UNIT 2 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)	Earthquake occurred.	—	—	Initiating external event.	–55:00 (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 regard to the TEPCO nuclear line (66 kV) from Tohoku Electric Power, the cables were damaged, though it was not possible to determine the cause. In 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. At Units 5 and 6, one transmission line tower (No. 27 tower) connecting to the switchyards of Units 5 and 6, collapsed.	–55:00 (min)
2011-03-11 14:47	01:00 (min)	Reactor trip on seismic trip set point.	Auto	100 Gal V 135 Gal H	Sensors B and C (two out of four).	–54:00 (min)
2011-03-11 14:47	01:00 (min)	Reactor water level dropped initially because of the collapsing steam voids.	—	TAF + 4320	Reactor water level within the normal band; the operators did not need to initiate HPCI (HPCI set point is L2, which is <148 cm from the bottom of the separator).	–54:00 (min)
2011-03-11 14:47	01:00 (min)	Reactor pressure dropped initially after trip.	—	~6.3 MPa	—	–54:00 (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 included initiation of in accordance with event based AOP, Natural Disaster Accident, Section IV, Natural Disasters, Chapter 22.	–-54:00 (min)
		AOP Natural Disaster Accident, Section IV, Natural Event entered.	—	> 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	—	–54:00 (min)
2011-03-11 14:47	01:00 (min)	PCIS generated.	Auto	Low Rx level L3 (18 cm from bottom of separator)	Or the reactor protection system power loss. It is unknown which logic initiated the isolation.	–54:00 (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.	- 54:00 min
2011-03-11 14:47	01:00 (min)	Normal HVAC stopped.	Auto	LOOP	PCV cooling is stopped.	–54:00 (min)
2011-03-11 14:47	01:00 (min)	Turbine trip.	Auto	—	Cause (i.e. signal) unknown.	–54:00 (min)
2011-03-11 14:47	01:00 (min)	6.9 kV power loss.	—	—	—	–54:00 (min)
2011-03-11 14:47	01:00 (min)	EDG start and load.	Auto	LOOP	—	–54:00 (min)
2011-03-11 14:47	01:00 (min)	Restoration of AC by on-site power source.	Auto	EDG	—	–54:00 (min)
2011-03-11 14:47	01:00 (min)	AOP Natural Disaster Accident, Section II, Turbine and Electrical entered.	—	LOOP	Chapters 12, 13 and 14 of the Accident Operating Manual with the external system fault, Section II, Turbine and Electrical.	–54:00 (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 appeared before and after the main steam isolation valve was closed. The NRA later estimated that these alarm signals were issued due to the LOOP caused by the earthquake.	–50:00 (min)

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UNIT 2 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 14:48	02:00 (min)	MSIVs closed.	Auto	LOOP — fail close	Reactor isolation from steam/power conversion system (normal core cooling via condenser ceased) due to power interruption.	–53:00 (min)
2011-03-11 14:50	04:00 (min)	RCIC started.	Manual	—	Operators started the RCIC system to maintain the reactor water level.	–51:00 (min)
2011-03-11 14:51	05:00 (min)	RCIC stopped.	Auto	Water level >L-8 (TAF + 5655)	—	–50:00 (min)
2011-03-11 14:52	06:00 (min)	SRV F opens and cycles.	—	7.54 MPa	SRV opens at 75.4 bar and closes at 72 bar, maintaining the reactor pressure by cycling.	–49:00 (min)
2011-03-11 15:01	15:00 (min)	Reactor confirmed as subcritical.	—	Intermediate range monitor levels decreasing steadily	—	–40:00 (min)
2011-03-11 15:02	16:00 (min)	RCIC started.	Manual	—	Increasing SC temperature as a result of pressure control via the cycling SRV and use of the RCIC.	–39:00 (min)
2011-03-11 15:06	20:00 (min)	Headquarters for Major Disaster Countermeasures established.	—	—	In the TEPCO office in Tokyo to assess damage from the earthquake and recover from the electric outage in TEPCO's service area	–35:00 (min)
2011-03-11 15:07	21:00 (min)	One train containment cooling system (CCS) started.	Manual	—	SC cooling commences. The SC cooling mode of the residual heat removal chain (i.e. RH and RHR systems).	–34:00 (min)
2011-03-11 15:11	25:00 (min)	The second train CCS started.	Manual	—	The SC cooling mode of the residual heat removal chain.	–30:00 (min)
2011-03-11 15:25	39:00 (min)	SC spray cooling with RHR	Manual	—	The SC spray mode of the residual heat removal chain (i.e. RH and RHR systems).	-16:00 (min)
2011-03-11 15:27	41:00 (min)	The first wave of the tsunami arrived at the NPP.	—	—	Consequent external event.	–14:00 (min)
2011-03-11 15:28	42:00 (min)	RCIC system stopped.	Auto	Water level >L-8 (TAF + 5655)	—	–13:00 (min)
2011-03-11 15:29	43:00 (min)	High-high alarm issued at some MPs.	—	> 430 nGy/h	However, low radiation MPs located in the same place took proper measurements with stable readings at about 40nGy/h.	–12:00 (min)
2011-03-11 15:36	50:00 (min)	The second wave of the tsunami arrived at the station.	—	—	Flooded the site and the buildings (time is approximate).	–05:00 (min)
2011-03-11 15:36	50:00 (min)	High-high alarm at some MPs cleared.	—	—	—	–05:00 (min)
2011-03-11 15:37	51:00 (min)	Water cooled EDG tripped.	—	—	—	- 04:00 (min)
2011-03-11 15:37	51:00 (min)	SC cooling stopped.	—	—	—	- 04:00 (min)
2011-03-11 15:39	53:00 (min)	RCIC started.	Manual	—	Operators start RCIC to maintain reactor water level.	–02:00 (min)
2011-03-11 15:41	55:00 (min)	M/C and P/C of the air cooled EDG failed.	—	—	EDG is air-cooled and located away from the ocean on the ground floor of the shared auxiliary facility (common SFP building); it was not flooded. However, the M/C and the power centre (PC) of that EDG were located below ground level in the basement of the shared auxiliary facility, and so were flooded (time is approximate).	00:00 (min)
2011-03-11 15:41	55:00 (min)	SBO	—	Loss of all AC	—	00:00 (min)
2011-03-11 15:41	55:00 (min)	DC power panel flooded and failed.	—	—	—	00:00 (min)
2011-03-11 15:41	55:00 (min)	Loss of DC power.	—	—	—	00:00 (min)
2011-03-11 15:41	55:00 (min)	Loss of DC distribution systems resulted in the loss of control room indications and alarms.	—	—	Tsunami waves struck the NPP, flooding either the diesel generators 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 (times are approximate).	00:00 (min)
		Control room lighting lost, with only emergency lighting remaining.	—	—		
		Control panel indications for HPCI barely visible, but slowly faded away. Operators determined that HPCI was not operable because indicators on the control panel were lost.	—	—		
		RCIC manipulation lost.	—	—		

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UNIT 2 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
		Flooding caused a loss of the instrumentation power system, resulting in a major loss of control room indications, including the reactor water level and SFP indications.	—	—		
2011-03-11 15:42	56:00 (min)	Emergency declared for nuclear disaster 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 the radiation dose is 5 μSv/h or higher (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 at the NPP will coordinate with the nuclear operator and local public organizations to start activities, such as collecting information.	01:00 (min)
2011-03-11 15:42	56:00 (min)	Corporate Nuclear Emergency Response Centre established.	—	SBO	TEPCO Level 1 state of emergency for a nuclear emergency is issued.	01:00 (min)
2011-03-11 15:42	56:00 (min)	Entry into EOP to maintain key safety functions.	—	SBO	Loss of all AC power.	01:00 (min)
2011-03-11 16:00	01 h 14 min	Government officials notified on SBO and declaration of emergency based on Article 10.	—	SBO	—	19:00 (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 damage to the access routes to the site (approximate time).	19:00 (min)
2011-03-11 16:36	01 h 50 min	Emergency for Nuclear Disaster declared based on Article 15 of the Nuclear Disaster Act.	—	Determination of loss of ECCS/reactor water level	Operators could not determine 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 500Sv/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.	55:00 (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 the ERC).	—	Determination of loss of ECCS/reactor water level	TEPCO Level 2 state of emergency. 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.	55:00 (min)
2011-03-11 16:45	01 h 59 min	Appropriate Government officials notified on declaration of the emergency based on Article 15.	—	—	Article 15 Emergency was declared at 16:36. A fax was sent to government officials at 16:45.	01 h 04 min
2011-03-11 16:50	02 h 04 min	Mobile high/low voltage supply vehicles sent to Fukushima Prefecture.	—	—	To the Fukushima Daini and Fukushima Daiichi sites. (time is approximate)	01 h 09 min
2011-03-11 17:12	02 h 26 min	The 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 accident management (AM) procedures, and confirmed the injection path using the installed fire pump into an RPV via the core spray system. Lining up alternate injection via the FP system in Unit 2 was decided after lining up Unit 1 since Unit 2 radiation levels were relatively more favourable.	01 h 31 min
2011-03-11 17:35	02 h 49 min	Those trip channel indicators still working showed the water level.	—	80%	The reason for recovery of the water indicator function is unknown. The Shift Supervisor reported to the ERC that the water level was 80%.	01 h 54 min
2011-03-11 18:00	03 h 14 min	Field operators were dispatched to perform power supply inspection/investigation.	—	—	The shift supervisor decided that the danger of aftershocks had declined sufficiently to dispatch teams. (time is approximate)	02 h 19 min
2011-03-11 18:12	03 h 26 min	MCR reactor water level measurement lost.	—	—	—	02 h 31 min
2011-03-11 19:00	04 h 14 min	Gate between Units 2 and 3 opened.	—	—	Securing vehicle travel routes to Units 1 to 4. (time is approximate)	03 h 19 min
2011-03-11 19:03	04 h 17 min	Nuclear Emergency declared by the Government of Japan.	—	—	—	03 h 22 min
2011-03-11 19:52	05 h 06 min	Radiation monitor data around plant MPs.	—	~ 60 nGy/h	MP locations 3, 4 and 6 read around 57–61 nGy/h between 17:30 and 18:30.	04 h 11 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 06 min

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UNIT 2 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 20:47	06 h 01 min	Time for uncovering of the core estimated to be 21:40.	—	—	TEPCO informed the government that the estimated time for the Unit 2 reactor water level to lower to TAF was 21:40.	05 h 06 min
2011-03-11 20:50	06 h 04 min	2 km zone evacuation order issued by local government.	—	2 km radius	Facing a still uncontrolled situation at the Fukushima Daiichi NPP, the governor of Fukushima Prefecture instructed the evacuation of residents within 2 km of the power plant.	05 h 09 min
2011-03-11 20:56	06 h 10 min	Survey team reported that all M/Cs were inoperable but some P/Cs were available.	—	—	—	05 h 15 min
2011-03-11 21:00	06 h 14 min	Alignment of alternative water injection valves from the fire protection system via RH started.	Local Manual	—	By manual opening of the motor operated valves in the reactor building.	05 h 19 min
2011-03-11 21:00	06 h 14 min	Diesel driven fire pump (DDFP) functional.	—	Standby	Since the FP pump room was inaccessible due to a flooded T/B basement, where the DDFP was located, confirmation of DDFP operation was obtained by observing smoke discharge from the exhaust of the DDFP.	05 h 19 min
2011-03-11 21:01	06 h 15 min	Radiation monitor data near plant communicated to government officials.	—	—	No anomalies.	05 h 20 min
2011-03-11 21:13	6 h 27 min	TEPCO informed Government on estimated time for uncovering of the core at 21:40.	—	—	Assessment based on the assumption that the RCIC was not operating.	05 h 32 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 following the uncovering of the Unit 2 core.	05 h 42 min
2011-03-11 21:50	07 h 04 min	MCR reactor water level measurement re-established.	—	TAF + 3400 mm	The water level indication corroborated that the RPV was still being fed by a running RCIC system and this was relayed to the relevant government agencies. Regardless of its status, it was not possible to manipulate RCIC due to the loss of DC power.	06 h 09 min
2011-03-11 22:00	07 h 14 min	Power supply vehicles from Tohoku Electric Power Company began arriving at the site.	—	—	Approximate time. Temporary cables from the power supply to the associated distribution panel were laid to allow operation of the SLC system. However, it could not be connected due to the damaged station electrical equipment.	06 h 19 min
2011-03-11 22:00	07 h 14 min	Alignment of alternative water injection valves from the fire protection system via MUWC and RH completed.	Local Manual	—	By manual opening of the motor-operated valves in the reactor building.	06 h 19 min
2011-03-11 22:10	07 h 24 min	Reactor water level above TAF reported to government officials.	—	—	TAF + 3400 mm. Also, the Government was informed that time to core uncovering calculations were being revised.	06 h 29 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 read around 60 nGy/h between 21:30 and 21:50	06 h 29 min
2011-03-11 23:00	08 h 14 min	High dose rate reading in front of the Unit 1 reactor building north door on the 1st floor of the TB.	Manual	1200 μSv/h	—	07 h 19 min
2011-03-11 23:00	08 h 14 min	High dose rate reading in front of the Unit 1 reactor building south door on the 1st floor of the TB.	Manual	500 μSv/h	—	07 h 19 min
2011-03-11 23:05	08 h 19 min	Entry to the Unit 1 reactor building restricted.	—	High radiation levels	Due to the rising radiation levels; ordered by the Site Superintendent.	07 h 24 min
2011-03-11 23:05	08 h 19 min	High dose rate in the MCR.	—	—	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 24 min
2011-03-11 23:25	08 h 39 min	DW pressure reading.	Local	1.41 bar	Indicated no quick need for venting.	07 h 44 min
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2011-03-12 00:06	09 h 20 min	The Site Superintendent directed preparations to vent the PCV.	—	Unit 1 DW >5.28 bar	Together with Unit 1, whose DW pressure reading had already exceeded the maximum containment design pressure.	08 h 25 min
2011-03-12 00:30	09 h 44 min	3 km zone evacuation completed.	—	—	Government confirmed the completion of evacuation. Evacuation for residents within a 3 km radius of Futaba and Okuma Towns was confirmed to have been completed; this was reconfirmed at 01:45. Completion of evacuation to start the venting was agreed with the Fukushima Prefecture authorities.	08 h 49 min
2011-03-12 01:00	10 h 14 min	Operators sent to the RCIC room.	—	—	To investigate the RCIC status	09 h 19 min

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UNIT 2 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 01:10	10 h 24 min	RCIC room ingress attempt unsuccessful due to high water level in the room.	—	—	Time is approximate. Water rushed out when the RCIC room doors were opened, so they were immediately closed.	09 h 29 min
2011-03-12 01:20	10 h 34 min	DDFP not operating.	Local	No exhaust smoke	During the verification walkdown, it was discovered that the DDFP had stopped since there was no exhaust smoke observed (the TB basement floor where the DDFP was located was found to be flooded to a depth of about 60 cm. Hence the FP pump room could not be entered, and operation of the DDFP was verified by an exhaust smoke check from outside.	09 h 39 min
2011-03-12 01:20	10 h 34 min	Power supply vehicle from TEPCO arrived at the site.	—	—	Approximate time.	09 h 39 min
2011-03-12 01:30	10 h 44 min	The Prime Minister, Minister of METI and NISA informed on containment venting plans.	—	—	The Prime Minister, Minister of METI and NISA concurred on the venting plans. The TEPCO corporate ERC informed the NPP that the venting of Unit 1 should proceed after 03:00, when the Minister of METI would announce the venting.	09 h 49 min
2011-03-12 01:45	10 h 59 min	Government reconfirms completion of 3 km-zone evacuation.	—	3 km radius	—	10 h 04 min
2011-03-12 02:00	11 h 14 min	Power restoration work started.	—	—	Parts of the power supply were restored by the use of high and low voltage power supply trucks (approximate time).	10 h 19 min
2011-03-12 02:12	11 h 26 min	Operators sent again to the RCIC room.	—	—	To investigate the RCIC status.	10 h 31 min
2011-03-12 02:20	11 h 34 min	Entry into RCIC room successful.	—	—	The RCIC room was flooded to an even higher level than during an earlier attempt to enter at 01:00 (time is approximate).	10 h 39 min
2011-03-12 02:20	11 h 34 min	Operators gained access to the RCIC instrument panel in the reactor building.	—	—	Time is approximate.	10 h 39 min
2011-03-12 02:20	11 h 34 min	Local reading of RPV pressure.	Local gauge	5.6 MPa	These readings verified that the RCIC was still functioning as the operators reported it to the MCR and the station ERC at 02:55 (time is approximate).	10 h 39 min
2011-03-12 02:20	11 h 34 min	Local reading of RCIC pump discharge pressure.	Local gauge	6.0 MPa		10 h 39 min
2011-03-12 02:55	12 h 09 min	RCIC declared operating.	—	—	Unit 2 field workers returned to the Units 1 and 2 control room and reported that the Unit 2 RCIC was observed to be in operation and provided pressure data collected in the field. Based on this report, venting of the Unit 1 containment was given a higher priority.	11 h 14 min
2011-03-12 02:56	12 h 10 min	CST water level low.	—	4.277 m	As the amount of water used had already significantly exceeded the normal filling level of the SC, and thus challenged its pressure suppression capabilities, it was decided to switch the RCIC pump suction leg from the CST to the SC.	11 h 15 min
2011-03-12 03:06	12 h 20 min	Plans to vent Unit 1 and 2 PCV announced to the public.	—	—	The plans were announced at a press conference. The announcement was made for Units 1 and 2 (it was unclear which unit has the priority) venting plans.	11 h 25 min
2011-03-12 03:33	12 h 47 min	The Government was informed of consequences of containment venting.	—	—	Radiological consequence predictions were provided	11 h 52 min
2011-03-12 04:00	13 h 14 min	Main gate radiation measurement.	—	0.069 µSv/h	—	12 h 19 min
2011-03-12 04:01	13 h 15 min	Government informed on the release and dose consequence predictions from Unit 1 containment venting.	—	—	—	12 h 20 min
2011-03-12 04:20	13 h 34 min	A team was dispatched to the RCIC room to manually open 3 MOVs to switch the RCIC source to SC from CST.	—	—	Time is approximate	12 h 39 min
2011-03-12 04:23	13 h 37 min	Increased main gate radiation measurement.	—	0.59 µSv/h	Significant increase from measurements taken 15 minutes earlier.	12 h 42 min
2011-03-12 04:23	13 h 37 min	Evacuation of field workers ordered.	—	—	On increased radiation levels (time is approximate).	12 h 42 min
2011-03-12 04:45	13 h 59 min	MCR staff provided with high range APDs.	—	100 mSv APD	—	13 h 04 min
2011-03-12 04:55	14 h 09 min	Government notified that radiation levels were increasing at the site.	—	—	—	13 h 14 min
2011-03-12 04:57	14 h 11 min	Order to wear full face masks and charcoal respirators for field workers issued.	—	—	ERC issues recommendation on rising site radiation levels and workers being found to be contaminated when they came back from the field.	13 h 16 min
2011-03-12 05:00	14 h 14 min	RCIC water intake line up to SC complete.	—	—	Valve manipulation was completed at 05:00, and resulted in a faster increase in SC temperature and pressure. This also led to an increase in the PCV pressure.	13 h 19 min
2011-03-12 05:04	14 h 18 min	Requirement to full face mask charcoal respirators in the MCR issued.	—	—	Shift managers issue the order to the operation personnel.	13 h 23 min
2011-03-12 05:44	14 h 58 min	Government orders evacuation of 10 km zone.	—	10 km radius	—	14 h 03 min

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UNIT 2 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 06:00	15 h 14 min	Additional fire engines from the Japan Self-Defense Forces started arriving at the site.	—	—	Between 06:00 and 07:00.	14 h 19 min
2011-03-12 06:33	15 h 47 min	Progress of evacuation from Okuma City to Miyakoji confirmed.	—	—	—	14 h 52 min
2011-03-12 06:34	15 h 48 min	2 V DC batteries arrived from Hirono thermal power station.	—	—	—	14 h 53 min
2011-03-12 06:50	16 h 04 min	METI issued order for containment venting.	—	—	Venting of both Unit 1 and 2 containments was issued in accordance with the Act on Special Measures Concerning Nuclear Emergency Preparedness	15 h 09 min
2011-03-12 06:50	16 h 04 min	Radiation measurement started within the seismically isolated building.	—	—	Periodic (daily) surveillance of the radiation measurements afterwards (time is approximate).	15 h 09 min
2011-03-12 07:11	16 h 25 min	Prime Minister arrived at the site.	—	—	—	15 h 30 min
2011-03-12 07:20	16 h 34 min	Power restoration work restarted.	—	—	After pause due to aftershocks, getting into protective gear and prioritization of work for venting efforts (time is approximate).	15 h 39 min
2011-03-12 08:04	17 h 18 min	Prime Minister left the site.	—	—	—	16 h 23 min
2011-03-12 09:04	18 h 18 min	Unit 1 venting activities started.	—	—	—	17 h 23 min
2011-03-12 09:53	19 h 07 min	Government was informed on the dose consequence predictions from containment venting on the operators.	—	—	—	18 h 12 min
2011-03-12 10:40	19 h 54 min	Increased radiation reading at the main gate and MPs.	—	—	Workers assumed that this was probably from venting the Unit 1 PCV.	18 h 59 min
2011-03-12 10:52	20 h 06 min	Total number of mobile power supply vehicles at the site, from TEPCO and Tohoku Electric: 19.	—	—	12 high voltage power supply cars and 7 low voltage power supply cars.	19 h 11 min
2011-03-12 11:15	20 h 29 min	Radiation reading at the main gate and MPs started to decrease.	—	—	This indicated that the Unit 1 venting was not fully effective.	19 h 34 min
2011-03-12 14:30	23 h 44 min	Unit 1 Venting commenced.	—	—	—	22 h 49 min
2011-03-12 15:29	01 d 00 h 43 min	Site radiation readings (corrected from 15:50 discovery).	—	1015 μSv/h	Discovered at 16:53 that radiation levels were 1015 μSv/h at 15:29.	23 h 48 min
2011-03-12 15:30	01 d 00 h 44 min	480 V low-voltage grid was reenergized.	—	—	By connecting mobile high voltage power cars (6.9 kV) via the undamaged power panel of Unit 2, using it as 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	23 h 49 min
2011-03-12 15:36	01 d 00 h 50 min	Explosion in Unit 1 occurred.	—	—	This explosion not only demolished the service floor of Unit 1, but also damaged the installed high voltage cable. Further, it is suspected, that the blast opened the ‘blow out panel’ in the Unit 2 service floor wall of the reactor building, thus possibly preventing an accumulation of a sufficient amount of flammable gases in the service floor.	23 h 55 min
2011-03-12 15:36	01 d 00 h 50 min	MCR lighting was lost.	—	—	Small mobile generator powering MCR lighting is damaged.	23 h 55 min
2011-03-12 15:49	01 d 01 h 03 min	Worker injury reported to the site ERC.	—	—	Five people (thee TEPCO employees and two contractors) had been injured by the Unit 1 explosion while performing injection via fire engine).	01 d 00 h 08 min
2011-03-12 15:54	01 d 01 h 08 min	Evacuation of field workers ordered	—	—	—	01 d 00 h 13 min
2011-03-12 15:54	01 d 01 h 08 min	Site ERC ordered the evacuation of the staff from two MCRs (Units 1 and 2 and Units 3 and 4), except for the 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 13 min
2011-03-12 16:17	01 d 01 h 31 min	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). 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 at the seismically isolated building.	01 d 00 h 36 min
2011-03-12 16:27	01 d 01 h 41 min	Incident according to Nuclear Emergency Act Article 15, ‘Abnormal site boundary radiation level increase’ notification.	—	>500 μSv/h	Abnormal site boundary radiation level increase.	01 d 00 h 46 min
2011-03-12 17:20	01 d 02 h 34 min	Dispatch of damage survey teams.	—	—	—	01 d 01 h 39 min
2011-03-12 17:30	01 d 02 h 44 min	Site Superintendent ordered preparations for Unit 2 and Unit 3 PCV venting.	—	—	Although the stable pressure of 2 to 3 bar inside the DW deemed venting of Unit 2 not imminent, the Site Superintendent ordered preparations for Unit PCV venting vessel to be started considering relatively less harsh radiological conditions.	01 d 01 h 49 min
2011-03-12 18:25	01 d 03 h 39 min	General population Evacuation Zone is extended by the Government.	—	20 km	—	01 d 02 h 44 min

[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 2 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 18:30	01 d 03 h 44 min	MCR reactor water level measurement reading.	—	TAF + 3650 mm	—	01 d 02 h 49 min
2011-03-12 18:30	01 d 03 h 44 min	DW pressure reading.	—	150 kPa	—	01 d 02 h 49 min
13 March 2011						
2011-03-13 06:00	01 d 15 h 13 min	Fire engines from Units 5 and 6 were placed by Unit 3 backwash valve pit	—	—	The fire engines located at the Unit 5-6 complex and an additional fire engine from the Kashiwazaki-Kariwa NPP (which was on standby at Fukushima Daini NPP) were dispatched at around 05:21	01 d 14 h 19 min
2011-03-13 06:30	01 d 15 h 43 min	Fire engines from Kashiwazaki-Kariwa NPP arrived at site and placed near Unit 3 backwash valve pit	—	—	They left Daini NPP at 05:30 (app. 1 hr drive time)	01 d 14 h 49 min
2011-03-13 08:10	01 d 17 h 24 min	Operators entered reactor building for venting setup.	—	—	—	01 d 16 h 29 min
2011-03-13 08:10	01 d 17 h 24 min	Containment vent valve (MOV) partially opened.	Local Manual	25%	Operators opened the motor operated containment vent valve approximately 25%, as directed by the procedure. They deferred the opening of AOV to the time of venting implementation.	01 d 16 h 29 min
2011-03-13 08:30	01 d 17 h 44 min	Attempt to energize P/C failed.	—	Overcurrent relay trip	Energizing P/C from the high voltage power supply vehicle failed due to overcurrent relay trip.	01 d 16 h 49 min
2011-03-13 08:56	01 d 18 h 10 min	Site radiation readings.	—	882 µSv/h	MP-4.	01 d 17 h 15 min
2011-03-13 09:01	01 d 18 h 15 min	Incident according to Nuclear Emergency Act Article 15 ‘Abnormal site boundary radiation level increase’ notification.	—	>500 µSv/h	Abnormal site boundary radiation level increase.	01 d 17 h 20 min
2011-03-13 10:15	01 d 19 h 29 min	Site Superintendent ordered opening of large SC AOV for venting Unit 2 to complete the line up to the rupture disc.	—	—	AOV opening was to be accomplished using the small generator, utilized to power temporary MCR lighting, to excite the solenoid lining up the vent up to the rupture disc.	01 d 18 h 34 min
2011-03-13 11:00	01 d 20 h 14 min	Large SC AOV is opened for venting.	Local manual	100%	As the pressure inside the SC was 3.7 bar, which is well below the disc rupture pressure of 5.28 bar, the venting was set but did not occur at this point. However, in order to keep the AOV open, a portable compressor was needed, and it was ordered from the Fukushima Daini NPP later that day (at 22:22).	01 d 19 h 19 min
2011-03-13 11:00	01 d 20 h 14 min	SC pressure reading.	—	3.7 bar	Less than rupture disk pressure. No venting.	01 d 19 h 19 min
2011-03-13 12:05	01 d 21 h 19 min	Site Superintendent ordered preparations for seawater injection.	—	—	As a precautionary measure, in case the RCIC failed, the fire engines were to be connected to the FP lines as Unit 3 backwash valve pit being the water source.	01 d 20 h 24 min
2011-03-13 12:20	01 d 21 h 33 min	Fresh water from the FP tanks at Unit 3 and 4 depleted	—	—	—	01 d 20 h 39 min
2011-03-13 13:10	01 d 22 h 24 min	Ten 12V batteries connected to the SRV control panel.	—	—	To perform remote manual RPV depressurization from the MCR batteries were gathered from the vehicles.	01 d 21 h 29 min
2011-03-13 14:15	01 d 23 h 29 min	Site radiation readings.	—	905 µSv/h	—	01 d 22 h 34 min
2011-03-13 14:15	01 d 23 h 29 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 µSv/h	Government is notified at 14:23	01 d 22 h 34 min
2011-03-13 14:31	01 d 23 h 45 min	Unit 3 reactor building north side radiation reading.	—	300 mSv/h	—	01 d 22 h 50 min
		Unit 3 reactor building south side radiation reading.	—	100 mSv/h	—	
2011-03-13 14:45	01 d 23 h 59 min	Temporary evacuation of the Unit 3 MCR and workers in the field around Unit 3.	—	—	The ERC expected a hydrogen explosion similar to that in Unit 1, halting activities around backwash valve pit for seawater injection.	01 d 23 h 04 min
2011-03-13 15:18	02 d 00 h 32 min	The Government was informed of consequences of, and predictions concerning, containment venting.	—	—	—	01 d 23 h 37 min
2011-03-13 17:00	02 d 02 h 14 min	Workers return to Unit 3 area to resume activities.	—	—	Including activities on the seawater injection line.	02 d 01 h 19 min
14 March 2011						
2011-03-14 01:52	02 d 11 h 06 min	Temporary compressors from Fukushima Daini NPP arrived.	—	—	—	02 d 10 h 11 min
2011-03-14 02:20	02 d 11 h 34 min	Site radiation readings.	—	751 µSv/h	Near main gate.	02 d 10 h 39 min
2011-03-14 02:20	02 d 11 h 34 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 µSv/h	Government is notified at 04:24	02 d 10 h 39 min
2011-03-14 02:40	02 d 11 h 54 min	Site radiation readings.	—	650 µSv/h	MP-2.	02 d 10 h 59 min

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UNIT 2 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 02:40	02 d 11 h 54 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 μSv/h	Government is notified at 05:37	02 d 10 h 59 min
2011-03-14 03:00	02 d 12 h 14 min	Temporary compressor connected to instrument air system to keep large SC vent valve open.	Manual	—	—	02 d 11 h 19 min
2011-03-14 03:20	02 d 12 h 34 min	Water injection to Unit 3 resumes after lowering the intake hose to the backwash valve pit.	—	—	—	02 d 11 h 39 min
2011-03-14 04:00	02 d 13 h 14 min	Site radiation readings.	—	820 μSv/h	MP-2.	02 d 12 h 19 min
2011-03-14 04:00	02 d 13 h 14 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 μSv/h	Government is notified at 08:00	02 d 12 h 19 min
2011-03-14 04:30	02 d 13 h 44 min	Alternative indicator for SC instruments restored.	—	—	During the morning, another indicator was restored for monitoring the SC pressure instead of the non-responsive indicator on the AM panel (time is approximate).	02 d 12 h 49 min
2011-03-14 04:30	02 d 13 h 44 min	SC pressure reading.	—	467 kPa	PCV pressure remained below the opening pressure of the rupture disk; the venting still did not start.	02 d 12 h 49 min
2011-03-14 06:30	02 d 15 h 44 min	Site Superintendent ordered temporary evacuation of the workers in the field upon potential Unit 3 core uncovering and hydrogen explosion.	—	—	Activities around the Unit 3 backwash valve pit halted.	02 d 14 h 49 min
2011-03-14 07:00	02 d 16 h 14 min	SC temperature reading.	—	146 °C	—	02 d 15 h 19 min
2011-03-14 07:30	02 d 16 h 44 min	Temporary evacuation order lifted, workers returned to Unit 3 backwash valve pit.	—	—	Activities around for restoration of seawater injection resumes	02 d 15 h 49 min
2011-03-14 09:05	02 d 18 h 19 min	Filling of the Unit 3 main condenser backwash valve pit commenced.	—	—	Two fire engines 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 tons of water to the backwash valve pit.	02 d 17 h 24 min
2011-03-14 09:12	02 d 18 h 26 min	Site radiation readings.	—	518.7 μSv/h	—	02 d 17 h 31 min
2011-03-14 09:12	02 d 18 h 26 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 μSv/h	Government is notified at 09:34	02 d 17 h 31 min
2011-03-14 10:00	02 d 19 h 14 min	Seven 5 t Japan Self-Defense Forces water supply vehicles arrived.	—	—	two of them were sent to the Unit 3 backwash valve pit	02 d 18 h 19 min
2011-03-14 11:00	02 d 20 h 14 min	Alternative seawater injection line assembly completed.	Manual	Standby	not initiated as the RCIC was deemed to be still functional	02 d 19 h 19 min
2011-03-14 11:01	02 d 20 h 15 min	Explosion in Unit 3.	—	—	explosion damaged seawater injection setup	02 d 19 h 20 min
2011-03-14 11:01	02 d 20 h 15 min	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 20 min
2011-03-14 11:01	02 d 20 h 15 min	Large isolation AOV in the SC venting line closed.	—	Fail-closed	Unit 3 explosion damaged the vent line up. The valve could not be reopened (time of failure is unknown)	02 d 19 h 20 min
2011-03-14 12:30	02 d 21 h 44 min	SC pressure reading.	—	486 kPa	Near saturation conditions in SC	02 d 20 h 49 min
		SC temperature reading.	—	149.3 °C		
2011-03-14 12:30	02 d 21 h 44 min	ERC decision to postpone RPV depressurization.	—	—	The ERC, who was concerned about high PCV pressure and saturated conditions in the SC, hesitated to depressurize the RPV as the PCV response to the mass and energy release from the RPV to the PCV. Therefore the depressurization of RPV was postponed until the containment venting line was re-established	02 d 20 h 49 min
2011-03-14 12:50	02 d 22 h 04 min	Vent line large isolation AOV solenoid found detached.	Failed	—	—	02 d 21 h 09 min
2011-03-14 13:00	02 d 22 h 14 min	Reactor pressure reading.	—	75.4 bar	Increased reactor pressure and decreased water level reading was corroborated as the RCIC failure.	02 d 21 h 19 min
		Reactor water level reading.	—	TAF+2400 mm		
2011-03-14 13:00	02 d 22 h 14 min	RCIC declared inoperable.	—	—	Increased reactor pressure and decreased water level reading was corroborated as the RCIC failure	02 d 21 h 19 min

[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 2 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 13:00	02 d 22 h 14 min	Emergency for nuclear disaster declared based on Article 15 of the Nuclear Disaster Act.	—	Loss of ECCS	Operators could not determine 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.	02 d 21 h 19 min
2011-03-14 13:05	02 d 22 h 19 min	Seawater injection line work restarted.	—	—	—	02 d 21 h 24 min
2011-03-14 13:24	02 d 22 h 38 min	DW pressure reading.	—	465 kPa	—	02 d 21 h 43 min
2011-03-14 13:25	02 d 22 h 39 min	Time for core uncovering estimated at 16:30.	—	No RCIC	Based on the consideration that RCIC failed, and the rate of decrease in the reactor water level. Decision to expedite water injection by alternative sources is made (calculation time is approximate).	02 d 21 h 44 min
2011-03-14 14:43	02 d 23 h 57 min	Seawater injection though core spray line re-established.	—	—	Two new fire trucks were utilized. Water injection was not possible as the discharge pressure of the fire engines required the depressurization of the RPV.	02 d 23 h 02 min
2011-03-14 15:15	03 d 00 h 29 min	RPV radiation readings.	CAMS	0.00108 Sv/h (DW) 0.0103 Sv/h (SC)	CAMS readings were lost afterwards.	02 d 23 h 34 min
2011-03-14 15:57	03 d 01 h 11 min	Estimated time for uncovering of the core revised to 17:30.		No RCIC	Based on the consideration that RCIC failed, and the rate of decrease in the reactor water level.	03 d 00 h 16 min
2011-03-14 16:00	03 d 01 h 14 min	Portable generator that powered the temporary MCR lighting and the large SC AOV's solenoid tripped.		Overload	—	03 d 00 h 19 min
2011-03-14 16:21	03 d 01 h 35 min	Portable generator only powering the large SC AOV's solenoid connected.	Manual	—	—	03 d 00 h 40 min
2011-03-14 16:21	03 d 01 h 35 min	Unsuccessful attempt to open large isolation SC vent AOV.	Remote manual	—	Although the solenoid was excited, the valve did not open, and it was thought that was due to low instrument air pressure.	03 d 00 h 40 min
2011-03-14 16:28	03 d 01 h 42 min	Operators decided to depressurize RPV via SRV.	—	—	The measured reactor water level dropped and level at TAF was estimated to be around 17:30 based on the time of presumed loss of RCIC, while the AOV on the venting line was still unopened to ensure SC pressure relief during RPV depressurization via SRV. Upon this information of imminent core uncovering, it was decided to depressurize the RPV by relief though the SRV to the SC, regardless of the concerns for PCV integrity (saturated/solid SC), to enable water injection.	03 d 00 h 47 min
2011-03-14 16:34	03 d 01 h 48 min	Reactor pressure reading.	—	7.098 Mpa(g)	—	03 d 00 h 53 min
2011-03-14 16:34	03 d 01 h 48 min	Attempts to open SRV failed.	Remote manual	—	Several attempts between 16:34 and 18:00 trying different SRVs.	03 d 00 h 53 min
2011-03-14 18:00	03 d 03 h 16 min	First SRV opened.	Remote manual	—	After trying the power setup with the other SRVs with the same result, the batteries connected in series were reconfigured and connected directly to the SRV solenoid valve of the fifth SRV.	03 d 02 h 21 min
		Second and third SRVs opened.	Remote manual	—	Since opening of one SRV did not decrease the RPV pressure sufficiently, two more SRVs were opened. (time is approximate)	
2011-03-14 18:03	03 d 03 h 17 min	Reactor pressure reading.	—	6.075 MPa(g)	—	03 d 02 h 22 min
2011-03-14 18:09	03 d 03 h 23 min	DW pressure reading.	—	395 kPa	—	03 d 02 h 28 min
2011-03-14 19:03	03 d 04 h 17 min	Reactor pressure reading.	—	0.63 MPa(g)	Below fire engine pump discharge pressure. During this pressure relief, the SC pressure did not show an increase in PCV pressure as a consequence of the mass and energy addition.	03 d 03 h 22 min
2011-03-14 19:05	03 d 04 h 19 min	Seawater injection via fire engines commenced.	—	—	Reactor pressure was below fire engine discharge pressure (approximate time).	03 d 03 h 24 min
2011-03-14 19:20	03 d 04 h 34 min	Water injection stops.	—	—	Fire engines ran out of fuel and stopped working (approximate time).	03 d 03 h 39 min
2011-03-14 19:54	03 d 05 h 08 min	Fire engines refuelled.	—	—	—	03 d 04 h 13 min

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UNIT 2 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 19:54	03 d 05 h 08 min	Seawater injection into RPV via FP system began.	—	~1000 m^3/min	It is not clear if all injection reached the core due to backflows in the line up.	03 d 04 h 13 min
2011-03-14 19:55	03 d 05 h 09 min	DW pressure reading.	—	395 kPa	—	03 d 04 h 14 min
2011-03-14 19:57	03 d 05 h 11 min	The second fire engine was added for seawater injection.	—	~1000 m^3/min	—	03 d 04 h 16 min
2011-03-14 20:03	03 d 05 h 17 min	DW pressure reading.	—	455 kPa	—	03 d 04 h 22 min
2011-03-14 20:37	03 d 05 h 51 min	RPV pressure reading indicated an increasing trend.	—	—	Time is approximate.	03 d 04 h 56 min
2011-03-14 20:37	03 d 05 h 51 min	Fourth SRV opened.	Remote manual	—	Time is approximate	03 d 04 h 56 min
2011-03-14 21:00	03 d 06 h 14 min	Attempt to open small (bypass) SC vent AOV.	—	Failed (assumed open)	Solenoid was excited and the valve was deemed opened; however, later at 23:25, it was confirmed that the bypass AOV did not open.	03 d 05 h 19 min
2011-03-14 21:00	03 d 06 h 14 min	DW pressure reading.	—	427 kPa	Lower than rupture disc burst pressure, no venting was expected.	03 d 05 h 19 min
2011-03-14 21:18	03 d 06 h 32 min	Reactor pressure reading.	—	1463 MPa	—	03 d 05 h 37 min
2011-03-14 21:20	03 d 06 h 34 min	Fifth SRV opened.	Remote manual	—	As the pressure did not decrease after the opening the fourth SRV.	03 d 05 h 39 min
2011-03-14 21:20	03 d 06 h 34 min	Reactor pressure reading.	—	7.5 bar	Decreased after the opening of the fifth SRV.	03 d 05 h 39 min
2011-03-14 21:34	03 d 06 h 48 min	Reactor Water level reading.	—	TAF – 3000 mm	—	03 d 05 h 53 min
2011-03-14 21:35	03 d 06 h 49 min	Site radiation readings.	—	760 μSv/h	—	03 d 05 h 54 min
2011-03-14 21:35	03 d 06 h 49 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 μSv/h	Government was notified at 22:35	03 d 05 h 54 min
2011-03-14 21:55	03 d 07 h 09 min	CAMS instrumentation restored.	—	5.36 Sv/h (DW) 0.38 Sv/h (SC)	Showing elevated radiation levels both in DW and SC compared to earlier readings at 15:15.	03 d 06 h 14 min
2011-03-14 22:50	03 d 08 h 04 min	Reactor pressure reading	—	1823 MPa	—	03 d 07 h 09 min
2011-03-14 22:50	03 d 08 h 04 min	RPV (DW) pressure reading	—	540 kPa (5.4 bar) > design pressure	Since this DW pressure exceeded the design pressure, it constituted an incident of “Unusual Rise of Pressure in Containment Vessel” of the Nuclear Emergency Act, Article 15.	03 d 07 h 09 min
2011-03-14 22:50	03 d 08 h 04 min	An incident of “Abnormal Rise of Pressure in Containment Vessel” of the Nuclear Emergency Act Article 15 is declared	—	DW pressure > design pressure	—	03 d 07 h 09 min
2011-03-14 23:00	03 d 08 h 14 min	Reactor pressure reading	—	2.07 MPa	Both reactor and DW pressures showed increasing trend.	03 d 07 h 19 min
		RPV (DW) pressure reading	—	580 kPa		
2011-03-14 23:00	03 d 08 h 14 min	Attempts to open the sixth SRV failed	—	Fail-closed	The batteries had run out and it was believed that the SRV drive air was depleted. While the attempts to open another SRV continued, the reactor pressure decreased; however, the correlation between the decreasing trend in reactor pressure and SRV opening was not certain.	03 d 07 h 19 min
2011-03-14 23:25	03 d 08 h 39 min	Discovery of small (by-pass) SC vent AOV being closed	—	—	It was discovered that the attempt at 21:00 for remote-manual opening of the small DW bypass AOV from the MCR failed.	03 d 07 h 44 min
2011-03-14 23:25	03 d 08 h 39 min	Decision making to vent PCV directly from DW began	—	—	Since the SC pressure remained below the rupture disc pressure, it was decided at **23:35** to vent the PCV directly from the DW by remote-manual opening of the small DW bypass AOV from the MCR.	03 d 07 h 44 min
2011-03-14 23:25	03 d 08 h 39 min	Reactor pressure reading	—	3.15 MPa	As the DW pressure increased, SC pressure remained between 3 and 4 bar (below disk rupture pressure), showing a pressure trend mismatch between the SC and DW, and decoupled pressure readings.	03 d 07 h 44 min
		RPV (DW) pressure reading	—	700 kPa		
2011-03-14 23:30	03 d 08 h 44 min	Reactor pressure reading	—	1.913 MPa		03 d 07 h 49 min

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UNIT 2 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
		RPV (DW) pressure reading	—	700 kPa		
2011-03-14 23:40	03 d 08 h 54 min	Reactor pressure reading	—	1.17 MPa		03 d 07 h 59 min
		RPV (DW) pressure reading	—	740 kPa		
15 March 2011						
2011-03-15 00:01	03 d 09 h 15 min	Commence opening DW vent (bypass) AOV	—	Failed	Excitation of solenoid on the DW vent bypass AOV was performed, but venting did not occur although it is believed that the valve was briefly open for a few minutes.	03 d 08 h 20 min
2011-03-15 00:05	03 d 09 h 19 min	Reactor pressure reading	—	0.653 MPa	As the reactor pressure increased, DW pressure did not decrease and the SC pressure remained nearly constant at 3 bar (below disc rupture pressure).	03 d 08 h 24 min
		RPV (DW) pressure reading	—	740 kPa		
2011-03-15 00:10	03 d 09 h 24 min	Reactor pressure reading	—	0.883 MPa		03 d 08 h 29 min
		RPV (DW) pressure reading	—	740 kPa		
2011-03-15 00:22	03 d 09 h 36 min	Reactor pressure reading	—	1.17 MPa		03 d 08 h 41 min
		RPV (DW) pressure reading	—	735 kPa		
2011-03-15 00:45	03 d 09 h 59 min	Reactor pressure reading	—	1.823 MPa	—	03 d 09 h 04 min
2011-03-15 01:10	03 d 10 h 24 min	Another SRV opened	Remote manual	—	—	03 d 09 h 29 min
2011-03-15 01:10	03 d 10 h 24 min	Reactor pressure reading	—	0.63 MPa	Increasing.	03 d 09 h 29 min
2011-03-15 02:22	03 d 11 h 36 min	Reactor pressure reading	—	0.675 MPa		03 d 10 h 41 min
2011-03-15 02:22	03 d 11 h 36 min	RPV (DW) pressure reading.	—	730 kPa	—	03 d 10 h 41 min
2011-03-15 02:22	03 d 11 h 36 min	Sixth SRV opened.	Remote manual	—	—	03 d 10 h 41 min
2011-03-15 02:22	03 d 11 h 36 min	Reactor pressure reading.	—	0.675 MPa	—	03 d 10 h 41 min
2011-03-15 02:45	03 d 11 h 59 min	RPV (DW) pressure reading.	—	750 kPa	Slightly increasing.	03 d 11 h 04 min
2011-03-15 02:45	03 d 11 h 59 min	RPV venting deemed ineffective.	—	—	DW pressure not decreasing despite direct venting.	03 d 11 h 04 min
2011-03-15 04:17	03 d 13 h 31 min	Government was informed that RPV venting was unsuccessful.	—	—	—	03 d 12 h 36 min
2011-03-15 06:14	03 d 15 h 28 min	Sound of explosions at site and tremors felt in the MCR.	—	—	Time is approximate	03 d 14 h 33 min
2011-03-15 06:14	03 d 15 h 28 min	SC pressure dropped to atmospheric pressure.	—	Off-scale	After re-checking the readings, it was confirmed that the DW pressure was still at 7.3 bar and the SC pressure was off-scale.	03 d 14 h 33 min
2011-03-15 06:14	03 d 15 h 28 min	Explosion reported in Unit 4.	—	—	An explosion in the upper part of the Unit 4 RB was observed by the evacuating personnel.	03 d 14 h 33 min
2011-03-15 06:30	03 d 15 h 44 min	SC pressure reading.	—	0.0 bar	Possibility of PCV damage concluded.	03 d 14 h 49 min
2011-03-15 06:30	03 d 15 h 44 min	All plant personnel in units ordered to temporarily evacuate to the Seismically Isolated Building.	—	—	Upon the atmospheric (0 bar) SC pressure reading at 06:30, due to the possibility of SC (PCV) damage and failure, all plant personnel in units was ordered to temporarily evacuate to the seismically isolated building where the ERC is located.	03 d 14 h 49 min
2011-03-15 06:50	03 d 16 h 04 min	Site radiation readings.	—	583.7 µSv/h	—	03 d 15 h 09 min
2011-03-15 06:50	03 d 16 h 04 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 µSv/h	Government was notified at 07:00.	03 d 15 h 09 min
2011-03-15 07:00	03 d 16 h 14 min	Site evacuation of non-essential personnel including temporary evacuation of some ERC personnel ordered.	—	—	Site Superintendent ordered evacuation. Female employees (including A, B) evacuate (thereafter, female employee B works 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 19 min
2011-03-15 07:20	03 d 16 h 34 min	RPV (DW) pressure reading.	—	7.3 bar	—	03 d 15 h 39 min
2011-03-15 08:11	03 d 17 h 25 min	Site radiation readings.	—	807 µSv/h	—	03 d 16 h 30 min
2011-03-15 08:11	03 d 17 h 25 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 µSv/h	Government was notified at 08:36.	03 d 16 h 30 min
2011-03-15 08:25	03 d 17 h 39 min	Steam or white smoke release from 5th floor of reactor building.	—	—	—	03 d 16 h 44 min

[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 2 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 09:00	03 d 18 h 14 min	Main gate radiation reading.	—	11 930 µSv/h	Highest reading after earthquake.	03 d 17 h 19 min
2011-03-15 11:00	03 d 20 h 14 min	Prime Minister issued an order for residents to take shelter indoors.	—	20–30 km	—	03 d 19 h 19 min
2011-03-15 11:25	03 d 20 h 39 min	RPV (DW) pressure reading.	—	155 kPa	—	03 d 19 h 44 min
2011-03-15 16:00	04 d 01 h 14 min	Site radiation readings.	—	531.6 µSv/h	—	04 d 00 h 19 min
2011-03-15 16:00	04 d 01 h 14 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 µSv/h	Government was notified at 16:22.	04 d 00 h 19 min
2011-03-15 23:05	04 d 08 h 19 min	Site radiation readings.	—	4 548 µSv/h	—	04 d 07 h 24 min
2011-03-15 23:05	04 d 08 h 19 min	Incident declared according to Nuclear Emergency Act, Article 15 ‘Abnormal site boundary radiation level increase’.	—	>500 µSv/h	Government was notified at 23:20.	04 d 07 h 24 min
2011-03-15		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 15 and 16 March.	—
16 March 2011						
17 March 2011						
2011-03-17		Laying of temporary cables between the Units 1 and 2 M/C and Unit 2 P/C 2C.	—	—	—	—
2011-03-17		Units 1 and 2 temporary M/C installed.	—	—	—	—
18 March 2011						
2011-03-18 09:24	06 d 18 h 38 min	Four workers entered the ground floor for damage assessment face high radiation levels.	—	3 mSv in 14 m	Observed high temperature, high humidity and received a dose of about 3 mSv in 14 minutes (~12 mSv/h dose rate).	06 d 17 h 43 min
2011-03-18 09:38	06 d 18 h 52 min	Reactor building ground floor radiation calculation.	Manual local	12 mSv/h	—	06 d 17 h 57 min
2011-03-18		Laying of temporary cables between M/C and Unit 2 P/C 2C completed.	—	—	—	—
19 March 2011						
2011-03-19		Temporary cable between the substation M/C and Units 1 and 2 temporary M/C connected.	—	—	—	—
20 March 2011						
2011-03-20 15:46	09 d 01 h 00 min	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 05 min
2011-03-20 15:46	09 d 01 h 00 min	Temporary Unit 2 off-site power restored.	—	—	Establishment of support to fundamental safety functions.	09 d 00 h 05 min
21 March 2011						
22 March 2011						
23 March 2011						
2011-03-23 02:30	11 d 11 h 44 min	Additional mobile pump (fire engine) for seawater injection into the reactor pressure vessel via the feed water system.	—	—	—	—
2011-03-23 02:30	11 d 11 h 44 min	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 49 min
24 March 2011						
2011-03-24 11:30	12 d 20 h 44 min	Units 1 and 2 CR lighting restored.	—	—	—	12 d 19 h 49 min
25 March 2011						
26 March 2011						
2011-03-26 15:37	15 d 00 h 51 min	Reactor injection changed from sea water to fresh water.	—	—	—	14 d 23 h 56 min

[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.