Security of offsite power supply of Fukushima Daini Nuclear Power Station

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Tokyo Electric Power Company

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1. Preface

As on April 15, 2011, we received an instruction document entitled “Offsite power supply security of nuclear power stations and reprocessing plants” from Nuclear and Industrial Safety Agency of Ministry of Economy, Trade and Industry (NISA), we put together measures on securing security of offsite power at our Kashiwazaki Kariwa Nuclear Power Station, Tokai No.2 Power Station of the Japan Atomic Power Company and Nuclear Fuel Cycle Engineering Laboratories (Tokai Research and Development Center) of Japan Atomic Energy Agency and submitted a report to NISA.

Regarding the above-mentioned report, NISA evaluated the content was appropriate. However, regarding measures on ensuring the security of offsite power at Fukushima Daini Nuclear Power Station, we received an instruction from NISA that we should report based on the situation of restoring facilities at the Station and the implementation status of emergency safety measures required to keep cold shutdown of its reactors. Hence, we will put together measures on ensuring the safety of offsite power and report to NISA.

Regarding responses to ensure the safety of offsite power at Fukushima Daini Nuclear Power Station, we will follow the method of analyses and evaluations of the report to NISA on May 16 (Former Report).

1.1 Requested items based on a document of Minister of Ministry of Economy, Trade and Industry

TEPCO should respond to the followings and report to NISA their implementation status.

[Concrete requested items]

1. Due to a power supply trouble caused by an earthquake etc., a situation in which offsite power of a nuclear power plant etc. (a nuclear power plant and a reprocessing plant) is influenced may occur. TEPCO should analyze and evaluate the supply safety of your electric power system that can influence power supply to a nuclear power plant etc.. In addition, based on such analysis and evaluation, TEPCO should review measures to further improve the safety of power supply to the Power Station etc. including the enhancement of onsite power supply. In a reprocessing plant, TEPCO should review the

organization of onsite equipments to respond to the above-mentioned measures regarding the supply safety of electric power system of the plant.

2. In order to contribute enhancing the safety of power supply to each unit of your nuclear power plants, TEPCO should connect all transmission lines of multiple power supply ones with each unit and TEPCO can supply power at any time.

3. Regarding high tension towers of power supply lines in your nuclear power plants, TEPCO should evaluate earthquake-proof safety and stability of their bases in case of an earthquake and take required countermeasures such as reinforcement etc. based on the evaluation result.

4. Regarding electric facilities such as switching yards in your nuclear power plant etc., TEPCO should take measures such as their indoor installment and watertightening to prevent influences caused by tsunamis

2. Analyses and evaluations on security off offsite power (Order 1)

2.1 How to proceed with evaluations

Regarding a way of thinking of present facility formation, we basically form offsite power supply system including power supply lines in a nuclear power plant etc. based on the following.

(1) Regarding a N-2 fault(a fault with two simultaneous failures of equipments/devices), it is a rare accident and partial power outages and supply troubles can be accepted. However, in case supply troubles are huge and social influences are concerned, TEPCO should consider taking measures. (Excerpt of “Guideline of Electric Power System Council of Japan ”)

(2) Offsite power system should be designed so that equal to or more than two transmission lines are connected with electric power one. (Excerpt of “Guideline of Examination of Safety Design of Light Water Nuclear Power Facility”; “Guideline of Examination of Safety of Reprocessing Facility” is similarly stipulated)

As power supply to part of nuclear facilities was suspended at the the Miyagiken-oki Earthquake, we evaluate whether the safety of offsite power is ensured, while newly considering the viewpoint of (3) and (4) in addition to (1) and (2) above.

(3) In case of a rare accident (a N-2 fault), the safety of offsite power is ensured. In short, offsite power is not failed or temporary supply by onsite power such as a nuclear power plant etc. can be accepted, but offsite power is soon restored.

(4) Regarding more severe accidents, as we further consider the safety of offsite power, we will evaluation of its consideration and review measures if needed.

We will evaluate the following cases. The power outage in broad areas in the Tohoku Region at the Miyakiken-oki Earthquake was caused by the disjuncture of electric power system between North and South at one voltage class at one subsation, as lots of electric power system troubles occurred nearby a main substation. This will

correspond to the “(2) severe case”. However, in this report, we have evaluated the “(1) super severe case” that exceeds the “(2) severe case”.

[Evaluation case]

(1) Super severe case:

One substation (including switch station) entirely loses power

(2) Severe case:

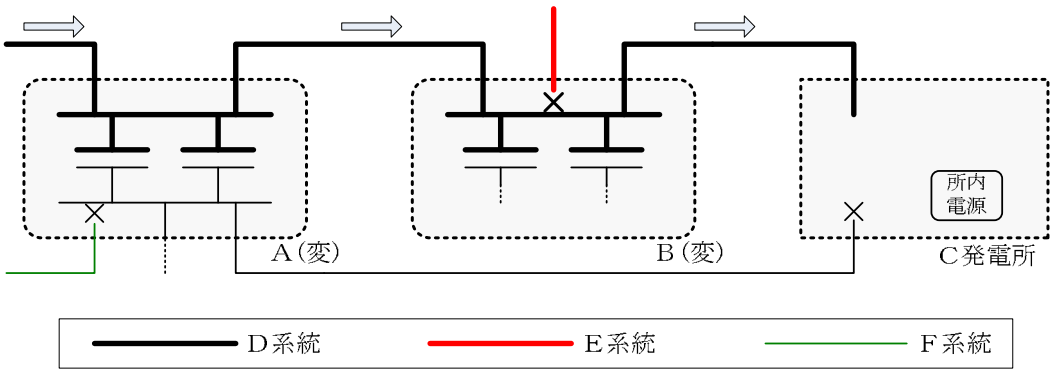
Bus line of one voltage class in one substation loses power

(3) Other:

Other than (1)(2)(including the“N-2” fault)

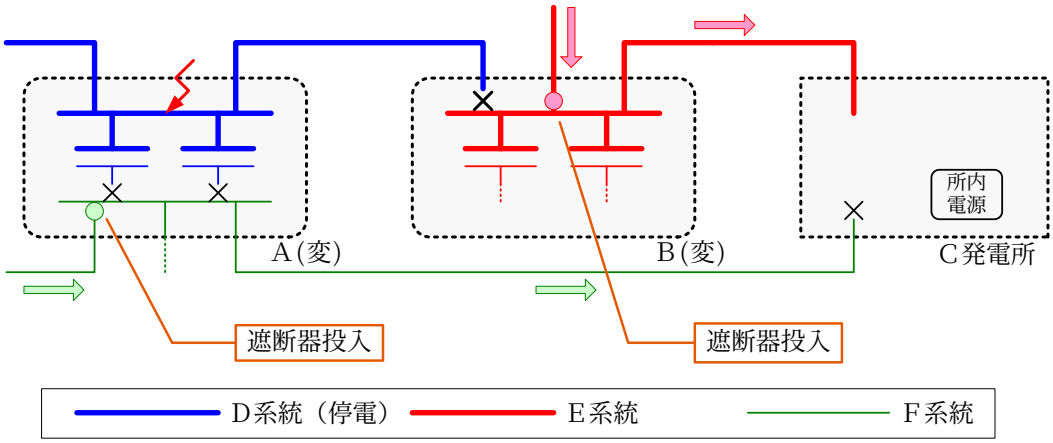
(Reference) Evaluation image ((2)[severe case])

<Normal power system>



- Power station C receives off site power from power system D under normal operations.

<Bus fault in upper level voltage of Substation A occur (transmission line and transformer outage) >



-Immediately after the fault, power station C loses offsite power temporarily (manage by on site power).

-And then, the offsite power of power station C is restored quickly from

power system E by switching the power system. (Further, it could be supplied by power system F)

2.2 Evaluation Results (Trunk Transmission System)

First, we evaluated our trunk transmission system.

Specifically, we evaluated the supply reliability of the electrical power system in the case of (1) regarding all 500kV substations except those covered in 2.3. This evaluation encompasses the evaluation of case (1) to case (3) regarding all substations and transmission lines of 500kV or lower voltage levels.

As a result of the evaluation, we conclude that the supply reliability of the electrical power system for case (1) regarding the above 500kV substations is sufficient. In our trunk transmission system, we form a multiple-route/grid power system that consists of double or triple transmission routes which encircle Tokyo, a high demand area, from east to west and multiple transmission routes which run through north to south mutually interconnected. The conclusion above is obtained through the enhancement of the supply reliability by the loop operation of this trunk transmission system.

2.3 Evaluation results (Fukushima Daini Nuclear Power Station)

The power supply line of Fukushima Daini Nuclear Power Station is structured of two 500kV transmission line, and two 66kV transmission line.

We evaluated the transmission facilities installed on the supply route from a 500kV substation as a starting point to Fukushima Daini Nuclear Power Station.

As a result of evaluation, amongst the cases□～□, with regard to case□, super severe case, there is a possibility where external power source is temporarily lost, and no external power source is achieved from the power system. In these case, and even if onsite AC power source is lost, Fukushima Daini Nuclear Power Station is currently under cold shutdown, and at stable condition, as decay heat is sufficiently reduced, it is possible to handle the matter using some time, plus it is possible to speedily supply power by emergency security measure. Therefore, we evaluate that the supply reliability of the electrical power system to maintain the current cold shutdown stable status of the reactor achieved(□). In addition, around the second half of the 2011 (fiscal) year, we are planning to install a large power facility within the site, and further reliability can be expected.

（※）In the unlikely case, all AC power source is lost including onsite power source, in order to maintain monitor/control function

and maintain reactor water level by alternative water injection, power supply by power source vehicle etc within 10 hours is stated in the emergency security measure (Approx. 3 hours is recorded at drills). Even if the loss of all AC power source is supposed to continue, as Fukushima Daini is currently under cold shutdown, and approx. 4 month has passed since the incident, decay heat has already been sufficiently been reduced, and therefore there is enough time to respond to the matter. Further, as reduction of decay heat will further proceed, there will be more time to respond.

On the other hand, regarding all other cases, external power source will either not be lost, or external power source will immediately be restored by switching lines (In the most time consuming case, line switching will take approx. 60 minutes, and 20minutes at Fukushima Daini for operation to receive power from intact line）.

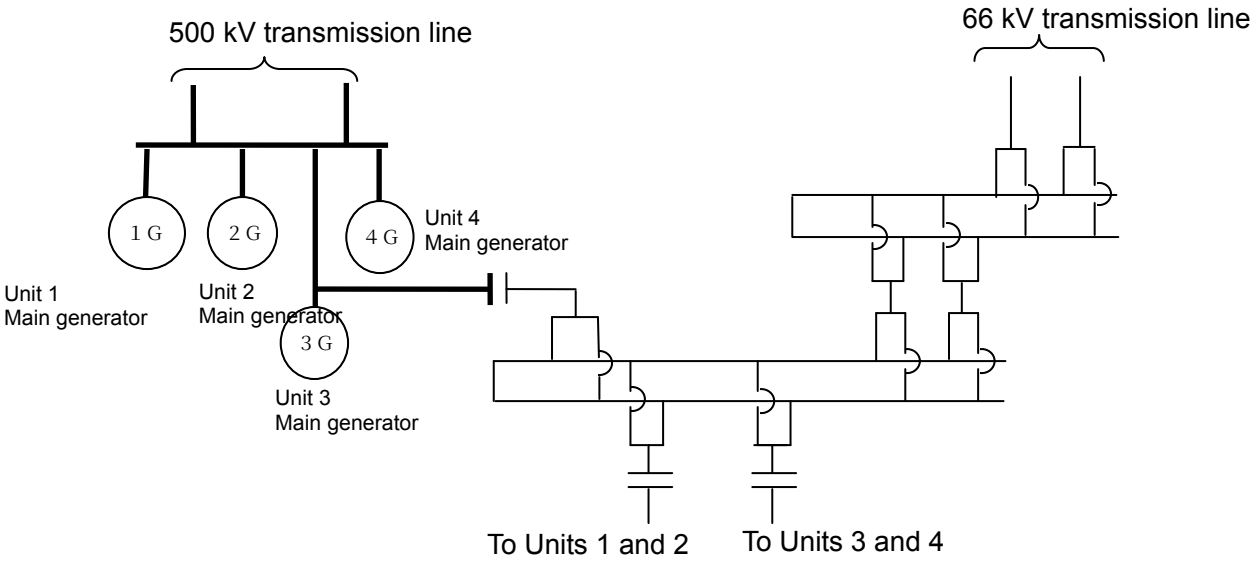
2.4 Summary of evaluation results

As described above, since Fukushima Daini is stabilized in a cold shutdown, the decay heat has been sufficiently reduced so that we will have enough time to respond to this issue. In addition, because we have already implemented emergency safety countermeasures, the reliability of electricity supply is secured to maintain the reactors in stabilized condition or a cold shutdown. Provided that, however, there is a possibility that Fukushima Daini will not able to secure with external power source in the event of super severe accident. For this reason, for further improving the power network reliability in order to maintain the cold shutdown of the reactors in a stabilized condition, we will secure a 66kV transmission route from the power grid owned by Tohoku Electric Power Company. The implementation schedule will be discussed in coordination with the concerned parties.

3. Connection to power lines to each unit (Order 2)

3.1 Onsite power transmission system at Fukushima Daini Nuclear Power Station

The safety rules require offsite power system at nuclear power stations to be connected to power lines by at least two transmission lines. At Fukushima Daini Nuclear Power Station, all of Units 1 to 4 are connected by 2 550kV transmission lines and 2 66kV transmission lines, in addition, power can be shared among units. Therefore, we understand no additional countermeasures are necessary.



【Overview of on site power system at Fukushima Daini Nuclear Power Station】

4. Earthquake-proof safety of power line towers (Order 3)

4.1 Earthquake-proof safety of transmission facilities

Based on “Basic Disaster Management Plan” (decided by the Central Disaster Management Council in July 1995), basic concepts of earthquake-proof safety of each electric facility is shown in the report on November 24, 1995 by “the examination meeting on the measures for protecting the electricity installation in disaster” (a private examination meeting for Director-General, Agency for Natural Resources and Energy) as follows;

(1) Regarding normal seismic movements

Functions of each facility are not severely affected.

(2) In addition, regarding high level seismic movements

Functions of the system are secured comprehensively by securing alternatives and redundancy etc. so as to avoid severe (long last and in broad range) troubles in supply.

The report also analyzed whether the seismic movement and the degree of damages were within the range assumed in designing, and conducted empirical examination reflecting the actual damages and examinations on validity of the current earthquake-proof standards.

This examination evaluated that the current earthquake-proof standard were adequate for securing quake resistance of each electric facility. In other words, it was confirmed that current earthquake-proof standards for each electric facility secure the quake resistance in normal seismic movements to avoid severe troubles to its functions and also secure the function of the system comprehensively in high level seismic movements by securing alternatives and redundancy to avoid severe (long last and in board range) troubles in supply, thus the standards were evaluated to be adequate.

Therefore, in the same manner as the previous report, in addition to the evaluation above we evaluated the quake resistance of 2 transmission facilities (2 lines, 24 towers) directly connected as off site power supply system to Fukushima Daini Nuclear Power Station reflecting the damage by Tohoku Taiheiyou-Oki Earthquake (hereafter, “this earthquake”).

【Surveyed transmission facilities for earthquake-proof safety evaluation】

Voltage	Transmission name	Number of towers

500kV	Tomioka Line	21
66kV	Iwaido Line	3

4.2 Earth-quake safety of power line towers

(1) Damage suffered in this earthquake and assumed causes

【Damage suffered】

・Out of transmission towers in power lines to nuclear power stations and other transmission lines, 1 tower was collapsed.

・Many supporting insulators were damaged. In some transmission lines, power was not transmitted due to inadequate insulating distance.

【Assumed causes】

・We currently assume that the soil of large mound adjacent to the tower collapsed by seismic movements slid into the tower area, and such soil pressure collapsed the tower.

・We assume that the cause of damages to supporting insulators is seismic movement.

(2) Evaluation of earthquake-proof safety

【Towers】

・In this earthquake, no transmission tower of either our company or Tohoku Electric Power Company was collapsed directly due to seismic movements.

・Including this earthquake, 3 transmission towers were collapsed in the previous large earthquakes (Hyogoken Nambu earthquake, Chuetsu-Oki Earthquake), however, all those cases were due to damages by the adjacent areas affected by earthquakes (hereafter “the secondary damage”). No transmission towers were collapsed by seismic movements.

・Therefore, in this earthquake, it can be evaluated that transmission towers are adequately quake resistant as stated in the report in 1995.

・However, seeing that 1 tower was collapsed by the collapse of large mount of soil adjacent to the tower, we need to examine the stability of the foundation against impacts by the adjacent areas.

【Supporting insulators】

・Seeing the many damages by seismic movements, it is difficult so evaluate that earthquake-proof safety is secured.

・ Therefore, countermeasures such as replacement to more earthquake- proof ones are necessary.

・Since the cause of the electric accident this time is damages to jumper supporting insulators using long rod supporting insulators, we extracted similar facilities in power lines to Fukushima Daini Nuclear Power Station.

・As a result, no similar facility was found.

【Surveyed transmission lines and number of similar facilities】

Surveyed transmission lines	Number of facilities countermeasures were taken to	Period of countermeasures
500kV Tomioka Line （21 in total）	0	Temporary measure: - Permanent measure: -
66kV Iwaido Line （3 in total）	0	Temporary measure: - Permanent measure: -

4.3 Stability of foundation

In general, regarding transmission line routes, in selecting routes landside areas are avoided as much as possible, thus the impact from the area adjacent to towers by the earthquake is minimized. If transmission lines inevitably go through such areas, we take measures such as specifically detailed surveys and selection of foundation type examining the stability of foundation.

However, since the tower was collapsed due to the secondary damage in this earthquake, we need to examine the stability of foundation against impacts from adjacent areas as evaluated in 4.2, in order to improve reliability of transmission facilities further.

(1) Evaluation items

Possible factors to cause the secondary damage are landslides and collapses of the soil at steep sloping lands in addition to collapses of mounts. Therefore, we will evaluate the following 3 items;

□ Collapses of mounts

We will extract points where large mounts are near transmission towers and evaluate the risk.

□ Landslides

We will extract potential landslide points based on landslide prevention areas, landslide hazards and distribution maps of landslide morphology and evaluate the risk.

□ Collapses of the soil at steep sloping lands

We will extract points in steep sloping lands where it is possible the soil collapses, and evaluate the risk.

(2) Transmission to be surveyed and number of towers

Name of transmission to be surveyed	Number of towers	Survey period □
500kV Tomioka Line （Total 21）	21	Survey period: H23.6 ～ H23.8 （ Measurement period ） H23.9 ～
66kV Iwaido Line （Total 3）	3	Survey period ： H23.6 ～ H23.8 （ Measuement period ） H23.9 ～

(3) Schedule

Item	Jun.	Jul.	Aug.	Sep.	Oct. and later
Extract of points to be surveyed using drawings etc.	━━				
Site survey etc.		━━			
Risk evaluation			━━		
Countermeasures (designing and construction)				━━	━━

5. Countermeasures against tsunamis at switching yards of nuclear power stations (Order 4)

5.1 Countermeasures against Tsunamis at switching yards of Fukushima Daini Nuclear Power Stations

Since the switching yards of Fukushima Daini are located on a higher hill (OP.330000), there is no need to take countermeasures against inundation. As for other electricity facilities, we will take countermeasures against Tsunami by carrying out such as a watertight method.

Regarding the implementation of these countermeasures, we are working fervently on emergency security measures. As we have already deployed power source cars at the power station, we have secured the reliability of emergency power source necessary to cool down each reactor. Hence, with a view to further improve the reliability, we will examine and conduct them as well as the countermeasures against Tsunamis.

5.2 Electric equipmente on which countermeasures will be taken against water inundation

Targeted are the offsite power source, and the facilities necessary for receiving electricity from gas-turbine-generating cars that are to be deployed at Fukushima Daini.

However those facilities located on a higher hill will not be targeted. They are as follows: (The switching yards that receive offsite power are located upland, so there is no need to take countermeasures against water inundation. For the facilities we are planning to install in the future, they will be located on a high hill safe from Tsunamis.)

a. Switching yards (OP.33000): 500kV Switchgear, 66kV GIS
b. High start-up transformers (OP.33000)
c. Distribution panels at the primary side (M/C etc.) (OP.6000)
d. Large scale power source (to be installed in the second half of FY 2011)

5.3 Countermeasures for electric equipment against water inundation

Considering the countermeasures for electric equipment against water inundation, we suppose there is nothing the matter with them, taking into account a Tsunami of the same level as the one brought about by Tohoku-Chihou-Taiheiyou-Oki Earthquake that occurred on March 11, 2011. The targeted facilities at Fukushima Daini will be the ones described in 5.2

with regards to the countermeasures against Tsunamis for the distribution panels at the primary side (M/C etc.). As for these, by the end of second half of FY 2011, we will adopt a preventing structure for the aeration louvers that are thought to be a rout for seawater inundation when a Tsunami occurs, as well as a watertight method to preventing from water inundation at equipment hatches, entrance doors and building penetrations, such as pipe ducts.

6. Summary

We, TEPCO, will make utmost efforts for the improvements regarding a response to secure the reliability of offsite power at Fukushima Daini Nuclear Power Station.