Regarding the Evaluation Results about Each Utility’s State of Implementation in Response to the Directions related to Securing Reliability of External Power Supply for Nuclear Power Stations, etc.

June 7, 2011
Nuclear and Industrial Safety Agency

I. Background
On April 15, 2011, the Nuclear and Industrial Safety Agency (NISA) directed General Electricity Utilities to take the following measures to further improve the reliability of their external power supplies considering the temporary loss of external power supply which occurred at the Higashidori Nuclear Power Station (NPS) of the Tohoku Electric Power Co. Inc. and at the Rokkasho Reprocessing Plant of the Japan Nuclear Fuel Limited (JNFL) due to the earthquake that occurred off the coast of Miyagi Prefecture on April 7, 2011. (Attachment 1)

Direction 1:
- Analyze and evaluate the supply reliability of the electric power system as an external power supply for the NPS, etc. Furthermore, review measures for improving the reliability considering the results of the analysis and evaluation.

Direction 2:
- Connect each unit to all transmission lines linked to the plural power lines within the NPS, etc.

Direction 3:
- Evaluate the seismic adequacy of the transmission steel towers of the power lines and the safety of their foundations. Furthermore, undertake any response necessary for reinforcement, etc., considering the results of the evaluation.

Direction 4
- Make a plan for measures against tsunami for the electric equipment, such as the switchyard within the NPS, etc. (making the facilities indoors, increasing watertightness).

After receiving these directions, each Electricity Utility, etc. submitted a report to NISA related to the state of implementation of their measures. NISA made the following evaluations in relation to the subject reports.
II. Reports from each Electricity Utility, etc. and NISA's evaluation
   1. Direction 1: Supply reliability of electric power system

   (1) Content of reports from Electricity Utilities
       ① Each Electricity Utility’s method for analysis and evaluation
           Each Electricity Utility, etc. analyzed and evaluated the
           situations described in following case from the perspective of
           reviewing how to further improve the reliability of electric
           supply to the NPS, etc.
           <Analyzed and evaluated facilities>
           • Power substation and transmission lines connected to the
             NPS, etc.
           • Power substations where bottlenecks arise during the electric
             supply for the overall facilities.
           <Details of potential accidents>
           • Complete shutdown for 1 power substation (very extreme
             case)
           • Complete shutdown for bas or 1 voltage class for 1 power
             substation (extreme case)
           • Accident of 1 transmission line route cut off (standard case)
           In their analysis and evaluation of the situations described in
           each case above, each Electric Utility’s approach for evaluating
           the reliability of its electric supply was as follows:

<table>
<thead>
<tr>
<th>Securing external power supply</th>
<th>Reliability of supply for electric power system</th>
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<tbody>
<tr>
<td>① When there is no loss to the external power supply</td>
<td>Reliability of the power system is secured</td>
</tr>
<tr>
<td>② When the external power supply was temporarily lost, but it can be recovered quickly (*) due to replacing the transmission line of electric power system</td>
<td>Reliability of the electric power system is secured</td>
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<tr>
<td>③ When the external power supply is lost, and time is required for recovery</td>
<td>Undertake measures in order to further improve the reliability of the electric power system.</td>
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(*) The reference for “recovered quickly” here is when the time is shorter in comparison to the maintenance time of controlling the electric supply of the reactor core isolation cooling system (“RCIC”), etc.
② Each Electricity Utility’s analysis and evaluation, as well as their counter measures

The summary of the results for analysis and evaluation regarding the reliability of the electric power supply conducted by each Electricity Utility is as follows:

【Results of Evaluation】

1. NPS, etc. with satisfactory reliable supply
   ① External power supply would not be lost because there are two or more different power substations where electricity is received from 【9 NPS, etc.】 * with respect to each unit in Tsuruga and Genkai:
      Tomari, Kashiwazaki-Kariwa, Hamaoka, Mihama, Takahama, Ohi, Tsuruga (Unit 1), Monju, and Genkai (Units 3 and 4).

   ② External power supply could be lost since the main power source has only 1 power substation, but these NPS, etc. can recover quickly due to replacement transmission lines. 【7 NPS, etc.】 * with respect to each unit in Ikata and Genaki:
      Onagawa, Tokai Dai-ni, Shika, Shimane, Ikata (Unit 3), Genkai (Units 1 and 2), and Sendai.

2. NPS, etc. undertaking measures to further improve the reliability of supply

   NPS, etc. that require time to recover because they receive their external power supply from only 1 power substation or the main power source has only 1 power substation 【6 NPS, etc.】 * with respect to each unit in Ikata and Tsuruga:
   · Tsuruga (Unit 2) and Ikata (Units 1 and 2) ⇒ After the measures are undertaken, go to 1.① (no loss of external power supply); and
   · Higashidori, Oma, Rokkasho Reprocessing Plant, and Tokai Reprocessing Plant ⇒ After the measures are undertaken, go to 1.② (quick recovery possible due to replacement transmission power grid).
(Note) Tohoku Electric Power Co. Inc. has plans to add a new single 2-circuit route (500,000V power system), with the goal of starting operations by the end of June 2011). The above comments are presuming that the 500,000 V power system will be operational.

(2) NISA’s Evaluation and Actions

① Regarding the Electricity Utilities’ method for analysis and evaluation

The analysis and evaluation by the electricity Utilities is taken from the strictest perspective for securing external power supply, and covered accidents befalling the power substations or transmission lines directly connected to the NPS, etc. Moreover, considering the wide area blackout on April 7, 2011, the analysis and evaluation also focused on accidents befalling power substations where bottlenecks arise during the electric supply for the overall facilities. The details of the potential accidents include an accident where 1 transmission line route is cut off (standard case), or a complete shutdown for a bus or 1 voltage class for 1 power substation (extreme case); in addition, a further complete shutdown for 1 entire power substation as occurred on April 7 when the accident of a wide area blackout occurred (very extreme case) was also conceived.

Taking the above into consideration, NISA believes that the Electricity Utilities’ method for analysis and evaluation were valid.

② Regarding the Electricity Utilities’ results of analysis and evaluation, as well as their counter measures

Even in the very extreme case conceived this time (complete shutdown for 1 power substation), NISA confirmed from the results of evaluation by the Electricity Utilities that 9 NPSs would not lose external power supplies, and the reliable supply to the electric power system were secured.

Furthermore, although temporary loss of power supply would occur at 7 NPS, quick recovery would be possible by a replacement transmission power system; accordingly, NISA confirmed the results of evaluation by the Electricity Utilities that the reliable supply to the power systems for these 7 NPS was secured. However, while NISA did determine that these evaluation results were valid, NISA considers it necessary to implement drills in response to accidents conceived this time at each Electricity Utility, as the counter measures to ensure the replacement of the power system quickly and precisely, and to further shorten the time required for the power system replacement.
As to the other 6 NPS, etc., NISA confirmed the results of evaluation by the Electricity Utilities that it was necessary to undertake counter measures to further improve the reliability of the external power supply because time was required for recovery when the external power supply was lost in the very extreme case (complete shutdown for 1 power substation) conceived this time.

Regarding these 6 NPS, etc., each Electricity Utility is drafting a plan for counter measures, such as provisionally connecting transmission lines, newly installing transmission routes, or connecting all transmission lines to all units (Direction 2). Regarding these counter measures, NISA confirmed the reliability of the external power supply once these counter measures have been completed, and considered them valid. Going forward, NISA will confirm the state of implementation for the counter measures undertaken by each Electricity Utility.

Lastly, regarding replacing the power system, it was also conceived to respond not only by not only automatic replacement but also by sequential replacement of the long distance transmission power system. Regarding this point, it is requested to consider taking drastic measures, such as rebuilding the foundations in the middle to long-term to improve the structure of the power system, in order to improve the reliability of the external electric power supply.

2. Direction 2: Connect all transmission lines to all units

(1) Content of Reports from All Electricity Utilities

At this stage, only part of the transmission lines drawn into the power stations are connected to each unit at Tomari Power Station, Hamaoka NPS, Ohi Power Station, Shiga NPS, Shimane NPS, Ikata Power Station, Genkai NPS, and Tsuruga Power Station.

The above power stations are proceeding with either of the below methods to undertake the counter measures that will connect all the transmission lines to all the units in a power station.

(i) By receiving electricity directly from the unconnected circuits; or
(ii) By receiving electricity indirectly via the adjacent bus, which receives electricity from the unconnected circuits.

(2) NISA's evaluation and actions

NISA confirmed that counter measures were being
undertaken to connect all transmission lines drawn into a power station to all units of the power station by either of the above methods, as well as that, when reviewing these counter measures, the below points were considered, and confirmed that, as necessary, facilities were being added, etc.

(a) The newly installed facilities have the structure of the facilities using the same equipment as the existing facilities;

(b) The connection to the circuits is such that it can separate with certainty the subject unit from the other unit’s emergency bus by a circuit breaker, etc. to be manually operated only in case of emergency, and they do not have any mutual electrical effect on the system;

(c) The structure of the facilities, including large pumps, etc., has electric capacity capable of supplying sufficient electric power to the facilities necessary to transfer to cold shutdown.

(Genkai NPS is planning to replace the power substation soon, because it is necessary to increase the electric capacity, and NISA confirmed whether it had sufficient ability to supply electricity.)

(d) The replacement of the electric power supply can be performed in a short period in case of emergency.

Furthermore, NISA considered the design and build of the facilities (bus and circuit breakers, etc.), the construction of the onsite switchyard, as well as the operations for their transmission lines drawn into the power stations, etc. together with the shutdown for the circuits; as well, NISA confirmed that a plan exists to complete all the counter measures within 2-4 years.

In view of all the above, NISA confirmed that the counter measures would appropriately connect all the transmission lines to all the units within the subject power stations, and NISA determined that these counter measures were valid.

NISA will confirm the state of implementation for the counter measures undertaken by each Electricity Utility going forward.

3. Direction 3: Evaluation of the seismic adequacy and foundation stability of the steel towers of the power supplies line

(1) Content of Reports from Electricity Utilities

① Regarding the seismic adequacy of the transmission line towers

Each Electricity Utility determined that the seismic adequacy of the transmission line towers were sufficient because nothing overturned by the seismic ground motion
during the earthquakes on March 11, 2011 and April 7, 2011, respectively.

However, as many fractures, etc. appeared in the supporting insulators for the electric circuits, there are plans underway to undertake measures by the end of fiscal 2011 at the latest to replace the support insulators with something more earthquake-resistant.

② Regarding the stability of the foundations of the transmission line towers

Regarding the stability of the foundations of the transmission line towers, considering that, at the electric power supply line of Fukushima Dai-ichi NPS (Yonomori Line No. 27 steel tower), 1 tower fell down due to the soil pressure caused by crumbling of the embankment close to the tower by the earthquake which occurred on March 11, 2011, each Electricity Utility will investigate the risk of an embankment collapsing by conducting onsite investigations before August or September of this year.

(2) NISA’s evaluation and actions

TEPCO reported to NISA that it believed the nearby major crumbling of the embankment due to the seismic ground motion was the cause for Yonomori Line No. 27 steel tower falling down. From the state of the site reported by TEPCO this reasoning can generally be considered as fact.

Accordingly, NISA requested that the technical standards for electric equipment be resistant to wind speed of 40 m/s. Considering that the damage of Yonomori Line No. 27 steel tower falling down was due to the collapse of the embankment during the recent earthquakes, and the falling down of the tower was not caused by the earthquake itself, and that no transmission line towers incurred any significant damage by the recent earthquakes despite the maximum wind speed around the tower this time (699 gal) was superseded by the maximum wind speed during the earthquake in the south part of Hyogo Prefecture in 1995 (818 gal), no problems could be found seismic adequacy of transmission line towers built in accordance with the current technical standards for building earthquake-resistant transmission line towers.

However, the supporting insulators for the electric lines showed many cracks and fractures. In the respective reports from Tohoku Electric Power Co. and TEPCO, notwithstanding the cracks in the line long-rod insulator due to the recent earthquakes, the dangling insulator and the organic insulator did not show any fractures, and so, NISA considers that replacing the
insulators with dangling insulator would be a valid counter measure.

NISA will confirm the state of implementation for the investigations related to the counter measures of the supporting insulators and the stability of the foundations of the transmission line towers undertaken by each Electricity Utility going forward.

4. **Direction 4: Make a plan for measures against tsunami for the electric facilities within the NPS, etc.**

(1) **Content of reports from electricity utilities**

All Electricity Utilities prepared the necessary measures for waterproof treatment of equipment as part of the emergency safety measures, however, since the electric equipment, such as the switchyard, etc., are not included in the scope of the emergency safety measures presumed loss of external power supply, the Electricity Utilities must consider a similar tsunami and specify the equipment which must be undertake measures for, as well as, select one or a combination of the below measures (Attachment 2):

(i) Transfer or newly install to a high location the electric equipment, such as the switchyard, etc.
(ii) Create multiple electricity supply routes
(iii) Install tide embankments, etc. around the switchyard, etc.
(iv) Perform waterproof treatment on the electric equipment, such as the switchyard, etc.
(v) Change the equipment from an air equipment to a gas insulated switchgear

(2) **NISA’s evaluation and actions**

Regarding the above counter measures, similar to when it conducted its review of the emergency safety measures, NISA considered adding the value for the tsunami height evaluated by the Japan Society of Civil Engineers of 9.5 m to the tsunami height (maximum of 15 m), and confirmed that the equipment, which must be subject to the plan for these counter measures within the electric equipment, such as the switchyard, etc., are concretely specified from the height of the equipment of each electric equipment, etc.

In addition, NISA confirmed that for the applicable equipment, there were concrete plans to change the installation height of the equipment, to install a seawall to control the impact of tsunami, and to undertake waterproofing measures, based on the similar thinking of the measures against tsunami in the emergency safety measures, to strengthen as much as possible
the resistance against tsunami.

Moreover, for these counter measures, there will be major construction (creating multiple circuit routes and transferring transformers to a higher location) as well as simple matters (waterproof measures): NISA confirmed that these plans existed to complete all the counter measures within 1-4 years.

Taking the above into consideration, since each Electricity Utility had considered and appropriately specified the height of tsunami necessary for the equipment to undertake the measures, as well as, have a plan for the concrete measures to reinforce the resistance against tsunami with respect to said equipment, NISA determined that each Electricity Utility’s measures were valid.

NISA will strictly confirm the state of implementation for the counter measures undertaken by each Electricity Utility going forward.

III. Future Action

NISA believes that each Electricity Utility is undertaking the appropriate measures in response to the directions from NISA for further improving the reliability of the external power supply for the NPS, etc. NISA will strictly confirm the state of implementation for the report submitted by each Electricity Utility going forward.

As an aside, in response to the directions from NISA for a report outlining the damage to the electric equipment inside and outside Fukushima Dai-ichi NPS and the investigations to determine the causes since the earthquake on March 11, 2011, NISA received a report from TEPCO (dated May 16, 2011) about the damage of the air circuit breaker and the disconnector in the switchyard of the Fukushima Dai-ichi NPS due to the earthquake.

To improve the reliability of the external power supply to a completely new level, considering the results of the analysis of the earthquake observation records registered at TEPCO’s Fukushima Dai-ichi NPS, in addition to evaluating whether there is possibility for destruction or damage to arise a malfunction of the electric facilities, such as the switchyard, etc., and if it is determined that the possibility for such impact does exist, NISA instruct each Electricity Utility to draft a plan for measures against earthquakes. NISA will confirm whether the content of the reports is reasonable, and publish the results going forward.

Furthermore, regarding the technical review related to the seismic adequacy of electric equipment, such as a switchyard, etc., reviews will be conducted by academic associations, and NISA will summarize these results in approximately 2 years or so.

Lastly, if additional measures are required in view of the detailed investigation about the accident at the Fukushima Dai-ichi NPS, NISA
will make further requests to each Electricity Utility to respond.
### Explanation of Abbreviated Terms

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<tr>
<th>Abbreviated Term</th>
<th>Official Name</th>
<th>Electricity Utility</th>
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<tbody>
<tr>
<td>Tomari</td>
<td>Tomari Power Station</td>
<td>Hokkaido Electric Power Co., Inc.</td>
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<tr>
<td>Higashidori</td>
<td>Higashidori Nuclear Power Station</td>
<td>Tohoku Electric Power Co., Inc.</td>
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<td>Monju</td>
<td>Fast Breeder Reactor</td>
<td>Japan Atomic Energy</td>
</tr>
<tr>
<td>Location</td>
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<td>Operator</td>
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<td>Monju</td>
<td>Agency (an incorporated administrative agency)</td>
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<td>Tokai Reprocessing</td>
<td>Tokai Research and Development Center, Nuclear Fuel Cycle Engineering Laboratories Reprocessing Facility (Tokai Reprocessing Facility)</td>
<td>Japan Atomic Energy Agency (an incorporated administrative agency)</td>
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<td>Rokkasho Reprocessing</td>
<td>Reprocessing plant (Rokkasho Reprocessing Facility)</td>
<td>Japan Nuclear Fuel Ltd.</td>
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