Regarding Earthquake Countermeasures at Switching Stations, etc. for Ensuring Reliability of External Power at Hamaoka Nuclear Power Station (Overview)

Chubu Electric Power today submitted a report to the Ministry of Economy, Trade and Industry's Nuclear and Industrial Safety Agency that summarizes earthquake countermeasures at switching stations, etc. to ensure reliability of external power at Hamaoka Nuclear Power Station. The report is in response to the directive of the Nuclear and Industrial Safety Agency, which was issued following damage to circuit breakers and other equipment at switching stations at the Tokyo Electric Power Co., Inc.'s Fukushima Daiichi Nuclear Power Station when it was shaken by the Tohoku-Pacific Ocean Earthquake of March 11, 2011. An outline of the results of the assessments is as follows.

1 Facilities subject to assessment

Although the mechanisms, etc. of how the circuit breakers, etc. at Fukushima Daiichi Nuclear Power Station, Reactors No. 1 and 2 were damaged in this event are not understood in detail, in light of the damage to circuit breakers, etc., it has been decided to do impact assessments of similar switching station facilities at Hamaoka Nuclear Power Station.

Additionally, nuclear power stations have transformers that convert the voltage of electrical power after it is received at the switching station facility, and this includes some large equipment. Therefore it was decided to do impact assessment on a scenario of strong excitation force from an earthquake.

(1) Switching station facilities

- 275 kV, 500 kV gas insulated switchgears (GIS) (Reactors No. 3 and 4)
- 500 kV gas insulated switchgear (GIS) (Reactor No. 5)

(2) Transformer facilities

- Startup transformer (A) (B) (Reactors No. 3 and 4)
- Main transformer, direct connection transformer, auxiliary transformer (all Reactor No. 5)

2 Impact assessment technique

It was decided to do assessments according to the Japan Electrical Manufacturers' Association standard JEAG 5003-2010, "Electric Facility Seismic Design Guideline for Substations, Etc." and check equipment design tolerance (the ratio of stress occurring at each component to that component's allowable stress).

(1) Switching station facilities impact assessment technique

- It is assumed that equipment is shaken by resonance.
- A value of 300 Gal of acceleration at the ground surface (lower end of equipment stand) was taken as the value enveloping about 98% of earthquakes over the past 75 years.
- During the assessment, the stress caused to each component of the equipment by vibration was calculated and checked to make sure it was below the allowable stress value.

(2) Transformer facilities impact assessment technique

- The main body of the transformer has a high natural frequency and a low possibility of resonating with an earthquake, and so it was evaluated as adding a certain amount of acceleration to the equipment.
- An acceleration of 500 Gal was used.
- During the assessment, the stress caused to transformer anchor bolts, etc. was calculated and checked to make sure it was below the allowable stress value.

3 Assessment results

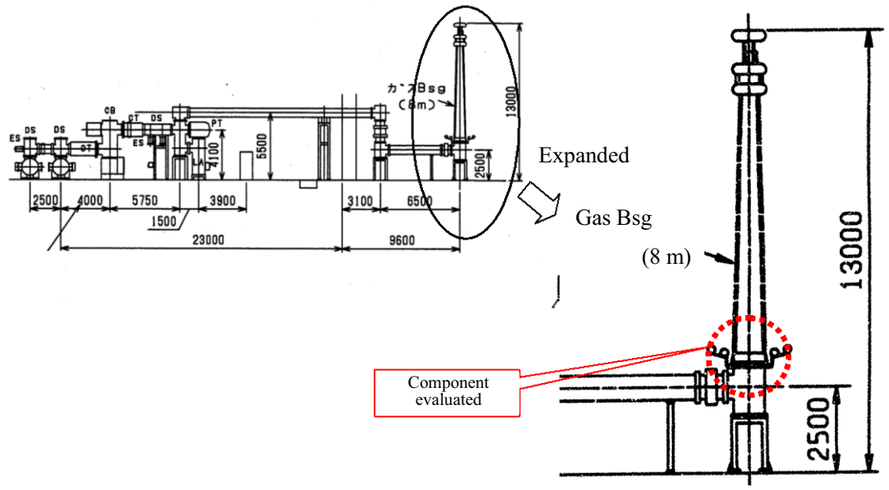
JEAG 5003-2010 techniques were used to calculate allowable stress tolerance for Hamaoka Nuclear Power Station's switching station facilities and transformer facilities. The tolerance shown in the table for each facility is for the component with the lowest tolerance.

(1) Switching station facilities

For switching stations, vibration with an acceleration response multiplier of 1.3 can envelope nearly all past earthquake data, so if tolerance was 1.3 or greater, it was judged that there was low possibility of collapse, damage, etc. that would cause functional failure, even taking past large-scale earthquakes into account.

[Assessment results based on JEAG 5003-2010 for switching stations]

Reactor	Voltage	Specifications	Tolerance	Component evaluated
Reactors No. 3, 4	275kV	Gas insulated switchgear (GIS)	2.80	Lightning arrester stand
	500kV	Gas insulated switchgear (GIS)	1.58	Bushing base
Reactor No. 5	500kV	Gas insulated switchgear (GIS)	2.25	Bushing base



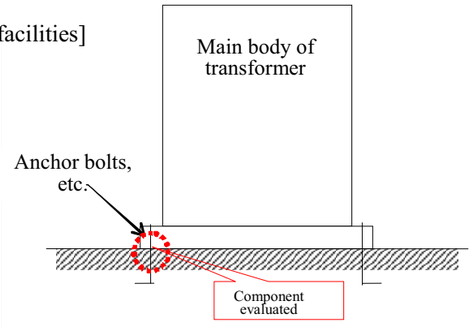
Example of component evaluated in 500 kV switching station facility

(2) Transformer facilities

Concerning transformer facilities, the main body of the transformer has a high natural frequency and a low possibility of resonating with an earthquake, and so if the tolerance was 1.0 or greater, it was judged that there was a low possibility of collapse, damage, etc. that would cause functional failure.

[Assessment results based on JEAG 5003-2010 for transformer facilities]

Reactor	Transformer name	Tolerance	Component evaluated
Reactors No. 3, 4	Startup transformer (A)	1.44	Anchor bolts
	Startup transformer (B)	1.80	Anchor bolts
Reactor No. 5	Main transformer	3.58	Foundation seismic resistance fittings
	Direct connection transformer	3.41	Anchor bolts
	Auxiliary transformer	5.91	Foundation seismic resistance fittings



Transformer assessment image

Switching stations and transformer equipment at Hamaoka Nuclear Power Station were found to have at least the above tolerance and assessed as having a low possibility of collapse, damage, etc. that would cause functional failure.

4 Future measures

Because there are still unknowns about the damage to the circuit breakers, etc. at Fukushima Daiichi Nuclear Power Station, Reactors No. 1 and 2, including the response spectrum and damage mechanism, the Tokyo Electric Power Co., Inc. will be doing a detailed assessment of this.

When the results of that evaluation are known, a new study will be performed that includes checking whether the new knowledge needs to be reflected, and the results of that study will be reported to the Nuclear and Industrial Safety Agency.