

**Final Report on the Accident at Fukushima Nuclear Power Stations
of Tokyo Electric Power Company
--- Recommendations ---**

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

July 23, 2012

On March 11, 2011, the Fukushima Dai-ichi Nuclear Power Station (“Fukushima Dai-ichi NPS”) and the Fukushima Dai-ni Nuclear Power Station (“Fukushima Dai-ni NPS”) of the Tokyo Electric Power Company (“TEPCO”) were hit and damaged by the Tohoku District - off the Pacific Ocean Earthquake and accompanying tsunami. Particularly at the Fukushima Dai-ichi NPS, a serious severe accident occurred, which was of Level 7 in the International Nuclear Event Scale (INES) of the International Atomic Energy Agency.

This Investigation Committee was established on May 24, 2011 by a cabinet decision. Its mission is to make policy recommendations, by investigating 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 site including the Fukushima Dai-ichi and Dai-ni NPSs, and interviewed many 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 Investigation Committee continued its multifaceted analysis, after the publication of the Interim Report, on matters including the then-available accident preventive measures and disaster preparedness, emergency response actions taken on-site and off-site at the accident. The results are contained in the Final Report. It became clear through the investigation that the accident had been initiated on the occasion of a natural disaster of an earthquake and tsunami, but that there had been various complex problems behind this very serious and large scale accident, i.e., the problems in the accident preventive measures and disaster preparedness, in on-site emergency responses to the accident, and in preventive measures against the spread of damage outside the nuclear power station.

Examples are: the then-available accident preventive measures and disaster preparedness of TEPCO and the Nuclear Industry and Safety Agency (“NISA”) were insufficient against tsunami and severe accidents; the preparedness for a large-scale complex disaster was insufficient; and they were unprepared for the release of a large amount of radioactive materials into the environment caused by a containment failure. Inadequate TEPCO emergency responses to the accident at the site were also identified. Furthermore, in the preventive measures against the spread of damage taken by the central and local governments, problems were identified which lacked consideration to the victims, such as the radiation monitoring operation, the utilization of the System for Prediction of Environmental Emergency Dose Information (SPEEDI), evacuation instructions to the residents, responses to the people’s radiation exposure, or the provision of information to the nation and outside the country. In addition, problems of the crisis management system of the government came to light, too.

The investigation thus far has suggested that radical strengthening revision be required of the measures for preventing a recurrence of a grave accident at the nuclear power station, and for limiting/mitigating the spread of damage. In this context, the Investigation Committee has made a number of recommendations in the Final Report (It also reproduces the recommendations made in the Interim Report).

This document excerpts the recommendations which the Investigation Committee made in the Final Report. The Investigation Committee believes that the realization of these recommendations be useful and important for preventing a recurrence of a nuclear disaster and mitigating its damage. The central and local governments concerned, nuclear operators and other relevant organizations are strongly urged to incorporate and act upon these recommendations in their safety measures and disaster preparedness.

The English version of the Interim Report of the Investigation Committee and its Executive Summary is available on the Committee’s website (<http://icanps.go.jp/eng/>). The English version of the Final Report and its Executive Summary will also be uploaded shortly.

- (1) Recommendations for a basic stance for safety measures and disaster preparedness
 - Recommendations for disaster preparedness in light of complex disasters in mind (Final Report VI. 2. (2))

When reviewing the existing safety measures at nuclear power stations, risks of a large scale complex disaster should be sufficiently considered in disaster preparedness.

- Recommendations for changing an attitude to see risks (Final Report VI. 2. (3))
 - 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 disaster 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 disaster preparedness.

- Recommendations for “deficiency analyses from the disaster victims’ standpoint” (Final Report VI. 2. (4))

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.

Radioactive materials may scatter over vast areas due to an accident at a nuclear power station. The prefecture and local municipalities involved should closely collaborate in building up an effective system through evacuation planning and its drills for minimizing confusion.

- Recommendations for incorporating the latest knowledge in the disaster prevention plan (Final Report VI. 2. (5))
 - i. Scientific knowledge of earthquakes is not sufficient yet. The latest research results should be continually incorporated in disaster 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 disaster 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. Disaster risks in nuclear power plant siting regions should be noted. It was the role of NISA to prepare for nuclear disasters at nuclear power stations. However, the policy of the Central Disaster Management Council has strong relevance to the disaster preparedness at nuclear power stations. The Central Disaster Management Council should duly consider the nuclear power stations, too, in its policy making.

(2) Recommendations for safety measures regarding nuclear power generation

- Recommendations for building disaster prevention measures (Final Report VI 2 (1))

Quite a number of issues exist, which need highly specialized nuclear knowledge over a wide range for solving technical and nuclear engineering problems concerning the emergency responses to the accident at TEPCO Fukushima Dai-ichi NPS, and the then-available disaster preparedness by the government, TEPCO and other organizations. These issues 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.

- Recommendations for the necessity of comprehensive risk analysis (Final Report VI. 2. (4) a. (b))

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. Nuclear operators should actively utilize currently available methods in their analyses of such external events, even if the Probabilistic Safety Assessment (PSA) approach is not firmly established for them. The government should consider support to promote relevant research programs for such initiatives.

- Recommendations for severe accident management (Final Report VI. 1. (4) a. (c))

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, 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.

(3) Recommendations for nuclear disaster response systems

- Recommendations for reforming the crisis management system for a nuclear disaster (Final Report VI. 2. (6))

Learning from the experience as a result of the accident at the Fukushima Dai-ichi NPS, the crisis management system for a nuclear disaster 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, which are supposed to serve as the base for response during a nuclear emergency (hereafter simply referred to as "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 responsebodies.

- Recommendations for the nuclear emergency response headquarters (Final Report VI. 2. b. (a))

The emergency response headquarters should, in general, be located 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. To promptly collect accurate information is, needless to say, the fundamental principle in 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.

- 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, learning from the fact that the Off-site Center (in Fukushima) became unusable because the risks of radioactive contamination had not been adequately considered beforehand.

- Recommendations for the roles of the prefectural government in nuclear emergency responses (Final Report VI. 1. (2) c.)

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

(4) Recommendations for damage prevention and mitigation

- Recommendations for the provision of information and risk communication (Final Report VI. 2. (7))

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.

- Recommendations for improving radiation monitoring operations (Interim Report VII. 5. (2) d.)

- 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, storm surge, flood, sediment disasters, volcanic eruptions and gale force winds. Measures should be taken to prevent the system from functional failures even in a complex disaster simultaneously involving two or more such events. 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.
- Training sessions 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.)

In order to protect the lives and dignity of residents caught up in a disaster, and to prevent the spread of harm from the disaster, measures should be developed to improve operational guidelines of the SPEEDI system so that crucial information on radiation dose rates 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 during a complex disaster.

- Recommendations for evacuation procedures of residents (Items i. to iv. in Interim Report VII. 5. (4) c. and item v. in Final Report VI. 1. (4) b.)

- Activities to raise public awareness in daily lives are needed to provide residents with basic, practical 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 the ground, 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 exceptionally grave nature of a nuclear accident, periodically conduct evacuation drills in a realistic circumstance, 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 detailed 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 a disaster prevention plan, in consideration of the situation that a nuclear emergency would affect a large area.
 - v. 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 areas 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.
- Recommendations for administering stable iodine tablets (Final Report VI. 1. (3) e. (c))

In the existing emergency preparedness, administration of stable iodine tablets is, in

principle, subject to the judgment of the government NERHQ. 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.

- Recommendations for radiation emergency medical care institutions (Final Report VI. 1. (3) e. (f))

A considerable number of medical facilities for initial 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 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.

- Recommendations for public understanding of radiation effects (Final Report VI. 1. (3) e. (g))

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 should 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.

- Recommendations for information sharing with, and receiving support from, overseas (Final Report VI. 1. (3) g. (a), (b))

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 polite responses should be in place for prompt and accurate provision of relevant information with due consideration to language barriers.

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 in Fukushima, operation manuals of competent ministries, nuclear operator emergency management operation plans and other relevant materials should prescribe how

to respond to such international support.

(5) Recommendations for harmonization with international practices

- Recommendations for harmonization with international practices such as the IAEA safety standards (Final Report VI. 1. (7))

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. 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.

(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.)

An organization with regulatory oversight over nuclear safety must be able to make decisions effectively and independently, and must be able to function separately from any organization that could unduly influence its decision-making process. The new nuclear safety regulatory organization should therefore 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 as an entity concerned with nuclear safety 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 (Interim Report VII. 8. (2) b.)

In light of the serious impact of a nuclear disaster on the nation, the nuclear safety regulatory organization, which would play a key role in disaster response, should, during normal times, work out a disaster prevention plan 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 responsibly to crises. 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 disaster-related information to Japan and the world (Interim Report VII. 8. (2) c.)

The new 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 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 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 new nuclear safety 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 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))

The fixed 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.

- vii. Strengthening of the regulatory body (Final Report VI. 1. (5))

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. Considering that the impact of a nuclear disaster on society can be sizable, emergency preparedness should be fully established during normal times by formulating a disaster prevention plan 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.

- Recommendations for TEPCO (Final Report VI. 6. e.)

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.

- Recommendations for rebuilding safety culture (Final Report VI. 2. (8))

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.

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

- Recommendations for continued investigation of accident cause (Final Report VI. 2. (9) a.)

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.

- Recommendations for extended investigation of the whole picture of accident damage (Final Report VI. 2. (9) b.)

Japan as a country which experienced an unprecedented nuclear disaster should transfer as lessons to future generations the whole picture of “Damage to humans” including the facts in detail. This can be done by: recording the results of a comprehensive investigation of academic investigation 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 “Damage to humans” to future generations based on the recorded results of comprehensive investigation of the Fukushima nuclear disaster. The investigation of the “Damage to humans” 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.