Information on Status of Nuclear Power Plants in Fukushima

Policy on information and compilation
This JAIF-compiled information chart represents the situation, phenomena, and operations in which JAIF estimates and guesses the reactors and related facilities are, based on the latest data and information directly and indirectly made available by the relevant organizations when JAIF’s updating works done. Consequently, JAIF may make necessary changes to descriptions in the chart, once (1) new developments have occurred in the status of reactors and facilities and (2) JAIF has judged so needed after reexamining the prior information and judgments. JAIF will do its best to keep tracks on the information on the nuclear power plants quickly and accurately.

Japan Atomic Industrial Forum, Inc.
Status of nuclear power plants in Fukushima as of 10:00 March 31 (Estimated by JAIF)

<table>
<thead>
<tr>
<th>Power Station</th>
<th>Fukushima Dai-ichi Nuclear Power Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td></td>
</tr>
<tr>
<td>Electric / Thermal Power output (MW)</td>
<td>460 / 1380</td>
</tr>
<tr>
<td>Type of Reactor</td>
<td>BWR-3</td>
</tr>
<tr>
<td>Operation Status at the earthquake occurred</td>
<td>In Service / Shutdown</td>
</tr>
<tr>
<td>Fuel assemblies loaded in Core</td>
<td>400</td>
</tr>
<tr>
<td>Core and Fuel Integrity (Loaded fuel assemblies)</td>
<td>Damaged</td>
</tr>
<tr>
<td>Reactor Pressure Vessel structural integrity</td>
<td>Unknown</td>
</tr>
<tr>
<td>Containment Vessel structural integrity</td>
<td>Not damaged (estimation)</td>
</tr>
<tr>
<td>Core cooling requiring AC power 1 (Large volumetric freshwater injection)</td>
<td>Not Functional</td>
</tr>
<tr>
<td>Core cooling requiring AC power 2 (Cooling through Heat Exchangers)</td>
<td>Not Functional</td>
</tr>
<tr>
<td>Building Integrity</td>
<td>Severely Damaged (Hydrogen Explosion)</td>
</tr>
<tr>
<td>Water Level of the Reactor Pressure Vessel</td>
<td>Fuel exposed partially or fully</td>
</tr>
<tr>
<td>Pressure / Temperature of the Reactor P/ Vessel</td>
<td>Gradually increasing / Decreased a little after increasing over 400℃ on 24th</td>
</tr>
<tr>
<td>Containment Vessel Pressure</td>
<td>Decreased a little after increasing up to 0.4Mpa on 24th</td>
</tr>
<tr>
<td>Water injection to core (Accident Management)</td>
<td>Continuing (Switch from seawater to Freshwater)</td>
</tr>
<tr>
<td>Water injection to Containment Vessel (AM)</td>
<td>(To be confirmed)</td>
</tr>
<tr>
<td>Containment Venting (AM)</td>
<td>Temporarily stopped</td>
</tr>
<tr>
<td>Fuel assemblies stored in Spent Fuel Pool</td>
<td>292</td>
</tr>
<tr>
<td>Fuel Integrity in the spent fuel pool</td>
<td>Unknown</td>
</tr>
<tr>
<td>Cooling of the spent fuel pool</td>
<td>Water injection to be considered</td>
</tr>
<tr>
<td>Main Control Room Habitability &amp; Operability</td>
<td>Poor due to loss of AC power</td>
</tr>
</tbody>
</table>

Environmental effect

- Radiation level: 1.000 mSv/h at the south side of the office building, 156 µSv/h at the Main gate, and 72 µSv/h at the West gate, as of 21:00, Mar. 30th.
- Radioactive material was detected from milk and agricultural products from Fukushima and neighboring prefectures. The government issue order to limit shipment (Mar. 21st-) and intake (Mar. 23rd-) for some products from some areas.
- Radioactive iodine was detected from tap water sampled at some prefecture. Level of iodine in tap water temporarily exceed the provisional legal limit for infant consumption.
- Radioactive iodine, cesium, ruthenium, and tellurium were detected from seawater collected in the sea surrounding the power station.
- Nuclear Safety Commission of Japan released prediction of radioactive material spread caused by the accident (Mar. 23rd). This prediction was based on the calculation using computer code called SPEEDI (System for Prediction of Environmental Emergency Dose Information). The prediction was released at the press conference on Mar. 26th.

Evacuation

- 20km from NPS (Mar. 12): People who live between 20km to 30km from the Fukushima Dai-ichi NPS shall stay in the buildings or houses (Mar. 15), should consider leaving Mar. 25).

INES (estimated by NISA)

- Level 5
- Level 6
- Level 3

Remarks

- High radiation makes difficult the work to restore originally installed pumps for injection.
- It is presumed that radioactive material inside the reactor vessel would have leaked outside the containment vessel at Unit 1, 2, and 3, based on the investigation of the water sampled in the turbine building from Mar. 24th to 27th.

[Source]
NISA: News Release (-3/30 16:30), Press conference
TEPCO: Press Release (-3/30 21:00), Press Conference

[Abbreviations]

[Significance judged by JAIF]
- Low
- High
- Severe (Need immediate action)
<table>
<thead>
<tr>
<th>Power Station</th>
<th>Fukushima Dai-ji Nuclear Power Station</th>
<th>Onagawa Nuclear Power Station</th>
<th>Tokai Dai-ji</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Electric / Thermal Power output (MW)</strong></td>
<td>1100 / 3293</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type of Reactor</strong></td>
<td>BWR-5</td>
<td>BWR-5</td>
<td>BWR-5</td>
</tr>
<tr>
<td><strong>Operation Status at the earthquake occurred</strong></td>
<td>In Service =&gt; Automatic Shutdown</td>
<td>In Service =&gt; Automatic Shutdown</td>
<td>In Service =&gt; Automatic Shutdown</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>All the units are in cold shutdown.</td>
<td></td>
<td>Safe</td>
</tr>
<tr>
<td><strong>INES (estimated by NISA)</strong></td>
<td>Level 3</td>
<td>Level 3</td>
<td>Level 3</td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
<td>Unit-1, 2, 3 &amp; 4, which were in full operation when the earthquake occurred, all shutdown automatically.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>External power supply was available after the quake. While injecting water into the reactor pressure vessel using make-up water system, TEPCO recovered the core cooling function and made the unit into cold shutdown state one by one.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Latest Monitor Indication: 5.6 μSv/h at 21:00, Mar. 30 at NPS border.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evacuation Area: 10km from NPS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All the units are in cold shutdown.</td>
<td></td>
<td>Safe</td>
</tr>
<tr>
<td></td>
<td>In cold shutdown.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Parameters in the Table

IAF picks up these parameters to evaluate safety condition of the nuclear plants during this accident from the viewpoint of the principles of nuclear power plant safety, which are "Shutdown", "Cooling" and "Containment". Then we create the chart. The following diagram is to show the correspondence of those parameters in the table to nuclear power plant safety.

Nuclear Power Plant Safety and Related Items

- Reactor Safety
- Shutdown
- Cooling
  - Design base cooling capability
- Containment
  - Design base containment Function
  - 5 Barriers
    - 1. Fuel Pellet
    - 2. Cooling Tube
    - 3. Reactor Pressure vessel
    - 4. Containment Vessel
    - 5. Reactor Building

<Accident Management: AM>
(Operation beyond design base accident)

- Alternative Cooling operation
- Operation for containment vessel protection against burst

Parameters in the Table

- Operation Status at the earthquake
  - Core cooling requiring AC power
    - Core cooling requiring AC power 1
      - Large volumetric freshwater injection
    - Core cooling requiring AC power 2
      - Cooling through Heat Exchanger

- Water level of the Reactor Pressure Vessel
- Pressure of the Reactor Pressure Vessel

- Core and Fuel Integrity
  - Reactor Pressure Vessel Integrity
  - Containment Vessel pressure
  - Containment Vessel Integrity
  - Building Integrity

- Injection to core (AM)
- Injection to Containment Vessel (AM)
- Containment Venting (AM)

- Safety of the spent fuel pool
  - Fuel Integrity in the spent fuel pool
    - Fuel Damage
  - Cooling of the spent fuel pool
    - Water injection, pool temp, water level

- Work environment in main control room
  - Main Control Room Habitability and Operability
    - (Ventilation, Lights, Indicator)

- Environmental effect
  - Environmental effect (Radiation Monitor, Contamination)

- Evacuation
  - Evacuation (Order, Evacuated Area)
1. Latest Major Incidents and Actions

**Accidents of Fukushima Dai-ichi and Fukushima-Dai-ni Nuclear Power Stations**

March 31th, 2011 07:30

30th High level of radioactive iodine, I-131, which is 3,355 times higher than criterion, was detected in the seawater sampled in the vicinity of the south discharge outlet of Fukushima Dai-ichi NPS at 13:55, Mar. 29th.

2. Chronology of Nuclear Power Stations

**1) Fukushima Dai-ichi NPS**

<table>
<thead>
<tr>
<th>Major Incidents and Actions</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4</th>
<th>Unit 5 and 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>11th 15:42 Report IAW Article 10* (Loss of power)</td>
<td>11th 15:42 Report IAW Article 10* (Loss of power)</td>
<td>11th 15:42 Report IAW Article 10* (Loss of power)</td>
<td>14th 04:06 Water temperature in Spent Fuel Storage Pool increased at 84°C</td>
<td>Water temperature in SF Storage Pool is increasing</td>
<td></td>
</tr>
<tr>
<td>11th 16:36 Event falling under Article 15* occurred (Incapability of water injection by core cooling function)</td>
<td>13th 05:10 Event falling under Article 15* occurred (Loss of reactor cooling functions)</td>
<td>15th 06:38 Fire occurred on 3rd floor (extinguished spontaneously)</td>
<td>18th Vent hole was opened on the rooftop for avoiding hydrogen explosion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12th 00:49 Event falling under Article 15* occurred (Abnormal rise of CV pressure)</td>
<td>13th 08:41 Start venting</td>
<td>16th 05:45 Fire occurred (extinguished spontaneously)</td>
<td>16th 05:05 RHR-pump in the Unit-5 restarted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12th 14:30 Start venting</td>
<td>14th 13:25 Event falling under Article 15* occurred (Loss of reactor cooling functions)</td>
<td>16th 05:45 Fire occurred (extinguished spontaneously)</td>
<td>19th 22:14 RHR-pump in the Unit-6 restarted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12th 15:36 Hydrogen explosion</td>
<td>14th 16:34 Seawater injection to RPV</td>
<td>Since 20th, operation of spraying water to the spent fuel pool continues.</td>
<td>21st 14:30 Reactor is in cold shutdown mode at Unit-5. 20th 19:27 Reactor is in cold shutdown mode at Unit-6.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12th 20:20 Seawater injection to RPV</td>
<td>14th 07:44 Event falling under Article 15* occurred (Abnormal rise of CV pressure)</td>
<td>21st 20:00 work to restore external AC power was interrupted after black smoke rising</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**2. State of Emergency Declaration**

11th 19:03 State of nuclear emergency was declared (Fukushima Dai-ni NPS)

12th 07:45 State of nuclear emergency was declared (Fukushima Dai-ichi NPS)

25th Governmental advise: for the residents within 20-30 km radius from Fukushima I to voluntarily evacuate

3. State of Emergency Declaration

11th 19:03 State of nuclear emergency was declared (Fukushima Dai-ni NPS)

12th 07:45 State of nuclear emergency was declared (Fukushima Dai-ichi NPS)

**2) Fukushima Dai-ni NPPs**

All units are cold shutdown (Unit-1, 2, 4 have been recovered from a event falling under Article 15*)

**4. Evacuation Order**

11th 21:23 PM direction: for the residents within 3km radius from Fukushima I to evacuate, within 10km radius from Fukushima I to stay in-house

12th 05:44 PM direction: for the residents within 10km radius from Fukushima I to evacuate

12th 17:39 PM direction: for the residents within 10km radius from Fukushima II to evacuate

12th 18:25 PM direction: for the residents within 20km radius from Fukushima I to evacuate

15th 11:06 PM direction: for the residents within 20-30km radius from Fukushima I to stay in-house

22nd 10:30 lights in the main control room becomes available

22nd 11:20 RHR-pump stopped automatically at unit-5.

22nd 11:40 EVACUATION order was issued for residents within 10km radius from Fukushima I to evacuate

23rd 17:24 RHR-pump stopped automatically at unit-5.

24th 11:00 Hydrogen explosion

24th 11:30 lights in the main control room becomes available

24th 11:50 lights in the main control room becomes available

25th Governmental advise: for the residents within 20-30 km radius from Fukushima I to voluntarily evacuate
The accident that brings environmental impact is going on at several units in Fukushima Daiichi nuclear power Station after the earthquake occurred on March 11th. Other nuclear power plants in Japan are in normal operation or safely shutdown.