions ahead of schedule without waiting them to be incorporated in the regulatory requirements.

B3.3 Activities by the Regulator for Severe Accident Management

For severe accident management in Japan, the operators voluntarily proceeded to establish accident management measures in response to the request of the (then) Ministry of International Trade and Industry in 1992 as described in B3.1.1. Fukushima Dai-ichi NPS had

been no exception in following these measures.

In June 2011, the Nuclear Emergency Response Headquarters identified lessons-learned concerning severe accident measures such as making regulatory requirements instead of leaving it to operator's voluntary efforts in the "Report of the Japanese Government to the IAEA Ministerial Conference on Nuclear Safety".

In identifying lessons-learned, on June 7, 2011, NISA specified five items, including securing the working environment of central control room, securing communication facilities, preparation of materials and equipment such as protective clothing, and the establishment of organizational structure to manage radiation control, measures to prevent hydrogen explosions and the preparation of heavy machinery to dispose of debris as measures to be taken immediately, directed the operators to implement these items, and conducted an examination of their implementation status through on-site inspections by NISA, etc. (Reference B3.3-1)

Also, in October 2011, the NSC made a decision on "Measures against Severe Accidents at Light Water Nuclear Power Reactor Facilities". Although the requirement based upon the concept of defense-in-depth has previously been limited to the scope where only design base events should be dealt with (the scope corresponding to level-3 defense as defined by a defense-in-depth measure of IAEA-INSAG), it was decided by the NSC that safety-securing measures should be enhanced from now on with respect to "prevention of the occurrence of severe accidents and mitigation of their effects" which correspond to level-4 defense as defined by IAEA-INSAG, including necessary expansion of the scope of regulatory requirements and those subject to examination. (Reference B3.3-2)

In January 2012, the government presented to the Diet a bill on reform of the organization in charge of Nuclear Safety Regulation which includes an amendment of Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors (hereinafter referred to as "Reactor Regulation Act"). After discussions between the governing and opposition parties, a new bill was submitted to the Diet and passed on June 20. The Act was promulgated on 27th June. Based on these, this bill encompasses amendments to extend the scope of safety regulations to take severe accidents into consideration. (Reference B4.3)

Furthermore, NISA prepared 30 items of safety measures which include measure for severe accident management such as enhancing alternative water injection function, preventing containment vessel from damage due to excessive pressure / temperature and hydrogen explosions as described in the paragraph B.2.3.3 as the technical knowledge gained from the accident at Fukushima Dai-ichi NPS of TEPCO, and NISA expressed the necessity to prepare and systematically review severe accident countermeasures in a top-down approach. Furthermore, NISA identified viewpoints to be reflected to future regulation such as the necessity of severe accident countermeasures incorporating wide range of items such as the thoroughness of defense-in-depth concept, the diversity, flexibility and operability of severe accident countermeasures, and internal and external events. (Reference A-1)

At present, NISA is reorganizing fundamental policies on the systematic regulation of severe accident measures based on the above described points of view, consulting external experts' opinions. Specifically, NISA is examining the principle of the defense-in-depth including the severe accident measures, principle of the external events to be considered, how the safety assessment should be made, and the performance goals of the measures, etc. Based on the lessons-learned from the accident, a study on the regulation relating to the

severe accident measures is being continued:

i) Application of strict denial of the defense-forward in the defense-in-depth principles

ii) The extent and scope of severe accident management

iii) Diversity, flexibility and operability of severe accident management

iv) Enhancement of international harmonization and continuous improvement

In addition, as described in the paragraph B1.3.7, we are currently conducting two levels of evaluation of nuclear power stations as stress tests, wherein NISA is conducting in the primary assessment of effectiveness of accident management measures and emergency safety countermeasures mainly from the viewpoint of prevention of significant damage to fuel. In the secondary assessment which will be conducted in the future, NISA will conduct evaluation on the effectiveness of mitigation methods after fuel damage, the time required to reach to cliff edge, etc. in relation to the effectiveness of the response that is taken after the event escalated into the severe accident, based on IAEA recommendation and suggestion. (Reference A-3)

Following the above-described e measures, NISA will proceed with the investigation as mid- and long- term efforts concerning severe accident management taking into consideration the technical knowledge gained from the accident at Fukushima Dai-ichi NPS of TEPCO, the IAEA safety standards and the situation of stress test implementation in Europe, and will consider if a formulation of comprehensive accident management program should be or should not be requested to operators.

It was decided that the activities of NISA and the NSC are to be properly taken over by a new nuclear regulatory organization. It was also decided that the operator's development of comprehensive accident management program and other efforts are to be monitored and supervised by the new nuclear regulatory organization based on the amended Reactor Regulation Act that legally requires operators to implement severe accident measures.

B3.4 Efforts toward Restoration from the Accident, Decommissioning, etc.

B3.4.1 Current Status of TEPCO's Fukushima Dai-ichi NPS

TEPCO had worked hard to accomplish the "cold shutdown condition" in Step 2 of its Roadmap towards settlement of the accident published in April 2011. The "cold shutdown condition" is defined as the condition that fulfills the following 3 requirements:

1) Temperature at the bottom of the pressure vessel and inside containment vessel is below approximately 100°C.
2) Conditions are maintained in such a way that a release of radioactive materials from the containment vessel is restrained by controlling water injection that contributes to restraining steam generation in the containment vessel.
3) Mid-term safety of the circulating injection water cooling system is secured.

NISA declared the completion of Step 2 in December 2011 when it confirmed that the above-summarized conditions were all fulfilled and judged that the cold shutdown status was established after consulting with the external experts at the public advisory meeting and carrying out on-site inspections with the external experts. (Reference B3.4.1-1)

They are trying hard to further improve the reliability of the systems while maintaining the cold shutdown condition at the Fukushima Dai-ichi NPS. In the meantime, they have developed the mid- to long-term roadmap aiming at decommissioning, and continue to work hard to achieve the goal.

Concerning the spent fuel pool of Unit 4 of Fukushima Dai-ichi NPS, where a large number of fuel assemblies are being stored, no abnormality has been observed in the fuel rack so far as the result of taking pictures inside the spent fuel pool. It was also confirmed that there is no leakage at the lower part of the spent fuel pool, and no damage on the walls surrounding the pool. Structural integrity of the Unit 4 building was confirmed by the seismic ground motion analysis conducted to assess the current seismic resistance of the building taking into consideration the impacts of the damage on the exterior walls. Reinforcement of the bottom of the spent fuel pool of Unit 4 has also been performed. Thus, we consider the operator has taken proper response measures. Moreover, it was confirmed that the building is not excessively leaning because no significant difference was observed in the water level as the result of measurement of the water level at 4 points in the upper part of the reactor. The operator will start removing the fuel from the spent fuel pool by the end of 2013, according to the mid- to long-term roadmap. (Reference B1.3.4-2)

B3.4.2 Government's Efforts towards Settlement of the Accident and Decommissioning, etc.

Based on the directive of former Prime Minister Kan on April 12, 2011, TEPCO published the Roadmap towards settlement of the accident to be carefully planned recovery actions on April 17, 2011. The Roadmap was prepared with the basic concept that stably cooled condition of reactors and spent fuel pool should be achieved, the release of radioactive materials should be restrained, all the efforts should be made so that evacuated residents' returning home could be realized and Japanese citizens could live in a safe manner. The Roadmap consists of two steps with the goal for each step.

On October 3, 2011, NISA established the "Principles of Mid-term Safety Assurance" including the basic goal for securing safety during the period from the completion of Step 2 to the start of decommissioning operations, and directed TEPCO to follow these principles. In response to this, TEPCO submitted to NISA on October 17, 2011 the facility management plan and safety assessment results concerning the facilities related to the circulating water cooling system. NISA carefully examined the assessment results with the experts' opinions, and validated the assessment on December 12, 2011. Based on this, it was confirmed on December 17, 2011 that the reactors reached a cold shutdown condition as described above, and that the operator could maintain the conditions that exposure doses should remain sufficiently low at the boundary of site even in the case of occurrence of an unforeseen event, and subsequently, Step 2 was completed. (Reference B3.4.2-1)

Following completion of step 2, on December 21 the Government and TEPCO's Mid- and Long-Term Countermeasures Meeting co-chaired by Mr. Edano, the Minister of METI and Mr. Hosono, the Minister for the Restoration from and Prevention of Nuclear Accidents under the Nuclear Emergency Response Headquarters determined and announced the Mid- and Long-Term Roadmap towards decommissioning which include retrieval of fuel from the spent fuel pools of Units 1 to 4 and retrieval of fuel debris from the reactor pressure vessels and containment vessels of Units 1 to 3. (Reference B3.4.2-2)

On the other hand, because a leakage of high-level radioactively contaminated water still occurs, NISA directed TEPCO to develop a specific implementation program for the matters that should be dealt with first, for example, the improvement of the reliability by replacing the temporally-installed major systems with the permanent systems. In response to this direction, TEPCO developed and proposed an implementation program to NISA on May 11, 2012. The

mid- and long-term roadmap will be promptly revised, and appropriate progress management is to be carried out with the experts' evaluation of the implementation plan.

With the intention of foreseeing various types of risks at the accident site and ensuring that diverse measures are always effectively taken, we will make management system function successfully and appropriately carry out the PDCA (Plan-Do-Check-Act) cycle, taking advantage of the Mid- and Long-Term Countermeasure Meeting.

B4 National Organizations

B4.1 Topic Analysis

The Integrated Regulatory Review Service (IRRS) of the IAEA which was accepted in 2007 made some recommendations and suggestions on the Japanese nuclear regulatory body including the following recommendation and suggestion:

- Recommendation: The role of NISA as the regulatory body and that of NSC, especially in producing safety guides, should be clarified.
- Suggestion: NISA is effectively independent from ANRE, in correspondence with the GS-R-1. This situation could be reflected in the legislation more clearly in future.

The Japanese government had not sufficiently responded to these recommendations and suggestions. It has been pointed out that the remote cause of the Fukushima Dai-ichi accident was the fact that the safety regulations had not been strictly applied because the nuclear regulatory body belongs to the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry (METI), which is promoting nuclear energy. It is also considered as a problem that the institutional structure of nuclear regulatory organizations such as NISA and the NSC made the scope of responsibility ambiguous, making it difficult to promptly respond to a large scale nuclear accident in coordination with each other.

Taking into account these issues, it was decided to separate NISA from the Ministry of Economy, Trade and Industry and establish a new nuclear regulatory authority under the Ministry of the Environment from the viewpoint of “separation of regulation and utilization” and to integrate the function of the NSC for “unification of nuclear safety regulations” in order to regain the credibility of nuclear regulatory authority and enhance the function of the nuclear safety administration. In addition, enhancement of crisis management system, development of professional human resources, and reinforcement of new safety regulations are also set as the challenges for the reform. Concerning the reform of the nuclear regulatory organization and system, examinations had been continuously made at the Advisory Committee for Prevention of Nuclear Accident by experts in order to respond to the lessons-learned from the Fukushima Dai-ichi accident and the recommendations and suggestions by the IAEA mission team in the framework of IRRS, and the relevant bill was submitted to the Diet. After discussions between the government and the opposition parties, in order to create further independent nuclear regulation authority, a new bill was submitted to the Diet and passed on 20 June, 2012. The Act was promulgated on 27 June.

The principles of the new nuclear regulatory organization continue to be examined by the National Diet Investigation Committee and the Government Investigation Committee. The Government intends to make further examinations based on the lessons-learned from investigations.

B4.2 Activities by Operators for National Organizations

Operators, as entire nuclear industry, have intended to share and enhance nuclear safety culture taking lessons from the criticality accident that occurred at JOC in 1999. Also they have engaged in further improvement of independent safety activities and securing safe and stable operation corresponding to problems and undesirable events that occurred repeatedly thereafter, which include TEPCO’s falsification of independent inspection records and falsification of records on the criticality accident caused by the withdrawal of control rods by Hokuriku Electric Power Company.

In response to these undesirable events, the operators enhanced the technical basis, and promoted the independent safety assurance activities and established the Japan Nuclear Technology Institute as a result of a concerted effort of the entire nuclear industry in Japan, aiming to achieve further safety assurance of nuclear power.

However, since measures against a severe accident taken by operators as their independent safety activities were revealed to be insufficient in light of the lessons-learned from the Fukushima Dai-ichi accident, they are to establish a new organization by the end of 2012 in order to further enhance measures for securing safety of nuclear power stations.

The new organization identifies its mission as “achievement of the world's highest level of safety in the Japanese nuclear industry – unceasing pursuit of excellence”. It is considered that the new organization should be able to collect information of safety improvement measures, etc. from various foreign countries that have so far been independently collected by each operator and to be in charge of total management of the information exchange with the Institute of Nuclear Power Operations (INPO) and the World Association of Nuclear Operators (WANO) to provide proposals, instructions and recommendations on safety measures to the operators.

B4.3 Activities by the Regulator for National Organizations

In light of the lessons from the Fukushima Dai-ichi accident, the Japanese government is implementing reform of its nuclear regulatory organization and system. In August 2011, the Cabinet Decision for the basic policy on reform of organization related to nuclear safety regulation was adopted. After that, specific recommendations concerning a reform of the nuclear regulatory organization and system such as independency, risk management and new safety regulation were presented in December 2011 by the Advisory Committee for Prevention of Nuclear Accidents which was established upon the request of Mr. Hosono, the Minister for Restoration from and Prevention of Nuclear Accidents. Based on these recommendations, the government prepared and presented to the Diet the bill concerning a reform of the nuclear regulatory organization and system in the end of January 2012. After discussions between the government and opposition parties, in order to create further independent nuclear regulation authority, a new bill was submitted to the Diet and passed on 20 June, 2012. The Act was promulgated on 27 June.

In a reform of the nuclear regulatory organization and system by this Act, three major components were identified; establishment of a highly-independent nuclear regulatory authority, enhancement of nuclear disaster preparedness and transformation of nuclear safety regulation.

A Nuclear Regulation Authority will be established as an independent commission body affiliated to the Ministry of the Environment to realize separation of regulation function from promotion function as well as an integration of related tasks of nuclear regulation. This will allow the establishment of an effective regulatory system in order to “protect people and the environment from harmful effects of radiation.” This organizational reform is consistent with the recommendations and suggestions provided by the IAEA mission team in the framework of IRRS in 2007. The Nuclear Regulation Authority will be highly independent from the government and have sufficient authority to produce safety guides and standards.

Nuclear emergency preparedness and response arrangements will be enhanced through close cooperation between the newly-established Nuclear Emergency Preparedness Committee and the Nuclear Regulation Authority, expansion of structure and function of the

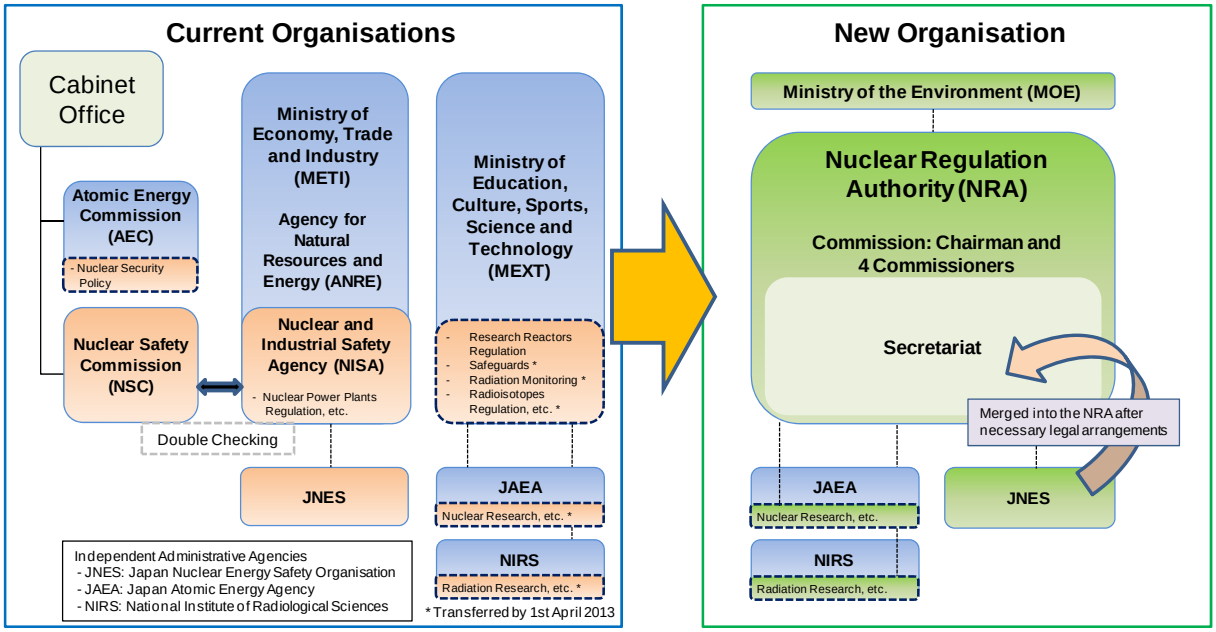
Nuclear Emergency Response Headquarters, amendment of the Act on Special Measures concerning Nuclear Emergency Preparedness for enhanced implementation of emergency drills by operators, a re-formulation of governmental and regional plan for measures against a disaster, review and enhancement of an offsite center, etc.

Concerning transformation of nuclear safety regulation, the Reactor Regulation Act will be amended for making measures against a severe accident based on legal obligation, introducing backfitting by which even already licensed power station should conform to the standard based on the latest technical knowledge, introducing the rule to disclose overall risk analysis results of each reactor, introducing the "operational limit of 40 years" as measures against aging of nuclear reactors, etc. Furthermore, in order to collect up-to-date scientific knowledge from outside of Japan, the Nuclear Regulation Authority will implement necessary measures, including a preparation for inviting international advisors from foreign countries, and continuously improve nuclear safety.

Furthermore, the Act encourages the government to promote human resources development considering its importance to realize effective regulation. In this context, the Nuclear Regulation Authority will actively employ professional staffs and experts for nuclear regulation, promote personnel exchanges with universities, international organizations and overseas regulatory bodies and establish training facilities.

(Figure B4.3) Reform of Nuclear Regulatory Organizations

- **Independence**: Separate nuclear regulation function and nuclear promotion function and establish the "Nuclear Regulation Authority (NRA)", as an independent commission body affiliated to the MOE. Chairman and Commissioners are appointed by the Prime Minister after the approval of the National Diet.
- **Integration**: Integrate nuclear regulation functions, namely, nuclear safety, security, safeguards, radiation monitoring and radioisotopes regulation, into the NRA.
- **Crisis Management**: Establish "Nuclear Emergency Preparedness Commission (NEPC)" in a cabinet and implement nuclear emergency prevention measures in close cooperation with relevant organisations.



B5 Emergency Preparedness, Emergency Response and Post-Accident Management (off-Site)

B5.1 Topic Analysis

B5.1.1 Emergency Preparedness and Response

Based on the lessons-learned from the Fukushima Dai-ichi accident and the principles worldwide, the Nuclear Safety Commission (NSC) considered the feedback that must be incorporated in the "Emergency Preparedness and Response at Nuclear Facilities," and proposed the principles in March 2012 that the Precautionary Action Zone (PAZ) should be roughly 5 km, the Urgent Protective Action Planning Zone (UPZ) be roughly 30 km, and the Plume Protection Planning Area (PPA), where protective measures are taken for avoiding effects of exposure to a plume (an air mass containing gaseous or particulate materials) containing radioactive materials be roughly 50 km (reference value). (Reference B5.1.1)

We think that the reason why this way of thinking was not introduced before the accident, but was lack of awareness that a severe accident in which the situation develops in a short time like the Fukushima Dai-ichi accident can occur, and was lack of a positive attitude toward incorporating the global trend promptly. We recognize that it is necessary to reflect on these points thoroughly and pay attention to the global trend in nuclear regulations without falling into what is called the myth of the safety from now on.

In this accident, there were considerable difficulties in assessing the accident situation promptly and accurately, securing means of communication and procurement, and mobilizing a range of support personnel for the accident and disaster response. Particularly, the off-site center in the vicinity of the accident site, which should have served as a base for the emergency response, could not function adequately due to limited communication means and high radiation dose. This decisively increased the difficulty of the accident response this time. Therefore, NISA has taken such measures as deployment of satellite phones which use dedicated lines and increases reserves of goods and materials at the off-site centers. Also, alternate materials and equipment have been deployed so that alternate facilities can be used immediately even in the event that the function of an off-site center has to be relocated. Studies are to be continued on the functions and siting conditions required of the off-site centers, and necessary measures are to be taken for the reinforcement of the functions of the off-site centers, including the implementation of radiological countermeasures.

B5.1.2 Post-Accident Management (off-Site)

In order to show an entire picture of immediate efforts and future prospects, the government decided on “Immediate Actions for the Assistance of Nuclear Sufferers,” etc. and regularly announced the progress of the measures for the affected areas such as implementation of environment monitoring, etc. At present, the government is continuing all-out efforts to implement these assistance measures.

The government will keep sharing the lessons and findings obtained through the above efforts and experiences with the international community so as to contribute to the international study on more effective measures for the off-site post-accident management. Moreover, followed by the Act on Special Measures concerning the Handling of Radioactive Pollution, the government will continue to implement relevant measures on decontamination and disposal of the waste contaminated by radioactive materials.

B5.2 Activities by Operators for Emergency Preparedness, Emergency Response and Post- Accident Management

Under the current legal system, the operators should take emergency preparedness actions and emergency response in cooperation with the national and local governments.

Hereafter, severe accident drills are required to be strengthened and the operators are obliged to report the results of nuclear emergency drills to the Minister of the Environment. If the Minister judges that the results are not satisfactory to prevent the occurrence or mitigation of a nuclear accident, the order on improvement may be issued.

At the beginning of the accident, it was difficult to secure the information communication means mainly due to suspension of public communication services, and this caused insufficient communication between the government and TEPCO. Therefore, in order to secure prompt information transfer between the governmental organizations' off-site centers at the time of nuclear disaster (Official Residence of Prime Minister, ERC (Emergency Response Center) and OFC (Off-site Center)) and those of the operators (the emergency center, etc.), measures including introduction of a video conference system, diversification of communication transmission routes and strengthened power supplies for communication equipment will be taken. In case of a nuclear disaster, the government will dispatch an emergency response officer to the emergency response center at the nuclear facility (the head office of a nuclear operator, etc.), and one of the operator's off-site centers, which will allow close communication and cooperation with the operator.

After the accident occurred, as preparation for an emergency, the operators are considering the integrated management arrangements for materials and equipment such as robots working in a high-radiation environment, or arrangement of the support team for the affected plant using such equipment.

For the post-accident management, the operators except TEPCO supplied goods to Fukushima Dai-ichi NPS and launched human support activities in the Fukushima area under the cooperation agreement among the operators. To be specific, human support activities in Fukushima include environmental radiation monitoring and whole body counting and radiation survey of baggage carried by the residents from the affected areas at the time of their brief visit to their homes.

B5.3 Activities by the Regulator for Emergency Preparedness, Emergency Response and Post-Accident Management

B5.3.1 Emergency Preparedness and Emergency Response

As described above (B3.3), on June 7, 2011, NISA made clear the measures to be taken immediately such as securing of communication means in the power plant premises during an emergency from the viewpoint of ensuring a quick response in the event of a severe accident such as securing of communication means in the power plant premises during an emergency, directed operators to implement these measures, and later checked the implementation status of them. Furthermore, in March 2012, NISA came up with 30 safety measures in their report on the technical knowledge of the accident at Fukushima Dai-ichi NPS of TEPCO, which include, as emergency response measures, the securing and improving of a command post at the time of an accident, the securing of communication functions, the securing of reliability of instrumentation facilities, the reinforcement of plant status monitoring functions,

the reinforcement of monitoring functions at the time of an accident, the building of an emergency response system and the implementation of training. NISA organized these measures as the items to be reflected in the future safety regulations. (Reference A-1, B3. 3-1)

Concerning emergency response measures for a wide area outside nuclear power stations, as described above (B5.1.1), the NSC conducted a study on the re-examination of the “Emergency Preparedness and Response at Nuclear Facilities, etc.” in March 2012, and proposed the principles that the Precautionary Action Zone (PAZ) should be roughly 5 km, the Urgent Protective Action Planning Zone (UPZ) be roughly 30 km, and the Plume Protection Planning Area (PPA) where protective measures are taken for avoiding effects of exposure to a plume (an air mass containing gaseous or particulate materials) containing radioactive materials be roughly 50 km (reference value). (Reference B5.1.1)

In addition, reflecting on the fact that the secretariat of the Nuclear Emergency Response Headquarters could not function as the hub of information fully, and the fact that at the local nuclear emergency response headquarters, there was a delay in personnel call-up at an early stage, and a failure of the function of the off-site center that is expected to serve as a base, the government is to completely re-examine the emergency preparedness and response system. Specific measures to be taken include: prompt establishment of a secretariat function of the Nuclear Emergency Response Headquarters in the Prime Minister’s office for the information collection and response, and information transmission based at the Prime Minister’s office; dispatch of officials at the vice ministerial level to emergency headquarters at the head office of the operator, etc. so as to understand the situation of the nuclear power plant; and the launch of a video conferencing system linking the Prime Minister’s office, nuclear safety regulatory bodies, emergency headquarters of the operator, the nuclear power plant, etc.

Concerning the off-site center, NISA took measures for radiation protection and securing of water and food are to be taken so that personnel can remain at the center and carry out activities for several days in the event of emergency. As for an alternative off-site center, mobile materials and equipment were prepared so that the center can be started up immediately.

NISA are holding advisory meetings of experts to study how the off-site center should be function. Benefiting from the inputs from experts and related municipalities, siting location of the off-site center, radiation shielding function to be provided, etc. will be studied after clarifying the roles of off-site centers and considering the effects of dissipation of radioactive materials and the effects from multiple disasters

It is assumed that the new emergency preparedness system is to be put in place along with the establishment of a new regulatory agency. However, in preparation for an emergency situation that may occur until then, the function of the secretariat of the Nuclear Emergency Response Headquarters is to be centralized in the Prime Minister’s office and enhanced, and based on the concept of PAZ, responses that take into account the new concept as much as possible are to be made, including prompt issuance of directives on evacuation.

By the introduction of UPZ, the evacuation preparation zone is greatly expanded, and the number of municipalities involved is also increased, so the formulation of regional disaster prevention plans is being prepared in these municipalities.

There was harsh criticism that information was not provided appropriately to the

municipalities and residents at the time of the accident. Harsh criticism was leveled against the government that the government might have tried to hide information since appropriate data was not provided at the right time. Hereafter, based on the reflections on this criticism, the mechanism of information provision during emergency is to be re-examined while the communication system is to be enhanced.

As described above, from the viewpoint of the separation of nuclear regulation from nuclear promotion, and the unification of nuclear safety regulation, the government submitted the Nuclear Power Organization Reform Bill, etc. to the 180th ordinary Diet session aiming at restructuring relevant organizations to enhance their functions including the establishment of the Nuclear Regulation Authority in the Ministry of the Environment. After discussions between the Government party and the opposition parties, in order to create further independent nuclear regulation authority, a new bill was submitted to the Diet and passed on 20 June, 2012.

For the future, guidelines on nuclear emergency preparedness are to be formulated, and a study is to be conducted on issues such as how off-site centers should function, the result of which is to be reflected in the guidelines on nuclear emergency preparedness while necessary revisions are to be made to the Basic Plan for Emergency Preparedness and manuals on nuclear emergency preparedness so that each organization can implement its activities smoothly during emergency.

B5.3.2 Post-Accident Management

After deciding on “Immediate Actions for the Assistance of Nuclear Sufferers” and “Roadmap for Immediate Actions for the Assistance of Nuclear Sufferers” at the Nuclear Emergency Response Headquarters on May 17, 2011, the government regularly announced the progress of the various assistance measures such as implementation of environmental monitoring, efforts related to evacuation zones, efforts toward return of evacuees to their homes and compensation for the victims of the accident and affected business operators until the completion of Step 2 in December 2011.

Concerning environmental monitoring, the government has to responsibly coordinate with local governments, the nuclear operator and relevant companies to avoid any omissions in carrying out radiation monitoring, for the purposes of restoring the environment around Fukushima Dai-ichi NPS, conducting more detailed monitoring in response to demands for children’s health and people’s peace and safety, and providing integrated information in an easy-to-understand manner. It is also important to develop an appropriate system for collecting and accumulating data to be obtained through radiation monitoring over a long period of time so as to utilize them as basic data for managing health issues of people living in the affected regions. (Reference B5.3.2-1)

Concerning the efforts related to evacuation zones, etc. in connection with the accident of Fukushima Dai-ichi NPS, the Director-General of the Nuclear Emergency Response Headquarters lifted the designation of the evacuation-prepared zone in case of emergency on September 30, 2011. On March 30, 2012, directives were issued to lift the designation of the restricted zone in the relevant areas of Kawauchi Village and Tamura City effective on April 1, 2012 and of Minamisoma City effective on April 16, 2012, and to newly designate the evacuation-directed zone as a difficult-to-return zone, a habitation-restricted zone, and a zone being prepared to have the evacuation directive lifted. As for the Fukushima Dai-ni NPS, Prime Minister Noda declared a lift of nuclear emergency at the Fukushima Dai-ni NPS on

December 26, 2011, and the designation of the evacuation-directed zone was lifted accordingly. (Reference B5.3.2-2)

Regarding decontamination of radioactive materials, the national government has been implementing environmental remediation activities in accordance with the Act on Special Measures concerning the Handling of Radioactive Pollution (promulgated in August 2011 and entered into force in January, 2012) as well as the Basic Principles and the guideline based on the Act. In implementation of environmental remediation activities, the government has been implementing decontamination works for public facilities (municipal offices, community centers, etc.) which will be working offices of environmental remediation activities as well as conducting decontamination demonstration model work and full-scale decontamination for houses and farmlands, etc., that will be implemented in the near future. Moreover, the Ministry of the Environment of Japan is developing an organizational system by opening the "Fukushima Office for Environmental Restoration" to promote decontamination and disposal of contaminated waste. (Reference B5.3.2-3)

As for the disposal of contaminated waste, the Ministry of the Environment established a policy, etc. on its waste disposal as some waste is contaminated with radioactive materials. Since the Act on Special Measures for Concerning Handling of Radioactive Pollution was enforced, waste contaminated with radioactive materials has been disposed in accordance with the Act. The waste that can be disposed by a usual method is being disposed in accordance with the Waste Disposal and Public Cleansing Law (Reference B5.3.2-4)

Actions concerning the disposal of waste and soil, and a temporary storage place and intermediate storage facilities necessary for the disposal are being considered based on "Basic Concept on Interim Storage Facilities, etc. Necessary for Dealing with Environmental Contamination with Radioactive Materials Resulting from the accident of Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Company (Ministry of the Environment, October 29, 2011)." (Reference B5.3.2-4)

Concerning the compensation for nuclear damage, Japan has a nuclear liability system pursuant to the "Act on Compensation for Nuclear Damage", aiming at indentifying victims and promoting the sound development of the nuclear industry. Responsibility for the compensation for nuclear damage is placed on nuclear operators, who are required to accept no-fault unlimited liability. Under the "Act on Compensation for Nuclear Damage", nuclear operators are obligated to take financial availability for compensation of nuclear damage (hereinafter referred to as "financial availability"), and TEPCO has been concluded a private liability insurance and a government indemnity agreement as financial availability for Fukushima Dai-ichi NPS. Since the nuclear damage was due to earthquakes, etc. covered by the government indemnity agreement, TEPCO made a request to the government for payment of compensation based on the governmental indemnity agreement, and was paid 120 billion yen. However, concerning the nuclear damage caused by the accident, TEPCO is responsible for compensating for any damage having a sufficient causal relationship to the accident since nuclear operators are required to accept unlimited liability.

Also, in order to provide relief for the victims promptly, fairly and appropriately, the government established the Dispute Reconciliation Committee for Nuclear Damage Compensation to formulate guidelines for determination of the scope of nuclear damage based on the "Act on Compensation for Nuclear Damage", and has thus far formulated Interim Guidelines, the First Supplement to the Interim Guidelines, and the Second Supplement to the Interim Guidelines, etc. Based on these guidelines, TEPCO is conducting compensation in

accordance with its own concrete compensation standard. The government also established the Nuclear Damage Compensation Dispute Resolution Center under the Dispute Reconciliation Committee for Nuclear Damage Compensation to mediate reconciliation of many disputes concerning compensation.

In addition, aiming at building detailed programs for compensation by TEPCO based on Article 16 of the “Act on Compensation for Nuclear Damage” in response to this accident, the government enacted the “Nuclear Damage Compensation Facilitation Corporation Act.” Based on the Act, the government established the Nuclear Damage Compensation Facilitation Corporation. (Reference B5.3.2-5)

B6 International Cooperation

B6.1 Topic Analysis

Japan sees it as its responsibility to share with the international community knowledge and lessons-learned from the Fukushima Dai-ichi accident, and Japan has presented comprehensive reports on the accident taking the opportunities of the IAEA Ministerial Conference on Nuclear Safety in June 2011 and the IAEA General Conference in September 2011.

At the initial phase of the accident, there were cases in which information was not always fully shared in advance in communicating with neighboring countries and the international community as well as cases in which it took some time for the Japanese Government to coordinate assistance offered by the international community. Japan has addressed these issues and shared with the international community the lessons-learned from the accident. Building upon knowledge and the lessons-learned from the accident, Japan will continue to actively contribute to strengthening international nuclear safety.

Japan sincerely appreciates the kind and generous assistance offered by so many countries, regions and various entities around the world. Through the efforts towards the settlement of the accident, Japan has deeply recognized the importance of responding to a nuclear emergency by bringing together the wisdom of the international community and through international cooperation. Based on the recognition, Japan will continue to seek more effective collaboration with other countries and organizations by building upon communication with neighboring countries and the international community, cooperation with the international community, efforts on nuclear safety-related conventions, contribution to and utilization of the IAEA Safety Standards and international peer reviews since the accident occurred.

B6.2 Activities for International Cooperation

B6.2.1 Communication with Neighboring Countries and the International Community

Since the occurrence of the accident, Japan has emphasized information provision in a prompt and accurate manner to international organizations such as the IAEA, governments of other countries, foreign media and citizens whose mother language is not Japanese. Specifically, Japan continuously held briefings to diplomatic corps in Tokyo and press conferences to foreign media.

However, there were cases in which information was not always fully shared in advance, especially with neighboring countries, such as outflow of water with high-level radioactivity and discharge of stagnant water with low-level radioactivity to the sea in April 2011. Japan recognized the necessity to improve the communication with neighboring countries. Therefore, we reviewed the communication channels within the governmental organizations and explained to individual countries about the background of the measures taken by the government and operators, the relevant data and other information. Also, we identified a contact point where we can maintain around-the-clock communication with the neighboring countries. Subsequently, we are making individual prior notifications to neighboring countries in addition to those to the IAEA on events which would be of particular interest to them. Building upon experiences in responding to the accident, Japan sees it as its responsibility to provide information to the international community promptly and accurately with maximum transparency and is making every effort for active communication. (Reference B6.2.1)

B6.2.2 Cooperation with the International Community

Japan has recognized the necessity to address the accident by bringing together the wisdom of the world, in close collaboration with other countries, supplies and equipment offered and experts sent from the world from the beginning of the accident. Japan sincerely appreciates the kind and generous assistance offered by so many countries, regions and various entities around the world. Initially, it took some time for the Japanese government to identify the demand for such assistance within Japan, but the Japanese government brought about solutions by building a collaborative structure of relevant agencies within the government, and with the countries providing assistance and through close cooperation with those countries. Also, from the standpoint that Japan puts emphasis on cooperation with international organizations, the Japanese government has worked closely with international organizations including the IAEA, the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD/NEA), the Food and Agriculture Organization (FAO), and the WHO through the acceptance of their missions and holding workshops in Japan. Building upon these experiences of cooperation with the international community, the Japanese government has been actively contributing to the international efforts to strengthen international emergency response, such as by making concrete proposals for enhancing IAEA's Response Assistance Network (RANET) capabilities. (Reference B6.2.2)

B6.2.3 Efforts on Nuclear Safety-related Conventions

Japan is a Party to all of four conventions, which are so-called nuclear safety-related conventions; the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, the Convention on the Early Notification of a Nuclear Accident (hereinafter referred to as "the Notification Convention") and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (hereinafter referred to as "the Assistance Convention"). Building upon the Fukushima Dai-ichi accident, Japan proposed to strengthen these nuclear safety-related conventions at various international fora such as the G8 Summit and the IAEA Ministerial Conference on Nuclear Safety in 2011. Improving the effectiveness of the international legal framework is also included in the Action Plan endorsed at the IAEA General Conference in 2011.

Also, Japan made proposals for strengthening the RANET, which is an implementation framework of the Assistance Convention, and for enhancing the implementation of the Notification Convention in order to strengthen the international system for notification of nuclear accidents at international fora such as the sixth meeting of representatives of competent authorities identified under the Notification Convention and the Assistance Convention held in April 2012. Japan will continue to actively contribute to international discussions on strengthening nuclear safety-related conventions, building upon knowledge and lessons-learned from the accident.

B6.2.4 Contribution to and Utilization of IAEA Safety Standards

There have been some Japanese domestic laws and regulations that were not complied with the IAEA safety standards, etc. It is important to develop domestic standards and rules consistent with international standards in the future.

On the other hand, it is also considered important to introduce internationally the standards based on information and data accumulated in Japan and to make them international standards. NISA and JNES have made proposals on revisions of the IAEA safety guides for seismic design (NS-G-1.6), for siting (DS433), etc. after the analysis of 28 lessons presented in the report to the IAEA concerning the Fukushima Dai-ichi accident. In cooperation with the IAEA International Seismic Safety Centre, Japan is also preparing specific examples of application of safety guides, taking into account the latest technological information concerning the Fukushima Dai-ichi accident, situation of establishment of standards at the Atomic Energy Society of Japan, etc., results of study concerning earthquake and tsunami by JNES, etc. to reflect them into the IAEA technical documents. We will continuously commit ourselves to making further contributions.

B6.2.5 Acceptance of International Peer Reviews

An IAEA review mission team visited Japan in January 2012 to review the evaluation method for the stress tests. The recommendations and suggestions given by the IAEA mission team were meaningful in continuously enhancing evaluation activities and improving credibility. Japan will keep reviewing various measures based on recommendations in the framework of IRRS, etc.

Japan is now promoting reforms of a nuclear regulatory organization and system, and it is important to keep on making efforts toward continuous improvement of nuclear safety even after the reform of the system is accomplished. From this point of view, Japan is going to utilize international peer reviews, including the acceptance of the IAEA IRRS as soon as preparations are made at the new nuclear regulatory body.

C Conclusion

More than one year has passed since the Fukushima Dai-ichi accident occurred. This accident is a very severe one as shown by the facts: electrical systems lost their functions extensively due to the common external event of the earthquake and tsunami; severe accidents of fuel damage and core melts occurred simultaneously at multiple units; the accident affected a large area around the site; and more than 100,000 people are still leading painful lives as evacuees.

The on-site situation is also quite severe. We internationally have no experience in accurately understanding the state inside the severely damaged reactors, taking out damaged fuel from such reactors and taking steps for decommissioning, and it is supposed that it will take several decades to accomplish such work. It is also viewed that new technologies will be required for such works. Besides, many challenges remain in improving the reliability of measures, such as the presence of a large amount of waste and contaminated water, and the fact that many pieces of the equipment for circulation injection cooling system are temporally construction. In addressing these challenges, it is necessary for us to gather international knowledge and utilize it.

There are a number of nuclear facilities in Japan and it is necessary to ensure their safety. Looking back on the accident, although the Fukushima Dai-ichi accident was caused directly by natural disasters, i.e**.** an earthquake and a tsunami, the assumption of these hazards had been insufficient, and preparations for response to a complex disaster of natural hazards and an accident at a nuclear power station had been not enough either. So far, provisions for a severe accident have been left to operators' voluntary arrangements, and have not been a regulatory requirement. Japan must reflect on these points. In the new regulatory system, measures related to the above-described preparations are included in the regulatory requirements. We must take it seriously that insufficient safety measures taken so far aggravated the accident. Concerning the regulatory system and activities, continuous improvements have to be made, taking new technical knowledge into account. At the same time, operators have to establish a "safety culture" in which safety levels are ceaselessly reviewed. In the process, it is necessary to actively keep up with the best practices in the world by having close interactions with the international community and working closely with them. Japan is determined to surely establish a new organization/structure which will be able to respond to any emergency properly.

This report describes how Japan has responded to and what lessons Japan learned from the accident, and what actions Japan will take in the future, from the aspects of external events, design, severe accident management, domestic organizations, emergency response and international cooperation. Although it will take still long time to clarify the entirety of all aspects of the accident and identify lessons-learned, we will continuously share new knowledge and lessons with the international community at various occasions, such as, under the Convention on Nuclear Safety or the IAEA framework, and contribute to enhancement of nuclear safety in the world. We are also committed to dedicating all our efforts to make the best use of global cutting edge knowledge and technologies in response to accidents in the future.

Attachment Summary of the Activities and Conclusion

Activity	Activities by the Operators			Activities by the Regulator		
	Activity -Taken -Ongoing -Planned	Schedule or Milestones for Planned Activities	Results Available -Yes -No	Activity -Taken -Ongoing -Planned	Schedule or Milestones for Planned Activities	Conclusion Available -Yes -No
B1 External Events						
1. Evaluation of Earthquake and Tsunami on NPPs Taking into Account Knowledge of Earthquake on March 2011						
Revision of the Regulatory Guide for Reviewing Seismic Design -NSC started to review the Regulatory Guide for Reviewing Seismic Design based on the accident, and released the draft revision of necessary matters for the treatment and the evaluation of tsunami.				Taken	March, 2012	Available
Evaluation of earthquake and tsunami based on knowledge of the earthquake -NISA analyzed the earthquake and the tsunami of March 2011, and released an interim report on results such as evaluation of a trench type earthquake, fault interactions, estimated tsunami height and wave power.				Taken	February, 2012	Available
-NISA continues to analyze the earthquake and the tsunami, and aims at incorporating new knowledge into the future seismic backcheck and safety review.				Ongoing		
2. Restart of Seismic Backcheck Based on Knowledge of Earthquake on March 2011						
-NISA restarted the seismic back check based on knowledge such as the interaction of hypocenters, the effect of the combination of tsunamis on the tsunami height and reactivation of a fault that had not been deemed active. -NISA is additionally examining the interaction of capable faults and the current specific evaluation methods of tsunamis.	Ongoing	Sequentially taken	---	Ongoing	Sequentially review	---
3. Interim Report on Evaluation and Impact on Reactor Buildings, etc. of Fukushima Dai-ichi and Dai-ni NPSs						
-NISA evaluated whether the main seven components at Fukushima Dai-ichi and Dai-ni were in a condition to maintain their safety function during and just after the earthquake, and released an interim report on study results which stated that they were presumed to be in a safety condition to maintain operation -NISA evaluated earthquake resistance of R/Bs, etc. of all units of Fukushima Dai-ichi NPS under the current conditions, and released the interim report on study results assuming that the earthquake that might occur in the future would not have lead to ripple effects on the significant seismic safety components.				Taken	February, 2012	Available

	-NISA will undertake detailed analysis and evaluation on components other than the seven significant seismic safety components.				Planned	---	---
4. Impact of Aging Degradation during Fukushima Dai-ichi Accident							
	-NISA evaluated impacts of aged equipment on the outbreak or expansion of the Fukushima Dai-ichi accident, and concluded that it was highly unlikely that aging degradation caused the outbreak and expansion of the accident.				Taken	February, 2012	Available
	-For the purpose of obtaining new knowledge through field investigation in the future, NISA will undertake additional examination.				Planned	---	---
5. Emergency Safety Measures Based on the Fukushima Dai-ichi Accident							
	Short-term measures -NISA directed operators to take measure such as deploying power supply vehicles and fire pumps, preventing flooding of buildings, securing water sources, preparing emergency procedures and training to prevent the occurrence of serious conditions such as core damage and to mitigate cold shutdown conditions in the case that the loss of total DC power supply and an ultimate heat sink due to an earthquake and a tsunami equivalent to that which caused the Fukushima Dai-ichi accident. NISA confirmed their implementation status.	Taken	May, 2011	Available	Taken	May, 2011	Available
	Mid and long-term measures -NISA directed operators to take measure such as securing spare motors for sea water pumps, installing air cooled emergency generators, water proofing of equipment, construction of sea walls and tide embankments. Operators are implementing these measures.	Ongoing	Systematically implementing	---	---	---	---
6. Technological knowledge of the Fukushima Dai-ichi Accident							
	NISA systematically extracted the technical knowledge by analyzing and categorizing equipment and operating procedures according to the accident sequence, and examined the ordering of the necessary measures. As the result of the examination, NISA released 30 safety measures in five fields as below. 1) Measures to ensure external power supply (4 measures): Prevention of the prolonged loss of external power supply due to earthquake, etc. 2) Measures to ensure on-site electric equipment (7 measures): Prevention of the loss of function of on-site power supply due to a common cause and enhancement of emergency power supply. 3) Measures to ensure cooling and water injection systems (6 measures): Prevention of the loss of function of cooling and water injection.				Taken	March, 2012	Available

	4) Measures to prevent containment failure and hydrogen explosion (7 measures): Prevention of damage of containment vessel at an early stage and prevention of uncontrolled release of radioactive materials. 5) Measures to ensure instrumentation and control systems (6 measures): Drastic enhancement of the function to monitor study the plant status and maintain plant management.						
	Short-term measures -As already stated, NISA directed operators to take measure such as deploying power supply vehicles and fire pumps, preventing flooding of buildings, securing water sources, preparing emergency procedures and training, and confirmed their implementation status.	Taken	May, 2011	Available	Taken	May, 2011	Available
	Mid- and long-term measures -Operators are undertaking the installation of permanent emergency generators, strengthening emergency DC sources, raising tide embankments, installing filtered vents and a quake-proof office building.	Ongoing	Systematically taken	---	---	---	---
	Compiling basic principles for regulation of measures responding to severe accidents -NISA is compiling basic principles for regulation of measures responding to a severe accident.				Ongoing	---	---
	Future measures -Under a new regulatory body, based on the amended Reactor Regulation Law requiring measures for severe accidents, NISA will oversee a comprehensive severe accident management program developed by operators				Ongoing	---	---
7. Comprehensive Assessments for Safety of Existing Power Reactor Facilities							
	Development of assessment method and implementation plan -NISA released evaluation methodology composed of primary and secondary assessments and an implementation plan confirmed by NSA.				Taken	July, 2011	Available
	Acceptance of IAEA review mission -IAEA review mission team reviewed NISA's directives and review process for the stress tests, and concluded that they were generally consistent with the IAEA safety standards. IAEA team identified the issues that would enhance overall effectiveness of the stress test process including the secondary assessment and other regulatory activities.				Taken	January, 2012	Available

	Implementation of comprehensive assessments <Primary assessment> -NISA directed operators to assess ensured safety margins for important safety related components and equipment against beyond design basis events. Currently, operators are under assessment. -NISA received 22 reports from operators and is reviewing them sequentially. Of those, NISA finished reviewing Units 3 and 4 of Ohi NPS and Unit 2 of Ikata NPS. NSC confirmed NISA's review results of Units 3 and 4 of Ohi NPS and released its opinion. (As of June 30) <Secondary assessment> -NISA directed operators to assess safety margins to withstand beyond design basis events without causing critical fuel damage. Currently, operators are under assessment.	Taken (Primary assessment completed for some NPPs)	Primary assessment : Before restart Secondary assessment After preparatory work	Partly available	Ongoing (Primary assessment completed for some NPPs)	Sequentially review	Partly available
B2 Design Issues							
1. Emergency Safety Measures Based on the Fukushima Dai-ichi Accident (re-print)							
2. Ensuring Reliability of External Power Supply at NPPs							
	Short-term measures -NISA directed operators to install multiple emergency diesel generators, to ensure common use of electric sources between units and power supply vehicles in order to further enhance reliability based on assessments of the electric power loss due to the Miyagiken-oki earthquake on April 7, 2011. NISA confirmed their implementation.	Taken	June, 2011	Available	Taken	June, 2011	Available
	Mid-term measures -NISA directed operators to connect all units to multiple power lines, strengthen power lines and prevent flooding of the switchyard. Operators are implementing these measures. -NISA directed operators to evaluate seismic safety and take measures securing switchyards against future possible earthquake. Operators are implementing these measures.	Ongoing	Systematically taken	---	---	---	---
3. Review of Basic Design Principles Based on the Fukushima Dai-ichi Accident							
	-NSC examined the Regulatory Guide for Reviewing Safety Design of Light Water Nuclear Power Reactor Facilities, and re-organized the basic principles of the measures for the loss of total AC power supply and the loss of ultimate heat sink.				Taken	March 2012	Available
4. Technological knowledge of Fukushima Dai-ichi Accident (re-print)							
5. Comprehensive Assessments for Safety of Existing Power Reactor Facilities (re-print)							
6. Judging Criteria for Safety on Restart of NPPs							

	The “Judging Criteria for Safety on the Restart of Nuclear Power Plants” were decided at the ministerial level on April 6, 2012, as follows: Criterion (1) The following safety measures have already been implemented to prevent station blackout due to earthquake and tsunami: 1) Measures to protect on-site power supply systems. 2) Measures to protect cooling and water injection systems. 3) Measures to prevent containment failure. 4) Measures to protect control and instrumentation systems. Criterion (2) The national government has confirmed that “the core damage that occurred at the Fukushima Dai-ichi NPS will never occur at the power plants, even in the case of the earthquake and the tsunami of the same scale that struck Fukushima Dai-ichi NPS, by maintaining cooling of the reactor core and the spent fuel pit or the spent fuel pool.” Criterion (3) The operators have specified clear-cut plans to implement measures to achieve further safety and reliability concerning the following matters. Moreover, the operators themselves have surely adopted a proper management system to find out the necessary steps to ensure safety and to make continuous efforts to implement such steps in addition to the prompt application of new regulations to be developed by a new regulatory authority that will be established in the near future. 1) The matters on which further improvements are requested by NISA after its review on the results of the stress tests (primary assessment). 2) 30 safety measures presented in NISA’s report, “Technical Knowledge of the Accident at Fukushima Dai-ichi NPS of TEPCO”.				Taken	April, 2012	Available
B3 Severe Accident Management and Recovery (On-site)							
1. Implementation of Preparatory Measures against Severe Accidents in NPSs							
	Short-term measures -NISA directed operators to take measures concerning severe accident management such as securing the working environment of central control room, securing communication facilities, preparation of materials and equipment such as protective clothing, and the establishment of organizational structure to manage	Taken	June, 2011	Available	Taken	June, 2011	Available

	radiation control, measures to prevent hydrogen explosions and the preparation of heavy machinery to dispose of debris. NISA confirmed their implementation.						
	Mid and long- term measures -NISA directed operators to take measures such as relocating on-site PHS to higher elevation, hydrogen venting to prevent explosions (BWR) and static hydrogen catalytic recombination (PWR). Operator's implementation is ongoing.	Ongoing	Systematically taken	---	---	---	---
2. Reform of Regulation System on Measures for Severe Accidents							
	Renewal of regulations for severe accident management -NSC made policy that safety-securing measures should be enhanced with respect to "prevention of occurrence of severe accidents and mitigation of its effects", including expansion of regulatory requirements and scope of subjects for confirmation.				Taken	October, 2011	Available
	Basic principles on regulation of measures for severe accidents -NISA is examining the defense-in-depth principle, including measures in the event of severe accidents, principles of the external events to be considered, appropriate safety assessment methodology, and the performance goals of these measures, etc., in order to reorganize the basic principles on the systematic regulation of measures against severe accidents based on study results of "Technical knowledge of the accident at Fukushima Dai-ichi NPS"				Ongoing	---	---
	Amendment of the reactor regulation law -In January 2012, The government presented a draft bill of reform of nuclear regulatory organizations to the national Diet which includes amendments of the Reactor Regulation Act, such as changes to safety regulations taking into account severe accidents. After discussions between the government party and the opposition parties, the new bill was submitted to the Diet and passed on June 20. The Act was promulgated on June 27.				Taken	---	---
3. Efforts toward Restoration from the Accident, Decommissioning, etc.							
	Establishment of Principles of Mid-term safety assurance -NISA established the "Principles of Mid-term Safety Assurance" including the basic goal of ensuring safety during the period from the completion of Step 2 to the start of decommissioning operations.				Taken	October, 2011	Available
	-NISA directed TEPCO to conform to the principles, and carefully examined the safety assessment and the management plan related to the water-circulating cooling system.	Taken	December, 2011	Available	Taken	December, 2011	Available

	Completion of Step 2 -Regarding Fukushima Daii-chi NPS, The Nuclear Emergency Response Headquarters judged that "cold shutdown condition" is achieved to confirm the condition that fulfills the following 3 requirements: 1) Temperature at the bottom of the pressure vessel and inside the containment vessel is below approximately 100°C, 2) Conditions are maintained in such a way that a release of radioactive materials from the containment vessel is minimized, and 3) Mid-term safety of the water-circulating injection cooling system is secured And Step 2 of "Road towards Settlement of the Accident at Fukushima Daiichi NPS" was completed.	Taken	December, 2011	Available	Taken	December, 201	Available
	Implementation of Mid-term safety assurance -TEPCO assures safety based on the management plan of the NPP. NISA oversees its activities.	Ongoing	Until start of decommissioning	---	Ongoing	Until start of decommissionin g	---
	Development of mid and long-term road map towards decommissioning -Following completion of step 2, the government and TEPCO's Mid- and Long-Term Countermeasure Meeting determined and announced the Mid- and Long-Term Roadmap towards decommissioning which includes retrieval of fuel from the spent fool pools of Units 1 to 4 and retrieval of fuel debris from reactor pressure vessels and containment vessels of Units 1 to 3.	Taken	December, 2011	Available	Taken	December, 2011	Available
	Mid- and long-term road map of activities towards decommissioning -TEPCO is taking necessary measures towards decommissioning. ANRE oversees its activities.	Ongoing	-Start retrieval of fuel from the spent fool pools (within 2 years) -Start retrieval of fuel debris (within 10 years) -Completion of decommissioning(after 30 -40 years)	---	Ongoing	-Start retrieval of fuel from the spent fool pools (within 2 years) -Start retrieval of fuel debris (within 10 years) -Completion of decommissionin g(after 30 -40 years)	---
B4 National Organizations							
1. Reform of Organizations							
	-Operators will establish a new organization by the end of 2012 in order to further enhance measures including severe accident measures for securing safety of nuclear power stations. -Operators will establish a new organization to propose or recommend safety measures. The new organization is to collect information from foreign sources and to elaborate on safety improvements. -The government presented the draft bill concerning	Ongoing	By the end of 2012	----	Ongoing	----	---

	reform of the nuclear regulatory organization including the establishment of a regulatory authority as an external bureau of the MOE in order to ensure separation of regulating and operating bodies, and to ensure integration of related tasks to the Diet in January, 2012. After discussions between the ruling government party and the opposition parties, in order to create a more independent nuclear regulation authority, the new bill was submitted to the Diet and passed on June 20. The Act was promulgated on June 27.						
2. Enhancement of Nuclear Emergency Response System							
	-The government presented the draft bill concerning reform of the nuclear regulatory system, such as the expansion of the structure and function of the Nuclear Emergency Response Headquarters, amendments to the Act on Special Measures concerning Nuclear Emergency Preparedness for enhanced implementation of emergency drills by operators, re-formulation of governmental and regional plans for measures against disasters, review and enhancement of an offsite center to the Diet in January, 2012. After discussions between the ruling government party and the opposition parties, the new bill was submitted to the Diet and passed on June 20. The Act was promulgated on June 27.	Ongoing	By the end of 2012	---	Taken	---	---
3. Reform of Nuclear Safety Regulation							
	-The government presented the draft bill concerning reformation of nuclear regulatory system, such as, making measures against a severe accident legal obligation, introducing backfitting by which even currently licensed power station should conform to the standards based on the latest technical knowledge, introducing the rule necessitating disclosure of overall risk analysis results for each reactor, introducing the “rule of limitation of operation beyond 40 years” as measures against aging of nuclear reactors, to the national Diet in January, 2012. After discussions between the ruling Government party and the opposition parties, the new bill was submitted to the Diet and passed on June 20. The Act was promulgated on June 27.				Taken	---	---
B5 Emergency Preparedness, Emergency Response and Post-Accident Management (off-site)							
1. Emergency Preparedness and Response							
	Re-examination of emergency guidelines -In order to adopt the lessons learned from the accident and a global way of thinking regarding nuclear emergency preparedness, NSC re-examined “Concerning the Emergency Preparedness in Nuclear				Taken	March, 2012	Available

	Facilities" and it suggested that the Precautionary Action Zone (PAZ) should be roughly 5 km radius, the Urgent Protective Action Planning Zone (UPZ) be roughly 30 km, and the Plume Protection Planning Area (PPA), where protective measures are taken to avoid effects of exposure to a plume containing radioactive materials, be roughly 50 km (reference value).						
	Severe accident measures (re-print) -NISA directed operators to ensure on-site communication systems and oversaw their implementation.	Taken	June, 2011	Available	Taken	June, 2011	Available
	Technical Knowledge of the Fukushima Dai-ichi NPS Accident (re-print) -NISA organized measures as items to be reflected in future safety regulations, such as securing and improving a command post at an accident, securing communication functions, securing facilities to ensure reliability of instrumentation, reinforcement of plant status monitoring functions, reinforcement of monitoring functions at an accident, construction of an emergency response system and implementation of training.				Taken	March, 2012	Available
	Enhancement of emergency preparedness and response system -Operators are taking such measures as installing video conference systems, diversifying communication routes and communication systems power supplies. -The government is taking such specific measures as ensuring reliable information collection and response in the Prime Minister's office, information transmission bases, dispatch of officials at the vice ministerial level to emergency headquarters at the head office of the operator and the launch of video conferencing systems linking the prime minister's office to emergency headquarters of the operator. -The government is taking such measures as securing satellite phones, radiation protection, securing of water and food. As for an alternative off-site center, mobile materials and equipment are to be secured.	Ongoing	Systematically taken	---	Ongoing	---	---

Future measure to enhance emergency preparedness -Operators are planning to implement such measures as a centralized management system of materials such as robots and accident support teams for NPPs. -Under the new regulatory organization, guidelines on nuclear emergency preparedness are to be formulated, and a study is to be conducted on issues such as how off-site centers should function, the results of which are to be reflected in the guidelines on nuclear emergency preparedness, while necessary revisions are to be made to the Basic Plan for Emergency Preparedness and to manuals on nuclear emergency preparedness.	Planned	Systematically taken	---	Planned	---	---
2. Environment Monitoring						
-The government responsibly coordinates with local governments and the nuclear operator and related companies to avoid any omissions in carrying out radiation monitoring, for the purposes of restoring the environment around Fukushima Dai-ichi NPS, conducting more detailed monitoring in response to demands for children's health and people's peace and safety, and providing integrated information in an easy-to-understand manner.				Ongoing	Sequentially taken	---
3. Efforts related to Evacuation zones, etc.						
Fukushima Dai-ichi -The Director-General of the Nuclear Emergency Response Headquarters lifted the designation of the evacuation-prepared zone in case of emergency, on September 30, 2011. On March 30, 2012, a directive was issued to lift the designation of the restricted zone in the relevant areas of Kawauchi Village and Tamura City effective April 1, 2012 and of Minamisoma City effective April 16, 2012, and to newly designate the evacuation-directed zone as a difficult-to-return to zone, a habitation-restricted zone, and a zone being prepared to have the evacuation directive lifted.				Taken	---	---
Fukushima Dai-ni -Prime Minister Noda declared a lift of a nuclear emergency at Fukushima Dai-ni NPS on December 26, 2011, and the designation of the evacuation-directed zone was lifted accordingly.				Taken	---	---
4. Efforts for Dealing with Waste Contaminated with Radioactive Materials						
-MOE and relevant organizations which developed the basic principles and guidelines (Decontamination road map) etc., based on the Act on Special Measures for Dealing with Contamination by Radioactive Materials, are implementing decontamination.				Ongoing	Implement according to the basic principles, decontamination road map, etc.	---
5. Challenges Associated with Disaster Waste, and Others						

-MOE developed the Act on Special Measures for Dealing with Contamination by Radioactive Materials and basic policy for interim storage locations.				Taken	In 2011	Available
-MOE is disposing of waste and soil based on the Act, and managing temporary storage locations and intermediate storage facilities necessary for the disposal of waste and soil based on the policy.				Ongoing	Act whenever necessary	---
6. Activities for Nuclear Damage Compensation						
-Payment of compensation to the government based on the government compensation contract covering Fukushima Dai-ichi				Taken	---	---
-Formulation of guidelines on judgment of the scope of nuclear damage by the Liability Dispute Resolution Committee for Nuclear Damage				Ongoing	---	---
-Mediation by the Center for Solving Nuclear Damage Compensation Disputes to mediate reconciliation for the dispute between victims and TEPCO				Ongoing	---	---
-Support TEPCO compensation for victims by the Nuclear Damage Liability Facilitation Fund				Ongoing	---	---
B6 International Cooperation						
1. Communication with Neighboring Countries and the International Community						
-Japan has emphasized information provision in a prompt and accurate manner and continuously held briefings to diplomatic corps in Tokyo and press conferences for foreign media. -Based on experiences of the accident, Japan provides information to the international community promptly and accurately with maximum transparency and is making every effort for active communication				Ongoing	---	---
2. Cooperation with the International Community						
-Japan has utilized, in close collaboration with other countries, supplies and equipment offered and experts sent from the world from the beginning of the accident -From the standpoint that Japan puts emphasis on cooperation with international organizations, the Government has worked closely with international organizations including the IAEA, the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD/NEA), the Food and Agriculture Organization (FAO), and the WHO through the acceptance of their missions and holding workshops in Japan. -The government has been actively contributing to the international efforts to strengthen international emergency response, such as by making concrete proposals for enhancing IAEA's Response Assistance Network (RANET).				Ongoing	---	---

3. Efforts on Nuclear Safety-related Conventions						
-Based on the Fukushima Dai-ichi accident, Japan proposed to strengthen these nuclear safety-related conventions at international fora such as the G8 Summit and the IAEA Ministerial Conference on Nuclear Safety in 2011.				Ongoing	---	---
-Japan made proposals for strengthening the RANET, which is an implementation framework of the Assistance Convention, and for enhancing the implementation of the Notification Convention in order to strengthen the international notification system for nuclear accidents -Japan will continue to actively contribute to international discussions on strengthening nuclear safety-related conventions, based on knowledge and lessons learned from the accident.				Ongoing	---	---
4. Contribution to and Utilization of IAEA Safety Standards						
-NISA and JNES have made a proposal on the revision of the IAEA safety guides and technical documents to reflect lessons learned concerning the Fukushima Dai-ichi accident. Japan will continuously make contributions.				Ongoing	---	---
5. Acceptance of International Peer Reviews						
- Japan invited IAEA review mission team to review the evaluation method for the stress tests in January 2012.				Taken	January, 2012	Available
-Japan will keep reviewing various measures based on recommendations from IRRS, etc. Japan is going to utilize international peer reviews, including the acceptance of IAEA IRRS after preparations are made at the new nuclear regulatory organization.				Ongoing	---	---

List of Reference Materials

A Introduction

Reference A-1
- Technical Knowledge of the Accident at Fukushima Dai-ichi Nuclear Power Station of Tokyo Electric Power Co., Inc. (March 2012, Nuclear and Industrial Safety Agency)

Reference A-2
- Regarding the Implementation of Emergency Safety Measures for the Other Power Stations Considering the Accident of Fukushima Dai-ichi Nuclear Power Station" (March 30, 2011, Nuclear and Industrial Safety Agency)
- Result of Confirming Implementation Status of the Emergency Safety Measures (May 6, 2011, Nuclear and Industrial Safety Agency)

Reference A-3
- Assessment Procedures and Implementation Plan Regarding the Comprehensive Assessments for the Safety of Existing Power Reactor Facilities Taking into Account the Accident at Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co. Inc. (July 21, 2011, Nuclear and Industrial Safety Agency)

Reference A-4
- IAEA MISSION TO REVIEW NISA'S APPROACH TO THE "COMPREHENSIVE ASSESSMENTS FOR THE SAFETY OF EXISTING POWER REACTOR FACILITIES" Preliminary Summary (23-31, January 2012, IAEA)

B1 External Events

Reference B1.3.2-1
- Proposed Requirements for Incorporation into Safety Design Guide and Other Related Regulatory Guides (Summary) (March 14, 2012, Special Committee on Nuclear Safety Standards and Guides Subcommittee on Safety Design Guide)

Reference B1.3.2-2
- Interim Report on the Evaluation of Earthquake and Tsunami on Nuclear Power Plants Taking into Consideration the Knowledge and Findings of the Tohoku District - Off the Pacific Ocean Earthquake in 2011

Reference B1.3.4-1
- Interim Report on the Evaluation of Impacts of the Tohoku District - Off the Pacific Ocean Earthquake in 2011 on Reactor Buildings, etc. of Fukushima Dai-ichi NPS and Fukushima Dai-ni NPS

Reference B1.3.4-2
- The integrity evaluation of the reactor building at unit4 in the Fukushima Daiichi nuclear power station (May 2012, Government and TEPCO's Mid-to Long Term Countermeasure Meeting Management Council)

Reference B1.3.7-1
- Implementation of comprehensive safety review of existing nuclear power plants based on insights from the accident at the Fukushima Dai-ichi Nuclear Power Station of the Tokyo Electric Power Co., Inc. (July 6, 2011, The Nuclear Safety Commission)

Reference B1.3.7-2
- Confirmation of the Safety of Nuclear Power Stations in Japan (Introduction of safety assessments using stress tests as a source of reference, etc.) (July 11, 2011, Chief Cabinet Secretary, Minister of Economy, Trade

and Industry, Minister for the Restoration from and Prevention of Nuclear Accident)

Reference B1.3.7-3 - Outline of the Fukushima Accident and Safety Measures Taken at the Ohi Nuclear Power Station, Unit 3 and Evaluation of Those Measures

Reference B1.3.7-4 - On the Nuclear and Industrial Safety Agency (NISA) Review of The Comprehensive Safety Assessment (Preliminary Assessment) of The Kansai Electric Power Company Ohi Units 3 and 4 Nuclear Power Plants (March 23, 2012, Nuclear Safety Commission)

B2 Design Issues

Reference B2.2 - Outline on Implementation Status of Emergency Safety Measures by Operators

Reference B2.3.2-1 - Regarding Reliability Assurance of External Power Supply to Nuclear Power Stations and Reprocessing Facilities (April 15, 2011, Nuclear and Industrial Safety Agency)

- Regarding the Evaluation Results about Each Utility's State of Implementation in Response to the Directions related to Securing Reliability of External Power Supply for Nuclear Power Stations, etc. (June 7, 2011, Nuclear and Industrial Safety Agency)

Reference B2.3.2-2 - Proposed Requirements for Incorporation into Safety Design Guide and Other Related Regulatory Guides (Summary) (March 14, 2012, Special Committee on Nuclear Safety Standards and Guides Subcommittee on Safety Design Guide)

B3 Severe Accident Management and Restoration (on-Site)

Reference B3.3-1 - Regarding Implementation of Preparatory Measures for Severe Accidents in Other NPSs Taking into Account the 2011 Accident at Fukushima Dai-ichi NPS (Direction) (June 7, 2011, Minister of Economy, Trade and Industry Banri Kaieda)

- Verification Results of the State of Implementation of Preparatory Measures for Response to Severe Accidents in Other NPSs Taking into Account the Accident at Fukushima Dai-ichi NPS Verification (June 18, 2011, Nuclear and Industrial Safety Agency)

Reference B3.3-2 - Measures against Severe Accidents at Light Water Nuclear Power Reactor Facilities (October 20, 2011, Nuclear Safety Commission)

Reference B3.4.1-1 - Current Status of TEPCO's Fukushima Dai-ichi NPS

Reference B3.4.2-1 - "Roadmap towards Settlement of the Accident at Fukushima Daiichi Nuclear Power Station, TEPCO" Step 2 Completion Report (December 16th, 2011, Nuclear Emergency Response Headquarters Government-TEPCO Integrated Response Office)

Reference B3.4.2-2 - Mid-and-long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Station Units 1-4, TEPCO (December 21, 2011, Nuclear Emergency Response Headquarters Government and TEPCO's Mid-to-Long Term

Countermeasure Meeting)

B5 Emergency Preparedness, Emergency Response and Post-Accident Management (off-Site)

Reference B5.1.1	- Interim Report for Reviewing “Regulatory Guide: Emergency Preparedness for Nuclear Facilities” (March 22, 2012, Nuclear Safety Commission Emergency Preparedness Guidelines Working Group Special Committee on Nuclear Disaster)
Reference B5.3.2-1	- Environment Monitoring
Reference B5.3.2-2	- Efforts for evacuation area etc. - Regarding Declaration on Cancelation of Nuclear Emergency Situation of Fukushima Dai-ni Nuclear Power Station, Tokyo Electric Power Co., Inc. (December 26, 2011, Nuclear and Industrial Safety Agency)
Reference B5.3.2-3	- Efforts for Dealing with Waste Contaminated with Radioactive Materials
Reference B5.3.2-4	- Challenges Associated with Disaster Waste, and Others
Reference B5.3.2-5	- Activities for nuclear damage compensation

B6 International Cooperation

Reference B6.2.1	- Communication with Neighboring Countries and International Community
Reference B6.2.2	- Cooperation with International Community