

**Information on the current status of the plants in Japan  
damaged by the earthquake and the subsequent tsunami  
on 11 March 2011**

**Compilation by GRS**

**as at 13 April 2011, 12:30 h (CEST)**

All times local time (JST) unless otherwise indicated

(CET (until 26-03-2011) = JST minus 8 hours)

(CEST (since 27-03-2011) = JST minus 7 hours)

**Updated compilation of information**

Changes compared with the previous state in Chapter 2 are given in Section 1. The accident sequence so far can be found in Chapter 2. A short description in tabular form of the safety-related situation and updated plant parameters can be found in Chapter 3. This also includes further specifications and supplementations of events and conditions reported over the past couple of days.

**1 Changes compared with the previous state**

**1.1 Fukushima Dai-ichi**

On 12-04-2011, resin was sprayed in the area of 700 m<sup>2</sup>.

TEPCO reports that the aftershocks of 12-04-2011 at 14:07 h of a magnitude 6.3, caused neither interruption of power supply, no interruption of the injection into the RPV and no injuries of persons at the site of Dai-ichi.

### **1.1.1 Unit 1**

No change.

### **1.1.2 Unit 2**

On 12-04-2011 there began works to close the crack in the wall of the coolant water inlet building by means of a metal plate.

The works to pump-off high radioactive water inventory from the pipes and cable channels of the turbine building to the condenser started on 12-04-2011 at 19:35 h.

### **1.1.3 Unit 3**

No change.

### **1.1.4 Unit 4**

On 12-04-2011 water samples were taken from the fuel pool of Unit 4 for a nuclide analysis in order to be capable to estimate the status of the fuel in the fuel pool.

### **1.1.5 Units 5 and 6**

No change.

### **1.1.6 Interim storage facility at the Fukushima Dai-ichi site**

No change.

## 1.2 Fukushima Dai-ni

TEPCO reports that the aftershocks of 12-04-2011 at 14:07 h of a magnitude 6.3 (with the epicentre in Fukushima-Hama-dori) had no impacts at the site Dai-ni. The inspections of the site are still ongoing.

## 1.3 Onagawa 1-3, Tokai and Higashidori

No change.

# 2 Radiological situation

## 2.1 Radiological situation

### Radiological situation at the site

The local dose rates were available on 13-04-2011 at 9:00 h. The measurement values for the measuring location „south front central building“ rose in the night, by contrast to the previous day, from von 560  $\mu\text{Sv/h}$ , up to 580 and later, until 9:00 h - up to 570  $\mu\text{Sv/h}$ . The measurement readings for other measuring locations remain constant or show a slightly decreasing trend.

Fig. 1.1 Local dose rate on 13-04-2011

### Sea contamination

Contamination values for the sea water are available of the status until 11-04-2011, 14:00 h (for diagrams s. German report, Section 2.3). The measurement readings reveal contamination in particular for iodine-132 well above the limiting values.

## **Radiological situation in the vicinity**

The local dose rate measurement readings in the selected prefectures – like in the previous days – remain constant or decrease on for the prefectures Ibaraki and Kanagawa.

## **External AM**

According to the Japan Atomic and Industrial Forum (JAIF) the evacuation zone of 20 km around the site Fukushima Dai-ichi should be extended so that also the areas will be comprised where the annual radiation exposure of higher than 20 mSv is expected. In the so called „Planned Evacuation Area“, comprising the towns of Kutsurao, Namie, Iitate and parts of Kawamata and Minami Souma, plans should be developed with the local administration to carry out the evacuation in the next month. The „Planned Evacuation Area“ joins the existing evacuation area in the north-west. In the „Evacuation Prepared Area“, comprising the 30 km area around NPP Fukushima Dai-ichi, but for the „Planned Evacuation Area“, the same limitation for living are effective. Pregnant women, children and diseased persons may not stay in the area. Nursery schools and schools shall be closed. Voluntary evacuation of this area is recommended. In the case of emergency evacuation measures are conceivable.

## **3 Summary of the plant situation so far**

On 11-03-2011 at 14:46 h (6:46 CET), an earthquake struck Japan. This earthquake and the subsequent tsunami also affected the nuclear power plant sites Fukushima I (Dai-ichi), Fukushima II (Dai-ni), Onagawa and Tokai.

The previous information (31-03-2011, 12:30 h) on the temporary smoke development in the turbine building was reported by TEPCO both for Dai-ichi and for Dai-ni. GRS holds it for possible that one of the both reports could be erroneous. According to JAIF, the smoke was detected only for the turbine building of Unit 1, Dai-ni.

### 3.1 Fukushima Dai-ichi

At this site, Units 1-3 were in power operation mode at the time of the onset of the accident. Units 4-6 were shut down when the event set in. At the site, the emergency diesel generators failed as a consequence of the tsunami. Mobile emergency diesel generators were taken to the plant.

Due to the high levels of radiation, the plant was evacuated completely on 16-03-2011 at 10:45 h (2:45 h CET). It is only entered to carry out important measures or record measurements (government press conference at 12:00 h (4:00 h CET)). The local dose rate at the main gate lies within a range of 2.5 – 6.5 mSv/h. In the meantime, part of the personnel has returned to the plant grounds as radiation levels have fallen.

NISA reports that TEPCO wants to establish the electricity supply from power lines in the vicinity. Power to these lines is provided by Tohoku Electric Power. A corresponding connection was to be established by the afternoon of 17-03-2011. The exact status of the re-establishment of the electricity supply is presently not known. According to TEPCO (quoted by ASAHI), however, it is not yet guaranteed that emergency cooling system will work again with the re-established electricity supply.

According to NHK it is intended to repair the auxiliary service water pumps.

According to TEPCO, cobalt, iodine and caesium were detected in discharge channel of Unit 1 to 4 on 21-03-2011.

According to JAIF it was derived that the flood wave at the power plant had height of 14 m, thus exceeding the design value by more than two times.

According to press releases, the switchgears of all 6 units were connected to external electricity supplies on 22-03-2011. However, no consumers have yet been connected (with the exception of Unit 5) as further tests are necessary.

Preparations continue to supply electricity to Units 1-4. In Unit 3, the main control room has been supplied with electricity again since 13:43 h (23-03-2011). In Units 1,2 and 4, electricity supply has been established up to the switchgears.

According to JAIF, temperature measurements of the RPV surface temperature have been re-established in Unit 1 to 3.

According to IAEA information of 23-03-2011 at 6:00 h CET (14:00 h local time in Japan), dose rates are available for the containments and the pressure suppression pools of Unit 1-3 of the Fukushima Dai-ichi plant. Up-to-date information on the dose rates in the containment and the pressure suppression pool can be found in the Table in Chapter 3.

According to IAEA information (25-03-2011, 6:00 h CET), illumination of the control rooms of Units 1 and 3 and of several items of the instrumentation of Units 1, 2 and 4 has been re-established.

The government ordered the evacuation of the inhabitants of the 20-km zone and advised the inhabitants in the area between the radiuses of 20 km and 30 km around the power plant to leave this zone voluntarily. (TEPCO on 27-03-2011 16:00 h)

According to reports by Kyodo, TEPCO is planning to spray water-soluble resin over parts of the damaged units by means of an unmanned vehicle from Thursday, 31-03-2011, in order to prevent a further release of radioactivity and re-suspension of dust particles.

Due to too low tank volumes for radioactively contaminated water, the NSC recommends the temporary creation of pools within the plant grounds.

According to a TEPCO spokesman, the construction of final enclosing structures (similar to a "Sarcophagus") is being considered for the units at the Dai-ichi site.

Contaminated water inventory in the turbine building (Unit 1, 2 and 3) and in the pipes and cable channels impair the necessary works. To store the water as well as to enable better access in the turbine building, the contaminated water must be pumped-off to tanks like condenser or via the condenser and condenser vessel to other tanks.

According to JAIF information on Tuesday, the spraying of the water-soluble resin was postponed owing to adverse weather conditions.

On 31-03-2011 at 12:21 h, a person tried to trespass the grounds of Dai-ichi by car. This was prevented by the guards.

On 31-03-2011 at 15:42 h, a ship of the US marines brought to Dai-ichi coolant and the like meant for the damaged Units.

On 01-04-2011 at 15:58 h, it was begun to pump fresh water by means of a hose from the barge to the vessel at the site. However, this action had to be suspended since the hose turned to be faulty. On 02-04-2011 at 10:20 h, the pumping of the fresh water to the vessel at the site was re-started. The pumping was completed on 02-04-2011 at 16:40 h. (NISA, TEPCO)

On 02-04-2011 at 09:10 h another barge of the US marines loaded with about 1300 t fresh water, arrived, (NISA, TEPCO). The fresh water was pumped to the first barge on 03-04-2011 starting from 09:52 h.

According to the NHK release of 02-04-2011 at 09:05 h, four provisional auxiliary coolant water pumps were arranged on Friday, 01-04-2011. They should cool the freshwater circuit by sea water.

TEPCO reports that since Monday 04-04-2011, at 19:00 h, 10.000 t slightly radioactive contaminated water from the central water treatment facility has been discharged from the central water treatment facility and since 21:00 h additionally, 1.500 t from Unit 5 and 6 to the Pacific which is meant to arrange containing capacities for highly radioactive water int. al. from Unit 2 until the week-end (09 or 10-04-2011). According to JAIF, 30 t water had been pumped-off until Tuesday, 05-04-2011, from Unit 5 and Unit 6 (status 00:00 h) and 2800 t water had been pumped from the water treatment facility into the sea (status 09:00 h). For the total 60,000 t radioactive water from the cable channels and service rooms from Units 1 through 3 (i. e. 20,000 t from each of the unit respectively), storage capacities should be arranged directly at the site. After the discharge to the sea, the central water treatment facility should have capacity for 30.000 m<sup>3</sup> water; a floating vessel provided from the area of Tokyo can receive up to 18.000 m<sup>3</sup>. The additional storage capacity should be provided by the US-marines.

Also, it has been tried to reduce the leakage amounts from the site to the Pacific as well as to find their locations. For that, a colorant was admixed to the water on 04-04-

2011. This however only verified that the leakage at the inlet of Unit 2 is not the only one leaking location.

Preliminary to the final containment of reactors 1 through 4, it is being verified according to Kyodo (06-04-2011, at 02:08 h) if the reactor buildings could be covered with foil in short term. According to the construction company, the works to seal off and to cover the reactor buildings of Units 1-4 with foil - int. al. in order to minimize the radioactive releases and environmental impacts - can be started in June at the earliest. Thus, the measure which is meant to be a short-term can become effective only beginning from September.

On 01-04-2011 at 15:00 h it was tested to spray resin. The resin is meant to bind radioactive particles to prevent re-suspension. The resin was sprayed in the vicinity of the common interim storage facility in an area of about 500 m<sup>2</sup> until 16:05 h. (TEPCO)

On 05-04-2011 and 06-04-2011, another try to spray resin was undertaken. The resin should bind particles to prevent the re-suspension of radioactivity. The resin was sprayed in the vicinity of the common interim storage facility in the area of approx. 600 m<sup>2</sup> (TEPCO).

Our next information will not report explicitly on the injection of fresh water into the fuel pools of Units 1 through 4. Should any notable changes occur, they will be reported. Also, only notable changes of the continued injection of fresh water into the RPV to cool the fuel in Units 1 through 3 will be reported.

According to TEPCO, it is possible that containments of Units 1 through 3 are damaged. Also, ingress of hydrogen from the RPV via the condenser chamber into the pressure suppression pool of containments can be assumed. Though it is assumed that water steam atmosphere is predominating in the containment, a hydrogen explosion is held for possible, since it cannot be ruled out that air or oxygen intrude into the containment. This is only conceivable if due to the condensation process pressure conditions occur, that let the air or oxygen from the environment of the containment via leakages. Therefore, the injection of nitrogen into the containment for Units 1 through 3 was applied for at the authority to prevent a hydrogen explosion (TEPCO 06-04-2011).



The aftershocks of 7 April at 23:32 h had no major impacts on the site of Fukushima Dai-ichi. The injection of fresh water to cool Reactors 1 through 3 and the injection of nitrogen into the containment of Unit 1 were not impaired. On 08-04-2011 and on 10-04-2011, attempts were undertaken again to spray resin. The resin should bind particles to prevent the re-suspension of radioactivity. The resin was sprayed in the vicinity of the common interim storage facility in the area of approx. 680 m<sup>2</sup> and 550 m<sup>2</sup>.

On 10-04-2011 an unmanned helicopter with a video-camera was sent to give evidence of the state of Units 1 through 4.

According to JAIF, TEPCO confirmed that the flood wave had amounted to 14 m, thus overrunning the site by 5 m.

According to the press releases, an earthquake struck on Monday, 11-03-2011 at 17:16 h in the vicinity of the site Fukushima Dai-ichi at a magnitude of 7.0. This caused an external loss of power for a short period, and the cooling of Units 1 and 2 were interrupted. About 50 min later, the power supply and thus the cooling were re-established. Other incidents were not reported.

TEPCO released the results of investigations of water levels at the site of Fukushima Dai-ichi after the flood wave caused by the earthquake of 11-04-2011. The flood wave amounted to 14 or 15 m above the normal sea level in the area of Units 1 through 4. This caused the overflowing of facilities at the coolant water inlets of Units 1 through 4 by 5 to 7 m. The flood wave was from 13 to 14 m higher than the normal sea level in the area of Units 5 and 6 which are located 13 m higher than the sea level. That means that the flooding in the area of the turbine buildings and the reactor buildings of Units 5 and 6 was about 0 to 1 m. TEPCO reports that the aftershocks of 11-04-2011 of a magnitude 7.1 caused a temporary loss of power. The loss of power caused loss of supply for injection into the RPV of Units 1 through 3. However, there was no notable decrease in the water level until the injection was re-established. The injection of nitrogen into the containment of Unit 1 was interrupted for 6 hours. No other impairments or injuries of persons at the site Dai-ichi were reported.

On 12-04-2011 at 06:38 h, fire was detected at a switchgear with accumulators near the southerly coolant water outlet of Units 1 through 4 which could be extinguished

early by a fire brigade. The fire had no impacts on the cooling of the fuel or release of radioactivity.

On 12-04-2011, the INES classification 5 for the nuclear accident at Fukushima Dai-ichi initially given by the Japanese nuclear safety authority was provisionally revised upwards to INES 7 for Fukushima Dai-ichi with regard to the radioactive release. The classification is effective for the site of Fukushima Dai-ichi and no more for specific Units. The radioactive releases make so far up to 10 % of the amount released in Chernobyl. The spraying of resin in the vicinity of the joint interim storage facility was extended to the area of 1200 m<sup>2</sup>. (TEPCO, 11-04-2011).

According to the press release of KYODO, TEPCO claimed that during the aftershocks on 12-04-2011 at 14:07 h of a magnitude 6.3, the personnel was temporarily evacuated and the aftershocks had no impacts on Dai-ichi (no interruption of power supply, no interruption of the injection into the RPV).

On 12-04-2011, resin was sprayed in the area of 700 m<sup>2</sup>.

TEPCO reports that the aftershocks of 12-04-2011 at 14:07 h of a magnitude 6.3, caused neither interruption of power supply, no interruption of the injection into the RPV and no injuries of persons at the site of Dai-ichi.

### **3.1.1 Unit 1**

Pressure inside the containment of Unit 1 rose during the course of 12-03-2011. Filtered containment venting was carried out as from 14:30 h on 12-03-2011. A hydrogen explosion occurred inside the reactor building, but outside the containment, at 15:36 h on 12-03-2011.

Borated sea water was pumped into the reactor pressure vessel (it remains unclear whether the containment was flooded as well). Injection was begun on 12-03-2011 at 20:20 h.

On 13-03-2011 at 11:13 h, the Kyodo news agency reported that the authority suspected a leak in Unit 1.

Government spokesman Edano said that there may have been a core meltdown. According to TBS (Japanese TV station), approx. 70 % of the fuel assemblies are damaged. The number of damaged fuel assemblies is said to have risen from 43% to 70% (source: German Federal Foreign Office, 16-03-2011). According to information of 16-03-2011, the fuel rods inside the reactor pressure vessel are uncovered along 1.8 metres of their length (17:00 h).

The IAEA states that electricity supply by mobile generators is ensured and that the injection of sea water is continuing.

For up-to-date information on physical values such as pressure and temperature, see the Table in Chapter 4.

According to JAIF (Japan Atomic Industrial Forum), as at 9:00 h on 17-03-2011, there is no information about the integrity of the fuel assemblies in the fuel pool of Unit 1.

The cables to the switchgear of Unit 1 and Unit 2 have been connected (report by JAIF, 22:00 h, 20-03-2011).

Sea water injection into the reactor pressure vessel is being continued. According to a press release by the operator, the sea water has been injected into the reactor via the feedwater system since 2:30 h (23-03-2011).

In a NISA press conference at 10:00 h (23-03-2011) core temperatures are said to be around 400°C. Core cooling is subsequently said to have been improved by providing further injection trains (JAIF No24 and Kyodo News).

According to recent information, the measured values of above 400 °C that were referred to as core temperatures are temperature values measured on the outside of the RPV. By 16:00 h (23-03-2011), these had gone down to approx. 305 °C.

According to NISA (24-03-2011, 5:00 h), the rate of injection into the RPV increased on 23-03-2011 from 2:33 h onwards from 2 m<sup>3</sup>/h to 18 m<sup>3</sup>/h as a result of the additional

injection via the feedwater line. From 9:00 h onwards, TEPCO reduced the rate of injection to 11 m<sup>3</sup>/h since there had been a rise in containment pressure due to the increased amount of coolant injected (24-03-2011, 11:30 h, JAIF). According to JAIF (24-03-2011, 16:00 h), pressure in the RPV has risen and temperatures have fallen. Containment pressure is rising.

According to JAIF (24-03-2011, 22:00 h), pressure in the RPV is slowly rising and the RPV temperature is slowly falling. Containment pressure is slowly rising.

Electricity supply to the control room was established at around 11:30 h (24-03-2011).

According to the Kyodo news agency (25-03-2011), work on Units a and 2 had to be abandoned as highly contaminated water was found in the lower storeys of the buildings.

White smoke is continuously rising, and sea water was injected into the RPV (NISA, 25-03-2011, 6:20 h). On 25-03-2011 at 15:37 h, injection into the RPV was switched from sea water to freshwater (TEPCO).

White smoke has continuously been rising from the unit since 6:30 h 28-03-2011. (NISA)

According to the Nuclear Safety Commission of Japan (NSC), the water found in the turbine building of Unit 1 is condensate from the containment or water that was sprayed onto the buildings during the course of the accident.

Since 8:20 h on 29-03-2011, a provisional, electrically driven pump has been in use for freshwater injection in Unit 1, as the last of the three units remaining in operation.

The pumping-out of radioactive water from the turbine building into the condenser of Unit 1 was interrupted due to a high water level in the condenser. Possibilities are to be created to pump the water from the condenser to the condensate storage tank. (TEPCO)

Freshwater injection into the RPV is monitored by means of a provisional flow meter: (NISA)

260 l/min at 2:35 h, 24-03-2011  
113 l/min at 21:45 h, 24-03-2011  
120 l/min at 15:37 h, 25-03-2011  
113 l/min at 14:00 h, 27-03-2011  
141 l/min at 20:00 h, 28-03-2011  
133 l/min at 8:32 h, 29-03-2011  
117 l/min at 16:18 h, 01-04-2011  
100 l/min at 20:27 h, 02-04-2011  
108 l/min at 12:02 h, 03-04-2011  
100 l/min at 17:30 h, 03-04-2011

On 31-03-2011, from 13:03 h until 16:04 h, the fuel pool was water-supplied by a truck-mounted concrete pump.

The freshwater injection into the RPV is continued so far (NISA). The injection has been provided since 03-04-2011 by means of an electrically driven pump supplied from the external grid (TEPCO).

On 02-04-2011 a part of lighting in the turbine building could be made operational.

Owing to a large amount of leaks, the feeding amounts to the reactor pressure vessel of Units 1 and 2 were reduced on Saturday evening, 02-04-2011. The pressure and the temperature readings remained stable (JAIF).

White smoke has continuously been rising from the unit (NISA, status on 03-04-2011, at 06:30 h)

Hydrogen is assumed to have gathered in the containment of Unit 1. Therefore, nitrogen will be injected into the containment of Unit 1 on Wednesday, 06-04-2011 in order to avoid explosive effects. This measure implies that the radiation could be released into the environment.

The assumption of hydrogen in the RPV implies oxidation process in the reactor core. In the steam water atmosphere, this would mean at least 500 °C for temperatures of structures. With the measurement readings of 250 °C for the temperature at the feed-

water inlets outside the RPV, it is well possible, that such temperatures are reached in the reactor core.

Works to inject nitrogen into the containment began on 06-04-2011 at 22:30 h. The injection of nitrogen has been ongoing since 07.04.2011, 01:31 h (TEPCO). According to Kyodo, it is intended to inject 6000 m<sup>3</sup> nitrogen in 6 days.

### ***INES classification by the authority***

Due to the release to the outside of the plant, on 12-03-2011 the authority provisionally classified the event in Unit 1 as INES 4. This INES classification was revised upwards to INES 5 on 18-03-2011. The classification was provisionally revised upwards to INES 7 for Fukushima Dai-ichi on 12-04-2011.

### **3.1.2 Unit 2**

The coolant level in the reactor pressure vessel of Unit 2 was below the normal level until 14-03-2011. Initially, it did not drop any further. Injection was by means of an emergency cooling system. It was reported by NISA that on 13-03-2011 at 11:55 local time, the electrical power supply was secured (according to the IAEA via mobile generators) and that injection into the reactor was maintained.

On 14-03-2011 at 13:25 h, cooling in Unit 2 failed. For some time, cooling was re-established with sea water. The fuel assemblies were temporarily not covered by water. On 14-03-2011 at about 20:00 h, containment pressure rose to approx. 4.15 bar (corresponds to about design pressure). At 20:37 h, containment venting was begun. According to TEPCO an opening was made in the reactor building to prevent an explosion of the hydrogen in the reactor building.

On 15-3-2011 at 06:20 h, an explosion occurred in Unit 2. According to the IAEA, up to 400 mSv/h were measured on the plant premises. JAIF reports 30 mSv/h between Units 2 and 3, 400 mSv/h next to Unit 3 and 100 mSv/h next to Unit 4. According to press reports, the assumption – based on the fact that containment pressure is falling - is that the pressure suppression pool is damaged.

According to Kyodo, TEPCO says that approx. 33% of the fuel assemblies are damaged. NISA assumes that the high levels of radiation measured since approx. 10:00 h originate from Unit 2. However, it may also be that there is a link between the high radiation levels and the vapour plume emanating from Unit 3.

The fuel rods inside the reactor pressure vessel are uncovered along approx. 1.4 metres of their length.

According to information by NISA of 18-03-2011, 6:00 h, the injection of sea water into the reactor pressure vessel via the fire extinguishing system is being continued. There is white steam rising from the reactor building.

For up-to-date information on physical values such as pressure and temperature, see the Table in Chapter 3.

According to JAIF (Japan Atomic Industrial Forum), as at 10:00 h on 19-03-2011, there is no information about the integrity of the fuel assemblies in the fuel pool of Unit 2.

Information by TEPCO on 19-03-2011, 9:00 h: an external electricity supply via a standby grid transformer has been established. At present, cables are being routed to an auxiliary switchgear system.

Sea water injection into the fuel pool was started on 20-03-2011 at 15:05 h (report by JAIF, 22:00 h, 20-03-2011).

The switchgear of Unit 2 was supplied with voltage on 20-03-2011 at 15:36 h.

At around 18:20 h on 21-03-2011, white smoke was rising from the partially destroyed roof of the reactor building. TEPCO reported that this was water vapour that did not, however, originate from the fuel pool.

According to JAIF, TEPCO reported that the smoke development was abating and that it was no longer visible at approx. 7:00 h on 22-03-2011.

From 16:07 h until 17:01 h on 22-03-2011, 18 t of sea water were injected in to the fuel pool.

As a result of the high radiation levels of more than 500 mSv/h at Unit 2, no work has been possible lately to re-establish the electricity supply of the control room. (Kyodo)

Sea water injection into the reactor pressure vessel is being continued.

According to the Kyodo news agency (25-03-2011), work on Units a and 2 had to be abandoned as highly contaminated water was found in the lower storeys of the buildings.

White smoke is continuously rising, and sea water was injected into the RPV (NISA, 25-03-2011, 6:20 h). From 10:30 h until 12:19 h on 25-03-2011, sea water was injected into the fuel pool by means of the pool cooling and purification system (TEPCO, NISA).

On 26-03-2011 at 10:10 h, injection into the RPV was switched from sea water to freshwater (with boric acid). On 27-03-2011 at 18:31 h, injection was switched from the fire-fighting pump to a provisional, electrically driven pump. (TEPCO)

Since 26-03-2011 at 16:46 h, lighting has been re-established in the unit control room. (TEPCO)

White smoke has continuously been rising from the unit since 6:30 h 28.03.2011. (NISA)

The Nuclear Safety Commission of Japan (NSC) assumes that the water in the turbine building of Unit 2 was in direct contact with molten nuclear fuel and subsequently leaked out into the turbine building via a yet unknown path.

From 16:30 h until 18:25 h on 29-03-2011, freshwater was injected into the fuel pool via the pool cooling and purification system (TEPCO).

On 29-03-2011 at around 16:45 h it was begun to pump water from the condensate tanks into storage tanks for the pressure suppression pool in order to be able to pump the water from the turbine building channels into the condenser. (TEPCO)

After freshwater injection into the fuel pool had been switched from the mobile fire-fighting pump to a provisional motor-driven pump on 30-03-2011 at 9:25 h, the provisional pump failed at 9:45 h. At 12:30 h, a fire-fighting pump was connected as a re-



placement. At 13:10 h, injection had to be stopped due to a tear in the hose. At 19:05 h, injection was resumed and ended at 23:50 h. (TEPCO)

At a press conference, NISA concludes from the low pressure levels in Units 2 and 3 that the reactor pressure vessels may be damaged. It is excluded, however, that there is any major RPV damage.

On 01-04-2011, since 14:56 h, the fuel storage pool had been supplied by a provisional electrically driven pump (TEPCO).

Freshwater injection into the RPV is monitored by means of a provisional flow meter: (NISA)

200 l/min at 17:00 h, 24-03-2011  
340 l/min at 1:07 h, 25-03-2011  
310 l/min at 10:10 h, 26-03-2011  
275 l/min at 17:22 h, 26-03-2011  
117 l/min at 00:12 h, 28-03-2011  
133 l/min at 10:14 h, 30-03-2011  
150 l/min at 14:00 h, 30-03-2011  
133 l/min at 20:43 h, 02-04-2011  
133 l/min at 12:12 h, 03-04-2011

The freshwater injection into the RPV is continued so far (NISA). The injection has been provided since 03-04-2011 by means of an electrically driven pump supplied from the external grid (TEPCO).

Contaminated water gathers in the cable channel of 2 m deep, near the coolant water inlet of Unit 2. The water level on 02-04-2011 was about 10 through 20 cm in the channel cavity. A dose rate of more than 1000 mSv/h was measured in the cavity at a level of about 60 cm. The dose rate above the cavity was 400 mSv/h. On the concrete side-wall of the cavity a crack of about 20 cm long was found letting a leak of contaminated water directly to the sea. Twice it was tried to fill this crack with concrete which was however no success. It is intended to close this crack with special synthetics. Presumably, this water comes from the turbine building of Unit 2, whereas both locations are connected by channels. After water sampling, a nuclide analysis will be carried out. (NISA, TEPCO)

On 02-04-2011 a part of lighting in the turbine building could be made operational.

The leak in the reactor cavity near the coolant water inlet could not be closed by the synthetics (Kyodo, 04-04-2011). Barriers of sand should be arranged instead of.

Owing to a large amount of leaks, the feeding amounts to the reactor pressure vessel of Units 1 and 2 were reduced on Saturday evening, 02-04-2011. The pressure and the temperature readings remained constant (JAIF).

On 04-04-2011 from 11:05 h until 13:37 h, fresh water was injected into the fuel pool by means of a provisional electrically driven pump (TEPCO).

The employment of a colorant (04-04-2011) for the untight cable channel was not successful. No changes could be detected in the flow or the colour of the water. Presumably, the water does not originate from the channel, but intrudes via connection into the channel and penetrates through pebbles layer under the pipelines. To prevent the flow, decision was made on 05-04-2011, to seal the pebbles layer by liquid glass. Experts and special equipment were requested (TEPCO).

On 05-04-2011 at 07:00 h, it was started to inject totally 6000 l "liquid glass" (sodium silicate) into the crack of the coolant water inlet building of Unit 2.

On 06-04-2011 at 05:38 h, the leak of high radioactive water from the crack of the coolant water inlet building was stopped.

According to TEPCO, on 07-04-2011 the water level in the cable channel to the inlet building increased until 07:00 h by around 5 cm, caused presumably by the sealing of a crack in the wall of the inlet building on 06-04-2011. There is allegedly only 1 m room up to the upper edge. An overflow would gravely impair the works in this area.

Around the coolant water facility of Unit 2, a barrier of about 120 m in length was erected in the sea water to contain radioactivity in the case of a leakage of contaminated water out to the sea.

On 12-04-2011 there began works to close the crack in the wall of the coolant water inlet building by means of a metal plate.

The works to pump-off high radioactive water inventory from the pipes and cable channels of the turbine building to the condenser started on 12-04-2011 at 19:35 h.

### ***INES classification by the authority***

The event in Unit 2 had been provisionally classified by the authority as INES 3 on 12-03-2011. The classification was revised upwards to INES 5 on 18-03-2011. The classification was provisionally revised upwards to INES 7 for Fukushima Dai-ichi on 12-04-2011.

### **3.1.3 Unit 3**

In Unit 3, the emergency cooling system failed on 13-03-2011 at around 5:30 h. There followed a depressurisation of the reactor pressure vessel, and borated water was pumped into the reactor from 13:12 h onwards on 13-03-2011. Sea water was injected with the help of fire extinguishing pumps. Containment venting was carried out.

On 14-03-2011 at 11:00 a hydrogen explosion occurred in Unit 3. According to IAEA information, the containment was not damaged. According to TEPCO, containment pressure is stable.

According to NHK, a plume of vapour is said to have been visible above Unit 3 since 8:30 h on 16-03-2011. According to NISA, it is assumed that the containment is damaged after all. Therefore the personnel from the common main control room of Units 3 and 4 were evacuated on 16-03-2011 at 10:45 h. At 11:30 h, the operating personnel returned to resume the injection of water.

On 16-03-2011, the fuel rods inside the reactor pressure vessel are uncovered along approx. 2.30 metres of their length. According to information by NISA of 18-03-2011, 6:00 h, the injection of sea water into the reactor pressure vessel via the fire extinguishing system is being continued.

For up-to-date information on physical values such as pressure and temperature, see the Table in Chapter 3.

The water level in the fuel pool of Unit 3 is low (JAIF, 17-03-2011, 9:00 h). The water level in the fuel pool is dropping (TEPCO at 18:00 h).

It was tried on 16-03-2011 to pour water from a helicopter into the fuel pool. This measure was abandoned without success due to the high activity levels in the surroundings. The military has begun to fill water into the fuel pool by means of five water cannon. NHK reported on 17-03-2011 that according to NISA, 30 t of water had been added to the fuel pool by the military water cannon. Regarding the use of water cannon, the authority NISA states that on 18-03-2011, 6 water cannon from the army sprayed a total of approx. 50 t of water on Unit 4 at around 14:00 h. Also, a US army water cannon was used until 14:45h. It was concluded from the water vapour that became visible that the water had reached the fuel pool.

According to NISA, containment pressure increased on 20-03-2011 to 320 kPa. Measures to reduce pressure were successful. Renewed containment venting was not necessary.

According to NISA, containment pressure has fallen from 320 kPa (20-03-2011, 11:00 h) by more than 160 kPa (21-03-2011, 4:00 h) to 120 kPa (21-03-2011, 12:15 h). NISA stated that on 20-03-2011 between 21:39 h and 03:58 h (21-03-2011), water was sprayed into the fuel pool.

According to a press release, grey smoke was visibly rising from Unit 3, and workers subsequently had to evacuate from the plant area temporarily (21-03-2011, 15:55 h local time). No explosion was heard. The smoke development stopped shortly after 18:00 h, with the cause of the smoke still unclear. There were no relevant changes observed in the values of RPV pressure, containment pressure, and radiation level.

The resumption of spraying with water cannon has initially been planned for Tuesday. According to NISA it is unlikely that the smoke originates from the fuel pool as no increased local dose rates have been measured. Since the electricity supply in Unit 3 has not yet been re-established, a short-circuit can be excluded as the cause of the smoke development.

The electricity supply continues to be prepared, cables have been laid, but further preparations were postponed due to the smoke development in Unit 3.

According to information by JAIF of 22-03-2011, 16:00 h, spraying with water cannon was resumed for 1 hour at 15:50 h. The total time of spraying is thus approx. 20 hours.

According to JAIF and Kyodo, water is to be sprayed again on Unit 3 in the afternoon of Wednesday, 23-03-2011.

TEPCO announced inspections of the cooling pumps in Unit 3 to take place on 23-03-2011 in order to be able to switch from sea water injection to freshwater injection. The electricity supply of the main control room of the unit was re-established at 13:43 h (23-03-2011).

From 11:03 h until 13:20 h on 23-03-2011, 35 t of sea water were pumped into the fuel pool of Unit 3 via the pool cooling and purification system.

At 16:20 h (23-03-2011), black smoke emanated from the reactor building of Unit 3. Subsequently, the surrounding premises of Units 3 and 4 were evacuated as a precaution. However, the measured values of the reactor pressure vessel and of the containment as well as radiation measurements by the measuring probes in the direct vicinity of the plant showed no significant changes.

Following the cessation of the smoke development on 24-03-2011 at around 4:50 h, workers returned to the plant area affected.

From 5:35 h until 14:04 h, sea water (approx. 120 t) was injected into the fuel pool via the pool water and purification system.

On 24-03-2011, three workers received radiation doses of more than 170 mSv when laying cables in the turbine building of Unit 3. Two of them were confirmed to have the skin on their legs contaminated. As it appeared possible that burns had still been suffered through beta radiation despite decontamination, they were hospitalised. In total, 17 workers have so far been exposed to a radiation dose of more than 100 mSv.

According to JAIF (25-03-2011, 10:00 h), the containment is not damaged. However, TEPCO assumes that the fuel assemblies inside the reactor or in the fuel pool are damaged and that highly contaminated water has reached into the turbine building via a leak. In the meantime, draining work has been going on in the turbine building (25-03-2011, 10:25 h).

Sea water injection into the reactor pressure vessel is being continued.

On 25-03-2011, water was injected into the fuel pool by means of water cannon between 13:28 h and 16:00 h. At 18:02 h, injection into the RPV was switched from sea water to freshwater. (TEPCO)

On 27-03-2011, injection of 100 l of water was carried out with the help of a truck-mounted concrete pump from approx. 12:34 h until 14:36 h. (TEPCO)

On 28-03-2011 at 20:30 h, feeding of the RPV was switched over from the fire-fighting pump to a provisional, electrically driven pump (TEPCO).

White smoke has continuously been rising from the unit since 6:30 h 28.03.2011. (NISA)

According to the Nuclear Safety Commission of Japan (NSC), the water found in the turbine building of Unit 3 is condensate from the containment or water that was sprayed onto the buildings during the course of the accident.

On 28-03-2011 at around 17:40 h it was begun to pump water from the condensate tanks into storage tanks for the pressure suppression pool in order to be able to pump the water from the turbine building channels into the condenser.

On 29-03-2011 from 14:17 h until 18:18 h, Unit 3 was sprayed with freshwater by means of the truck-mounted concrete pump. So far, sea water had been used. (TEPCO)

When working on the auxiliary service water system, three workers were splashed with water that had remained in an associated pipe. The water was not contaminated. (29-03-2011, 12:03 h, NISA)

At a press conference, NISA concludes from the low pressure levels in Units 2 and 3 that the reactor pressure vessels may be damaged. It is excluded, however, that there is any major RPV damage.

Freshwater injection into the RPV is monitored by means of a provisional flow meter:  
(NISA)

240 l/min at 18:02 h, 25-03-2011

240 l/min at 20:05 h, 25-03-2011

230 l/min at 7:00 h, 26-03-2011

220 l/min at 18:00 h, 26-03-2011

210 l/min at 14:00 h, 27-03-2011

220 l/min at 18:00 h, 27-03-2011

200 l/min at 20:32 h, 28-03-2011

116 l/min at 14:39 h, 29-03-2011

133 l/min at 12:18 h, 03-04-2011

116 l/min at 17:32 h, 03-04-2011

On 31-03-2011, from 16:30 h until 19:33 h, the fuel storage pool was water-supplied by a truck-mounted concrete pump.

The freshwater injection into the RPV is continued so far (NISA). The injection has been provided since 03-04-2011 by means of an electrically driven pump supplied from the external grid (TEPCO).

On 02-04-2011 a part of lighting in the turbine building could be made operational.

On 02-04-2011 from 19:52 h until 12:54 h, fresh water was injected into the fuel pool by means of a concrete pump (NISA, TEPCO).

White smoke has continuously been rising from the unit (NISA, 03-04-2011, 06:30 h).

On 04-04-2011 it was found that the water level in the cable channel of Unit 3 has risen by 15 cm. It is unknown where the water comes from and it cannot be ruled out that water from the turbine building of Unit 4 intrudes into the cable channel. Thereupon the pumping of water to the turbine building of Unit 4 was suspended. The water level in the cable channel of Unit 3 has not changed since then.

On 04-04-2011 from 17:03 h until 19:39 h, water was injected into the fuel pool of Unit 3 by means of a concrete pump (TEPCO).

#### ***INES classification by the authority***

The event in Unit 3 was classified by the authority on 18-03-2011 as INES 5. The classification was provisionally revised upwards to INES 7 for Fukushima Dai-ichi on 12-04-2011.

#### **3.1.4 Block 4**

The reactor core had been completely unloaded into the fuel pool during the refuelling outage. There are thus no fuel assemblies inside the RPV.

In Unit 4, there were a fire and an explosion in the reactor building in the area of the fuel pool on 15-03-2011 at around 6:00 h. The IAEA confirmed that the fire was extinguished at about 11:14 h. The fire/explosion created two holes in the reactor building, both approx. 8 m<sup>2</sup> wide. According to TEPCO (as reported in media reports) and NISA, another fire broke out in the area of the fuel pool at about 5:45 h (16-03-2011). In this connection, the roof of the reactor building was also severely damaged. The TV station NHK reported that following attempts to extinguish the fire, no flames were visible any more. Media reports say that two workers have been missing since the fire broke out. On a photo of Unit 4 published by TEPCO, a hole in the outer wall of the reactor building is visible, measuring approx. 8 m<sup>2</sup>. The outer shell of the reactor building facing Unit 3 is damaged severely, also near the ground. The roof of the reactor hall is damaged. According to JAIF (12:30 h), the reactor building is also damaged.





Photo of the Fukushima Dai-ichi plant, Units 1-4 (from right to left), of 16-03-2011

The fuel assemblies in the fuel pool are presumably damaged. According to media information of 16-03-11, 19:00 h CET, the water in the fuel pool is boiling. The fuel pool is to be injected with the help of fire fighting equipment (fire engine). Police water cannon has arrived at the site but cannot be used yet as rubble first has to be cleared.

Water injection was stopped on 16-03-2011 at 14:00 h (NISA). At this point in time, the IAEA gives no details about the water temperature in the fuel pool (last information had been on 15-03-2011 at 19:00 h).

According to JAIF (Japan Atomic Industrial Forum), as at 9:00 h on 17-03-2011, the water level in the fuel pool of Unit 4 is low. According to Jiji, TEPCO reports at 18:00 h that the fuel assemblies in the fuel pool are partly covered by water.

Data by IAEA on water temperature in the fuel pool (normal levels below 25 °C):

14-03-2011, 19:08 h: 84 °C

15-03-2011, 19:00 h: 84 °C

from the 16-03-2011 until 01-04-2011: no data

02-04-2011, 70:45 h: 44.0 °C

03-04-2011, 70:50 h: 42.0 °C

04-04-2011, 07:20 h: 30.0 °C

05-04-2011, 07:20 h: 50.0 °C

According to NISA, water was sprayed by 13 water cannon into the fuel pool on 21-03-2011 between 06:37 h and 08:41 h.

The electric power supply of the unit continues to be prepared, cables have been laid (approx. 15:00 h, 21-03-2011), but further preparations were postponed due to the smoke development in Unit 3. The switchgear was connected on 22-03-2011 at 10:35 h.

According to French information, the number of fuel assemblies in the fuel pool of Unit 4 is 1500 fuel assemblies instead of the 1331 fuel assemblies counted so far. This difference may be due to approx. fresh 200 fuel assemblies that have so far not been counted.

On 22-03-2011, a truck-mounted concrete pump injected water into the fuel pool from 17:17 h onwards (capacity of the truck-mounted concrete pump: 50 t/h). After more than three hours, the injection was terminated again according to schedule at 20:30 h.

According to JAIF, injection with the truck-mounted concrete pump into the fuel pool was started again at 10:00 h on 23-03-2011.

At 22:45 h on 22-03-2011, first consumers were connected to the external electricity supply grid.

Due to black smoke above Unit 3, the surroundings premises of Units 3 and 4 were evacuated.

Injection of approx. 130 t of water with the truck-mounted concrete pump into the fuel pool took place from 10:00 h until 13:02 h on 23-03-2011.

NISA says that the water temperature in the fuel pool is 100 °C (24-03-2011, 2:40 h). This information can be put down to a wrong indication. (24-03-2011).

From 14:35 h until 17:30 h (24-03-2011), water was injected into the fuel pool by means of the truck-mounted concrete pump.

White smoke is continuously rising, and sea water is continued to be injected into the RPV (NISA, 25-03-2011, 6:20 h). From 6:05 h until 10:20 h on 25-03-2011, sea water was injected into the fuel pool by means of the pool cooling and purification system (TEPCO, NISA).

From 19:05 h until 22:07 h on 25-03-2011, the fuel pool was injected with the help of a truck-mounted concrete pump (150 t of sea water). Water was again injected in this manner on 28-03-2011 from 16:55 h until 19:25 h (125 t of sea water). (NISA)

White smoke has continuously been rising from the unit since 6:30 h 28.03.2011. (NISA)

On 28-03-2011 from 16:55 h until 19:25 h, approx. 125 t of sea water were sprayed into the fuel pool.

On 29-03-2011 at around 11:50, lighting was re-established in the control room.

On 30-03-2011 from 14:04 h until 18:33 h, the fuel pool was supplied by 140 t freshwater with the help of a truck-mounted concrete pump.

On 30-04-2011, lighting could be partly re-established in the turbine building.

On 01-04-2011 from 08:28 h until 14:14 h, the fuel pool was water-supplied with the help of a truck-mounted concrete pump (TEPCO).

On 03-04-2011 from 17:08 h until 22:16 h, 180 t fresh water was injected into the fuel pool of Unit 4 with the help of a truck-mounted concrete pump.

White smoke has continuously been rising from the unit (NISA, 03-04-2011, 06:30 h).

On 05-04-2011 from 17:35 h until 18:22 h, fresh water was injected into the fuel pool of Unit 4 with the help of a truck-mounted concrete pump.

On 12-04-2011 water samples were taken from the fuel pool of Unit 4 for a nuclide analysis in order to be capable to estimate the status of the fuel in the fuel pool.

***INES classification by the authority***

The event in Unit 4 was classified by the authority on 18-03-2011 as INES 3. The classification was provisionally revised upwards to INES 7 for Fukushima Dai-ichi on 12-04-2011.

### 3.1.5 Units 5 and 6

The IAEA reports about Unit 5 that on 15-03-2011 at 21:00 h (13:00 h CET), the water level in the fuel pool has dropped to 201 cm above the fuel assemblies. This was a drop of 40 cm since 16:00 h (8:00 h CET). It is planned to use an available emergency diesel generator from Unit 6 for water injection.

According to JAIF (8:00 h, 16-3-2011), the water level in the fuel pools of both units is sinking. At 14:00 h, TEPCO reports a fuel pool temperature of approx. 60 °C in both units. The fuel pool temperature is rising.

Further sources say on 16-03-2011 that venting of the reactor building is under preparation to prevent a hydrogen explosion.

On 17-03-2011, 17:30 h, NISA said that in the meantime an emergency diesel generator in Unit 6 was supplying the electricity for injecting water into the fuel pools of Units 5 and 6. Water injection is carried out by the condensate purification system. Once the external grid connection has been re-established, injection into the RPV is to be resumed.

By 19-03-2011, three openings each were made into the roofs of the reactor buildings of Units 5 and 6 to prevent a hydrogen accumulation.

On 19-03-2011 at 04:22 h, a second emergency diesel of Unit 6 became available after repairs. This meant that it was possible to use the residual-heat removal system of Unit 5 from 19-03-2011, 5:00 h onwards and the residual-heat removal system of Unit 6 from 22:00 h onwards for cooling the fuel pools of the two plants.

"Subcritical cold" condition was reached for Unit 5 on 20-03-2011 at 14:30 h and for Unit 6 on 20-03-2011 at 19:27 h.

Fool pool temperatures on 20-03-2011 at 16:00 h were 35.1 °C in Unit 5 and 28.0 °C in Unit 6. Fool pool temperatures on 21-03-2011 at 5:00 h were 39.5 °C for Unit 5 and 32.0 °C for Unit 6.

The electricity supply of Unit 5 was switched over via transformers to external electricity supply at 11:36 h on 21-03-2011 (IAEA/JAIF).

According to TEPCO, a provisional auxiliary service water pump for Unit 5 was automatically shut down when the electricity supply was switched over to external supply (23-03-2011, 17:24 h). The pump was subsequently repaired. At around 16:14 h (24-03-2011), it was possible to start up the pump, and the reactor has been cooled with the help of this pump since 16:35 h.

On 25-03-2011 at approx. 15:40 h, the provisional electricity supply of the provisional auxiliary service water pump of Unit 6 was switched over to external electricity supply. (NISA)

Data on water temperature in the fuel pool of Unit 5 (normal levels below 25 °C):

14-03-2011, 19:08 h: 59.7 °C  
15-03-2011, 19:00 h: 60.4 °C  
16-03-2011, 14:00 h: 62.7 °C  
17-03-2011, 3:00 h: 64.2°C  
17-03-2011, 18:00 h: 65.5°C  
19-03-2011, 6:00 h: 68.8 °C  
20-03-2011, 16:00 h: 35,1 °C  
21-03-2011, 5:00 h: 39.5 °C  
22-03-2011, 5:00 h: 36.3 °C  
22-03-2011, 11:00 h: 37.5 °C  
23-03-2011, 12:00 h: 39.0 °C  
24-03-2011, 5:00 h: 45.1 °C  
24-03-2011, 17:00 h: 49.0 °C  
25-03-2011, 10:00 h: 39.5 °C  
27-03-2011, 14:00 h: 37.8 °C  
29-03-2011, 6:00 h: 37.1 °C  
29-03-2011, 14:00 h: 38.6 °C

29-03-2011, 23:00 h: 32.4 °C  
30-03-2011, 14:00 h: 37.2 °C  
31-03-2011, 06:00 h: 32.4 °C  
01-04-2011, 06:00 h: 36.6 °C  
01-04-2011, 14:00 h: 38.1 °C  
02-04-2011, 06:00 h: 34.1 °C  
02-04-2011, 14:00 h: 37.1 °C  
03-04-2011, 06:00 h: 31.0 °C  
03-04-2011, 13:00 h: 29.7 °C  
04-04-2011, 06:00 h: 38.1 °C

Data by IAEA/JAIF on water temperature in the fuel pool of Unit 6 (normal levels below 25 °C):

14-03-2011, 19:08 h: 58.0 °C  
15-03-2011, 19:00 h: 58.5 °C  
16-03-2011, 14:00 h: 60.0 °C  
17-03-2011, 3:00 h: 62.5 °C  
17-03-2011, 18:00 h: 62.0 °C  
19-03-2011, 6:00 h: 66.5 °C  
20-03-2011, 16:00 h: 28,0 °C  
21-03-2011, 5:00 h: 32.0 °C  
22-03-2011, 5:00 h: 26.0 °C  
22-03-2011, 11:00 h: 25.0 °C  
23-03-2011, 12:00 h: 20.0 °C  
24-03-2011, 5:00 h: 23.5 °C  
24-03-2011, 17:00 h: 28.5 °C  
25-03-2011, 10:00 h: 19.5 °C  
27-03-2011, 14:00 h: 21.0 °C  
29-03-2011, 6:00 h: 22.0 °C  
29-03-2011, 14:00 h: 21.5 °C  
29-03-2011, 23:00 h: 25.0 °C  
30-03-2011, 14:00 h: 26,5 °C  
31-03-2011, 06:00 h: 24,0 °C  
01-04-2011, 06:00 h: 22,0 °C  
01-04-2011, 14:00 h: 21.0 °C

02-04-2011, 06:00 h: 27.0 °C

02-04-2011, 14:00 h: 25.5 °C

03-04-2011, 06:00 h: 27.0 °C

03-04-2011, 13:00 h: 29.5 °C

04-04-2011, 06:00 h: 21.5 °C

For up-to-date information on physical values such as pressure and temperature, see the Table in Chapter 3.

### **3.1.6 Interim storage facility at the Fukushima Dai-ichi site**

IRSN (Institut de Radioprotection et Sûreté Nucléaire) estimates that there are approx. 6000 fuel assemblies in the interim storage facility pool. The radioactive material of these fuel assemblies there has been decaying for longer than that of the fuel assemblies in the fuel pools of the 6 units and therefore produces less decay heat. There is no information available about the cooling status.

As at 18-03-2011, 6:00 h CET, NISA states that the interim storage pool is completely filled with water. TEPCO confirms on 18-03-2011, 10:00 h that the water level in the interim storage pool is ensured. The interim storage pool is yet to be closely inspected.

The dry-storage facility was subjected to a visual inspection on 17-03-2011. This revealed no deviations from normal conditions. An inspection of the dry-storage facility is being prepared.

NISA reports that the water temperature in the interim storage pool is 55 °C (as at: 18-03-2011, 11:19 h). On 19-03-2011 at 09:00 h, the interim storage pool temperature reached 57 °C. Water was injected into the interim storage facility from 10:37 h until 15:30 h on 21-03-2011. At 16:30 h on 21-03-2011, the storage pool temperature was 61 °C.

At 15:37 h (24-03-2011), the electricity supply of the interim storage facility was switched over to external supplies, and cooling operation was subsequently started (24-03-2011, 18:05 h).

On 26-03-2011 at 15:30 h, the water temperature in the storage pool was 43 °C.

The water temperature in the pool was 35 °C (28-03-2011, 16:10 h, NISA).

On 30-03-2011 at 08:20 h, the water temperature in the storage pool was 32 °C

### **3.2 Fukushima Dai-ni**

A small fire in the auxiliary building of Unit 1 was extinguished within 2 hours (source: European Clearinghouse).

Initially, residual-heat removal from the pressure suppression pools of Units 1, 2 and 4 was not possible. In Units 1, 2 and 4, the pressure suppression pool temperature of 100°C was exceeded. There is no such information about Unit 3. There are reports that Unit 3 reached a cold subcritical condition on 12-03-2011.

Coolant levels in the reactor pressure vessels of the four units did not drop. Electricity supply from an external grid is available in these units.

According to TEPCO, containment venting was being prepared for all 4 units. It was, however, not carried out.

Following repairs of the auxiliary service water pumps that had been inundated by sea water, all units reached cold subcritical conditions on 14-3-2011.

According to information by the operator, the residual-heat removal system was turned off for approx. 1 hour on 15-03-2011. It was subsequently made operational again.

On 30-03-2011 at 14:30 h, a possibility was created to connect the residual-heat removal system B for the cooling of the reactor of Unit 1 to an emergency power supply source additional to the external electricity supply. This means that are backed up by emergency power supply sources for residual-heat removal.

In Unit 1 of the Dai-ni NPP, smoke was detected in the switchgears on 30-03-2011 between 17:56 h and 18:13 h. The smoke development could be stopped by interrupting the electricity supply.



On 31-03-2011 at 13:10 h, a person broke by car through the cordons of the Dai-ni site and trespassed the grounds for 10 minutes. The person was detained by the police.

The aftershocks on 7 April at 23:32 h had no major impact on the site Fukushima Dai-ni.

TEPCO released the results of investigations of water levels at the site of Fukushima Dai-ni after the flood wave caused by the earthquake of 11-03-2011. The flood wave amounted to 14 or 15 m above the normal sea level in the area of Units 1 through 4. This caused the flooding of facilities at the coolant water inlets of Units 1 through 4 by 3 m. The flooding in the area of the turbine buildings and the reactor buildings of Units 1 and 2 as well as in the southerly area of Unit 3 it caused flooding by up to 3 m.

TEPCO reports that the aftershocks of 11-04-2011 of a magnitude 7.1 had no impacts at the site Dai-ni.

TEPCO reports that the aftershocks of 12-04-2011 at 14:07 h of a magnitude 6.3 (with the epicentre in Fukushima-Hama-dori) had no impacts at the site Dai-ni. The inspections of the site are still ongoing.

### ***INES classification by the authority***

The event in Unit 1 was classified on 12-03-2011 as INES 3.

The event in Unit 2 was classified on 18-03-2011 as INES 3.

The event in Unit 4 was classified by the authority on 18-03-2011 as INES 3.

### **3.3 Onagawa, Tokai and Higashidori**

According to current information, the Onagawa and Tokai sites have no acute safety-related problems related to the earthquake of 11-05-2011. At the Onagawa plant, a fire in the turbine building was detected and extinguished. All three units at Onagawa are in shutdown condition and cold. The plant is currently being inspected.

According to media reports, two diesel generators failed at the Tokai plant, with one diesel generator remaining operable. Of two pumps provided for cooling, one was not available. TEPCO (17-03-2011, 16:00 h) reports that an external grid supply was established on 13-03-2011. Core cooling has been in operation since then.

According to the press release of Kyodo, in particular the nuclear power plants at sites Onagawa and Higashidori were impacted by the aftershocks of 7 April at 23:32 h. These sites suffered loss of some external power supplies for a short time; the external power supply was however re-established few hours later. (The end of the blackout in Higashidori was on Friday, 08-04-2011 at 03:30 h; that in Onagawa also early on Friday). As a consequence of the blackout, the fuel pool coolant systems failed in Onagawa and Higashidori for 20 or 80 minutes, the temperature of the spent fuel pool remaining however almost constant.

According to Kyodo, radioactive water from the fuel pools of all three Units of Onagawa spilled to the reactor floor. For Unit 1 it is a matter of 3.8 l contaminated water and 5410 Bq/kg activity.

JAIF and NISA also reported, that the nuclear power plants at the sites Onagawa (3 units) and Higashidori (1 unit) were affected by the earthquake of 7-04-2011 at 23:23 h. The earthquake is estimated at a magnitude of 7.4.

In Onagawa a loss of 3 of 4 external power supplies occurred; the fifth external power supply was not available, as it was in repair. One of the external power supplies that had failed and the fifth power supply which had been in repair could be re-established in a short time. The cooling of the fuel pool was interrupted for a while. A third power supply was re-established on 08-04-2011 at 14:01 h as well as another power supply on 08-04-2011 at 14:01 h.

After a loss of power supply occurred in Higashidori, diesel generators provided the power supply. An external power supply could be re-established on 08-04-2011 at 03:30 h. The cooling of the fuel assemblies and of the fuel pool was impaired. One of the diesel generators failed on 08-04-2011 at 14:06 h due to an oil leakage. The other two of the three external power supplies were re-established on 08-04-2011 at 14:59 h. On 09-04-2011 at 07:00 h the disconnected diesel was available again.

In Onagawa all five external power supplies were again available on 10-04-2011 at 15:38 (NISA).

#### 4 Brief overview of the current plant status

GRS is not in a position to judge on the basis of the information available to what extent the measured values indicated (pressures, temperatures, water levels) are reliable or incorrect.

Name	Power	<b>Current status</b> <b>Confirmed: report by operator or NISA – unconfirmed: more detailed press report</b>
Fukushima I (Dai-ichi 1)	460 MWe, 1380 MW <sub>therm</sub>	<p>- Condition of core and building structures: Core damage assumed, containment intact. Depressurisation of reactor carried out. Containment venting carried out. Hydrogen explosion on 12-03-2011 at 15:36 h. Severe structural damage to reactor building. According to TBS (Japanese TV station), presumably 70% of fuel assemblies damaged.</p> <p>- Condition of feeding/injection: Electrical power supply via mobile generators. Flooding of reactor with sea water. Sea water injection into containment via pipes of fire water system since 13-03-2011, 11:55 h (temporarily interrupted on 14-03-2011 at 1:10 due to water shortage in the sea water pool). Since 23-03-2011 as from 2:33 h, the RPV has additionally been fed via the feedwater line. An external electricity supply for supplying control room lights and the illumination of several instruments has been established. Since 29-03-2011, 8:32 h, injection into the RPV, which has been switched over to freshwater, has been carried out by a provisional electrically driven pump. The injection amount is monitored by a flow meter.</p> <p>- Important plant parameters (time of measurement always 09-04-2011, 00:00 h): Amount injected into the RPV: 6.0 m<sup>3</sup>/h (04-04-2011, 17:30 h) Reactor pressure: 0.395 MPa (measuring location A), 0.803 MPa (measuring location B) [overpressure] Water level in the reactor: 1650 mm/1650 mm below upper core edge (measuring location A and measuring location B) RPV temperature at the feedwater nozzle / at the lower plenum; 240.52 °C / 119.7 °C Containment temperature (thermographs): 33° C (08-04-2011, 07:30 h. JAIF)</p>

		<p>Containment pressure: 0.190 MPa            Pressure suppression pool pressure: 0.155 MPa, water temperature unknown            Dose rate in the containment / pressure suppression pool: failure / 12.2 Sv/h</p> <p>- Information on fuel pool:            Asahi with reference to TEPCO:            - 292 fuel assemblies (1 core consisting of 400 fuel assemblies (source: TEPCO))            - Heat output: approx. 60 kW            - Volume 1020 m<sup>3</sup>            - No information available on the condition of the fuel assemblies in the fuel pool.            Pool temperature ((thermographs):): 23 °C (08-04-2011 at 07:30, JAIF)</p>
Fukushima I (Dai-ichi 2)	784 MWe, 2381 MW <sub>therm</sub>	<p>- Condition of core and building structures:            According to information by NISA, an evaluation by TEPCO on 14-03-2011 at 22:14 h shows core damage to be "less than 5%", according to Kyodo on 15-03-2011, TEPCO reports that approx. 33% of the fuel assemblies are damaged. Containment damaged (pressure suppression pool). Depressurisation of reactor carried out. Containment venting carried out. Hydrogen explosion on 15-03-2011 at 6:20 h. Structural damage to reactor building. An external electricity supply for supplying control room lights and the illumination of several instruments has been established. Since 27-03-2011, 18:31 h, injection into the RPV, which had previously been switched over to freshwater, has been carried out by a provisional electrically driven pump. The injection amount is monitored by a flow meter.</p> <p>- Condition of feeding/injection:            Electrical power supply via mobile generators. Sea water injection into containment via pipes of fire water system since 14-03-2011, 22:50 h.</p> <p>- Important plant parameters (time of measurement always 09-04-2011, 00:00 h):            Amount injected into the RPV: 7 m<sup>3</sup>/h (07-04-2011 19:100 h)            Reactor pressure: -0.018 MPa (measuring location A), -0.020 MPa (measuring location B) [overpressure]            Water level in the reactor: 1500 mm below upper core edge (measuring location A, measuring location B not available)            RPV temperature at the feedwater nozzle / at the lower plenum; 141,6 °C / measuring location not available</p>

		<p>Reactor building temperature ((thermographs):): 30 °C (08-04-2011 at 07:30, JAIF)</p> <p>Containment pressure: 0.095 MPa</p> <p>Pressure suppression pool pressure: below measuring range (under scrutiny), water temperature unknown</p> <p>Dose rate in the containment / pressure suppression pool: 29.4 Sv/h /0.751 Sv/h</p> <p>Pressure suppression pool: pressure below measuring range, water temperature unknown</p> <p>- Information on fuel pool:</p> <p>Asahi with reference to TEPCO:</p> <ul style="list-style-type: none"> <li>- 587 fuel assemblies (1 core consisting of 548 fuel assemblies (source: TEPCO))</li> <li>- Heat output: approx. 400 kW</li> <li>- Volume 1425 m<sup>3</sup></li> <li>- No information available on the condition of the fuel assemblies in the fuel pool.</li> <li>- Temperature 50.0 °C (09-04-2011, 002:00 h)</li> </ul>
Fukushima I (Dai-ichi 3)	784 MWe, 2381 MW <sub>therm</sub>	<p>- Condition of core and building structures:</p> <p>Core damage assumed. Depressurisation of reactor carried out. Containment venting carried out. Hydrogen explosion on 14-03-2011 at 11:00 h. Severe structural damage to reactor building. Containment not damaged (JAIF 24-03-2011, 10:00 h). White smoke or vapour visible since 16-03-2011, 11:45 h.</p> <p>- Condition of feeding/injection:</p> <p>Electrical power supply via mobile generators. Flooding with sea water. Freshwater injection into the containment via pipes of fire water system since 13-03-2011, 11:55 h. Since 13:12 h on 13-03-2011, sea water has been injected (temporarily interrupted on 14-03-2011 from 1:10 h until 3:20 h due to water shortage in the sea water pool). An external electricity supply for supplying control room lights and the illumination of several instruments has been established. Intermittent injection into the fuel pool has been taking place since 27-03-2011 by means of a truck-mounted concrete pump; since 29-03-2011, freshwater has been intermittently injected. Since 28-03-2011, 20:30, injection into the RPV, which had previously been switched over to freshwater, has been carried out by a provisional electrically driven pump. The injection amount is monitored by a flow meter.</p> <p>- Important plant parameters (time of measurement always 09-04-2011, 002:00 h):</p> <p>Amount injected into the RPV: 7 m<sup>3</sup>/h (03-04-2011 17:32 h)</p> <p>Reactor pressure: 0.002 MPa (measuring location A), -0.085 MPa (measuring location C) [overpressure]</p> <p>Water level in the reactor: 1950 mm (measuring location A) and 2300 mm (measuring location B), respectively,</p>

		<p>below upper core edge  RPV temperature at the feedwater nozzle / at the lower plenum; 99,2 °C (under scrutiny) / 107.5 °C  Reactor building temperature ((thermographs):): 35 °C (08-04-2011 at 07:30, JAIF)</p> <p>Containment pressure: 0.1054 MPa  Pressure suppression pool pressure: 0.1727 MPa, water temperature unknown  Dose rate in the containment / pressure suppression pool: 18.6 Sv/h / 0.028 Sv/h (is monitored)</p> <p>- Information on fuel pool:  Asahi with reference to TEPCO:  - 514 fuel assemblies (1 core consisting of 548 fuel assemblies (source: TEPCO))  - Heat output: approx. 200 kW  - Volume 1425 m<sup>2</sup>  - Suspected fuel assembly damage</p> <p>Pool temperature (thermographs): 56 ° C (08-04-2011, at 07:30 h, JAIF)</p>
<p>Fukushima I (Dai-ichi 4)</p>	<p>784 MWe,  2381  MW<sub>therm</sub></p>	<p>Unit was shut down before the earthquake. Core had been fully unloaded from the reactor. Hydrogen explosion in the reactor building (fuel pool). Damage to the reactor building (15-03-2011 at 6:40 h) First fire in reactor building on 15-03-2011 at 9:38 h, ending at 11:00 h. Second fire on 15-03-2011 at 5:45 h, no longer visible from the plant premises at 6:15. According to press reports, the pool could not yet be refilled again. Attempts to do so by means of helicopter and fire engines. Intermittent injection into the fuel pool has been taking place since 22-03-2011 by means of a truck-mounted concrete pump. An external electricity supply for supplying control room lights and the illumination of several instruments has been established.</p> <p>Number of fuel assemblies in the core: 0  - Information on fuel pool:  Asahi with reference to TEPCO:  - 1331 fuel assemblies, 1 core consisting of 548 fuel assemblies, there are presently no fuel assemblies stored inside the reactor (source: TEPCO))  - Heat output: approx. 2000 kW  - Volume 1425 m<sup>2</sup>  - Suspected fuel assembly damage  - Temperature: faulty indication</p> <p>Pool temperature (thermographs): 46 ° C (08-04-2011, at 07:30 h, JAIF)</p>

<p>Fukushima I (Dai-ichi 5)</p>	<p>784 MWe, 2381 MW<sub>therm</sub></p>	<p>Unit was shut down before the earthquake, according to information by ENSI on 03-01-2011. Core in the reactor. Since 20-03-2011, 14:30 in cold shutdown condition. Residual-heat removal takes place alternately from the RPV and the fuel pool. External electricity supply is available.</p> <p>- Important plant parameters (measuring time always 09-04-2011, 06:00 h):</p> <p>Water level in the reactor: 1510 mm above upper core edge  Reactor pressure: 0.002 MPa [overpressure]  Water temperature in the reactor: 33.8 °C  Containment pressure: unknown  Pressure suppression pool water temperature unknown  Pressure suppression pool pressure: unknown  Emergency power supply from Unit 6 as of 19-03-2011, 4:22 h.</p> <p>- Information on fuel pool:</p> <p>Residual-heat removal system in operation again on 19-03-2011, 5:00 h.  Temperature on 09-04-2011 at 06:00 h: 35.2 °C</p> <p>Asahi with reference to TEPCO:</p> <ul style="list-style-type: none"> <li>- 946 fuel assemblies (1 core consisting of 548 fuel assemblies (source: TEPCO))</li> <li>- Heat output: approx. 700 kW</li> <li>- Volume 1425 m<sup>2</sup></li> <li>- No fuel assembly damage</li> </ul>
<p>Fukushima I (Dai-ichi 6)</p>	<p>1100 MWe, 3293 MW<sub>therm</sub></p>	<p>Unit was shut down before the earthquake, according to information by ENSI on 12-08-2010. Core in the reactor. Since 20-03-2011, 14:30 in cold shutdown condition. Residual-heat removal takes place alternately from the RPV and the fuel pool. External electricity supply is available.</p> <p>- Important plant parameters (measuring time always 09-04-2011, 06:00 h):</p> <p>Water level in the reactor: 1727 mm above upper core edge  Reactor pressure: 0.005 MPa [overpressure]  Water temperature in the reactor: 45.9 °C  Containment pressure: unknown  Pressure suppression pool water temperature: unknown  Pressure suppression pool pressure: unknown</p>



		<p>- Information on fuel pool: Temperature on 09-04-2011 at 06:00 h: 24.0 °C</p> <p>Asahi with reference to TEPCO:  <ul style="list-style-type: none"> <li>- 876 fuel assemblies (1 core consisting of 764 fuel assemblies (source: TEPCO))</li> <li>- Heat output: approx. 600 kW</li> <li>- Volume 1497 m<sup>2</sup></li> <li>- No fuel assembly damage</li> </ul> </p>
Fukushima II (Dai-ni 1)	1100 MWe, 3293 MW <sub>therm</sub>	<p>No containment venting. External electricity supply, plant state subcritical cold since 14-03-2011.</p> <p>- Important plant parameters (measuring time always 09-04-2011, 06:00 h):  Reactor pressure: 0.15 MPa [absolute pressure]  Reactor water temperature: 25.3 °C  Water level in the reactor: 9.346 m above upper core edge  Pressure suppression pool water temperature: 23 °C  Pressure suppression pool pressure: 105 kPa</p>
Fukushima II (Dai-ni 2)	1100 MWe, 3293 MW <sub>therm</sub>	<p>No containment venting. External electricity supply, plant state subcritical cold since 14-03-2011.</p> <p>- Important plant parameters (measuring time always 09-04-2011, 06:00 h):  Reactor pressure: 0.14 MPa [absolute pressure]  Reactor water temperature: 25.2 °C  Water level in the reactor: 10.396 m above upper core edge  Pressure suppression pool water temperature: 24 °C  Pressure suppression pool pressure: 105 kPa</p>
Fukushima II (Dai-ni 3)	1100 MWe, 3293 MW <sub>therm</sub>	<p>No containment venting. External electricity supply, plant state subcritical cold since 12-03-2011.</p> <p>- Important plant parameters (measuring time always 09-04-2011, 06:00 h):  Reactor pressure: 0.10 MPa [absolute pressure]  Reactor water temperature: 34.6 °C  Water level in the reactor: 7.809 m above upper core edge  Pressure suppression pool water temperature: 26 °C  Pressure suppression pool pressure: 111 kPa</p>

Fukushima II (Dai-ni 4)	1100 MWe, 3293 MW <sub>therm</sub>	No containment venting. External electricity supply, plant state subcritical cold since 15-03-2011. - Important plant parameters (measuring time always 09-04-2011, 06:00 h): Reactor pressure: 0.17 MPa [absolute pressure] Reactor water temperature: 30,1 °C Water level in the reactor: 8.785 m above upper core edge Pressure suppression pool water temperature: 31 °C Pressure suppression pool pressure: 110 kPa
Onagawa 1	524 MWe	All 3 units are in cold shutdown (below 100 °C) condition. The plant is currently being inspected.  Due to the aftershocks of 7 April at 23:32 h, radioactive water from the fuel pools of all three Units of Onagawa spilled to the reactor floor. For Unit 1 it is a matter of 3.8 l contaminated water and 5410 Bq/kg activity Also, four of the five external power supplies were not available. As a consequence of the external power failure, the fuel pool coolant systems failed in Onagawa for a short time, the temperature of the spent fuel pool remaining however constant. All five external power supplies could be re-established.
Onagawa 2	825 MWe	
Onagawa 3	825 MWe	
Higashidori 1		The facility had been in outage before the earthquake, no fuel assemblies had been in the RPV, the reactor core unloaded. Due to the aftershocks of 7 April at 23:32 h, the external power supply failed for a short time, but was re-established few hours later. (The end of the blackout in Higashidori was on Friday, 08-04-2011 at 03:30 h). As a consequence of the blackout, the fuel pool coolant systems failed in Higashidori for a short time, the temperature of the spent fuel pool remaining however almost constant. On external power supply was re-established.
Tokai 2	1100 MWe, 3293 MW <sub>therm</sub>	Plant in safe cold shutdown condition.

MWe: electrical power, MW<sub>therm</sub>: thermal power