

Assessment Procedures and Implementation Plan Regarding the
Comprehensive Assessments for the Safety of Existing Power Reactor
Facilities Taking into Account the Accident at Fukushima Dai-ichi Nuclear
Power Station, Tokyo Electric Power Co. Inc.

July 21, 2011

Nuclear and Industrial Safety Agency

Responding to the request of the Nuclear Safety Commission (NSC) in the official document of 23 SCD No.7 dated 6 July 2011, Nuclear and Industrial Safety Agency (NISA) has decided as follows concerning the assessment procedures and implementation plan regarding the comprehensive assessments for the safety of existing power reactor facilities taking into account the accident at Fukushima Dai-ichi Nuclear Power Station (NPS) of Tokyo Electric Power Co. Inc. (TEPCO).

I. Assessment procedures

1. Facilities subject to the assessments

All existing power reactor facilities, including those under construction, are subject to the assessments. However, Fukushima Dai-ichi and Dai-ni NPSs, TEPCO as well as any facilities that are being taken measures for decommissioning and do not have any fuels remaining in the facilities are excluded.

Separate implementation of assessments on nuclear fuel cycle facilities will be considered.

2. Specific time subject to the assessments

The assessments will be implemented on subject facilities and their management condition at a time of choosing, prior to report time.

3. Events subject to the assessments

The following events are subject to the assessments taking into account the accident at Fukushima Dai-ichi NPS, TEPCO.

- Natural phenomena: Earthquake and tsunami
- Loss of safety functions: Loss of all Alternating Current (AC) power

sources and loss of the ultimate heat sink (UHS)

4. Implementation method of the assessments

Electricity Utilities and other related organization (Operators) will implement assessments based on the following methods and will submit the results of the assessments to NISA. NISA will evaluate the assessment results from each Operator and request the NSC to confirm its evaluation results.

The assessments by each Operator comprise a preliminary assessment and a secondary assessment. Both assessments are required to specify implemented measures as the emergency safety measures and other related measures after the accident at Fukushima Dai-ichi NPS, TEPCO.

(1) Preliminary assessments

Assessments will be implemented for the degree to which safety margins are secured for structures, systems and components (SSCs) with safety functions of especially high importance, against the events beyond the design basis. The assessment will be implemented from the perspective of the degree to which safety margins are secured against the allowable limit and other related value.* The assessments will also indicate the effectiveness of measures taken to secure safety against the events beyond the design basis, from the defense-in-depth perspective. These processes will determine whether higher safety margins have been added to the required safety standards.

* In the cases where the allowable limit has been set with ample margin as compared with the upper limit of resilience, a value that takes this margin into account may be used as long as the usage is technologically accountable.

(2) Secondary assessments

The safety margin (the ultimate limitations of strength) will be assessed by evaluating the scale of events that an NPS can withstand without significant damage to the fuel, assuming the occurrence of events beyond the design basis. Additionally, in terms of measures to

prevent significant damage to the fuel, their effectiveness will be indicated from the defense-in-depth perspective. At the same time, any cliff edge effect will be identified to uncover potential vulnerabilities. These processes will yield a comprehensive assessment of the robustness of existing NPSs against external events beyond the design basis.

(3) Method to proceed with assessments

In the assessments, each Operator will indicate an event tree for the development process of an event, and at each stage of the event tree, the Operator will consider the protective measures that can be used at the given stage and indicate the validity and limitations of each measure. Indicating the situation at each stage in this manner, results in a clear-cut assessment from the defense-in-depth perspective. When implementing the assessment, the Operators should take note of the following points.

- As the situation when an initiating event arises, in addition to assuming the most severe operation conditions, such as under the maximum output operation, the Operator will assume the most severe plant situation, for example, the spent fuel pools are completely filled with spent fuels.
- The assuming natural phenomena are earthquakes and tsunamis. It is supposed that these natural phenomena occur concurrently; furthermore, in the secondary assessments, the most severe conditions assumable in light of the recent experience, the events beyond the design basis and, as needed, a concurrence of other natural phenomena will also be considered without limitation to the events for the design basis,
- The Operator will also review the development of the event and the time required for the operations when considering the course of events.
- The Operator will suppose that the reactor and the spent fuel pool are simultaneously affected. Furthermore, for the assessments of protective measures, the Operator will suppose severe situations, such as those where the function will not recover if it is once lost excluding the case that the recovery of a function can be expected due to reasonable assumptions, and where the Operator cannot receive any support from outside the

plant.

- For the secondary assessments, the Operator may include in its assessments the SSCs, even though they are the facilities and functions voluntarily reinforced by the Operator, or the structures and components of the class B and C based on the classification of importance in seismic design (Seismic Class B and C), if their functions are expected to be maintained by reasonable assumptions.
- As to the loss of safety functions, the loss of all AC power sources and the loss of the UHS are assumed, and their concurrent loss is also supposed for the secondary assessments.
- For NPSs that have multiple units, the Operator will consider the possibility of interaction between the different units.
- A deterministic approach will be used and the realistic assessment will be implemented without considering excessive conservativeness.
- Implementation should be accompanied by an awareness of this undertaking as a part of a process that enables a grasp of the reserves and potential vulnerabilities possessed by the Operator's NPSs and leads to improved safety.

5. Implementation matters for the preliminary assessments

The below-listed matters will be implemented in the preliminary assessments.

(1) Earthquake

- (a) Assess whether SSCs of Seismic Class S as well as SSCs of other seismic class that could be involved in significant fuel damage would suffer damage or loss of function, according to a degree where the seismic motion exceeds the design basis, taking into account the knowledge derived from seismic probabilistic safety assessment (PSA) and other related knowledge or a comparison with the allowable limit or other related value.
- (b) Identify the course of events from the initiating event to any significant damage to the fuel and specify the presence of any cliff edge effect, taking into account the results of the assessment described in (a). In addition, specify the

magnitude of the seismic ground motion on that occasion.

- (c) In terms of measures to prevent the development of events in the process leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.

(2) Tsunami

- (a) Assess whether SSCs with safety functions of especially high importance and SSCs that could be involved in significant fuel damage would suffer damage or loss of function, according to a degree where the tsunami height exceeds the height of the tsunami postulated in the design (design-basis tsunami height), which was evaluated using the “Tsunami Assessment Method for Nuclear Power Plants in Japan” (2002) by Japan Society of Civil Engineers, taking into account the knowledge derived from tsunami PSA and other related knowledge or a comparison with the design-basis tsunami height or other related value.

- (b) Identify the course of events from the initiating event to any significant damage to the fuel and specify the presence of any cliff edge effect, taking into account the results of the assessment described in (a). In addition, specify the height of the tsunami on that occasion.

- (c) In terms of measures to prevent the development of events in the process leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.

(3) Concurrence of earthquake and tsunami

- (a) Assess whether SSCs with safety functions of especially high importance and SSCs that could be involved in significant fuel damage would suffer damage or loss of function in the event of an earthquake exceeding the design basis followed by a tsunami exceeding the design basis, taking into account the knowledge derived from earthquake and tsunami PSA or a comparison with the design basis.

- (b) Identify the course of events from the initiating event to any significant damage to the fuel and specify the presence of any cliff edge effect, taking into account the results of the

assessment described in (a). In addition, specify the magnitude of the seismic ground motion and the height of the tsunami on that occasion.

- (c) In terms of measures to prevent the development of events in the process leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.

(4) Loss of all AC power sources

- (a) Identify the course of events from the loss of all AC power sources as the initiating event to any significant damage to the fuel, taking into account the knowledge derived from PSA addressing internal events. In addition, specify the duration of the loss of all AC power sources on that occasion.

- (b) Specify the presence of any cliff edge effect, taking into account the course of events identified in (a) and the development process from the loss of external power supply to the loss of all AC power sources.

- (c) In terms of measures to prevent the development of events in the process leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.

(5) Loss of the ultimate heat sink (UHS)

- (a) Identify the course of events from the loss of the UHS as the initiating event to any significant damage to the fuel, taking into account the knowledge derived from PSA addressing internal events. In addition, specify the duration of the loss of the UHS on that occasion.

- (b) Specify the presence of any cliff edge effect, taking into account the development in the course of events identified in (a).

- (c) In terms of measures to prevent the development of events in the process leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.

(6) Other severe accident management

In terms of severe accident management measures introduced in the regulations with the document of “How to Advance Accident

Management Measures in the Future” announced by the Ministry of International Trade and Industry (at the time) in July 1992 and implemented by Operators (measures to prevent significant damage to the fuel, and measures to maintain the integrity of containment functions to prevent the large-scale release of radioactive materials), indicate their effectiveness from the defense-in-depth perspective.

However, exclude measures to prevent the development of events in the process leading to any significant damage to the fuel described in each paragraph (c) in the above sections (1) to (5).

6. Implementation matters for the secondary assessments

The below-listed matters will be implemented in the secondary assessments.

(1) Earthquake

- (a) Assess whether SSCs would suffer damage or loss of function according to a degree where the seismic motion exceeds the design basis, taking into account the knowledge derived from seismic PSA and other related knowledge.
- (b) Identify the course of events from the initiating event to any significant damage to the fuel and specify the presence of any cliff edge effect, taking into account the results of the assessment described in (a). In addition, specify the magnitude of the seismic ground motion on that occasion.
- (c) In terms of measures to prevent the development of events leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective. Moreover, if there is a possibility to incur a significant impact on the course of events due to the concurrence of other natural phenomena, consider the impact and the response measures.

(2) Tsunami

- (a) Assess whether SSCs would suffer damage or loss of function according to a degree where the tsunami height exceeds the design basis, taking into account the knowledge derived from tsunami PSA and other related knowledge.
- (b) Identify the course of events from the initiating event to any significant damage to the fuel and specify the presence of any

cliff edge effect, taking into account the results of the assessment described in (a). In addition, specify the height of the tsunami on that occasion.

- (c) In terms of measures to prevent the development of events leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective. Moreover, if there is a possibility to incur a significant impact on the course of events due to the concurrence of other natural phenomena, consider the impact and the response measures.

(3) Concurrence of earthquake and tsunami

- (a) Assess whether SSCs would suffer damage or loss of function in the event of an earthquake exceeding the design basis followed by a tsunami exceeding the design basis, taking into account the knowledge derived from earthquake and tsunami PSA.
- (b) Identify the course of events from the initiating event to any significant damage to the fuel and specify the presence of any cliff edge effect, taking into account the results of the assessment described in (a). In addition, specify the magnitude of the seismic ground motion and the height of the tsunami on that occasion.
- (c) In terms of measures to prevent the development of events leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective. Moreover, if there is a possibility to incur a significant impact on the course of events due to the concurrence of other natural phenomena, consider the impact and the response measures.

(4) Loss of all AC power sources

- (a) Identify the course of events from the loss of all AC power sources as the initiating event to any significant damage to the fuel, taking into account the knowledge derived from PSA addressing internal events. In addition, specify the duration of the loss of all AC power sources on that occasion.
- (b) Specify the presence of any cliff edge effect, taking into account the course of events identified in (a) and the

development process from the loss of external power supply to the loss of all AC power sources.

- (c) In terms of measures to prevent the development of events leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.
- (5) Loss of the ultimate heat sink (UHS)
- (a) Identify the course of events from the loss of the UHS as the initiating event to any significant damage to the fuel, taking into account the knowledge derived from PSA addressing internal events. In addition, specify the duration of the loss of the UHS on that occasion.
 - (b) Specify the presence of any cliff edge effect, taking into account the development in the course of events identified in (a).
 - (c) In terms of measures to prevent the development of events in the process leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.
- (6) Compound of loss of all AC power sources and loss of the UHS
- (a) Identify the course of events from the compound event of the loss of all AC power sources and the loss of the UHS as the initiating event to any significant damage to the fuel, taking into account the knowledge derived from PSA addressing internal events. In addition, specify the duration of the compound event of the loss of all AC power sources and the loss of the UHS on that occasion.
 - (b) Specify the presence of any cliff edge effect, taking into account the course of events identified in (a).
 - (c) In terms of measures to prevent the development of events leading to any significant damage to the fuel, including response to any specified cliff edge effect, indicate their effectiveness from the defense-in-depth perspective.
- (7) Severe accident management
- (a) In terms of severe accident management measures introduced in the regulations with the document of “How to Advance Accident Management Measures in the Future”

announced by the Ministry of International Trade and Industry (at the time) in July 1992 and implemented by Operators (measures to prevent significant damage to the fuel, and measures to maintain the integrity of containment functions to prevent the large-scale release of radioactive materials), identify any cliff edge effect. In addition, assess the interval between the time the severe accident management measures start and the time the event reaches the cliff edge effect.

- (b) In terms of measures to prevent a cliff edge effect, indicate their effectiveness from the defense-in-depth perspective, examining not only hardware but also the aspects of software such as preparedness of manuals and organization.

II. Implementation plan

1. Preliminary assessments

Preliminary assessments will be implemented on a reactor, which is in periodic inspection and has organized its start-up preparations.

2. Secondary assessments

Secondary assessments will be implemented on all existing power reactor facilities (However, Fukushima Dai-ichi and Dai-ni NPSs of TEPCO, as well as any facilities that are being taken measures for decommissioning and do not have any fuel remaining in the facilities, are excluded). The target deadline for the Operators to submit their reports is by the end of the year. However, this deadline will be adjusted, as necessary, considering the states of implementation of the stress tests in European countries and the state of review in the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company.

Power reactor facilities currently under construction will be implemented the assessments prior to starting-up.

The assessments will be implemented per NPS.

3. Actions taken by NISA

(1) Preliminary assessments

NISA will evaluate the content of the preliminary assessment when NISA receives submission of it. NISA will report the results of its findings to the NSC and request the NSC for its confirmation.

(2) Secondary assessments

NISA will evaluate the content of submitted reports. NISA will report the results of its findings to the NSC and request the NSC for its confirmation.

Furthermore, if necessary, NISA will revise the implementation matters for the secondary assessments, and will instruct the Operators again to implement the assessments based on the revised implementation matters, considering the states of implementation of the stress tests in European countries and the state of review in the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company.

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50th Nuclear Safety Commission

Reference No.1

July 6, 2011

Mr. Banri Kaieda

Minister of Economy, Trade and Industry

Haruki Madarame

Chairman,

The Nuclear Safety Commission

Request to the NISA to report on Comprehensive Safety Review of Existing Nuclear Power Plants Based on the Lessons Learnt from the Fukushima Dai-ichi NPS Incident

Pursuant to Article 25 of the Act for Establishment of the Atomic Energy Commission and the Nuclear Safety Commission, we hereby ask for arrangements for reporting requested in the attached document.

(Attached sheet)

Implementation of comprehensive safety review of existing nuclear power plants based on insights from the accident at the Fukushima Dai-ichi Nuclear Power Station of the Tokyo Electric Power Co., Inc.

July 6, 2011

The Nuclear Safety Commission

In light of the March 11, 2011 accident at the Fukushima Dai-ichi NPS of Tokyo Electric Power Co., Inc., the Nuclear Safety Commission has determined that the Nuclear and Industrial Safety Agency (NISA) should carry out comprehensive review of existing nuclear power plants (NPPs) for their robustness against beyond-design-basis external events.

The NPP designs, emergency operational procedures and accident management measures are all based on the defense-in-depth concept. There is expectation that NPPs would respond in a robust manner to events exceeding the conditions postulated in their designs. Nevertheless, in such an event as a tsunami well beyond the design basis, excessive loads imposed on the facility may possibly cause simultaneous, wide-spread loss of safety functions, due to certain common factors, revealing so-called cliff edge effects. It is recognized that the development of the Fukushima Dai-ichi NPS accident included such effects. In order to find potential vulnerabilities typified by cliff edge effects, and to take measures against them, it is crucial to assess the robustness of NPPs against beyond-design-basis events in a comprehensive manner.

Already, the NISA has given several instructions to the electric power utilities to implement additional measures for prevention and mitigation of severe core damage, and has reviewed the state of implementation. These individual measures are believed to be effective in enhancing the safety level of NPPs. However, in light of the lessons learnt from the accident, the effectiveness of these measures as a whole in enhancing the facility robustness and in overcoming vulnerabilities has to be assessed in a comprehensive manner. The assessment should cover: (1) natural phenomena such as earthquake and tsunami, including superposition of these phenomena, unlimited to the range of design basis but spanning to the most severe probable conditions and even severer conditions, (2) plant states including loss of all AC sources, loss of the ultimate heat sink, and superposition of these states, where possible scenarios leading to the losses should be addressed in addition to considering scenarios initiated by the losses,

with possible multi-unit interactions), and (3) severe accident countermeasures including preventive and mitigative measures, and on-site emergency plan.

Based on the matters mentioned above, the Commission requests the NISA to carry out comprehensive review of existing NPPs for their robustness against beyond-design-basis external events.

In this context, the Commission requests, pursuant to Article 25 of Act for Establishment of the Atomic Energy Commission and the Nuclear Safety Commission, the NISA to formulate and report to the Commission the methods of assessment and the implementation schedule, noting that the assessment should:

- (1) Define clearly the roles of individual preventive/mitigative measures in defense-in-depth.
- (2) Evaluate the effectiveness and limitation of individual measures in securing the relevant layer(s) of defense-in-depth, by assuming that the measures are to fail one by one, and thereby identifying the scenarios leading to severe core damage. Evaluate, not necessarily quantitatively, the routes and margin to failure for each measure.
- (3) Use deterministic methods.
- (4) Assume the severest initial operating conditions.
- (5) Utilize outcomes from probabilistic safety assessment (PSA) on internal events, earthquake and tsunami.

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