Analysis and evaluation of the operation record and accident record of Fukushima Daiichi Nuclear Power Station at the time of Tohoku-Chihou-Taiheiyou-Oki-Earthquake (summary)

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Tokyo Electric Power Company

TEPCO 東京電力

Results of Analysis

- On 16th May 2011, Nuclear and Industrial Safety Agency (NISA) instructed to analyze the operation record and accident record of Fukushima Daiichi Nuclear Power Station before and after Tohoku-Chihou-Taiheiyou-Oki-Earthquake and to evaluate the safety of reactor facilities. This instruction is implemented to plan appropriate first aid measures for the future.
- This report is submitted under the above instruction of NISA. We estimated the plant situation of Unit 1,2,3 using the operation record and accident record of Fukushima Daiichi Nuclear Power Station which was submitted on 16th May 2011.

Data and Status of Unit1 (1/2)

Record	Data
Chart	Data at the time of earthquake and tsunami. Not available after lost of power and signal due to tsunami.
Alert	Available only for approximately ten minutes after scram. (cause unknown)
Operation	White board
Transition	For thirty minutes after the earthquake

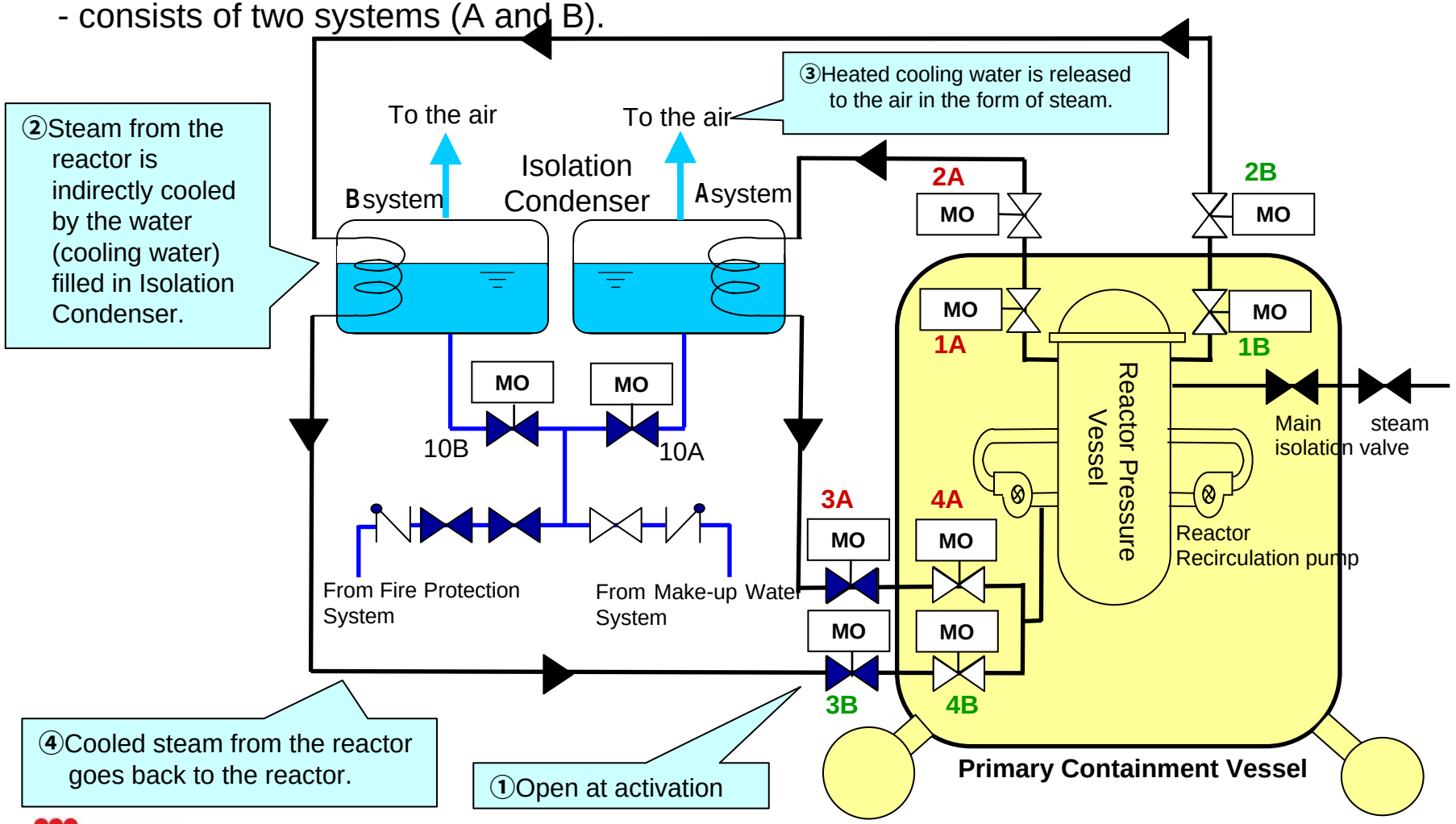
	Item	Status
1	reactor facilities before earthquake	operated at rated capacity spent fuel pool level: full capacity、pool temperature：25℃
2	reactor after scram	all controlled rod installed at 14:47 on March 11th by scram due to the earthquake. average power range monitor (APRM)：Output decreased rapidly as scheduled.
3	water level, temperature and pressure of reactor pressure vessel after scram	reactor water level：decreased by void effect after scram →maintained normal level without using emergency core cooling system reactor pressure：decreased after scram → increased by closing main stream isolation valve at 14:47 on March 11th .managed by isolation condenser. Water injection initiated at 5:46 on March 12th by fire pump.
4	isolation condenser after scram	automatically activated at 14:52 on March 11th .deactivated at 15:03 on March 11th.it is said valve was operated by 21:30. however, it is uncertain whether it was effective or not at the present moment.

Data and Status of Unit1 (2/2)

	Item	Status
5	emergency core cooling system	no automatic activation until tsunami. containment vessel spray pump was activated to cool down suppression chamber at 15:07 on March 11th .afterward containment vessel spray pump and core spray pump deactivated due to AC power lost. high pressure coolant injection system deactivated around 20:00 due to DC power lost.
6	main steam piping and other reactor facilities after scram	alert regarding main steam piping fracture was noted before or after closing main steam isolation valve. However main steam flow of process recorder is 0 after closing main steam isolation valve. Steam flow increase due to piping fracture is not noted in this process. Therefore, it is assumed that alert regarding main steam piping fracture was noted due to the offsite power source caused by the earthquake, and fail-safe closing signal was noted.
7	core of unit 1	as results of analysis, after assumed Emergency Isolation Condenser (IC) was stopped, core damage was started in relatively early stage and thereafter, the reactor pressure vessel was damaged. Although the results of analysis, based on the current temperature data and plant data of the reactor pressure vessel, it is thinkable that most part of core is cooling in the reactor pressure vessel. We think that results of analysis show more stern results than current situation. (as same as temporarily results of analysis announce on May 15th)
8	emergency diesel generators	lost offsite power source due to the earthquake. At around 14:47 on March 11th, two Emergency Diesel Generators was functioned. Normal electric voltage was confirmed and necessary electricity was secured. At 15:37 on the same day, lost all AC source.
9	emission of radiation and radioactive materials	Exhaust stack radioactive monitor：noise was confirmed after reactor scram, but it was stable until termination of recording

Overview of Isolation Condenser at Unit 1 of Fukushima Daiichi NPS

Isolation Condenser
- works to reduce the pressure in the reactor by cooling steam when the reactor is isolated (i.e. the main steam isolation valve is closed).
- consists of two systems (A and B).



Records on Operation of Isolation Condenser

May 11, 2011

Approx. 2:52 pm　Automatic activation

Automatic activation due to the high pressure in the reactor

Approx. 3:03 pm Stop (Closure of MO-3A and 3B)

Stopped so that the change of ration of the temperature in RPV doesn't exceed 55℃/h (as stated in the procedure manual)

3:10 to 3:30 pm Adjustment of pressure in reactor by A system

We estimate it was started-up and operated based on the pressure and the temperature in the reactor

3:37 pm　Loss of all AC power

6:18 pm activation (Open MO-2A, 3A)
6:25 pm Stop (Closure of MO-3A)

9:30 pm Star-up (Open MO-3A)

It is said the valve was operated and generation of steam was confirmed, however, it is uncertain how it worked at the present moment.

March 12, 2011

1:48 am Failure of fire protection pump was confirmed

Data and Status of Unit2 (1/2)

Record	Data
Chart	Data at the time of earthquake and tsunami. Not available after lost of power and signal due to tsunami.
Alert	Available only for approximately two minutes after scram.（cause unknown）. Data was restored based on the record in the hard disk.
Operation	White board.
Transition	For thirty minutes after the earthquake. Thereafter, for thirty minutes after aftershocks（including tsunami rushed）.

	Item	Status
1	reactor facilities before earthquake	operated at rated capacity spent fuel pool level: full capacity、pool temperature：26℃
2	reactor after scram	all controlled rod installed at 14:47 on March 11th by scram due to the earthquake. average power range monitor（APRM）：Output decreased rapidly as scheduled.
3	water level, temperature and pressure of reactor pressure vessel after scram	reactor water level：decreased by void effect after scram →maintained normal level without using emergency core cooling system reactor pressure：decreased after scram → increased by closing main stream isolation valve at 14:47 on March 11th, managed by opening/closing the main steam safety relief valve and the pressure is under control.
4	reactor core isolation cooling system after scram	started up manually at 14:50 on March 11th／automatically deactivated at 14:51 on March 11th (high water level). Started up manually at 15:02 on March 11th／automatically deactivated at 15:28 on March 11th（high water level）. Started up manually at 15:39 on March 11th／at 13:25 on March 14th deactivated (presumption).

Data and Status of Unit2 (2/2)

	Item	Status
5	emergency core cooling system	no automatic activation until tsunami. From 15:00 on March, started up the residual heat removal system pump (RHRSP) and cooled the suppression chamber pool. Containment vessel spray pump was activated to cool down suppression chamber at 15:07 on March 11th. Afterward, RHRSP and core spray pump deactivated due to AC power lost. High pressure coolant injection system deactivated around 15:31 due to DC power lost.
6	main steam piping and other reactor facilities after scram	alert regarding main steam piping fracture was noted before or after closing main steam isolation valve. However main steam flow of process recorder is 0 after closing main steam isolation valve. Steam flow increase due to piping fracture is not noted in this process. Therefore, it is assumed that alert regarding main steam piping fracture was noted due to the offsite power source caused by the earthquake, and fail-safe closing signal was noted.
7	core of unit 2	[please refer to the attachment]
8	emergency diesel generators	lost offsite power source due to the earthquake. At around 14:47 on March 11th, two Emergency Diesel Generators was functioned. Normal electric voltage was confirmed and it is assumed that necessary electricity was secured. At 15:41 on the same day, lost all AC source.
9	emission of radiation and radioactive materials	Exhaust stack radioactive monitor：noise was confirmed after reactor scram, but it was stable rate until termination of recording.

Data and Status of Unit3 (1/2)

Record	Data
Chart	Data at the time of earthquake and tsunami. Not available after lost of power and signal due to tsunami.
Alert	Available only for approximately three hours and thirty minutes minutes after scram. (cause unknown).
Operation	There are unknown records. Complete records are not remained.
Transition	Data are collected using temporarily power source during the period of after earthquake occurred until at around 16:00.

	Item	Status
1	reactor facilities before earthquake	operated at rated capacity spent fuel pool level: full capacity、pool temperature：25℃
2	reactor after scram	all controlled rod installed at 14:47 on March 11th by scram due to the earthquake. average power range monitor (APRM) ：Output decreased rapidly as scheduled.
3	water level, temperature and pressure of reactor pressure vessel after scram	reactor water level：decreased by void effect after scram →maintained normal level at stable without using emergency core cooling system reactor pressure：decreased after scram → increased by closing main stream isolation valve at 14:48 on March 11th, managed by opening/closing the main steam safety relief valve and the pressure is under control.
4	reactor core isolation cooling system after scram	started up manually at 15:05 on March 11th／automatically deactivated at 15:25 on March 11th . Started up manually at 16:03 on March 11th／automatically deactivated at 11:36 on March 12th.

Data and Status of Unit3 (2/2)

	Item	Status
5	emergency core cooling system	no automatic activation until tsunami. Residual heat removal pump and core spray pumps were deactivated due to AC power lost. At 12:35 on March 12th, high pressure coolant injection system was started up due to lower water level. Since reactor pressure decreased it is stopped at 2:42 on March 13th. Thereafter, it is assumable that it is deactivated due to DC power lost.
6	main steam piping and other reactor facilities after scram	alert regarding main steam piping fracture was noted before or after closing main steam isolation valve. However main steam flow of process recorder is 0 after closing main steam isolation valve. Steam flow increase due to piping fracture is not noted in this process. Therefore, it is assumed that alert regarding main steam piping fracture was noted due to the offsite power source caused by the earthquake, and fail-safe closing signal was noted.
7	core of unit 3	[please refer to the attachment]
8	emergency diesel generators	lost offsite power source due to the earthquake. At around 14:47 on March 11th, two Emergency Diesel Generators was functioned. Normal electric voltage was confirmed and it is assumed that necessary electricity was secured. At 15:38 on the same day, lost all AC source.
9	emission of radiation and radioactive materials	Exhaust stack radioactive monitor：noise was confirmed after reactor scram, but it was stable rate until termination of recording From around 5:00 on March 12th, it showed temporarily gradual increase. Since it is assumable that the water level of the reactor of Unit 3 at that time was above flooded level to cover the fuel, increase in dose is effected by the other units at the site.