The Fukushima Daiichi Nuclear Power Station Accident

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Cooperation with JEPIC (Japan an Electric Power Information Center)
Nuclear Power Plants in Japan

Chubu EP Co. – Hamaoka-1,2 (2009)

<table>
<thead>
<tr>
<th>Number of units</th>
<th>Total power (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In operation</td>
<td>54</td>
</tr>
<tr>
<td>Under construction</td>
<td>3</td>
</tr>
<tr>
<td>Preparation for construction</td>
<td>11</td>
</tr>
</tbody>
</table>
| Total           | 68               | 68,155

Output scale:
- Under 500MW
- Under 1,000MW
- Over 1,000MW

Operating
Under construction
Preparation for construction
Status of Nuclear Power Plants after the Earthquake

The accident caused environmental damage at several units in the Fukushima Daiichi nuclear power Station after the earthquake occurred on March 11. Other nuclear power plants in Japan were in normal operation or safely shutdown.

All units (Unit 1-3) were immediately shut down automatically. Then safely went into cold shut down.

The unit was immediately shut down automatically. Then safely went into cold shut down.

Source: Japan Atomic Industrial Forum, INC. (JAIF)
The Fukushima Daiichi Nuclear Power Station

Before the earthquake
Overview of Boiling Water Reactor (BWR)
(Mark-I Type; Fukushima Daiichi Unit 1, 2, 3, 4 and 5)

Source: NISA (http://nei.cashfly.net/static/images/BWR_illustration.jpeg)
Mechanism of Boiling Water Reactor (BWR)

1. Water is boiled within the reactor.

2. Steam is generated and sent to the turbine.

3. Electricity is generated by rotating the turbine and the generator with steam.

Electricity is generated by rotating the turbine and the generator with steam.
Before the earthquake, Unit 1, 2, and 3 of the Fukushima Daiichi Power plant were operating.

Unit 4, 5, and 6 were under periodic inspection.

After the earthquake, all control rods were inserted into the reactor as designed and Unit 1, 2, and 3 automatically shutdown.

Offsite power supply was lost because of the earthquake.

The emergency diesel generators installed in each Unit started normally.

Direct damage to the safety-related equipment due to the earthquake was not found.

Seawater pumps, DGs, and power panels at all Units were flooded by the tsunami, then all AC power sources for Units 1 to 6, except for one air-cooled DG for Unit 6 lost their functionality.

All motor operated safety systems, water injection and cooling facilities at Units 1 to 5 became inoperable. This is the major cause of the Fukushima daiichi accident.
Inundated and Inflow Area at Fukushima Daiichi and Daini Site

Fukushima Daiichi

Fukushima Daini

inundated

inflow

Intensive Inflow

© GeoEye
Accident progression at Unit1 (1/3)

Effort to sustain reactor water level

Core Cooling by Isolation Condenser (3/11 14:52)

Inoperable due to the emergency DGs soaked in water (3/11 15:37)

External electricity was inoperable due to the earthquake (3/11 14:46)

Source: Nuclear and Industrial Safety Agency (NISA)
Decrease in reactor water level due to loss of cooling capability of emergency condenser, followed by uncovering the core

Decrease in reactor water level

Uncovering the Core
(3/11 around 17:00 estimated)

- Hydrogen Generation due to a Zirconium-Water reaction
- Fuel Rod damage

Source: Nuclear and Industrial Safety Agency (NISA)
Accident progression at Unit1(3/3)

Hydrogen explosion in the operation floor

Source: Nuclear and Industrial Safety Agency (NISA)
Accident Progression at Unit 2 through 4

Vapors rising from Unit 3 are assumed to be produced from Spent Fuel Pool.

Source: Nuclear and Industrial Safety Agency (NISA)
Fukushima Daiichi Unit 2 Plant Parameter and Operation

- **Earthquake** (14:46)
- **Tsunami** (15:27)
- **Unit1 R/B Explosion** (15:36)
- **Fuel Range (A) (mm)**
- **Fuel Range (B) (mm)**
- **CAMS D/W(A)(Sv/h)**
- **CAMS S/C(A)(Sv/h)**
- **Unit3 R/B Explosion** (11:01)
- **Core Damage Started due to MAAP Analysis**
- **Impact sound** (6:00-6:10)

**Rx Water Level [mm]**

**Rx Pressure [MPa]**

**Rx Pressure (A) (MPa)**

**Rx Pressure (B) (MPa)**

**D/W & S/C Pressure [MPa]**

**S/C Pressure (MPa)**

**D/W Pressure (MPa)**

**S/C pressure:0Mpa**

**Source:** The Tokyo Electric Power Company, Inc.
Plant Parameter: Fukushima Daiichi Unit 2

March 11 ~ March 30, 2011

Increase in D/W pressure
Decrease in D/W pressure

Radioactive gas released into the air

Source: NISA and JNES