UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-11 14:46	00:00 (min)	Occurrence of earthquake.	—	M9.0	Initiating external event.	–51:00 (min)
2011-03-11 14:46	00:00 (min)	Reactor trip at the seismic trip set point.	Auto	100 Gal V 135 Gal H	Sensors B and C (two out of four).	–51:00 (min)
2011-03-11 14:46	00:00 (min)	Loss of off-site power.	—	—	Concurrent event The earthquake caused damage to the breakers of the switchyards of Units 1 and 2. With reference to the TEPCO nuclear line (66 kV) from Tohoku Electric Power, cables were damaged although it was not possible to find the cause. Regarding Units 3 and 4, in addition to the Okuma No. 3 transmission line under construction, the breakers of Nos 3 and 4 transmission lines on the side of the Shin Fukushima Power Substation failed. In the case of Units 5and 6, one transmission line tower (No. 27 tower) connecting to the switchyards of Units 5 and 6 collapsed.	–51:00 (min)
2011-03-11 14:47	01:00 (min)	Reactor water level dropped initially because of the collapsing steam voids.	—	TAF + 3580 mm	Since the reactor water level was within the normal band, the operators did not have to initiate HPCI (the HPCI set point was L2, which was <148 cm from the bottom of the separator). The level recovered as a result of feedwater (time is approximate, level drop and recovery between 14:47 and 14:48).	–50:00 (min)
2011-03-11 14:47	01:00 (min)	Reactor pressure dropped initially after trip.	—	~6 MPa	Consequently, reactor pressure started rising due to decay heat after isolation by MSIV closure (time is approximate).	–50:00 (min)
2011-03-11 14:47	01:00 (min)	Level 3 state of emergency declared and Emergency Plan activated.	—	Seismic intensity >6 on the Japanese scale	TEPCO Headquarters and other offices simultaneously declared a Level 3 state of emergency and established the ERC according to the Operation Plan for Disaster Preparation for general disasters and internal rules. Post-earthquake actions initiated in accordance with event based AOP, Natural Disaster Accident, Section IV, Natural Disasters, Chapter 22.	–50:00 (min)
		AOP Natural Disaster Accident, Section IV, Natural Event activated.	—	>45 Gal		
		Earthquake Emergency Response Team activated at the ERC.	—	—		
2011-03-11 14:47	01:00 (min)	All control rods fully inserted.	Auto	ARI	—	–50:00 (min)
2011-03-11 14:47	01:00 (min)	PCIS generated.	Auto	Low Rx Level L3 (18 cm from the bottom of the separator)	or the reactor protection system power loss. It is not known what initiated the isolation.	–50:00 (min)
2011-03-11 14:47	01:00 (min)	Normal HVAC stopped.	Auto	LOOP	PCV cooling ceased.	–50:00 (min)
2011-03-11 14:47	01:00 min	SFP cooling and make-up lost.	—	LOOP	The SFPs, which store the used and new fuel assemblies, are filled with water providing radiation shielding and removal of heat from the nuclear fuel located there. However, without cooling, the pool water would heat up and eventually start evaporating. Alternative SFP cooling would have been possible via the residual heat removal system (RHR), which was supplied with power by the EDG. However, switching from RHR cooling to SFP cooling would have required manual actions, which had not taken place before the arrival of the tsunami which affected the RHR components.	- 50:00 min
2011-03-11 14:47	01:00 (min)	Turbine trip on high vibration.	Auto	—	Chart shows manual trip here	– 50:00 (min)
2011-03-11 14:47	01:00 (min)	6.9 kV power loss.	—	—	Buses 1C and 1D power loss	–50:00 (min)
2011-03-11 14:47	01:00 (min)	EDGs started and loaded.	Auto	Loss of AC	—	–50:00 (min)

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event | Core Cooling | Power/station auxiliary | Confinement | Reactivity | Emergency Management | Radiation | Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-11 14:47	01:00 (min)	AC power restored by on-site power source.	Auto	EDG	EDG 1B energizing the 6.9 kV bus 1D; EDG 1A energizing the 6.9 kV bus 1C	–50:00 (min)
2011-03-11 14:47	01:00 (min)	AOP Natural Disaster Accident, Section II, Turbine and Electrical declared.	—	LOOP	Chapters 12, 13, and 14 of the Accident Operating Manual with the external system fault, Section II, Turbine and Electrical	–50:00 (min)
2011-03-11 14:47	01:00 (min)	Radiation monitoring alarms for SGTS exhaust and main stack.	Auto	>Alarm set point	The chart of the main stack radiation monitoring system showed that the measured radiation level instantaneously exceeded the pre-set alarm level and then dropped back to the original level. In addition, ‘main steam pipe broken’ and other alarm signals sounded before and after the MSIV was closed. The NRA later estimated that these alarm signals were issued due to the LOOP caused by the earthquake.	- 50:00 (min)
2011-03-11 14:48	02:00 (min)	MSIVs closed.	Auto	LOOP — Fail Close	Reactor isolation from the steam/power conversion system (normal core cooling via condenser ceased) due to power interruption	–49:00 (min)
2011-03-11 14:52	06:00 (min)	Both trains of isolation condensers (ICs) started.	Auto	Pressure > 7.13 MPa	Standby gas treatment system (SGTS) to automatically start up	- 45:00 (min)
2011-03-11 14:53	07:00 (min)	Decrease in reactor pressure vessel (RPV) pressure.	Chart recorder	—	IC cooled water reaches reactor core (chart recorder)	- 44:00 (min)
2011-03-11 14:53	07:00 (min)	Reactor water level in normal range.	Chart recorder	—	Since the reactor water level was within the normal band, the operators did not have to initiate HPCI (the HPCI set point is L2, which is <148 cm from the bottom of the separator)	- 44:00 (min)
2011-03-11 15:02	16:00 (min)	Reactor confirmed to be subcritical.	—	Intermediate range monitor levels steadily decreasing	—	- 35:00 (min)
2011-03-11 15:03	17:00 (min)	Low reactor pressure.	Chart recorder	~ 4 MPa	Chart recorder (time is approximate). Reactor Pressure is <50 bar, indicating that the IC cooled too much.	- 34:00 (min)
2011-03-11 15:03	17:00 (min)	IC stopped.	Manual	Cooldown rate > 55°C/h (maintaining the reactor pressure at 6–7 MPa)	Operators removed the IC from service by closing the cold leg return dry well outboard isolation MOVs (MO-3A and B) to prevent the cooldown rate from exceeding the 55°C/h limit specified in technical specifications, and maintain the reactor pressure at 6–7 MPa.	- 34:00 (min)
2011-03-11 15:05	19:00 (min)	One train of the containment cooling system (CCS) started.	Manual	—	SC cooling commenced. The PCV pressure continued to increase after the reactor trip and loss of normal HVAC. Furthermore, an inflection point was observed in the differential pressure between the PCV and the suppression chamber (SC). This was thought to be due to the pressure drop in the SC. This pressure drop could have been induced by the manual startup of the PCV spray system pump.	- 32:00 (min)
2011-03-11 15:06	20:00 (min)	Headquarters for General Disaster Countermeasures established.	—	Natural Disaster: Earthquake	The TEPCO office in Tokyo assessed damage from the earthquake and recovers from the electrical outage in TEPCO’s service area.	- 31:00 (min)
2011-03-11 15:10	24:00 (min)	The second train of the CCS started.	Manual	—	Additional SC cooling (in anticipation of SRV actuation and HPCI activation).	- 27:00 (min)
2011-03-11 15:17	31:00 (min)	A-Train IC system operation restarted (valve MO-3A opened).	Manual	Reactor pressure ~7 MPa	Operators determined that only one train of IC was needed to control reactor pressure. operated by the opening and closing of the motor operated valve (MO-3A) to control reactor pressure. To limit the cooldown rate of the reactor to 55°C/h, the crew closed the IC train B and stopped the IC train A three times between 15:17 and 15:34 in accordance with procedures. Therefore they closed the outer containment isolation valves for the condensate backflow pipe.	- 20:00 (min)
2011-03-11 15:17	31:00 (min)	Decrease in RPV pressure.	Chart recorder	IC	IC cooled water reaches reactor core (time is approximate).	- 20:00 (min)
2011-03-11 15:19	33:00 (min)	A-Train IC system operation stopped.	Manual	Reactor pressure ~6 MPa	Maintain the reactor pressure at 6–7 MPa	- 18:00 (min)
2011-03-11 15:20	34:00 (min)	Increase in RPV pressure.	Chart recorder	—	—	- 17:00 (min)

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-11 15:24	38:00 (min)	A-Train IC system operation restarted (valve MO-3A was opened)	Manual	Reactor pressure ~7 Mpa	Maintain the reactor pressure at 6–7 MPa	- 13:00 (min)
2011-03-11 15:24	38:00 (min)	Decrease in RPV pressure.	Chart recorder	—	IC cooled water reached reactor core (time is approximate).	- 13:00 (min)
2011-03-11 15:26	40:00 (min)	A-Train IC system operation stopped.	Manual	Reactor pressure ~6 Mpa	Maintain the reactor pressure at 6–7 MPa	- 11:00 (min)
2011-03-11 15:27	41:00 (min)	Increase in RPV pressure.	Chart recorder	—	—	- 10:00 (min)
2011-03-11 15:27	41:00 (min)	First wave of tsunamis arrived at the NPP.	—	3–4 m	Consequent external event	– 10:00 (min)
2011-03-11 15:29	43:00 (min)	High-high alarm issued at some MPs.	—	>430 nGy/h	MP 3 alarmed. However, low radiation MPs located in the same place took proper measurements with stable readings at about 40 nGy/h.	–08:00 (min)
2011-03-11 15:32	46:00 (min)	A-Train IC system operation restarted (valve MO-3A opened).	Manual	Reactor pressure ~7 Mpa	Maintain the reactor pressure at 6–7 MPa	–05:00 (min)
2011-03-11 15:32	46:00 (min)	Decrease in RPV pressure.	Chart recorder	—	IC cooled water reached reactor core (time is approximate).	–05:00 (min)
2011-03-11 15:34	48:00 (min)	A-Train IC system operation stopped.	Manual	Reactor pressure ~6 Mpa	Last position of A-Train IC valves: outboard on/off valve MO-3A closed, outboard supply line valve MO-2A open. Inboard (inside containment isolation valves are open, (time is approximate).	–03:00 (min)
2011-03-11 15:36	50:00 (min)	Second wave of tsunami arrived at the station.	—	14–15 m	The tsunami wave flooded the site and the buildings (time is approximate).	–01:00 (min)
2011-03-11 15:36	50:00 (min)	High-high alarm at some MPs cleared.	—	—	—	–01:00 (min)
2011-03-11 15:37	51:00 (min)	EDGs tripped.	—	—	—	00:00 (min)
2011-03-11 15:37	51:00 (min)	Station black out (SBO).	—	Loss of all AC	—	00:00 (min)
2011-03-11 15:37	51:00 (min)	Loss of DC power.	—	—	Tsunami waves struck the NPP, flooding either the EDGs themselves or the associated power centres, resulting in a total loss of AC power and a gradual loss of DC power between 15:37 and 15:50. Hence the times are approximate.	00:00 (min)
2011-03-11 15:37	51:00 (min)	Loss of DC distribution systems leads to loss of control room indications and alarms. Control room lighting lost; only emergency lighting remain. Control panel indications for HPCI were barely lit, and slowly faded to black. Operators determined HPCI was not operable because indicators on the control panel were lost. Valve status of IC lost on the control panel. Flooding caused loss of instrumentation power system, resulting in loss of control room indications, including the reactor water level and SFP indications.				
2011-03-11 15:42	56:00 (min)	SBO confirmed.	—	—	—	05:00 (min)
2011-03-11 15:42	56:00 (min)	Emergency for nuclear disaster declared based on Article 10 of the Nuclear Disaster Act.	—	SBO	Article 10, Paragraph 1 of the Nuclear Disaster Act. Nuclear Emergency Act Article 10 Notification is issued by the nuclear operator to the government and local public organizations when radiation dose of 5μSv/hr (micro Sieverts per hour) or higher, which is higher than normal, is detected in the vicinity of the nuclear site or if some safety systems become unavailable. When the competent Minister (in this accident, the Minister of METI) receives an Article 10 notification, the minister then establishes the METI Nuclear Disaster Alert Headquarters along with the Local Alert Headquarters at the off-site centre. The nuclear disaster preparedness officials and others residing in nuclear plant siting communities will coordinate with the nuclear operator and local public organizations to start activities such as collecting information.	05:00 (min)

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-11 15:42	56:00 (min)	Corporate Nuclear Emergency Response Centre established.	—	SBO	TEPCO Level 1 state of emergency for nuclear emergency is issued.	05:00 (min)
2011-03-11 15:42	56:00 (min)	Entry to EOP to maintain key safety functions.	—	SBO	Loss of all AC power.	05:00 (min)
2011-03-11 16:00	01 h 14 min	Government officials notified on SBO and declaration of emergency based on Article 10.	—	SBO	By fax.	23:00 (min)
2011-03-11 16:00	01 h 14 min	TEPCO and contractor workers dispatched to assess damage from earthquake and tsunami.	—	—	including assessment of off-site power sources and damages to the access routes to the site (approximate time).	23:00 (min)
2011-03-11 16:10	01 h 24 min	TEPCO Headquarters ERC orders all facilities to assemble and account for mobile high/low voltage supply vehicles.	—	—	Transport routes are also ordered to be determined.	33:00 (min)
2011-03-11 16:30	01 h 44 min	Radiation monitoring vehicles dispatched.	—	—	—	53:00 (min)
2011-03-11 16:36	01 h 50 min	Emergency for nuclear disaster declared based on Article 15 of the Nuclear Disaster Act.	—	Loss of ECCS/reactor water level determination function	Operators could not determine the reactor water level or the status of injection into the reactor (Article 15, paragraph 1 of the Nuclear Disaster Act). If the nuclear disaster conditions degrade and a radiation dose of 500 μSv/h or higher is detected, the nuclear operator issues a Nuclear Emergency Act Article 15 Notification to the Government and local public organizations. When the competent Minister receives this notification and recognizes that a nuclear emergency situation has occurred, the Minister reports this to the Prime Minister. The Prime Minister then declares a nuclear emergency situation and establishes the Nuclear Disaster Response Headquarters, with the Prime Minister serving as chief. The Local Nuclear Disaster Response Headquarters is established locally at the off-site centre, with the Senior-Vice Minister or Parliamentary Secretary serving as chief.	59:00 (min)
2011-03-11 16:36	01 h 50 min	Entry to the Severe Accident Operating Procedure (at MCR) and to the Accident Management Guidelines (at ERC).	—	Loss of ECCS/Reactor water level determination function	TEPCO Level 2 state of emergency is issued. The ERC began reviewing the accident management procedures and checking the vent procedures to determine how to open the containment vent valves without power. Workers in the ERC went through the administration building and retrieved drawings and manuals needed to develop the procedure.	59:00 (min)
2011-03-11 16:42	01 h 56 min	Reactor water level gauge became temporarily available, level measured.	—	TAF+2530 mm	The reason for recovery of the water indicator function is unknown.	01 h 05 min
2011-03-11 16:45	01 h 59 min	Emergency declaration under Article 15 (declared at 16:36) cancelled.	—	Reactor water level determination function regained	—	01 h 08 min
2011-03-11 16:45	01 h 59 min	Appropriate Government officials notified on declaration of the emergency based on Article 15 earlier at 16:36.	—	—	Emergency based on Article 15 was declared at 16:36. Fax was sent to government officials at 16:45.	01 h 08 min
2011-03-11 16:50	02 h 04 min	Mobile high/low voltage supply vehicles mobilized and sent to Fukushima Prefecture.	—	—	To the Fukushima Daini and Fukushima Daiichi sites.	01 h 13 min
2011-03-11 16:55	02 h 09 min	Appropriate Government officials were notified on cancellation of the Article 15 emergency.	—	—	Article 15 emergency was cancelled at 16:45.	01 h 18 min
2011-03-11 16:55	02 h 09 min	Field operators dispatched to activate DDFP.	—	—	The shift supervisor decided that the danger due to aftershocks declined sufficiently to dispatch teams to activate DDFP on-site.	01 h 18 min
2011-03-11 16:56	02 h 10 min	Reactor water level indicator went off-scale.	—	<TAF + 1930 mm	Bottom scale in WR level indicator is –150 cm (or TAF + 1930).	01 h 19 min
2011-03-11 17:07	02 h 21 min	MCR water level indication lost.	—	—	—	01 h 30 min
2011-03-11 17:07	02 h 21 min	Emergency for nuclear disaster based on Article 15 of the Nuclear Disaster Act declared again.	—	Loss of ECCS/reactor water level determination	Operators again lost indication of reactor water level or the status of injection into the reactor. Article 15, paragraph 1 of the Nuclear Disaster Act.	01 h 30 min

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-11 17:12	02 h 26 min	Appropriate government agencies notified.	—	—	Emergency of Article 15 was declared at 17:07.	01 h 35 min
2011-03-11 17:12	02 h 26 min	Site Superintendent directed workers to investigate methods of injecting water into the reactor using the fire protection system or fire engines.	—	—	Operators reviewed methods for alternative water injection using the accident management (AMG) procedures and confirmed the injection path using the installed fire pump into the RPV via the core spray system. The team had to return to the MCR due to the tsunami warning.	01 h 35 min
2011-03-11 17:15	02 h 29 min	Site ERC technical support staff calculate time to uncovering of core.	—	1 h	—	01 h 38 min
2011-03-11 17:19	02 h 33 min	Entered turbine building basement to survey DDFP status.	—	—	To start the DDFP and align injection line.	01 h 42 min
2011-03-11 17:30	02 h 44 min	Operators cleared the fault trip on DDFP,	Local Manual	—	—	01 h 53 min
2011-03-11 17:30	02 h 44 min	Diesel driven fire pump available.	—	Standby	Left in standby mode until the injection line is established.	01 h 53 min
2011-03-11 17:30	02 h 44 min	Plans initiated to establish alternative water injection line from the fire protection system to the core spray.	—	—	—	01 h 53 min
2011-03-11 17:30	02 h 44 min	Main Gate radiation reading.	—	49 nGy/h	—	01 h 53 min
2011-03-11 17:37	02 h 51 min	Government officials notified on radiation levels being within normal range in the area surrounding the plant.	—	—	—	02 h 00 min
2011-03-11 17:40	02 h 54 min	Radiation reading taken at Main Gate.	—	56 nGy/h	—	02 h 03 min
2011-03-11 18:00	03 h 14 min	Field operators dispatched to perform power supply inspection/investigation.	—	—	The shift supervisor decided that the danger due to aftershocks declined sufficiently to dispatch teams.	02 h 23 min
2011-03-11 18:18	03 h 32 min	Some instrument panels discovered to be functioning.	—	—	Reason not known.	02 h 41 min
2011-03-11 18:18	03 h 32 min	Indications show both outboard IC valves closed.	—	Close (isolation signal due to loss of DC power)	Operators found that the valve indicator lamps were lit sometime before 18:18. Not only MO-3A, which was controlled by operators for IC activation/deactivation and was left closed before the second wave of the tsunami, but also the IC supply piping containment isolation valve (MO-2A), which was normally open was closed. Thus, operators inferred that an IC isolation signal was generated during the loss of control (DC) power, possibly by the IC pipe rupture detection circuit. It was corroborated that they were closed at the time of DC failure; thus, there was no shutdown heat removal since then.	02 h 41 min
2011-03-11 18:18	03 h 32 min	Operator started IC by opening the motor operated IC valves MO-3A and MO-2A.	Remote manual	Open	Outboard (outside containment) valves of Train A, assuming that the inboard valves (which cannot be controlled without power) were open since they would fail as-is in the case of loss of AC power. They failed open since they were open at the time of the SBO.	02 h 41 min
2011-03-11 18:18	03 h 32 min	IC observed to be operating.	—	—	Steam was observed from the IC exhaust area for a short duration. It was reported to the station ERC that IC is operating.	02 h 41 min
2011-03-11 18:25	03 h 39 min	IC operation cannot be confirmed.	—	—	Steam that was observed from the IC exhaust area ceased. There was a doubt regarding the integrity of the IC system. Possible causes were: inboard valves closed, IC tank inventory depleted, line break, etc.	02 h 48 min
2011-03-11 18:25	03 h 39 min	Operator closed the motor operated IC valves MO-3A, securing IC.	Remote manual	Closed	—	02 h 48 min

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Colour indication:

Main event | Core Cooling | Power/station auxiliary | Confinement | Reactivity | Emergency Management | Radiation | Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-11 18:35	03 h 49 min	Work started on establishing alternative water injection line from the fire protection system to the core spray, sending crew to the reactor building.	—	—	Veteran operators, wearing full face masks and APDs (on unverified reports of high radiation levels).	02 h 58 min
2011-03-11 18:35	03 h 49 min	Field crew closed outlet valves of FP tank.	Local manual	Closed	Water leak at transformer fire protection line that was discovered during the field survey could not be stopped in a timely manner. To prevent FP inventory, the valves were closed but the inventory remained available when needed and while the leak was being repaired.	02 h 58 min
2011-03-11 19:00	04 h 14 min	Gate between Units 2 and 3 opened.	—	—	Securing vehicle travel routes to Units 1–4	03 h 23 min
2011-03-11 19:03	04 h 17 min	Nuclear emergency declared by the Government of Japan.	—	—	—	03 h 26 min
2011-03-11 19:52	05 h 06 min	Radiation monitor data around plant monitoring points.	—	~ 60 nGy/h	MP location 3, 4 and 6 was around 57–61 nGy/h between 17:30 and 18:30.	04 h 15 min
2011-03-11 20:07	05 h 21 min	High reactor pressure.	Local gauge	6.9 MPa	Reading of the gauge in the reactor building. This pressure reading further suggested that the IC was not working.	04 h 30 min
2011-03-11 20:30	05 h 44 min	Established alternative water injection line from the fire protection system to the core spray began operation, sending crew to the reactor building.	Local manual	—	By manual alignment of injection line in the reactor building. No unusual exposure is observed from APDs.	04 h 53 min
2011-03-11 20:40	05 h 54 min	DDFP started.	Remote manual	—	DDFP operation switch was moved from the shutdown position in the MCR, having been manually held since placing the DDFP in standby earlier to prevent unintended start.	05 h 03 min
2011-03-11 20:40	05 h 54 min	DDFP failed to start.	—	Ground fault trip	Operators in the reactor building kept resetting the fault trip.	05 h 03 min
2011-03-11 20:47	06 h 01 min	Some temporary lights restored in the MCR.	—	—	A small portable electric generator was installed.	05 h 10 min
2011-03-11 20:50	06 h 04 min	2 km zone evacuation order issued by the local government.	—	2 km radius	Facing a still uncontrolled situation at the Fukushima Daiichi NPP, the Governor of Fukushima Prefecture ordered the evacuation of residents within 2 km of the NPP.	05 h 13 min
2011-03-11 20:50	06 h 04 min	DDFP started continuous operation.	Remote manual	—	DDFP stopped tripping on fault.	05 h 13 min
2011-03-11 20:50	06 h 04 min	Water injection not achieved.	—	RPV pressure > 7.9 bar	The pump head of the DDFP is 7.9 bar.	05 h 13 min
2011-03-11 21:01	06 h 15 min	Radiation monitor data near plant communicated to government officials.	—	—	No anomalies detected.	05 h 24 min
2011-03-11 21:01	06 h 15 min	Government officials informed that Unit 2's core cooling could not be confirmed.	—	—	Start of work to calculate the time to uncovering of the Unit 2 core, as well as preparation of request for local governments to evacuate residents.	05 h 24 min
2011-03-11 21:13	06 h 27 min	Time to uncovering of the Unit 2 core estimated.	—	~ at 21:40	Assessed based on the fact that the Unit 2 RCIC was not operating.	05 h 36 min
2011-03-11 21:19	06 h 33 min	MCR water level indication confirmed as being functional.	—	TAF + 200 mm	Two batteries powered. Temporary batteries and cables were gathered and carried to the Units 1/2 control room. After confirming the wiring layout using drawings, batteries were connected to instrument panels. The top priority was to verify the status of water injection into the RPV, so efforts were focused on connecting batteries to the DC powered reactor water level indicator.	05 h 42 min
2011-03-11 21:23	06 h 37 min	3 km zone evacuation and 3–10 km-zone shelter order issued.	—	3 km radius	Order issued by the Prime Minister upon receiving estimate of the uncovering of the Unit 2 core at 21:40.	05 h 46 min

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-11 21:30	06 h 44 min	Motor operated IC valve MO-3A opened.	Remote manual	Open	Attempt to cool the reactor by IC since injection by the DDFP was not possible. However, the DDFP could be used to supply the IC tank inventory.	05 h 53 min
2011-03-11 21:30	06 h 44 min	IC observed to be operating.	—	—	Steam was observed from the IC, but later stopped.	05 h 53 min
2011-03-11 21:50	07 h 04 min	Time to uncovering of the Unit 2 core re-estimated.	—	Later than 21:40	The initial assessment was cancelled. Reassessed based on the non-operation of the Unit 2 RCIC, and updated based on the reactor water level measurement of TAF + 3400 mm	06 h 13 min
2011-03-11 21:50	07 h 04 min	Entry into reactor building attempted.	—	—	To locally read the reactor water level and IC pool level (time is approximate).	06 h 13 min
2011-03-11 21:51	07 h 05 min	Reactor building dose confirmed to be too high for entry.	—	0.8 mSv in 10 s	Exposures of 0.8 mSv in a very short time was observed (dosimeters are set to have 1 mSv limit in normal operation).	06 h 14 min
2011-03-11 21:51	07 h 05 min	IC operation could not be confirmed.	—	—	Operators who were dispatched to read the IC tank water level and reactor water level locally in the reactor building turned back due to high radiation levels.	06 h 14 min
2011-03-11 22:00	07 h 14 min	First mobile power supply vehicle arrived at site.	—	—	From the Tohoku Electric Power Company (approximate time). Elapsed time since dispatch: ~5 h	06 h 23 min
2011-03-11 22:00	07 h 14 min	Increased reactor water level.	—	TAF + 550 mm	An earlier reading was TAF + 450 mm.	06 h 23 min
2011-03-11 22:10	07 h 24 min	Reactor water level above TAF reported to government officials.	—	—	TAF + 450 mm.	06 h 33 min
2011-03-11 22:10	07 h 24 min	Radiation monitor data around plant monitoring points reported to government.	—	~ 60 nGy/h	MP location 6 was around 60 nGy/h between 21:30 and 21:50.	06 h 33 min
2011-03-11 22:20	07 h 34 min	Increasing reactor water level reported to government officials.	—	TAF + 550 mm	Measured at 22:00.	06 h 43 min
2011-03-11 23:00	08 h 14 min	High dose rate reading in front of the north door of the reactor building on the 1st floor of the TB.	Manual	1.2 mSv/h	The dose rate inside the reactor building was extrapolated to be ~300 mSv/h.	07 h 23 min
2011-03-11 23:00	08 h 14 min	High dose rate reading in front of the south door of the reactor building on the 1st floor of the TB.	Manual	0.5 mSv/h		07 h 23 min
2011-03-11 23:05	08 h 19 min	Entry to the reactor building restricted.	—	High radiation levels.	Due to the rising radiation levels, ordered by the Site Superintendent. Radiation zone (restricted entry) signs were posted at 23:33 and 23:50 on the north and south air lock doors, respectively.	07 h 28 min
2011-03-11 23:05	08 h 19 min	Dose rate in the MCR noted.	—	—	Because of the necessary cable connection between the mobile generator and the MCR, it was not possible to close the door and the dose rate in the MCR increased simultaneously to the dose rates in the other parts of the control building. Due to increasing dose rates in the Unit 1 side, operators had to move periodically to the Unit 2 side of the MCR.	07 h 28 min
2011-03-11 23:40	08 h 54 min	Government authorities notified of high radiation readings in the reactor building and TB.	—	—	1.2 mSv/h in the reactor building, 0.5 mSv/h in the TB.	08 h 03 min
2011-03-11 23:50	09 h 04 min	Temporary generator powered the dry well pressure instrument.	—	—	Small generator used for temporary MCR lighting was connected to DW pressure instrumentation.	08 h 13 min
2011-03-11 23:50	09 h 04 min	Dry well pressure high.	—	6 bar	The first measurement since loss of DC power.	08 h 13 min
12 March 2011						

[1] Time may be approximate, especially during the first two minutes of the main event, due to data recording frequency, chart recorder scale or delays in the operator reports and logs.

UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-12 00:06	09 h 20 min	The Site Superintendent directed preparations to vent the PCV.	—	PCV pressure (DW) > design pressure (5.28 bar)	In the MCR, operators assembled piping and instrumentation drawings, accident management procedures, valve drawings, and a white board. The operators began to develop a procedure for venting, including how to manually operate the valves, and the associated sequence. Operators collected the equipment needed to perform the evolution, including fire-fighting turnout gear, SCBAs, dosimeters, survey meters, and flashlights.	08 h 29 min
2011-03-12 00:30	09 h 44 min	Evacuation of the 3 km zone completed.	—	—	Government confirmed the completion of evacuation. Evacuation for residents within a 3 km radius of Futaba and Okuma Towns was confirmed as being completed, reconfirmed at 01:45. Completion of evacuation to start the venting was agreed with the Fukushima Prefecture authorities.	08 h 53 min
2011-03-12 00:49	10 h 03 min	An emergency based on Article 15 declared following abnormal rise of PCV pressure.	—	PCV pressure >5.28 bar	Since the PCV pressure exceeded the maximum operating pressure, the Site Superintendent decided that the condition fell under an event corresponding to Article 15 of the Nuclear Disaster Act (abnormal rise in PCV pressure).	09 h 12 min
2011-03-12 00:55	10 h 09 min	Appropriate government agencies notified on Article 15 emergency.	—	Abnormal rise of PCV pressure	—	09 h 18 min
2011-03-12 01:20	10 h 34 min	Power supply vehicle from TEPCO arrived at the site.	—	—	Approximate time.	09 h 43 min
2011-03-12 01:30	10 h 44 min	Prime Minister, Minister of METI, and NISA informed on containment venting plans for permission.	—	—	The Prime Minister, Minister of METI, and NISA concurred on the venting plans. The TEPCO corporate ERC told the NPP that the venting should proceed after 03:00, after the Minister of METI announced the venting.	09 h 53 min
2011-03-12 01:45	10 h 59 min	Government reconfirmed the completion of evacuation of the 3 km zone.	—	3 km radius	—	10 h 08 min
2011-03-12 01:48	11 h 02 min	DDFP not operating.	Local manual	Fail	Team was sent to check the status of the DDFP at 01:25.	10 h 11 min
2011-03-12 01:48	11 h 02 min	DDFP out of service.	—	—	Pump failed to run after start attempt.	10 h 11 min
2011-03-12 02:00	11 h 14 min	Start of power restoration work.	—	—	Approximate time.	10 h 19 min
2011-03-12 02:03	11 h 17 min	ERS notified on DDFP loss as water injection source to the reactor.	—	DDFP unavailable	Approximate time. The DDFP that was on standby malfunctioned. The pump would not restart.	10 h 26 min
2011-03-12 02:03	11 h 17 min	Plan for using fire trucks to inject water into the reactor initiated.	—	—	—	10 h 26 min
2011-03-12 02:10	11 h 24 min	Efforts for TB seaside access started.	—	—	To access the building and find the fire protection system intake.	10 h 33 min
2011-03-12 02:10	11 h 24 min	Efforts for refuelling and providing DC power for DDFP started.	—	—	As troubleshooting of the DDFP continued, four operators collected a few dozen containers (of approximately 0.5 L capacity) for carrying fuel by carts and by hand through the truck bay to the DDFP room located in the TB basement. Operators also requested the restoration team to replace the DDFP startup batteries.	10 h 33 min
2011-03-12 02:24	11 h 38 min	Radiation measurements were taken in the torus room.	—	3 mSv/h	In preparation of venting.	10 h 47 min
2011-03-12 02:24	11 h 38 min	Maximum stay time for person working in the torus room during venting preparation was limited.	—	17 min	To maintain the personal dose limit of 100 mSv (based on the estimated dose rate of 300 mSv/h in the area). The personal air tank capacity was 20 min, and iodine tablets were provided.	10 h 47 min

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-12 02:30	11 h 44 min	Reactor water level reading taken.	—	TAF+ Ch. A 1300 mm, Ch. B 530 mm	The reliability of these readings are questionable.	10 h 53 min
2011-03-12 02:30	11 h 44 min	Maximum (recorded) containment (DW) pressure.	—	8.4 bar	Subsequently, the pressure decreased.	10 h 53 min
2011-03-12 02:45	11 h 59 min	DW pressure decreased.	—	8 bar	Pressure stabilized between 7 and 8 bar (700–800 kPa) afterwards.	11 h 08 min
2011-03-12 02:47	12 h 01 min	Notification issued of Government of Japan on increased containment pressure.	—	—	—	11 h 10 min
2011-03-12 02:55	12 h 09 min	Field observation indicated the operation of Unit 2 RCIC.	—	—	Unit 2 field workers returned to the Unit 1/2 control room and reported that the Unit 2 RCIC was observed to be in operation. Based on this report, venting of the Unit 1 containment was given a higher priority.	11 h 18 min
2011-03-12 02:56	12 h 10 min	DDFP refuelled.	Local manual	—	—	11 h 19 min
2011-03-12 02:56	12 h 10 min	DDFP did not start.	—	—	After refuelling, the attempt to restart the DDFP was unsuccessful.	11 h 19 min
2011-03-12 03:06	12 h 20 min	Plans to vent Unit 1 PCV announced to the public.	—	—	A press conference was used to announce the plans. Announcement was made for the Units 1 venting plans and 2 (though it was unclear which unit has the priority)	11 h 29 min
2011-03-12 03:30	12 h 44 min	FP system intake found.	—	—	The field crew had to look for the intake location (time is approximate).	11 h 53 min
2011-03-12 03:30	12 h 44 min	Line-up of FP system connected.	Local manual	—	No fire trucks were available to pump water.	11 h 53 min
2011-03-12 03:45	12 h 59 min	Attempt to enter the reactor building failed.	—	—	Workers attempted to enter the reactor building air lock door to perform surveys. As soon as the door was opened, workers saw steam and closed the door. No radiological surveys were performed.	12 h 08 min
2011-03-12 04:00	13 h 14 min	Water injection into the reactor by one fire engine.	Local manual	1300 m^3	One fire truck’s inventory was pumped through the FP line.	12 h 23 min
2011-03-12 04:00	13 h 14 min	Units 1/2 shift supervisors moves the Unit 1 shift team to the Unit 2 side of the MCR.	—	—	Radiation protection staff noted increasing radiation dose rate in the MCR.	12 h 23 min
2011-03-12 04:00	13 h 14 min	Radiation measurement taken at main gate.	—	0.069 µSv/h	—	12 h 23 min
2011-03-12 04:01	13 h 15 min	The Government was informed of the consequences of, and predictions concerning, containment venting.	—	—	—	12 h 24 min
2011-03-12 04:19	13 h 33 min	PCV pressure dropped and stabilized.	—	7.8 bar	PCV pressure unexpectedly decreased and stabilized without venting.	12 h 42 min
2011-03-12 04:23	13 h 37 min	Main gate radiation measurement showed increase.	—	0.59 µSv/h	Significant increase from the measurements 20 minutes earlier.	12 h 46 min
2011-03-12 04:23	13 h 37 min	Evacuation of field workers ordered.	—	—	On increased radiation levels (time is approximate).	12 h 46 min
2011-03-12 04:23	13 h 37 min	Water injection to reactor work paused.	—	—	The fire brigade evacuated.	12 h 46 min
2011-03-12 04:45	13 h 59 min	MCR staff was provided high range APDs.	—	100 mSv APD	Radiation protection staff collected high range APDs from the solid radwaste building and delivered them to the MCR	13 h 08 min
2011-03-12 04:55	14 h 09 min	The Government notified that radiation levels were increasing at the site.	—	—	—	13 h 18 min

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-12 04:57	14 h 11 min	Orders issued for field workers to wear full-face masks and charcoal respirators.	—	—	ERC issues the recommendation on rising site radiation levels and the workers being found to be contaminated when they came back from the field.	13 h 20 min
2011-03-12 05:04	14 h 18 min	Orders issued use to full-face masks and charcoal respirators in MCR.	—	—	Shift managers issue orders to the operation personnel.	13 h 27 min
2011-03-12 05:14	14 h 28 min	Government agencies notified of external leakage of radioactive material.	—	Increased site radiation readings/decrease in PCV pressure	—	13 h 37 min
2011-03-12 05:44	14 h 58 min	Government orders evacuation of 10 km zone.	—	10 km radius	—	14 h 07 min
2011-03-12 05:46	15 h 00 min	Freshwater injection by the fire engine to the reactor restarted.	—	—	Through the fire engine. The fire engine was kept refilled from the nearest fire protection (FP) tank, and returned to the connection point six times until 09:15. In the meantime, a hose connection between the FP tank, the fire engine and the intake was established, so that a continuous water injection became possible	14 h 09 min
2011-03-12 05:52	15 h 06 min	Water injection into reactor by one fire engine completed.	Local manual	1000 m^3	One fire truck’s inventory of water was pumped through the FP line.	14 h 15 min
2011-03-12 06:00	15 h 14 min	Additional fire engines from Japan Self-Defense Forces started arriving at the site.	—	—	Between 06:00 and 07:00.	14 h 23 min
2011-03-12 06:24	15 h 38 min	Freshwater injection by the fire engine to the reactor restarted.	—	—	Time is approximate	14 h 47 min
2011-03-12 06:30	15 h 44 min	Water injection to reactor by one fire engine completed.	Local manual	1000 m^3	One fire truck’s inventory of water was pumped through the FP line.	14 h 53 min
2011-03-12 06:33	15 h 47 min	Progress of evacuation from Okuma City to Miyakoji confirmed.	—	—	—	14 h 56 min
2011-03-12 06:34	15 h 48 min	2 V DC batteries arrived from Hirono thermal power station.	—	—	Twelve of them were taken to the DDFP pump room to be used as DDFP startup batteries.	14 h 57 min
2011-03-12 06:50	16 h 04 min	METI issued the order for containment venting.	—	—	Venting of both Units 1 and 2 containments was issued in accordance with the Act on Special Measures Concerning Nuclear Emergency Preparedness.	15 h 13 min
2011-03-12 06:50	16 h 04 min	Radiation measurement within the seismic isolated building started.	—	—	Periodic (daily) surveillance of the radiation measurements afterwards (time is approximate).	15 h 09 min
2011-03-12 07:11	16 h 25 min	The Prime Minister arrived at the site.	—	—	—	15 h 34 min
2011-03-12 07:49	17 h 03 min	Freshwater injection by the fire engine to the reactor restarted.	—	—	Time is approximate.	16 h 12 min
2011-03-12 07:55	17 h 09 min	Water injection into the reactor by one fire engine completed.	Local manual	1000 m^3	One fire truck’s inventory of water was pumped through the FP line.	16 h 18 min
2011-03-12 08:03	17 h 17 min	Site Superintendent orders venting to start at 09:00.	—	—	—	16 h 26 min
2011-03-12 08:04	17 h 18 min	The Prime Minister left the site.	—	—	—	16 h 27 min
2011-03-12 08:09	17 h 23 min	Freshwater injection by the fire engine to the reactor restarted.	—	—	Time is approximate.	16 h 32 min
2011-03-12 08:15	17 h 29 min	Water injection into the reactor by one fire engine completed.	Local manual	1000 m^3	One fire truck’s inventory of water was pumped through the FP line.	16 h 38 min

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event | Core Cooling | Power/station auxiliary | Confinement | Reactivity | Emergency Management | Radiation | Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-12 08:27	17 h 41 min	Evacuation of Okuma (south of the unit) reported incomplete.	—	—	A TEPCO employee who had been dispatched to check the status of evacuations reported that the evacuation of Okuma was not yet complete.	16 h 50 min
2011-03-12 08:24	17 h 38 min	Freshwater injection by the fire engine to the reactor restarted.	—	—	Time is approximate.	16 h 47 min
2011-03-12 08:30	17 h 44 min	Water injection into the reactor by one fire engine completed.	Local manual	1000 m^3	One fire truck's inventory of water was pumped through the FP line.	16 h 53 min
2011-03-12 08:37	17 h 51 min	The Fukushima Prefectural government informed that venting would start at approximately 09:00.	—	—	Venting was being coordinated to ensure the evacuation was completed prior to the commencement of venting.	17 h 00 min
2011-03-12 09:02	18 h 16 min	Evacuation of Okuma (south of the unit) reported complete.	—	Complete	Pre-requisite for venting as per agreement with Fukushima Prefecture	17 h 25 min
2011-03-12 09:04	18 h 18 min	Start of venting.	—	—	—	17 h 27 min
2011-03-12 09:04	18 h 18 min	Team 1 (of 3) was dispatched to manually open containment vent valves (motor and air operated).	—	—	The control room operators formed three teams to perform the venting, with two operators on each team (one to perform actions and the other to assist by holding flashlights and monitoring dose rates and for other safety concerns, such as ongoing aftershocks). Because there was no means of communicating with the field teams, the decision was made to dispatch one team at a time, with the next team leaving only after the preceding team returned.	17 h 27 min
2011-03-12 09:05	18 h 19 min	Commencement of venting conveyed to the public through the press.	—	—	—	17 h 28 min
2011-03-12 09:09	18 h 23 min	Freshwater injection by the fire engine to the reactor restarted.	—	—	Time is approximate.	17 h 32 min
2011-03-12 09:15	18 h 29 min	Containment vent valve (MO) partially opened.	Local manual	25%	At approximately 09:15, operators opened the motor operated containment vent valve approximately 25%, as directed by procedure. The two operators involved each received a dose of 25 mSv.	17 h 38 min
2011-03-12 09:15	18 h 29 min	Water injection into reactor by one fire engine completed.	Local manual	1000 m^3	One fire truck's inventory of water was pumped through the FP line.	17 h 38 min
2011-03-12 09:15	18 h 29 min	Direct transportation between the FP tank and FP intake connection via the fire engine established.	Local manual	—	Not confirmed.	17 h 38 min
2011-03-12 09:24	18 h 38 min	Team 2 (of 3) dispatched to manually open the suppression chamber vent valve for containment venting.	—	—	The control room operators formed three teams to perform the venting, with two operators on each team.	17 h 47 min
2011-03-12 09:32	18 h 46 min	Attempt to manually open the air operated suppression chamber vent by-pass valve failed.	Local manual	0%	The second team of operators was unsuccessful in the attempt to manually open the suppression chamber air operated vent valve. The operators entered the torus room but had to turn back because they expected they would exceed the 100 mSv dose limit.	17 h 55 min
2011-03-12 09:32	18 h 46 min	One of the operators who had entered the torus room to attempt to vent the PCV received dose in excess of the personal limit.	—	106 mSv >100 mSv	—	17 h 55 min
2011-03-12 09:30	18 h 44 min	Team 3 (of 3) put on hold to manually open the suppression chamber vent valve for containment venting, and finally not dispatched.	—	—	The MCR decided not to dispatch the third team to the field because of the doses received, and notified the ERC of the inability to open the AOV. The ERC then began working on methods to open the suppression chamber air operated vent valve. This would require DC power and a temporary air source. The ERC also instructed the control room to attempt to operate the small air operated valve remotely, hoping there would be sufficient residual air pressure in the system to operate the valve.	17 h 53 min

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event | Core Cooling | Power/station auxiliary | Confinement | Reactivity | Emergency Management | Radiation | Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-12 09:40	18 h 54 min	Water injection into reactor by fire engine reaches 15 000 $m^{3.}$	Local manual	15 000 m^3	One fire truck's inventory of water was pumped through the FP line.	18 h 03 min
2011-03-12 09:53	19 h 07 min	Government informed on the dose consequence predictions from containment venting on the operators.	—	—	—	18 h 16 min
2011-03-12 10:17	19 h 31 min	The first attempt to remotely open smaller (bypass) air operated suppression chamber vent valve failed.	Remote manual	0%	Operators attempted to open the suppression chamber AOV remotely from the MCR utilizing residual air pressure in the instrumentation air system and temporary DC power supplied by batteries.	18 h 40 min
2011-03-12 10:23	19 h 37 min	The second attempt to remotely open air operated suppression chamber vent bypass valve failed.	Remote manual	0%		18 h 46 min
2011-03-12 10:24	19 h 38 min	The third attempt to remotely open air operated suppression chamber vent bypass valve failed.	Remote manual	0%		18 h 47 min
2011-03-12 10:30	19 h 44 min	One more fire engine from the Kashiwazaki-Kariwa NPP arrived in the site.	—	—	Placed near the Unit 3 backwash valve pit.	18 h 53 min
2011-03-12 10:40	19 h 54 min	Radiation reading at the main gate and MPs shows increase.	—	—	Assumed that is from venting the Unit 1 PCV; shortly after it decreased.	19 h 03 min
2011-03-12 10:52	20 h 06 min	Total number of mobile power supply vehicles at the site, coming from TEPCO and Tohoku Electric reached 19.	—	—	12 high voltage power supply cars and 7 low voltage power supply cars.	19 h 15 min
2011-03-12 11:15	20 h 29 min	Radiation reading at the main gate and MPs started to decrease.	—	—	Which indicated that the venting was not fully effective.	19 h 38 min
2011-03-12 11:15	20 h 29 min	No notable change in PCV pressure.	—	~7.5 bar	—	19 h 38 min
2011-03-12 11:39	20 h 53 min	Government was informed that the dose received by one of the operators entering the torus room exceeded the 100 mSv limit.	—	—	—	20 h 02 min
2011-03-12 12:30	21 h 44 min	A temporary air compressor was brought in to operate the large isolation AOV rather than the small bypass AOV which was tried before.	—	—	The compressor was placed outside the truck bay of the reactor building.	20 h 53 min
2011-03-12 12:53	22 h 07 min	Work on DDFP completed.	—	—	Out of service since 01:48.	21 h 16 min
2011-03-12 12:59	22 h 13 min	DDFP failed to start.	Local manual	Ground fault	—	
2011-03-12 13:21	22 h 35 min	Repair crew reported to ERC that DDFP was unavailable.	—	—	Pump cannot be restarted.	21 h 44 min
2011-03-12 14:00	23 h 14 min	A temporary air compressor was connected and started to open air operated suppression chamber vent valve.	—	—	The ERC team was informed that a small air compressor was in a subcontractor's office. Workers retrieved drawings and took pictures of the connection point and planned how to install the compressor to enable remote operation of the AOV in the vent system from the control room. The air compressor was located and transferred to the equipment bay, and the needed fittings were located earlier.	22 h 23 min
2011-03-12 14:30	23 h 44 min	The large (isolation) suppression chamber venting valve (AO) was opened.	Manual remote	—	Inferred from the following PCV pressure drop (sometime between 14:00 and 14:30).	22 h 53 min
2011-03-12 14:30	23 h 44 min	Venting commenced.	—	—	The venting and release of radioactive material were confirmed through an indicated decrease in containment pressure.	22 h 53 min
2011-03-12 14:50	01 d 00 h 04 m	Containment pressure decreased.	—	5.80 bar	Due to successful venting.	23 h 13 min

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-12 14:53	01 d 00 h 07 m	Water injection to the reactor by fire engine reaches 80 000 m^3	Local manual	80 000 m^3	It was suspected that not all the injected water went into the RPV because the water injection by fire engines was through the FP, MUWC and CS lines and there were several branches in the MUWC line to provide water for pump and valve seals, gland steam evaporators, etc.	23 h 16 min
2011-03-12 14:53	01 d 00 h 07 m	FP tank inventory depletes.	—	80 000 m^3	—	23 h 16 min
2011-03-12 14:54	01 d 00 h 08 m	Instruction to inject sea water into the reactor.	—	—	The Site Superintendent ordered the injection of sea water into the reactor.	23 h 17 min
2011-03-12 15:18	01 d 00 h 32 m	Government was informed of the successful venting.	—	—	—	23 h 41 min
2011-03-12 15:18	01 d 00 h 32 m	Work on seawater injection line-up started.	—	—	To use sea water accumulated in the Unit 3 condenser backwash valve pit for reactor water injection.	23 h 41 min
2011-03-12 15:18	01 d 00 h 32 m	Work on restoration of standby liquid control system (SLCS) restoration.	—	—	To use the SLC pump for reactor water injection.	23 h 41 min
2011-03-12 15:29	01 d 00 h 43 m	Site radiation readings (corrected from 15:50).	—	1015 µSv/h	Discovered at 16:53 that radiation levels were 1015 µSv/h at 15:29.	23 h 52 min
2011-03-12 15:30	01 d 00 h 44 m	480 V low voltage grid reenergized.	—	—	By connecting mobile high voltage power cars (6.9 kV) via the undamaged power panel of Unit 2, using it as a transformer, to the 480 V low voltage grid of Unit 1 in support of restarting the SLC system in order to inject feedwater into the RPV. (time is approximate).	23 h 53 min
2011-03-12 15:30	01 d 00 h 44 m	Seawater injection lineup completed.	—	—	From the Unit 3 backwash valve pit. (time is approximate)	23 h 53 min
2011-03-12 15:36	01 d 00 h 50 m	Explosion in Unit 1.	—	—	The explosion damaged seawater injection and 480 V grid setup.	23 h 59 min
2011-03-12 15:36	01 d 00 h 50 m	480 V low voltage grid connection damaged from explosion.	—	—	—	23 h 59 min
2011-03-12 15:36	01 d 00 h 50 m	Seawater injection lineup damaged from explosion.	—	—	—	23 h 59 min
2011-03-12 15:36	01 d 00 h 50 m	MCR lighting lost.	—	—	The small mobile generator powering MCR lighting is damaged.	23 h 59 min
2011-03-12 15:36	01 d 00 h 50 m	PCV pressure measurement lost	—	—	—	23 h 59 min
2011-03-12 15:49	01 d 01 h 03 m	Worker injury reported to the site ERC.	—	—	Five people (three TEPCO employees and two contractors) had been injured by the Unit 1 explosion while performing injection via fire engine).	01 d 00 h 12 m
2011-03-12 15:54	01 d 01 h 08 m	Evacuation of field workers ordered.	—	—	—	01 d 00 h 17 m
2011-03-12 15:54	01 d 01 h 08 m	Site ERC ordered the evacuation of the staff from two MCRs (Unit 1 and 2 and Unit 3 and 4), except for the three most senior staff.	—	—	The Shift Supervisor, Deputy Shift Supervisor, and the Senior Operator stayed in the MCR to collect data and continue field response under guidance from the ERC (time is approximate).	01 d 00 h 17 m
2011-03-12 16:17	01 d 01 h 31 m	Site radiation readings.	—	569 µSv/h	It was confirmed at 16:17 that radiation levels measured near MP 4 were 569 µSv/h as of 15:31. This situation was deemed to fall under Article 15 of the Nuclear Emergency Act and government agencies were notified (notification was corrected when it was discovered that at 16:53 the radiation levels were 1015 µSv/h at 15:29). The radiation protection staff, escorting the evacuees from the field and MCR, reported as high as 10 mSv/h readings on the way to the ERC when they arrived to the seismically isolated building.	01 d 00 h 40 m

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event | Core Cooling | Power/station auxiliary | Confinement | Reactivity | Emergency Management | Radiation | Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-12 16:27	01 d 01 h 41 m	Incident according to Nuclear Emergency Act Article 15, ‘abnormal site boundary radiation level increase’ issued.	—	> 500 µSv/h	Abnormal site boundary radiation level increase.	01 d 00 h 50 m
2011-03-12 17:20	01 d 02 h 34 m	Dispatch of damage survey teams.	—	—	It was decided at 17:20 on 12 March that SFP status would be confirmed the next day from a helicopter in the daylight (time is approximate).	01 d 01 h 43 m
2011-03-12 18:25	01 d 03 h 39 m	General population Evacuation Zone is extended by Government.	—	20 km	—	01 d 02 h 48 m
2011-03-12 19:04	01 d 04 h 18 m	Damaged hoses for water injection repaired.	—	—	For seawater injection.	01 d 03 h 27 m
2011-03-12 19:04	01 d 04 h 18 m	Seawater injection into reactor started upon start of the fire engine.	Manual	~1000 m^3/min	—	01 d 03 h 27 m
2011-03-12 20:45	01 d 05 h 59 m	Boric acid added to the seawater injection.	—	—	Recriticality concerns.	01 d 05 h 08 m
13 March 2011						
2011-03-13 08:56	01 d 18 h 10 m	Site radiation readings.	—	882 µSv/h	MP-4.	01 d 17 h 19 m
2011-03-12 16:27	01 d 01 h 41 m	Incident according to Nuclear Emergency Act Article 15, ‘abnormal site boundary radiation level increase’ issued.	—	> 500 µSv/h	Abnormal site boundary radiation level increase.	01 d 00 h 50 m
2011-03-13 13:37	01 d 22 h 51 m	PCV pressure measurement re-established.	—	—	—	01 d 22 h 00 m
2011-03-13 13:37	01 d 22 h 51 m	SC pressure reading.	—	0.590 MPa	—	01 d 22 h 00 m
2011-03-13 13:37	01 d 22 h 51 m	DW pressure reading.	—	0.595 MPa	—	01 d 22 h 00 m
2011-03-13 14:15	01 d 23 h 29 m	Site radiation readings.	—	905 µSv/h	MP-4.	01 d 22 h 38 m
2011-03-13 14:15	01 d 23 h 29 m	Incident according to Nuclear Emergency Act Article 15, ‘abnormal site boundary radiation level increase’ declared.	—	> 500 µSv/h	Abnormal site boundary radiation level increase.	01 d 22 h 38 m
2011-03-13 14:31	01 d 23 h 45 m	Unit 3 reactor building north side radiation reading.	—	300 mSv/h	—	01 d 22 h 50 m
		Unit 3 reactor building south side radiation reading.	—	100 mSv/h		
2011-03-13 14:45	01 d 23 h 59 m	Temporary evacuation of the Unit 3 MCR and workers in the field around Unit 3, including backwash valve pit area that is used to supply Unit 1 seawater injection.	—	—	ERC expected a hydrogen explosion similar to Unit 1. Halting activities around backwash valve pit for seawater injection.	01 d 23 h 08 m
2011-03-13 17:00	02 d 02 h 14 m	Workers returned to Unit 3 area to resume activities.	—	—	Including activities on the seawater injection line.	02 d 01 h 23 m
2011-03-13 18:00	02 d 03 h 14 m	SC pressure decreasing.	—	—	Based on a series of measurements between 14:00 and 18:00.	02 d 02 h 23 m
14 March 2011						
2011-03-14 01:10	02 d 10 h 24 m	Water injection to the reactor halted.	—	Low level at backwash valve pit	—	02 d 09 h 33 m
2011-03-14 01:52	02 d 11 h 06 m	Temporary compressors from Fukushima Daini NPP arrived.	—	—	—	02 d 10 h 11 m

[1] Time may be approximate, especially during the first two minutes of the main event, due to data recording frequency, chart recorder scale or delays in the operator reports and logs.

UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event | Core Cooling | Power/station auxiliary | Confinement | Reactivity | Emergency Management | Radiation | Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-14 02:20	02 d 11 h 34 m	Site radiation readings.	—	751 µSv/h	Near main gate.	02 d 10 h 43 m
2011-03-14 02:20	02 d 11 h 34 m	Incident according to Nuclear Emergency Act Article 15, ‘abnormal site boundary radiation level increase’ declared.	—	> 500 µSv/h	Abnormal site boundary radiation level increase.	02 d 10 h 43 m
2011-03-14 02:40	02 d 11 h 54 m	Site radiation readings.	—	650 µSv/h	MP-2.	02 d 11 h 03 m
2011-03-14 02:40	02 d 11 h 54 m	Incident according to Nuclear Emergency Act Article 15, ‘abnormal site boundary radiation level increase’ declared.	—	> 500 µSv/h	Abnormal site boundary radiation level increase.	02 d 11 h 03 m
2011-03-14 03:20	02 d 12 h 34 m	Water injection to Unit 3 started, Unit 1 injection postponed to ration the inventory to Unit 3.	—	—	After lowering the hose intakes further into the pit. Unit 1 injection was postponed until the pit was refilled given the priority of Unit 3.	02 d 11 h 43 m
2011-03-14 04:00	02 d 13 h 14 m	Site radiation readings.	—	820 µSv/h	MP-2.	02 d 12 h 23 m
2011-03-14 04:00	02 d 13 h 14 m	Incident according to Nuclear Emergency Act Article 15, ‘abnormal site boundary radiation level increase’ declared.	—	> 500 µSv/h	Abnormal site boundary radiation level increase.	02 d 12 h 23 m
2011-03-14 06:30	02 d 15 h 44 m	Site Superintendent ordered temporary evacuation of the workers in the field upon potential uncovering of the Unit 3 core and hydrogen explosion.	—	—	Halting activities around Unit 3 backwash valve pit.	02 d 14 h 53 m
2011-03-14 07:30	02 d 16 h 44 m	Temporary evacuation order lifted.	—	—	Activities focusing on restoration of seawater injection resumed.	02 d 15 h 53 m
2011-03-14 09:05	02 d 18 h 19 m	Filling Unit 3 main condenser backwash valve pit commenced.	—	—	Two fire engines were used to pump the water from the ocean to the valve pit. A water tank truck which came from a TEPCO Chiba branch office fed 1.9 t of water to the backwash valve pit.	02 d 17 h 28 m
2011-03-14 10:00	02 d 19 h 14 m	Seven 5-ton Japan Self-Defense Force water supply vehicles arrived to help refill.	—	—	Two of them were sent to the Unit 3 backwash valve pit.	02 d 18 h 23 m
2011-03-14 11:01	02 d 20 h 15 m	Unit 3 backwash valve pit inventory replenished to allow Unit 1 injection to start.	—	—	Injection did not start because of the Unit 3 explosion.	02 d 19 h 24 m
2011-03-14 11:01	02 d 20 h 15 m	Unit 3 explosion.	—	—	Explosion damaged seawater injection setup.	02 d 19 h 24 m
2011-03-14 11:01	02 d 20 h 15 m	Unit 3 explosion damaged seawater injection setup.	—	—	Due to scattered debris and high local radiation zones on-site, the Unit 3 backwash valve pit was no longer usable as water source.	02 d 19 h 24 m
2011-03-14 14:04	02 d 23 h 18 m	ERC is informed by TEPCO Headquarters that NISA approved increasing the dose limit for emergency workers.	—	250 mSv	—	02 d 22 h 27 m
2011-03-14 20:00	03 d 05 h 14 m	Seawater injection through core spray line started.	—	—	Directly from the ocean via two new fire trucks.	03 d 04 h 23 m
15 March 2011						
2011-03-15 06:14	03 d 15 h 28 m	Sound of an explosion heard at site and tremors felt in the MCR.	—	—	Unit 2 SC pressure dropped.	03 d 14 h 37 m
2011-03-15 06:14	03 d 15 h 28 m	Explosion in Unit 4.	—	—	—	03 d 14 h 37 m
2011-03-15 06:30	03 d 15 h 44 m	Unit 2 SC pressure went off-scale, and atmospheric pressure is read.	—	—	Possibility of Unit 2 PCV damage was concluded.	03 d 14 h 53 m

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-15 06:30	03 d 15 h 44 m	All plant personnel in units ordered to temporarily evacuate to the seismically isolated building.	—	—	Upon the atmospheric Unit 2 SC pressure reading at 06:30, due to the possibility of SC (PCV) damage and failure (time is approximate).	03 d 14 h 53 m
2011-03-15 07:00	03 d 16 h 14 m	Site evacuation of non-essential personnel including temporary evacuation of some ERC personnel ordered.	—	—	Site Superintendent ordered the evacuation. Female employees (including A, B) were evacuated (thereafter, female employee B worked in the Fukushima Daiichi back office located at Fukushima Daini. Approximately 650 people evacuated to Fukushima Daini NPP and 50–70 people, including the Site Superintendent, remained at Fukushima Daiichi ERC.	03 d 15 h 23 m
2011-03-15 07:20	03 d 16 h 34 m	Steam or white smoke released from Unit 2 reactor building 5th floor.	—	—	—	03 d 15 h 43 m
2011-03-15 09:00	03 d 18 h 14 m	Main Gate radiation reading.	—	11 930 µSv/h	The highest reading after the earthquake.	03 d 17 h 23 m
2011-03-15 11:00	03 d 20 h 14 m	Government issued order for residents to take shelter indoors of the residents.	—	20–30 km	—	03 d 19 h 23 m
2011-03-15	03 d	TEPCO nuclear line circuit breaker energized.	—	—	Power via Tohoku Electric Power Company. Integrity check of TEPCO nuclear line between power receiving circuit breaker and M/C was performed on March 15 and 16.	03 d
16 March 2011						
17 March 2011						
2011-03-17	05 d	Laying of the temporary connecting cables between Units 1 and 2 M/C and Unit 2 P/C 2C started.	—	—	—	05 d
2011-03-17	05 d	Unit 1 and 2 temporary M/C installed.	—	—	—	05 d
18 March 2011						
2011-03-18	—	Laying the temporary connecting cables between Units 1 and 2 M/C and Unit 2 P/C 2C completed.	—	—	—	—
19 March 2011						
2011-03-19	—	A temporary cable between the substation M/C and Units 1 and 2 temporary M/C being connected.	—	—	—	—
20 March 2011						
2011-03-20 15:46	09 d 01 h 00 m	480 V emergency low voltage switchboard (power centre 2C) energized.	—	—	Units 1 and 2 P/C 2C was energized. Power supplied by a temporary line from the Tohoku Electric Power Company TEPCO nuclear line.	09 d 00 h 09 m
2011-03-20 15:46	09 d 01 h 00 m	Temporary Unit 1 off-site power restored.	—	—	Establishment of support to fundamental safety functions.	09 d 00 h 09 m
21 March 2011						
22 March 2011						
23 March 2011						
2011-03-23 02:30	11 d 11 h 44 m	An additional mobile pump (fire engine) for seawater injection into the RPV via the feedwater system.	—	—	—	11 d 10 h 53 m
2011-03-23 02:30	11 d 11 h 44 m	Reactor injection changed to the feedwater system.	—	—	Because of indications that the core spray injection nozzles were clogging from salt accumulation.	11 d 10 h 53 m
24 March 2011						

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UNIT 1 SEQUENCE OF EVENTS

Colour indication:

Main event	Core Cooling	Power/station auxiliary	Confinement	Reactivity	Emergency Management	Radiation	Other Unit Event

Date and time[1]	Time elapsed after initiating event	Event/action	Auto/manual; local/remote	Set point; criterion/value	Remarks	Time Elapsed after SBO
2011-03-24 11:30	12 d 20 h 44 m	Unit 1 and 2 CR lighting restored.	—	—	—	12 d 19 h 53 m
25 March 2011						
2011-03-25 15:37	14 d 00 h 51 m	Reactor injection changed from sea water to fresh water.	—	—	—	14 d 00 h 00 m

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