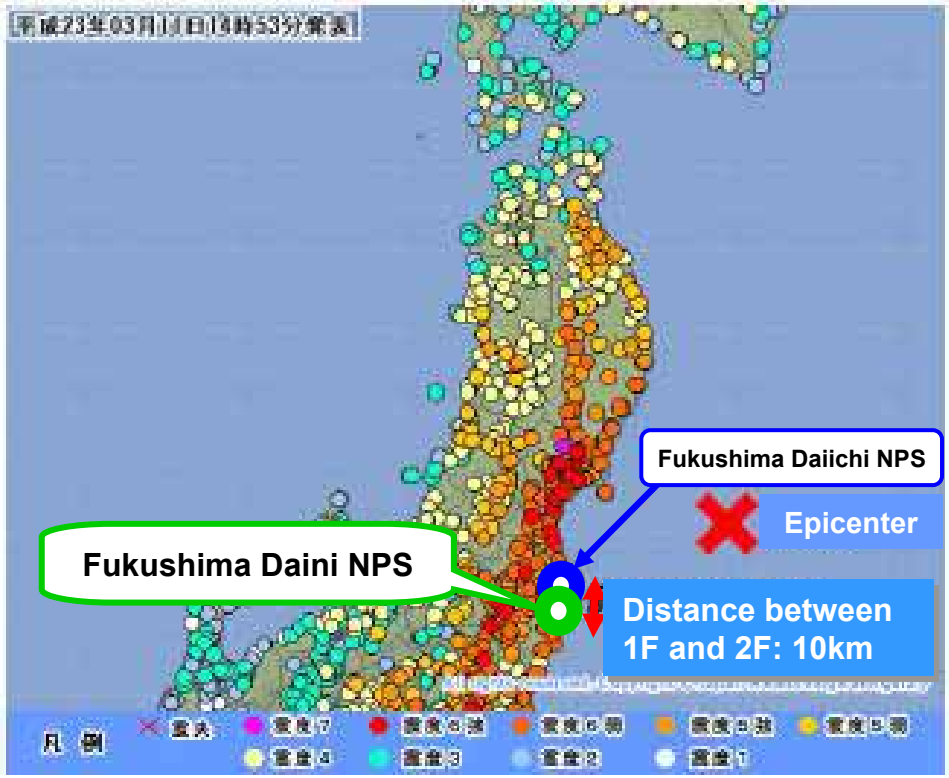
Overview of the Disaster Situation and the Restoration Condition at Fukushima Daini Nuclear Power Station

June 7, 2013

Fukushima Daini Nuclear Power Station

The 2011 off the Pacific Coast of Tohoku Earthquake

- Date and Time: At 2:46 PM on March 11, 2011
- Location: Offshore of Sanriku coast (northern latitude of 38.1 degrees, east longitude of 142.9 degrees), 24km in depth
- Magnitude: 9.0
- Intensity (Announced by Japan Meteorological Agency):
  Upper 6 at Naraha, Tomioka, Okuma and Futaba in Fukushima Prefecture



All the four units at Fukushima Daini Nuclear Power Plant were operating at their rated power before the earthquake.

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All units automatically tripped by acceleration signals (scram*).

The largest acceleration in Fukushima Daini NPS: 277 gal in horizontal[*1] and 305 gal in vertical direction[*2].
(*1 The deepest floor in Unit 3 Reactor Building)
(*2 The deepest floor in Unit 1 Reactor Building)
* Trip set point: 135 gal for horizontal acceleration, 100 gal for vertical acceleration at the deepest floor of the Reactor Building

Arrival of Tsunami

- Date and Time: At 2:46 PM on March 11, 2011
  - Location: Offshore of Sanriku coast (northern latitude of 38.1 degrees, east longitude of 142.9 degrees), 24km in depth
  - Magnitude: 9.0
  - Intensity (Announced by Japan Meteorological Agency): Upper 6 at Naraha, Tomioka, Okuma and Futaba in Fukushima Prefecture
- Arrival of Tsunami: Around 3:30 PM

Photo taken from upland near the Main Anti-earthquake Building to Unit 1 (east side) at Fukushima Daini NPS

Flooding Caused by the Tsunami (1)

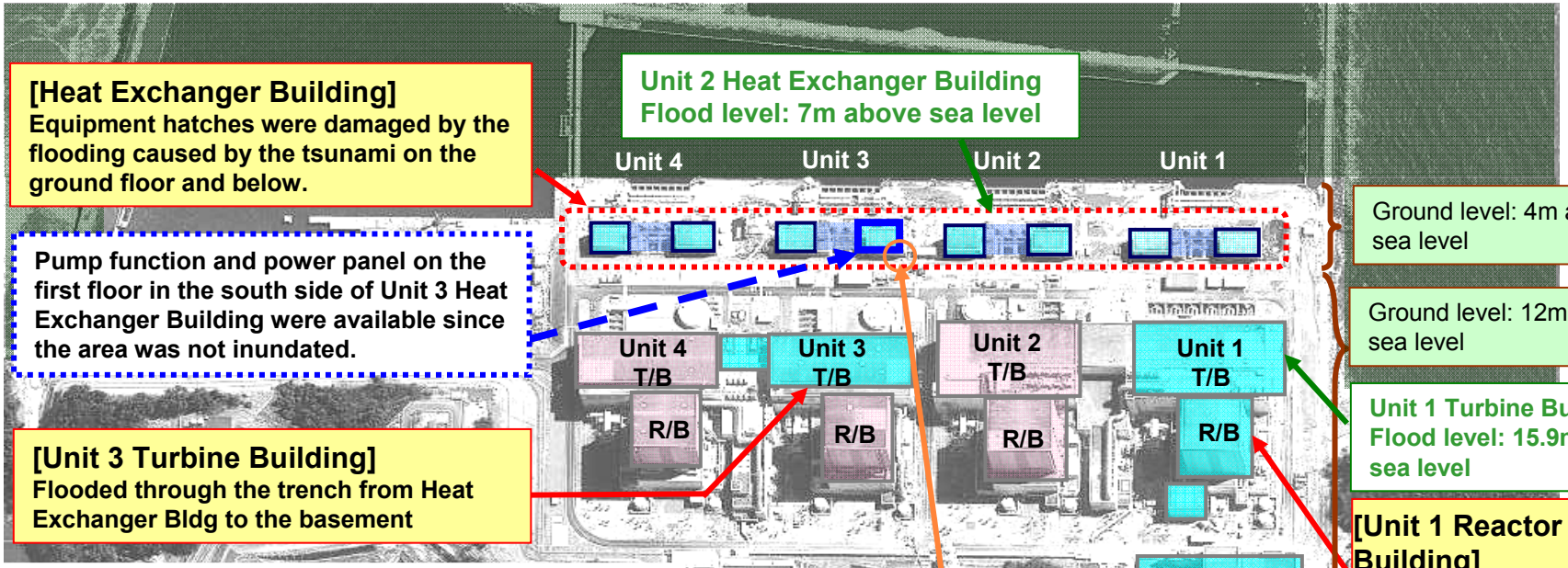
Flooded

Not Flooded

[Heat Exchanger Building]
Equipment hatches were damaged by the flooding caused by the tsunami on the ground floor and below.

Pump function and power panel on the first floor in the south side of Unit 3 Heat Exchanger Building were available since the area was not inundated.

[Unit 3 Turbine Building]
Flooded through the trench from Heat Exchanger Bldg to the basement



Ground level: 4m above sea level

Ground level: 12m above sea level

Unit 1 Turbine Building
Flood level: 15.9m above sea level

[Unit 1 Reactor Building]
Flooded through the ventilation louvers on the ground

[Waste Treatment Building]
Flooded from ground floor

[Main Anti-earthquake Building]
Flooded from ground floor

[Main Office]
Not Flooded

[Reactor Building]
Unit 2-4: Not Flooded
[Turbine Building]
Unit 2 and 4: Not Flooded

Flooding Caused by the Tsunami (2)

* Equipment hatches of all Units except the south heat exchanger building of Unit 3 were destroyed by the tsunami.

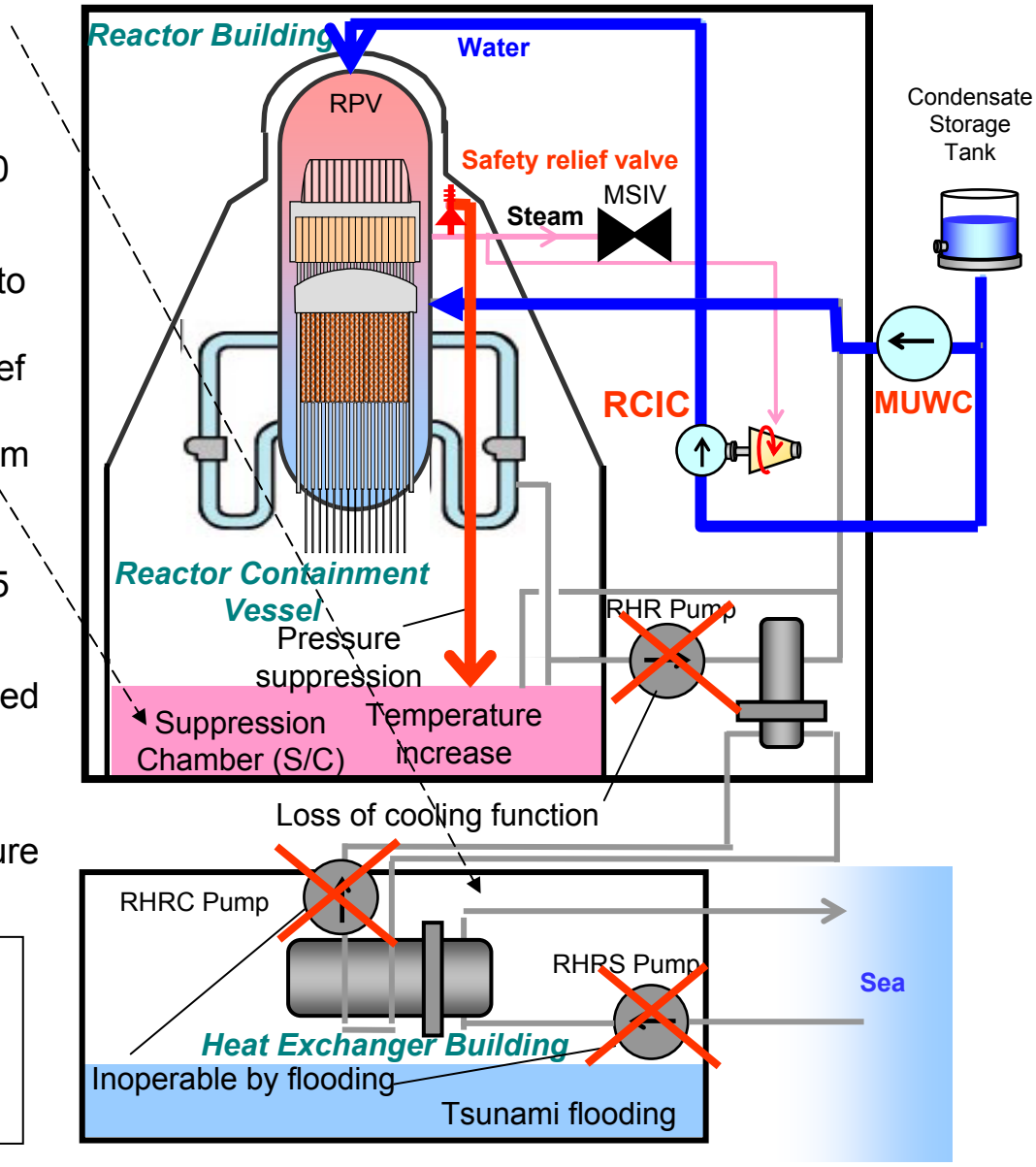
* Unit 1
Flooded to the Reactor Building through EDG ventilation louver

* Units 2-4
Hardly any flooding to the Reactor Building

Loss of Reactor Heat Removal Function/Measures to Prevent the Accident from Progressing

- The tsunami caused the loss of pump motors*1, which caused Units 1, 2 and 4 to lose reactor heat removal function.
  (*1 The case falls under Act on Special Measures concerning Nuclear Emergency Preparedness Article 10 (loss of reactor cooling function))
- As stated in the EOP manual, RCIC actuated manually to maintain reactor water level by high-pressure water injection, and actuated to reduce pressure by safety relief valve. However, the temperature of the water in suppression chamber exceeded 100℃*2 due to the steam from the reactor.
  (*2 The case falls under Act on Special Measures concerning Nuclear Emergency Preparedness Article 15 (loss of pressure suppression function))
- After the reactor was depressurized, MUWC was actuated for alternative water injection to maintain reactor water level.
- The alternative container spray by MUWC eased pressure rise in the PCV.

RCIC:	Reactor Core Isolation Cooling system
MUWC:	Make-Up Water Condensate
RHR:	Residual Heat Removal System
RHRC:	Residual Heat Removal System - Cooling Water
RHRS:	Residual Heat Removal System - Sea Water



Restoration Work of Reactor Heat Removal Function and Cold Shutdown

- **Walking around the site to check damages of the facilities (at midnight on March 11, 2011)**
  - Being provided with safety measures, employees walked around the site when a tsunami warning had been going off.
  - We have considered a way to restore cooling function in a short time efficiently, and have determined which equipment to restore first (restoration of RHR (B) system was prioritized) under conditions of many equipments are damaged.
- **Emergency procurement of equipments for the restoration work (March 12, 2011)**
  - Emergency procurement of backup electric motor, power cable, mobile power vehicle and mobile transformer was performed.
  - The backup electric motor was secured by air transportation from factory of TOSHIBA and by track transportation from Kashiwazaki-Kariwa Nuclear Power Station.
- **Restoration of equipment and power supply at the site (March 13, 2011)**
  - Auxiliary cooling system pump at RHR (B) system was investigated, and electric motor which was not available was replaced.
  - Power panel was replaced to a new one at Waste Treatment Building, and high pressure power vehicle and mobile transformer were deployed at the site. In addition, temporary cables were installed.
  - Most of the temporary cables (total length of 9km) were installed by approx. 200 of TEPCO employees and corporate company employees in almost one day.
- **Cooling of the reactors have started after activating residual heat removal system pump (March 14, 2011)**

Cold shutdown was achieved by various efforts in all Units at 7:15 AM on March 15, 2011

Procurement of mobile power vehicles

Replacement of electric motors

Installation of temporary cables

Implementation Flow of the Progress Status

On May 30, 2013, the restoration of the equipment/facilities necessary for maintaining cold shutdown at all Units 1-4 has been completed.

2011

3/11: Earthquake occurred

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3/11: Subcritical state achieved by inserting all control rods

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3/11-12: Nuclear accident occurred due to tsunami

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3/12: The Nuclear Emergency Situation was declared based on the Act on Special Measures Concerning Nuclear Emergency Preparedness

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Emergency measures implementation

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12/26: Declaration of the Nuclear Emergency Situation was cancelled

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2012 1/31: Submission of the plan to restore equipments/facilities to maintain the cold shutdown condition

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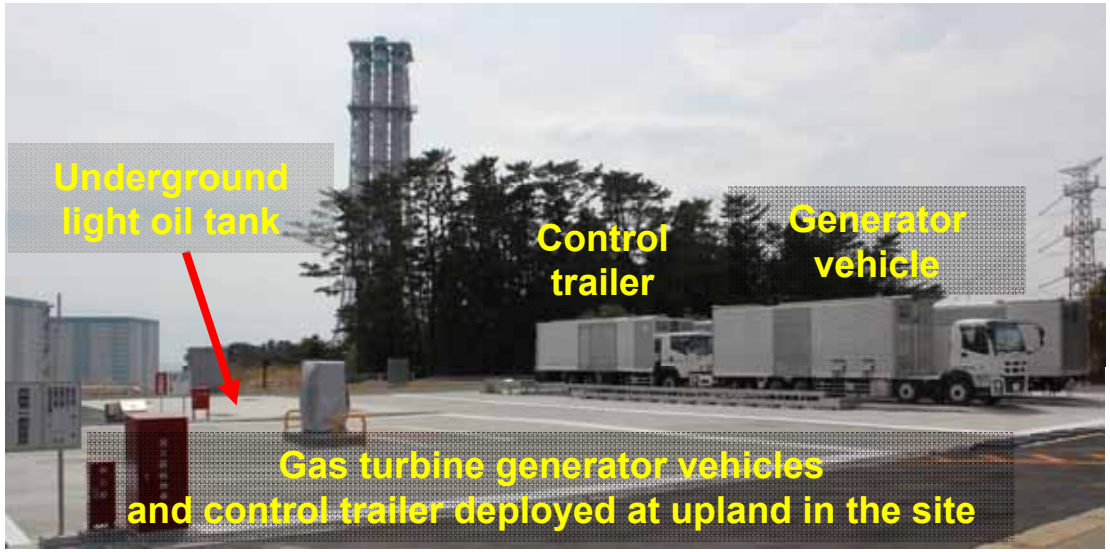
Restoration of the equipments/facilities to maintain the cold shutdown condition and reliability improvement

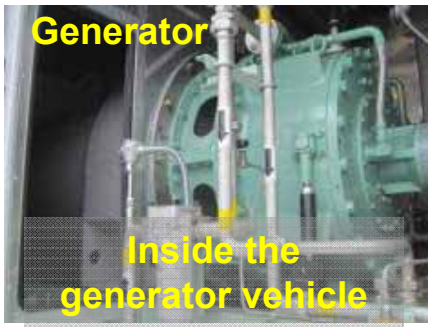
Unit 4 restoration Completed (May 17, 2012)	Units 3-4 discharge channel monitor restoration Completed (Sep 21, 2012)	Unit 3 restoration Completed (Oct. 11, 2012)	Unit 2 restoration completed (Feb. 15, 2013)	Units 1-2 discharge channel monitor restoration completed (Feb. 18, 2013)	Unit 1 restoration completed **(May 30, 2013)**

Emergency Response Measures (1)

Cooling of reactor and spent fuel pool is available flexibly in case of station blackout or loss of heat removal capability.

- Securement of power supply in case of emergency
  - Gas turbine generator vehicles and mobile power vehicles were deployed at upland in the site, and procedures to secure power supply was developed.





Emergency Response Measures (2)

- Securement of final heat removal function and cooling of spent fuel pool in case of emergency
  - Fire engines were deployed at upland in the site, and procedures to perform alternative water injection were developed.
  - Procedures to operate PCV vent utilizing backup gas cylinder in case of station blackout were developed.

Fire engines deployed at upland in the site

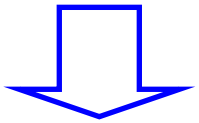
Seawall (Southeast side/sea side of Unit 1)

- Prevention of water entry and implement of debris removal
  - Water-tightness of the doors at the heat exchanger building and the Turbine Building was enhanced, and 15.4m seawall was installed.
  - Heavy machinery for debris removal, and gravels was deployed.

Training of heavy machinery for debris removal

Future Approach

The restoration work of the equipment/facilities necessary to maintain cold shutdown at Unit 1 was completed on May 30, 2013 herewith, and all the "the post nuclear disaster incident measurement" in accordance with Act on Special Measures concerning Nuclear Emergency Preparedness (Articles 27) at Fukushima Daini NPS was completed.



We will continue to perform inspections in a planned manner and secure soundness of the equipment/facilities necessary to maintain cold shutdown in accordance with the "Special Maintenance Plan."
In addition, we will perform management of safety, radiation and quality, inspection check in case of natural disaster, emergency/individual drill continuously, and continue our utmost efforts in ensuring safety at Fukushima Daini NPS.

Transfer of fuels

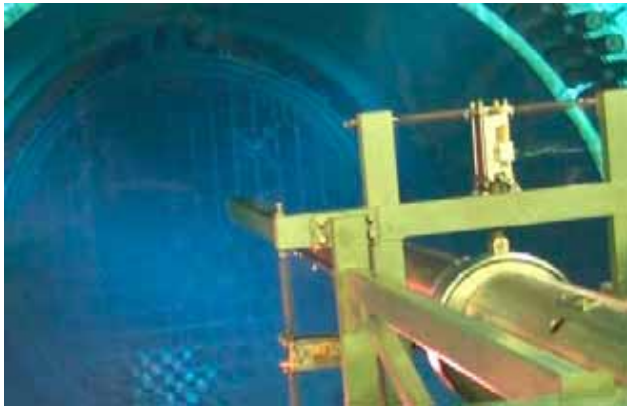
Transfer of fuels (Transfer from inside the reactors to the spent fuel pools)

The fuels inside the reactors of Units 1-3 will be transferred to the spent fuel pools by FY2014 in terms of simplifying maintenance of the facilities due to the prolonged suspension period.

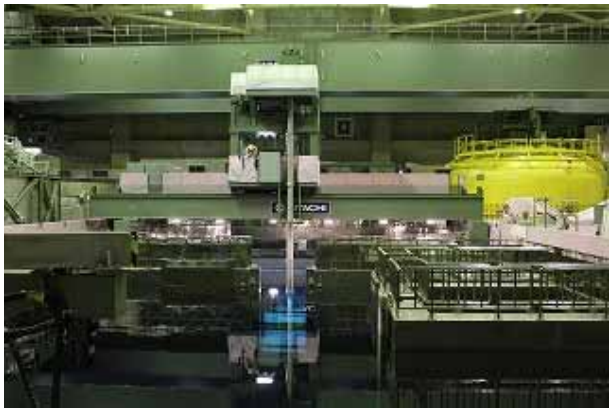
Unit	Work	FY2013	FY2014	
Unit 1	Soundness inspection of the equipments necessary for transferring the fuel			(Tentative)
	Opening of the reactor and transfer of fuels			(Tentative)
Unit 2	Soundness inspection of the equipments necessary for transferring the fuel			(Tentative)
	Opening of the reactor and transfer of fuels			(Tentative)
Unit 3	Soundness inspection of the equipments necessary for transferring the fuel			(Tentative)
	Opening of the reactor and transfer of fuels			(Tentative)
Unit 4	Soundness inspection of the equipments necessary for transferring the fuel	Completed in FY2012		(Completed)
	Opening of the reactor and transfer of fuels			(Completed)

- Investigation of tie rod which is installed inside the reactor will be performed after the fuels in Unit 2 and 3 are transferred in order to acquire knowledge.

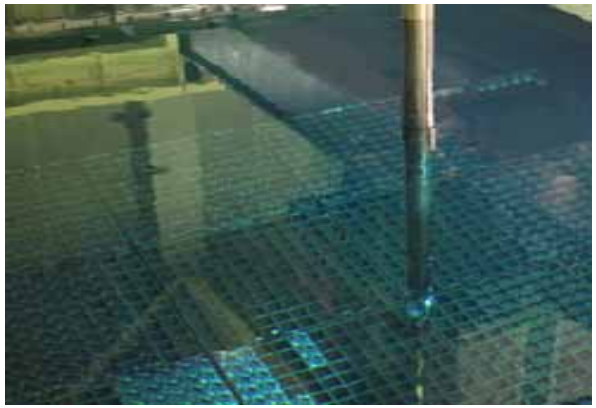
* Tie rod: A pillar used to tighten and fix shroud vertically.



Extracting and lifting of fuels inside the reactors



Transfer of fuels to the spent fuel pools



Insertion of fuels at the spent fuel pools

(Photo taken during transfer of fuels at Unit 4)

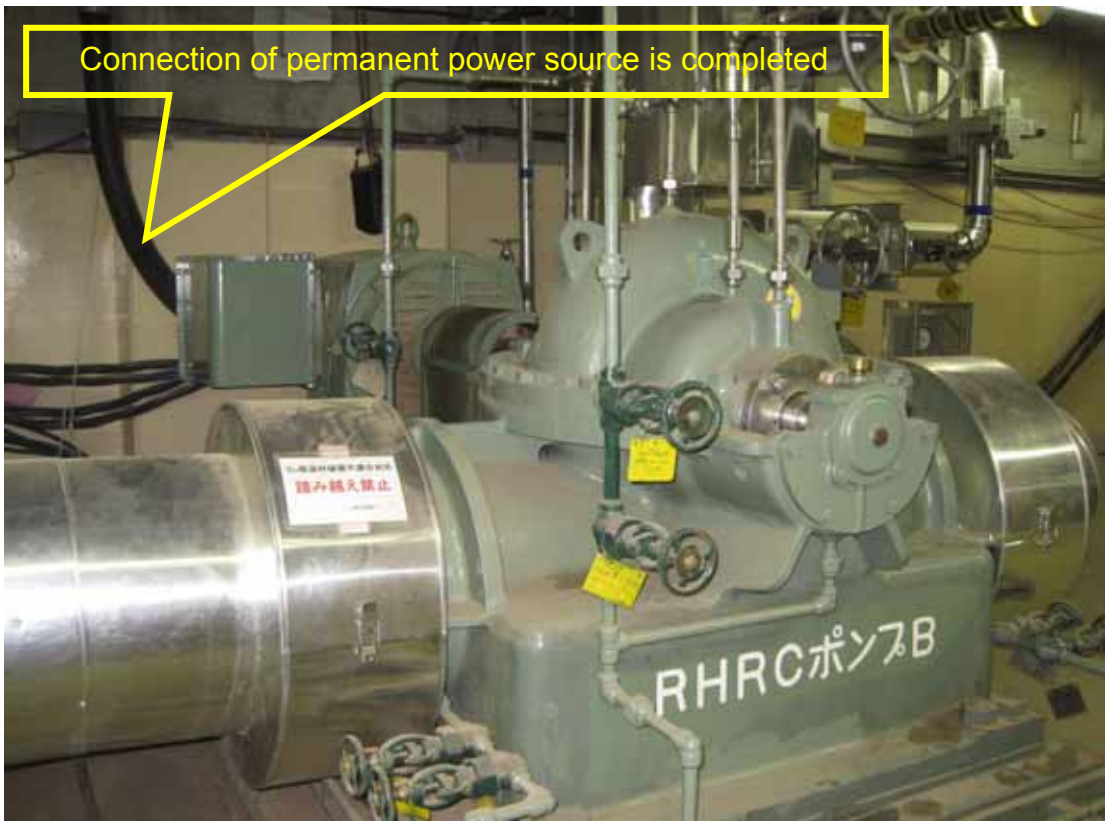
Power panel (Power center 1D-2)

(Before restoration work)

(After restoration work)

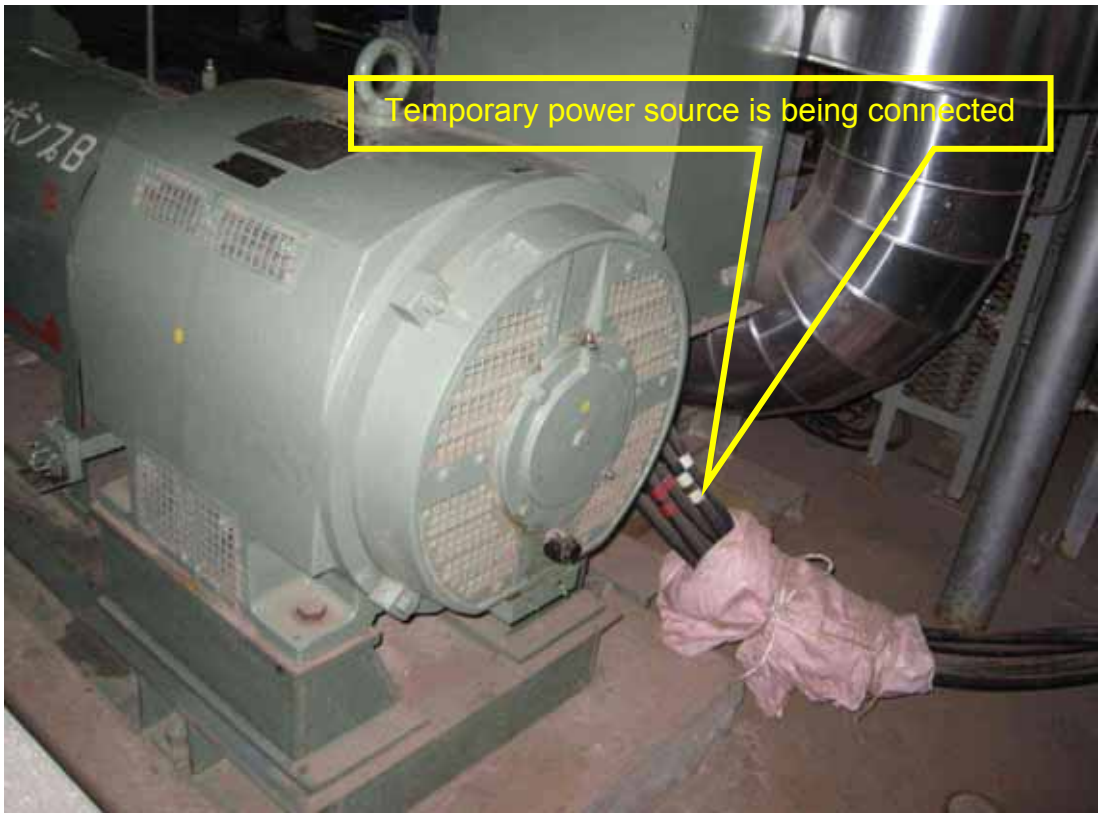
Residual heat removal cooling system pump B

(Before restoration work)



(After restoration work)

Emergency diesel generator cooling system pump B



(Before restoration work)

(After restoration work)

Emergency air blower of emergency diesel generator A

(Before restoration work)

(After restoration work)

Power panel (metal crad switchgear 1C)

(Before restoration work)

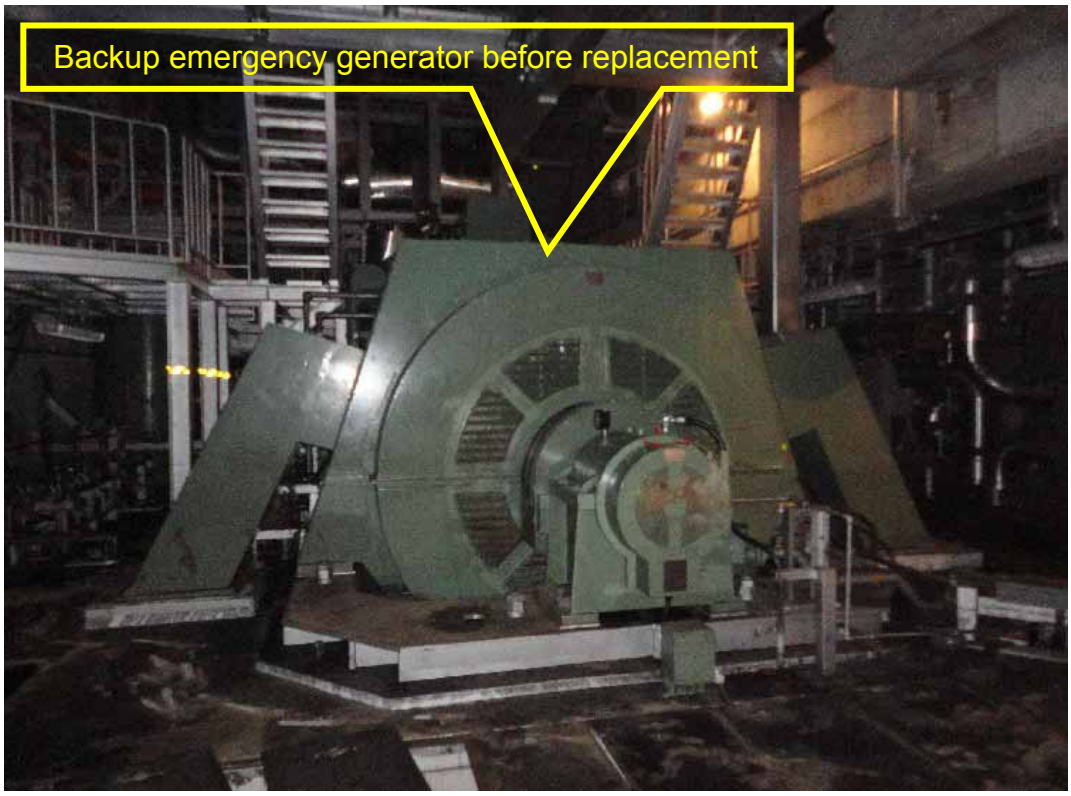
(After restoration work)

Power panel (Power center 1C-1)

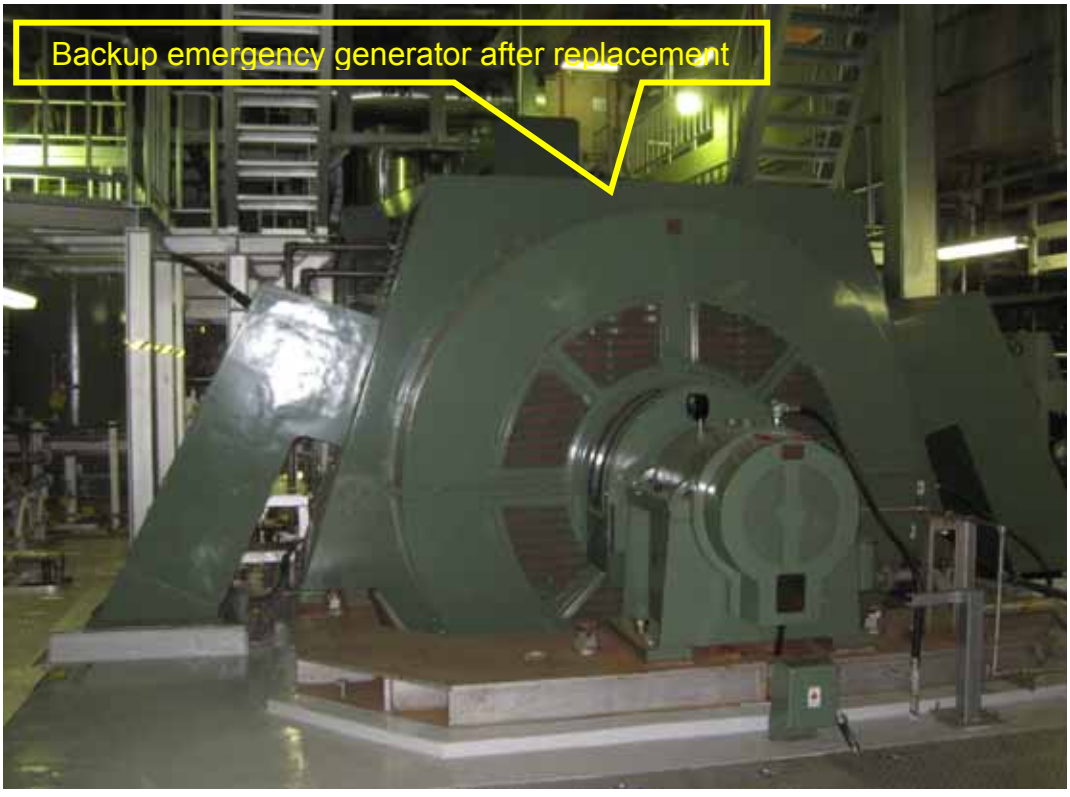
(Before restoration work)

(After restoration work)

Emergency diesel generator A



(Before restoration work)



(After restoration work)