Executive Summary of the Final Report

July 23, 2012

Investigation Committee on the Accident at Fukushima Nuclear

Power Stations of Tokyo Electric Power Company

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Introduction [I, VI: Introduction]

On March 11, 2011, the Fukushima Dai-ichi Nuclear Power Station (hereafter, "Fukushima Dai-ichi NPS") and Fukushima Dai-ni Nuclear Power Station (hereafter, "Fukushima Dai-ni NPS") of Tokyo Electric Power Company (hereafter, "TEPCO") were damaged in the Tohoku District - off the Pacific Ocean Earthquake and the ensuing tsunami. In particular, an extremely severe accident measuring Level 7 on the International Nuclear and Radiological Event Scale (INES) occurred at the Fukushima Dai-ichi NPS.

The Investigation Committee was established on May 24, 2011 by a Cabinet decision. Its mission is to make policy recommendations, by investigating and verifying the causes of the accident and ensuing damage, on measures to prevent the further spread of damage caused by the accident and a recurrence of similar accidents in the future. The Investigation Committee inspected the accident sites including the Fukushima Dai-ichi NPS and the Fukushima Dai-ni NPS, and interviewed individuals concerned, including the mayors and residents of relevant municipalities. The number of interviewees reached 772 in total. The Investigation Committee published its Interim Report on December 26, 2011 and its Final Report on July 23, 2012.

The Final Report, with the Interim Report as its complementary piece, describes mainly the results of investigations after the Interim Report.

This Executive Summary is a condensed version of the Final Report, mainly Chapter VI of the main text which analyzes the problems and provides recommendations. The contents of the parenthesis [ ] that follow the title indicate the relevant corresponding locations in the Final Report (Main text). Recommendations are indicated in bold.

1. Analyses of Major Problems

(1) TEPCO responses to the accident and the damage to the plant

a. Problems with the on-site response at the Fukushima Dai-ichi NPS in comparison with that of the Fukushima Dai-ni NPS [II-5. (8), VI-1. (1) a.]

Problems regarding the response to the accident at the Fukushima Dai-ichi NPS are as described in the Interim Report. The following problems have also become clear since the compiling of the Interim Report, as a result of comparative review against the newly-investigated response at the Fukushima Dai-ni NPS.

(a) Alternative means of water injection at Unit 3

At Unit 3 of the Fukushima Dai-ichi NPS, an alternative means of water injection was not prepared before the manual shutdown of the High Pressure Coolant Injection system (HPCI). Consequently, the injection of water to the nuclear reactor was cut off for more than six hours. At the Fukushima Dai-ni NPSs, basically, an alternative means of water injection to be taken was first verified to actually function before switching to the alternative means of water injection, although there were differences in the detailed procedure.

As off-site power was available at the Fukushima Dai-ni NPS, the working environment there was better in comparison with the environment at the Fukushima Dai-ichi NPS. As such, the staff in charge of responding to the situation at the Fukushima Dai-ni NPS were deemed to be in better psychological conditions. Nevertheless, even upon consideration of these points, the response made at the Fukushima Dai-ichi NPS was not appropriate.

(b) Monitoring of S/C pressure and temperature at Unit 2

At Unit 2 of the Fukushima Dai-ichi NPS, the Reactor Core Isolation Cooling System ("RCIC") continued to operate after the complete loss of power on March 11, but as a result of the power loss it could not be controlled and interruption of its operation could be interrupted at any moment. Under such conditions, the water source for the RCIC was switched from the condensate storage tank to the Suppression Chamber (S/C) after approximately 04:00 on March 12. However, in the event that the Residual Heat Removal system could not achieve the expected cooling due to the power loss, maintaining this operational method for a long period of

time would cause S/C pressure and temperature to rise, and the RCIC cooling capability and water injection capability to weaken. Furthermore, it could become difficult to depressurize the reactor by the operation of the main steam Safety Relief Valve (SRV) for an alternative water injection method using the fire protection system lines by fire engines, should the RCIC fail to function. As such, it is considered necessary to have continually monitored the S/C pressure and temperature, prepared the fire engine water injection lines, and conducted reactor depressurization without waiting for the RCIC to stop functioning. However, in reality, these measurements were not made till around 04:30 on March 14, and the alternative water injection was not implemented promptly either.

At the Fukushima Dai-ni NPS, on the other hand, the SRVs were opened in phases and water was injected through the Make-up Water Condensate System (MUWC), by monitoring the S/C pressure and temperature while the RCIC was still in operation, in consideration of preparing an uninterrupted water injection process.

As described previously in (a) above, it should be pointed out that the response measures taken at the Fukushima Dai-ichi NPS were inappropriate in comparison with the measures taken at the Fukushima Dai-ni NPS, regardless of different circumstances at the Fukushima Dai-ichi NPS and the Fukushima Dai-ni NPS.

b. The need to continue thorough clarification of the damage [VI. 1 (1) b.]

Although the Investigation Committee has put its utmost effort into the investigation and verification of the truth, there are still points that it has been unable to clarify as of this point in time, due to the difficulties of conducting on-site investigations as well as time limitations. These include details of the overall damage incurred, including the damaged areas in the main facility of the Fukushima Dai-ichi NPS, the degree of damage, and the development of events over time. The background to the leakage of radioactive substances and the causes of the explosions in the reactor buildings are also included therein. Almost all stakeholders (relevant organizations) in the field of nuclear power generation, including the national government, nuclear power operators, nuclear power plant manufacturers, research institutes and related academic societies, are in position to shoulder the responsibility of undertaking thorough investigation and fact analyses on the accident. They should take an organizational stance and

continue, in their respective capacities, comprehensive and thorough investigation and verification of the unresolved issues.

(2) Responses to the accident by the government and other bodies

a. Local Nuclear Emergency Response Headquarters [III. 5. (4), VI. 1 (2) a.]

The Nuclear Emergency Response Manual of the government is drawn up based on the ground that the Off-site Center actually functions, where the Nuclear Emergency Response Local Headquarters is established. However, that ground failed to stand in the event of this accident, and consequently, the response measures stipulated in the Nuclear Emergency Response Manual could not be taken.

To begin with, the measures to ensure the continued functionality of the Off-site Center even at a severe accident should have been in place, and further, the measures should also have been taken to facilitate response to such an accident in case of failure of the functional failure of the Off-site Center.

Moreover, with respect to the delegation of authority from the Director-General of the Nuclear Emergency Response Headquarters (hereafter, "NERHQ") to the Director-General of the local response headquarters (hereafter, "Local NERHQ"), the staff from the Nuclear and Industrial Safety Agency (hereafter, "NISA") missed a chance to seek approval from Prime Minister Naoto Kan who was acting as the Director-General of the NERHQ. They also failed to act proactively to get the approval despite repeated requests from the Local NERHQ to check on the progress of delegation procedures. Furthermore, the staff of the Cabinet Secretariat and Cabinet Office also failed to drive the NISA staff to carry forward the delegation procedures. The problem arose that no delegation procedures were carried out after all.

Under such circumstances, the Local NERHQ consulted the Secretariat for the NERHQ within the Emergency Response Center (ERC) of METI, made various decisions on the implementation of such as evacuation measures and implemented them, seeking to take all necessary steps promptly and without fail, assuming that the delegation of authority was already complete.

b. Nuclear Emergency Response Headquarters [III. 2. (1), 4. (2), VI. 1. (2) b.]

(a) Response within the Prime Minister's Office

According to the Nuclear Emergency Response Manual, the NERHQ is to be set up at the Prime Minister's Office to serve as the center for emergency response by the government, in the event of a nuclear disaster. In addition, the Emergency Response Office of the Prime Minister's Office is to be set up within the Crisis Management Center located in the basement of the Prime Minister's Office, with the role of collecting information, reporting to the Prime Minister, and centralizing coordination of overall government activities. Director-general level personnel from each Ministry and Agency concerned are to gather at this Crisis Management Center and to make up an Emergency Operations Team. In order to facilitate prompt and accurate decision-makings during an emergency, this Team is expected to consolidate quickly the information brought to the Center from each Ministry and Agency, and coordinate the opinions in a flexible manner.

However, in the case of the accident this time, many of the important decisions that were made in relation to the responses to the accident, including evacuation measures, were undertaken by relevant Cabinet members, the Chairman of the Nuclear Safety Commission of Japan (hereinafter ,"NSC"), senior NISA key officials and senior TEPCO officials in a room in the mezzanine floor in the basement of the Prime Minister's Office or in the fifth floor of the Prime Minister's Office, away from the Crisis Management Center (Emergency Operations Team). **The emergency responses should, in general, be based at a location close to the accident site where the relevant information is easy to obtain in a nuclear emergency, and the activities at the accident site are easy to grasp.** This time the decision-making was made in the Prime Minister's Office (fifth floor of the Prime Minister's Office, for instance), at a distance from the ERC which served as the government's base for the collection of information on the Fukushima Dai-ichi NPS, and even in the Prime Minister's Office the decisions were made in places separated from the Crisis Management Center which served as the base for the gathering of information. This resulted in a lack and bias in information, creating a situation where a decision had to be made without sufficient information. This is a major lesson that should be drawn from the responses to this accident.

On March 15, 2011, the Integrated Headquarters for Response to the Incident at the

Fukushima Nuclear Power Stations was established in TEPCO's Head Office. While this may be evaluated positively as an attempt to improve the accessibility of information pertaining to the Fukushima Dai-ichi NPS, the information required for the government's response was not necessarily information related to TEPCO. In addition, as there is a possibility that similar accidents may occur in nuclear power stations under other power companies that do not have head offices in Tokyo, the Fukushima incident should not be regarded as a universal precedent. **To promptly collect accurate information is, needless to say, the fundamental element in responding to a nuclear emergency. The government emergency response headquarters should be set up in a way which enables the government people access to the necessary information while staying in government facilities like the Prime Minister's Office, without moving to the nuclear operator's head office.**

(b) Problems with collection of information

As described in detail in the Interim Report, there was hardly anyone at the ERC, who had known that the TEPCO Head Office and the Off-site Center were obtaining on-site information via the TEPCO's television-conference system, and no thought was given to setting up a TEPCO's television-conference system terminal in the ERC, and there were not any such proactive steps taken as to dispatch NISA staff to the TEPCO's Head Office to get relevant information.

c. Fukushima Prefecture Nuclear Emergency Response Center [IV. 3. (2) b., VI. 1. (2) c.]

Fukushima Prefecture established the Fukushima Prefecture Nuclear Emergency Response Center (hereafter, the "Prefectural Emergency Response Center") on March 11, 2011, with the Governor of Fukushima heading the Center. While the purpose of the Center had been to take response measures to the accident, insufficiencies in internal and external coordination by the Prefectural Emergency Response Center gave rise to problems such as significant delays in the evacuation and rescue of patients in Futaba Hospital, who had been left behind in the evacuation area.

In order to prevent the recurrence of such situations in the evacuation and rescue of victims from disaster areas, there is a need: To make firstly the team organization in the emergency

response center, that is set up by a prefectural government, cross-sectional and functional depending on measures that should be taken, rather than to simply bring together the personnel in a vertical manner from the existing relevant organizations. On top of that, there is a need to establish a framework that is able to oversee and coordinate the overall situation, as well as a need to strengthen mutual communication between each team; and secondly, to prepare in the disaster prevention plan, too, a system to respond to a disaster by not only the staff who will be based in the emergency response center in the prefecture, but also, whenever necessary, the entire government personnel.

In a nuclear emergency, the prefectural government should take a responsible role in front, because the damage can extend to a regional size. The nuclear emergency preparedness should take this point into account.

d. Analyses of other specific responses [III. 2. (1), VI. 1. (2) d.]

(a) Declaration of a nuclear emergency

At about 17:42 on March 11, 2011, Minister of Economy, Trade and Industry, Banri Kaieda, together ("METI Minister Kaieda") with Director-General of NISA, Nobuaki Terasaka ("NISA Director-General Terasaka"), being accompanied by other officials reported to Prime Minister Kan on the occurrence of a nuclear emergency as defined by Paragraph 1, Article 15 of the Act on Special Measures Concerning Nuclear Emergency Preparedness. At the same time, they requested approval for the declaration of a nuclear emergency. However, NISA Director-General Terasaka and the accompanying officials were unable to provide sufficient explanations to the questions by Prime Minister Kan, when questioned on the situation of the nuclear reactors at the Fukushima Dai-ichi NPS as well as on related legislation. As time passed, the petition proceedings were temporarily suspended because Prime Minister Kan had to leave them about five minutes after around 18:12 on the same day, in order to attend a meeting among party leaders that had been scheduled. After returning from the meeting, Prime Minister Kan soon gave his approval for the declaration of a nuclear emergency, and the declaration was issued at 19:03 on the same day.

Generally, as the situation may develop suddenly and rapidly during a nuclear disaster, it is believed that priority should have been given to the declaration of a nuclear emergency, rather

than a search for details on the development of the situation and on relevant laws.

(b) Inspection visit to the Fukushima Dai-ichi NPS

Prime Minister Kan implemented the inspection visit to the Fukushima Dai-ichi NPS on March 12, 2011, for reasons including the lack of adequate information pertaining to the accident at the Fukushima Dai-ichi NPS. This inspection visit ended without any accident and apparently did not affect venting procedures at the Fukushima Dai-ichi NPS after all. However, a question still remains as to whether a less problematic step should have been taken by, for instance, dispatching another person to check the situation, instead of having the Prime Minister, who is the supreme commander, staying absent from the Prime Minister's Office for long time in the event of such a large-scale disaster and accident, taking a risky inspection tour to, and visiting, the accident site where the site staff were being pre-occupied with emergency response.

(c) Involvement of the Prime Minister's Office in Specific Response to the Accident

At slightly past 18:00 on March 12, 2011, Prime Minister Kan received a report from METI Minister Kaieda about his order to inject seawater into Unit 1 of the Fukushima Dai-ichi NPS, issued immediately before the report. Prime Minister raised a question of whether or not there would be a possibility of recriticality if seawater were injected into the nuclear reactor. In response, as the Chairman of the Nuclear Safety Commission, Haruki Madarame ("Chairman Madarame"), who was present on the scene, did not deny the possibility, Prime Minister Kan instructed to further review the pros and cons of injecting seawater. TEPCO Fellow, Ichiro Takekuro ("Fellow Takekuro"), who was also present there, made a telephone call to Fukushima Dai-ichi Site Superintendent Yoshida slightly after 19:00 on the same day, and made a strong request to "suspend the injection of seawater as the issue was being reviewed in the Prime Minister's Office."

When Prime Minister Kan had raised a question about the possibility of recriticality, there were several individuals present with expertise about nuclear reactors, such as NISA Vice Director-General Eiji Hiraoka and TEPCO Fellow Takekuro as well as Chairman Madarame. None of them, however, gave an appropriate reply. None of them assumed the job of an expert. There was also a problem of the attitude of TEPCO management personnel, who jumped to a

request to suspend the injection of seawater without giving much consideration.

As such, actions that would be extremely relevant to on-site response should first be taken based on the judgment of nuclear operators in their responsibility, which are in the best position to grasp the on-site situation, and possess special and technical knowledge. The government and the Prime Minister's Office, while gaining a good understanding of the response measures taken and reviewing the measures carefully to assess if they have been appropriate, should leave the response action to the operator, if the operator is taking the appropriate response, and only if the response is assessed to have been inappropriate or inadequate, they should issue an order for the appropriate actions. It should be considered inappropriate for the government and the Prime Minister's Office to spearhead the response and intervene in the on-site response from the onset of the incident.

(3) Measures to prevent the expansion of damage

a. Unique characteristics of a nuclear accident [VI. 1. (3) a.]

A large-scale accident that occurs at a nuclear power station is not regarded simply as a serious accident in the sense of devastating damage to facilities and equipment. Rather, a nuclear accident is extremely extraordinary in the sense of having a level of impact that is not seen in other types of accidents, because, for instance, it causes, by the dispersion of leaked radioactive substances, an impact on the health and lives of residents over a wide area, contaminates urban areas, farms, forests, and seawater, brings economic activities to a standstill, and eventually jeopardizes the local community. In the investigation and verification of such nuclear accidents, there is a need to clarify the causes of the accident and the background to the event, as well as to assess if measures taken to prevent the occurrence and spread of damage have been appropriate. If the measures taken have not been sufficient, there is then a need to assess the reasons behind that. These problems must be investigated and analyzed from many perspectives in order to uncover policies that should be in place to prevent damage.

b. Monitoring readiness [IV. 1. (2) a., VI. 1. (3) b.]

Although problems pertaining to monitoring have already been reviewed in the Interim Report, the Investigation Committee would like to examine the division of monitoring roles in

the event that the Off-site Center fails to function.

In this accident, the monitoring activities based in the Local NERHQ within the Off-site Center were insufficient. Therefore, on March 16, 2011, the division of roles of the related organizations was coordinated. It was decided then that the consolidation and release of monitoring data from the respective organizations would be undertaken by the Ministry of Education, Culture, Sports, Science and Technology ("MEXT"), the assessment of data would be undertaken by the NSC, and response measures based on the assessment conducted by the NSC would be undertaken by the NERHQ. However, it is difficult to assess that a decision was made with adequate coordination beforehand, amidst a situation that requires an urgent response, among the related organizations, with regard to the range of data assessment.

The need to decide on the division of roles under such emergency situations is believed to be a result of not assumed functional failure on the part of the Local NERHQ (the Off-site Center), which was to be responsible for the series of work processes, from the consolidation of monitoring data, assessment and release of information, to the implementation of responses based on the assessment. A lesson drawn from this incident is the need to review monitoring readiness development.

c. SPEEDI utilization policy [IV. 2. (1), (3), (4), VI. 1. (3) c.]

(a) Problems with the systems and the entities that make use of them

The System for Prediction of Environmental Emergency Dose Information (SPEEDI) is a system that can predict radiation dose rates in the surrounding environment when a nuclear accident occurs, based on the emissions source information that is transmitted from the Emergency Response Support System (ERSS). However, the ERSS may fail to function when an accident occurs. The policies of utilizing SPEEDI under such circumstances should have been reviewed beforehand, and the results of the review should have been shared among the personnel who have roles in responding to the accident.

Nevertheless, many of the individuals who were responsible for taking response measures in the event of an accident had a belief that there would no room to allow for the utilization of SPEEDI in evacuation activities once the ERSS failed to function. The Guideline for Environmental Radiation Monitoring has a clause on the methods of utilizing SPEEDI in the

event that emissions source information cannot be obtained. However, no consensus had been reached on whether this could be applied to evacuation activities. Furthermore, no clarification had been made as to the entities that would make use of SPEEDI (operation and public announcement) in the event that an off-site center failed to function.

(b) SPEEDI and evacuation orders

One of the major reasons as to why SPEEDI was not effectively utilized, as described in (a) above, is considered to lie in the fact that any of the relevant organizations did not have the idea of using it in the implementation of evacuation activities, being in preconception about the impossibility of utilizing SPEEDI in evacuation activities when emissions source information could not be obtained from the ERSS. However, prediction results through SPEEDI that assumed the unit emissions had been actually obtained; it may be concluded that, if that information were distributed, the respective local governments and residents could have been able to select a more appropriate timing or direction to evacuate. Even if emissions source information could not be obtained from the ERSS, it is believed that there was room of allowance for the utilization of SPEEDI.

d. Evacuation orders for residents [IV. 3. (1) b., (2), VI. 1. (3) d.]

The problems pertaining to evacuation orders to residents are discussed in the Interim Report. The following points are raised in light in addition based on the investigations and verification conducted after the Interim Report.

(a) Evacuation orders to areas beyond 10km radius from the Fukushima Dai-ni NPS

At 17:39 on March 12, 2011, an evacuation order was issued for the evacuation to areas beyond 10 km radius from the Fukushima Dai-ni NPS. This evacuation order was issued on the fifth floor of the Prime Minister's Office, based on a judgment that preparations in readiness would be necessary for the possibility of an incident occurring at the Fukushima Dai-ni NPS, similar to the explosion at Unit 1 of the Fukushima Dai-ichi NPS at 15:36 the same day. The judgment was not based upon the information on the specific conditions at each unit of the Fukushima Dai-ni NPS, such as the injection of water into the nuclear reactors, or the water

levels and pressures in the nuclear reactors.

At 18:25 of the same day, approximately one hour after this evacuation measure was taken, an evacuation order was issued for evacuation to areas beyond 20 km of the Fukushima Dai-ichi NPS. A very limited part of the northern area of Hirono Town was not within the 20 km radius zone from the Fukushima Dai-ichi NPS, and it would not have been included in the evacuation area upon order if an evacuation order for evacuation to areas beyond 10 km from the Fukushima Dai-ni NPS had not been issued. The order for evacuation to areas beyond 10 km from the Fukushima Dai-ni NPS was issued, based on a judgment that had been made amidst confusion due to insufficient information and based on the explosion in the nuclear reactor building at Unit 1 of the Fukushima Dai-ichi NPS. The plant conditions at the Fukushima Dai-ni NPS were then, in fact, comparatively stable. As such, problems remained with the decision-making process of the evacuation order in question.

(b) Evacuation of hospital patients, etc.

With regard to the Futaba Hospital, where many bedridden patients had been accommodated, the evacuation response could only be assessed as having been inappropriate, for instance: the rescue of warded patients had been greatly delayed; and the transportation destination for those who had been rescued was a gymnasium of a high school in remote location. In order to prevent the recurrence of such situations, in addition to the measures as described in (2) c. above, there is a need for the Self-Defense Forces, which is responsible for evacuation, to make sure to secure a communication system with external parties, for instance, by seeking the cooperation of the prefectural police which owns a police radio system. Needless to say, those who are responsible for the rescue of human lives should gain a renewed awareness of the weight of that responsibility, and undertake their duties with a strong sense of that responsibility.

e. Response to radiation exposure [IV. 4. (3) b. (c), (5) a., b., (6), 5. (2) a., VI. 1. (3) e.]

(a) Problems of not using APDs

To workers on duty at the Fukushima Dai-ichi NPS (radiation workers) after the accident, it was vital for each worker to wear an alarm pocket dosimeter (APD) in order to measure the radiation dose they received and avoid excessive exposure above the exposure limits. However,

in the Fukushima Dai-ichi NPS, the APD that had originally been stocked were damaged with water and became useless. As a consequence, the workers commenced work since March 15, 2011 under extraordinary conditions whereby only the group representatives wore an APD. This situation continued till March 31.

Investigations into this problem found that a total of 950 APDs actually had been delivered from other power plants immediately after the accident, but that these APDs had remained unused for reasons such as the unavailability of corresponding power chargers and devices for alarm settings.

Looking at the background to these events, it should be pointed out that the level of awareness among TEPCO staff was low concerning the prevention of radiation exposure of on-site workers. This suggests an insufficient understanding of the widely accepted stance of the International Commission on Radiological Protection (ICRP), which stipulates that radiation exposure should be kept as low as possible. Therefore, it is determined that there were problems with TEPCO's radiation education in the area of avoiding radiation exposure.

(b) Orders from the government concerning the intake of iodine tablets

On March 13, 2011, the Medical Squad of the Local NERHQ commenced preparations to issue an order from the Director-General of the Local NERHQ, concerning the screening level. During that process, the NSC delivered a FAX transmission to the ERC with the comment that stable iodine tablets should be administered to those whose radiation contamination exceeded the screening level. A liaison officer dispatched from the NSC to the ERC received this transmission, but this comment was not shared and reviewed among the ERC Medical Squad, and was not communicated to the Local NERHQ, either. This was considered to be the result of a lack of awareness, on the part of the NSC liaison officer, of the importance and necessity of incorporating the NSC comments into orders to be issued by the Head of the NERHQ.

On the other hand, it is to be pointed out that the NSC, too, lacked a sense of responsibility as an administrative agency that controls the safety of the people. This is evident through the fact that, despite the awareness that the abovementioned comment would probably not be included in the abovementioned order, the NSC did not take any further action based on the excuse that the NSC was ultimately an advisory body, and had thus already provided advice on an item that

it should provide advice on.

(c) Orders from the local governments concerning the intake of iodine tablets

At midnight on March 14, 2011, the Miharu Town administration decided to distribute and issue orders for the intake of stable iodine tablets, based on an anticipation of residents' exposure to radiation. On March 15, this was announced to the residents of the town. Under the supervision of pharmacists, stable iodine tablets were distributed to the residents. A Fukushima Prefecture government staff that came to know of this fact issued an order to suspend the distribution and recall the tablets, based on the reason that no instructions had been received from the national government. However, the Miharu town administration did not comply. Considering the fact that the NSC's opinion about the administration of stable iodine tablets was dismissed as outlined in (b) above, it cannot be concluded that the decision by the Miharu Town administration was inappropriate simply because it had not been backed by an instruction from the national government. **In the existing emergency preparedness, administration of stable iodine tablets is, in principle, subject to the judgment of the government nuclear emergency response headquarters. However, in view of the aforementioned incident, a system which allows local municipalities to independently administer the tablets should be reconsidered, and so is the appropriateness to distribute them in advance to the residents as a precaution.**

(d) Raising the screening level

Fukushima Prefecture initially established the screening level at 40 Bq/cm^2 (equivalent to 13,000 cpm). However, it raised on March 13, 2011 the screening level for whole-body decontamination to 100,000 cpm, effective from March 14, 2011. Knowing about the intentions of the Fukushima Prefecture government to raise the screening level, the NSC advised the ERC that the screening level should be kept at 13,000 cpm. However, on March 19, the NSC renewed its advice that endorsed raising the level to 100,000 cpm, and on March 20, the Director-General of the Local NERHQ issued the order to set the screening level at 100,000 cpm.

However, at the time, it was more important to formulate policies for detailed

decontamination methods (removal of clothes, wiping off, etc.) corresponding to doses, rather than raising the screening level for whole-body decontamination (shower). Furthermore, the NSC advice, which allowed for the 100,000 cpm screening level, as well as the order issued by the Director-General of the Local NERHQ based on that advice, posed problems, too. By simply raising the screening level to 100,000 cpm, no decontamination procedures were specified for those detected to have radiation levels of 13,000 cpm or higher but below 100,000 cpm, and left room for an interpretation that decontamination was not required for such people.

Moreover, problems also arose in the communication between the national and prefectural governments with respect to screening levels, such as the fact that orders issued by the Director-General of the Local NERHQ on March 13 were not communicated to the team in-charge at the Prefectural Emergency Response Center. In emergency situations such as this, it is vital to acknowledge the importance of sharing important information among the personnel in charge, to nominate a person, who is adept in coordinating the relevant administrative organizations, at the top of the emergency response department (team), and to take response measures in a unified manner among the related national and local administrative organizations.

(e) Standards for the use of school buildings and schoolyards

MEXT announced its stance on April 19, 2011, with respect to criteria for the use of school buildings and schoolyards : restricting activities on schoolyards to about one hour per day at schools that have an air dose rate measuring 3.8μSv/h (annually, this corresponds to the 20mSv that ICRP has established as the upper limit of the reference level for “existing exposure situations”) or above; and permissible to continue using school buildings and schoolyards as usual at schools that have an air dose rate measuring below 3.8μSv/h. This announcement raised criticisms and concerns about the lack of consideration for children by obviously allowing radiation exposure up to 20mSv/year of radiation exposure, as well as about the lack of sufficient prior explanations and publicity.

Certainly the MEXT explanations at the time might have been comprehended as establishing 20m Sv/year as a reference value for the use of school buildings and schoolyards. It is difficult to say that such an explanation could allay the strong sense of anxiety and unease toward radiation, and it was not appropriate from the point of view of risk communication, either.

Furthermore, there is still room for debate as to whether it was appropriate to apply the upper limit of the value, that is used under "existing exposure situations," to school buildings and schoolyards that were used by children, who are generally considered to be more susceptible to the influence of radiation than adults.

Later, MEXT re-estimated an exposure dose that corresponded more closely to typical living conditions, and set a figure of 10m Sv/year or lower. However, the government should not feel satisfied in a figure of 10 mSv/year, but should have put in place policies to reduce the exposure dose to the extent possible, in consideration of the fact that radiation has a greater impact on children than on adults, and of the ICRP recommendation seeking a reduction, as far as possible (optimization of protection), of the exposure dose under reference level of 1 to 20 mSv/year set out in the "existing exposure situations". Even for schools that have an air dose rate measuring below 3.8 μSv/h, it would have been appropriate to make further attempts to reduce exposure dose by, for instance, setting criteria for activities within the schoolyards.

(f) Radiation emergency medical care institutions

Six hospitals had been designated as initial radiation emergency medical care institutions for response to accidents such as that which occurred at the Fukushima Dai-ichi NPS. But four these six hospitals were unable to fulfill their function as radiation emergency medical institutions because they were included in the evacuation area. Therefore, **a considerable number of medical facilities for radiation emergency medical treatment should be located in the area which is not likely to be included in an evacuation designated area, so that radiation emergency medical care could be provided even in a severe accident like the accident at the Fukushima Dai-ichi NPS. Those medical facilities should not be concentrated in the area close to the nuclear power station. At the same time, such medical care systems in a nuclear emergency would need to be coordinated for collaborating over a wide area across the prefectural borders.**

(g) Public understanding of radiation effects

This accident has served as a reminder of the need not only to take all possible precautions in order to protect ourselves against radiation, but also to "fear radiation properly." There is, of

course, a need to put utmost effort into preventing unnecessary exposure in the future, and at the same time, **as many opportunities as possible should be institutionalized for the public to get knowledge and deepen their understanding of radiation. By doing so, the individuals would be able to judge the radiation risks based on correct information; in other words, they would be freed from unnecessary fears about, or from underestimating, the radiation risks because of the lack of information.**

f. Analysis concerning the provision of information to the public [IV. 8. (2), (4), (5), (8), (9), VI. 1. (3) f.]

(a) Prior consent from the Prime Minister's Office

On March 12, 2011, NISA Deputy Director-General, Koichiro Nakamura, announced the possibility of a "core meltdown" at Unit 1 of the Fukushima Dai-ichi. The relevant parties who had been gathered at the Prime Minister's Office had not received any prior report of a possible core meltdown. Knowing the announcement, they saw as problem that NISA had announced a fact unknown to the Prime Minister's Office without informing the Prime Minister's Office of it in advance, and requested a prior report on the contents before the announcement. Consequently, based on a decision made by NISA Director-General Terasaka, NISA decided to obtain prior consent on the contents of press announcements from the Prime Minister's Office. Starting on March 13, TEPCO also decided to obtain consent from the Prime Minister's Office prior to its press announcements, thereby leading to delays in these press announcements.

It is natural for the Prime Minister's Office, which should serve as the center of the government for decision-making and announcements, to seek prompt provision of information. But, requiring a prior consent for making press announcements could create a situation where urgent information cannot be released immediately. It is not necessarily appropriate to seek prior consent from the Prime Minister's Office for the release of all information, as there are cases where each public relations organization needs to make announcements by its own decision, regarding urgent information.

(b) NISA publicity that actively negated a core meltdown

NISA started seeking prior approval from the Prime Minister's Office for the content of press

announcements as noted in (a) above. Evidences show that some of the spokespersons of NISA began to make awkward statements thereafter in efforts to avoid a reference to a "core meltdown." For instance, at a press conference by NISA on March 14, 2011, when NISA spokesperson Hidehiko Nishiyama affirmed the possibility of a core meltdown or made comments to the effect of not denying the possibility of a core meltdown, another NISA staff who was also at the press conference stated "I think the situation has not reached the stage of such as a meltdown" – as if to dismiss the statement and negate actively the possibility of a core meltdown.

Regardless of the subjective knowledge underlying the remarks made by the abovementioned NISA staff, the remarks actively negated the possibility of a core meltdown, which was a fact hard to deny. As such, these remarks were extremely inappropriate in the sense that they had misguided local residents and emergency response staff at the central government and on site, who were desperately in need of information.

(c) Publicity about the impact of radiation

When conducting publicity activities concerning radiation exposure or concerns for radiation exposure to residents during the accident at the Fukushima Dai-ichi NPS, the government often used the expression "immediate" ("no immediate effect on the human body"). However, the expression "There is no immediate effect on the human body" could refer to "there is no need to worry about the effect on the human body" or conversely, "while there is no immediate effect on the human body, there are long-term effects to the human body." It was not necessarily clear which meaning the expression had been used in reference to. Expressions such as this, which could be comprehended in more than one way, should be avoided in the use of publicity in times of emergency, and is an important issue to be reviewed in the future from the perspective of risk communication.

(d) Problem with non-publicity of the "sketch of a contingency scenario"

On March 22, 2011, Prime Minister Kan made a request to the Chairman of the Japan Atomic Energy Commission, Shunsuke Kondo, to provide a hypothesis of the worst-case scenario for the accident at the Fukushima Dai-ichi NPS, and the measures to be taken in the

event of such a scenario. In response to this request, Dr. Kondo drew up a "Sketch of a Contingency Scenario for the Fukushima Dai-ichi Nuclear Power Station" (hereafter, the "Sketch"). On March 25, Dr. Kondo submitted the Sketch to Special Advisor to the Prime Minister, Goshi Hosono (Special Advisor Hosono). Special Advisor Hosono reviewed the measures laid out in the Sketch, but did not release the Sketch publicly.

As the Sketch had been a simulation based on a hypothetical scenario with a low probability of taking place in real life, it cannot be flatly said that the action of not releasing the document publicly was inappropriate. However, generally speaking, there can be also an option of releasing it, even for a simulation based on a hypothetical scenario. This can be carried out with a thorough explanation of the preconditions behind the simulation, and with consideration given to factors such as the need for publication, the presence or absence of measures in response to the simulated results of the scenario, and the timing of the publication.

g. Distribution of information overseas and coordination with international community [IV. 9, 10. (2), VI.1 (3) g.]

(a) Sharing of information with international community

After the onset of the accident, Japan did not necessarily provide information pertaining to the accident to other countries in a satisfactory manner. **Provision of information to overseas countries is equally important as to the Japanese public, especially to neighboring countries or those countries which have many of their nationals residing in Japan. Active and careful responses should be in place for prompt and accurate provision of relevant information with due consideration to language barriers.**

(b) Receiving support from other countries

There were flaws in the way Japan received relief supplies from other countries, and in addition there were no storage space for the supplies that were received. For these reasons, Japan was initially not able to receive provisions of relief supplies immediately. **International support in a nuclear emergency should be accepted and received as early as possible, when offered, for international comity and for urgently meeting national needs. To avoid confusion and inappropriateness experienced in the early stages at the time of the**

accident, operation manuals of competent ministries, nuclear operator emergency management operation plans and other relevant materials should prescribe how to respond to such international support.

(4) Accident preventive measures and emergency preparedness

a. Need for comprehensive risk analysis and severe accident measures [V. 3. (1). (2), VI. 1. (4) a.]

(a) The background of why accident management, targeting external events, not introduced

In Japan, only measures for incidents arising as a result of internal events have been drawn up as part of accident management programs. External Events such as earthquakes and tsunamis were not viewed as targets for specific consideration.

A couple of reasons can be provided as a background to the abovementioned situation, including: the Probabilistic Safety Assessment (PSA) that is regarded as a useful means of reviewing severe accident measures was still limited as a means, because the PSA for external events established prior to the Fukushima nuclear accident was only the seismic PSA; the Periodic Safety Review (PSR) failed to offer opportunities for improving severe accident measures, in consideration of technological advancements of PSA for external events; or the early introduction of the PSA had not been considered due to factors such as work pressure on seismic back checks, despite the suggestions by some that the implementation of external event PSA and of reasonable additional measures, if there had been any, should have been encouraged.

Consequently, comprehensive risk analysis for external events was not conducted, encompassing analysis through seismic PSA and safety analysis for tsunami, and fires, volcanoes, and slope collapses, which could cause a disaster, were not conducted.

(b) Need for comprehensive risk analysis

Nuclear facilities are installed in a natural environment, which is really diversified. Nuclear operators should conduct comprehensive risk analysis encompassing the characteristics of the natural environment including the external events, not only earthquakes and their accompanying events but also other events such as flooding,

volcanic activities or fires, even if their probabilities of occurrence are not high, as well as the internal events having been considered in the existing analysis. Nuclear regulators should check the operators' analysis.

In doing so, nuclear operators should actively utilize currently available methods in their analyses of such external events, even if the PSA approach is not firmly established for them. The government should consider support to promote relevant research programs for such initiatives.

(c) Formulation of severe accident measures in consideration of comprehensive risk analysis

In order to ensure maintaining nuclear safety at nuclear power stations, vulnerability of individual facilities for a wide range of characteristics of various internal and external events should be identified by comprehensive safety analysis encompassing external events also, and appropriate measures (severe accident management) against such vulnerability should be examined and placed in shape, assuming a situation in which the core may have serious damage by an accident far exceeding the design basis. The effectiveness of such severe accident management should be evaluated through the PSA or other means.

Under such circumstances, there may be restrictions in risk analysis methods due to factors such as immaturity in PSA techniques. Nevertheless, nuclear operators should review and assess severe accident measures in order to ensure the safety of their own facilities, in consideration of the characteristics and limitations of the risk analysis method employed. In conducting this review, there is a need to take sufficient reference from other sources, too, such as situations in other countries. When implementing severe accident measures in urgent need, the regulating authorities should also verify and review, using risk analysis methods or other means, the effectiveness of those measures in the event of a natural disaster.

b. Revision of nuclear emergency preparedness [V. 4. (2), (3), VI. 1. (4) b.]

With regard to the development of a nuclear emergency preparedness system, the NSC commenced work in 2006 on revising the regulatory guide "Emergency Preparedness for Nuclear Facilities", in tandem with the establishment of safety standards for nuclear or radiation

emergency situations under the International Atomic Energy Agency (IAEA). In the process the introduction of the Preventive Action Zone (PAZ) to Japan was discussed, but the concept and scope of PAZ were never directly included in this regulatory guide after all, as a result of coordination between NISA and the NSC.

NISA commenced its review on complex disasters, which saw the simultaneous occurrence of a nuclear accident and large-scale natural disaster. But it was only three days prior to the Tohoku District - off the Pacific Ocean Earthquake, when a review was requested to the Central Disaster Prevention Council, which deliberated managing natural disasters and nuclear disasters.

The existing Emergency Planning Zone (EPZ) had been set before the accident on the basic assumption of 8 to 10 km from a nuclear power station, so that the situation could be well dealt with even in an incident far exceeding a hypothetical accident. However, the accident has shown the need to reconsider what accidents to assume and how to designate evacuation areas.

Furthermore, the roles of the government in a nuclear emergency are so large that the government responses should not be limited to those outside nuclear site boundaries such as the residents' evacuation. It should also be considered what the government should do to cooperate or support the nuclear operator in a nuclear emergency, in consultation with the operator.

(5) Nuclear safety regulatory bodies [V. 6, VI. 1. (5)]

It is difficult to say that NISA has sufficiently fulfilled its role as the organization responsible for taking preventive measures against accidents as well as for responses to the accident. In consideration of problems such as those posed by NISA, the Investigation Committee has raised five points in the Interim Report with respect to the operations of nuclear safety regulatory bodies. The following two points have been added in the Final Report in consideration of investigations and verifications conducted after the Interim Report. The two points included here are items that are also applicable to the NSC.

(i) Active relationship with international organizations and regulatory bodies of other countries

Under existing staff capacity conditions at NISA, relationships with international community are limited to a small number of personnel exchanges with the IAEA and the Nuclear Regulatory Commission (NRC) of the United States. Furthermore, as priority must be given to the processing of domestic administrative affairs, there are limitation to the presence that can be sufficiently shown at international conferences and other such events. These efforts do not contribute sufficiently to the enhancement of organizational competence of the regulatory authorities and to coordination with the international community with respect to nuclear safety.

The limited number of personnel at a government administrative organization is a collective issue of the all administrative organizations, and not limited to an issue of NISA, etc. But that of the new regulatory body should be duly considered, because of the importance of nuclear safety. The new regulatory body should secure its personnel, should establish an organizational system competent for international contribution, and develop human resources who can take a role in personnel interaction with international organizations or regulatory bodies of other countries.

(ii) Strengthening of the regulatory body

In order to ensure nuclear power safety, responses to individual problems encountered are not sufficient. Continuous efforts are needed to keep national regulatory guides updated at their newest and best qualities, with consideration to international trends of safety regulations and nuclear security, not only to the latest scientific knowledge in the country and overseas. It is, of course, important to take preventive measures against accidents such as the accident this time. But in addition, **considering that the impact of a nuclear disaster on society can be sizable, responses in an emergency should be fully established during normal times by formulating the emergency preparedness or by conducting nuclear emergency response drills so that effective and prompt responses could be taken in an emergency. The regulatory organization should foster the specialized skills to provide individuals and organizations responsible for emergency response with expert advice and guidance and should also foster the management potential to utilize organizational resources effectively and efficiently. Appropriate size of budget and human resources should be duly examined.**

(6) TEPCO competence [VI. 1. (6)]

a. Vulnerabilities in emergency response capability

Upon examination of the response measures taken by TEPCO staff toward this severe accident, it cannot be denied that the ability to think about and confront the situation independently was poor, and that there was a lack in flexible and proactive thinking, which is necessary in responding to a crisis. These are not the problems of individuals, but rather should be addressed as TEPCO's corporate failure to provide staff education and training focused on the enhancement of such qualities and capabilities. Further probing into this issue reveals a fundamental problem of the inability to capture such crises as a reality that could happen in our lives; this, in turn, is the result of a myth of safety that existed among nuclear operators including TEPCO as well as the government, that serious severe accidents could never occur in nuclear power plants in Japan.

The Investigation Committee strongly expects TEPCO, as a nuclear operator that bears the primary responsibility for nuclear safety, to sincerely revise its existing education and training contents, as well as to implement practical education and training programs aiming at the enhancement of qualities and capabilities that are required in accident response, for each individual that deals with nuclear power.

b. Problems of a vertical organization based on specialized official capacities

TEPCO has structured its organization with an Emergency Response Center and other relevant departments, under which functional teams are formed, including power generation teams, recovery teams, and engineering teams, etc. with the aim of providing an organizational, unified response in the event of a nuclear disaster. However, these functional teams did not perform sufficiently well in capturing the situation from a comprehensive point of view, positioning the roles of their own teams within the overall picture, and carrying out the necessary support operations based on such perspectives.

c. Lack of education and training with a view to extreme situations

The insufficient ability of each individual in functional teams in the Emergency Response Centers to make decisions and judgments in a timely manner, and to fulfill his or her function as

a member of the functional team, can be considered to stem from a consequence of inadequate education and training that gives a view to an extreme situation such as the complete and simultaneous loss of AC power at multiple nuclear reactor units.

d. Lack of enthusiasm in uncovering the causes behind the accident

Even as of the present point in time more than one year after the accident, TEPCO has not demonstrated sufficient enthusiasm in thoroughly clarifying the causes behind the accident and thereby contributing to the prevention of the recurrence of a similar accident.

The Investigation Committee calls strongly for a proactive stance from TEPCO in proceeding with clarification of the causes behind the accident.

e. Need for the creation of a safety culture of an even higher level

TEPCO bears critical responsibilities to society as a nuclear operator primarily responsible for nuclear power plant safety. Nevertheless, TEPCO was not sufficiently prepared for such an accident, that natural disasters including tsunami may lead to large-scale core damage. Furthermore, TEPCO had not taken adequate preparedness for tsunami risks beyond design basis at the Fukushima Dai-ichi NPS. The accident showed quite a number of problems with TEPCO such as insufficient capability in organizational crisis management; hierarchical organization structure being problematic in emergency responses; insufficient education and training assuming severe accident situations; and apparently no great enthusiasm for identifying accident causes. TEPCO should receive with sincerity the problems which the Investigation Committee raised and should make further efforts for solving these problems and building higher level safety culture on a corporate-wide basis.

(7) Harmonization with international practices such as the IAEA safety standards [V. 5., VI. 1. (7)]

Regulatory authorities such as NISA had been aware of the need to review and formulate national guides and standards with reference to IAEA safety standards. But, they mostly failed to implement these measures. **It is necessary to keep the national regulation qualities**

constantly updated in line with the nuclear knowledge accumulation and technological development in the international and national community. To this end, continuous efforts are needed to keep the national regulatory guides newest and best while monitoring international standards, such as those at the IAEA.

Japan has contributed to activities related to the formulation of IAEA standards in the area of earthquakes and tsunami. Further on, **lessons on nuclear safety should be extracted from the accident, and those lessons and relevant knowledge should be provided to the international community so that they could contribute to the prevention of similar accidents, not only in our country but also in other countries. In the process of revising national regulatory guides, international contribution should be pursued by making efforts to propose them to incorporate into the IAEA standards etc., if they turn out to be effective and useful as international standards.**

2. Recapitulation of Major Issues

(1) Building of fundamental and effective disaster preventive measures [VI. 2. (1)]

The Investigation Committee conducted investigations and verifications into the damage due to, and actual responses to, the accident at the Fukushima Dai-ichi NPS, as well as prior measures having been taken by the government and TEPCO toward the prevention of nuclear accidents. In the Interim Report and the Final Report, the Investigation Committee pointed out that there had been many problems in these areas. The Investigation Committee strongly seeks the sincere acceptance of these criticisms by practically all stakeholders in nuclear power generation, including the government, nuclear power operators, nuclear power plant manufacturers, research institutes, and nuclear academic societies, as well as the implementation of specific initiatives to eliminate and improve upon these problem areas. **Quite a number of problems exist, which need highly specialized nuclear knowledge over a wide range for solving technical and nuclear engineering problems. These problems should be reviewed and resolved, results being shaped into concrete actions, through competent knowledge by stakeholders in nuclear power generation. In doing so, they should sincerely take into consideration the recommendations the Investigation Committee has made and they should do so with accountability to society for its process and results**.

(2) Lack of a viewpoint of complex disasters [VI. 2. (2)]

The Tohoku District - off the Pacific Ocean Earthquake caused a large-scale, wide-area, and complex disaster that included the elements of an earthquake, tsunami, and nuclear accident. Amidst a situation in which the earthquake and loss of power cut off communication lines, undermining the functions of the Off-site Center and causing damage to monitoring and other equipment, the national and local governments fell into a state of confusion at various stages and consequently failed to respond to problems timely or adequately.

The lack of forethought given by the national government and the majority of local governments to the occurrence of a nuclear accident in the form of a complex disaster highlights the inadequacies in Japan’s crisis management attitude, in both aspects of the safety of nuclear power plants as well as safety of the surrounding local communities. **When reviewing the existing safety measures at nuclear power stations, risks of a large scale**

complex disaster should be sufficiently considered in emergency preparedness.

(3) Change needed in an attitude to face risks [VI. 2. (3)]

In recent seismological research based on the plate tectonics theory, attention has been shifting to the regional characteristics of seismic source areas, the characteristics of submarine faults concerning tsunami earthquakes causing major tsunamis, and probabilistic assessment on the frequency and probability of occurrence of such earthquakes. The application of such new forms of knowledge in identifying specific priority regions for emergency preparedness could be deemed reasonable to a certain extent.

However, despite advances in academic knowledge, a gap was also growing between such advanced knowledge and emergency preparedness, as seen in the following cases: (i) the probabilistic assessment of earthquakes and tsunami are based on limited case studies for which detailed records remain. On the other hand, earthquakes and tsunami occurring in long intervals with insufficient records such as those mentioned in historical documentation, which are difficult to estimate their source model and scale, are left out from the database; (ii) research institutes and the relevant administrative agencies have attempted to improve precision in computing the probability of occurrence of natural disasters such as earthquakes and tsunami, in order to provide clear justification for the establishment of certain emergency preparedness measures. On the other hand, however, there were growing tendencies to forget the traditional concept of emergency preparedness that mandated the consideration and preparation at the same time for those rare natural phenomena lying beyond the boundaries of existing academic knowledge; or (iii) in assuming earthquakes and tsunami for design, extremely rare cases have been raised as issues to be reviewed under the expressions “residual risk” and “remaining challenges,” but, in actual fact, they have continued to be left behind without further and deeper discussions.

In order to avoid such pitfalls, it is necessary to make the following significant changes in the perception of risks, based on the premises of safety measures and emergency preparedness.

(i) It is necessary to humbly face the reality of natural threats, diastrophism and other natural disasters, which are sizable in scale and time, keeping in mind that Japan has often had them in its long history.

(ii) Risk reduction should be tackled in a drastically different approach. In the government as well as in private entities, a new approach to safety measures and emergency preparedness should be established for a disaster which potentially brings about serious damage in broad areas like a gigantic tsunami or the severe accident at the Fukushima Nuclear Power Station, regardless of its probability of occurrence.

(iii) An institutional framework is needed to ensure continued in-depth examination of "residual risks" or "remaining issues" without leaving them behind beyond the predetermined safety measures and emergency preparedness.

(4) Importance of "Deficiency analysis from the disaster victims' standpoint" [VI. 2. (4)]

When examining the approach towards the safety of systems from the standpoint of an operator by dividing the areas related to nuclear power generation into three domains: the "system core domain," "system support domain" and "regional safety domain," naturally, the area where an all-out effort is initially made is in ensuring the safety of "system core domain." However, if perception about the safety of the system core domain turns into complete confidence, then a certain laxity tends to develop in the stance of engaging in tasks and undertaking checks with a sense of vigilance when ensuring safety in the domains other than the central core domain. Regardless of whether it is the "system core domain" or the "system support domain," having ensured safety" only means that the safety is ensured within the boundaries of the design assumptions, for which it was designed. Should an incident beyond the assumptions occur, the safety can no longer be ensured. In other words,

(i) If nuclear operators and regulatory bodies overestimate the safety of the "system core domain" within only those assumptions, for which it was designed, safety measures will fail.

(ii) Safety measures in the "system support domain" and "regional safety domain" need to be able to function independently in the case of an emergency, regardless of the level of safety of the "system core domain." Should this principle be neglected, it would increase risks to create many "pitfalls" (deficiency) in the safety barrier, which should protect the lives of regional people.

In order to locate these flaws and make the safety barrier reliable, the Investigation Committee proposes an approach which can be called a "deficiency analysis from the disaster

victims' standpoint." This is a method of analysis conducted from the standpoint of a person who has fallen victim to the disaster. Through this method, personnel in charge of emergency preparedness at regulatory bodies and local governments, working in collaboration with specialists in the field of disaster issues, put themselves and their families in the shoes of residents of the affected areas and analyze thoroughly the events that might befall themselves in the worst case.

The government and nuclear operators should take the improvement steps for flaws and defects in the safety measures that are identified through this analysis. It would probably be difficult to block up all the "pitfalls" immediately. Under such circumstances, it is important that information on the remaining measures and the related issues be released, and for regulatory bodies and local government bodies to discuss with residents the future measures to take, and, in cooperation, to come up with the next best solution. Only by capturing disasters from the perspective of the residents in the affected areas, and establishing safety systems accordingly, a truly safe and secure society will be created in Japan.

An accident at a nuclear power station has risks to bring about damage in vast areas. Nuclear operators on one hand, nuclear regulators on the other, should establish a systematic activity to identify all risk potentials from the "disaster victims' standpoint," when designing, constructing and operating such nuclear systems, for ensuring credible nuclear safety including evacuation planning in the local society. Such an approach should be practiced.

Also, with regard to the residents' evacuation plans and evacuation drills, the prefecture and local municipalities involved should closely collaborate in building up an effective system through evacuation planning and its drills for minimizing confusion in view of the fact that radioactive materials may disperse over vast areas due to an accident at a nuclear power station.

(5) The issue of "beyond assumptions" and lack of the sense of crisis at the administrative bodies and TEPCO [VI. 2. (5)]

The word "beyond assumptions," broadly speaking, can refer to two meanings. One means that an incident, which could not be predicted even with possession of the most advanced

academic knowledge, occurred. The other one means that, in light of financial limitations and other limitations to the ability to respond to all predictable events, a line was drawn to exclude incidents that were realistically assessed to have a low probability of occurrence, and an incident of a scale far beyond that line occurred. Based on the study of the seismological progression and emergency preparedness administration over the past ten or so years, it is clear that the latter meaning held true in the case of the latest major tsunami.

It cannot be denied that the process of the government's decision-making on emergency preparation for the earthquake and tsunami off the coast of Fukushima Prefecture was reasonable to a certain extent when the logical framework of government administration is taken into account. However, in the face of the major damage that arose as a result of this accident, can the government walk away simply by saying that it made no mistakes and that there was nothing they could have done more because this major earthquake and tsunami were "beyond assumptions?" If so, no lesson useful to create a safe society can be learned.

Regardless of the government's logic and whether the government held responsibility, an analysis into the causes from the perspectives of whether there had been options or methods to reduce damage even by the slightest degree and of whether there was any way to reform the government's decision-making framework draws the following problems.

(i) Scientific knowledge of earthquakes is not sufficient yet. The latest research results should be continually incorporated in emergency preparedness. In other words, a policy/rule concluded at a certain point based on the then-available knowledge should be reviewed with flexibility and revised, without groundless procrastination, when new knowledge of earthquakes and tsunami become available.

(ii) If an area is excluded, due to limited financial resources or other reasons, from the areas for strengthening emergency preparedness because of low or unknown probabilities of occurrence, the damage would be extremely serious once a massive earthquake and tsunami hit the area. Administrative bodies should take initiatives of, for instance, launching research projects on earthquake evaluation in specific areas for which some seismologists warn of risks, even if few in number, or which show traces of massive earthquakes and gigantic tsunami (tsunami deposits, for instance) from the remote past; or formulating an innovative disaster prevention plan in full cooperation of public

administration, residents and experts through disclosing relevant information.

(iii) Up to now, emergency preparedness plans decided on by the Central Disaster Prevention Council have moved forward without paying a particular attention to the regions where nuclear power plants are located. However, **disaster risks in nuclear power plant siting regions should be noted. It was the role of NISA to prepare for nuclear emergencies at nuclear power stations. However, the policy of the Central Disaster Management Council has strong relevance to the emergency preparedness at nuclear power stations. The Central Disaster Management Council should duly consider the nuclear power stations, too, in its policy making.**

On the other hand, based on a review of how TEPCO's tsunami measures were formed, it is to be mentioned that TEPCO lacked a sense of urgency and imagination toward major tsunami, which could threaten to deal a fatal blow to its nuclear power plants. Consequently, this could be considered as one of significant background factors that led to a serious nuclear accident and inadequate measures against the expansion of damage.

(6) Issues of the government crisis management systems [VI. 2. (6)]

This time, a command center was set up on the fifth floor of the Prime Minister's Office, which had not been stipulated in the Nuclear Emergency Response Manual, and Prime Minister Kan came to the forefront to deal with the accident. The background to these circumstances can be attributed to the inability of the Local NERHQ to fulfill its original roles, as well as to inadequacies in the information consolidation scheme in the Prime Minister's Office, and in the advisory function of the NSC. However, the Prime Minister's original role is to give appropriate, final decisions on the most important matters brought up by specialized divisions along with suggested options and leave information gathering and response measures to each organization, department and agency of the government. Intervening in the site of the disaster as a commander may create confusion on-site, and lead to a loss in the opportunity of making important decisions or lead to making wrong judgment. As such, such an action should be viewed more as a possible cause of a greater harm than that of good.

Learning from the experience as a result of the accident at the Fukushima Dai-ichi NPS, the crisis management system for a nuclear emergency should be urgently reformed, in

which the nuclear emergency response manual should be revised assuming an occurrence of a complex disaster combining an earthquake/tsunami disaster and a nuclear accident. In its reforming process, the strengthening of response capabilities of off-site centers is needed. In addition, it is also required to build a crisis management system by examining how to respond to a situation which a local nuclear emergency response headquarters cannot handle by convening personnel from relevant emergency response bodies.

(7) Issues of the provision of information and risk communication [VI. 2. (7)]

The ways in which information was provided from the government to the public in the aftermath of this accident raised many questions and doubts as to whether the information had been communicated in a prompt and accurate manner, from the perspective of the residents in the surrounding areas who had had to evacuate, and the people at large. Examples are: the way of providing information on the situation and predictions of dispersion of radioactive substances, which is important in the evacuation of residents in the vicinity; way of providing information on the core conditions (in particular, core meltdown) and the critical conditions at Unit 3 of the Fukushima Dai-ichi NPS; and repeated explanations of "there is no immediate effect on the human body," that were difficult to understand, when providing information on the impact of radiation on the human body.

It is necessary to build mutual trust between the public and the government and to provide relevant information in an emergency while avoiding societal confusion and mistrust. To this end, a risk communication approach on risks and opinion exchanges thereupon should be adopted for a consensus building among all stakeholders based on mutual trust. The government should examine, by institutionalizing an appropriate body, how to provide relevant information in an emergency to the public, promptly, accurately, and in an easily understandable as well as clear-cut (not misleading) manner. Inappropriate provision of information can lead to unnecessary fear among the nation. Therefore, an expert on crisis communication may be assigned for providing appropriate suggestions to the cabinet secretary responsible for information provision to the public in an emergency.

(8) Importance of a safety culture vital to the lives of the public [VI. 2. (8)]

It is difficult to assess both TEPCO, which is the nuclear operator, and NISA, which is the regulatory authority, as having sufficiently established a safety culture. **Well established safety culture is vitally important to people's lives in the nuclear power industry, which may cause serious situations once an accident occurs. In view of the reality that safety culture was not necessarily established in our country, the Investigation Committee would strongly require rebuilding safety culture of practically every stakeholder in nuclear power generation such as nuclear operators, regulators, relevant institutions, and government advisory bodies.**

(9) Necessity of continued investigation of the whole picture of accident causes and damage [VI. 2. (9)]

a. Need to continue uncovering the causes of the accident

Although the responsibilities of the Investigation Committee are concluded with the submission of the Final Report, there are still many points that remain to be clarified, as raised in 1. (1) b. above. These include: the details of the overall damage incurred, beginning with the damaged areas in the main facility of the Fukushima Dai-ichi NPS, their degree of damage, and the development of events over time; the background to the leakage of radioactive substances; and the cause of the explosion in the reactor buildings.

Meanwhile, the impact on residents' health, and contamination of air, soil, water and items such as the agricultural, farming, and fishery products, are issues that require continued investigation and verification going forward. The Investigation Committee has no choice but to conclude its investigations and verifications at this point in time. Furthermore, there are also problems in repairing the damage that has been caused, and expected to require long-term response into the future, including decontamination and methods of compensation for damages caused. As such, items that were not subjected to investigation and verification by the Investigation Committee remain of great importance to the victims and affected areas, and are issues that are of great concern to the society.

The government, nuclear operators, nuclear plant manufacturers, research institutions, academies, all such stakeholders (relevant organizations) involved in nuclear power

generation should take active roles in investigating the accident and in fact analyses, and continue, in their respective capacities, their comprehensive and thorough investigations of the remaining unresolved problems. The government, in particular, should not conclude its investigations of the Fukushima nuclear accident at the time when this Investigation Committee or the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) of the National Diet conclude their activities. It should continue its initiatives to investigate the causes of the accident. On-the-spot investigations of reactor buildings should certainly be conducted in detail, including the impacts of earthquakes, as soon as the radiation level lowers.

b. Need to conduct investigations in order to clarify the full scope of damage

This nuclear accident brought various forms of serious damage to regions covering a wide area. **Japan as a country which experienced an unprecedented nuclear disaster should transfer as lessons to future generations the whole picture of "Human suffering" including the facts in detail. This can be done by: recording the results of a comprehensive investigation of academic study in respective specialized fields and collection of testimonies of an enormous number of stakeholders and victims; investigating the adequacy of relief, support and reconstruction programs for the victims; or transferring the facts showing how extensive and serious the damage by a nuclear disaster could be. The Investigation Committee believes that it is the national responsibility of Japan to transfer the whole picture of "Human suffering" to future generations based on the recorded results of comprehensive investigation of the Fukushima nuclear disaster. The investigation of the "Human suffering" may need the participation of a wide area of academic fields, vast costs and time. The Investigation Committee requests the government to actively build the investigation system, in cooperation with local municipalities, research institutions, private organizations and other relevant bodies, and provide necessary support to such investigation initiatives.**

3. Recommendations for Preventing Recurrence of a Nuclear Disaster and Mitigating its Damage

The Investigation Committee has made recommendations for preventing recurrence of a nuclear disaster and mitigating its damage in the Interim and Final Reports, based on the facts that were clarified through the investigations and verification conducted to date. The Investigation Committee strongly urges the relevant organizations including the national government, the relevant local governments, and nuclear operators to reflect these recommendations in future safety measures and emergency preparedness, and to implement them. Within the government, in addition to providing specific instructions toward the reflection and implementation of recommendations in the relevant ministries/agencies and departments, the Investigation Committee seeks faithful follow-up activities on the part of the government through gaining an understanding of the situation of measures being taken by the relevant ministries/agencies and departments, and through summarizing and releasing information on the development. The relevant local governments, TEPCO, and other relevant organizations are equally requested to reflect and implement the recommendations in their measures, and to follow up on the development.

Below the recommendations that were proposed in the Interim and Final Reports are organized in seven categories. To the recommendations proposed in the Final Report, the section numbers in the Final Report (Main text) and page numbers in this Executive Summary, are provided in the parenthesis after the heading, where their details are found. With regard to recommendations proposed in the Interim Report, the section numbers where they are found in the Interim Report (Main text) are provided, and the contents of the recommendations are reproduced here in abridgement.

(1) Recommendations for a basic stance for safety measures and emergency preparedness

- **Recommendations for emergency preparedness in light of complex disasters in mind** (Final Report VI. 2. (2), Executive Summary p. 27)
- **Recommendations for changing an attitude to face risks** (Final Report VI. 2. (3), Executive Summary p. 28)
- **Recommendations for "deficiency analysis from the disaster victims' standpoint"** (Final

Report VI. 2. (4), Executive Summary p. 29)

- **Recommendations for incorporating the latest knowledge in the emergency preparedness** (Final Report VI. 2. (5), Executive Summary p. 31)

(2) Recommendations for safety measures regarding nuclear power generation

- **Recommendations for building disaster preventive measures** (Final Report VI. 2. (1), Executive Summary p. 27)
- **Recommendations for the necessity of comprehensive risk analysis** (Final Report VI. 1. (4) a. (b), Executive Summary p. 20)
- **Recommendations for severe accident management** (Final Report VI. 1. (4) a. (c), Executive Summary p. 21)

(3) Recommendations for nuclear emergency response systems

- **Recommendations for reforming the crisis management system for a nuclear emergency** (Final Report VI. 2. (6), Executive Summary p.32)
- **Recommendations for the nuclear emergency response headquarters** (Final Report VI. 1. (2) b. (a), Executive Summary p. 5)
- **Recommendations for off-site centers** (Interim Report VII. 3. (1) a.)

  The government should take prompt actions to ensure that off-site centers are able to maintain their functions even during a major disaster.
- **Recommendations for the roles of the prefectural government in nuclear emergency responses** (Final Report VI.1. (2) c., Executive Summary p. 6)

(4) Recommendations for damage prevention and mitigation

- **Recommendations for the provision of information and risk communication** (Final Report VI. 2. (7), Executive Summary p. 33)
- **Recommendations for improving radiation monitoring operations** (Interim Report VII. 5. (2) d.)

  (i) In order to ensure that the monitoring system does not fail at critical moments, the system should be designed against various possible events, including an earthquake and tsunami.

Measures should be taken to prevent the system from functional failures even in a complex disaster. Furthermore, measures should be developed to facilitate the relocation of monitoring vehicles and their patrols even in a situation where an earthquake has damaged roads.

(ii) Training and other learning opportunities should be enhanced to raise awareness of the functions and importance of the monitoring system among competent authorities and personnel.

- **Recommendations for the SPEEDI system** (Interim Report VII. 5. (3) c.)

  Measures should be developed to improve operational guidelines of the SPEEDI system so that the spread of harm from the disaster can be prevented and information is provided promptly in a manner acceptable to the people. Measures, including hardware and infrastructure-related measures, should be developed and implemented to ensure that SPEEDI functions remain operable even against complex situations including an earthquake.

- **Recommendations for evacuation procedures of residents** (Items (i) to (iv) in Interim Report VII. 5. (4) c., and further Final Report VI. 1. (4) b. and Executive Summary p.21)

  (i) Public activities to raise public awareness in daily lives are needed to provide residents with basic, practical knowledge of how radioactive substances are released, dispersed and fall back to the ground during a major nuclear accident, as well as knowledge of how the exposure to radiation can affect human health.

  (ii) Local government bodies need to prepare evacuation readiness plans that take into account the unique characteristics of a nuclear accident, periodically conduct evacuation drills in a realistic manner, and take steps to promote the earnest participation of residents in those drills.

  (iii) It is necessary to complete, during normal times, readiness preparations, such as drafting concrete plans for ensuring means of transportation, traffic control, securing evacuation sites in outlying areas, and securing water and food supplies at the evacuation site, taking into consideration the situation that the evacuees may number in the thousands to over a hundred thousand. It is especially important to develop measures that support the evacuation of the disadvantaged, such as seriously ill or disabled people in medical institutions, homes for the aged, social welfare facilities, or in their own homes.

  (iv) The above types of measures should not be left up to the local municipal governments, but need in addition to involve the active participation of the prefectural and national

governments in designing and operating an evacuation plan and an emergency preparedness, in consideration of the situation that a nuclear emergency would affect a large area.

- **Recommendations for the intake of stable iodine tablets** (Final Report VI. 1. (3) e. (c), Executive Summary p.14)
- **Recommendations for radiation emergency medical care institutions** (Final Report VI. 1. (3) e. (f), Executive Summary p.16)
- **Recommendations for public understanding of radiation effects** (Final Report VI. 1. (3) e. (g), Executive Summary p.16)
- **Recommendations for information sharing with, and receiving support from, overseas** (Final Report VI. 1. (3) g. (a), (b), Executive Summary p.19)

(5) Recommendations for harmonization with international practices

- **Recommendations for harmonization with international practices such as IAEA safety standards** (Final Report VI.1. (7), Executive Summary p.25)

(6) Recommendations for relevant organizations

- **Recommendations for the nuclear safety regulating body**

(i) The need for independence and transparency (Interim Report VII. 8. (2) a.)

The nuclear safety regulatory organization should be granted independence and should maintain transparency. It must be also granted the authority, financial resources and personnel it needs to function autonomously and should also be given the responsibility of explaining nuclear safety issues to the people.

(ii) Organizational preparedness for swift and effective emergency response (Interim Report VII. 8. (2) b.)

The nuclear safety regulatory organization should, during normal times, work out an emergency preparedness and implement emergency response drills to facilitate rapid response if a disaster occurs. Furthermore, it should foster the specialized skills to provide individuals and organizations responsible for emergency response with expert advice and guidance, and should foster as well the management potential to utilize organizational resources effectively and efficiently.

In addition, the nuclear safety regulatory organization must be well aware that its role is to respond to crises with responsibility. It should beforehand prepare systems that can deal with a major disaster if it occurs, and develop partnerships with relevant government ministries and agencies and with relevant local governing bodies to create mechanisms for cross-organizational response, with the role of the nuclear safety regulatory organization clearly demarcated.

(iii) Recognition of its role as a provider of emergency-related information to Japan and the world (Interim Report VII. 8. (2) c.)

The nuclear safety regulatory organization must be fully conscious that the way it provides information is a matter of great importance, and must also, during normal times, establish an organizational framework that enables it to provide information in a timely and appropriate manner during an emergency.

(iv) Development of competent human resources and specialized expertise (Interim Report VII. 8. (2) d.)

The nuclear safety regulatory organization should consider establishing a personnel management and planning regime that encourages personnel to develop lifetime careers. For example, it should offer improved working conditions to attract competent human resources with excellent specialized expertise, expand opportunities for personnel to undergo long-term and practical training, and promote personnel interaction with other administrative bodies and with research institutions, including those involved in nuclear energy and radiation.

(v) Efforts to collect information and acquire scientific knowledge (Interim Report VII. 8. (2) e.)

The nuclear safety regulatory organization should keep abreast of trends embraced by academic bodies and journals in the field (including those in foreign countries) and by regulatory bodies in other countries, in order to continue acquiring knowledge that will contribute to its regulatory activities. It must also understand the implications of that knowledge, systematically share and sufficiently utilize such knowledge, and resulting outcomes should be archived and continually utilized as an organization.

(vi) Active relationship with international organizations and regulatory bodies of other countries (Final Report VI. 1. (5), Executive Summary p.22)

(vii) Strengthening of the regulatory body (Final Report VI. 1. (5), Executive Summary p.23)

- **Recommendations for TEPCO** (Final Report VI. 1. (6) e., Executive Summary p.25)
- **Recommendations for rebuilding a safety culture** (Final Report VI. 2. (8), Executive Summary p.33)

(7) Recommendations for continued investigation of accident causes and damage

- **Recommendations for continued investigation of accident cause** (Final Report VI. 2. (9) a., Executive Summary p.34)
- **Recommendations for extended investigation of the whole picture of accident damage** (Final Report VI. 2. (9) b., Executive Summary p.35)

Chairman's remarks (excerpt)

(Concerning knowledge gained through this accident)

In order for the knowledge acquired through this accident to be applicable in other fields and to withstand an assessment even 100 years from now, this knowledge should not simply remain as knowledge pertaining to a single, particular field, but rather, become general and universal knowledge. I would like to hereby show what knowledge can be acquired from the latest accident and highlight main points to mark in concluding our investigation into the unprecedented disaster which took place at the Fukushima Nuclear Power Stations.

(1) Possible phenomena occur. Phenomena that are considered impossible also occur.

The direct cause of the latest accident can be boiled down to nothing but the fact that everything was structured and operated based on the assumption "an extended station blackout will not happen." It should be assumed that "all possible phenomena would occur." Moreover, it is necessary to recognize that there could be kinds of phenomena, which do not even be recognized as impossible phenomena, in other words, unthinkable phenomena can also occur.

(2) You cannot see things you do not wish to see. You can see what you wish to see.

When people see things or think, they tend to see only the things they like and look only in the direction they wish to move forward. Things that they do not wish to see, or which are inconvenient for them, tend to be invisible. We have to always remember that our views are biased by not only our own interest but also various effects of the organization, the society and the times we live in and therefore that there is always an oversight.

(3) Assume to the extent possible and make full preparations.

It is necessary, without adhering to the assumptions made at a point in the past, to review them constantly and as extensively as possible and to implement measures to prevent an accident or a disaster. It is necessary to make full preparations based on the assumption that unthinkable phenomena might occur.

(4) Creating a framework alone does not mean it will function. Frameworks can be constructed, but goals not collectively shared.

Each of the nuclear operator, the regulatory bodies and the local governments formally had its own system in place to respond to a nuclear accident. However, once the accident occurred, the flaws in their responses became apparent. The reason for that seems to be the absence of understanding by each member of the organizations about the objectives of the response systems of his/her organization or his/her duties entrusted by the society. An environment must be created where each member of the organizations is always aware of his/her duties entrusted by the society, his/her role in the overall organization and how his/her work affects the overall operation.

(5) Everything changes; respond flexibly to changes.

Detailed responses, in terms of formality, can be possible if given conditions are fixed. However, as the given conditions are constantly in flux, we would fail to respond to a real situation if we do not constantly look for ways to respond to changes. It is important to have the perception that everything changes, and to observe situations with careful attention, listen humbly to the voices of outsiders, and continue to take appropriate response measures.

(6) Acknowledge that risks exist, and create a culture able to debate the risks directly

When it is impossible for anyone to predict without fail what sort of phenomenon might occur, an attempt to eliminate risks completely bears the apprehensions of creating the so-called “myth of safety,” which rules out risks with low probability. Unless a culture is created where risks are acknowledged as risks and straightforward discussion is held about risks, significant risks will be left unattended which are covered behind the veil of safety.

(7) It is vital to be conscious of the importance of seeing with your own eyes, thinking with your own head, making decisions and taking action, and vital to cultivate such faculties.

In dealing with accidents and disasters beyond our assumptions, one should assume an independent attitude to confront the situation, and think flexibly and proactively. It is important to run organizations and provide education and training from normal times so that the qualities and capability for the emergency situation should be enhanced.

We must take this accident as a lesson by the nature given to us that there are flaws in human thoughts. We shall never forget this accident and must continue learning lessons.

July 23, 2012

Chairperson of the Investigation Committee on the Accident at Fukushima Nuclear Power Stations of Tokyo Electric Power Company
Yotaro Hatamura