Executive Summary of the Interim Report

December 26, 2011

Investigation Committee on the Accident at Fukushima Nuclear

Power Stations of Tokyo Electric Power Company

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1. **Introduction** [Chapters I.1, I.4, I.6*]

The Investigation Committee on the Accident at the Fukushima Nuclear Power Stations (the Investigation Committee) of Tokyo Electric Power Company (TEPCO) was established by the Cabinet decision on May 24, 2011. Its objectives are: to conduct investigation for finding out the causes of accidents at the Fukushima Dai-ichi Nuclear Power Station (Fukushima Dai-ichi NPS) and Fukushima Dai-ni Nuclear Power Station (Fukushima Dai-ni NPS) of TEPCO as well as the causes of accident damage; and to make policy recommendations for limiting the expansion of damage and preventing reoccurrence of similar accidents.

The Investigation Committee has conducted its investigation and evaluation since its first meeting on June 7, 2011. Its activities included: site visits to the Fukushima Dai-ichi and Dai-ni NPSs, as well as to other facilities; hearing of heads of local governments around the Fukushima Dai-ichi NPS; and hearing of people concerned through interviews mainly arranged by the Secretariat. As of December 16, 2011, the number of interviewees reached 456.

The investigation and evaluation by the Investigation Committee are still ongoing and the Interim Report does not cover every item that the Committee aims at investigating and evaluating. Fact-finding of even some of those items discussed in the Interim Report are not yet completed.

The Investigation Committee continues to conduct its investigation and evaluation and will issue its Final Report in the summer of 2012.

This brief executive summary covers mainly considerations and evaluation of the issues in Chapter VII of the Interim Report, with brief reference to Chapters I to VI. The Investigation Committee recommendations are printed in bold.

[*] after the headings refers to corresponding chapters of the Interim Report

2. **Outline of the Accident** [Chapters II, IV, V]

On March 11, 2011, the Fukushima Dai-ichi and Dai-ni NPS were hit by the Tohoku District - off the Pacific Ocean Earthquake and accompanying tsunami. The earthquake was of Magnitude 9.0 in Richter scale and the tsunami waves height at the Fukushima Dai-ichi NPS exceeded 15 meters above O.P. (Reference sea level at Onahama Peil).

Six nuclear power units stood at the Fukushima Dai-ichi NPS: Units 1 to 3 were in operation, and Units 4 to 6 were in maintenance modes for scheduled outage at the time of the earthquake. It is believed that Units 1 to 3 were automatically scrammed at the earthquake, but external power supplies and almost all in-house AC power supplies were lost due to the earthquake and the tsunami. Reactors and spent fuel pools at the Fukushima Dai-ichi NPS lost their cooling capabilities. Explosions occurred on Units 1, 3 and 4, which were caused presumably by the hydrogen released from the possible core damage and filled in the reactor buildings. The reactor core of Unit 2 also seems to have been damaged, although the investigation is still incomplete.

A large amount of radioactive materials were released and spread from the Fukushima Dai-ichi NPS. The zone up to 20km from the site was designated as the Access Restricted Areas and no entry is allowed unless authorized. Some areas outside 20km from the site were also designated as the Deliberate Evacuation Area. As many as more than 110,000 people have evacuated. Many people are still forced to live in evacuation, and radiation contaminations have caused serious impacts on extended areas.

3. **Problems of the Responses by Government Organizations to the Accident** [Chapters III.2, VII.3 (2)]

(1) **Problems of the local nuclear emergency response headquarters** [Chapters III.5, VII.3 (1)]

a Loss of functionality at the Off-site Center

The Act on Special Measures Concerning Nuclear Emergency Preparedness ("Nuclear Emergency Preparedness Act") and the Nuclear Emergency Response Manual of the Government stipulate that once a nuclear accident occurs, a local nuclear emergency response headquarters ("local NERHQ") shall be established close to the accident site, as the center of the emergency response coordination. A local NERHQ is to be located at a local standing facility for emergency responses and measures ("Off-site Center").

The Off-site Center of the Fukushima Dai-ichi NPS was located about 5km from the Fukushima Dai-ichi site but it could not function as intended.

The Off-site Center had to be evacuated because of the following reasons: difficulty in collecting its personnel due to damaged transportation and heavily congested traffic caused by the earthquake; Moreover, the staff had to evacuate finally from the Off-site Center because of loss of telecommunication infrastructures, power cut, shortages of food, water and fuel; and the elevated radiation levels in the building which was not equipped with air cleaning filters.

In other words, the Off-site Center lost its functionality because:

i. It was not assumed that nuclear disaster may strike simultaneously with outbreak of an earthquake; and

ii. Its building structure was not designed to withstand elevated radiation levels, although it was intended for use in nuclear emergencies.

The Ministry of Internal Affairs and Communications identified the latter point in its "Recommendations based on the results of administrative evaluation and inspection of nuclear disaster prevention programs (Second Issue)" in February 2009. However the Nuclear and Industrial Safety Agency (NISA) of the Ministry of Economy, Trade and Industry (METI) did not take concrete steps for installing air cleaning filters, etc.

The Government should take prompt actions to ensure that off-site centers are able to maintain their functions even during a major disaster.

b Problems concerning delegation of authority to the local NERHQ

The Nuclear Emergency Preparedness Act stipulates that the head of the Nuclear Emergency Response Headquarters ("NERHQ") may delegate part of its authority to the head of the local NERHQ. However, in the case of the Fukushima nuclear accident, necessary notification concerning delegation of authority was not issued. In order to execute necessary actions in a timely manner, the head of the local NERHQ had to make various decisions such as implementation of evacuation and carry out those decisions assuming the formal notifications had been provided and he had been given the authority. The Investigation Committee will continue to investigate why such a situation had happened.

(2) **Problems of the government nuclear emergency response headquarters** [Chapters III.2, VII.3 (2)]

a Responses at the NERHQ at the Prime Minister's Office

Once a nuclear disaster occurs, the Government's Nuclear Emergency Response Headquarters (NERHQ), headed by the prime minister, is to be established at the Prime Minister's Office and to execute the emergency responses. Also the Director-General level officials of relevant ministries and agencies are to assemble at the Crisis Management Center of the Government located on the underground floor of the Prime Minister's Office, and to serve as members of an emergency operations team. The team is expected to promptly put together the information from respective ministries and agencies, and coordinate their views with flexibility.

At the time of the accident, decisions on emergency responses were made primarily by the NERHQ (located on the 5th Floor of the Prime Minister's Office).

All relevant Ministers and the Chairman of the Nuclear Safety Commission ("NSC") of Japan assembled there. Senior executives of TEPCO were convened and also present.

The emergency operations team members (on the underground floor) could hardly get hold of the discussions that took place on the fifth floor. When all resources of the entire Government were demanded, there was poor communication between the fifth floor (NERHQ) and the emergency operations team at the underground floor.

b Problems of collection of information

The Nuclear Emergency Response Manual stipulates that, in the event of emergency, nuclear operators must report information about the accident to the Emergency Response Center (ERC) at the Ministry of Economy, Trade and Industry (METI), and that the information is transferred to the NERHQ at the Prime Minister's Office via the ERC. At the accident, however, such routes for collection and transfer of information did not function in a satisfactory manner. NISA staff and others at the ERC were aware of slowness in the collection and transfer of information but they did not think of setting up a terminal for the teleconference system that had been employed extensively by TEPCO. Neither did they dispatch their members to TEPCO Head Office for information collection. After all they failed to make positive efforts to collect information.

The problem is serious because the collection of accurate and most up-to-date information is a prerequisite for prompt and exact decision-making., and moreover, it is important from the view point of the need to provide information to the public.

(3) **Remaining issues** [Chapters III.4 (2), VII.3 (3)]

The Nuclear Emergency Preparedness Act was established and the Nuclear

Emergency Response Manual was prepared to enable prompt implementation of appropriate measures in response to nuclear disaster. However existing manuals and designated emergency organizations set-up did not function properly. Therefore, the Integrated Headquaters for the Response to the Accident had to be established outside the scope of the Manuals, etc..

- Why procedures in the Manuals did not work as intended?
- What problems existed in the crisis management operations at the Prime Minister's Office?
- Were the emergency response procedures assumed in the existing Nuclear Emergency Response Manual realistic?

The Investigation Committee will conduct further interviews with the persons concerned to be able to address these questions in the final report.

4. Problems of Responses to the Accident at the Fukushima Dai-ichi NPS

(1) **Misjudgment of operational situation of IC at Unit 1** [Chapters IV.3 (1), VII.4 (1)]

Unit 1 lost its all power supplies shortly after the arrival of the tsunami. The isolation condensers (IC) seemed to have lost its functionality as its isolation valves were fully or almost fully closed by the fail-safe circuits. But at the initial stage of the accident, appropriate corrective actions were not taken, nor were instructions given. This was because it was erroneously assumed that the IC had been operating normally. Later on, aided by partial restoration of the status display on the control panel, for example, shift operators on duty began to have doubts about the normal operation of IC and eventually switched off the IC**.** This judgment was not necessarily incorrect, but the decision was not properly reported to, or consulted with, the NPS emergency response center.

On the other hand, besides the information and consultation from the shift operators on duty, the emergency response centers at the NPS and at the TEPCO head office in Tokyo (“NPS ERC” and “TEPCO ERC”, respectively) could have become aware of the loss of functionality of the IC at many opportunities. But they failed to become aware of this and continued to assume the normal operation of the IC. These incidents in sequence indicate that not only the shift operators on duty but also the staff members of the emergency response centers, both at the station and at the head office, lacked sufficient understanding about the functioning of the IC. Such situation is quite inappropriate as a nuclear operator.

As soon as the IC had become inoperable, Unit 1 required alternative water injection for core cooling as quickly as possible, and it became necessary to depressurize the reactor vessel for allowing water injection. In the view of the Investigation Committee, misjudgment of the operational situation of the IC caused unwarranted delay in alternative water injection and primary containment vessel (PCV) venting. As a result, an earlier opportunity for core cooling was missed.

(2) **Poor handling of alternative water injection at Unit 3** [Chapters IV.4 (2), VII.4 (2)]

At Unit 3, the high pressure coolant injection (HPCI) system had been running at a low rpm (revolutions per minute) below the operating ranges of the driving turbine, as specified in the operating procedures for long duration, while the reactor pressure vessel (RPV) had been in low pressures. Therefore, shift operators on duty became concerned about insufficient water injection by the HPCI and switched off the HPCI manually at 2:42 a.m. on March 13, 2011. In doing so, the shift operators underestimated the risk of battery depletion in spite of the absence of assurance concerning the successful implementation of alternative water injection means. Eventually, they failed to lower the reactor pressure to a level that would allow the implementation of alternative water injection means. These decisions were made

only among shift operators and the limited number of staff of the operation team of the NPS emergency response center. They did not seek for instructions from the senior executives and moreover, a post fact report about these operating decisions was submitted only much later from the operation team of the plant's emergency response center to senior executives. Such situation is problematic in light of crisis management. It is highly regrettable that this caused the delay of alternative water injection until 9:25 a.m. on March 13.

Furthermore, due attention should have been paid to the depletion of battery that was essential for HPCI operation under the station blackout (SBO) conditions. If it had been done, the NPS emergency response center could have initiated much earlier alternative water injection by using fire engines, for example, as an alternative means for water injection. In reality, however, the NPS emergency response center did not prepare for the injection of water by alternative means using fire engines until they were informed by the shift operators at Unit 3 of their failure in implementing an alternative means of water injection after the manual switching off of the HPCI, even though the NPS emergency response center had been considering and preparing for mid- to long-term programs of water injection from the Standby Liquid Control System after the restoration of power. It must be concluded that the delay to the implementation of necessary measures was caused solely due to the lack of recognition at the NPS emergency response center of the necessity and urgency of alternative water injection into Unit 3.

(3) **Possible contribution to explosions in the Units 1 and 3 reactor buildings** [Chapters IV.4 (1), (2), VII.4 (3)]

It is still too early to judge at this stage whether earlier depressurization and alternative water injection of Units 1 and 3 could have prevented the explosions of reactor buildings.

5. Problems of the Hazard Control Measures

(1) **Problems of the initial radiation monitoring** [Chapters V.1, VII.5 (2)]

Monitoring data of radiation levels in the environment are indispensable to the protection of people from radiation exposure and also evacuation planning.

However, as many monitoring posts were carried away by the tsunami or became inoperable by the loss of power, monitoring activities could not be conducted in a satisfactory manner due to the consequences of the earthquakes and tsunami.

Furthermore, in the initial stage of responses to the accident, there were confusions over utilization of monitoring data. In particular, the government lacked an attitude of making the monitoring data promptly available to the public. Even when some data were made public, they were only partial disclosure.

The Investigation Committee calls on the relevant organizations concerned to take prompt actions for improvement on the following points:

(i) To ensure that the monitoring system does not fail at critical moments and to ensure the collection of data and other functions, the system should be designed against various possible events, including not only an earthquake but also a tsunami, etc. Measures should be taken for them to function 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 sessions and other learning opportunities should be enhanced to raise awareness among competent authorities and personnel of the functions and importance of the monitoring system.

(2) **Problems of the utilization of SPEEDI** [Chapters V.2, VII.5 (3)]

The Network System for Prediction of Environmental Emergency Dose Information (SPEEDI) is also expected to play an important role in protecting local population from radiation exposure and the planning of evacuation. However, the system was not utilized when evacuation was instructed.

The communication links were disrupted and inoperative due to the earthquakes, and the SPEEDI could not receive the basic source term information of released radioactivity. It was therefore not possible for the SPEEDI to estimate atmospheric dispersion of radioactive materials on the basis of the basic source term information.

Nevertheless, it is possible for the SPEEDI to estimate the course of dispersion of radioactive materials, making assumption of the reference release rate of 1 Bq/h. And actually those estimates were then calculated by the system. Such calculation only predicts the direction of dispersion and relative distribution of radioactivity. But, if the information had been provided timely, it could have helped local governments and population to choose more appropriate route and direction for evacuation.

Since the local NERHQ lost its functionality, the Government NERHQ or NISA should have taken the role of providing the SPEEDI results to the public. But none of them had the idea of making use of this information. The Ministry of Education, Culture, Sports, Science and Technology (MEXT), the competent ministry for SPEEDI, also did not come to realize the provision of the SPEEDI information to the public on its own or through the Government NERHQ. Furthermore, since March 16, the clear division of responsibility was kept undefined between MEXT and the NSC on the utilization of the SPEEDI. This was one of the reasons for the delay of making the SPEEDI results public.

In order to prevent the spread of harm from the disaster, measures should be developed to improve SPEEDI's management system so that crucial radiation dose rate information is provided promptly in a way that the Japanese people

find persuasive. Measures, including hardware and infrastructure-related measures should be developed and implemented to ensure that SPEEDI functions remain operable even during a complex disaster.

(3) **Problems of the decision-making of evacuation of residents and confusion experienced by the affected communities** [Chapters V.3 VII.5 (4)]

The government issued instructions for evacuation over several times. The decisions were made at the Government NERHQ solely on the basis of the information and views of the senior members of relevant ministries and TEPCO who assembled at the fifth floor of the Prime Minister's Office. There is no evidence that any official representing MEXT as the competent ministry of SPEEDI was present at the Government NERHQ. No knowledge of SPEEDI was utilized in the decision-making process. Since the SPEEDI had not been functional in a full form, the conclusions of evacuation zoning might have been the same as the government decisions. But it should be pointed out as problematical that the point of view of utilizing the SPEEDI was totally missing in planning the evacuation strategy.

The government instructions for evacuation did not reach promptly all the relevant local governments in the designated evacuation areas. Moreover, the instructions were not specific nor in detail. The local governments had to, without sufficient information, make decisions to evacuate, locate evacuation destination, and evacuation procedures. One of major reasons for such confusion is considered to be the background factors that the government and electric power companies had not tackled fully the problem of evacuation once a nuclear disaster occurs.

The Investigation Committee notes the following points in order to prepare for possible recurrence of such an accident.

i. Activities to raise public awareness are needed to provide residents with basic, customary knowledge of how radioactive substances are released

during a major nuclear accident, how they are dispersed by wind and other agents, and how they fall back to earth, as well as knowledge of what harm the exposure to radiation can do to health.

ii. Local government bodies need to prepare evacuation readiness plans that take into account the exceptionally grave nature of a nuclear accident, periodically conduct evacuation drills in realistic circumstances, and take steps to promote the earnest participation of residents in those drills.

iii. Beginning in times of normalcy, there is a need for readiness preparations, such as drafting detailed plans for ensuring modes of transportation, organizing transportation, establishing evacuation sites in outlying areas, and ensuring water and food supplies in places of refuge, taking into consideration the situation that evacuees may number in the thousands or tens of thousands. 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 drawing up and administering evacuation and disaster readiness plans, in consideration of the situation that a nuclear emergency would affect a large area.

(4) **Problems of provision of information to the nation and international society** [Chapters V.8, VII.5 (5)]

In the wake of the accident, quite a few cases were observed where the manner of providing information by the government gave rise to questions and suspicion on the populations in the areas around the Fukushima Dai-ichi NPS and people in the whole

nation that the government was not providing truth promptly and accurately. The manner in which the government provided information about the status of the reactor cores (core meltdowns, in particular) and the critical conditions of Unit 3, as well as the repeated announcement of an unclear statement that the radiation “will not immediately affect human bodies”, aroused such suspicions.

The following tendency was observed: transmission and public announcement of information of urgent matters were delayed, press releases were withheld, and explanations were kept ambiguous. Whatever the reasons behind, such tendency was far from the ideal response as to how the public should be informed of risks in an emergency.

The Investigation Committee will continue its investigation on this subject, and will make necessary recommendations in the final report.

As regards providing information to the international society, contaminated water was discharged to the ocean immediately after the decision had been made without prior explanation to the neighboring countries. It may not violate legal obligations under the relevant international conventions, but the case may have caused mistrust of the international communities in the adequacy of Japan’s response to nuclear disasters. We should take this an important lesson for the future.

(5) **Review of other hazard control measures** [Chapters V.4 (5) (6), 5 (2), VII.5 (6)]

The Investigation Committee is still in the process of investigating problems relating to the raising of screening levels, the criteria about the use of contaminated school grounds, and the medical institutions that provide emergency medical care to the victims of radiation exposure.

6. Inappropriate Precautionary Measures against Tsunami and Severe Accidents

(1) Inappropriate measures against tsunami and severe accidents [Chapters VI.3, 4, VII.6 (1)]

a Problems on tsunami assumptions

(a) Regulatory bodies concerned

The Nuclear Safety Commission (NSC) of Japan started its revision process of the Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities ("Seismic Design Regulatory Guide") in July 2001 within its Sub-committee on the seismic design regulatory guide. But no tsunami specialist was included among the Sub-committee members. This seems to demonstrate the NSC's insufficient awareness of the significance of tsunamis in nuclear safety. The revision of the seismic design regulatory guide (NSCRG L-DS-I.02) took five years of work and it was finally completed in September 2006. It is appreciable that a clause on the countermeasures against tsunami was included in the final version of the revised seismic design regulatory guide, but it did not lead to additional implementation of specific measures against tsunami.

It is the role of the regulators to set up the methodology for tsunami evaluation and the criteria for evaluating the effectiveness of measures against tsunami. The Investigation Committee is unable to find, however, evidence of such efforts made by the regulatory organizations concerned. NISA received from TEPCO in 2002 its safety evaluation report based on the "Tsunami Assessment Method for Nuclear Power Plants in Japan" (Ref. 1). But NISA did not provide TEPCO with any particular comment or instructions in return. In August/September 2009 and in March 2011, NISA received from TEPCO reports on the results of its test calculations of the wave height of possible tsunamis, etc. but failed to respond to them positively by requesting TEPCO to take specific measures such as implementing additional construction works to enhance protection against tsunamis.

(Ref. 1) Tsunami Assessment Method for Nuclear Power Plants in Japan, the Tsunami Evaluation Subcommittee, the Nuclear Civil Engineering Committee, Japan Society of Civil Engineers, 2002.

(b) TEPCO and others

The licenses for the Fukushima Dai-ichi NPS were granted between 1966 and 1972 assuming a maximum tsunami height of 3.1 m as part of design conditions. This height was set based on the maximum wave height observed at the Onahama Port (about 40km south of the Fukushima Dai-ichi NPS) when a tsunami originating from the 1960 Great Chilean Earthquake reached the port.

In February 2002, the Tsunami Evaluation Subcommittee of the Japan Society of Civil Engineers (JSCE, then an incorporated association and now a non profit foundation) compiled the "Tsunami Assessment Method for Nuclear Power Plants in Japan" (Ref.1). The methodology estimates a possible tsunami wave height, based on the historic records of tsunamis that could be judged fairly reliable from evident traces of wave heights. Prehistoric tsunamis, even if they might have occurred, were not considered in the methodology, so long as there are no records. And its limits of application or remarks for application were not mentioned in the compiled document.

Using the JSCE's tsunami assessment method, TEPCO revised the assumed maximum tsunami height for the Fukushima Dai-ichi NPS to 5.7 m (later revised again to 6.1 m).

In 2008, TEPCO reevaluated the tsunami risks at the Fukushima Dai-ichi NPS and got the wave heights exceeding 15 m. TEPCO got another estimated wave height of exceeding 9 m on the basis of the wave source model of the Jogan Tsunami in 869 A.D. (the Satake paper, Ref. 2). However, it did not lead TEPCO to take concrete measures against tsunami at the Fukushima Dai-ichi NPS. The reasons for this attitude was that: in their view, the former value (>15 m) was a virtually derived value obtained by repositioning the source wave model of the

Off-Sanriku coast (about 200km north of the site) to the Off-Fukushima coast, while the latter value (>9 m) was not sufficiently reliable, because the source model had not yet been finalized in the Satake paper.

(Ref. 2) Kenji Satake, Yuichi Namegaya, Shigeru Yamaki,, Numerical simulation of the AD 869 Jogan Tsunami in Ishinomaki and Sendai plains, katsudannsou・kojishinkennkyuuhoukoku, No.8, pp.71-89, 2008. (http://unit.aist.go.jp/actfault-eq/seika/h19seika/pdf/03.satake.pdf)

The Investigation Committee is of the view that specific measures against tsunami should have been implemented including measures against severe accidents for the purpose of preventing nuclear disaster, because it is considered that: i) natural phenomena entail by nature major uncertainties ii) with regards to tsunamis in particular, we must take note that we can closely examine only a limited number of tsunami disasters in the past by means of studying existing literatures, and iii) once a tsunami far exceeding the design basis hits nuclear power plants, a wide range of safety functions of nuclear facilities could be lost simultaneously by common mode failures. Nuclear power stakeholders, including the national government and industries, should seriously review the history of assessment activities conducted before the Fukushima nuclear accidents and learn lessons for the future.

b Severe accident management measures

As stated, if a tsunami far exceeding the design basis hits nuclear power plants, it is very likely that a broad range of safety functions could be lost simultaneously by common mode failures, which will lead immediately to a severe accident. But in the past, risks of tsunamis were not fully considered in the context of severe accident management that deals with incidents exceeding design basis assumptions.

In July 1992 the Ministry of International Trade and Industry (MITI, later reformed into METI) published a document titled the “Roadmap of Accident

Management (AM)", and initiated considerations on the Accident Management as measures against severe accidents. However, the scope of incidents was limited only to internal incidents such as mechanical failures and human factor errors. External incidents such as earthquakes and tsunamis were not included in the scope of consideration. Moreover, AM was regarded as voluntary initiatives by nuclear operators and not as part of regulatory requirements.

Measures against severe accidents should not be left to the operator's voluntary initiatives. The nuclear safety regulatory bodies should consider and determine legal requirements when they deem them necessary. This is a lesson learned from the experience with the accident of this time.

(2) **Problems of measures against natural disasters that had been taken by TEPCO** [Chapters VI.4 (6), (7), VII.6 (2)]

TEPCO did not implement measures against tsunami as part of its AM strategy and was very poorly prepared to cope with an accident of a degree of severity that reactor cores are seriously damaged by natural disasters. Listed below are some of the specific problems that were revealed through the accident.

(i) Lack of preparedness against the total loss of power

The risk of tsunami exceeding design basis assumptions had not been considered. Therefore, no preparation was made for an eventuality such as "simultaneous and multiple losses of power" and the "Station Blackout including the loss of DC power supplies". No operational manuals were in place for recovering measurement hardware, power supplies, and PCV venting, etc. in such situations. Staff education was not implemented for such eventuality. No stock of equipment and materials were available for such restoring operations.

(ii) No preparative plan for injection of freshwater and seawater by fire engines

Fire engines were brought in for the injection of freshwater and seawater for responding to the accident. These steps were not placed as part of the AM. Therefore, specific procedures were not established in advance and extra time was needed for their operation.

(iii) Breaking down of emergency telecommunication lines

The in-house telecommunication lines in an emergency were not sufficiently in place. As a result of the SBO, all PHS (personal handy phone system) became inoperative and information sharing among the people concerned was seriously disrupted.

(iv) Securing of materials and operators in an emergency

There were no specific procedures arranged in advance for handling equipment and materials for an emergency or in an extraordinary situation, which caused delay in securing operators of fire engines and heavy machinery.

7. Why Were the Measures against Tsunami and Severe Accident Insufficient? [Chapter VII.7]

i. Limitation of voluntary safety measures

TEPCO did not incorporate measures against tsunamis exceeding their heights of design basis assumptions. This indicates the limitation of voluntary safety measures.

ii. Insufficient organizational capabilities of regulatory bodies

Relevant research and knowledge continue to advance quickly on daily basis. The regulatory bodies should focus their efforts on formulating and updating the guidelines and criteria, taking into account the latest applicable knowledge. To this end, it is essential to ensure sufficient organizational capabilities of regulatory

bodies. Scholarly discussion with inconclusive nature could be left to the work of academic communities.

iii. **Adverse effects of specialization and sectoral subdivisions**

The successful implementation of tsunami protection measures requires knowledge and technology from different field of expertise. It is important to notice that problems should be solved by the joint effort of different groups of experts and engineers, where each has its own unique culture. It is necessary to make arrangements toward the formation of cross-sectoral organizations.

iv. Difficulties in presenting risk information

It is a paradox that the effort to further improve safety is met with negative reactions by others, because such effort may be interpreted as the negation of the past practices.

It is not easy to admit an idea that an absolute safety never exists, and to learn to live with risks. But it is necessary to make effort toward building a society where risk information is shared and people are allowed to make reasonable choices.

8. Recommendations on the New Nuclear Safety Regulatory Body [Chapter VI.7, VII.8]

The Government made a cabinet decision on August 15, 2011 to reorganize the nuclear safety regulatory bodies into a new government agency under the Ministry of Environment, by separating NISA from METI and combining its function with that of the NSC. The Investigation Committee suggests the Government to take the following points into account in establishing the new agency.

i. The need for independence and transparency

The new nuclear safety regulatory organization should be granted independence and should maintain transparency. The new nuclear safety regulatory organization must be 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 Japanese people.

ii. Organizational preparedness for swift and effective emergency response

The new nuclear safety regulatory organization should, beginning in times of normalcy, draw up disaster preparedness plans and implement drills to facilitate rapid response to disasters, should foster the specialized skills to provide expert advice and guidance that competent personnel and organizations responsible for emergency response will need, and should foster the management potential it needs to apply its resources effectively and efficiently.

In addition, the nuclear safety regulatory organization must be well aware that its role is to respond responsibly to crises. It should 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 disaster-related information to Japan and the world

The new entity must be fully conscious that the way it provides information is a matter of great importance, and must also, beginning in times of normalcy, establish an organizational framework that ensures it will, during an emergency, be able to provide information in a timely and appropriate manner.

iv. Retention of first-rate human resources; greater specialized expertise

The new 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 and retain talented 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

The new regulatory organization to be established 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 absorbing knowledge that will contribute to its regulatory activities. It must also understand the implications of that knowledge, share it and use it systematically, and convey it and pass it on as it befits an organization of its nature.

9. Interim Conclusions [Chapter VII.9]

Based on the examination of various facts found up to now, the Investigation Committee is of the view that the following three factors contributed greatly to the arising of many problems related to the accident and the responses after the accident.

i. Lack of severe accident preparedness for tsunamis

TEPCO did not take precautionary measures in anticipation that a severe accident could be caused by a tsunami such as the one which hit at this time. Neither did the regulatory authorities.

The tsunami that caused the accident at the Fukushima Dai-ichi NPS is an example of events that are believed to have a very small probability of happening but are likely to produce enormous damage if they do happen. We must refresh our awareness of the risks of such events. We should take the necessary measures to address such risks, which should never be ignored.

ii. Lack of awareness of the ramifications of a complex disaster

A lack of foresight is identified as a great problem for the safety of both nuclear power plants and surrounding communities that nuclear accident had not been assumed to occur in a complex disaster. Disaster prevention programs should be formulated by assuming a complex disaster, which will be the major point in reviewing nuclear power plant safety for the future.

iii. Lack of an all-encompassing perspective

It cannot be denied that the nuclear emergency response programs in the past lacked an overall perspective. This is a great shortfall in nuclear emergency

response programs. The excuse cannot be justified that it had been difficult to make sufficient preparations for such an exceptional event because the plant was struck by a tsunami beyond design basis assumptions.

The Investigation Committee is convinced of the need of a paradigm shift in the basic principles of disaster prevention programs for such a huge system, whose failure may cause enormous damage.

10. Final Remarks [Chapter VII.10]

Whatever to plan, design and execute, nothing can be done without setting assumptions. At the same time, however, it must be recognized that things beyond assumptions may take place. The Fukushima nuclear accident presented us crucial lessons on how we should be prepared for such incidents that we had not accounted for.

The Investigation Committee will continue its investigation, bearing in mind following points:

- Many people are still forced to spend restricted life in evacuation for a prolonged period of time;
- Many people are suffering from the consequences of radiation contamination or troubled by anxieties concerning the consequences of radiation exposure which they may face in the future; and also
- Many people continue to feel anxiety about contamination of air, soil and water or the safety of food.