Bozin, Sunny

From: Franovich, Mike
Sent: Saturday, April 02, 2011 12:28 PM
To: Ostendorff, William
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Subject: UPDATE from 08:30 Telecon on Fukushima Daiichi Events
Attachments: image001.jpg; Major dose assessment matrix_03312011.xlsx

Leeds led the call

- No change in status of Unit 1, 2, or 3 or the SFPs except one item regarding Unit 1 containment pressure drop. The Unit 1 primary containment pressure has decreased from approx. 25 psig to 9 psig. It appears to be an uncontrolled depressurization/leak. Through Q&A, PMT informed the CAs that drywell is leaking at 10 to 30 volume percent per day.

- Nitrogen inerting/purging of Unit1 containment drywell delayed till no earlier than **April 9**, if then. Plant high rad/access is problematic to establish inerting capability. From Q&A, RST director noted one key reactor building area has dose rate of 27 R/hr. Tepco may purge without inerting but the urgency to reduce containment pressure may have been negated at this time given the leakage/lowering containment pressure.

- Tepco is not looking to flood any of the Unit 1, 2, or 3 primary containments. Tepco will continue to us bleed makeup and steam venting in a controlled manner. Tepco feels more comfortable with this approach given plant conditions. (I suspect they have a long-term view incorporating environmental cleanup and securing the plant for commissioning).

- Second fresh water barge being retrofitted with higher capacity pump

- Bechtel single train is available. Second train not needed so no shipment from Australia at this time.

RST Priorities:

1. The NRC/RST updated the SAMG document and was issued as Revision 1. NRC/RST with GEH/INPO/others writing a supplemental paper to the SAMGs to discuss venting operations (for unit 1).
2. Revision 2 of SAMGs being prepared to include SFP guidance.
3. Answer new question on implications of sustained long-term feed and bled rather than containment flood up.

PMT Priorities:

Y/331

1. Monitor radiological conditions
2. Continue assessment work with NARAC on Ambassador Roos desire to provide guidance to US citizens returning to Japan/Tokyo after spring break (April 15).
3. Review source term for NARAC on various scenarios (note: source term assumptions/scenarios file is attached which was provided after the telecom. NRC/DOE/NARAC still seeking White House approval of scenario assumptions/results.

LT Priorities:

1. Continue to coordinate the daily 21:00 consortium calls. It was noted that NRC is not leading this effort, but coordinating each agenda with feedback/input from participants.
2. Continue routing interactions with outside agencies/organizations.

Other Items

- ☐ Asked about reports of concrete pumpers/truck being shipped from SRS MOX construction site. Media say a German design concrete pumper will be sent and that the manufactures pumpers were used to entomb Chernobyl Unit 4. Asked if discussed in consortium call. The ET has no note of the concrete truck being proposed for Fukushima.

- ☐ Asked about Unit 4 Tepco new video footage if the ET/RST has seen the video. RST has seen the 20 minute video and they were not able to ascertain damage/integrity of the SFP. The RST has asked the in-country team for additional assessment.

News Outside of Telecon:

- ☐ Tepco said high-level radioactive water is leaking into the ocean from Unit 2. Tepco said today the source of the leak is from a crack in the wall of a 2-meters deep pit that contains power cables near the reactor's water intake. Water measuring between 10 and 20 centimeters deep was found in the pit. The radiation level has been measured at over 100 R/hr. Tepco is preparing to pour concrete into the cracked pit to stop the leak.

- ☐ Eight monitoring posts to measure radiation levels on the border of the compound started functioning again on Friday for the first time since the quake/Tsunami struck. However, as the automatic data transmission system is still out of order, workers will make daily visits to collect the radiation data which Tepco will then post on its website.

- ☐ Workers are also testing the spraying of synthetic resin in areas around the reactors in the hope that it will contain radioactive materials released by the hydrogen blasts. This resin was reported as Zeolite in a CA telecom, but the press called it something different. (note: Soviets used polymer spray around Chernobyl to reduce tracking of contamination; I shared this with ET during an evening call a few days ago).

- ☐ Tap water in Tokyo declared safe again to drink declare J gov officials

- ☐ News reports of mounting public frustration with Tepco openness/transparency issues

- ☐ Story of the day on Reuters....see link to story/video on miracle Tsunami dog rescue after adrift for three weeks at sea.

http://www.smh.com.au/world/adrift-tsunami-dog-rescued-from-a-sea-of-debris-20110402-1cshx.html

3 APRIL 2011 02:00 UTC

IAEA

International Atomic Energy Agency

Incident and Emergency Centre

Status of the Fukushima Daiichi Nuclear Power Plant and related environmental conditions

Note: Updated and new information is underlined.

The IAEA receives information updates from a variety of official Japanese sources through the national competent authorities: the Nuclear and Industrial Safety Agency (NISA) and the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Based on the information received by 3 April 2011 00:00 UTC the following update related to the reactor units at the Fukushima Daiichi Nuclear Power Plant (NPP), and related environmental conditions, is provided:

Restoration of AC Power

Units 1 to 4

Efforts to restore AC power and energise specific plant equipment continue. However no reports of changes to plant equipment status have been received since the last status summary.

Management of on-site, contaminated water

In preparation for transferring water in the basement of the turbine building to the condenser, water in the Unit 1 condenser storage tank started being transferred to the surge tank of the suppression pool at 31 March 03:00 UTC. As of 2 April 06:27, the transfer of the water in the condenser storage tank to the suppression pool surge tank was completed. Water in the trench was transferred to a water tank at the central environmental facility main building, and the water level in the trench was reduced from -0.14 meters (measured from the top) to -1.14 meters 31 March between 00:20-02:25 UTC.

On Unit 2 in order to prepare for removal of the water from turbine building basement, pumping of water from the condensate storage tank to the suppression pool water surge tank was started 29 March 07:45 UTC and was finished 1 April 02:50 UTC. As of 2 April 08:10, the transfer of water from the condenser to the condenser storage tank was started.

On Unit 3 in order to prepare for removal of the water from turbine building basement, pumping of water from the condenser to suppression pool water surge tank was started 28 March 08:40 UTC and completed 30 March 23:37 UTC.

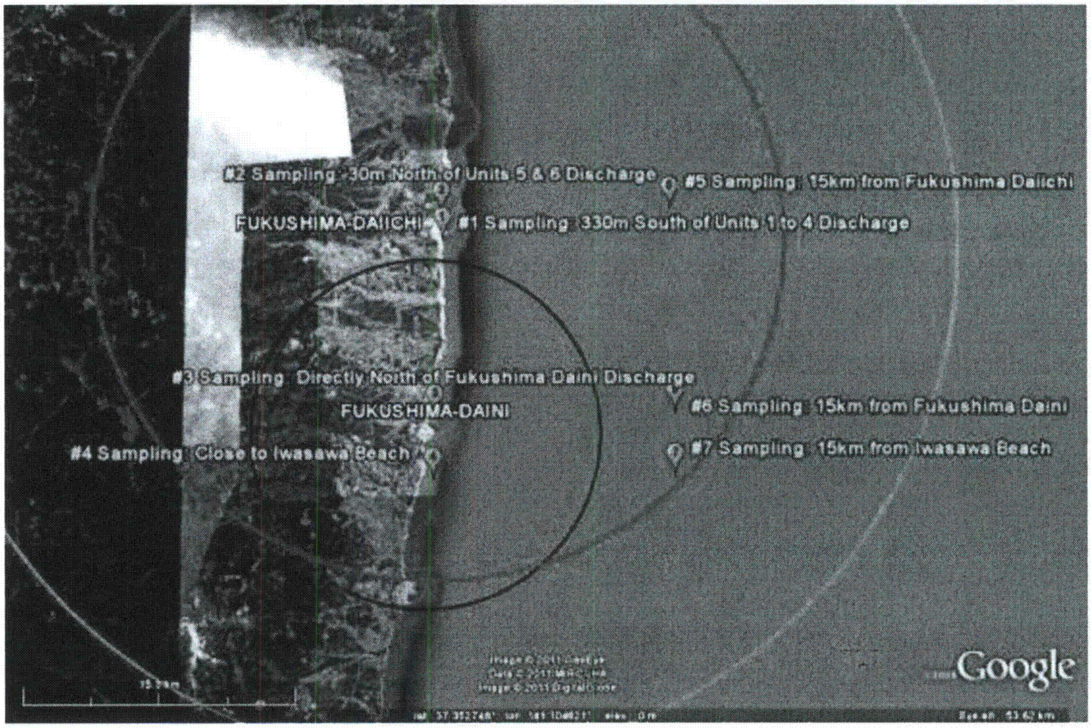
A US Navy barge carrying fresh water was towed to the special port of Fukushima Daiichi on 31 March 06:42 UTC. Transfer of fresh water from a US Navy barge to the "filtered water tank" started on 1 April 06:58 UTC, and was suspended on 1 April 07:25 UTC due to connection failure. A second US Navy barge left Onahama port and planned to arrive 2 April 00:30 UTC.

NISA press release from April 2, mentioned that water with dose rate of more than 1000 milisievert/hr was confirmed by TEPCO at around 00:30 UTC on April 2 inside the cable storage pit

Y1332

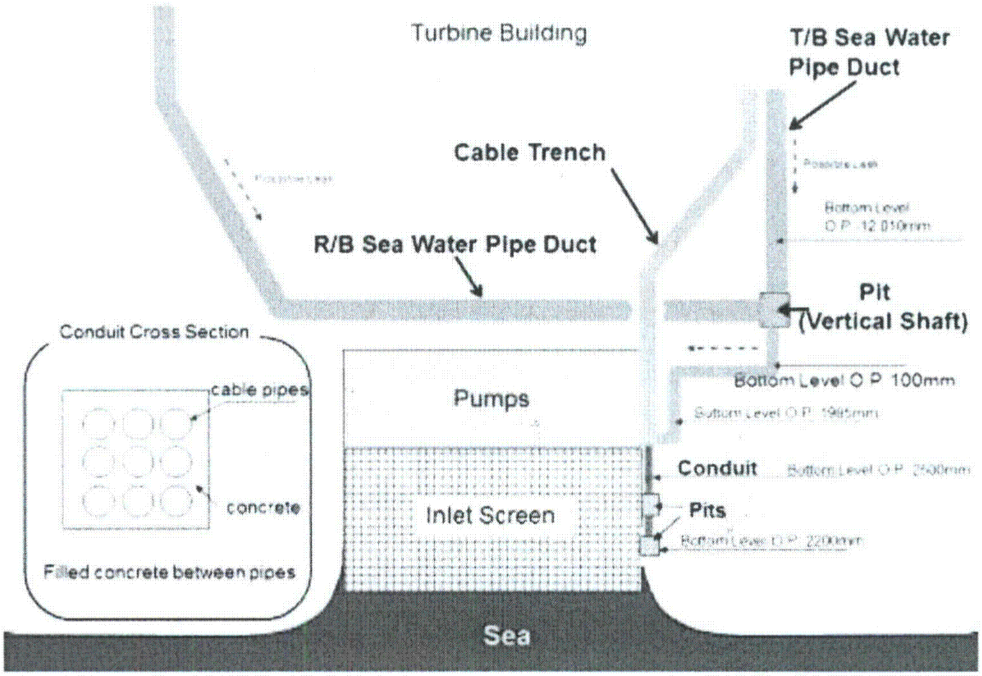
located next to Unit 2 inlet point. There exists a crack of approximately 20 cm on the sidewall of the pit closest to the sea and water inside the pit is confirmed to be leaking directly to the sea. This leakage was again confirmed at 03:20 UTC on the same day. Isotopic analysis of water sample inside the pit and seawater and nearby is in progress.

In addition to 4 sampling points in the sea around Fukushima Daiichi and Daini sites, an additional 3 points at 15km from these sites have been added as shown in the attached picture.



TEPCO has identified a possible leakage path from the Turbine building of Unit 2 to the sea via a series of trenches/tunnels used to provide power to the sea water intake pumps and supply of service water to the reactor and turbine buildings. The sketch shown below provides the general orientation of these tunnels and access pits.

Possible Leakage Routes from Unit 2



The cable trench/tunnel (shown in yellow) extends from sea water intake pumps to the Turbine Building and houses power and instrumentation cables for the intake pumps. This trench ends in a conduit (shown in orange) used to protect the cables from sea water and terminating at the two vertical pits (shown as orange squares) where contaminated water has been found.

The Reactor Building (R/B) sea water pipe duct (shown in green) is an underground trench/tunnel that houses the sea water intake pipe from the vertical shaft to the Reactor Building. This water is used for the Residual Heat Removal system and merges with the Turbine Building (T/B) sea water pipe duct at the vertical shaft (shown as the green square). The sea water pipe duct then extends (shown as thin green line) from the vertical shaft to the sea water intake pumps.

As of 2 April 07:25 UTC the pouring of concrete was started in an attempt to stop the water leakage. As of 2 April 10:15 UTC pouring of concrete had ceased and no significant decrease in the rate of leakage was observed.

Plant Status

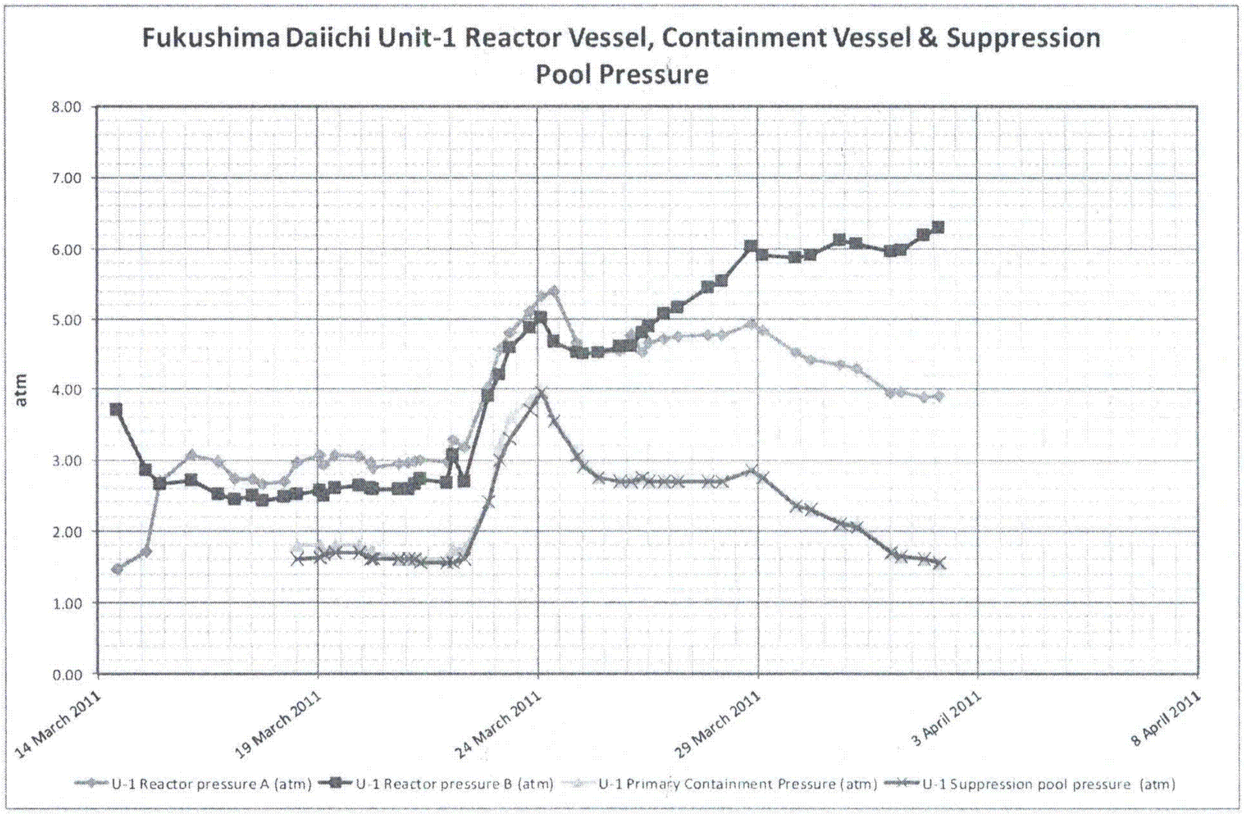
On 30 March, NISA issued a press release instructing nuclear plant operating companies to review safety plans and systems to ensure core and spent fuel cooling capability in case of tsunamis and/or station blackout conditions. Operating companies were requested to report on the status of their actions. Per this press release, NISA will verify these plans within one month.

Unit 1

In order to cool the spent nuclear fuel pool, 90 tonnes of fresh water was sprayed by concrete pump car 31 March between 04:03 UTC and 7:04 UTC.

Injection of fresh water into the reactor pressure vessel is on-going as of 1 April 06:30 UTC. The temperature of the RPV is stable at 259.4 °C at the feed nozzle and 117.6 ° C at the lower head on 2 April 03:00 UTC.

The pressure in the RPV and Containment Vessel is stabilised as presented in the following graph.



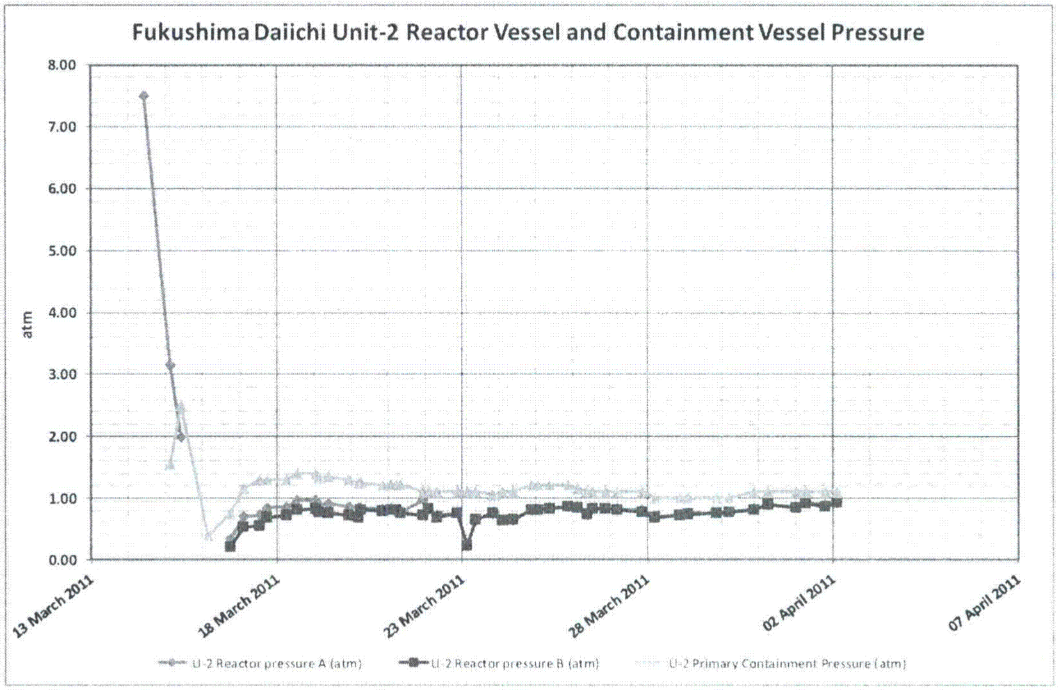
Unit 2

The temporary electric pump supplying water to the spent fuel pool in Unit-2 experienced a malfunction. The spent fuel pool water supply was changed to a fire truck pump but a crack was discovered in a hose on 30 March 04:10 UTC. As a consequence pumping water to spent fuel pool was stopped in Unit-2. Injection of water into spent fuel pond using the temporary pump was restarted on 1 April 05:56 UTC.

Injection of fresh water into the reactor pressure vessel is on-going as of 1 April on 06:30 UTC.

The temperature of the RPV at the feed water nozzle has decreased to 152.9 °C as of 2 April 03:00 UTC.

The pressure in the RPV and Containment Vessel is stabilised as presented in the following graph.



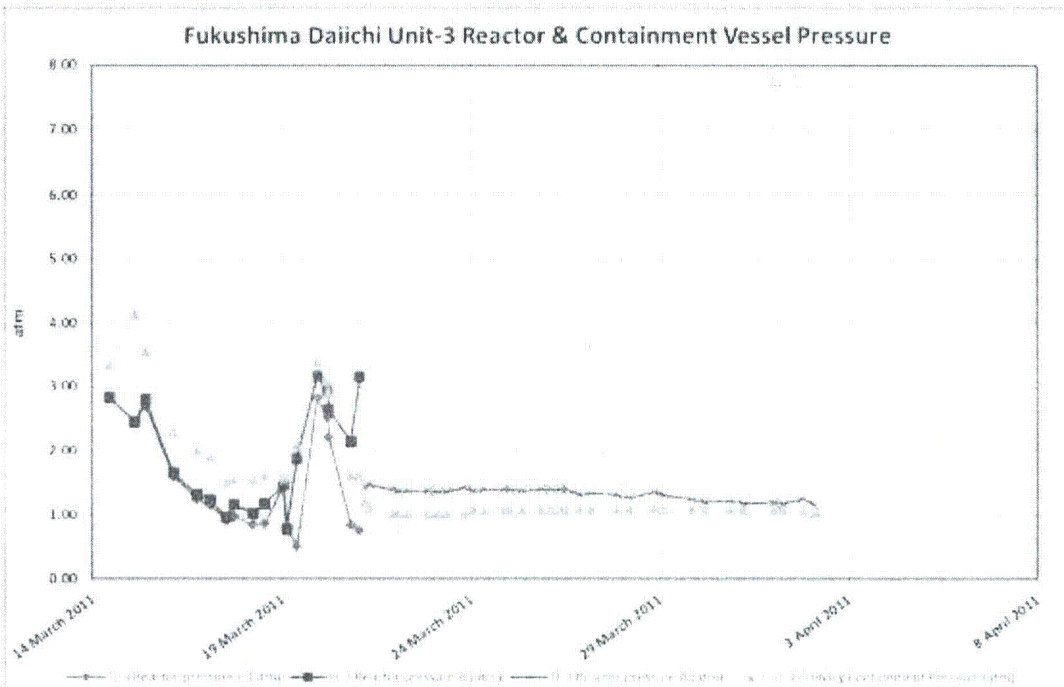
Unit 3

105 tonnes of fresh water was sprayed to the spent fuel pool of Unit-3 by the concrete pump car (50 t/h) on 31 March 07:30 to 10:33 UTC.

Injection of fresh water into the reactor pressure vessel is on-going as of 1 April on 06:30.

The temperature of the RPV is stable at 92.3 °C at the feed nozzle and 117.8 °C at the lower head on 2 April 03:00 UTC.

The RPV and Containment Vessel pressure trends are stable (presented in the following diagram).



*The instruments names and their values have been amended to reflect updated data
*The reactor pressure instrument C from 21 March is not shown due to unreliable data

Unit 4

The water injection (180 t) into spend fuel pool by concrete pump was completed 1 April 05:14 UTC.

Fresh water was sprayed to the spent fuel pool of Unit 4 by the concrete pump car (50 t/h) starting on 31 March 23:25 UTC.

Units 5 and 6

Both units remain in cold shutdown with plant systems operating on off-site AC power. On 1 April at 04:40 UTC the stagnant water from the basement of Unit 6 waste facility building started to be transferred to Unit 5 condenser.

Common Spent Fuel Storage Facility

The Common Spent Fuel Pool temperature is stable. TEPCO tested an 'anti-scattering' agent (2000 l) on 500 m^2 area around the Common Spent Fuel Storage facility on 1 April 07:04 UTC. The purpose of spraying is to prevent radioactive particles from being dispersed from the plant by winds and rain.

Units 1, 2, 3, 4, 5 and 6 - Plant Status

Parameter / Indications	Unit	Fukushima Daiichi					
		Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Reactor Pressure Vessel Pressure	MPa	0.390 (A) 0.631 (B)	0.093 (A) 0.093 (B)	0.114 (A)	-	0.107	0.105
	atm	3.90 (A) 6.31 (B)	0.93 (A) 0.93 (B)	1.14 (A) -	-	1.07	1.05
Containment Vessel (Drywell) Pressure	kPa	155	110	105	-	-	-
	atm	1.55	1.10	1.05	-	-	-
Reactor Pressure Vessel Level	mm (above the top of active fuel)	-1650 (A) -1650 (B)	-1550 (A) (B) not available	-1850 (A) -2250 (B)	-	1700	2082
Suppression Pool Temperature	°C	No Data	No Data	No Data	No Data	No Data	No Data
Suppression Pool Pressure	kPa	155	Below the scale	175.0	-	-	-
	atm	1.55		1.75			
Adding water to Reactor Pressure Vessel	• Adding • Not adding • Unknown	Fresh water is injecting continuously into the reactor pressure vessel through feedwater line.	Fresh water is injecting continuously into the reactor pressure vessel through fire extinguisher line.	Fresh water is injecting continuously into the reactor pressure vessel fire extinguisher line.	-	Injection to RPV and the Spent Fuel Pool using make up water	Injection to RPV and the Spent Fuel Pool using make up water
Date/Time of Data Acquisition		02 April 03:00 UTC	02 April 03:00 UTC	02 April 03:00 UTC	-	02 April 05:00 UTC	02 April 05:00 UTC

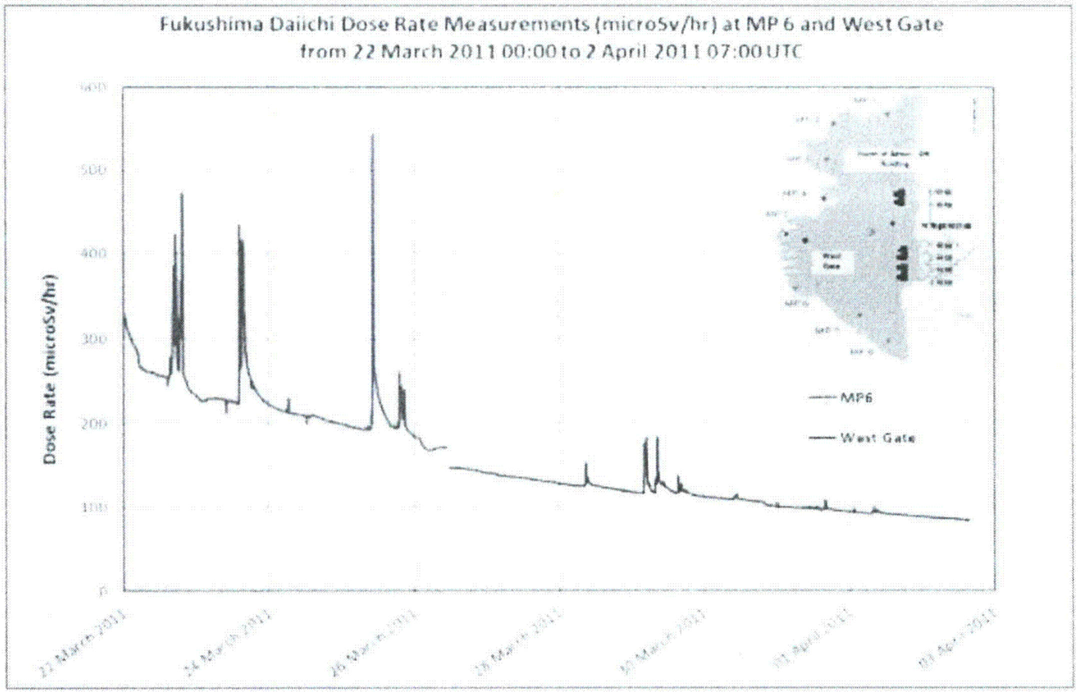
* All pressure values are absolute pressure (pressure including normal atmospheric pressure)

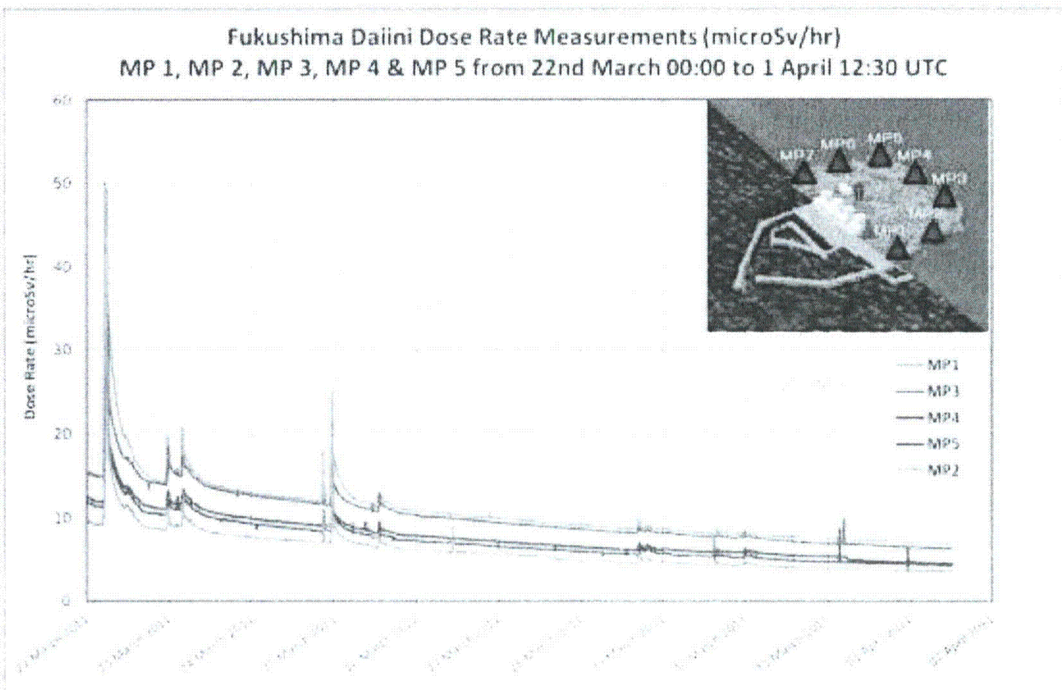
** (A), (B) and (C) refer to three measurement instruments

Radiation Monitoring

Daiichi and Daini On-Site Monitoring

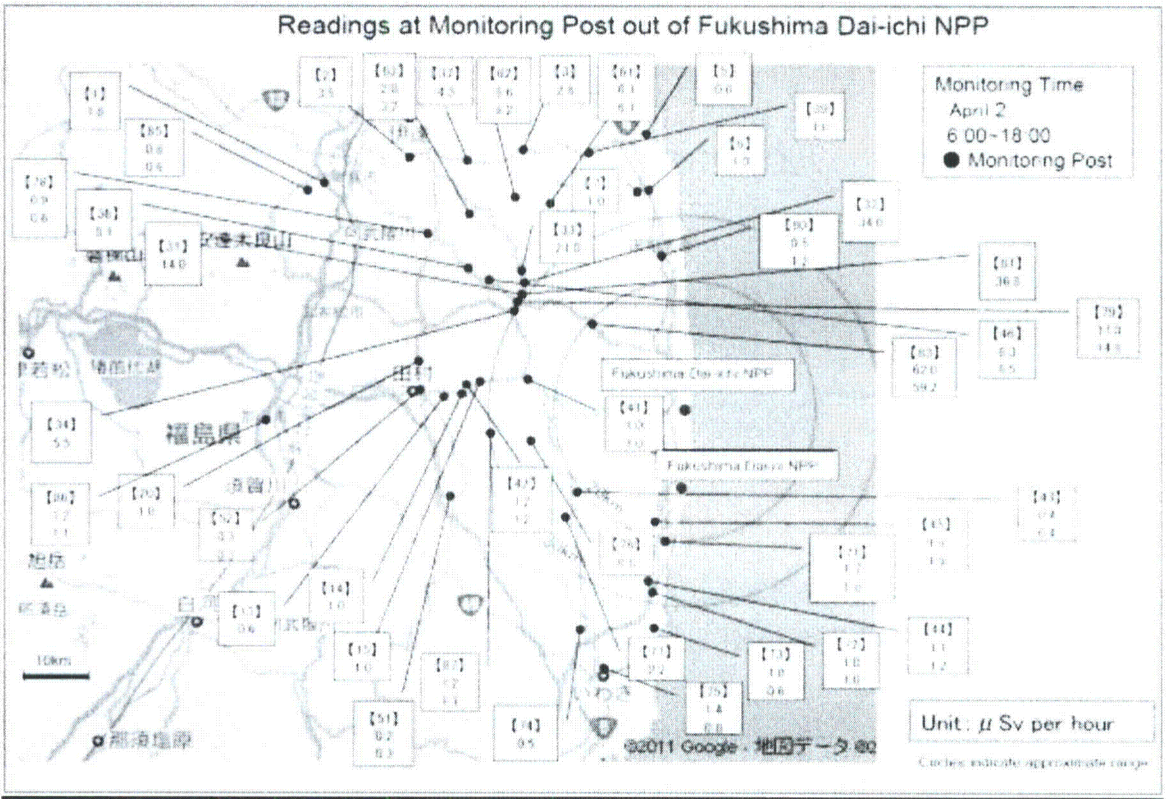
Updated dose rate data for the on-site monitoring stations at the Daiichi and Daiini sites from 22 March to 1 April are shown below. Apart from some peaks linked to specific events at the Daiichi site, a continuing downward trend in dose rates can be observed.





Radiation dose rate monitoring around Daiichi

Updated dose rate monitoring data around Daiichi is given below.



Monitoring in Fukushima Prefecture

Environmental Monitoring

On 30 March, MEXT announced that it was enhancing its local monitoring program in the area outside the 20 km evacuation zone. The level of radioactivity in air by prefecture will be measured, as well as the analysis of radionuclides in drinking water and deposition. In cooperation with universities and colleges of technology, MEXT has also commenced a program to measure the dose rate in air on campuses located in major cities.

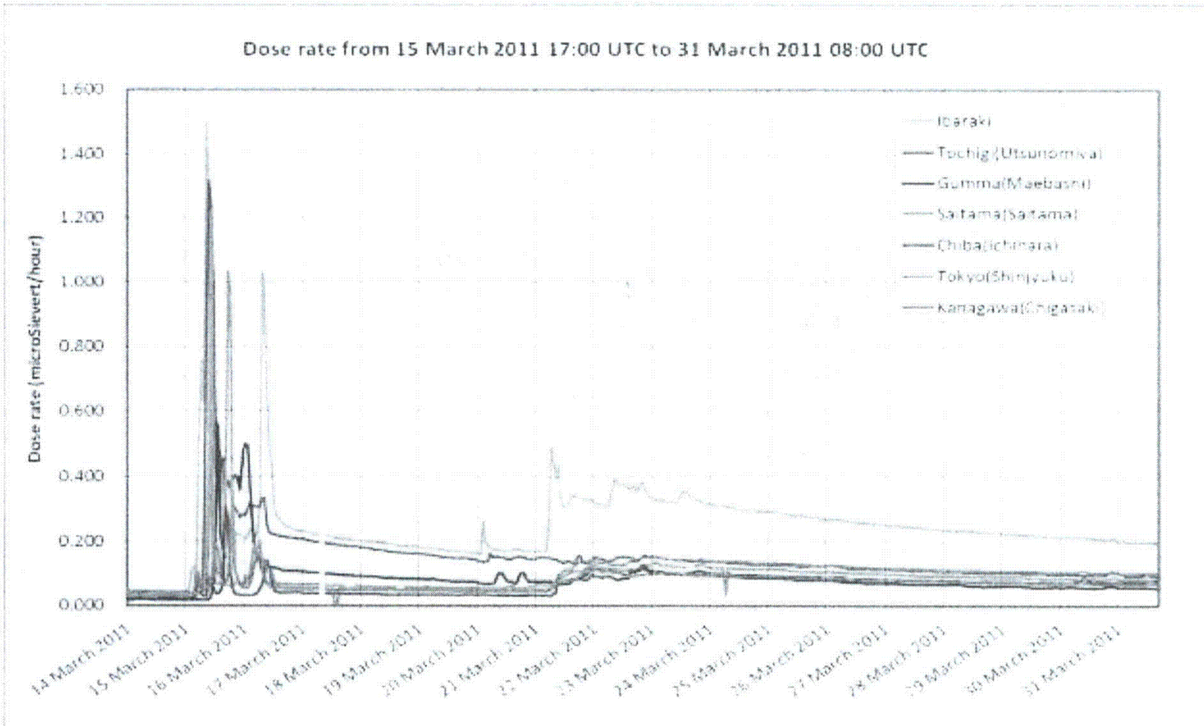
Monitoring of Public and Workers

NISA reported that monitoring was conducted for 106,095 people by 29 March at Fukushima prefecture; among them 102 people indicated levels above 100,000 counts per minute (cpm). These 102 people were re-examined after removing clothes, and measured values went down to a level lower than 100,000 cpm, there were no cases that may influence health.

On 31 March NISA also reported that among the workers at the Fukushima Daiichi plant, 21 workers have received doses exceeding 100mSv. No worker has received a dose above Japan's guidance value of 250 mSv for restricting the exposure of emergency workers.

Environmental Monitoring in other prefectures

Measurements of gamma dose rates in all the prefectures are being taken continuously. Since 23 March, the dose rates show in general a decreasing behavior. The figure below displays the dose rates from 14 to 31 March in seven prefectures.

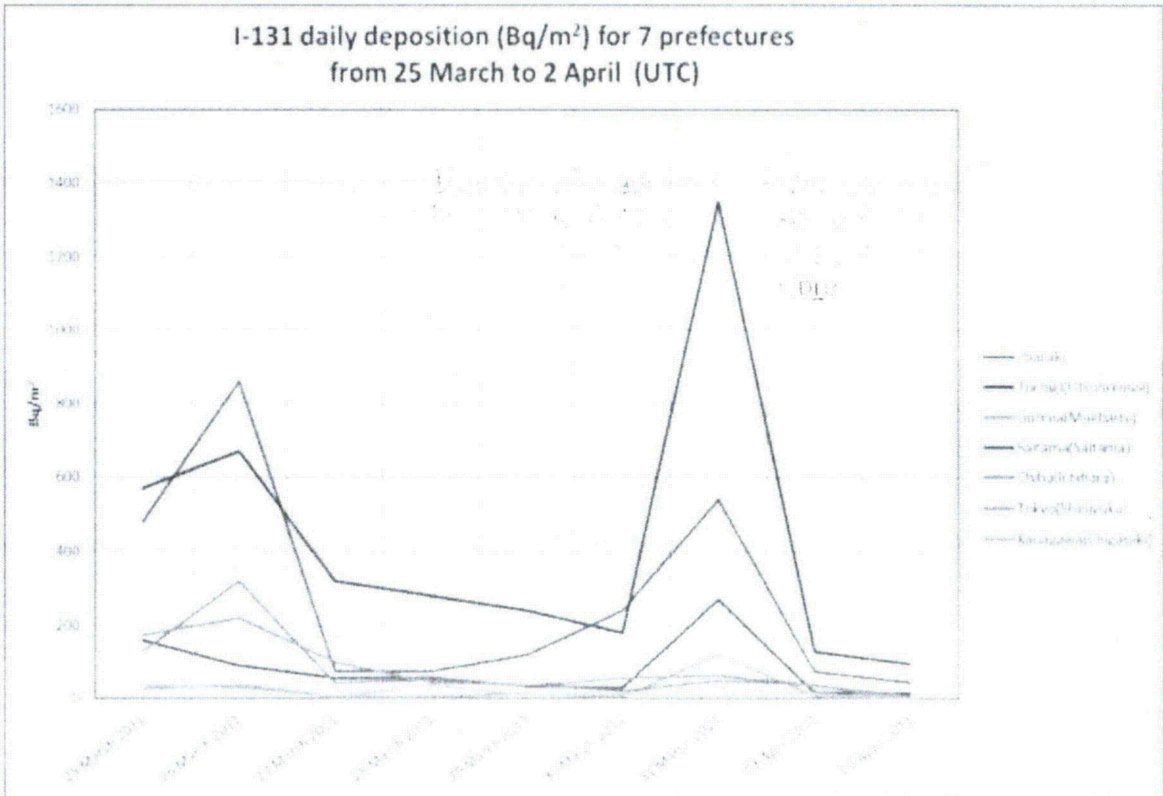


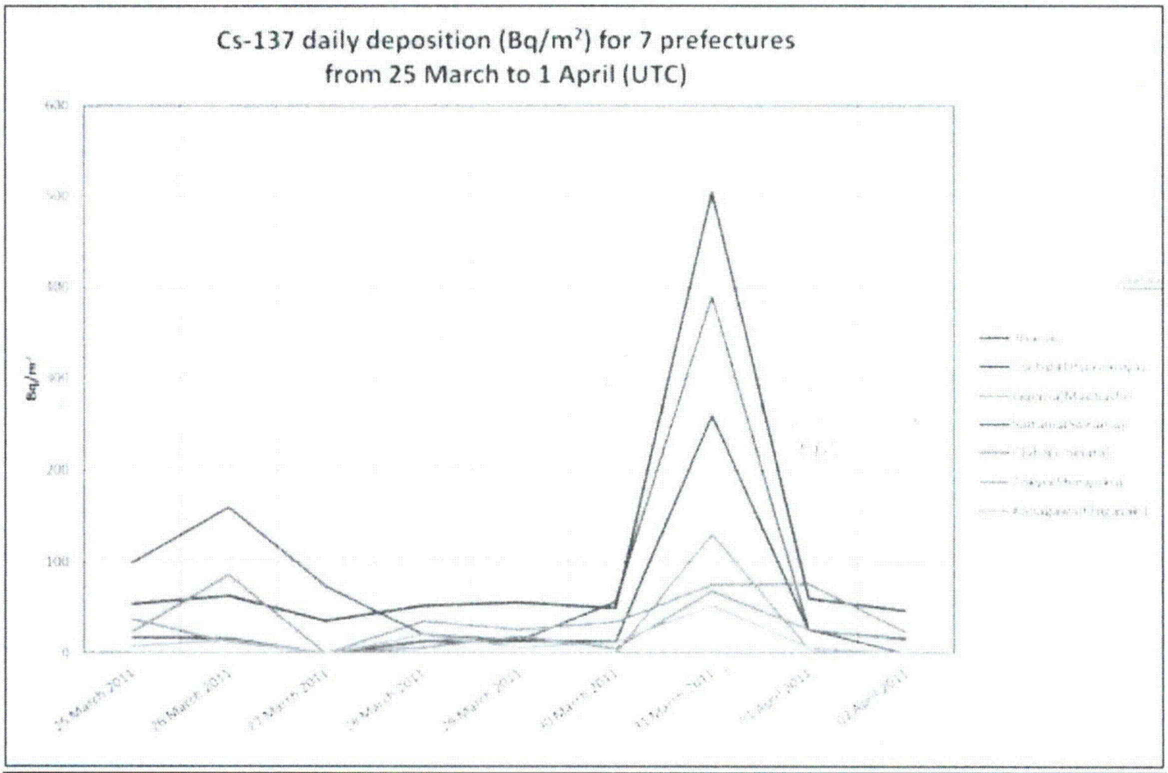
Deposition Data by Prefecture

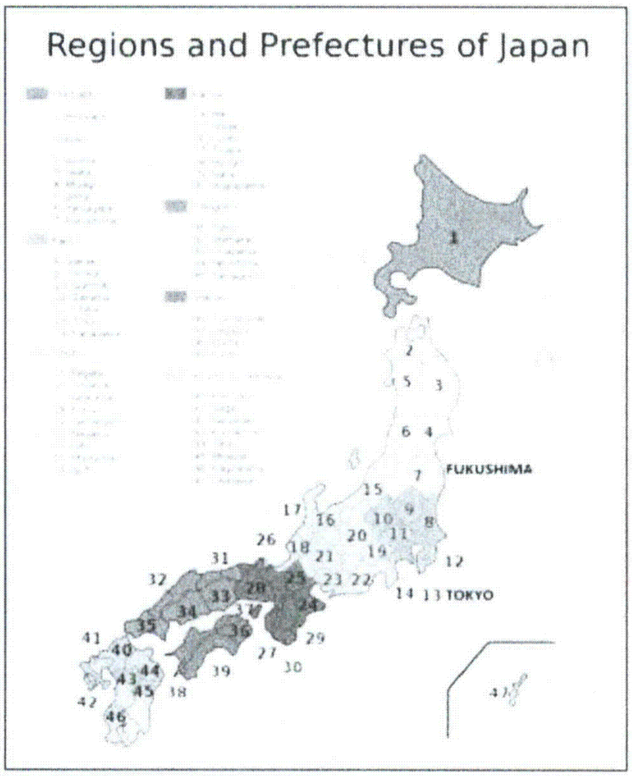
During the period 19 March to 1 April, daily deposition was recorded on at least one occasion in 21 prefectures. In eight of these (Aomori, Ishikawa, Miyazaki, Nagano, Nigata, Okayama, Saga and Shimane), only I-131 was detected. No deposition has been recorded in 25 prefectures and there is still no information from the prefecture of Miyagi due to damage from the earthquake and tsunami.

An increase in the deposition of both I-131 and Cs-137 were observed on 31 March but levels have now returned to those of previous days. On 31 March and 1 April deposition was reported for 10 prefectures. In the prefectures of Shizouka and Yamanashi no I-131 was detected and the deposition of Cs-137 was less than 5 Bq/m^2.

Only one sampling location is used in each prefecture and so it is possible that some deposition has also taken place in other parts of these prefectures or on dates prior to 19 March.




Cs-137 daily deposition (Bq/m²) for 7 prefectures
from 25 March to 1 April (UTC)

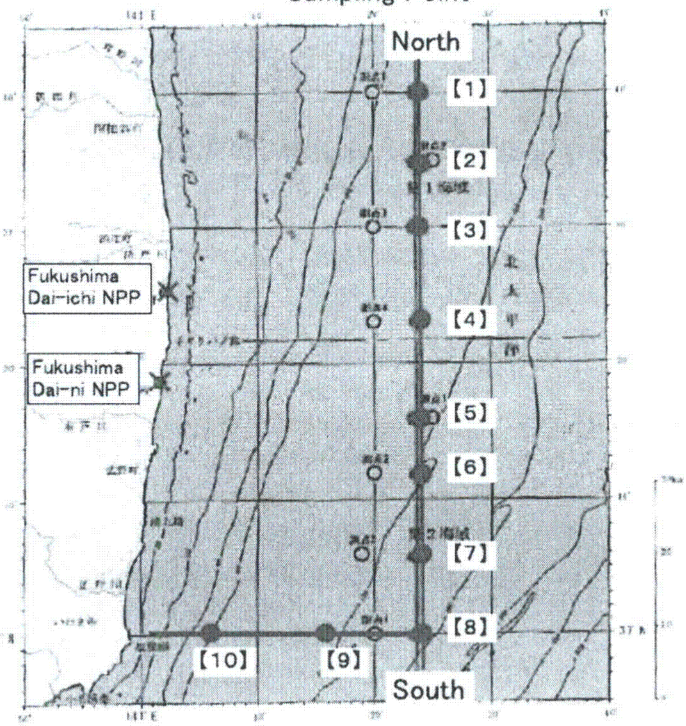

Regions and Prefectures of Japan
FUKUSHIMA
TOKYO

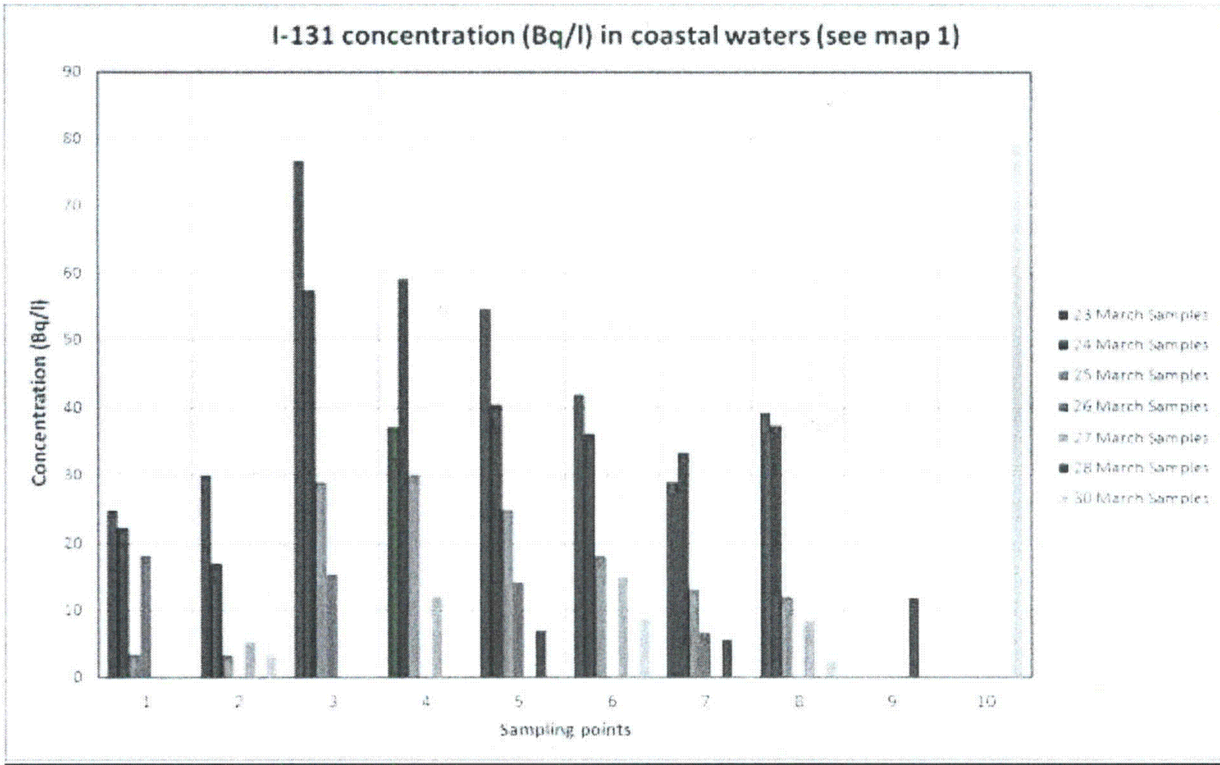
Monitoring in the Marine Environment

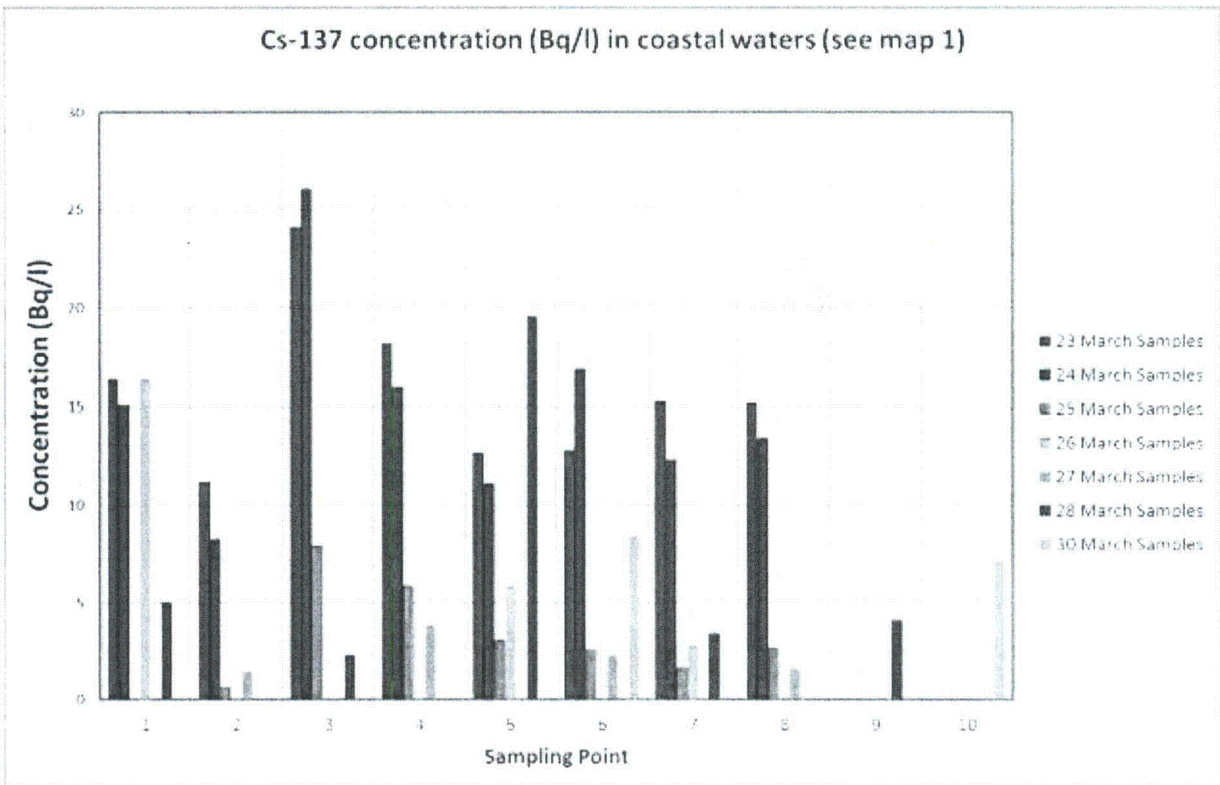
As a result of nuclide analysis in sea-water in the vicinity of discharge water outlet of Unit 4, 180 Bq/cm^3 of I-131 was detected on 30 March at 13:55, which is 4385 times higher than the established criterion.

<u>The following figures and tables reporting measurement of radioactivity in sea water, airborne and dust in the Fukushima area were provided by MEXT on 31 March.</u>

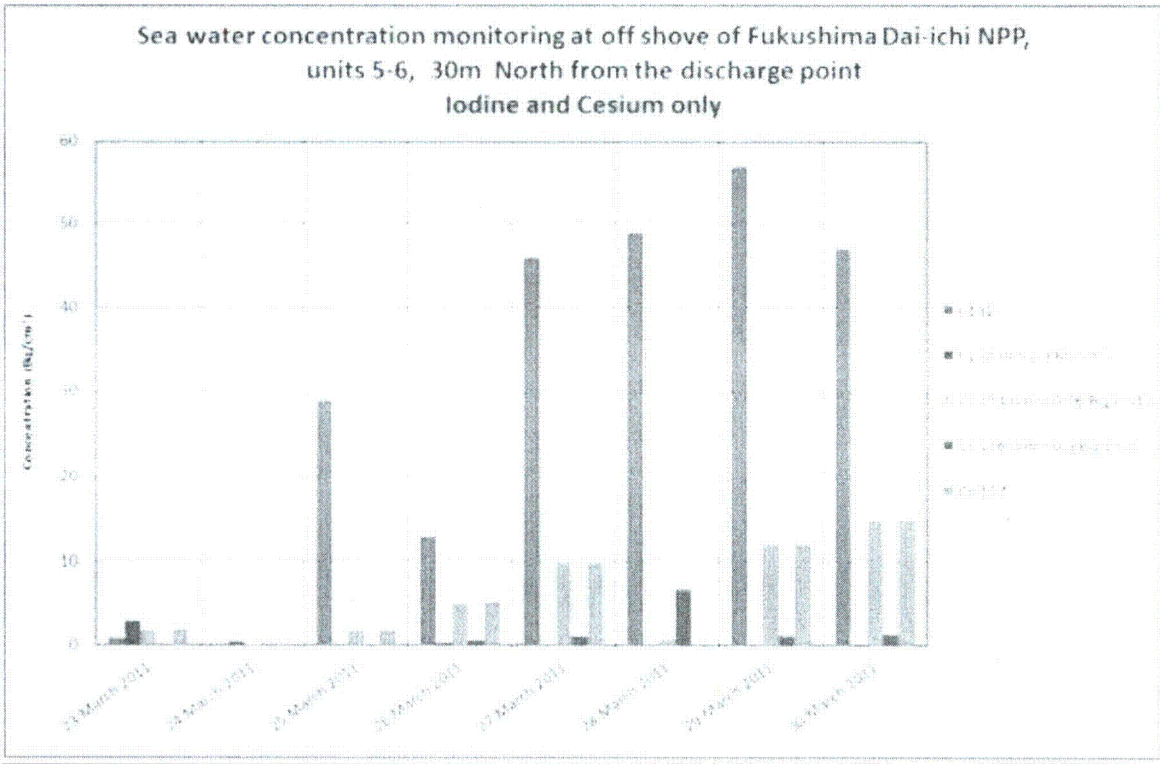
Sampling Point




I-131 concentration (Bq/l) in coastal waters (see map 1)
Concentration (Bq/l)
Sampling points
23 March Samples
24 March Samples
25 March Samples
26 March Samples
27 March Samples
28 March Samples
30 March Samples


Cs-137 concentration (Bq/l) in coastal waters (see map 1)
Concentration (Bq/l)
Sampling Point
23 March Samples
24 March Samples
25 March Samples
26 March Samples
27 March Samples
28 March Samples
30 March Samples

I-131 and Cs-137 concentration in sea water



RESULTS OF MEASURMENTS AT SEA SAMPLING POINTS

Sampling Points		26-Mar			27-Mar			28-Mar			30-Mar		
		microSv/hr	Bq/m^3	Bq/m^3	microSv/hr	Bq/m^3	Bq/m^3	microSv/hr	Bq/m^3	Bq/m^3	microSv/hr	Bq/m^3	Bq/m^3
Old Name	New Name	over sea	I-131 in dust	Cs-137 in dust	over sea	I-131 in dust	Cs-137 in dust	over sea	I-131 in dust	Cs-137 in dust	over sea	I-131 in dust	Cs-137 in dust
SP1SA1	SP1	0.051	1.12	0.10				0.15	ND	ND			
SP2SA1	SP2				0.026	ND	ND				0.12	0.445	ND
SP3SA1	SP3	0.068	0.604	ND				0.12	0.277	ND			
SP4SA1	SP4				0.051	0.38	ND				0.10	0.908	0.50
SP1SA2	SP5	0.10	1.37	ND				0.13	0.761	ND			
SP2SA2	SP6				0.061	0.63	ND				0.10	0.179	ND
SP3SA2	SP7	0.041	1.20	ND				0.11	0.156	ND			
SP4SA2	SP8				0.057	20.00	0.88				0.09	0.156	ND
	SP9							0.13	23.50	3.27			
	SP10										0.10	0.0968	ND

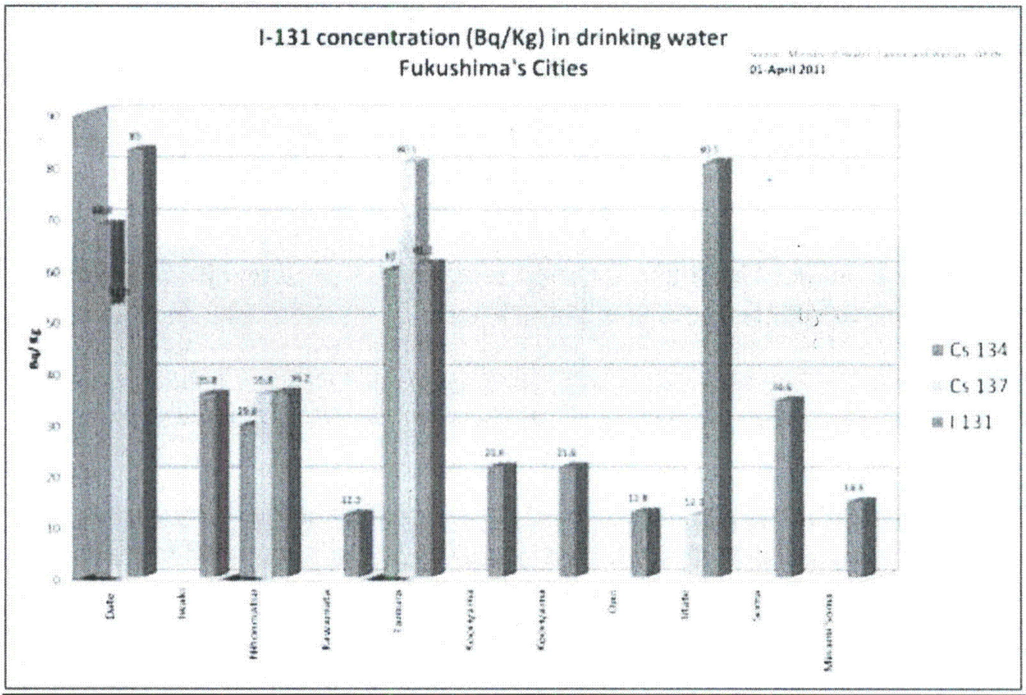
ND = Not Detectable

Radioactivity in Drinking Water, Milk and Foodstuffs

Data related to activity concentrations in food were reported on 31 March by the Japanese Ministry of Health, Labour and Welfare. As summarized by FAO, the reported analytical results covered 111 samples taken on 15 March (2 samples) and from 27-31 March (109 samples). Analytical results for 98 of the 111 samples for various vegetables, spinach and other leafy vegetables, fruit (strawberry), seafood, various meats (beef, chicken and pork) and unprocessed raw milk in eight prefectures (Chiba, Fukushima, Gunma, Ibaraki, Kanagawa, Niigata, Tochigi, and Tokyo), indicated that iodine-131, caesium-134 and caesium-137 were either not detected or were below the regulation values set by the Japanese authorities. However, it was reported that analytical results in Chiba, Fukushima, Ibaraki and Tochigi prefectures for the remaining 13 of the total 111 samples for spinach and other leafy vegetables, parsley and beef indicated that iodine-131 and/or caesium-134 and caesium-137 exceeded the regulation values set by the Japanese authorities. See Annex I.

The Ministry of Agriculture, Forestry and Fisheries of Japan informed the IAEA that, because of winter conditions, most cattle, pigs and chickens are presently kept indoors. Animals are primarily fed on dried grass, silage and stored grain that has not been contaminated by the releases from the Fukushima Daiichi NPP. In addition, farmers have been advised to take additional measures to prevent the direct deposition of radionuclides on drinking water provided to cattle.

As of 1 April, restrictions have been lifted on the consumption of drinking water by adults in Iitate; the restriction now applies to infants only. <u>According to the latest update as of 1 April, restrictions on the consumption of drinking water remain only in Iitate for infants only. The restriction in all other earlier reported locations for the prefecture of Fukushima have been lifted.</u>



Radioactivity in Groundwater

On 31 March, the Prime Minister's Office reported that the concentration of I-131 in groundwater at Unit 1 of the Fukushima Daiichi NPP was 430 Bq/cm^3 (4.3×10^5 Bq/l)

Public Information

Local Emergency Response Headquarters and Fukushima's Emergency Response Headquarters have released a newsletter for people living outside the 30km zone and those living in evacuation sites. The newsletter includes information such as how to prevent exposure to radioactive material and a list of relevant contacts.

Patel, Amar

From: Casey, Lauren
Sent: Monday, April 04, 2011 11:48 AM
To: Patel, Amar
Subject: FW: All Employees Meeting regarding events in Japan and Chairman Jaczko testimony before Congress - Broadcast in IRC

From: Walker, Tracy
Sent: Wednesday, March 16, 2011 10:49 AM
To: All R1 Users
Subject: RE: All Employees Meeting regarding events in Japan and Chairman Jaczko testimony before Congress - Broadcast in IRC

The hearing broadcast has been set up in the DRP conference room and in the VTC room (1081A). If you are interested in observing the hearing, we encourage you to view from one of these common locations rather than from your desktop. We have had a number of reports of connectivity issues and the common viewing locations will limit issues with internet access. Thank you.

From: Walker, Tracy
Sent: Wednesday, March 16, 2011 9:55 AM
To: All R1 Users
Subject: RE: All Employees Meeting regarding events in Japan and Chairman Jaczko testimony before Congress - Broadcast in IRC

Due to technical difficulties, the broadcast of the hearing this morning is being broadcast in the IRC. No bridge line will be available for the morning session.

We will try to resolve the technical difficulties so that the broadcast this afternoon can be done in the Main Conference Room following the All Employee Meeting.

We apologize for any inconcenience.

From: R1BULLETIN RESOURCE
Sent: Wednesday, March 16, 2011 9:20 AM
To: All R1 Users
Subject: All Employees Meeting regarding events in Japan and Chairman Jaczko testimony before Congress

This morning at 9:30, C-SPAN will carry Chairman Jaczko's testimony before a Joint hearing of the Energy and Commerce Committee. We will show it in the Main Conference Room.

This afternoon following the All Employee Meeting regarding events in Japan we will switch to C-SPAN's coverage of the Senate Environment and Public Works Committee on the Japanese nuclear crisis and the assistance the U.S. is providing.

Bridges will be available for both sessions. Bridge information will be provided shortly.

Y\ 333

Caponiti, Kathleen

From: Astwood, Heather INRR
Sent: Monday, April 04, 2011 9:56 AM
To: Leeds, Eric; Boger, Bruce; Cheok, Michael; Blount, Tom; Azeem, Almas; Cartwright, William; Cusumano, Victor; Fields, Leslie; Heida, Bruce; Meighan, Sean; Nguyen, Quynh; Roquecruz, Carla; Susco, Jeremy; Titus, Brett; Valentine, Nicholee
Cc: Miller, Charles; Grobe, Jack; Holahan, Gary; Hopkins, Jon
Subject: Information: DG Amano's opening statement at CNS

FYI- The Chairman and the EDO are in Vienna this week at the Convention of Nuclear Safety meeting. Here is the opening address by the Director General of IAEA.

Heather Astwood
International Team Leader
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
301-415-1075

From: Hopkins, Jon INRR
Sent: Monday, April 04, 2011 8:54 AM
To: Cullingford, Michael; Astwood, Heather
Subject: DG Amano's opening statement at CNS

http://www.iaea.org/newscenter/statements/2011/amsp2011n009.html

"The accident at Fukushima Daiichi is a matter of concern for all IAEA Member States, not just for the Contracting Parties to the Convention on Nuclear Safety. Japan and the IAEA are co-sponsoring a side event on the accident, and the initial response from safety regulators around the world, at 18.30 this evening. This will include presentations by specialists from the Japanese safety agency NISA and the operating company TEPCO, as well as from the United States and Europe. This event will be open to all IAEA Member States."

Y\334

Caponiti, Kathleen

From: Nuclear Plant Journal [anu@goinfo.com]
Sent: Monday, April 04, 2011 6:26 PM
To: Cusumano, Victor
Subject: NPJ E-News April 4, 2011 Fukushima Update

Having trouble viewing this email? Click here

Like

Nuclear Plant Journal
An International Publication
Published in the United States

Nuclear Plant Journal E-News

Japan Update
April 4, 2011

Dear VICTOR,

In this issue of NPJ E-News you'll find an update of the Fukushima Nuclear Plants in Japan. Information is current as of April 4, 2011, 17:00 CDT. All items are directly quoted, without any editing.

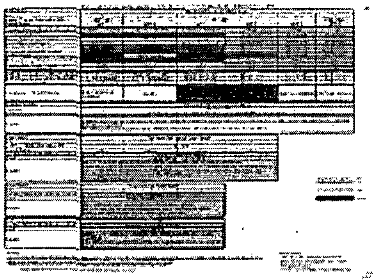
In this issue

TEPCO Update

From the TEPCO website:

- **Improvement Plan for Nuclide Analysis**
  At the site of Fukushima Daiichi Nuclear Power Station, as part of our investigation for the pathway and the volume of emission, which contains radioactive material, we have been conducting nuclide analysis for air inside the plant, seawater near the plant and water puddle in the turbine building. We have been informing you the result of the nuclide analysis. It is ascertained that the result of nuclide analysis of tellurium 129 (half life : about 70 minutes) conducted on March 30th, for water puddle collected near the trench and ground water collected near the turbine building are doubtful. Click for more.
- Plant status update: Click for more

Y|| 335



JAIF Status Update

Update 62, April 4, 2011

A PDF document provides a simple summary of each of the units at Fukushima nuclear power plants. This is a multi-page document that also provides a chronology of events and a map that details the status of each of the Japanese nuclear units.

Earthquake Update 42.

US NRC FAQs related to Fukushima earthquake and subsequent events

NRC frequently asked questions related to the March 11, 2011 Japanese Earthquake and Tsunami. Some sample questions:

- Can an earthquake and tsunami as large as happened in Japan also happen here?
- Did the Japanese underestimate the size of the maximum credible earthquake and tsunami that could affect the plants?
- How high was the tsunami at the Fukushima nuclear plants?
- Was the damage to the Japanese nuclear plants mostly from the earthquake or the tsunami?

Quick Links...

- NPJ Website
- Cost-free Subscription (to NPJ)
- JAIF
- TEPCO
- NISA
- U.S. NRC Actions on Japan

Like Nuclear Plant Journal's new page on Facebook!

Contact Information
phone: 630-313-6739
email: NPJ@goinfo.com

Caponiti, Kathleen

From: Gall, Jennifer
Sent: Monday, April 04, 2011 8:24 AM
To: Whitman, Josh; Bernard, Matthew; Widrevitz, Dan; Audrain, Margaret; DiFrancesco, Nicholas; Crane, Samantha; Craffey, Ryan; Davidson, Evan
Subject: FW: Slide show follows Japanese accident

From: Lyon, Warren \\ WL
Sent: Monday, April 04, 2011 5:52 AM
To: Gall, Jennifer; Miller, Joshua; Miranda, Samuel; Parks, Benjamin; Rutz, Wayne; Reyes, Debra
Subject: RE: Slide show follows japanese accident

Woops – mistake in address. The correct one is up http://iis-db.stanford.edu/evnts/6615/March21_JapanSeminar.pdf .

From: Lyon, Warren
Sent: Sunday, April 03, 2011 7:14 AM
To: Gall, Jennifer; Miller, Joshua; Miranda, Samuel; Parks, Benjamin
Subject: Slide show follows japanese accident

Did a Google search on "hanson japan core melt" that turned up http://iis-db.stanford.edu/events/6615/March21_JapanSeminar.pdf . Excellent 32 slide coverage of accident progression as understood at that time.

4\336

On the Implementation of Emergency Safety Measures at Other Power Plants drawn from the 2011 Accident at Fukushima Dai-ichi and Dai-ni Nuclear Power Stations
(Minister's Instructions, Released on March 30th)

Nuclear and Industrial Safety Agency
April 4th, 2011

4/327

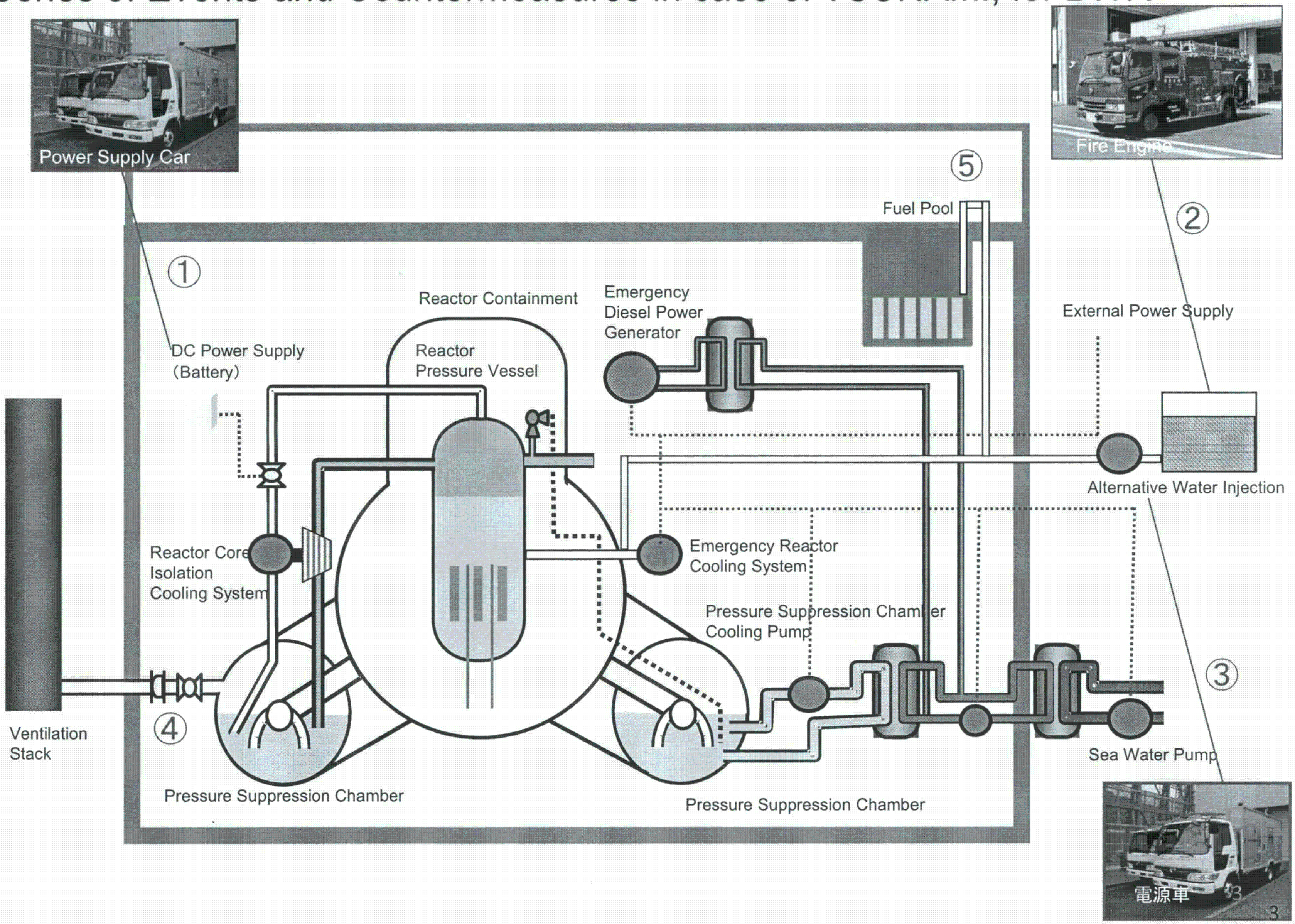
Summary

- While continuing to do our utmost to take every possible measure to deal with the accident, NISA will launch an effort to understand every aspect of the accident, including the onset mechanism of the tsunami that struck the area, and to analyze and assess the situation so as to take drastic and fundamental corrective measures.
- NPPs other than Fukushima Dai-ichi and Fukushima Dai-ni will implement emergency safety measures to enable the recovery of cooling functions while preventing, to the extent possible, the release of radioactive materials. This activity will be based on the currently available scientific knowledge.
- Electric utility companies are to appropriately undertake these emergency safety measures which would then be verified through NISA inspections, thereby preventing the possible damage to reactor core due to tsunami-induced loss of all AC power supply and preventing the subsequent nuclear disaster.

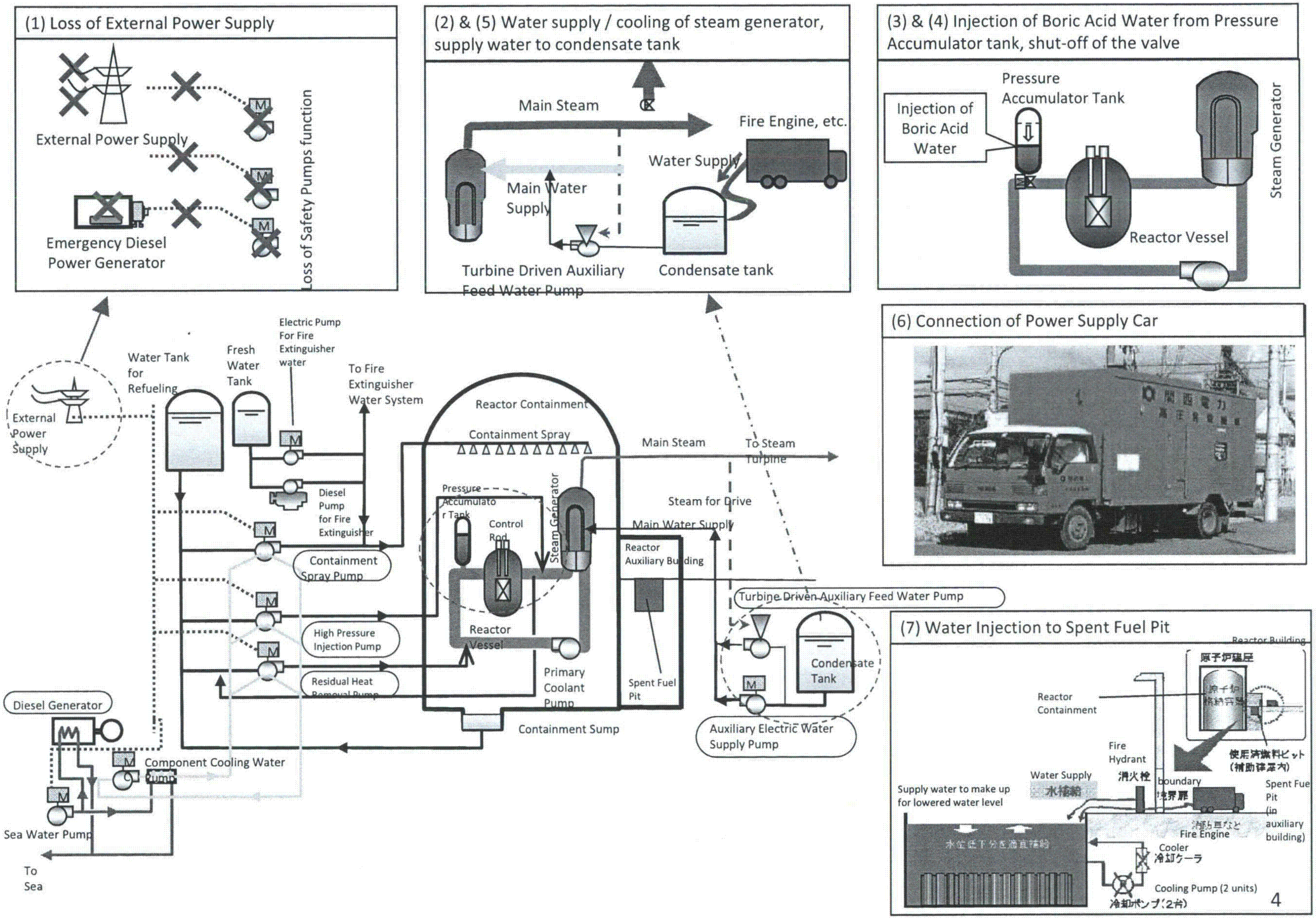
Measures drawn from Fukushima Dai-ichi Nuclear Power Accident

Phase	Emergency Safety Measures	Drastic measures
	Short term	Medium-to-Long term
Expected completion	Approx. 1 month (around mid-April)	Decide as per debate at Accident Investigation Commission, etc.
Target (Required standard)	Depending on tsunami, prevent core damage and occurrence of spent-fuel damage even when 1) all alternate-current power sources, 2) seawater cooling function, and 3) spent-fuel pool cooling function are lost.	Prevent occurrence of disasters taking into account "anticipated tsunami height" to be set by referencing tsunami that caused recent disaster.
Examples of specific measures	<u>Securing equipment</u>: ・Deploy power-supply vehicles (to cool reactors and spent-fuel pools). ・Deploy fire engines (to supply coolant water). ・Deploy fire hoses (to secure water-feeding path from fresh-water tank, sea-water pit, etc.). <u>Developing manual</u>: ・Develop implementation procedures for emergency measures utilizing above-mentioned equipment. <u>Training</u>: ・Implementation of training on emergency measures based on implementation procedures manual.	<u>Securing equipment</u> ・Build seawalls. ・Deploy watertight doors. ・Devise other necessary equipment-related measures. *To be followed by implementation of equipment-related improvements as necessary (e.g.: secure spare air-cooled diesel generators, sea water pump motors). <u>Develop manual</u> <u>Conduct training</u>
Confirmation by NISA, etc.	・Approval of amendment of ministerial ordinance to ensure effectiveness of emergency safety measures as well as operational safety program that incorporates those measures. ・Rigorous vetting of implementation status of emergency safety measures by means of inspection, etc.	
Operators' response	・Efforts under way to procure equipment. (Locations to set them up also being secured). ・Manual compiled anew drawing on recent accident. Training being implemented. ・Strive to improve emergency safety measures continuously, even after their confirmation, to ensure their reliability.	

Series of Events and Countermeasures in case of TSUNAMI, for BWR



Series of Events and Countermeasures in case of TSUNAMI, for PWR



Rihm, Roger

From: Rihm, Roger
Sent: Monday, April 04, 2011 8:28 AM
To: Schmidt, Rebecca; Powell, Amy
Subject: FW: Testimony
Attachments: Testimony_April6_2011_Rev2 -DPR edits.docx

Does this meet your needs? I had edited the intro to indicate that the incident response piece would be at the end, but NSIR put it in a different place. Does that work for you? It more or less addresses most of what Rebecca asked for

Where is this in the commission review cycle?

From: Marshall, Jane
Sent: Sunday, April 03, 2011 12:29 PM
To: Rihm, Roger; Schmidt, Rebecca
Cc: McDermott, Brian
Subject: Testimony

Here is the testimony with additional information on the incident response program changes that resulted from the TMI experience. If you have any questions, please let me know.

Y/338

TESTIMONY OF MARTIN VIRGILIO
DEPUTY EXECUTIVE DIRECTOR FOR REACTOR AND PREPAREDNESS PROGRAMS
UNITED STATES NUCLEAR REGULATORY COMMISSION
TO THE COMMITTEE ON ENERGY AND COMMERCE
SUBCOMMITTEE ON INVESTIGATIONS
UNITED STATES HOUSE OF REPRESENTATIVES

NRC RESPONSE TO RECENT NUCLEAR EVENTS IN JAPAN AND THE CONTINUING SAFETY OF THE U.S. COMMERCIAL NUCLEAR REACTOR FLEET

APRIL 6, 2011

The staff of the U.S. Nuclear Regulatory Commission is deeply saddened by the tragedy in Japan. I and many of my colleagues on the NRC staff have had many years of very close and personal interaction with our regulatory counterparts and we would like to extend our condolences to them.

Introduction

The NRC is mindful that our primary responsibility is to ensure the adequate protection of the public health and safety of the American people. We have been very closely monitoring the activities in Japan and reviewing all currently available information. Review of this information, combined with our ongoing inspection and licensing oversight, allows us to say with confidence that the U.S. plants continue to operate safely. There has been no reduction in the licensing or oversight function of the NRC as it relates to any of the U.S. licensees.

We have a long history of conservative regulatory decision-making. We have been using risk insights to help inform our regulatory process, and, over more than 35 years of civilian nuclear power in this country, we have never stopped making improvements to our regulatory framework as we learn from operating experience.

Notwithstanding the very high level of support being provided to respond to events in Japan, we continue to maintain our focus on our domestic responsibilities.

I'd like to begin with a brief overview of our immediate and continuing response.

including our recommendation for U.S. Citizens in Japan to evacuate out to 50 miles from the Fukushim-Daiichi site. I then ~~want to spend the bulk of my time discussing~~will discuss the reasons for our confidence in the safety of the U. S. commercial nuclear reactor fleet, and the path forward that we will take to ensure we learn any lessons we need to from events in Japan. Finally, I will give you an overview of NRC incident response capabilities here in the U.S.

The NRC's immediate and Continuing Response to Events in Japan

On Friday, March 11th an earthquake hit Japan, resulting in the shutdown of more than 10 reactors. From what we know now, it appears possible that the reactors' response to the earthquake went according to design. The ensuing tsunami, however, appears to have caused the loss of normal and emergency AC power to the six units at the Fukushima Daiichi site; it is those six units that have received the majority of our attention since that time. Units One, Two, and Three at the site were in operation at the time of the earthquake. Units Four, Five, and Six were in previously scheduled outages.

Shortly after 4:00 AM EDT on Friday, March 11th, the NRC Emergency Operations Center made the first call, informing NRC management of the earthquake and the potential impact on U.S. plants. We went into the monitoring mode at the Emergency Operations Center and the first concern for the NRC was possible impacts of the tsunami on U.S. plants and radioactive materials on the West Coast, and in Hawaii, Alaska, and U.S. Territories in the Pacific.

On that same day, we began interactions with our Japanese regulatory counterparts and dispatched two experts to help at the U.S. embassy in Japan. By Monday, we had dispatched a total of 11 staff to Japan. We have subsequently rotated in ~~additional~~ replacement staff to continue our on-the-ground assistance in Japan. The areas of focus for this team are: 1) to assist the Japanese government with technical support as part of the

USAID response; and 2) to support the U.S. ambassador. The NRC's Chairman, Dr. Gregory Jaczko, traveled to Toyko on March 28th for several days to convey directly to his Japanese counterparts a message of support and cooperation, and to discuss the current situation. While our focus now is on helping Japan in any way that we can, the experience will also help us assess the implications for U.S. citizens and the U.S. reactor fleet in as timely a manner as possible.

Formatted: Superscript

We have an extensive range of stakeholders with whom we have ongoing interaction, including the White House, Congressional staff, our state regulatory counterparts, a number of other federal agencies, and international regulatory bodies around the world. We recently sent an NRC staff member to Hawaii to support the United States Armed Forces Pacific Command (USPACOM).

The NRC response in Japan and our Emergency Operations Center continue with the dedicated efforts of over 250 NRC staff on a rotating basis. [UPDATE IF STAFFING SITUATION CHANGES] The entire agency is coordinating and pulling together in response to this event so that we can provide assistance to Japan while continuing the normal activities necessary to fulfill our domestic responsibilities.

The decision regarding the 50 mile evacuation recommendation was made in order to provide timely information to the U.S. Ambassador in Japan, and to best protect the health and safety of U.S. citizens in Japan. We based our assessment on the conditions as we understood them at the time. Since communications were limited and there was a large degree of uncertainty about plant conditions at the time, it was difficult to accurately assess the radiological hazard. In order to determine the proper evacuation distance, the NRC staff performed a series of calculations using NRC's RASCAL computer code to assess possible offsite consequences. The computer models used meteorological model data appropriate for the Fukushima Daiichi vicinity. Source terms were based on hypothetical, but not unreasonable

Formatted: Normal, Indent: First line: 0", Don't adjust space between Latin and Asian text, Don't adjust space between Asian text and numbers estimates of fuel damage, containment, and other release conditions. These calculations demonstrated that the Environmental Protection Agency's Protective Action Guidelines could be exceeded at a distance of 50 miles from the Fukushima site, if a large-scale release occurred from the reactors or spent fuel pools. We understood that some of our assumptions were conservative, but believed that it was better to err on the side of protection, especially in the case of a seemingly rapidly deteriorating situation. The U.S. Emergency Preparedness framework provides for the expansion of emergency planning zones as conditions require. Acting in accordance with this framework, and with the best information available at the time, the NRC determined that evacuation out to 50 miles for U.S. citizens was an appropriate course of action, and we made that recommendation to other U.S. Government agencies.

Let me ~~also just~~ note here in concluding this section of my remarks that the U.S. government has an extensive network of radiation monitors across this country. Monitoring equipment at nuclear power plants and in the U. S. Environmental Protection Agency's (EPA) system has identified trace amounts of radioactive isotopes consistent with the Japanese nuclear incident, but still far below levels of natural background radiation or of public health concern. ~~has not identified any radiation levels of concern in this country.~~ ~~In fact, natural background radiation from sources such as rocks, the sun, and buildings, is 100,000 times more than doses attributed to any level of the radiation from this event that has been detected in the U.S. to date.~~ ~~Therefore,~~ ~~W~~We feel confident, based on current data, that there is no reason for concern in the United States regarding radioactive releases from Japan.

Comment [RSR1]: This sentence came from 3/22 NRC press release. On 3/31 EPA reported "levels slightly higher than those found by EPA monitors last week...but still far below levels of public health concern." In another week at time of testimony, we expect to continue to see safe levels, but I don't know if the 100,000 figure will still be correct.

Continuing Confidence in the Safety of U.S. Nuclear Power Plants

I will now turn to the factors that assure us of ongoing domestic reactor safety. We have, since the beginning of the regulatory program in the United States, used a philosophy of Defense-in-Depth, which recognizes that nuclear reactors require the highest standards of design, construction, oversight, and operation, and does not rely on any single layer for protection of public health and safety. We begin with designs for every individual reactor in this country that take into account site-specific factors and include a detailed evaluation for any natural event, such as earthquakes, tornadoes, hurricanes, floods, and tsunamis, as they relate to that site.

There are multiple physical barriers to radiation in every reactor design. Additionally, there are both diverse and redundant safety systems that are required to be maintained in operable condition and frequently tested to ensure that the plant is in a high condition of readiness to respond to any scenario.

We have taken advantage of the lessons learned from previous operating experience to implement a program of continuous improvement for the U.S. reactor fleet. We have learned from experience across a wide range of situations, including most significantly, the Three Mile Island accident in 1979. As a result of those lessons learned, we ~~have~~ significantly revised emergency planning requirements and emergency operating procedures for licensees, and made substantive improvements in NRC's incident response capabilities ~~as well as significantly improved our own response to an incident~~. We also ~~have~~ addressed many human factors issues regarding ~~how~~ control room indicators and layouts ~~employees operate the plant~~, added new requirements for hydrogen control to help prevent explosions inside of containment, and created requirements for enhanced control room displays of the status of pumps and valves.

~~The NRC has a post-accident sampling system that enables the monitoring of radioactive material release and possible fuel degradation. One of the most~~ Two significant changes after Three Mile Island ~~was~~ were the expansion of the Resident Inspector Program~~, which has at least two full-time NRC inspectors on site at each nuclear power plant,~~ and the ~~improvements to our own~~ incident response program. ~~These~~ Today, there are at least two Resident inspectors at each nuclear power plant. The inspectors have unfettered access to all licensees' activities, and serve as NRC's eyes and ears ~~on site during any event at a nuclear~~ at the power plant. The NRC headquarters operations center and regional incident response centers are prepared ~~is ready~~ to respond to all emergencies, including any resulting from operational ~~safety~~ events, security events, or ~~other events such as man-made or~~ natural phenomena. Multidisciplinarye teams in these centers have access to detailed information regarding licensee facilities, and access to plant status information through telephonic links with the resident

Formatted: Highlight

Formatted: Highlight

Formatted: Default, Indent: First line: 0", Right: 0", Line spacing: single

Formatted: Highlight

Formatted: Highlight

Formatted: Font: 11 pt, Highlight

Formatted: Highlight

Formatted: Font: 11 pt, Highlight

Formatted: Highlight

Formatted: Highlight

inspectors, an automated emergency response data system, and directly from the licensee over the emergency notification system. NRC's response would include the dispatch of a site team to augment the Resident Inspectors on site and integration with the licensee's emergency response organization of their Emergency Offsite Facility. The program is designed to provide independent assessment of events, to ensure that appropriate actions are taken to mitigate the events, and to ensure that State officials have the information they would need to make decisions regarding protective actions.~~address these events singly or in combination where conditions exist or could lead to a radiological risk to public health or safety from an NRC licensed facility.~~

As a result of operating experience and ongoing research programs, we have developed requirements for severe accident management guidelines. These are components and procedures developed to ensure that, in the event all of the above precautions failed and a severe accident occurred, the plant would still protect public health and safety. The requirements for severe accident management have been in effect for many years and are frequently evaluated by the NRC inspection program.

As a result of the events of September 11, 2001, we identified important pieces of equipment that, regardless of the cause of a significant fire or explosion at a plant, we want licensees to have available and staged in advance, as well as new procedures, training requirements, and policies that would help deal with a severe situation.

Our program of continuous improvement based on operating experience will now include evaluation of the significant events in Japan as well as what we can learn from them. We already have begun enhancing inspection activities through temporary instructions to our inspection staff, including the resident inspectors and the region-based inspectors in our four Regional offices, to look at licensees' readiness to deal with both the design basis accidents and the beyond-design basis accidents. The information that we gather will be used to evaluate the industry's readiness for similar events, and will aid in our understanding of whether additional regulatory actions need to be taken in the immediate term.

We have also issued an information notice to the licensees to make them aware of the

Formatted: Font: 11 pt, Highlight

Formatted: Highlight

Formatted: Font: 11 pt, Highlight

Formatted: Highlight

Formatted: Font: 11 pt, Highlight

Formatted: Font: 12 pt

Formatted: Default, Indent: First line: 0", Right: 0", Line spacing: single

Comment [j2]: Would it be appropriate to add a short paragraph about how we have an integrated interagency response that we practice with the facility ; other federal partners, and state and local (and tribal!) stakeholders?

events in Japan, and the kinds of activities we believe they should be engaged in to verify their readiness. Specifically, we have requested them to verify that their capabilities to mitigate conditions that result from severe accidents, including the loss of significant operational and safety systems, are in effect and operational. Licensees are verifying the capability to mitigate a total loss of electric power to the nuclear plant. They also are verifying the capability to mitigate problems associated with flooding and the resulting impact on systems both inside and outside of the plant. Also, licensees are confirming the equipment that is needed is in place for the potential loss of equipment due to seismic events appropriate for the site, because each site has its own unique seismic profiles.

During the past 20 years, there have been a number of new rulemakings that have enhanced the domestic fleet's preparedness against some of the problems we are seeing in Japan. The "station blackout" rule requires every plant in this country to analyze what the plant response would be if it were to lose all alternating current so that it could respond using batteries for a period of time, and then have procedures in place to restore alternating current to the site and provide cooling to the core.

The hydrogen rule requires modifications to reduce the impacts of hydrogen generated for beyond-design basis events and core damage. There are equipment qualification rules that require equipment, including pumps and valves, to remain operable under the kinds of environmental temperature and radiation conditions that you would see under a design basis accident. With regard to the type of containment design used by the most heavily damaged plants in Japan, the NRC has had a Boiling Water Reactor Mark I Containment Improvement Program since the late 1980s, which has required installation of hardened vent systems for containment pressure relief, as well as enhanced reliability of the automatic depressurization system.

The final factor I want to mention with regard to our belief in the ongoing safety of the

U.S. fleet is the emergency preparedness and planning requirements in place that provide ongoing training, testing, and evaluations of licensees' emergency preparedness programs. In coordination with our federal partner, the Federal Emergency Management Administration (FEMA), these activities include extensive interaction with state and local governments, as those programs are evaluated and tested on a periodic basis.

The Path Ahead

Beyond the initial steps to address the experience from the events in Japan, the Chairman, with the full support of the Commission, directed the NRC staff to establish a senior level agency task force to conduct a methodical and systematic review of our processes and regulations to determine whether the agency should make additional improvements to our regulatory system and make recommendations to the Commission for its policy direction. This activity will have both near-term and longer-term objectives.

For the near term effort, we are beginning a 90-day review. This review will evaluate all of the currently available information from the Japanese events to identify immediate or near-term operational or regulatory issues potentially affecting the 104 operating reactors in the U.S., including their spent fuel pools. Areas of investigation will include the ability to protect against natural disasters, response to station blackouts, severe accidents and spent fuel accident progression, radiological consequence analysis, and severe accident management issues ~~regarding equipment~~. Over this 90-day period, we will develop recommendations, as appropriate, for changes to inspection procedures and licensing review guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.

This 90-day effort will include a 30-day "Quick Look Report" to the Commission to provide a snapshot of the regulatory response and the condition of the U.S. fleet based on information we have available at that time. Preparing a "Quick Look Report" will also ensure that the Commission is both kept informed of ongoing efforts and prepared to resolve any policy recommendations that surface. I believe we will have limited stakeholder involvement in the first 30 days to accomplish this. However over the 90-day and longer-term efforts we will seek additional stakeholder input. At the end of the 90-day period, a report will be provided to the Commission and to the public. The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan.

The task force will evaluate all technical and policy issues related to the event to identify additional potential research, generic issues, changes to the reactor oversight process, rulemakings, and adjustments to the regulatory framework that should be pursued by the NRC. We also expect to evaluate potential interagency issues, such as emergency preparedness, and examine the applicability of any lessons learned to non-operating reactors and materials licensees. We expect to seek input from stakeholders during this process. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day and final reports will be made publicly available in accordance with normal Commission processes.

Conclusion

In conclusion, I want to reiterate that we continue to make our domestic responsibilities for licensing and oversight of the U.S. licensees our top priority and that the U.S. plants continue to operate safely. In light of the events in Japan, there is a near-term evaluation of their relevance to the U.S. fleet underway, and we are continuing to gather the information necessary for us to take a longer, more thorough look at the events in Japan and their lessons for us. Based on these efforts, we will take all appropriate actions necessary to ensure the continuing safety of the U.S. fleet.

Rihm, Roger

From: Rihm, Roger
Sent: Monday, April 04, 2011 11:29 AM
To: Landau, Mindy
Subject: Do you have suggestions for further cuts?
Attachments: Testimony_Oral_April6_2011.docx

Having not heard anything from OCA re: the status of Marty's draft testimony with the additional info on 50-mile evacuation and additional info on incident response system added (as requested by Committee staff), I am proceeding to craft Marty's shorter written statement. It is still about a page too long. Do you see more things we could eliminate?

Y1329

TESTIMONY OF MARTIN VIRGILIO
APRIL 6, 2011

Formatted: Not Highlight

Introduction

The NRC is mindful that our primary responsibility is to ensure the adequate protection of the public health and safety of the American people. We have been very closely monitoring the activities in Japan and reviewing all currently available information. Review of this information, combined with our ongoing inspection and licensing oversight, allows us to say with confidence that U.S. plants continue to operate safely. There has been no reduction in the licensing or oversight function of the NRC as it relates to any of the U.S. licensees. Notwithstanding the very high level of support being provided to respond to events in Japan, we continue to maintain our focus on our domestic responsibilities.

The NRC's immediate and Continuing Response to Events in Japan

On Friday, March 11th an earthquake hit Japan, resulting in the shutdown of more than 10 reactors. From what we know now, it appears possible that the reactors' response to the earthquake went according to design. The ensuing tsunami, however, appears to have caused the loss of normal and emergency AC power to the six units at the Fukushima Daiichi site.

Shortly after 4:00 AM EDT on Friday, March 11th, the NRC Emergency Operations Center made the first call, informing NRC management of the earthquake and the potential impact on U.S. plants. We went into the monitoring mode at the Emergency Operations Center and the first concern for the NRC was possible impacts of the tsunami on U.S. plants and radioactive materials on the West Coast, and in Hawaii, Alaska, and U.S. Territories in the Pacific.

On that same day, we began interactions with our Japanese regulatory counterparts and dispatched two experts to help at the U.S. embassy in Japan. By Monday, we had dispatched a total of 11 staff to Japan. We continue to have staff on the ground in Japan, and their areas of focus for this team are: 1) to assist the Japanese government with technical support as part of the USAID response; and 2) to support the U.S. ambassador. NRC Chairman, Dr. Gregory Jaczko, traveled to Toyko on March 28th for several days to convey directly to his Japanese counterparts a message of support and cooperation, and to discuss the current situation.

The decision regarding the 50 mile evacuation recommendation was based on our assessment on the conditions as we understood them at the time. Since communications were limited and there was a large degree of uncertainty about plant conditions, it was difficult to accurately assess the radiological hazard. In order to determine the proper evacuation distance, the NRC staff performed a series of calculations using NRC's RASCAL computer code to assess possible offsite consequences. Source terms were based on hypothetical, but not unreasonable estimates of fuel damage, containment, and other release conditions. These calculations demonstrated that the Environmental Protection Agency's Protective Action Guidelines could be exceeded at a distance of 50 miles from the Fukushima site, if a large-scale release occurred from the reactors or spent fuel pools. We understood that some of our assumptions were conservative, but believed that it was better to err on the side of protection, especially in the case of a seemingly rapidly deteriorating situation. Acting in accordance with the U.S. Emergency Planning framework, and with the best information available at the time, the NRC determined that evacuation out to 50 miles for U.S. citizens was an appropriate course of action, and we made that recommendation to other U.S. Government agencies.

Continuing Confidence in the Safety of U.S. Nuclear Power Plants

I will now turn to the factors that assure us of ongoing domestic reactor safety. We have, since the beginning of the regulatory program in the United States, used a philosophy of Defense-in-Depth, which recognizes that nuclear reactors require the highest standards of design, construction, oversight, and operation, and does not rely on any single layer for protection of public health and safety. We begin with designs for every individual reactor that take into account site-specific factors and include a detailed evaluation for any natural event, such as earthquakes, tornadoes, hurricanes, floods, and tsunamis, as they relate to that site.

There are multiple physical barriers to radiation in every reactor design. Additionally, there are both diverse and redundant safety systems that are required to be maintained in operable condition and frequently tested to ensure that the plant is in a high condition of readiness to respond to any scenario.

We have taken advantage of the lessons learned from previous operating experience to implement a program of continuous improvement for the U.S. reactor fleet. We have learned from experience across a wide range of situations, including most significantly, the Three Mile Island accident in 1979. As a result of those lessons learned, we significantly revised emergency planning requirements and emergency operating procedures for licensees, and made substantive improvements in NRC's incident response capabilities. We also have addressed many human factors issues regarding control room indicators and layouts, added new requirements for hydrogen control to help prevent explosions inside of containment, and created requirements for enhanced control room displays of the status of pumps and valves.

Two significant changes after Three Mile Island were the expansion of the Resident Inspector Program and the incident response program. Today, there are at least two Resident inspectors at each nuclear power plant. The inspectors have unfettered access to all licensees' activities, and serve as NRC's eyes and ears at the power plant. The NRC headquarters operations center and regional incident response centers are prepared to respond to all emergencies, including any resulting from operational events, security events, or natural phenomena. Multidisciplinary teams in these centers have access to detailed information regarding licensee facilities, and access to plant status information through telephonic links with the resident inspectors, an automated emergency response data system, and directly from the licensee over the emergency notification system. NRC's response would include the dispatch of a site team to augment the Resident Inspectors on site and integration with the licensee's emergency response organization at their Emergency Offsite Facility. The program is designed to provide independent assessment of events, to ensure that appropriate actions are taken to mitigate the events, and to ensure that state officials have the information they would need to make decisions regarding protective actions.

Our program of continuous improvement based on operating experience will now include evaluation of the significant events in Japan as well as what we can learn from them. We already have begun enhancing inspection activities through temporary instructions to our inspection staff to look at licensees' readiness to deal with both the design basis accidents and the beyond-design basis accidents. The information that we gather will be used to evaluate the industry's readiness for similar events, and will aid in our understanding of whether additional regulatory actions need to be taken in the immediate term.

We have also issued an information notice to the licensees to make them aware of the events in Japan, and the kinds of activities we believe they should be engaged in to verify their readiness. Specifically, we have requested them to verify that their capabilities to mitigate conditions that result from severe accidents, including the loss of significant operational and safety systems, are in effect and operational. Licensees are verifying the capability to mitigate a total loss of electric power to the nuclear plant. They also are verifying the capability to mitigate problems associated with flooding and the resulting impact on systems both inside and outside of the plant. Also, licensees are confirming the equipment that is needed is in place for the potential loss of equipment due to seismic events appropriate for the site, because each site has its own unique seismic profiles.

The Path Ahead

Beyond the initial steps to address the experience from the events in Japan, the Chairman, with the full support of the Commission, directed the NRC staff to establish a senior level agency task force to conduct a methodical and systematic review of our processes and regulations to determine whether the agency should make additional improvements to our regulatory system and make recommendations to the Commission for its policy direction. This activity will have both near-term and longer-term objectives.

For the near term effort, we are beginning a 90-day review. This review will evaluate all of the currently available information from the Japanese events to identify immediate or near-term operational or regulatory issues potentially affecting the 104 operating reactors in the U.S., including their spent fuel pools. Areas of investigation will include the ability to protect against natural disasters, response to station blackouts, severe accidents and spent fuel accident progression, radiological consequence analysis, and severe accident management issues. Over this 90-day period, we will develop recommendations, as appropriate, for changes to inspection procedures and licensing review guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.

This 90-day effort will include a 30-day "Quick Look Report" to the Commission to provide a snapshot of the regulatory response and the condition of the U.S. fleet based on information we have available at that time. Preparing a "Quick Look Report" will also ensure that the Commission is both kept informed of ongoing efforts and prepared to resolve any policy recommendations that surface.

The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan. The task force will evaluate all technical and policy issues related to the event to identify additional potential research, generic issues, changes to the reactor oversight process, rulemakings, and adjustments to the regulatory framework that should be pursued by the NRC. We also expect to evaluate potential interagency issues, such as emergency preparedness, and examine the applicability of any lessons learned to non-operating reactors and materials licensees. We expect to seek input from stakeholders during this process. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day and final reports will be made publicly available.

Conclusion

In conclusion, I want to reiterate that we continue to make our domestic responsibilities for licensing and oversight of the U.S. licensees our top priority and that the U.S. plants continue to operate safely. In light of the events in Japan, there is a near-term evaluation of their relevance to the U.S. fleet underway, and we are continuing to gather the information necessary for us to take a longer, more thorough look at the events in Japan and their lessons for us. Based on these efforts, we will take all appropriate actions necessary to ensure the continuing safety of the U.S. fleet.

Rihm, Roger

From: Rihm, Roger
Sent: Monday, April 04, 2011 2:59 PM
To: Marshall, Jane; Milligan, Patricia
Subject: KI Question

Importance: High

I am putting together background materials for Marty's appearance before a House subcommittee on Weds. Markey is on the Subcommittee. Do we (you) have (or can I get) some sort of Q&A that would address Markey's current interest in expanding KI out to 20 miles (as I understand it)?

Rihm, Roger

From: Rihm, Roger
Sent: Monday, April 04, 2011 5:10 PM
To: Sheron, Brian
Cc: Uhle, Jennifer
Subject: Spent fuel Moving to Dry Cask Storage

Brian, Marty is testifying on Weds in the House and wants a little background information on the above subject. He said you/your staff could provide. Don't need much (a page or less), but will need it on TUESDAY. Thank you!

C

Khanna, Meena

From: Hiland, Patrick NRC
Sent: Monday, April 04, 2011 7:27 AM
To: NRR_DE Distribution
Subject: FW: CRS draft document on Japanese event - for your awareness
Attachments: CRS Report 110331 Japan reactor v2.pdf

Attached report is a detailed explanation of current knowledge, and it provides some reference data.

X/340

Congressional Research Service

The Japanese Nuclear Incident: Technical Aspects

Jonathan Medalia
Specialist in Nuclear Weapons Policy

March 31, 2011

Congressional Research Service
7-5700
www.crs.gov
R41728

CRS Report for Congress
Prepared for Members and Committees of Congress

Summary

Japan's nuclear incident has engendered much public and congressional concern about the possible impact of radiation on the Japanese public, as well as possible fallout on U.S. citizens. This report provides information on technical aspects of the nuclear incident, with reference to human health.

While some radioactive material from the Japanese incident may reach the United States, it appears most unlikely that this material will result in harmful levels of radiation. In traveling thousands of miles between the two countries, some radioactive material will decay, rain will wash some out of the air, and its concentration will diminish as it disperses.

Many atoms are stable; they remain in their current form indefinitely. Other atoms are unstable, or radioactive. They "decay" or "disintegrate," emitting energy through various forms of radiation. Each form has its own characteristics and potential for human health effects.

Nuclear reactors use uranium or mixed oxides (uranium oxide and plutonium oxide, or MOX) for fuel. Uranium and plutonium atoms fission, or split, releasing neutrons that cause additional fissions in a chain reaction, and also releasing energy. A nuclear reactor's core consists of fuel rods made of uranium or MOX encased in zirconium, and neutron-absorbing control rods that are removed or inserted to start or stop the chain reaction. This assembly is placed underwater to carry off excess heat. The incident at the Fukushima Daiichi Nuclear Power Plant prevented water from circulating in the core of several reactors, causing water to evaporate and temperature to rise. High heat could melt the fuel rods and lead to a release of radioactive material into the air.

When uranium and plutonium fission, they split into smaller atoms that are highly radioactive and generate much heat; indeed, fuel rods that have just been removed from a reactor are much more radioactive, and hotter, than fuel rods before they have been inserted into a reactor. After fuel rods can no longer efficiently produce energy, they are considered "spent" and are placed in cooling pools of water for several years to keep them from overheating while the most radioactive materials decay. A concern about the spent fuel pool at reactor 4 is that it may have lost most or all of its water, yet it has more fuel rods than pools at the other five reactors, as it contains all the active fuel rods that were temporarily removed from the reactor core in November 2010 to permit plant maintenance in addition to spent fuel rods.

A nuclear reactor cannot explode like an atomic bomb because the concentration of the type of uranium or plutonium that fissions easily is too low to support a runaway chain reaction, and a nuclear weapon requires one of two configurations, neither of which is present in a reactor.

Some types of radiation have enough energy to knock electrons off atoms, creating "ions" that are electrically charged and highly reactive. Ionizing radiation is thus harmful to living cells. It strikes people constantly, but in doses low enough to have negligible effect. A concern about the reactor incident is that it will release radioactive materials that pose a danger to human health. For example, cesium-137 emits gamma rays powerful enough to penetrate the body and damage cells. Ingesting iodine-131 increases the risk of thyroid cancer. Potassium iodide tablets protect the thyroid, but there is no need to take them absent an expectation of ingesting iodine-131.

Contents

Tables

Contacts

Introduction

The Japanese earthquake and tsunami of March 2011 caused extensive damage to the Fukushima Daiichi Nuclear Power Plant (NPP). This damage has released some radioactive materials, and there are widespread fears about the health effects of current and possible future releases. These fears, and public concern about radiation in general, have attracted the world's attention. This report presents scientific and technical aspects of these issues in order to provide a basis for understanding the risks associated with this event.

Could Harmful Levels of Fallout Reach the United States?[1]

To monitor radiation in the United States, the Environmental Protection Agency (EPA) operates RadNet, which "is a national network of monitoring stations that regularly collect air, precipitation, drinking water, and milk samples for analysis of radioactivity. The RadNet network, which has stations in each state, has been used to track environmental releases of radioactivity from nuclear weapons tests and nuclear accidents."[2] EPA has an online map of these stations,[3] and provides updates on the results of its air monitoring as relates to the Japanese nuclear incident.[4]

Whether harmful levels of radioactive material from the incident reach the United States depends on many factors:

- Particle size: Tiny particles are more readily carried by the wind and can travel farther than large particles, which fall to Earth more rapidly.
- Wind patterns.
- Amount of material released: The more material released, the more likely some of it is to travel long distances.
- Melt vs. burn: If nuclear fuel rods (fresh or spent) melt and form a pool of very hot, highly radioactive liquid, that liquid might be contained by a containment structure. If it melts through that structure, it might contaminate groundwater. If the fuel rods burn, the fire would loft radioactive material into the air. The larger and hotter the fire, and the longer it burns, the more material would be injected into the air.
- Travel time: The longer radioactive material is in the air, the more of it will decay.
- Distance: The farther radioactive material travels, the greater the volume of air in which the material disperses, diluting it.

[1] This section was written by Jonathan Medalia, Specialist in Nuclear Weapons Policy, Foreign Affairs, Defense, and Trade Division.

[2] U.S. Environmental Protection Agency. "RadNet—Tracking Environmental Radiation Nationwide," http://www.epa.gov/narel/radnet/.

[3] U.S. Environmental Protection Agency. "RadNet Map View," https://cdxnode64.epa.gov/radnet-public/showMap.do.

[4] U.S. Environmental Protection Agency. "Japanese Nuclear Emergency: EPA's Radiation Air Monitoring," http://www.epa.gov/japan2011/.

- Rain and snow: Precipitation washes some particles out of the air.

The first four of these factors depend on circumstances; the other three would reduce the amount of material reaching the United States under any circumstances.

According to U.S. nuclear authorities, the reactor incident does not appear to pose an immediate threat to the United States. On March 13, the Nuclear Regulatory Commission (NRC) stated, "Given the thousands of miles between the two countries [United States and Japan], Hawaii, Alaska, the U.S. Territories and the U.S. West Coast are not expected to experience any harmful levels of radioactivity."[5] On March 18, EPA and the Department of Energy stated that a monitoring station in Sacramento "today ... detected minuscule quantities of iodine isotopes and other radioactive particles that pose no health concern at the detected levels," and that between March 16 and 17, a detector in Washington state detected "trace amounts of Xenon-133, which is a radioactive noble gas produced during nuclear fission that poses no concern at the detected level."[6] In a briefing to the Nuclear Regulatory Commission on March 21, Bill Borchardt, NRC Executive Director for Operations, said, "natural background from things like ... rocks, sun, buildings, is 100,000 times more than any level that has been detected to date. We feel confident in our conclusion that there is no reason for concern in the United States regarding radioactive releases from Japan."[7] A press report of March 22 stated that equipment in Charlottesville, VA, detected radiation from the reactor incident, but that "health experts said that the plume's radiation had been diluted enormously in its journey of thousands of miles and that—at least for now, with concentrations so low—its presence will have no health consequences in the United States."[8]

It is useful to put these doses in perspective. Using the figure that natural sources provide 100,000 times the dose recorded in California and Washington state, it is possible to calculate a rough approximation of the dose from the Japanese incident, using the improbable assumption that the dose persists at the detected rate for an entire year. As discussed later, a report estimates that the average American receives a dose of 310 millirem (mrem) per year from natural sources. (Units of radiation dose are discussed under "Health Effects of Ionizing Radiation.") NRC requires its licensees to "limit maximum radiation exposure to individual members of the public" to 100 mrem per year. One one hundred thousandth of 310 mrem per year is a dose of 0.00310 mrem per year. At that rate, it would take 32,258 years to accumulate a dose of 100 mrem; over a 70-year lifespan, the cumulative dose at this rate would amount to 0.22 mrem.

[5] U.S. Nuclear Regulatory Commission. "NRC Sees No Radiation at Harmful Levels Reaching U.S. from Damaged Japanese Nuclear Power Plants," press release no. 11-046, March 13, 2011, http://pbadupws.nrc.gov/docs/ML1107/ML110720002.pdf.

[6] U.S. Department of Energy and Environmental Protection Agency. "Joint EPA/DOE Statement: Radiation Monitors Confirm That No Radiation Levels of Concern Have Reached the United States," press release, March 18, 2011, http://www.energy.gov/news/10190.htm.

[7] U.S. Nuclear Regulatory Commission. "Briefing on NRC Response to Recent Nuclear Events in Japan," public meeting, March 21, 2011, p. 13, http://www.nrc.gov/reading-rm/doc-collections/commission/tr/2011/20110321.pdf.

[8] William Broad, "Radiation over U.S. Is Harmless, Officials Say," *New York Times*, March 22, 2011, p. 6.

What Is Radiation?[9]

Many atoms are stable: they will remain in their current form indefinitely. Some atoms are unstable, or radioactive. They "decay" or "disintegrate," often transforming into atoms of a different element, such as through emission of radiation, which permits the atom to reach a more stable state.[10] The most common types of radiation emitted in decay, and their characteristics, are:

- Alpha particles are two protons plus two neutrons. They are electrically charged and massive by subatomic standards, and travel relatively slowly, so they lose energy quickly in matter. They travel only an inch in air, and are stopped by a sheet of paper or the dead outer layers of skin.
- Beta particles (an electron or positron[11]) are electrically charged, so are readily absorbed by matter, but are much less massive than alpha particles or neutrons. Depending on their energy, some are stopped by outer layers of skin, while others can penetrate several millimeters. They can travel up to several feet in air.
- Neutrons are typically emitted by heavy atoms like uranium and plutonium. They have no electrical charge and may be highly penetrating, depending on their speed. They can travel tens of meters in air; energetic neutrons can penetrate the body. They can be slowed down by hydrogen-containing material like water.
- Gamma rays are photons released during radioactive decay. Photons may be thought of as packets of electromagnetic energy; radio waves, light, and x-rays are less-energetic photons. Gamma ray energies vary widely. Those of medium to high energies are highly penetrating and can travel hundreds of meters in air. Stopping them requires a thick layer of a dense material like lead.

Several measurements are useful in discussing radioactivity. Radioactivity is measured in units of curies (Ci), where 1 Ci = 3.7×10^{10} disintegrations per second, or becquerels (Bq), where 1 Bq = 1 disintegration per second. (The curie is widely used in the United States; the Becquerel is more widely used internationally.) Specific activity—curies per gram—measures how radioactive a material is. Half-life is the time for half the atoms in a mass of particular type of radioactive material to decay. Specific activity is inversely related to half-life. For example, radioactive iodine-131 is intensely radioactive. It has a specific activity of 124,000 curies per gram and a half-life of 8 days; in 10 half-lives (80 days), 99.9 percent of the iodine-131 created at a given time will have decayed. In contrast, uranium-235 has a specific activity of 0.000002 curies per gram and a half-life of 700 million years; it would take 7 billion years (10 half-lives) for 99.9 percent of it to decay.[12] According to Richard Firestone, staff scientist, Lawrence Berkeley

---

[9] This section was written by Jonathan Medalia, Specialist in Nuclear Weapons Policy, Foreign Affairs, Defense, and Trade Division.

[10] For descriptions of radiation, see Roger Eckhardt, "Ionizing Radiation—It's Everywhere," *Los Alamos Science,* no. 23, 1995, http://www.fas.org/sgp/othergov/doe/lanl/00326627.pdf, and U.S. Environmental Protection Agency, "Radiation: Ionizing and Non-Ionizing," http://www.epa.gov/radiation/understand/index.html.

[11] A positron is a positively-charged electron.

[12] For data on half-lives and other characteristics of radionuclides, see Lawrence Berkeley National Laboratory, "Exploring the Table of Isotopes," http://ie.lbl.gov/education/isotopes.htm, and U.S. Department of Energy. Office of Environmental Management. "Table B.1. Characteristics of important radionuclides," http://www.orau.org/ptp/PTP%20Library/library/DOE/Misc/Table%20B_1_%20Characteristics%20of%20Important%20Radionuclides.htm.

National Laboratory, uranium-235 emits so little radiation that "holding a piece in the hand would cause negligible radiation exposure."[13]

Energy released per decay is measured differently. A standard measure is the electron volt or, more commonly, thousands of electron volts (keV).[14] The penetrating power of gamma rays, and thus their threat to human health, increases as their energy increases.

Each radioactive atom, or "radionuclide," decays in a specific way. For example, when uranium-235 decays,[15] it emits gamma rays, most of which are of 186 keV (a low energy) or less, and alpha particles; cesium-137 emits gamma rays, virtually all of which are of 662 keV, a medium energy, and beta particles. Each radionuclide that emits gamma rays does so in a unique pattern, or "spectrum," of energies that is the primary characteristic used to identify many radionuclides.

Radioactivity and Nuclear Reactors[16,17]

Some heavy atoms, such as uranium-235 and plutonium-239, "fission" when struck by a neutron. In fission, an atom typically (1) splits into two lighter atoms, called "fission products"; (2) releases two or three neutrons; and (3) emits vast quantities of radiation. Fission products are often highly radioactive, such as cesium-137, iodine-131, and strontium-90.

Uranium-235 and plutonium-239 can support a nuclear chain reaction: to oversimplify, one neutron fissions one atom, which releases two neutrons that fission two atoms, releasing four neutrons that fission four atoms, and so on. Neutrons thus drive chain reactions; this is a key concept for understanding nuclear reactors. A supercritical mass supports an increasing rate of fission; fission diminishes in a subcritical mass; and fission proceeds at a constant rate in a critical mass. In an atomic bomb, a supercritical mass of uranium or plutonium supports a chain reaction that proceeds in a tiny fraction of a second, releasing vast quantities of energy. A nuclear reactor is designed to maintain a constant rate of fission. If fission proceeds too quickly, it gets out of control, in which case the fuel rods generate so much heat that they melt. When control rods are inserted into the reactor core, individual atoms continue to fission but the chain reaction stops. Control rods typically contain boron or cadmium because they are efficient neutron absorbers. (Because boron absorbs neutrons, it was added to cooling water in the Fukushima Daiichi NPP incident to prevent inadvertent criticality.) Fission that proceeds at the desired rate releases energy over several years from one load of fuel. The energy heats water to generate steam that spins turbines to generate electricity.

[13] Personal communication, March 30, 2011.

[14] "An electron volt is a measure of energy. An electron volt is the kinetic energy gained by an electron passing through a potential difference of one volt." Fermi National Accelerator Laboratory, "How Big Is an Electron Volt?," http://www-bd.fnal.gov/public/electronvolt.html.

[15] The number following the name of an element is the number of protons plus neutrons in the nucleus.

[16] This section was written by Jonathan Medalia, Specialist in Nuclear Weapons Policy, Foreign Affairs, Defense, and Trade Division, and Mark Holt, Specialist in Energy Policy, Resources, Science, and Industry Division. See also CRS Report R41694, *Fukushima Nuclear Crisis*, by Richard J. Campbell and Mark Holt.

[17] For the status of each reactor, see "Status of the Nuclear Reactors at the Fukushima Daiichi Power Plant," *New York Times*, http://www.nytimes.com/interactive/2011/03/16/world/asia/reactors-status.html., and Japan, Nuclear and Industrial Safety Agency, http://www.nisa.meti.go.jp/english/.

A nuclear reactor cannot explode like an atomic bomb because the fuels and configurations differ. In nature, uranium is 99.3 percent uranium-238 and 0.7 percent uranium-235. Only the latter is "fissile," that is, it will fission when struck by neutrons moving at relatively slow speeds. To make fuel for a bomb or a reactor, the fraction of uranium-235 must be increased through "enrichment."[18] An atomic bomb uses uranium enriched to about 90 percent uranium-235 ("highly enriched uranium," HEU), while nuclear reactor fuel is typically enriched to less than 5 percent ("low enriched uranium," LEU). LEU does not have enough uranium-235 to support a chain reaction of the sort found in an atomic bomb. In addition, a bomb must be configured in one of two ways to create a large enough mass to support a runaway chain reaction; reactors are arranged in an entirely different configuration.

A nuclear reactor uses pellets of LEU or mixed oxides (MOX, i.e., uranium oxide and plutonium oxide) for fuel. Fuel rods—thin zirconium tubes typically between 12 and 15 feet long—hold the fuel. According to one report,

> Zirconium is the metal of choice in this application because it absorbs relatively few of the neutrons produced in a fission reaction and because the metal is highly resistant to both heat and chemical corrosion.
>
> Low neutron absorption is vital to any structural material used in a nuclear reactor because large numbers of neutrons produced by the reaction must be free to interact simultaneously with all the nuclear fuel confined inside hundreds of fuel rods. This interaction sustains the necessary chain reaction throughout the reactor's core.[19]

Even with control rods fully inserted to halt the nuclear chain reaction, the radioactive decay of the fuel rods (primarily from fission products) generates heat, which must be dissipated. At the Fukushima Daiichi NPP, cooling was done by pumping cool water into the reactor. If the heat is not dissipated, the rods become so hot that they melt or burn. A fire would loft particles of radioactive material into the air. If fuel rods become too hot, their zirconium cladding may also react with water and produce hydrogen. The Fukushima Daiichi NPP primary containments used inert nitrogen gas to preclude hydrogen ignition. However, the operators had to vent the primary containment to relieve pressure, introducing hydrogen into the secondary containment, which is believed to have caused the explosions at reactor units 1-3.[20] This explains the urgency of the efforts to keep the fuel rods cool, and why the reactors suffered major damage when backup cooling systems failed.

In order to cool the fuel rods, personnel have been spraying huge amounts of seawater into the reactors and spent fuel pools. However, when seawater boils away from the heat of the fuel rods, it leaves behind large quantities of salt.

> The big question is how much of that salt is still mixed with water, and how much now forms a crust on the reactors' uranium fuel rods. Chemical crusts on uranium fuel rods have been a problem for years at nuclear plants.

---

[18] For information on the enrichment process, see U.S. Nuclear Regulatory Commission. "Fact Sheet on Uranium Enrichment," May 15, 2009, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/enrichment.html.

[19] "Zirconium: Covering for Fuel Rods," *New York Times*, June 9, 1995, http://www.nytimes.com/1995/06/09/nyregion/zirconium-covering-for-fuel-rods.html.

[20] Information provided by Nuclear Regulatory Commission, personal communication, March 25, 2011.

> Crusts insulate the rods from the water and allow them to heat up. If the crusts are thick enough, they can block water from circulating between the fuel rods. As the rods heat up, their zirconium cladding can ignite, which may cause the uranium inside to melt and release radioactive material.[21]

To alleviate this problem, workers have begun using fresh water instead of seawater.[22]

As the fuel fissions in a reactor, the fraction of fission products in fuel rods increases. When the ratio of fission products to fissile material rises to the point at which a fuel rod can no longer efficiently maintain a chain reaction, it is referred to as spent fuel. "Spent" seems to imply that the fuel has been used up, and is therefore less dangerous, than fresh uranium fuel, but this is not necessarily the case. When fuel rods are first removed from a nuclear reactor, they have a high level of short-lived radionuclides, unlike new fuel rods, so they are intensely radioactive. This radioactivity generates intense heat, so spent fuel rods are placed in pools of water to cool them, typically for several years, until most of the short-lived radionuclides decay. The water also provides shielding against any radioactive release into the air, and the spent fuel pools have no hardened containment structure that would protect against radiation release. If a pool is drained, the fuel rods would heat up, melt, and perhaps burn. This possibility led to concern about the spent fuel rods at Fukushima Daiichi NPP reactor 4:

> The spent fuel pools can be even more dangerous than the active fuel rods, as they are not contained in thick steel containers like the reactor core. As they are exposed to air, the zirconium metal cladding on the rods can catch fire, and a deadly mix of radioactive elements can spew into the atmosphere. ...
>
> According to Tokyo Electric [Power Company]'s data, the spent fuel pool at the No. 4 reactor contains 548 fuel assemblies that were in use at the reactor until last November, when they were moved to the storage pool on the site. That means that the fuel rods were only recently taken out of active use and that their potential to burn and release radioactivity is higher than spent fuel in storage for a longer period.[23]

Another danger comes from the potential release of plutonium from the MOX fuel used at reactor 3. Even very small amounts of plutonium, if inhaled, can potentially cause lung cancer. This explains the concern about that reactor, as it is the only one that uses MOX fuel, although irradiation of uranium fuel also creates plutonium. Water is being pumped into the spent fuel pools at the Fukushima Daiichi NPP reactors as well to cool the fuel rods and prevent additional radiation release.

---

[21] Keith Bradsher, "New Problems at Japanese Plant Subdue Optimism and Present a Risky Agenda," *New York Times*, March 24, 2011, p. 11.

[22] David Nakamura and Steven Mufson, "Japan Urges More to Evacuate," *Washington Post*, March 26, 2011, p. 1, and "Nuclear Energy—Crisis in Japan," *New York Times*, update of March 30, 2011.

[23] David Sanger, Matthew Wald, and Hiroko Tabuchi, "U.S. Sees 'Extremely High' Radiation Level at Plant, Focusing on Spent Fuel's Impact," *New York Times*, March 17, 2011, p. 13.

Health Effects of Ionizing Radiation[24]

Humans are continuously exposed to significant amounts of ionizing radiation from various naturally occurring and manmade sources. Because of its relatively high energy level, ionizing radiation is capable of producing significant biological change. Ionizing radiation gets its name from the fact that it causes ionization—ejection of electrons—when it interacts with atoms in the molecules that constitute cells and tissue. This process creates charged, often unstable, and highly reactive entities. The ensuing reactions may result in permanent molecular damage. Radiation disrupts cell division, which is why the most sensitive tissues are those in which cells frequently divide, such as skin, hair, bone marrow (where precursor cells give rise to new blood cells), and the cells that line the stomach and small intestine. Ionizing radiation may also damage DNA in chromosomes, resulting in mutations that are responsible for long-term effects such as the development of cancer.

Sources of Radiation Exposure

Naturally occurring sources of ionizing radiation to which all humans are exposed include cosmic radiation from outer space and terrestrial radiation from radioactive materials in rock deposits and soil. The Earth's atmosphere acts as a shield against cosmic radiation, so exposure levels increase with altitude (especially when flying). The most important source of terrestrial exposure is the inhalation of radon, which is produced by the radioactive decay of naturally occurring uranium.

In the United States, radiation exposure as a result of medical practice has increased significantly over the past 25 years as a result of the growing use of CT scans and nuclear medicine procedures to diagnose and treatment disease. Other manmade sources of radiation account for a relatively small fraction of the U.S. population's total exposure. Those sources include consumer products (e.g., cigarettes, building materials, appliances); industrial, security, educational, and research activities, including nuclear power generation; and various types of occupational exposure.

Measuring Exposure: Absorbed Dose v. Equivalent Dose

Human exposure is measured by the amount of energy that ionizing radiation deposits in a unit mass of tissue. This is called the *absorbed dose*. The international unit for the absorbed dose is the gray (Gy), which replaced an earlier unit of dose, the rad (short for "radiation absorbed dose"). One gray equals 100 rad. The biological impact of ionizing radiation, however, depends not just on the absorbed dose (i.e., the amount of energy absorbed) but on the type of radiation. For example, an alpha particle is more damaging to biological tissue than a beta particle or gamma radiation because of its mass, electrical charge, and slow speed. Alpha particles lose their energy much more densely along the relatively short path they travel though biological tissue. Thus, 1 Gy of alpha radiation is more harmful than 1 Gy of beta or gamma radiation.

Radiation scientists use another quantity, called *equivalent dose*, which allows them to measure all types of exposure on an equal basis. Equivalent dose is equal to the absorbed dose multiplied by a factor that takes into account the relative effectiveness of each type of radiation to cause harm. For beta particles and gamma radiation, the factor is set at 1; that is, the absorbed dose

[24] This section was written by Jonathan Medalia, Specialist in Nuclear Weapons Policy, Foreign Affairs, Defense, and Trade Division, and C. Stephen Redhead, Specialist in Health Policy, Domestic Social Policy Division.

equals the equivalent dose. For alpha particles the factor is set at 20, which means that the equivalent dose is 20 times the absorbed dose. This reflects the fact that alpha radiation is more harmful than beta and gamma radiation. The international unit for the equivalent dose is the sievert (Sv). So, 1 Sv of alpha radiation to the lung would create the same risk of lung cancer as 1 Sv of beta radiation. The sievert is a large unit relative to common exposures, so the more common unit is the millisievert (mSv), which is one-thousandth of a sievert. The sievert replaced an earlier unit of equivalent dose, the rem, which is still widely used in the United States. One sievert = 100 rem; 1 mSv = 100 millirem (mrem).

The National Council on Radiation Protection and Measurement (NCRP) estimates that the *average annual equivalent dose* to an individual in the United States is 6.2 mSv (620 mrem).[25] Of that amount, 3.1 mSv (310 mrem) is from natural background sources, primarily inhalation of radon and its decay products, and 3.0 mSv (300 mrem) is from diagnostic and therapeutic medical procedures. The remaining 0.1 mSv (10 mrem) is from consumer products, industrial activities, and occupational exposure, among other sources. For comparison, the radiation dose from a jet airplane flight is 0.5 millirems (mrem) per hour in the air; from a chest x-ray, 6 mrem; and from living at an altitude of one mile, about 50 mrem/year.[26] **Table 1** shows various doses and their health consequences or regulatory limits.

[25] National Council on Radiation Protection and Measurement, "Ionizing Radiation Exposure of the Population of the United States," report no. 160, 2009.

[26] American Nuclear Society, "Radiation Dose Chart," http://www.ans.org/pi/resources/dosechart/. This interactive chart permits the user to adjust values to find an approximation of his or her total annual dose.

Table 1. Radiation Dose Levels

Dose, mSv	Dose, rem	Source	Comments
1/yr	0.1/yr	(2)	NRC requires its licensees to "limit maximum radiation exposure to individual members of the public" to this level.
6.2/yr	0.62/yr	(1)	Average U.S. individual's total effective radiation dose in 2006; half is from natural background and half is from medical uses and other human activities.
20	2	(7)	Federal Emergency Management Agency and Environmental Protection Agency recommend relocating the public from an area if the expected dose in the first year after a radiological incident is above this level.
50/yr	5/yr	(2)	NRC requires its licensees to "limit occupational radiation exposure to adults working with radioactive materials" to this level.
100	10	(6)	A National Research Council committee defines "low dose" of certain types of ionizing radiation, such as gamma rays, as this level or below.
0-250	0-25	(3)	For an "acute" (i.e., received over a short time) whole-body external dose of ionizing radiation, "No detectable clinical effects; small increase in risk of delayed cancer and genetic effects."
250	25	(4)	Japan raised the permitted dose for emergency workers at the Fukushima Daiichi NPP from 100 mSv/10 rem to this level.
500	50	(5)	For an acute whole-body external dose of ionizing radiation, "blood count changes."
1,000-2,000	100-200	(3)	For an acute whole-body external dose of ionizing radiation, "Minimal symptoms; nausea and fatigue with possible vomiting; reduction in [certain white blood cells], with delayed recovery."
2,000-3,000	200-300	(3)	For an acute whole-body external dose of ionizing radiation, "Nausea and vomiting on first day; following latent period of up to 2 weeks, symptoms (loss of appetite and general malaise) appear but are not severe; recovery likely in about 3 months unless complicated by previous poor health."
3,200-3,600	320-360	(5)	Half the population exposed to an acute whole-body external dose of ionizing radiation will die within 60 days despite receiving minimal supportive care.
3,500-5,000	350-500	(2)	NRC believes that half the population receiving this dose in a few hours or less would die within 30 days.
8,000	800	(5)	100% mortality, despite best available treatment, for people receiving this external dose of whole-body ionizing radiation.

Sources: (1) National Council on Radiation Protection and Measurement, "Ionizing Radiation Exposure of the Population of the United States," report no. 160, 2009, p. 11. (2) U.S. Nuclear Regulatory Commission. "Fact Sheet on Biological Effects of Radiation," January 2011, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html, and 10 CFR 20. (3) Dade Moeller, *Environmental Health*, revised edition, Cambridge, Harvard University Press, 1997, p. 250. (4) Keith Bradsher and Hiroko Tabuchi, "50 Workers Bravely Stay at Troubled Japan Reactors," *New York Times*, March 16, 2011. (5) Princeton University, Environmental Health and Safety. "Open Source Radiation Safety Training, Module 3: Biological Effects," http://web.princeton.edu/sites/ehs/osradtraining/biologicaleffects/page.htm, adapted from National Council on Radiation Protection and Measurements, Report No. 98, "Guidance on Radiation Received in Space Activities," Bethesda, MD, 1989. (6) National Research Council, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, "Health Risks from Exposure to Low Levels of Ionizing Radiation," BEIR [Biological Effects of Ionizing Radiation] VII Phase 2, p. 2, http://www.nap.edu/openbook.php?record_id=11340&page=1 and click on PDF Summary. (7) U.S. Environmental Protection Agency. Office of Radiation Programs. *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents*, revised 1991 (second printing, May 1992), p. 4-4, http://www.epa.gov/radiation/docs/er/400-r-92-001.pdf, and Federal Emergency Management Agency, "Planning Guidance for Protection and Recovery Following Radiological Dispersal Device (RDD) and Improvised Nuclear Device (IND) Incidents," 73 *Federal Register* 45034, August 1, 2008.

External v. Internal Exposure: Effective Dose

The health risks of ionizing radiation can occur as a result of both external and internal exposure. External exposure is almost exclusively from radioactive material that emits gamma radiation, which is very penetrating and, at higher energies, can only be stopped by a thick layer of lead or concrete. External sources of gamma radiation produce a whole-body exposure. Importantly, the level of exposure to gamma radiation falls off sharply with distance from the source. Cesium-137 (^{137}Cs), which has a half-life of 30 years, is the most common source of gamma radiation from nuclear weapons tests and reactor accidents.

Alpha and beta particles outside the body are typically not a source of external exposure. Alpha particles travel only a few centimeters through the air and cannot penetrate clothing or the outermost dead layer of skin. Beta particles, composed of electrons or positrons, can travel at most several feet through the air and penetrate to the live layer of skin causing burns (as happened to workers at Chernobyl). But they too are blocked by radiation suits.

Internal radiation exposure occurs through the inhalation of airborne radioactive material or the ingestion of contaminated food and drink. The potential for harm depends on the type and quantities of radioactive material taken in and the length of time they remain in the body. As already noted, isotopes that emit alpha particles present a greater hazard than those that emit beta particles and gamma radiation. In addition, the fate of the radioactive material depends on its chemical identity. For example, Strontium-90 (^{90}Sr), which is chemically similar to calcium and emits beta particles, accumulates in bone and can cause leukemia and bone cancer.

Iodine-131 (^{131}I), another beta emitter, tends to accumulate in the thyroid gland, where it is used in the synthesis of thyroid hormones. Beta radiation from iodine-131 damages the surrounding cells and increase the risk of non-malignant thyroid disease and thyroid cancer. Iodine-131 from radioactive fallout accumulates on grass and leafy crops and becomes concentrated in the milk of cows and goats that feed on the contaminated vegetation. Children who drink the contaminated milk are especially at risk because they are still growing and their thyroid glands are very active. However, iodine-131 has a half-life of only 8 days, so it decays relatively quickly on the ground, in the food chain, and in the body.

Iodine-131 posed the most important health risk following the incident at the Chernobyl nuclear power plant in 1986. According to the International Atomic Energy Agency:

> The main consequence of the Chernobyl accident is thyroid cancer in children, some of whom were not yet born at the time of the accident. Following the vapour [sic] explosion and fire at the Chernobyl reactor, radioactive iodine was released and spread in the surrounding area. Despite measures taken, children in southern Belarus and northern Ukraine, were exposed to radiation in the weeks following the accident, particularly by consuming milk from pastured cows and leafy vegetables that had been contaminated with radioactive iodine.[27]

Unlike whole-body external exposures, the exposure from ingested or inhaled radioactive material is often limited to certain parts of the body or even specific organs. Radiation scientists

[27] International Atomic Energy Agency, "Thyroid Cancer Effects in Children," staff report, August 2005, http://www.iaea.org/newscenter/features/chernobyl-15/thyroid.shtml.

are able to calculate a whole-body equivalent dose, or *effective dose*, for partial-body exposures. These amounts can be summed with external exposure to calculate a total dose.

Acute Health Effects v. Long-Term Cancer Risk

The health effects of ionizing radiation exposure depend on the total dose and dose rate. Radiation health experts distinguish between (1) acute, or short-term, effects such as radiation sickness that are associated with relatively high doses over a short period; and (2) long-term effects such as increased lifetime cancer risk that result from chronic exposure to low-levels of radiation. Short-term health effects are typically seen in workers and others in close proximity to nuclear weapons tests and accidents, while the long-term cancer risks apply to the general population. Scientists calculate the cancer risk from radiation exposure using data from epidemiological and other studies, such as those following the health outcomes of the Japanese atomic bomb survivors. According to the International Commission on Radiological Protection (ICRP), the lifetime risk of contracting a fatal cancer from chronic exposure to low-level radiation exposure is 0.05 per sievert, or 1 in 20 per sievert (i.e., 1 in 2,000 per rem). The ICRP and NCRP both recommend an annual exposure limit of 1 mSv (100 mrem) for members of the general population. An individual that received that much annual exposure over a 70-year lifetime (a total of 70 mSv, or 7 rem) would, as a result, have an increased risk of cancer death of approximately 1 in 300.

Table 1 summarizes the health effects of exposure to various acute doses of ionizing radiation. For comparison, the table also includes the current exposure standards for the general public and workers, and the average background radiation exposure in the United States.

Potassium Iodide

There is considerable interest in potassium iodide (also referred to by its chemical formula, KI) tablets to protect against thyroid cancer. These tablets contain non-radioactive iodine-127, the same type used in iodized table salt, to saturate the thyroid with iodine. Once the thyroid is saturated, it cannot absorb more of any isotope of iodine, including iodine-131. As a result, potassium iodide tablets, taken shortly *before* exposure to iodine-131, offer protection from thyroid cancer. The protection is of limited duration, however, and potassium iodide protects only the thyroid only against radioactive iodine. It does not protect against any other radioactive material or against radiation in general. Nor is there value in taking potassium iodide as a precautionary measure unless iodine-131 is expected to be present. As the next section of this report discusses, the amount of radioactive material that has reached the United States from the Japanese nuclear reactor incident is minuscule. Accordingly, the website of the Centers for Disease Control and Prevention, accessed on March 22, said, "At this time, CDC does not recommend that people in the United States take KI or iodine supplements in response to the nuclear power plant explosions in Japan. You should only take KI on the advice of emergency management officials, public health officials, or your doctor. There are health risks associated with taking KI."[28] Further, "Some general side effects caused by KI may include intestinal upset, allergic reactions (possibly severe), rashes, and inflammation of the salivary glands."[29]

---

[28] U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. "Emergency Preparedness and Response: Radiation and Potassium Iodide (KI)," http://www.bt.cdc.gov/radiation/japan/ki.asp.

[29] U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. "Emergency (continued...)

The Japanese Situation

Understanding dose and its health effects casts light on the Japanese situation. The (U.S.) Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation of the National Research Council reported on the health risks from a certain type of radiation that includes gamma rays and x-rays. It considered doses below about 100 mSv (10 rem) to be low doses. The committee found that many factors "make it difficult to characterize the effects of ionizing radiation at low levels," and that "at doses less than 40 times the average yearly background exposure (100 mSv), statistical limitations make it difficult to evaluate cancer risk in humans." To develop an estimate of risk, the committee constructed a "lifetime risk model [that] predicts that approximately 1 person in 100 would be expected to develop cancer (solid cancer or leukemia) from a dose of 0.1 Sv [10 rem] above background." For comparison, about 42 percent of the population will be diagnosed with cancer in their lifetimes.[30] At Fukushima Daiichi NPP,

> The workers are being asked to make escalating—and perhaps existential—sacrifices that so far are being only implicitly acknowledged: Japan's Health Ministry said Tuesday that it was raising the legal limit on the amount of radiation exposure to which each worker could be exposed, to 250 millisieverts from 100 millisieverts, five times the maximum exposure permitted for nuclear plant workers in the United States.
>
> The change means that workers can now remain on site longer, the ministry said. "It would be unthinkable to raise it further than that, considering the health of the workers," the health minister, Yoko Komiyama, said at a news conference.[31]

An acute dose of 250 mSv (25 rem) is the upper threshold at which dose is unlikely to cause noticeable health effects, but it increases the risk of cancer. Based on the National Research Council report, 25 of 1,000 people would be expected to develop solid cancers or leukemia as a result of receiving this dose. Workers exposed to this dose will probably not be allowed to be exposed to additional radiation above background for at least a year to give their bodies time to repair cell damage.

Beyond the Fukushima Daiichi NPP, the external doses reported fall far below the low-dose threshold of the U.S. Nuclear Regulatory Commission (NRC). Japan's Ministry of Education, Culture, Sports, Science and Technology reported dose readings from 80 monitoring stations between 25 and 60 km from the Fukushima Daiichi NPP.[32] On March 20, almost all the readings were less than 15 microsieverts per hour. (One millisievert = 1,000 microsieverts; 1 microsievert = 0.1 millirem.) At a rate of 15 microsieverts per hour, it would take 278 days to accumulate a dose of 10 rem. At the highest rate reported, 110 microsieverts per hour, it would take 38 days to accumulate that dose. Staying inside an uncontaminated building would reduce exposure

---

(...continued)

Preparedness and Response: Potassium Iodide (KI)," http://emergency.cdc.gov/radiation/ki.asp#med.

[30] National Research Council. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation. *Health Risks from Exposure to Low Levels of Ionizing Radiation,* Washington, National Academies Press, 2006, pp. 1, 2, 7, 8, http://www.nap.edu/openbook.php?record_id=11340&page=1, and click on "pdf summary."

[31] Keith Bradsher and Hiroko Tabuchi, "50 Workers Bravely Stay at Troubled Japan Reactors," *New York Times,* March 16, 2011.

[32] Japan. Ministry of Education, Sports, Culture, Science and Technology (MEXT), "Readings at Monitoring Post out of 20 Km Zone of Fukushima Dai-ichi NPP [Nuclear Power Plant]," news release, as of 19:00 March 20, 2011, http://www.mext.go.jp/component/english/__icsFiles/afieldfile/2011/03/20/1303972_2019.pdf.

considerably, and short-lived radionuclides like iodine-131 (half-life, 8 days) would decay significantly during a month or more, sharply reducing the dose they produce. On the other hand, a larger release of radionuclides would be expected to increase dose, and cesium-137 (half-life, 30 years) decays much more slowly than iodine-131, so it would contribute to dose for many decades.

Given the increase in thyroid cancer as a result of the Chernobyl disaster, a major concern in Japan is minimizing the risk of thyroid cancer. This is especially important for children. At Chernobyl, as noted earlier, ingestion of radioactive iodine-131 resulted mainly from drinking milk from cows that ate contaminated feed, and from eating leafy greens. Accordingly, Japanese authorities have tested spinach, other vegetables, and milk for iodine-131, and found elevated levels. In response, on March 23 Prime Minister Naoto Kan restricted the distribution and consumption of spinach, cabbage, broccoli, and other vegetables in Fukushima Prefecture, and restricted the distribution of fresh raw milk and parsley produced in Ibaraki Prefecture.[33] In addition, authorities have reportedly found traces of radioactive iodine in drinking water in Tokyo. On March 23,

> Ei Yoshida, head of water purification for the Tokyo water department, said ... that infants in Tokyo and surrounding areas should not drink tap water. He said iodine-131 had been detected in water samples at a level of 210 becquerels per liter, about a quart. The recommended limit for infants is 100 becquerels per liter. For adults, the recommended limit is 300 becquerels. ... The Health Ministry said in a statement that it was unlikely that there would be negative consequences to infants who did drink the water, but that it should be avoided if possible and not be used to make infant formula.[34]

However, by March 24 the level was reported to be 79 becquerels per liter, and by March 27 had diminished to the point where two readings showed no radiation and one showed 27 becquerels per liter.[35]

Author Contact Information

Jonathan Medalia
Specialist in Nuclear Weapons Policy
jmedalia@crs.loc.gov, 7-7632

[33] Japan. Policy Planning and Communication Division. Inspection and Safety Division. Department of Food Safety. "Restriction of Distribution and/or Consumption of Foods Concerned in Fukushima and Ibaraki Prefectures (in Relation to the Accident at Fukushima Nuclear Power Plant)," March 23, 2011, http://www.mhlw.go.jp/stf/houdou/2r98520000015wun-att/2r98520000015xym.pdf.

[34] David Jolly and Denise Grady, "Tokyo Says Radiation in Water Puts Infants at Risk," *New York Times*, March 23, 2010.

[35] David Jolly, "Radiation in Tokyo's Water Has Dropped, Japan Says," *New York Times*, March 24, 2011, and David Jolly, Hiroko Tabuchi, and Keith Bradsher, "High Radiation Found in Water at Japan Plant," *New York Times*, March 28, 2011, p. 11.

Acknowledgments

The Nuclear Regulatory Commission provided technical comments on this report.

Rihm, Roger

From: Rihm, Roger
Sent: Tuesday, April 05, 2011 11:17 AM
To: Sheron, Brian
Subject: FW: SOARCA likely to be referenced, questioned tomorrow

It seems this hearing is going everywhere. I know you are sending over some material on dry cask storage. Can you also provide a limited amount of background material on SOARCA and level 3 PRAs? I have the one pagers from NUREG 1925 to start with. Thx.

From: Powell, Amy
Sent: Tuesday, April 05, 2011 11:10 AM
To: Virgilio, Martin
Cc: Rihm, Roger; Shane, Raeann; Schmidt, Rebecca; Sheron, Brian
Subject: SOARCA likely to be referenced, questioned tomorrow

Marty –

OCA got a heads up from Mr. Waxman's staff that he and Rep. DeGette may reference the concept of SOARCA, work to date, and ask related questions at tomorrow's hearing. Dr. Sheron did a briefing for a number of House Energy and Commerce staffers that referenced ongoing work on this; staff was impressed so encouraged their bosses to ask about it (understanding that it is evolving, draft, preliminary, etc.).

Amy

Amy Powell
Associate Director
U. S. Nuclear Regulatory Commission
Office of Congressional Affairs
Phone: 301-415-1673

Y/341

From: 佐藤 隆 MSIR
To: Taylor, Robert
Cc: "?? ?"; Blamey, Alan
Subject: Re: 1F Plant DATA (4/5/2011)
Date: Tuesday, April 05, 2011 6:51:45 AM

Dear Mr. Taylor,

Thank you for the email.

Still we are on the crisis stage, we have been doing our best with your kind support.

We will forward the plant status data to Mr. Blamey tomorrow morning.

Please trip safely to your home country.

Best regards,

Takashi Sato
TEPCO

TEL:03-6373-4721
FAX:03-3596-8538
E-Mail:satoh.takashi@tepco.co.jp

----- Original Message -----
From: "Taylor, Robert" <Robert.Taylor@nrc.gov> INRR
To: <satoh.takashi@tepco.co.jp>
Cc: "'?? ?'" <horikawa.takeshi@tepco.co.jp>; "Blamey, Alan" <Alan.Blamey@nrc.gov>
Sent: Tuesday, April 05, 2011 1:54 PM
Subject: RE: 1F Plant DATA (4/5/2011)

Satoh-san,

As we discussed today, I will be leaving to go back to the United States on Thursday. I likely will not make it to tomorrow's 1100 meeting.

Please send the plant data and radiation maps to Mr. Alan Blamey (alan.blamey@nrc.gov) in the future.

I wish you the best and appreciate all the hospitality you have shown us. R

Best regards,

Rob Taylor
NRC Japan Team

-----Original Message-----
From: 川 健 [mailto:horikawa.takeshi@tepco.co.jp]
Sent: Monday, April 04, 2011 7:03 PM
To: Taylor, Robert
Cc: 伊藤 正裕; 二宮 豊; 川 健; 階 悟志; 佐藤 隆; 横尾 智
Subject: 1F Plant DATA (4/5/2011)

Y/342

東京電力株式会社
子力運営管理　運転管理グループ

川 健(ほりかわ たけし)

TEL:03-6373-4865(　通)91-4865(内線)
FAX:03-3596-8540
E-mail:horikawa.takeshi@tepco.co.jp

Susco, Jeremy

From: Susco, Jeremy NRR
Sent: Tuesday, April 05, 2011 12:27 PM
To: Galloway, Melanie
Subject: ACTION: OPA Answer to License Renewal Question

Importance: High

R

Melanie,

Please see the highlighted request below. I think it captures our current stance, you?

Jeremy

From: Anderson, Brian NRO
Sent: Tuesday, April 05, 2011 11:38 AM
To: Susco, Jeremy
Cc: Nelson, Robert; Burnell, Scott
Subject: OPA Answer to License Renewal Question

Jeremy –

I'm working with OPA to develop a generic answer to the question "How will the events in Japan affect license renewal for U.S. plants?" From DLR's perspective, is this answer okay?

The NRC's recently initiated review of U.S. plants will examine current practice at operating reactors to ensure proper actions will be taken if a severe event occurs – this covers plants regardless of where they are in their license lifetime. The events in Japan, based on what's known at this time, appear to be unrelated to issues examined in license renewal. The NRC's long-term review of its regulations will determine whether any revisions to license renewal reviews are called for.

Thanks for your help,
Brian

X/343

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 06, 2011 10:48 AM
To: Milligan, Patricia
Subject: Re-Entry Criteria around Fukushima

Trish, I tried to show Mike Weber the paper, and he asked if it had been vetted through the Ops Center, yet. I couldn't answer that. He wants to make sure Jim Wiggins has seen it before he reviews. Please let me know. Thanks.

Dan

Y\ 345

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 06, 2011 1:23 PM
To: Milligan, Patricia
Subject: Re-Entry Paper

Trish, I showed the paper to Mike Weber, and he had a couple of comments. I left it on your chair in your office. I thought they were relatively minor. One was to update the information about Japan recommending sheltering in place out to 30 km. He seems to recall they recommended voluntary evac out that far, so he wanted to verify that. If you could make the changes and vet the changes through the ET, then send it back to me, I'll get it to the CAs. Thanks a lot.

Dan

Y/346

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 06, 2011 1:58 PM
To: Andersen, James
Subject: Ops Center Staffing
Attachments: Japan Event Staffing.docx

Jim, I put a one-pager together for Marty on the staffing proposal for the Ops Center. Could you review and let me know if it needs something else? I think it conveys the ideas tossed around this morning. Thanks.

Dan

4/347

SUBJ: JAPAN EVENT STAFFING

Purpose: The purpose is to provide a plan for reducing the Operations Center staffing responding to the event at the Fukushima Daiichi nuclear facility.

Background: The Operations Center has been staffed with an event response team consisting of three shifts since March 11th. Operations Center staff members are supporting the site team, responding to Commission questions, and maintaining liaison with other federal agencies responding to the event.

The site team consists of nine staff members, led by Chuck Casto. The most recent team was dispatched during the week of April 4th.

The NRC has three roles in our event response: to support the Japanese government and NISA, to gather and assess any information to determine what implications the event has for U.S. licensees, and to support the U.S. Ambassador in Japan.

Discussion:

Capabilities Required

- Ability to have effective management interaction (and push back as appropriate) with other U.S. government entities and the consortium.
- Ability to provide timely response to the site team.

Future Staffing

Future staffing of the site team and Operations Center will be dependent on our assessment of plant conditions and the needs of the team in Japan and the U.S. Government. As the response of NISA and TEPCO moves from mitigation of the event to stabilization/recovery, the NRC monitoring response would be expected to be reduced. The recovery phase would be identified by restoration of AC power to all affected units, re-establishment of sustainable cooling for the reactors and spent fuel pools, and stabilization of plant conditions. Stabilization of plant conditions would be defined by maintaining sufficient water inventory in all spent fuel pools and/or cooling capacity to each pool, adequate long-term cooling established to each reactor core, and radioactivity releases have been terminated or the source of radioactivity release is under control.

Recommendations

- Stand down the PMT (other federal agencies have assumed lead for data collection, analysis, dose assessments and protective measures.)
- Stand down the LT (line organizations capable of fulfilling functions)
- Establish one team directed by one ET member, consisting of two members from RST, one member of PMT, and one member of LT to provide immediate support to site team, and one assistant to the ET director.
- As of 4/18, in the event of a government shutdown, the team would be on a shift work rotation, with 6 ET members identified as available team directors (Marty Virgilio, Mike Weber, Jim Wiggins, Brian Sherron, Mike Johnson, Bruce Boger).

- Site team – Chuck Casto has indicated that he needs another team to replace the current team after two weeks in Japan, with strengths in dose assessment, health physics, and/or severe accident mitigation.

Rihm, Roger

From: Rihm, Roger
Sent: Wednesday, April 06, 2011 2:18 PM
To: Rakovan, Lance
Subject: Marty's testimony on Japan
Attachments: Testimony_Oral_April6_2011.docx

Y/348

TESTIMONY OF MARTIN VIRGILIO
APRIL 6, 2011

Formatted: Not Highlight

Introduction

The NRC is mindful that our primary responsibility is to ensure the adequate protection of the public health and safety of the American people. We have been very closely monitoring the activities in Japan and reviewing all currently available information. Review of this information, combined with our ongoing inspection and licensing oversight, allows us to say with confidence that U.S. plants continue to operate safely. There has been no reduction in the licensing or oversight function of the NRC as it relates to any of the U.S. licensees and we continue to maintain our focus on our domestic responsibilities.

The NRC's immediate and Continuing Response to Events in Japan

On Friday, March 11th an earthquake hit Japan, resulting in the shutdown of more than 10 reactors. From what we know now, it appears possible that the reactors' response to the earthquake went according to design. The ensuing tsunami, however, appears to have caused the loss of normal and emergency AC power to the six units at the Fukushima Daiichi site.

Shortly after 4:00 AM EDT on Friday, we went into the monitoring mode at the Emergency Operations Center and the first concern for the NRC was possible impacts of the tsunami on U.S. plants and radioactive materials on the West Coast, and in Hawaii, Alaska, and U.S. Territories in the Pacific.

On that same day, we began interactions with our Japanese regulatory counterparts and dispatched two experts to help at the U.S. embassy in Japan. By Monday, we had dispatched a total of 11 staff to Japan. We continue to have staff on the ground in Japan, and their areas of focus for this team are: 1) to assist the Japanese government with technical support as part of the USAID response; and 2) to support the U.S. ambassador. NRC

Chairman, Dr. Gregory Jaczko, traveled to Toyko on March 28th to convey directly to his Japanese counterparts a message of support and cooperation, and to discuss the current situation.

The recommendation regarding the 50 mile evacuation was based on our assessment on the conditions as we understood them at the time. Since communications with knowledgeable Japanese officials were limited and there was a large degree of uncertainty about plant conditions, it was difficult to accurately assess the radiological hazard. In order to determine the proper evacuation distance, the NRC staff performed a series of calculations to assess possible offsite consequences. Source terms were based on hypothetical estimates of fuel damage, containment, and other release conditions. These calculations demonstrated that the Environmental Protection Agency's Protective Action Guidelines could be exceeded at a distance of 50 miles from the Fukushima site, if a large-scale release occurred from the reactors or spent fuel pools. Acting in accordance with the U.S. Emergency Planning framework, and with the best information available at the time, the NRC determined that evacuation out to 50 miles for U.S. citizens was a prudent course of action, and we made that recommendation.

Continuing Confidence in the Safety of U.S. Nuclear Power Plants

I will now turn to the factors that assure us of ongoing domestic reactor safety. We have, since the beginning of the regulatory program in the United States, used a philosophy of Defense-in-Depth, which recognizes that nuclear reactors require the highest standards of design, construction, oversight, and operation, and relies on multiple layers of safety for protection of public health and safety. We begin with designs for every individual reactor that take into account site-specific factors and include a detailed evaluation for any natural event, such as earthquakes, tornadoes, hurricanes, floods, and tsunamis, as they relate to that site.

We have taken advantage of the lessons learned from previous operating experience, including the Three Mile Island accident in 1979, to implement a program of continuous improvement for the U.S. reactor fleet. As a result of those lessons learned, we significantly revised emergency planning requirements and emergency operating procedures for licensees, and made substantive improvements in NRC's incident response capabilities and addressed many human factors issues.

Two significant changes after Three Mile Island were the expansion of the Resident Inspector Program and the incident response program. Today, there are at least two Resident inspectors at each nuclear power plant. The inspectors have unfettered access to all licensees' activities, and serve as NRC's eyes and ears at the power plant. The NRC headquarters operations center and regional incident response centers are prepared to respond to all emergencies, including any resulting from operational events, security events, or natural phenomena. Multidisciplinary teams in these centers have access to detailed information regarding licensee facilities, and access to plant status information through telephonic links with the resident inspectors, an automated emergency response data system, and directly from the licensee over the emergency notification system. NRC's response would include the dispatch of a site team to augment the Resident Inspectors on site and integration with the licensee's emergency response organization at their Emergency Offsite Facility. The program is designed to provide independent assessment of events, to ensure that appropriate actions are taken to mitigate the events, and to ensure that state officials have the information they would need to make decisions regarding protective actions.

Our program of continuous improvement based on operating experience will include evaluation of the significant events in Japan as well as what we can learn from them. We already have begun enhancing inspection activities through temporary instructions to our inspection staff to look at licensees' readiness to deal with both design basis accidents and beyond-design basis accidents.

We have also issued an information notice to our licensees. In response to the events, licensees have voluntarily verified their capabilities to mitigate conditions that result from severe accidents. They also are verifying the capability to mitigate problems associated with flooding and the resulting impact on systems both inside and outside of the plant. Also, licensees are confirming the any necessary mitigating equipment is in place to compensate for the potential loss of equipment due to seismic events appropriate for the site, because each site has its own unique seismic profiles.

The Path Ahead

Beyond the initial steps to address the experience from the events in Japan, the Chairman, with the full support of the Commission, directed the NRC staff to establish a senior level agency task force to conduct a methodical and systematic review of our processes and regulations to determine whether the agency should make additional improvements to our regulatory system and to make recommendations to the Commission for its policy direction. This activity will have both near-term and longer-term objectives.

For the near term effort, we have begun a 90-day review. This review will evaluate all of the available information from the Japanese events to identify immediate or near-term operational or regulatory issues potentially affecting the 104 operating reactors in the U.S., including their spent fuel pools. Areas of investigation will include the ability to protect against natural disasters, response to station blackouts, severe accidents and spent fuel accident progression, radiological consequence analysis, and severe accident management issues. Over this 90-day period, we will develop recommendations, as appropriate, for changes to inspection procedures and licensing review guidance, and recommend whether generic communications, orders, or other regulatory requirements are needed.

This 90-day effort will include a briefing to the Commission after approximately 30 days to provide a snapshot of the regulatory response and the condition of the U.S. fleet based on information we have available at that time. This briefing will also ensure that the Commission is both kept informed of ongoing efforts and prepared to resolve any policy recommendations that surface.

The task force's longer-term review will begin as soon as the NRC has sufficient technical information from the events in Japan. The longer term review will evaluate all technical and policy issues related to the event to identify additional potential research, generic issues, changes to the reactor oversight process, rulemakings, and adjustments to the regulatory framework that should be pursued by the NRC. We will evaluate interagency issues, such as emergency preparedness, and examine the applicability of any lessons learned to non-operating reactors and materials licensees. We expect to seek input from stakeholders during this process. A report with appropriate recommendations will be provided to the Commission within 6 months of the start of this evaluation. Both the 90-day and final reports will be made publicly available.

Conclusion

In conclusion, I want to reiterate that we continue to make our domestic responsibilities for licensing and oversight of the U.S. licensees our top priority and that the U.S. plants continue to operate safely. In light of the events in Japan, there is a near-term evaluation of their relevance to the U.S. fleet, and we are continuing to gather the information necessary for us to take a longer, more thorough look at the events in Japan and their lessons for us. Based on these efforts, we will take all appropriate actions necessary to ensure the continuing safety of the American public.

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 06, 2011 4:16 PM
To: Virgilio, Martin
Cc: Weber, Michael; Ash, Darren; Muessle, Mary; Andersen, James; Evans, Michele
Subject: One-Pager on Ops Center Staffing
Attachments: Japan Event Staffing.docx

Marty, attached is the one-pager on reducing Ops Center staffing, with your comments incorporated. If you have any further comments, let me know.

Dan

Y/349

SUBJ: JAPAN EVENT STAFFING

Purpose: The purpose is to provide a plan for reducing the Operations Center staffing responding to the event at the Fukushima Daiichi nuclear facility.

Background: The Operations Center has been staffed with an event response team consisting of three shifts since March 11th. Operations Center staff members are supporting the site team, responding to Commission questions, and maintaining liaison with other federal agencies responding to the event.

The site team consists of nine staff members, led by Chuck Casto. The most recent team was dispatched during the week of April 4th.

The NRC has three roles in our event response: to support the Japanese government and NISA, to gather and assess any information to determine what implications the event has for U.S. licensees, and to support the U.S. Ambassador in Japan.

Discussion:

Capabilities Required

- Ability to have effective management interaction (and push back as appropriate) with other U.S. government entities and the consortium.
- Ability to provide timely response to the site team.

Future Staffing

Future staffing of the site team and Operations Center will be dependent on our assessment of plant conditions and the needs of the team in Japan and the U.S. Government. As the response of NISA and TEPCO moves from mitigation of the event to stabilization/recovery, the NRC response would be expected to be reduced, and other U.S. Government agencies would be expected to take on a leadership role. The recovery phase would be identified by restoration of AC power to all affected units, re-establishment of sustainable cooling for the reactors and spent fuel pools, and stabilization of plant conditions. Stabilization of plant conditions would be defined by maintaining sufficient water inventory in all spent fuel pools and/or cooling capacity to each pool, adequate long-term cooling established to each reactor core, and radioactivity releases have been terminated or the source of radioactivity release is under control.

Recommendations

- Establish one team directed by one ET member, consisting of two members from RST, one member of PMT, and one member of LT to provide immediate support to site team, and one assistant to the ET director. The team would be supplemented as necessary based on workload, and line organizations would be tapped for support as needed. (Need to decide if additional functions needed, such as chronologist.)
- Reduce the PMT to one member of the core team (other federal agencies have assumed lead for data collection, analysis, dose assessments and protective measures.)
- Reduce the LT to one member of the core team (line organizations capable of fulfilling functions as directed by remaining member of LT)
- As of 4/18, in the event of a government shutdown, the team would be on a shift work rotation, with 5 ET members identified as available team directors (Office Directors and above).
- Site team – Chuck Casto has indicated that he needs another team to replace the current team after two weeks in Japan, with strengths in dose assessment, protective measures, health physics, and/or severe accident mitigation.

Nguyen, Quynh

From: Nelson, Robert ((NRR))
Sent: Thursday, April 07, 2011 10:47 AM
To: Roberts, Darrell; Kennedy, Kriss; Lara, Julio; Croteau, Rick; Guzman, Richard; Lyon, Fred; Markley, Michael; Meighan, Sean; Nguyen, Quynh; Oesterle, Eric; Polickoski, James; Tam, Peter; Thomas, Eric; Wertz, Trent
Cc: Shear, Gary; West, Steven
Subject: FYI: Helpful summary of resource links on Fukushima event

Follow Up Flag: Follow up
Flag Status: Flagged

From: Deahl, Elizabeth (OIS)
Sent: Thursday, April 07, 2011 9:37 AM
To: McDermott, Brian; Wright, Lisa (Gibney); Dudek, Michael
Cc: Lange, Walter; McGowan, Anna
Subject: information resources

Hello all,
Walter Lange suggested I share this document with you. The staff of the Technical Library have compiled this list of information resources about the recent Japan events. It covers general NRC information, links to other USG sites, international organizations, international news and local (Japan) information, and some material in the Technical Library. I know you have your own resources, but I am hoping you may find something useful here as well.

http://www.internal.nrc.gov/TICS/news/20110405_japan.html

Best regards,
Beth

Beth Deahl
Technical Information Center Section
NRC Office of Information Services
elizabeth.deahl@nrc.gov
301.415.5684

Y/350

Fukushima Dai-ichi **Unit 2** - Reactor and Spent Fuel Pool Status - Unofficial Chronology

Revision 4/07/2011 (07:20 a.m. EST)

Notes: 1) Information has not been 100% checked from original sources; however, information was compared between sources (e.g., NISA, TEPCO) and with reports from same source. All TEPCO PRs to date have been reviewed; only recent NISA PRs reviewed (previous PRs are under review).
2) Time are approximate and may differ slightly between sources.
3) Event descriptions were standardized where possible; however, original statement were used for uncertain interpretations.
4) NISA press release (PRs) are noted by PR number; TEPCO PRs are noted by date and later by PR number and date.
5) Approx Time column time in gray means report time and not specific event time.
6) Event descriptions in gray are related to spent fuel pool.

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
2	3/11	14:46	Earthquake at Sanriku-Oki, Epicenter: Off-Coast of Sanriku (North Latitude: 38; East Longitude: 142.9), 10km deep, M8.8)	#11	
2	3/11	15:41	emergency diesel generators shutdown due to malfunction resulting in the complete loss of alternating current for all three units		11-Mar
2	3/12	0:00	Reactor cooled by the Reactor Core Isolation Cooling system, the current operating status is unclear. Reactor coolant level can be monitored by a temporary power supply and the level is stable.		12-Mar
2	3/12	11:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		12-Mar
2	3/12	13:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		12-Mar
2	3/12	15:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		12-Mar
2	3/12	19:00	Continue injecting water by RCIC		12-Mar
2	3/12	20:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		12-Mar
2	3/13	9:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		13-Mar
2	3/13		Operated vent valve to lower pressure in reactor containment vessel		13-Mar
2	3/13	11:00	Completed venting operation	#52	13-Mar
2	3/13	12:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		13-Mar
2	3/13	14:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		13-Mar
2	3/13	21:00	Continue injecting water by RCIC; current reactor water level is lower than normal, but level is steady		#12
2	3/14	11:00	Blow-out Panel of reactor building was opened due to the explosion in the reactor building of Unit 3	#52	
2	3/14	13:18	Reactor water level tended to decrease	#52	
2	3/14	13:25	RCIC failed		#3
2	3/14	17:17	"while the water level in the reactor reached the top of the fuel rod, we have restarted the water injection with the valve operation"		#8 (3/16)
2	3/14	19:20	Seawater injection to RPV via the Fire Extinguish line was ready	#52	
2	3/14	22:50	Water level in RPV tended to decrease	#52	
2	3/15	0:02	(Started?) Operation of Vent	#52	
2	3/15	6:14	Explosion sound was confirmed near the suppression chamber and the pressure inside the chamber decreased afterwards. Seawater injection continues.	#52	#8(3/16)

Y/351

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
2	3/17	9:00	Continue injecting seawater		#4(3/17)
2	3/18	14:00	Continue injecting seawater into RPV		#3(3/18)
2	3/19	1:00	Continue injecting seawater into RPV		#1(3/19)
2	3/19	12:00	Continue injecting seawater into RPV		#5(3/19)
2	3/19	13:30	Electric power receiving at the emergency power source transformer from the external transmission line was completed. The work for laying the electric cable from the facility to the load side was carried out.	#52	#1(3/19)
2	3/20	9:00	Continue injecting seawater into RPV		#2(3/20)
2	3/20	15:05	Started Injection of 40t of Seawater to the Spent Fuel Pool was started	#66	
2	3/20	17:20	Stopped Injection of 40t of Seawater to the Spent Fuel Pool was started	#52	
2	3/20	15:46	Power Center in Unit 2 energized	#52	#9(3/20)
2	3/21	9:00	Continue injecting seawater into RPV		#1(3/21)
2	3/21	18:22	White smoke was confirmed arising from the top of the reactor building	#52	#5(3/22)
2	3/22	7:11	White smoke was died down and almost invisible	#52	#4(3/22)
2	3/22	9:00	Continue injecting seawater into RPV		#2(3/22)
2	3/22	16:07	Started Injection of 18t of Seawater to the Spent Fuel Pool was carried out	#52	#17(3/22)
2	3/22	17:01	Stopped Injection of 18t of Seawater to the Spent Fuel Pool was carried out	#52	#17(3/22)
2	3/24	10:20	White fog-like steam arising from the roof part of the reactor building was observed		26-Mar
2	3/25	6:20	White smoke was confirmed to generate continuously	#52	
2	3/25	10:30	Started Injection of seawater to the Spent Fuel Pool via the Fuel Pool Cooling Line	#52	#7(3/25)
2	3/25	12:19	Started Injection of seawater to the Spent Fuel Pool via the Fuel Pool Cooling Line was carried out	#52	#14(3/25)
2	3/25	19:30	Seawater injection to RPV continues	#52	
2	3/26	8:00	White smoke was confirmed to generate continuously	#57	
2	3/26	10:10	Started injecting fresh water (with boric acid) into the reactor		#2(3/26)
2	3/26	20:46	Restored lights in the Central Operations (main control) Room		#5(3/28)
2	3/27	15:30	Injection of fresh water to RPV continues	#57	
2	3/27	18:31	Injection of fresh water to RPV continues; however, switch from fire fighting pump to a temporary motor driven pump	#59	#11(3/27)
2	3/28	6:30	White smoke was confirmed to generate continuously	#59	
2	3/28	15:00	Injection of fresh water to RPV continues	#59	
2	3/29	6:30	White smoke was confirmed to generate continuously	#61	
2	3/29	15:00	Injection of fresh water to RPV continues	#61	
2	3/29	16:45	STARTED to remove water from a condensate storage tank (CST) to a suppression pool water surge-tank to enable water transfer from a condenser to the CST, in order to prepare to transfer the stagnant water on the basement floor of the turbine building of Unit 2 to the Condenser	#64	#13(3/30)
2	3/29	16:30	Started freshwater injection through Fuel Pool Cooling and Filtering System (switched from seawater using Fire Pump truck to freshwater using temporary motor driven pump)	#64	#2(30)
2	3/29	18:25	Completed freshwater injection through Fuel Pool Cooling and Filtering System	#64	#2(30)

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
2	3/30	6:30	White smoke was confirmed to generate continuously	#63	
2	3/30	9:25	Spent fuel pool injection: transferred from a temporary motor driven pump to the fire fighting pump due to pump problem	#64	#5(3/30)
2	3/30	13:10	Stopped Spent Fuel Pool: freshwater injection was paused due to hose leak	#64	#15(3/30)
2	3/30	15:30	Injection of fresh water to RPV continues	#63	
2	3/30	19:05	Spent Fuel Pool: STARTED freshwater injection	#64	#15(3/30)
2	3/31	23:50	Spent Fuel Pool: COMPLETED freshwater injection	#64	#2(3/31)
2	3/31	6:30	White smoke was confirmed to generate continuously	#64	
2	3/31	8:30	Injection of fresh water to RPV continues	#64	
0	3/31	15:42	A barge of the US armed forces carrying fresh water for cooling reactors, etc. arrived	#66	
2	4/1	9:30	Injection of fresh water to RPV continues	#66	
2	4/1	11:50	COMPLETED water transfer from a CST to a suppression pool water surge-tank to enable water transfer from a condenser to the CST, in order to prepare to transfer the stagnant water on the basement floor of the turbine building of Unit 2 to the Condenser		#7(4/1)
2	4/1	14:56	Spent Fuel Pool: STARTED freshwater injection via temporary motor driven pump		#5(4/1)
2	4/1	15:30	Injection of fresh water to RPV continues	#67	
0	4/1	15:56	STARTED operations to transfer of fresh water from the barge to the Filtrate Tank	#67	
2	4/1	17:05	Spent Fuel Pool: COMPLETED freshwater injection via temporary motor driven pump		#7(4/1)
2	4/2	17:10	STARTED water transfer from the condenser to the CST, in order to prepare to transfer the stagnant water on the basement floor of the turbine building of Unit 2 to the Condenser		#5(4/2)
2	4/2	12:30	Some lights in the turbine building were turned on	#71	#4(4/3)
2	4/3	8:00	Injection of fresh water to RPV continues	#70	
2	4/3	10:22	Injection of fresh water to RPV continues by temporary motor driven pump, but switched to fire fighting pump for < 2 hours (to 12:06) in order to connect offsite power to a motor driven pump (editor's note: not clear if the same MDP)	#71	#4(4/3)
2	4/3	12:12	Injection of fresh water to RPV continues by a motor driven pump powered from offsite power	#71	#4(4/3)
2	4/3	13:47	As the measure to prevent the outflow of the water accumulated in the Pits for Conduit in the area around the Inlet Bar Screen of Unit 2, the upper part of the Power Cable Trench for power source at Intake Channel was crushed and high polymer absorbent, etc. were put inside. Completed at 14:30.	#71	
2	~~4/3~~	~~13:55~~	~~STARTED water transfer from the condenser to the CST, in order to prepare to transfer the stagnant water on the basement floor of the turbine building to the Condenser.~~ (NOTE: Later TEPCO press release confirms this operation is assoicated with Unit 1, not Unit 2)		#1(4/7)
2	4/3	15:30	Injection of fresh water to RPV continues	#71	
2	4/4	8:00	Injection of fresh water to RPV continues	#72	
2	4/4	11:05	Spent Fuel Pool: STARTED freshwater injection via temporary motor driven pump	#74	#2(4/5)
2	4/4	13:37	Spent Fuel Pool: COMPLETED freshwater injection via temporary motor driven pump (70t)	#74	#2(4/5)
2	4/4	15:00	Injection of fresh water to RPV continues	#73	

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
2	4/5	6:30	White smoke was confirmed to generate continuously	#74	
2	4/5	8:00	Injection of fresh water to RPV continues	#74	
2					

Plant Parameters: **Unit 2**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/14	3/15	3/16	3/17	3/17	3/18	3/18	3/18	3/19	3/19	3/19	3/20	3/20	3/20
		19:30	11:42	12:25	3:10	11:30	2:50	7:55	21:10	3:30	11:00	16:30	5:00	11:00	15:00
RPV Injection..............Water Source	Salt/Fresh														
via Feed Water Line	L/min														
via Fire Extinguishing Line	L/min														
	m3/h														
RPV Level															
Fuel Range A	mm	dwn/scale	-1400	-1400	-1400	-1800	-1400	-1400	-1400	-1400	-1400	-1300	-1300	-1400	-1400
Fuel Range B	mm	dwn/scale	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail
RRV Pressure (note 1)		Note 1	Note 1	Note 2											
Channel A	MPa g	0.650	0.315	no dc	-0.065	-0.029	-0.016	-0.014	-0.005	-0.005	-0.009	-0.009	-0.014	-0.016	-0.016
Channel B	MPa g			no dc	-0.079	-0.047	-0.032	-0.029	-0.020	-0.018	-0.023	-0.025	-0.029	-0.032	-0.020
Channel A	MPa abs	0.751	0.416		0.036	0.072	0.085	0.087	0.096	0.096	0.092	0.092	0.087	0.085	0.085
Channel B	MPa abs				0.022	0.054	0.069	0.072	0.081	0.083	0.078	0.076	0.072	0.069	0.081
Drywell Pressure	MPa abs	0.395	0.155	0.040	0.075	0.115	0.130	0.130	0.140	0.135	0.135	0.135	0.130	0.125	0.125
Suppression Chamber Pressure	MPa abs	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale
RPV Temperature		Note 1: No instrument channel specified													
Feedwater Nozzle Temp	C			Note 2: "Due to loss of battery power"											
RPV Bottom Head Temp	C														
Containment Atm Monitoring System															
Drywell	Sv/h														
Suppression Chamber	Sv/h														
Notes:															
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.															
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 MPa															

Plant Parameters: **Unit 2**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/21	3/21	3/21	3/22	3/22	3/22	3/23	3/23	3/24	3/24	3/24	3/24	3/25	3/25
		3:00	8:00	14:25	6:00	11:20	15:30	4:20	9:00	1:00	9:00	17:00	21:45	1:07	6:00
RPV Injection…………..Water Source	Salt/Fresh									Salt	Salt	Salt		Salt	
via Feed Water Line	L/min														
via Fire Extinguishing Line	L/min													340	
	m3/h									11	12	12	Note 3	Note 4	
RPV Level															
Fuel Range A	mm	-1350	-1350	-1350	-1350	-1350	-1300	-1300	-1300	-1200	-1150	-1200			-1100
Fuel Range B	mm	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail	not avail			not avail
RRV Pressure (note 1)															
Channel A	MPa g	-0.018	-0.020	-0.023	-0.005	-0.018	-0.029	-0.025	-0.023	-0.025	-0.135	-0.036			-0.020
Channel B	MPa g	-0.020	-0.020	-0.025	-0.029	-0.018	-0.032	-0.025	-0.023	-0.025	-0.038	-0.036			-0.020
Channel A	MPa abs	0.083	0.081	0.078	0.096	0.083	0.072	0.076	0.078	0.076	-0.034	0.065			0.081
Channel B	MPa abs	0.081	0.081	0.076	0.072	0.083	0.069	0.076	0.078	0.076	0.063	0.065			0.081
Drywell Pressure	MPa abs	0.120	0.120	0.120	0.110	0.110	0.110	0.110	0.110	0.105	0.110	0.110			0.120
Suppression Chamber Pressure	MPa abs	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale			dwn/scale
RPV Temperature															
Feedwater Nozzle Temp	C									102	100	100			105
RPV Bottom Head Temp	C									109	105	105			105
Containment Atm Monitoring System															
Drywell	Sv/h									49.3	48.4	47.4			45.9
Suppression Chamber	Sv/h									1.49	1.4	1.36			1.54
Notes:													Note 3: "10 m3/hr neighborhc		
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.														Note 4: Flow readir	
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 MPa															

Plant Parameters: **Unit 2**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/25	3/25	3/26	3/26	3/26	3/26	3/26	3/27	3/27	3/28	3/28	3/28	3/29	3/29
		10:00	14:00	5:00	10:10	10:40	13:00	17:22	5:00	9:00	0:12	4:00	12:30	4:00	10:00
RPV Injection…………..Water Source	Salt/Fresh				Fresh			Fresh			Fresh				
via Feed Water Line	L/min							Note 6							
via Fire Extinguishing Line	L/min				310			270			117				
	m3/h														
RPV Level															
Fuel Range A	mm	-1200	-1400	-1000		-1100	-1200		-1200	-1200		-1500	-1500	-1500	-1500
Fuel Range B	mm	not avail	not avail	not avail		not avail	not avail		not avail	not avail		not avail	not avail	not avail	not avail
RRV Pressure (note 1)															
Channel A	MPa g	-0.020	-0.016	-0.014		-0.014	-0.027		-0.018	-0.018		-0.020	-0.032	-0.027	-0.025
Channel B	MPa g	-0.020	-0.018	-0.014		-0.016	-0.027		-0.018	-0.020		-0.023	-0.032	-0.029	-0.027
Channel A	MPa abs	0.081	0.085	0.087		0.087	0.074		0.083	0.083		0.081	0.069	0.074	0.076
Channel B	MPa abs	0.081	0.083	0.087		0.085	0.074		0.083	0.081		0.078	0.069	0.072	0.074
Drywell Pressure	MPa abs	0.120	0.120	0.120		0.115	0.110		0.110	0.110		0.110	0.100	0.100	0.100
Suppression Chamber Pressure	MPa abs	dwn/scale	dwn/scale	dwn/scale		dwn/scale	dwn/scale		dwn/scale	dwn/scale		dwn/scale	dwn/scale	dwn/scale	dwn/scale
RPV Temperature															
Feedwater Nozzle Temp	C	107	107	109		107	107		123.9	123.6		130.3		153.7	
RPV Bottom Head Temp	C	105	104	100		100	99		96.6	111.2		81.5		77.7	
Containment Atm Monitoring System						Note 5									
Drywell	Sv/h	45.6	45.2	43.8		43.4	43.2		41.9	41.6		40.5		40.4	
Suppression Chamber	Sv/h	1.54	1.54	1.51		1.49	1.48		1.43	1.41		1.37		1.37	
Notes:		od";				Note 5: 09:30		Note 6: 270 to 280 l/hr							
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.		gs from "temporary measuring instrument"													
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 MPa															

Plant Parameters: **Unit 2**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/29	3/30	3/30	3/30	3/30	3/31	3/31	4/1	4/1	4/2	4/2	4/2	4/3	4/3
		13:00	4:00	10:14	13:00	14:00	4:00	12:00	6:00	10:00	4:00	`12:00	20:43	3:00	9:00
RPV Injection…………..Water Source	Salt/Fresh			Fresh		Fresh							Fresh		
via Feed Water Line	L/min														
via Fire Extinguishing Line	L/min			133		150							133		
	m3/h														
RPV Level															
Fuel Range A	mm	-1500	-1500		-1500		-1500	-1500	-1500	-1500	-1500	-1550		-1500	-1500
Fuel Range B	mm	not avail													
RRV Pressure (note 1)															
Channel A	MPa g	-0.025	-0.025		-0.023		-0.018	-0.011	-0.014	-0.007	-0.011	-0.007		-0.016	-0.016
Channel B	MPa g	-0.025	-0.025		-0.023		-0.02	-0.011	-0.016	-0.009	-0.014	-0.007		-0.018	-0.018
Channel A	MPa abs	0.076	0.076		0.078		0.083	0.090	0.087	0.094	0.090	0.094		0.085	0.085
Channel B	MPa abs	0.076	0.076		0.078		0.081	0.090	0.085	0.092	0.087	0.094		0.083	0.083
Drywell Pressure	MPa abs	0.100	0.100		0.100		0.110	0.110	0.110	0.110	0.110	0.110		0.105	0.105
Suppression Chamber Pressure	MPa abs	dwn/scale	dwn/scale		dwn/scale		dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale		dwn/scale	dwn/scale
RPV Temperature															
Feedwater Nozzle Temp	C	160.5	170.7		174.3		181.2	172.4	163.6	161.0	155.0	152.9		153.4	150.5
RPV Bottom Head Temp	C	143.6	87.7		Note 7		Note 7	Note 7	Note 7	Note 7	Note 7	Note 7		Note 7	Note 7
Containment Atm Monitoring System															
Drywell	Sv/h	40.5	40		39.6		38.7	37.9	37.2	37.0	36.1	35.7		35.0	34.3
Suppression Chamber	Sv/h	1.33	1.28		1.26		1.19	1.16	1.11	1.09	0.981	0.966		0.947	0.935
Notes:					Note 7: "Measuring instrument malfunction"										
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.															
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 MPa															

Plant Parameters: **Unit 2**										
Revision 4/07/2011 (07:20 a.m. EST)										
Source: NISA Press Releases	Unit	4/3	4/4	4/4	4/5					
		12:12	0:00	11:00	6:00					
RPV Injection.............Water Source	Salt/Fresh	Fresh								
via Feed Water Line	L/min									
via Fire Extinguishing Line	L/min									
	m3/h	8								
RPV Level										
Fuel Range A	mm		-1500	-1500	-1500					
Fuel Range B	mm									
RRV Pressure (note 1)										
Channel A	MPa g		-0.011	-0.018	-0.018					
Channel B	MPa g		-0.014	-0.020	-0.018					
Channel A	MPa abs		0.090	0.083	0.083	0.101	0.101	0.101	0.101	0.101
Channel B	MPa abs		0.087	0.081	0.083	0.101	0.101	0.101	0.101	0.101
Drywell Pressure	MPa abs		0.105	0.100	0.100					
Suppression Chamber Pressure	MPa abs		dwn scale	dwn scale	dwn scale					
RPV Temperature										
Feedwater Nozzle Temp	C		140.3	139.0	141.7					
RPV Bottom Head Temp	C		Note 7	Note 7	Note 7					
Containment Atm Monitoring System										
Drywell	Sv/h		33.4	32.8	32.1					
Suppression Chamber	Sv/h		0.911	0.879	0.867					
Notes:										
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.										
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 MPa										

Fukushima Dai-ichi **Unit 3** - Reactor and Spent Fuel Pool Status - Unofficial Chronology

Revision 4/07/2011 (07:20 a.m. EST)

Notes: 1) Information has not been 100% checked from original sources; however, information was compared between sources (e.g., NISA, TEPCO) and with reports from same source. All TEPCO PRs to date have been reviewed; only recent NISA PRs reviewed (previous PRs are under review).
2) Time are approximate and may differ slightly between sources.
3) Event descriptions were standardized where possible; however, original statement were used for uncertain interpretations.
4) NISA press release (PRs) are noted by PR number; TEPCO PRs are noted by date and later by PR number and date.
5) Approx Time column time in gray means report time and not specific event time.
6) Event descriptions in gray are related to spent fuel pool.

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
3	3/11	14:46	Earthquake at Sanriku-Oki, Epicenter: Off-Coast of Sanriku (North Latitude: 38; East Longitude: 142.9), 10km deep, M8.8)	#11	
3	3/11	15:41	emergency diesel generators shutdown due to malfunction resulting in the complete loss of alternating current for all three units		11-Mar
3	3/12	0:00	Reactor cooled by the Reactor Core Isolation Cooling system. Currently, TEPCO does not believe there is any reactor coolant leakage inside the reactor containment vessel.		12-Mar
3	3/12	11:00	Continue to inject water by RCIC		12-Mar
3	3/12	13:00	Continue to inject water by RCIC.		12-Mar
3	3/12	15:00	Continue to inject water by RCIC.		12-Mar
3	3/12	19:00	Continue injecting water by RCIC		12-Mar
3	3/12	20:00	Continue inject water by High Pressure Core Injection (HPCI) System		12-Mar
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
3	3/13	2:00	Continue to inject water by HPCI		13-Mar
3	3/13	5:10	HPCI has been automatically shut down. Re-activation of RCIC was attempted but failed. Unable to confirm the level of water injection to the reactor		13-Mar
3	3/13	8:41	Start containment venting "completed procedure to open vent valve"		#8(3/11)
3	3/13	9:00	Steps to lowering the pressure of reactor containment vessel has been taken. Spraying in order to lower pressure level within the reactor containment vessel has been cancelled.		13-Mar
3	3/13	9:20	"Successfully completed" containment venting	#51	#8(3/11)
3	3/13	9:25	Started injecting water containing boric acid by fire pump		13-Mar
3	3/13	11:55	Fresh water started to be injected to RPV via the Fire Extinguish Line.	#51	
3	3/13	12:00	Safety relief valve has been opened manually, lowering the pressure level of the reactor, which was immediately followed by injection of sea water and boric acid		13-Mar
3	3/13	13:12	Seawater started to be injected to RPV via the Fire Extinguish Line.	#51	
3	3/13	15:00	"Taking account of the situation that the water level within the pressure vessel did not rise for a long time and the radiation dose is increasing, we cannot exclude the possibility that the same situation occurred at Unit 1 on Mar 12 will occur. We are considering the countermeasure to prevent that."		#10(3/13)
3	3/14	1:10	Seawater injection for Units 1 and 3 was interrupted due to the lack of seawater in pit	#51	

1/352

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
3	3/14	3:20	Seawater injection to RPV for Unit 3 was restarted	#51	
3	3/14	5:20	Operation of Vent *(No specific report by TEPCO of this venting)*	#51	???
3	3/14	6:50	While water injection to the reactor was under operation, the pressure in the reactor containment vessel	#51	#8(3/16)
3	3/14	9:05	Pressure in the reactor containment vessel decreased to 450 kPa		#8(3/16)
3	3/14	7:44	Unusual increase in PCV pressure; declared Article 15 at 7:52	#51	
3	3/14	11:01	"... an explosive sound followed by white smoke occurred at the reactor building of the Unit 3. It was believed to be a hydrogen explosion. According to the parameter, it is estimated that the reactor containment vessel remains intact."	#51	#1(3/14)
3	3/16	8:34	White smoke like steam generated	#51	
3	3/16	10:45	Because of the possibility that PCV of Unit 3 was damaged, the workers evacuated from the main control room of Units 3 and 4 (common room)	#51	
3	3/16	11:30	Operators returned to the control room and restarted the operation of water injection	#51	
3	3/17	6:15	Pressure in Suppression Chamber has temporarily increased. Venting not required at this time.		#4(3/17)
3	3/17	6:15	Continue injecting seawater into RPV		#4(3/17)
3	3/17	9:48	Seawater was discharged by the helicopters	#51	#2(3/20)
3	3/17	9:52	Seawater was discharged by the helicopters	#51	
3	3/17	9:58	Seawater was discharged by the helicopters	#51	
3	3/17	10:01	Seawater was discharged by the helicopters	#51	
3	3/17	19:05	Started water spray from the ground for 8 minutes (riot police water cannons)	#51	#2(3/20)
3	3/17	19:13	Stopped water spray from the ground (riot police)	#51	#2(3/20)
3	3/17	19:35	Started water spray from the ground using fire engine #1 (Self Defense Forces)	#51	
3	3/17	19:45	Started water spray from the ground using fire engine #2 (Self Defense Forces)	#51	
3	3/17	19:53	Started water spray from the ground using fire engine #3 (Self Defense Forces)	#51	
3	3/17	20:00	Started water spray from the ground using fire engine #4 (Self Defense Forces)	#51	
3	3/17	20:07	Started water spray from the ground using fire engine #5 (Self Defense Forces)	#51	
3	3/17	20:09	Stopped water spray from the ground using 5 fire engines	#51	#1(3/20)
3	3/18	14:00	Started water spray from the ground using 6 fire engines (6 tons of water spray per engine)	#51	#2(3/20)
3	3/18	14:38	Stopped water spray from the ground using 6 fire engines (6 tons of water spray per engine)	#51	#2(3/20)
3	3/18	14:00	Started water spray from the ground using U.S. fire engine provided by the US	#51	#1(3/19)
3	3/18	14:45	Stopped water spray from the ground using U.S. fire engine provided by the US	#51	#1(3/19)
3	3/18	23:30	Started water spray from the ground using TFD fire engine *(NOTE: Unable to confirm from TEPCO PR)*	#51	
3	3/19	0:45	Started water spray from the ground using TFD fire engine		#1(3/19)
3	3/19	1:10	Stopped water spray from the ground using TFD fire engine		#1(3/19)
3	3/19	14:10	Started water spray from the ground using TFD fire engine		#1(3/20)
3	3/20	3:40	Stopped water spray from the ground using TFD fire engine		#1(3/20)
3	3/19	9:00	Working on receiving external power supply to Units 3 and 4		#3(3/19)
3	3/19	12:00	Continue injecting seawater into RPV		#5(3/19)

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
3	3/20	9:00	Continue injecting seawater into RPV		#2(3/20)
3	3/20	11:00	PCV pressure increased to 320 kPa, then decreased to 120 kPa at 12:15 on 3/21	#66	
3	3/20	11:00	On-site survey for leading electric cable (From 11:00 till 16:00)	#51	
3	3/20	21:30	Start water spray over the Spent Fuel Pool by TFD	#51	#1(3/21)
3	3/21	3:58	Stopped water spray over the Spent Fuel Pool by TFD	#51	#1(3/21)
3	3/21	9:00	Continue injecting seawater into RPV		#1(3/21)
3	3/21	12:15	Pressure in PCV 120 kPa	#51	
3	3/21	15:55	"light gray smoke" from the "floor roof" of Unit 3 building. Parameters of reactor pressure vessel and reactor containment vessel of Unit 3, and monitored environmental data around the Nuclear Power Station remains at the same	#51	#5(3/21)
3	3/21	17:55	Smoke was confirmed to be died down	#51	#8(3/21)
3	3/22	7:11	Grayish smoke changed to be whitish and seems to be ceasing	#51	#4(3/22)
3	3/22	9:00	Continue injecting seawater into RPV		#2(3/22)
3	3/22	15:10	Started Water spray (Around 180t) by TFD	#51	#10(3/22)
3	3/22	15:59	Stopped Water spray (Around 180t) by TFD	#51	#10(3/22)
3	3/22	22:43	Lighting was recovered in the Central Operation Room	#51	#3(3/23)
3	3/23	11:03	Started Injection of 35t of seawater to the Spent Fuel Pool via the Fuel Pool Cooling Line	#51	#7(3/23)
3	3/23	13:20	Stopped Injection of 35t of seawater to the Spent Fuel Pool via the Fuel Pool Cooling Line	#51	#7(3/23)
3	3/23	14:00	Continue injecting seawater into RPV		#12(3/23)
3	3/23	16:20	"Light black smoke belching" from the reactor building. Parameters reactor, reactor containment vessel, and monitored figures around the site's immediate surroundings remained stable without significant change. Workers in the main control room of Unit 3 and around Unit 3 evacuated to a safe location.	#51	#7(3/23)
3	3/23	23:30	At around 23:30 March 23rd and around 4:50 March 24th, it was reported that the smoke seemed to cease.	#51	#1(3/24)
3	3/24	5:35	Started Injection of 120t of seawater to the Spent Fuel Pool via the Fuel Pool Cooling Line	#57	#1(3/24)
3	3/24	14:30	3 workers from other companies who was in charge of cable laying work in the 1st floor and the underground floor of turbine building were exposed to the radiation dose of more than 170 mSv		#5(3/24)
3	3/24	16:05	Stopped Injection of 120t of seawater to the Spent Fuel Pool via the Fuel Pool Cooling Line	#57	#12(3/24)
3	3/25	13:28	Start water spray over the Spent Fuel Pool by TFD	#52	#1(3/26)
3	3/25	16:00	Stopped water spray over the Spent Fuel Pool by TFD	#52	#1(3/26)
3	3/25	12:30	Seawater injection to RPV continues	#51	
3	3/25	18:02	Started injecting fresh water into RPV	#52	#1(3/26)
3	3/26	8:00	White smoke was confirmed to generate continuously	#57	
3	3/27	12:34	Started injection of seawater by concrete pump truck		#2(3/30)
3	3/27	14:36	Completed injection of seawater by concrete pump truck		#2(3/30)
3	3/27	8:00	Injection of fresh water to RPV continues	#57	
3	3/27	15:30	Injection of fresh water to RPV continues	#57	

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
3	3/28	6:30	White smoke was confirmed to generate continuously	#59	
3	3/28	15:00	Injection of fresh water to RPV continues	#59	
3	3/28	17:40	STARTED water transfer from a CST to a suppression pool water surge-tank to enable water transfer from a condenser to the CST, in order to prepare to transfer the stagnant water on the basement floor of the turbine building to the Condenser.	#64	#15(3/30)
3	3/28	20:30	Injection of fresh water to RPV continues; however, transferred from fire fighting pump to a temporary motor driven pump	#61	#10(3/28)
3	3/29	6:30	White smoke was confirmed to generate continuously	#61	
3	3/29	14:17	Started injection of fresh water by concrete pump truck (50t/h) (switched from seawater to freshwater)	#61	#2(3/30)
3	3/29	15:00	Injection of fresh water to RPV continues	#61	
3	3/29	18:18	Completed injection of fresh water (100t) by concrete pump truck	#64	#2(3/30)
3	3/30	6:30	White smoke was confirmed to generate continuously	#63	
3	3/30	15:00	Injection of fresh water to RPV continues	#63	
0	3/31	15:42	A barge of the US armed forces carrying fresh water for cooling reactors, etc. arrived	#66	
3	3/31	16:30	Spent Fuel Pool: STARTED water spray by the concrete pumping vehicle (105t)	#70	#13(3/31)
3	3/31	19:33	Spent Fuel Pool: COMPLETED water spray by the concrete pumping vehicle (105t))	#70	#13(3/31)
3	3/31	6:30	White smoke was confirmed to generate continuously	#64	
3	3/31	8:30	Injection of fresh water to RPV continues	#64	
3	3/31	8:40	COMPLETED water transfer from a CST to a suppression pool water surge-tank to enable water transfer from a condenser to the CST, in order to prepare to transfer the stagnant water on the basement floor of the turbine building to the Condenser.	#66	
3	4/1	9:30	Injection of fresh water to RPV continues	#66	
3	4/1	15:30	Injection of fresh water to RPV continues	#67	
0	4/1	15:56	STARTED operations to transfer of fresh water from the barge to the Filtrate Tank	#67	
3	4/2	9:52	Spent Fuel Pool: STARTED water spray by the concrete pumping vehicle (75t/h)	#70	#5(4/2)
3	4/2	12:54	Spent Fuel Pool: COMPLETED water spray by the concrete pumping vehicle (75t/h)	#70	#5(4/2)
3	4/2	12:30	Some lights in the turbine building were turned on		#4(4/3)
3	4/3	6:30	White smoke was confirmed to generate continuously	#70	
3	4/3	8:00	Injection of fresh water to RPV continues	#70	
3	4/3	10:03	Injection of fresh water to RPV continues by temporary motor driven pump, but switched to fire fighting pump for about 2 hours (until 12:16) in order to connect offsite power to a motor driven pump (editor's note: not clear if the same MDP)	#71	#4(4/3)
3	4/3	12:18	Injection of fresh water to RPV continues by a motor driven pump powered from offsite power	#71	#4(4/3)
3	4/3	15:30	Injection of fresh water to RPV continues	#71	
3	4/4	5:03	Spent Fuel Pool: STARTED water spray by the concrete pumping vehicle (50t/h)		#7(4/4)
3	4/4	6:30	White smoke was confirmed to generate continuously	#72	

Unit	Date	Approx Time	Event Description	NISA ref.	TEPCO ref.
3	4/4	8:00	Injection of fresh water to RPV continues	#72	
3	4/4	19:19	Spent Fuel Pool: COMPLETED water spray by the concrete pumping vehicle (70t)		#2(4/5)
3	4/4	15:00	Injection of fresh water to RPV continues	#73	
3	4/5	6:30	White smoke was confirmed to generate continuously	#74	
3	4/5	8:00	Injection of fresh water to RPV continues	#74	
3	4/7	6:53	Spent Fuel Pool: STARTED water spray by the concrete pumping vehicle (XXt/h)		#1(4/7)
3	4/7	8:53	Spent Fuel Pool: COMPLETED water spray by the concrete pumping vehicle (XXt/h)		#1(4/7)
3					
3					
3					
3					
3					
3					
3					
3					
3					
3					

Plant Parameters: **Unit 3**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/14	3/15	3/16	3/17	3/17	3/18	3/18	3/18	3/19	3/19	3/19	3/20	3/20	3/20
		19:30	11:42	12:40	3:20	11:10	2:45	12:35	21:05	6:10	11:15	17:25	4:30	11:00	16:00
RPV Injection.............Water Source	Salt/Fresh														
via Feed Water Line	L/min														
via Fire Extinguishing Line	L/min														
via Fire Extinguishing Line	m3/h														
RPV Level															
Fuel Range A	mm	-1900	-1900	-1900	-1950	-1950	-2000	-2000	-1900	-1200	-1950	-1850	-1950	-1950	-1650
Fuel Range B	mm	-2300	-2300	-2300	-2300	-2300	-2300	-2300	-2300	-2300	-2300	-2300	-2300	2350	-2000
RRV Pressure (see note)		Note: 1	Note: 1	Note: 1	Note: 1	Note: 1									
Channel A	MPa g	0.183	0.244	0.059	0.023	0.014	-0.005	-0.018	-0.016	0.045					
Channel B	MPa g	0.183	0.244	0.065	0.032	0.023	0.014	0.000	0.016	0.005	-0.023	0.086	0.216	0.189	0.162
Channel C	MPa g										-0.023	-0.050	0.180	0.149	0.119
Channel A	MPa abs	0.284	0.345	0.160	0.124	0.115	0.096	0.083	0.085	0.146					
Channel B	MPa abs	0.284	0.345	0.166	0.133	0.124	0.115	0.101	0.117	0.106	0.078	0.187	0.317	0.290	0.263
Channel C	MPa abs										0.078	0.051	0.281	0.250	0.220
Drywell Pressure	MPa abs	0.335	0.415	0.230	0.200	0.190	0.155	0.155	0.160	0.185	0.160	0.210	0.340	0.310	0.290
Suppression Chamber Pressure	MPa abs	0.500	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	Note 2	Note 3	Note 4
RPV Temperature		Note 1: Both readings are noted in the press releases as coming from channel A											Note 2: "Down scale 100"		
Feedwater Nozzle Temp	C												Note 3: "400 overscale"		
RPV Bottom Head Temp	C												Note 4: "800 down scale"		
Containment Atm Monitoring System															
Drywell	Sv/h														
Suppression Chamber	Sv/h														
Notes:															
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.															
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 Mpa															

Plant Parameters: **Unit 3**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/21	3/21	3/21	3/22	3/22	3/23	3/23	3/24	3/24	3/24	3/25	3/25	3/25	3/25
		4:00	12:15	14:55	5:30	10:35	4:00	9:10	2:40	10:20	18:00	6:10	16:10	18:02	20:05
RPV Injection..............Water Source	Salt/Fresh								Salt	Salt	Salt			Fresh	Fresh
via Feed Water Line	L/min														
via Fire Extinguishing Line	L/min								Note 8	Note 8	Note 8			240	240
via Fire Extinguishing Line	m3/h														Note 7
RPV Level															
Fuel Range A	mm	-1650	-1600	-1550	-1575	-1575	-1900	-1800	-1800	-1900	-1850	-1900	-1900		
Fuel Range B	mm	-1950	-2000	-2025	-2350	-2350	-2300	-2300	-2300	-2300	-2300	-2300	-2300		
RRV Pressure (see note)															
Channel A	MPa g	0.214	0.043	0.045	0.038	0.036	0.036	0.034	0.041	0.036	0.038	0.038	0.036		
Channel B	MPa g														
Channel C	MPa g	-0.027	-0.083	-0.088	-0.101	-0.101	-0.101	-0.104	-0.097	-0.099	-0.101	-0.097	-0.099		
Channel A	MPa abs	0.315	0.144	0.146	0.139	0.137	0.137	0.135	0.142	0.137	0.139	0.139	0.137		
Channel B	MPa abs														
Channel C	MPa abs	0.074	0.018	0.013	0.000	0.000	0.000	-0.003	0.004	0.002	0.000	0.004	0.002		
Drywell Pressure	MPa abs	0.160	0.120	0.110	0.100	0.100	0.100	0.100	dwn/scale	0.107	0.107	0.1074	0.1075		
Suppression Chamber Pressure	MPa abs	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	dwn/scale	0.199	0.200	0.1937	0.1895		
RPV Temperature									Note 5,6	Note 6	Note 6	Note 6	Note 6		
Feedwater Nozzle Temp	C								80.7	14.1	65.6	42.8	-33.4		
RPV Bottom Head Temp	C								185.4	185.5	155.7	111.6	111.0		
Containment Atm Monitoring System															
Drywell	Sv/h								57.9	55.9	53.3	51.0	38.8		
Suppression Chamber	Sv/h								1.66	1.62	1.45	1.5	1.31		
									Note 5: Time of temperatures 2:20						
Notes:									Note 6: Feedwater nozzle temperature reading under survey						
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.									Note 7: 240 to 250 l/hr Note 8: "measurement instrument malfunction"						
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 Mpa															

Plant Parameters: **Unit 3**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/26	3/26	3/26	3/26	3/26	3/27	3/27	3/27	3/28	3/28	3/28	3/29	3/29	3/29
		5:05	7:00	10:00	11:15	18:00	4:45	10:10	14:00	5:30	10:30	20:32	4:45	12:00	14:39
RPV Injection.............Water Source	Salt/Fresh		Fresh			Fresh			Fresh			Fresh			Fresh
via Feed Water Line	L/min														
via Fire Extinguishing Line	L/min		230			220			210			200			116
via Fire Extinguishing Line	m3/h														
RPV Level															
Fuel Range A	mm	-1850		-1800	-1850		-1850	-1900		-1900	-1850		-1900	-1850	
Fuel Range B	mm	-2300		-2300	-2300		-2300	-2300		-2300	-2250		-2300	-2250	
RRV Pressure (see note)															
Channel A	MPa g	0.038		0.038	0.038		0.029	0.032		0.029	0.025		0.034	0.029	
Channel B	MPa g														
Channel C	MPa g	-0.101		-0.101	-0.101		-0.099	-0.099		-0.090	-0.095		-0.090	-0.095	
Channel A	MPa abs	0.139		0.139	0.139		0.130	0.133		0.130	0.126		0.135	0.130	
Channel B	MPa abs														
Channel C	MPa abs	0.000		0.000	0.000		0.002	0.002		0.011	0.006		0.011	0.006	
Drywell Pressure	MPa abs	0.1069		0.1066	0.1068		0.1073	0.1076		0.1083	0.1076		0.1085	0.1075	
Suppression Chamber Pressure	MPa abs	0.1848		0.1839	0.1836		0.1804	0.1806		0.1794	0.1792		0.1792	0.1796	
RPV Temperature		Note 6		Note 6	Note 6		Note 6	Note 6		Note 6			Note 6	Note 6	
Feedwater Nozzle Temp	C	26.1		37.6	33.7		-1.7	13.6		38			61.5	62.2	
RPV Bottom Head Temp	C	102.5		106.1	100.4		106.8	121.6		123.0			120.9	121.1	
Containment Atm Monitoring System															
Drywell	Sv/h	36.6		36.1	36.1		34.2	33.7		31.5			29.2	28.6	
Suppression Chamber	Sv/h	1.41		1.4	1.4		1.34	1.31		1.24			1.18	1.16	
Notes:															
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.															
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 Mpa															

Plant Parameters: **Unit 3**															
Revision 4/07/2011 (07:20 a.m. EST)															
Source: NISA Press Releases	Unit	3/30	3/30	3/31	3/31	4/1	4/1	4/2	4/2	4/3	4/3	4/3	4/3	4/4	4/4
		3:50	13:30	4:40	9:40	5:45	11:45	1:30	12:10	2:30	10:30	12:18	17:32	3:30	9:30
RPV Injection.............Water Source	Salt/Fresh											Fresh	Fresh		
via Feed Water Line	L/min														
via Fire Extinguishing Line	L/min														
via Fire Extinguishing Line	m3/h											8	7		
RPV Level															
Fuel Range A	mm	-1850	-1850	-1900	-1850	-1900	-1900	-1850	-1850	-1850	-1850			-1800	-1800
Fuel Range B	mm	-2250	-2250	-2300	-2250	-2250	-2250	-2250	-2250	-2250	-2250			-2250	-2250
RRV Pressure (see note)															
Channel A	MPa g	0.023	0.018	0.020	0.016	0.018	0.016	0.025	0.014	0.011	0.011			0.007	0.005
Channel B	MPa g														
Channel C	MPa g	-0.092	-0.095	-0.09	-0.092	-0.086	-0.088	-0.086	-0.095	-0.088	-0.083			-0.081	-0.083
Channel A	MPa abs	0.124	0.119	0.121	0.117	0.119	0.117	0.126	0.115	0.112	0.112			0.108	0.106
Channel B	MPa abs														
Channel C	MPa abs	0.009	0.006	0.011	0.009	0.015	0.013	0.015	0.006	0.013	0.101			0.101	0.101
Drywell Pressure	MPa abs	0.1071	0.1064	0.1073	0.1066	0.1071	0.1068	0.1055	0.1050	0.1061	0.1062			0.1073	0.1069
Suppression Chamber Pressure	MPa abs	0.1780	0.1775	0.1764	0.1755	0.1755	0.1757	0.1748	0.1748	0.1748	0.1750			0.1754	0.1757
RPV Temperature			Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6	Note 6			Note 6	Note 6
Feedwater Nozzle Temp	C	75.3	76.7	88.5	88.6	92.6	90.2	90.8	92.3	90.6	90.6			89.8	90.0
RPV Bottom Head Temp	C	116	115.4	114.2	114.4	116.3	117.8	119.4	117.8	115.9	114.3			114.1	113.7
Containment Atm Monitoring System															
Drywell	Sv/h	27.6	26.8	25.7	25.4	24.5	24.2	24.0	23.2	22.2	21.7			21.5	21.1
Suppression Chamber	Sv/h	1.11	1.09	1.05	1.04	1.00	0.98	0.955	0.935	0.911	0.897			0.871	0.864
Notes:															
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.															
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 Mpa															

Plant Parameters: **Unit 3**							
Revision 4/07/2011 (07:20 a.m. EST)							
Source: NISA Press Releases	Unit	4/5					
		5:40					
RPV Injection.............Water Source	Salt/Fresh						
via Feed Water Line	L/min						
via Fire Extinguishing Line	L/min						
via Fire Extinguishing Line	m3/h						
RPV Level							
Fuel Range A	mm	-1850					
Fuel Range B	mm	-2250					
RRV Pressure (see note)							
Channel A	MPa g	0.011					
Channel B	MPa g						
Channel C	MPa g	-0.081					
Channel A	MPa abs	0.112	0.101	0.101	0.101	0.101	0.101
Channel B	MPa abs						
Channel C	MPa abs	0.101	0.101	0.101	0.101	0.101	0.101
Drywell Pressure	MPa abs	0.1078					
Suppression Chamber Pressure	MPa abs	0.1733					
RPV Temperature		Note 6					
Feedwater Nozzle Temp	C	84.7					
RPV Bottom Head Temp	C	113.7					
Containment Atm Monitoring System							
Drywell	Sv/h	21.0					
Suppression Chamber	Sv/h	0.839					
Notes:							
NISA News releases started reported gage pressure, then converted readings to absolute pressure. NISA separate parameter tables report gage pressure. Conversion in this table in BLUE.							
Standard atmospheric pressure = 101.325 kPa = 0.101325 Mpa Absolute pressure = 0.101325 MPa + 0.06 MPa = 0.161325 Mpa							

From: Giessner, John 1211
To: Blamey, Alan
Cc: Taylor, Robert
Subject: Fw: Convention on Nuclear Safety Slides
Date: Thursday, April 07, 2011 2:56:08 AM

This has a pretty good time line and says SFP#4 possible uncovery
(Sent from Blackberry)

----- Original Message -----
From: Emche, Danielle 1019
To: Giessner, John
Sent: Thu Apr 07 02:20:25 2011
Subject: Fw: Convention on Nuclear Safety Slides

Jack, apparently they are available on NISA's website. See link in email below, it worked for me on my bb, but probably best to use on a laptop/desktop.
Danielle
Sent from an NRC BlackBerry.

----- Original Message -----
From: 島 俊 <oshima-toshiyuki@meti.go.jp>
To: Emche, Danielle 1019
Cc: noda-tomoki@meti.go.jp <noda-tomoki@meti.go.jp>; nei-hisanori@meti.go.jp <nei-hisanori@meti.go.jp>; koyama-masaomi@meti.go.jp <koyama-masaomi@meti.go.jp>
Sent: Thu Apr 07 02:14:04 2011
Subject: RE: Convention on Nuclear Safety Slides

Dear Danielle

Thank you for your mail.
Please check NISA website and get two slides from it.

http://www.nisa.meti.go.jp/english/files/en20110406-1.html

Best regards,

Toshi

Toshiyuki Oshima, NISA

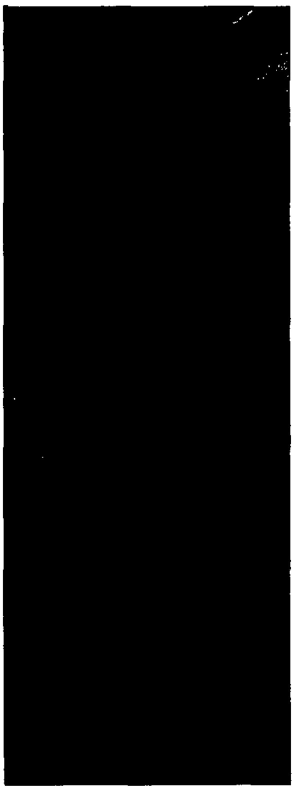
> -----Original Message-----
> From: Emche, Danielle [mailto:Danielle.Emche@nrc.gov]
> Sent: Thursday, April 07, 2011 2:32 PM
> To: 'oshima-toshiyuki@meti.go.jp'
> Subject: Convention on Nuclear Safety Slides
>
> Dear Shima-san,
>
> Could you kindly check if it is possible for NRC to receive a copy of the
> slides presented by NISA at the IAEA Convention on Nuclear Safety?
>
> Best regards,
>
> Danielle

Y1353

Apr. 8–Apr. 14, 2011

A report to members of the Nuclear Energy Institute

Overview



WNFC 2011: Industry Will Move Forward Post-Fukushima

April 11, 2011—NEI officials at the 2011 World Nuclear Fuel Cycle conference in Chicago last week gave a frank assessment of the formidable challenges facing the industry as it moves forward after Fukushima.

Speaking to nearly 400 industry executives at the first major conference after the nuclear accident, Richard Myers, NEI's vice president for policy development, said, "We will improve the technology and our management of the technology. We will learn from [Fukushima]."

He added, "The accident at Fukushima is a massive corporate and industrial catastrophe but, based on what we know, the worst of it stops at the plant boundary, and it does not appear that it will have major, or even measurable, public health consequences."

Myers praised the "measured response" of the American public and the Obama administration in reacting to the accident.

Despite the intensity of news media coverage of the accident, representatives of companies across the nuclear industry said that Fukushima would not fundamentally alter prospects for forecasted growth.

"Even with the accident at Fukushima, nuclear energy remains one of the safest—if not the safest—forms of electricity production in the world, with one of the smallest environmental footprints," Myers said.

Steven Kraft, NEI's senior director for special projects, provided an update of industry activity directed at achieving centralized interim storage for spent fuel.

"We must have a plausible, durable policy to manage the nation's stockpile of used fuel," Kraft said, adding that Fukushima "will be a driver" of that policy.

Acknowledging the political realities surrounding the Yucca Mountain repository program, Kraft reminded the conference that the Obama administration's Blue Ribbon Commission on America's Nuclear Future would deliver its final report to Congress this summer.

Meanwhile, the Energy Department continues to pursue a very long-range research and development program on reprocessing and recycling commercial used nuclear fuel.

Public opinion on used fuel storage safety has changed significantly in recent years, Kraft noted. In 2007, NEI's nuclear power plant neighbor survey showed that 70 percent of Americans living near nuclear plants believed that used fuel could be stored safely until moved to a permanent facility; by 2009, that percentage had fallen to 56 percent. Eighty-five percent of nuclear plant neighbors want used fuel moved to one or two central facilities, Kraft said. Plant neighbors will be surveyed again this June.

NEI

NUCLEAR ENERGY INSTITUTE

www.nei.org

Y/354

[redacted]

Kraft noted that the industry favors the designation of two centralized interim storage sites and is engaged with a number of interested host communities.

"It is clear that [nuclear] plant neighbors want assurances that used fuel will not stay at plants indefinitely," Kraft said. << NEI Staff, *overview@nei.org*

Review of Emergency Planning To Be Part of NRC Post-Fukushima Study

April 14, 2011—The NRC's March 16 recommendation that U.S. citizens in Japan evacuate 50 miles from the damaged Fukushima Daiichi nuclear plant continues to draw questions about emergency preparedness at U.S. plants, particularly the adequacy of the 10-mile emergency planning zone.

Responding to questions at a hearing this week before the Senate Committee on the Environment and Public Works, NRC Chairman Gregory Jaczko said existing emergency plans allow for extending protective measures beyond 10 miles, should that be warranted. However, he said the NRC will review its emergency planning requirements as part of the agency's follow-up to the accident in Japan.

The hearing also highlighted the NRC's challenge in explaining why safety issues such as seismic capability are not part of the agency's deliberations in considering whether to renew a plant's operating license. "I think you have to look at whether today you would license [nuclear] plants near fault lines," said Sen. Barbara Boxer (D-Calif.), who chairs the committee. "If you would say no to a new operator, you have to question whether it makes sense [for existing plants] to continue operating."

Jaczko said such issues as seismic response and tsunami protection are germane to nuclear plant safety whether a plant is operating under its original license or a renewed license. Thus, he said, those items are not among those the NRC specifically takes up in license renewal proceedings. He also explained, under pointed questioning by Boxer, that San Onofre and Diablo Canyon meet seismic requirements specific to their locations in areas of high seismic hazard.

Pacific Gas and Electric Co. announced April 11 that it has asked the NRC to delay final action on license renewal for the Diablo Canyon plant pending completion of 3D seismic studies (see accompanying story in this week's Nuclear Energy Overview).

"We recognize that many in the public have called for this research to be completed before the NRC renews the plant's licenses," said John Conway, PG&E's senior vice president of energy supply and chief nuclear officer. "We are being responsive to this concern by seeking to expeditiously complete the 3D seismic studies and provide those findings to the commission and other interested parties so that they may have added assurance of the plant's seismic integrity."

Charles Pardee, chief operating officer at Exelon Generation Co., discussed steps the industry has taken to ensure that U.S. nuclear plants can respond to events that may challenge safe operation of the facilities. He said the industry, the NRC, the Institute of Nuclear Power Operations and others will continue to study the events at Fukushima Daiichi. "When we fully understand the facts surrounding the event in Japan, we will use those insights to make nuclear energy even safer," Pardee said.

[redacted]

Sen. Lamar Alexander (R-Tenn.) sought to put the accident at Fukushima Daiichi in context. "I can't imagine a future for the United States that doesn't involve nuclear power to generate electricity," Alexander said, adding that while it produces just 20 percent of U.S. electricity, it provides 70 percent of the nation's "clean electricity." He cited the industry's practice of exploring events and incorporating lessons learned, including the accident at the Three Mile Island nuclear plant, the terrorist attacks of Sept. 11, 2001, and Hurricane Katrina. "It's important to recognize the safety record we have for this form of energy in the United States." << Lynne Neal, *dln@nei.org*

PG&E Asks NRC to Delay Diablo Canyon License Renewals Until Seismic Studies Are Complete

April 13, 2011—Pacific Gas and Electric Co. has asked the NRC to defer issuing its Diablo Canyon nuclear power plant a license renewal until the company completes seismic studies for the plant.

The company said it began the seismic study following the earthquake and tsunami that crippled Japan's Fukushima Daiichi plant and the public concern expressed about Diablo Canyon, which is located on the coast in central California. In particular, PG&E said it wants to answer concerns voiced by the board of supervisors in San Luis Obispo County.

"Because we live in a seismically active region," John Conway, PG&E's senior vice president of energy supply and chief nuclear officer, said, "PG&E takes care in all its operations, especially at Diablo Canyon, to analyze and address seismic risks."

In November 2008, PG&E's geosciences department, working with the U.S. Geological Survey, discovered a new shoreline fault zone. PG&E's evaluation of the safety risk to the plant presented by the newly discovered fault, as submitted to the NRC, confirmed that Diablo Canyon has adequate safety margin to withstand maximum ground motions that could occur from faults in the region.

PG&E plans to undertake high-energy offshore 3D studies of the shoreline fault's deeper regions as soon as it obtains permits from various regulatory agencies, including the State Lands Commission, California Coastal Commission and San Luis Obispo County.

Conway said, "Even after we have completed these advanced studies, our geoscientists will continue their ongoing seismic research to give us, our regulators and the public confidence that the plant remains safe."

Most of the coastal regions of the United States, including the location of Diablo Canyon, are not vulnerable to tsunamis due to the lack of geological structures that cause them. However, the plant lies close to the San Andreas and Hosgri faults. Diablo Canyon is designed to withstand an earthquake measuring 7.5 on the Richter scale.

The NRC schedule shows that it would not issue a license extension for Diablo Canyon until after January 2012, but could issue a final safety evaluation report and draft supplemental environmental impact statement as early as May.

Merzke, Daniel

From: Merzke, Daniel
Sent: Friday, April 08, 2011 7:14 AM
To: Evans, Michele
Subject: RE: Ops Center Staffing

I tossed that date out to him and he seemed very receptive to that. I knew you'd like to transition sooner, though, so he'd like to discuss it with us.

From: Evans, Michele
Sent: Thursday, April 07, 2011 4:54 PM
To: Merzke, Daniel
Subject: Re: Ops Center Staffing

Ok. I thought the date was April 18. I would like to implement sooner though.

Sent from an NRC Blackberry
Michele Evans

From: Merzke, Daniel
To: Evans, Michele
Cc: Wiggins, Jim; Morris, Scott; McDermott, Brian
Sent: Thu Apr 07 16:32:38 2011
Subject: Ops Center Staffing

Michele, the Chairman has blessed off on our recommendation to downsize the Ops Center staffing. The one topic we neglected to address was how (timeline) we would make the transition. Marty wants to meet with you and me to discuss. He's got a packed calendar tomorrow, but we can usually catch him after the Events brief, if you want to give that a shot. Let me know. Thanks.

Dan

Y1355

From: Brenner, Eliot (OPA)
Sent: Tuesday, April 12, 2011 8:51 PM
To: RST01 Hoc; Hayden, Elizabeth; Zoulis, Antonios
Subject: RE: Request from OCA on WSJ Article

Thanks. I am afraid to admit I am way way behind in reading my emails. You were faster to respond than I was to get around to reading it. Mea culpa.

From: RST01 Hoc (NSIR)
Sent: Tuesday, April 12, 2011 3:56 PM
To: Brenner, Eliot; Hayden, Elizabeth
Subject: FW: Request from OCA on WSJ Article

Mr. Brenner,

Please see below paragraph developed by the RST. If you have any questions please give us a call at the HOO Reactor Safety Team.

Thanks,
Antonios Zoulis
Severe Accident Analyst

From: RST09 Hoc (NSIR)
Sent: Tuesday, April 12, 2011 3:52 PM
To: RST01 Hoc
Subject: Request from OCA on WSJ Article

Eliot,

Regarding the statement from WSJ:

> *Still, Fukushima Daiichi operator Tokyo Electric Power Co. warned Tuesday that since the Fukushima Daiichi plant is still releasing radioactive materials, the total level of radiation released could eventually exceed that of Chernobyl, a spokesman said.*

Considering that potentially three reactors and two spent fuel pools have damaged fuel, the quantity of radioactive material present may exceed that of Chernobyl. However, the duration and magnitude of releases of radioactive material cannot be accurately estimated. Certainly, the magnitude of the sudden Chernobyl release has not occurred at Fukushima Daiichi. Measures are being taken to suppress and control the release of materials but the potential for continued release still exists.

Y1356

Kock, Andrea

From: Franovich, Mike
Sent: Tuesday, April 12, 2011 10:30 AM
To: Ostendorff, William
Cc: Nieh, Ho; Kock, Andrea; Zorn, Jason
Subject: UPDATE from 10:00 TUESDAY Telecon on Fukushima Daiichi Events

Jim Dyer led the call:

- ☐ No change in status of Unit 1, 2, or 3 or the SFPs. Some updates of a regarding a 6.4 earthquake that had no impact on the site and the previous 7.1 earthquake in Fukushima that caused a 50 minute temporary loss of coolant injection to Units 1, 2, and 3. No impact on the units noted. NRC did MELCOR runs that showed it would take 10 hours before additional core damage. NRC looking at the SDF backup plans to use alternate power supply for temp interruptions due to aftershocks.

- ☐ Three documents noted in the sit report are being refined; criteria to reduce 50 mile evac zone, limited reentry, and plant stability criteria. SAMGs rev 2 still being worked and the SFP guidance will be integrated. Note on reentry criteria, Jim mentioned issues with infrastructure challenges that would inhibit future evacuation actions and that NRC is using manual chapter 1601 (NRC/FEMA post natural disaster EP issues) similar to post hurricane actions.

- ☐ NRC site team working on presentation to brief Secretary Clinton.

- ☐ Increase staffing in Japan amounts to a few but target is around 11 persons.

- ☐ Discussed relocation of Japanese residents in 20-30 km zone based on potential long-term health impacts.

- ☐ INES scale 7 for the accident was mentioned with no amplifying details.

- ☐ We have not seen DOE or IAEA reports in the last 24 hours. Requested ET reinitiate forwarding those updates. NOTE: NRC sit reports now issued daily at NOON.

Y/357

Hiland, Patrick

From: Arndt, Steven
Sent: Tuesday, April 12, 2011 8:06 AM
To: Hiland, Patrick; Skeen, David
Cc: Grobe, Jack
Subject: ANS Special Report on Fukushima
Attachments: NNSpReptApr2011_20110407170910.pdf

FYI, Attached for your information is a pre-print of an article that will appear Nuclear News magazine shortly.

Steven

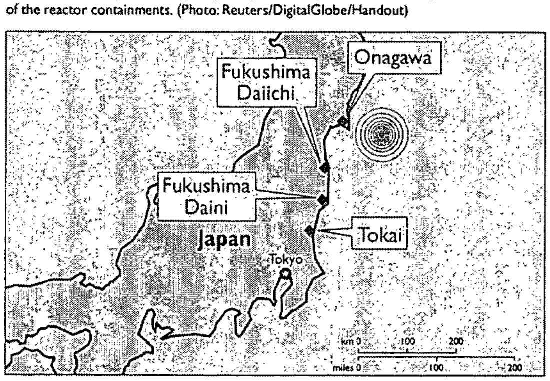
Y/358

Nuclear News Special Report: Fukushima Daiichi after the Earthquake and Tsunami

Natural disasters lead to nuclear emergency at Japan's Fukushima Daiichi

This report was prepared by the Nuclear News *staff, based on the best information available to us through March 24. Special thanks are due our contacts in Japan—Yoshiaki Oka, head of the Joint Department of Nuclear Engineering in the Graduate School of Advanced Science and Engineering at Waseda University and emeritus professor of the University of Tokyo, and Akira Omoto, a professor at the University of Tokyo and a commissioner on the Japan Atomic Energy Commission—who provided us with invaluable information and answers, via e-mail, to the many questions we presented to them. (Their input is based on their personal expertise and does not necessarily represent the viewpoints of the organizations for which they work.) The other main sources used to gather information include the Japan Atomic Industrial Forum, Japan's Nuclear and Industrial Safety Agency, and the International Atomic Energy Agency.*

This satellite image, released by DigitalGlobe on March 18, shows the substantial damage to the external structures of the reactor buildings of (from left) Units 4, 3, 2, and 1 of the Fukushima Daiichi plant. The hydrogen explosions that caused the damage occurred outside of the reactor containments. (Photo: Reuters/DigitalGlobe/Handout)



Onagawa was the nuclear plant closest to the epicenter of the earthquake, but it was not significantly affected by the tsunami that inundated northeast Honshu, and it was quickly taken to cold shutdown. The one operable reactor at Tokai also reached cold shutdown without incident. Two reactors at Fukushima Daini experienced pressure control problems, but eventually all four reached cold shutdown.

On Friday, March 11, an earthquake and a tsunami of unprecedented magnitude led to major problems in the stabilization of nuclear power reactors in northeast Japan. While all operating reactors in the earthquake zone underwent automatic shutdown, with control rods inserting into the reactor cores as intended because of ground acceleration, efforts to bring the reactors at Tokyo Electric Power Company's (Tepco) Fukushima Daiichi plant to cold shutdown and to maintain spent fuel pool cooling were hampered by the effects that the tsunami had on plant property and on nearby infrastructure.

Radioactive material was released to the environment as a result of the venting of the containments to reduce pressure, as normal cooling was not available, and hydrogen explosions that damaged the external structures of the reactor buildings. Readings from neutron detectors, however, indicate that no nuclear chain reactions have taken place since the control rod insertions. Tepco personnel have concluded that fuel has been damaged in all three of the reactors that were in operation before the quake, and a containment breach is believed to have occurred in the vicinity of the Unit 2 suppression pool, but new fission has not taken place. The released radioactive material has been attributed to fuel damage within the three reactors and perhaps in the spent fuel pools of Units 3 and 4.

According to the U.S. Geological Survey, the quake began at 2:46:23 p.m. (Japan time). The quake's epicenter (the point on the earth's surface directly above the quake) was in the Pacific Ocean, 80 miles east of the city of Sendai, which is located on the eastern coast of Japan's central island of Honshu. The center of the quake was at a depth of 20 miles below sea level. Originally measured at 8.8 on the Richter scale, on March 14 the earthquake was officially designated a 9.0 magnitude. Reports from some locations in Japan described the duration of the quake to be as long as three minutes. The quake set off a massive tsunami, which not only brought devastating floods to the northeast coast of Honshu but caused more damage and loss of life when the vast quantity of water receded.

The quake's ground acceleration was great enough to cause automatic shutdowns at four nuclear power plants along Honshu's northeast coast: Tohoku Electric Power Company's three-reactor Onagawa plant, in Miyagi Prefecture; Japan Atomic Power Company's Tokai plant, in Fukui Prefecture (where there is one operable boiling water reactor and a gas-cooled reactor that closed in 1998); and two Tepco plants in Fukushima Prefecture, known as Fukushima Daiichi (Daiichi translates roughly as "first") and Daini ("second"). All of these plants are north of Tokyo (see map on previous page).

(There is a nuclear power plant in Japan named Sendai, but it is on the southern island of Kyushu, and it was not affected by the quake or tsunami. Tohoku's Onagawa plant is near the city of Sendai. Although Sendai was inundated by the tsunami, the Onagawa plant was not significantly damaged; a fire began in the turbine building, but it was extinguished.)

While the quake was the most powerful ever recorded in the vicinity of Japan and was well beyond what was anticipated as an initiating event for a design basis accident, the greatest damage—both to Japan in general and to the effort to bring all of Fukushima Daiichi to cold shutdown—was caused by the tsunami that spread from the quake's epicenter.

Fukushima Daiichi event sequence

The following was derived from information collected by Japan's national nuclear regulator, the Nuclear and Industrial Safety Agency. All times are Japan time.

March 11

2:46 p.m. The 9.0-magnitude earthquake strikes. Ground acceleration triggers automatic shutdown of all three reactors in operation.

3:42 p.m. A 14-meter tsunami triggered by the earthquake disables all AC power to Units 1, 2, and 3.

3:45 p.m. Fuel tanks for emergency diesel generators are carried off by the tsunami.

4:46 p.m. Water injection fails in the emergency core cooling systems of Units 1 and 2.

March 12

9:07 a.m. A pressure relief valve is opened on the Unit 1 pressure vessel.

3:36 p.m. A hydrogen explosion damages the external structure of the Unit 1 reactor building.

8:20 p.m. Seawater injection to the Unit 1 pressure vessel begins.

March 13

5:58 a.m. Water injection fails in the emergency core cooling system of Unit 3.

9:20 a.m. A pressure relief valve is opened on the Unit 3 pressure vessel.

1:12 p.m. Seawater injection to the Unit 3 pressure vessel begins.

March 14

11:01 a.m. A hydrogen explosion damages the external structure of the Unit 3 reactor building.

1:25 p.m. The water level in the Unit 2 pressure vessel is found to be low, leading operators to conclude that reactor cooling is no longer functional.

4:34 p.m. Seawater injection into the Unit 2 pressure vessel begins.

March 15

6:20 a.m. An explosive sound is heard at Unit 2 and is concluded to indicate an abnormality in the pressure suppression pool. At the same time, part of a wall in the operation area of Unit 4 is damaged.

9:38 a.m. A fire breaks out in the Unit 4 reactor building.

12:29 p.m. The Unit 4 fire is extinguished.

March 16

8:37 a.m. A large quantity of white smoke issues from the Unit 3 reactor building.

March 17

9:48 a.m. Self-Defense Force helicopters drop water on the Unit 3 reactor building for the first of four times.

7:05 p.m. A police water cannon truck begins injecting water into the Unit 3 reactor building.

7:35 p.m. Self-Defense Force pumper trucks begin injecting water into the Unit 3 reactor building for the first of five times.

March 18

10:00 a.m. It is confirmed that the common spent fuel pool for Fukushima Daiichi (which is separate from the pools for the individual reactors) is filled with water, and no abnormalities are observed in the spent fuel dry cask storage buildings.

1:30 p.m. Work is begun to open holes in the roof of the Unit 5 reactor building in order to keep hydrogen from accumulating within the building.

2:42 p.m. A water cannon from the U.S. armed forces is used to inject water into the Unit 3 reactor building.

5:00 p.m. Work is begun to open holes in the roof of the Unit 6 reactor building.

5:50 p.m. Initial power connection from an external transmission line to a temporary substation for backup power is completed.

Impact of the tsunami

Roughly one hour after the quake, the tsunami reached the Fukushima Daiichi site, and all alternating current power sources (off-site power and on-site emergency diesel generators) were lost to the ongoing effort to cool down the reactor cores of Units 1, 2, and 3. (Units 4, 5, and 6 were already off line for inspection, and Unit 4 was completely defueled.) The tsunami also disabled the seawater pumps, depriving the reactors of their ultimate heat sink. The tsunami was originally thought to have had a height of roughly 10 meters (33 feet), but it was later determined that the height was 14 meters (about 46 feet). Fukushima Daiichi was originally designed to withstand a 3-meter tsunami, based on a tsunami observed in Chile in 1960, but around 2000 the plant was modified to withstand a design basis tsunami with a height of 5.7 meters.

The tsunami did more than disable the emergency diesel generators. Plant workers reported seeing the diesel fuel tanks being pulled out to sea by the receding waves.

The plant staff—management and workers—began implementing severe accident management requirements as soon as possible, focusing on controlling and cooling the reactor cores. Throughout the course of the accident, according to reports issued by Tepco and government agencies, procedures to protect workers and the public were considered before actions were taken. The procedures are based on an understanding of how a severe accident progresses, taking into account the possibility of a loss of circulation and coolant that would cause a rise in pressure, and of a loss of reactor integrity that could lead to the release of radioactivity to the environment.

With the diesels unavailable and off-site power lost because of damage to transmission lines, plant personnel tried to maintain core cooling and other shutdown activities through battery power, which could last for eight hours at most. Less than an hour after the arrival of the tsunami, the emergency core cooling systems of Units 1 and 2 stopped delivering water. This was reported to the national government, and a nuclear emergency response headquarters was set up in the Tokyo residence of Prime Minister Naota Kan.

There is an isolation condenser for Unit 1 and there are reactor core isolation cooling (RCIC) systems at the other reactors. The

March 19

12:01 a.m. Fire engines from the Tokyo Fire Department Hyper-Rescue Team begin injecting water into the Unit 3 reactor building, continuing for one hour.

5:00 a.m. The residual heat removal system pump for Unit 5 resumes operation, cooling the spent fuel pool.

7:42 a.m. Two Unit 6 emergency diesel generators resume operation, providing power for Units 5 and 6.

2:10 p.m. The Tokyo Fire Department team begins injecting water into the Unit 3 reactor building, continuing for the next 13 hours and 30 minutes.

10:14 p.m. The residual heat removal system pump for Unit 6 resumes operation, cooling the spent fuel pool.

March 20

8:21 a.m. Self-Defense Force fire trucks begin injecting water into the Unit 4 reactor building, delivering about 81 tons over the next hour and 19 minutes.

2:30 p.m. Unit 5 enters cold shutdown.

3:05 p.m. Utility fire trucks begin injecting water into the Unit 2 spent fuel pool, delivering 40 tons over the next two hours and 15 minutes.

3:46 p.m. Electricity is restored to the Unit 2 power center.

6:30 p.m. (approx.) Self-Defense Force fire trucks resume injecting water into the Unit 4 reactor building, delivering another 81 tons over roughly the next hour and 16 minutes.

7:27 p.m. Unit 6 enters cold shutdown.

8:39 p.m. A Tokyo Fire Department team resumes water injection into the Unit 3 reactor building, continuing for the next seven hours and 19 minutes.

March 21

6:37 a.m. Self-Defense Force fire trucks and utility personnel use the U.S. water cannon truck to begin injecting water into the Unit 4 reactor building, continuing for the next two hours and four minutes.

10:37 a.m. Utility fire trucks begin injecting water into the common spent fuel pool, continuing for the next four hours and 53 minutes.

3:55 p.m. Gray smoke emerges from the Unit 3 reactor building, ending two hours later.

6:22 p.m. White smoke emerges from the roof of the Unit 2 reactor building.

March 22

10:35 a.m. Electricity is restored to the Unit 4 power center.

3:10 p.m. A Tokyo Fire Department team resumes injecting water into the Unit 3 reactor building, continuing for the next 49 minutes.

4:07 p.m. Utility fire trucks begin injecting water into the Unit 2 reactor building, continuing for the next 54 minutes.

5:17 p.m. A concrete-pumping truck begins injecting water into the Unit 4 reactor building, continuing for the next three hours and 15 minutes.

10:43 p.m. Lighting is restored to the Unit 3 central control room.

March 23

2:33 a.m. At Unit 1, a water feeding line is added to the water injection line to the pressure vessel.

10:00 a.m. The concrete-pumping truck resumes injecting water into the Unit 4 reactor building, continuing for the next three hours and 20 minutes.

11:03 a.m. Water injection begins into the Unit 3 spent fuel pool through the cooling and purification line, continuing for the next two hours and 17 minutes.

4:20 p.m. (approx.) Black smoke is observed coming from the Unit 3 reactor building.

March 24

5:35 a.m. Water injection resumes into the Unit 3 spent fuel pool through the cooling and purification line, continuing for the next 10 hours and 30 minutes.

11:30 a.m. Lighting is restored to the Unit 1 central control room.

2:36 p.m. The concrete-pumping truck resumes water injection into the Unit 4 reactor building, continuing for the next two hours and 54 minutes.

RCIC system uses a turbine-driven pump powered by the steam from the reactor to inject water from the suppression chamber beneath the reactor, as well as from the water storage tank, into the reactor. As the water in the suppression chamber heats up, these pumps become ineffective.

If getting Fukushima Daiichi safely to cold shutdown had been the only problem in Japan at the time, it might have been possible to deliver ample resources to the site quickly and perhaps allow the resumption of the cooling process soon enough to avoid damage to the facility and the release of radioactive material, assuming that the availability of the ultimate heat sink was restored. At the time, however, much of northeast Honshu was being inundated by the tsunami, and local and national authorities understandably devoted considerable attention to rescue attempts and to setting up emergency care facilities. The tsunami (and perhaps also the quake—it is difficult to know at this time) also knocked out infrastructure all along the coast, including roads, transmission lines, and railroads. An oil refinery in Chiba, within about 20 miles of Tokyo, went up in flames and burned nonstop for 10 days. As a result, there were limits on what could be done from outside the plant property in the near term.

The damage caused by the tsunami inland of Fukushima Daiichi was not as extensive as it was on the coast, but many houses were affected. During the evening of March 11, Fukushima Prefecture issued an evacuation order for residents within 2 kilometers (1.2 miles) of Fukushima Daiichi who had not already been displaced by the tsunami. About half an hour later, Prime Minister Kan ordered the evacuation of residents within a 3-km radius (1.8-mi.), and sheltering by residents between 3 km and 10 km (6 mi.) from the plant.

JAPANESE NUCLEAR POWER PLANTS NEAR EARTHQUAKE ZONE

				Constr. Stage	Initial Criticality	Comm. Start	Reactor Supplier
• Unit 2	1060	BWR	BWR-5	100	1/78	11/78	GE
Tohoku Electric Power Co., Inc.							
• Unit 1	498	BWR	BWR-5	100	10/83	6/84	Toshiba
• Unit 2	796	BWR	BWR-5	100	11/94	7/95	Toshiba
• Unit 3	796	BWR	BWR-5	100	4/01	1/02	Toshiba
Tokyo Electric Power Co.							
• Unit 1	439	BWR	BWR-3	100	10/70	3/71	GE
• Unit 2	760	BWR	BWR-4	100	5/73	7/74	GE
• Unit 3	760	BWR	BWR-4	100	9/74	3/76	Toshiba
• Unit 4	760	BWR	BWR-4	100	1/78	10/78	Hitachi
• Unit 5	760	BWR	BWR-4	100	8/77	4/78	Toshiba
• Unit 6	1067	BWR	BWR-5	100	3/79	10/79	GE
• Unit 1	1067	BWR	BWR-5	100	6/81	4/82	Toshiba
• Unit 2	1067	BWR	BWR-5	100	4/83	2/84	Hitachi
• Unit 3	1067	BWR	BWR-5	100	10/84	6/85	Toshiba
• Unit 4	1067	BWR	BWR-5	100	10/86	8/87	Hitachi

Containment venting

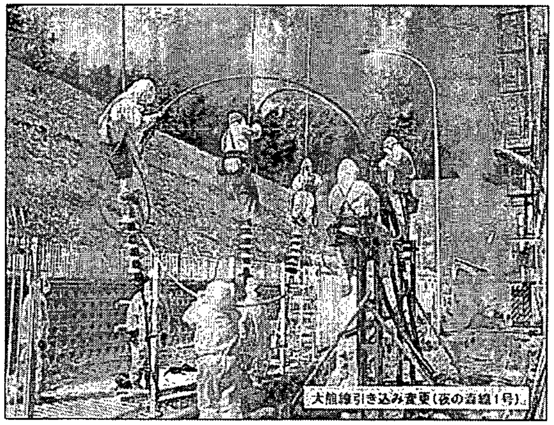
On the morning of March 12, pressure rose above design limits in the primary containment vessel of Unit 1, a General Electric BWR-3 model (an earlier design than any of the other units), and in the afternoon, plant personnel initiated primary containment venting to prevent damage to the vessel. This involved the release of steam, radioactive gases, and hydrogen (produced by the reaction of the hot zirconium fuel cladding with the water in the reactor) into the reactor building.

As it was likely that the water in the core had dropped below the top of the fuel rods, it became apparent that considerable amounts of water needed to be added to the core to prevent overheating and further core damage. As soon as it became possible, seawater with boron was injected into the reactor cores through the fire protection lines. This would have to continue until the plant's own cooling systems returned to operation.

At 3:36 p.m. on March 12, a hydrogen explosion occurred at the top of the Unit 1 reactor building, blowing out a large section of the roof and the walls of the top floor. Four Tepco technicians were injured and hospitalized. At the time, the explosion did not appear to damage the reactor pressure vessel or primary containment vessel. As radiation levels also increased substantially, it became clear that there was fuel damage and possibly some melting. Later that day, the evacuation zone was enlarged to a 20-km (12-mi.) radius.

While the conditions of Units 2 and 3 (BWR-4 models) were slightly different, they followed similar paths. It was possible to inject water into the Unit 3 reactor pressure vessel through the use of the high-pressure coolant injection system until the morning of March 13. The containment vessel was later vented, as reports indicated that the fuel was partially uncovered. Initial attempts to cover the fuel were successful, but

Continued on page 83



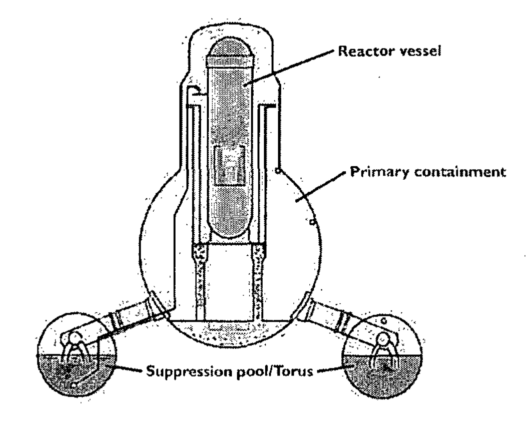
On March 18, workers repair equipment in an effort to restore off-site power to Units 3 and 4 at Fukushima Daiichi. (Photo: Tokyo Electric Power Company/Kyodo via AP Images)

Continued from page 18B

the water level soon dropped again, and some core melting occurred. Then, at 11:01 a.m. on March 14, a hydrogen explosion occurred in the upper part of the Unit 3 reactor building, blowing out large sections of walls and injuring 11 people.

Unit 2 also experienced difficulty in keeping the fuel covered. Late on March 14, part of the wall of the top floor of the reactor building was removed to prevent hydrogen from accumulating. The containment vessel was then vented. A few hours later, however, on March 15, an explosion was heard, believed to be in the suppression chamber, which is located under the reactor, and radioactivity was released into the reactor building. In both cases, seawater with boron was pumped into the reactor pressure vessels as soon as possible.

Problems were also experienced at the spent fuel pools, which in these plants are located on the upper levels of the reactor buildings. (These pools are for initial cooling. The fuel is later moved to a common pool, which was not damaged, and the 6375 fuel assemblies it holds remained covered by water.) In the case of Units 1 through 4, neither pool cooling nor water makeup could be maintained following the loss of power. This allowed fuel temperatures to rise and the water in the pools to evaporate. This became a particular issue in the Unit 4 pool, which contained a considerable amount of very hot fuel recently removed from the reactor before a planned maintenance outage. It appears that the fuel was hot enough to release hydrogen, which eventually exploded, destroying a large part of the building's roof and walls. The focus since then has been on replenishing the water in the pools of Unit 4 (and also Unit 3), mainly by fire engine pumps spraying through gaps in the roof. Helicopters were also used on occasion to drop water onto the pools.



A very general schematic diagram of the Mark I containment used in many early General Electric boiling water reactors. (Graphic: Tepco via Yoshiaki Oka)

Concerns have also been raised about the possibility of mixed-oxide (MOX) fuel—containing uranium and plutonium—being released into the spent fuel pools, but no MOX fuel had yet been discharged to the pools.

Moving toward final shutdown

In the days following the hydrogen explosions at Fukushima Daiichi, progress to make the reactors and the spent fuel pools safe has been slow because of the conditions in and around the plant. There have also been setbacks. Without instruments to monitor plant conditions, it has been difficult to manage the situation. On a number of occasions, smoke was seen issuing from the roofs of the reactor buildings, requiring the temporary evacuation of workers. It was not initially possible to determine what produced the smoke.

The first time that smoke was seen to emerge from Unit 3 was on Wednesday, March 16. Because of the high radiation field above the plant site, an initial attempt by Japan's Self-Defense Force (SDF) to douse it with water from helicopters was abandoned. Not until the next day were the helicopters able to drop water onto the Unit 3 reactor building, while later that day SDF fire trucks and police water-cannon vehicles were employed on the ground. The following day, high-pressure water-cannon trucks, provided by the U.S. Armed Forces in Japan, were used.

While it was possible to inject seawater into the pressure vessels, there was still the considerable problem of the inability to remove the heat. On some occasions, the injection of seawater into the core of Unit 1—which had to be increased to ensure that the fuel was covered—had to be stopped because pressure was rising in both the pressure vessel and the drywell. According to experts at the International Atomic Energy Agency, until heat could be removed from the reactor, pressure would tend to increase as water was injected.

Work to reconnect the units to an off-site transmission line moved forward slowly. Power for Units 5 and 6, which achieved cold shutdown on March 20, switched from emergency diesel generators to an off-site power source on March 22. For the damaged Units 1–4, however, power reconnection was a slow process. Several systems required a great deal of repair work before it was possible to connect the units and power them up. At this writing, power had been restored to the Unit 2 and Unit 4 power centers, and to lighting in the Unit 1 and Unit 3 control rooms.

In the meantime, a number of incidents occurred in which workers were contaminated by radioactivity in runoff water and debris.

Fukushima Daiichi fuel inventory

At Fukushima Daiichi, irradiated fuel is contained in the reactor cores; in the spent fuel pool for each reactor; in a common pool for fuel that has cooled somewhat; and in dry casks. The number of assemblies does not necessarily indicate relative activity because of the different fuel types used and the extent to which assemblies in different locations have cooled. The small Unit 1 uses one type of fuel, the large Unit 6 uses another, and the similar Units 2 through 5 generally have the same fuel specifications. At this writing, the common pool, the dry casks, and the pools for Units 5 and 6 had not been damaged or endangered.

IRRADIATED FUEL ASSEMBLIES BY LOCATION

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Reactor core	400	548	548	0	548	764
Unit pool	292	587	514	1331	946	876
Common pool: 6375 Dry casks: 408						

INES accident ratings

There has been some uncertainty and disagreement on how the Fukushima Daiichi accident should be placed on the International Nuclear Event Scale. Japanese authorities initially declared the accident to be at level 3 ("serious incident"), but on March 18, the incident report for Units 1, 2, and 3 rated the accident as level 5 ("accident with wider consequences"), the same as the Three Mile Island accident. Level 5 typically refers to the occurrence of core damage, as well as to an abnormal rise of radiation at the site boundary. The situation at Unit 4 was still defined as level 3.

The level rating for any of the units could be changed as the accident is further analyzed. France's Nuclear Safety Authority declared on March 16 that it considered Fukushima Daiichi to be at level 6 ("serious accident"). Level 7 ("major accident") has thus far been used only for the 1986 Chernobyl-4 accident in the Soviet Union, in what is now Ukraine.

At the other reactors

Fukushima Daiichi-5 and -6 are physically separate from Units 1 through 4, and many of the support facilities for these two units are independent of those for the other reactors. Units 5 and 6 also experienced problems, and although they had been taken off line for inspection before the quake, fuel was still in the reactors. The loss of off-site power interfered with efforts to maintain a normal environment, but Unit 6's emergency diesel power, which was not damaged by the tsunami and could be restarted, was used for cooling operations at Units 5 and 6. The water temperature in the spent fuel pools increased slightly, and the water levels in the reactor vessels decreased slightly.

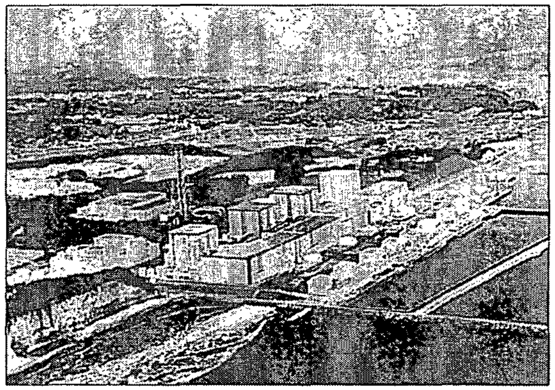
On March 18–19, holes were made in the roofs of the reactor buildings to prevent the accumulation of hydrogen. Off-site power was restored to Units 5 and 6 on March 20, and both reactors reached cold shutdown later that day. At this writing, it appeared that there was no damage to these reactors as a result of the shutdown effort.

To the south, Fukushima Daini faced many of the same problems that existed at Fukushima Daiichi. At Fukushima Daini, however, not all reserve power was lost. Early on March 12, Tepco reported to the government that it lost pressure control on Units 1 and 2. That morning, Prime Minister Kan ordered the evacuation of residents within a 3-km (1.8-mi.) radius, which was enlarged to a 10-km (6-mi.) radius later that day.

While there continued to be some difficulties, none of the reactors or spent fuel pools at Fukushima Daini required extreme measures or underwent significant damage. By the morning of March 15, all four reactors had been taken to cold shutdown, and there were no reports of fuel damage, spent fuel uncovering, or major system failures.

While reports of a fire at the Onagawa plant in the immediate aftermath of the quake gained some news coverage, the fire was in a turbine building and was quickly extinguished. Despite being closer to the epicenter than the other nuclear sites, all three reactors at Onagawa were in cold shutdown early on March 12, less than 11 hours after the quake.

Of the sites where ground acceleration was great enough to cause an automatic shutdown, Tokai was the farthest from the epicenter. No significant issues were reported for either the operable Unit 2 or the long-closed Unit 1. Unit 2 entered cold shutdown early on March 15.



Brief pressure control issues arose at Fukushima Daini-1 and -2, but by the morning of March 15, all four reactors at the site had been taken to cold shutdown. (Photo: Tepco)

Response in the United States

In the United States the political and public policy ramifications of the Fukushima Daiichi situation will continue to develop over the next several months, and there will be no speculation here about possible outcomes. Following is a summary of the most significant statements and specific actions.

Immediately after the quake and tsunami, the United States offered help to Japan for both the nuclear emergency and disaster recovery in general. The Nuclear Regulatory Commission sent two staff professionals to Tokyo on March 12, and nine more two days later. Their role was to monitor the situation and provide advice if and when Japan's Nuclear and Industrial Safety Agency requested it.

On March 14, the Department of Energy and its National Nuclear Security Administration sent 33 people (including consequence management response teams) and over eight tons of equipment (including aerial measurement systems) to Japan. In aerial surveys taken on March 17, 18, and 19, all readings were below 30 millirem per hour, and the vast majority were below 3 mrem/h. The illustration on the opposite page shows the airplanes' flight paths and the readings taken on those flights.

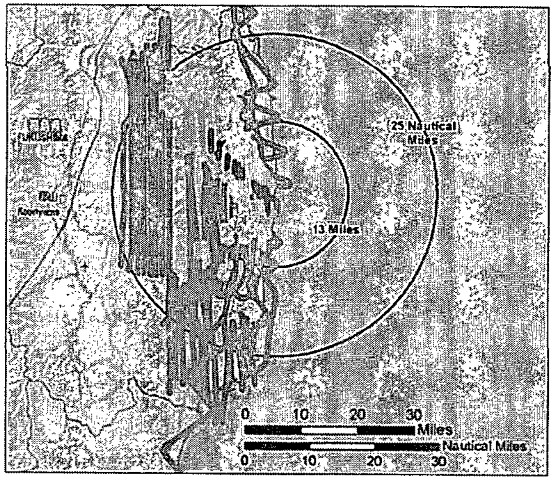
On March 16, the NRC advised the evacuation of all residents within 50 miles of Fukushima Daiichi, based on protective actions that would be taken if the same situation existed in the United States. In the NRC's view, within the 50-mile radius, projected radiation doses could exceed 1 rem to a whole human body or 5 rem to the thyroid. The U.S. ambassador to Japan issued a statement to this effect, advising Americans to stay at least 50 miles from the plant.

On March 18, the DOE reported that radioactive material from the Fukushima Daiichi accident had been detected in the United States. At Pacific Northwest National Laboratory, in Richland, Wash., xenon-133 was detected at about 100 millibecquerels per cubic meter of air. At a Sacramento, Calif., station of the International Monitoring System (of the Comprehensive Nuclear-Test-Ban Treaty Organization), the readings were much lower: iodine-131, 0.165 mBq/m^3; iodine-132, 0.03 mBq/m^3; tellurium-132, 0.04 mBq/m^3; and cesium-137, 0.002 mBq/m^3. The DOE pointed out that normal background radiation is more than 100 000 times greater than the radiation from any material that had migrated to the United States from Japan.

On March 21, the NRC held a public meeting on the events in Japan. The meeting, which was broadcast via the Internet, was limited to discussion among the commissioners and agency staffers (mainly William Borchardt, the executive director for operations). The webcast is archived on the NRC's Web site, at <www.nrc.gov>. The main development at the meeting was the commissioners' general concurrence with the staff's plan to review operating power reactor safety in the United States for issues arising from the effects of the earthquake and tsunami in Japan.

The NRC is already at work on the incorporation of new seismic data into its analyses of operating reactors. Borchardt noted that the U.S. Geological Survey updates its data every five years, and the NRC's work on the 2008 update is intended to resolve Generic Safety Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants." Thus far, there have been no indications that overall conclusions about power reactor seismic safety will be changed.

(The revised seismic data have been incorporated into the new reactor licensing process. Applicants for plants in the Southeast and Mid-Atlantic regions have been required to assess the influence, if any, on their projects from what has been learned about the East Tennessee Seismic Zone.)



The U.S. National Nuclear Security Administration's aerial survey of Fukushima Daiichi, conducted on March 17, 18, and 19, shows that the most significant migration of radioactive material from the site has been to the northwest. The black concentric rings are 13 and 25 nautical miles from the plant. The colored lines follow the survey flight paths. Green indicates less than 1.19 millirem per hour; yellow, 1.19 to 2.17 mrem/h; orange, 2.17 to 12.5 mrem/h; and red, greater than 12.5 mrem/h. No reading exceeded 30 mrem/h. (Graphic: DOE/NNSA)

On March 23, the NRC announced the formation of a task force made up of current senior managers and former agency experts to carry out the seismic review. Both short- and long-term analyses will be conducted, with the former to be delivered in updates in 30, 60, and 90 days. The long-term evaluation will begin within 90 days. The commissioners revised their meeting schedule to add two more public meetings, on April 14 and 28, on the NRC's response to the situation at Fukushima Daiichi, and meetings on May 3 and June 16 on the 30- and 60-day short-term analyses, respectively.

Section continued

Other issues

In addition to providing answers to our specific questions, Akira Omoto addressed some other issues related to the Fukushima Daiichi accident, including the following. (Note: "Gal" is the abbreviation for galileo, which is a unit of ground acceleration, with 1 Gal equal to 1 cm/sec^2.)

How do the observed ground acceleration of the earthquake and the height of the tsunami compare with the design basis of the Fukushima Daiichi reactors?

The acceleration was within the design basis event (DBE) except at Unit 3, where the observed acceleration was 507 Gal, and the DBE was 449 Gal. However, the height of the tsunami far exceeded the design basis. The original design basis was around 3 meters, based on the Chile tsunami in 1960. In the early 2000s, the basis was upgraded to around 6 m, based on the possibility of a big earthquake in the region of the March 11 earthquake, which triggered a tsunami more than 14 m high. The ground level is 10 m high at Fukushima Daiichi.

What kind of severe accident management (SAM) procedure was in place at Fukushima Daiichi, and what changes could potentially be necessary in the future?

The SAM procedure and modifications were established in the 1990s, including hardened containment scrubbing and venting to the main stack via the wet-well air space, makeup water that uses the fire protection system from a large portable water storage tank, electrical bus interconnection of one reactor to others, and so forth. The bus interconnection worked very well in Units 5 and 6, since one emergency diesel generator continued operating and supported both reactors.

It is still a bit early to discuss potential modifications, but the implementation of the SAM faced problems such as the loss of ultimate heat sink, the loss of equipment availability from the tsunami and flooding, and a harsh radiation environment for field work, requiring the use of nonconventional tools and methods.

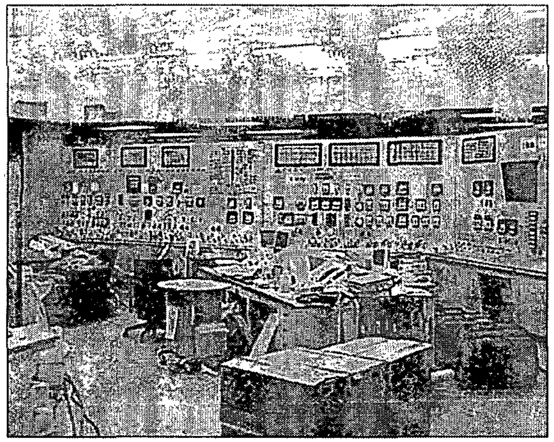
Consideration must be given to the reactor/containment instrumentation and also to the diversity of emergency power sources, especially in the context of heat sink for the power generating equipment. Provisions for hydrogen monitoring and venting at the top of the reactor building (at the level of the refueling floor) could have helped prevent the roof from collapsing and debris from falling into the spent fuel pool. (On the other hand, the collapse uncovered the spent fuel pool and allowed water to be sprayed through the roof.)

The organization of the operations group and the delineation of authority to implement the SAM, plus a group to deliberate coping strategies, should be based on lessons learned, including organized international support on the assessment of possible strategies to be taken and their impacts.

Response in the EU

European Union leaders have agreed that in the aftermath of the nuclear accident in Japan, power reactors in all EU member nations should undergo a comprehensive and transparent risk and safety assessment. The decision to undertake these reviews, referred to as "stress tests," was made during the March 24–25 meeting of the European Council, whose members are the heads of the EU's national governments. A report on the initial findings of the assessments should be available to the council by the end of 2011.

Noting the urgency of this matter, the council asked the European Commission (EC) and the European Nuclear Safety Regulatory Group (ENSREG) to develop "as soon as possible" the scope and nature of these tests, taking into account the lessons learned from the accident. The member countries will also be involved in helping to develop the content of the reviews. The assessments will be conducted by independent national authorities and through peer reviews. The outcomes and any necessary measures to be taken are to be shared with the EC and the ENSREG, and are also to be made public.



The Unit 1 control room on March 24, after lighting was restored. (Photo: Tokyo Electric Power Company/Kyodo via AP Images)

At the same time, the council instructed the EC to review the existing legal and regulatory framework for nuclear safety, with the aim of identifying any improvements that may be necessary. The EC will also consider how to promote nuclear safety in neighboring (and other) non-EU countries, and will request that they carry out similar tests.

In announcing the decision regarding the reactor reviews, the council stated, "The consequences [of the accident] for the world and for the EU need to be closely monitored, paying particular attention to the volatility of energy and commodity prices, in particular in the context of the G20." NN

In other news ...

Events not related to the earthquake and tsunami in Japan have occurred in the nuclear field since March 11. They would normally be reported in the Late News section of *NN*, but because of the need to give the Japan situation its due coverage, we only briefly mention them here and will cover some of them at greater length in the May issue.

■ **The final environmental impact statement for Vogtle-3 and -4** was issued by the Nuclear Regulatory Commission staff on March 18. This completes the environmental review for the new reactors to be built at the site in Georgia.

■ **The proposed rule to certify GE Hitachi Nuclear Energy's ESBWR design was published** in the *Federal Register (FR)* on March 24. Public comments will be accepted through June 7. The NRC has been using a target date of September for the issuance of the final rule.

■ **The mandatory hearing on the environmental review of Areva Enrichment Services' license application** has been opened to the participation of governmental agencies by the presiding Atomic Safety and Licensing Board. Areva intends to build and operate a uranium enrichment facility in Bonneville County, Idaho. More information is available in the March 2 *FR*.

■ **The renewed license for Vermont Yankee was issued** on March 21 by the NRC staff. The commissioners had taken their final action on the license renewal request on March 10 (see page 32, this issue).

■ **NextEra Energy Resources intends to apply in late June to use NFPA 805** at four of its five nuclear plants. The company told the NRC at a March 22 meeting that it will apply for amendments to switch to the risk-informed fire protection standard at Arnold, Point Beach, St. Lucie, and Turkey Point. Seabrook was not mentioned. NextEra includes Florida Power & Light Company reactors and merchant power reactors acquired by FPL Group.

■ **An environmental management partnering agreement** has been signed by the Department of Energy and Savannah River Remediation LLC. The pilot agreement, which will be used as a guide for other DOE sites, is aimed at fostering a more collaborative working relationship that will contribute to the safe, compliant, and cost-effective execution of high-level radioactive liquid waste operations at the Savannah River Site, in South Carolina. Savannah River Remediation manages the liquid waste contract for the DOE at the site.

■ **Three power uprate applications have been accepted for review** by the NRC. In a March 16 update to its power uprate Web page, at <www.nrc.gov>, the NRC indicated that it has completed its review for Florida Power & Light Company's Turkey Point-3 and -4 and St. Lucie-1, and that the acceptance review process for the St. Lucie-2 application, received on February 25, has begun.

■ **The proposed NRC fees for fiscal year 2011** were published in the March 17 *FR*. To meet its congressional requirement to recover about 90 percent of its funding from licensees, the NRC estimates that it must collect about $915.7 million for the fiscal year that ends September 30. The proposed fee for an operating power reactor is $4.669 million, down 2.4 percent from FY 2010.

■ **A 28-page report from the Blue Ribbon Commission** on America's Nuclear Future was issued in March. *What We've Heard*, available online at <www.brc.gov/>, summarizes the major themes in the testimony and comments the commission has received. The subjects covered in the report are grouped under seven broad headings: Program Governance and Execution; Nuclear Waste Fee and Fund; Approach to Siting; Reactor and Fuel Cycle Technologies; Transport of Used/Spent Fuel and High-level Wastes; Storage of Used/Spent Fuel and High-level Wastes; and Disposal System for Highly Radioactive Waste. NN

Wittick, Brian

From: Wittick, Brian
Sent: Tuesday, April 12, 2011 5:24 AM
To: '?? ??'; Emche, Danielle
Cc: 'tanabeyx@state.gov'; Stahl, Eric; 'smckenna@ofda.gov'
Subject: RE: Interpreter for April 13-15

Dear Yoriko-san,

We have a new meeting 4/13 scheduled for 1600-1800 at the METI building with NISA.

Thank you,
Brian Wittick

From: 上村 依子 [mailto:y-uemura@simul.co.jp]
Sent: Tuesday, April 12, 2011 1:55 AM
To: Emche, Danielle; Wittick, Brian
Cc: 'tanabeyx@state.gov'; Stahl, Eric; 'smckenna@ofda.gov'
Subject: Interpreter for April 13-15

Dear Danielle-san, Brian-san,

We have assigned Ms. Nagai for 9-17 work from 13th to 15th.
I have updated the attached schedule.

Thank you.

Best regards,
Yoriko
From: Emche, Danielle [mailto:Danielle.Emche@nrc.gov]
Sent: Monday, April 11, 2011 2:52 PM
To: 上村 依子
Cc: 'tanabeyx@state.gov'; Stahl, Eric; 'smckenna@ofda.gov'; Wittick, Brian
Subject: RE: Interpreter for April 12th

Dear Uemura-san,

You are correct that we will need an interpreter for the 1500 meeting tomorrow, and the location is the Kantei. In addition, I would like to acknowledge that Brian Wittick has joined the NRC team at the Embassy and he will be taking over completely on Wednesday. You can correspond with both of us for tomorrow and transition to Brian completely for Wednesday.

Danielle

From: 上村 依子 [mailto:y-uemura@simul.co.jp]
Sent: Monday, April 11, 2011 1:21 AM
To: Emche, Danielle
Cc: 'tanabeyx@state.gov'; Stahl, Eric; 'wallmm@state.gov'; 'smckenna@ofda.gov'
Subject: Interpreter for April 12th
Importance: High

Dear Danielle-san,

Y/359

I heard from one of the interpreters that there would be a meeting starting at 1500 tomorrow(12th). Should we send an extra interpreter for it？

Best regards,
Yoriko

From: Emche, Danielle [mailto:Danielle.Emche@nrc.gov]
Sent: Thursday, April 07, 2011 10:42 AM
To: 上村 依子
Cc: 'tanabeyx@state.gov'; 'njohnson@ofda.gov'; Stahl, Eric; 'wallmm@state.gov'; 'smckenna@ofda.gov'
Subject: Interpreter for 7 April at 3pm

Dear Uemura-san,

It has been brought to our attention that an interpreter will be required for a meeting at 3pm today. If possible, can you please have them arrive at the Embassy by 2:30pm today? Please let me know if this will be a problem.

Thank you in advance for your kind assistance.

Best regards,
Danielle

Wittick, Brian

From: Wittick, Brian
Sent: Tuesday, April 12, 2011 6:58 AM
To: LIA08 Hoc
Subject: information request

We are looking for a listing of EAL reporting criteria for a project we are working with the GOJ and DOS. Thanks for your help.

Brian Wittick

Y/360

Wittick, Brian

From: Wittick, Brian
Sent: Tuesday, April 12, 2011 7:10 AM
To: 'Quade, Christopher P'
Cc: Emche, Danielle
Subject: RE: TEPCO

Chris,

See the following link: http://edition.cnn.com/2011/WORLD/asiapcf/04/12/japan.quakes/index.html?hpt=T1

Thanks
Brian

From: Quade, Christopher P [mailto:QuadeCP@state.gov]
Sent: Tuesday, April 12, 2011 6:53 AM
To: Wittick, Brian
Cc: Emche, Danielle
Subject: RE: TEPCO

Thanks, Brian – that's very good news. (Actually, we received a question about whether or not the Fukushima plant was "evacuated" after the latest aftershock... might you know the answer to that?)

Best,
Christopher

This email is UNCLASSIFIED.

From: Wittick, Brian [mailto:Brian.Wittick@nrc.gov]
Sent: Tuesday, April 12, 2011 7:52 PM
To: Quade, Christopher P
Cc: Emche, Danielle
Subject: TEPCO

Chris,

Alan said you were interested in whether we had heard of whether Fukushima lost cooling as a result of todays earthquake. News reports on Kyodo indicate TEPCO reported no loss of cooling to the plants.

Thanks
Brian Wittick

Y/36

Merzke, Daniel

From: Merzke, Daniel
Sent: Tuesday, April 12, 2011 9:44 AM
To: Jones, Cynthia
Subject: URGENT - INES Level Change from 5 to 7

Importance: High

Cyndi, the Chairman is looking for the basis behind the Japanese decision to upgrade the INES level from 5 to 7, within the next 15 minutes. He's preparing to testify to Congress. I pulled the report off NEWS which talks about the amount of I-131 and Cs-137 released. Do you know if there's any other information he needs to know? Please call me ASAP 301-415-8744. Thanks.

Dan

Y/362

Merzke, Daniel

From: Merzke, Daniel
Sent: Tuesday, April 12, 2011 10:52 AM
To: Orders, William; Wittick, Brian
Subject: RE: Request

Brian is in Japan. I'll dig up the new inspection requirements for you.

Dan

From: Orders, William
Sent: Tuesday, April 12, 2011 10:51 AM
To: Wittick, Brian; Merzke, Daniel
Subject: Request

Commissioner Magwood asked for a copy of an Inspection Manual chapter that was added after Fukushima. I am thinking this might be the TI I have heard about.

Anyway, could I get a copy of that and whatever other new inspection requirements that have come about due to Fuku?

Thanks

Bill

William T. Orders
Reactors Technical Assistant
Staff of Commissioner William D. Magwood IV
310-415-8430
William.Orders@nrc.gov

Y/363

Merzke, Daniel

From: Merzke, Daniel
Sent: Tuesday, April 12, 2011 10:57 AM
To: Norkin, Donald
Subject: FW: Request

Don, according to Tim's e-mail, you are filling in for him. I sent this request to Jim Isom, too. Can someone there provide me the documents requested. I heard of a TI being issued, but couldn't find it in the Inspection Manual. Thanks.

Dan

From: Orders, William
Sent: Tuesday, April 12, 2011 10:51 AM
To: Wittick, Brian; Merzke, Daniel
Subject: Request

Commissioner Magwood asked for a copy of an Inspection Manual chapter that was added after Fukushima. I am thinking this might be the TI I have heard about.

Anyway, could I get a copy of that and whatever other new inspection requirements that have come about due to Fuku?

Thanks

Bill

William T. Orders
Reactors Technical Assistant
Staff of Commissioner William D. Magwood IV
310-415-8430
William.Orders@nrc.gov

Y/364

Merzke, Daniel

From: Merzke, Daniel
Sent: Tuesday, April 12, 2011 11:03 AM
To: Isom, James
Subject: RE: Request

Got it. Thanks, Jim.

From: Isom, James
Sent: Tuesday, April 12, 2011 11:02 AM
To: Merzke, Daniel
Cc: Kobetz, Timothy
Subject: RE: Request

Dan,

Here it is.. it is a TI, not an inspection manual chapter

Jim

From: Merzke, Daniel
Sent: Tuesday, April 12, 2011 10:54 AM
To: Kobetz, Timothy
Cc: Isom, James
Subject: FW: Request

Hi Tim. Can anyone in your branch send me the documents requested? I'm pretty sure I heard of a new TI issued, but I didn't see it when I checked the Inspection Manual. Thanks.

Dan

From: Orders, William
Sent: Tuesday, April 12, 2011 10:51 AM
To: Wittick, Brian; Merzke, Daniel
Subject: Request

Commissioner Magwood asked for a copy of an Inspection Manual chapter that was added after Fukushima. I am thinking this might be the TI I have heard about.

Anyway, could I get a copy of that and whatever other new inspection requirements that have come about due to Fuku?

Thanks

Bill

William T. Orders
Reactors Technical Assistant
Staff of Commissioner William D. Magwood IV
310-415-8430
William.Orders@nrc.gov

Y/365

Merzke, Daniel

From: Merzke, Daniel
Sent: Tuesday, April 12, 2011 2:07 PM
To: Westreich, Barry
Cc: Kobetz, Timothy; Brown, Frederick; Isom, James
Subject: RE: Just FYI. FW: Request

Not as of this time, Barry. If the Commissioner has questions, we may have to set something up. Thanks.

Dan

From: Westreich, Barry
Sent: Tuesday, April 12, 2011 2:04 PM
To: Merzke, Daniel
Cc: Kobetz, Timothy; Brown, Frederick; Isom, James
Subject: RE: Just FYI. FW: Request

Do we need to brief the Commissioner or his TA?

From: Isom, James
Sent: Tuesday, April 12, 2011 1:53 PM
To: Brown, Frederick; Westreich, Barry
Cc: Kobetz, Timothy
Subject: RE: Just FYI. FW: Request

Sent an electronic copy of the TI 2515/183 to Dan Merzke this am

Jim

From: Kobetz, Timothy
Sent: Tuesday, April 12, 2011 11:26 AM
To: Brown, Frederick; Westreich, Barry
Cc: Isom, James
Subject: Just FYI. FW: Request

Barry and Fred,

Just an FYI. I'm sending this as background to the last e-mail I cc:d you on.

Tim

From: Merzke, Daniel
Sent: Tuesday, April 12, 2011 10:54 AM
To: Kobetz, Timothy
Cc: Isom, James
Subject: FW: Request

Hi Tim. Can anyone in your branch send me the documents requested? I'm pretty sure I heard of a new TI issued, but I didn't see it when I checked the Inspection Manual. Thanks.

Dan

Y/366

SECY

From: Orders, William
Sent: Tuesday, April 12, 2011 10:51 AM
To: Wittick, Brian; Merzke, Daniel
Subject: Request

Commissioner Magwood asked for a copy of an Inspection Manual chapter that was added after Fukushima. I am thinking this might be the TI I have heard about.

Anyway, could I get a copy of that and whatever other new inspection requirements that have come about due to Fuku?

Thanks

Bill

William T. Orders
Reactors Technical Assistant
Staff of Commissioner William D. Magwood IV
310-415-8430
William.Orders@nrc.gov

Andersen, James

From: Evans, Michele
Sent: Tuesday, April 12, 2011 4:27 PM
To: Andersen, James
Subject: FW: New ERF on NEWS, INES Rating: 7, Japan, Power Reactor

Jim,

Good work by Dan. Thanks..

-----Original Message-----
From: Jones, Cynthia
Sent: Tuesday, April 12, 2011 3:40 PM
To: Wiggins, Jim; Evans, Michele
Subject: Fw: New ERF on NEWS, INES Rating: 7, Japan, Power Reactor

Fyi- I worked with Dan M in EDO office this morning your time to draft a few sentences on the for the Chairman within a 15 min window. (/lad he called me on my cell). Dan is an excellent asset for NSIR. Pls pass on to his mgmt as well.....

Cynthia G. Jones, Ph.D.
Sr. Technical Advisor for Nuclear Security, NRC/NSIR Sent from blackberry

----- Original Message -----
From: NEWS Administration <NEWS_Administrator@iaea.org>
To: NEWS.Contact-Point@iaea.org <NEWS.Contact-Point@iaea.org>
Sent: Mon Apr 11 23:43:35 2011
Subject: New ERF on NEWS, INES Rating: 7, Japan, Power Reactor

Dear NEWS User,

This is to notify you as a registered user of the NEWS Web site that an Event Rating Form (ERF) for the Event titled:

"Re-evaluation of INES rating; Effect to the Nuclear Facilities from the earthquake on east area of Japan"

has as of today, Tuesday, 12 April 2011, 05:43:32 UTC, been added to the NEWS Web site. Additional information regarding the ERF is as follows:

Country: Japan
Location/Facility: Fukushima Daiichi
Event Type: Power Reactor
Event Date: 2011.04.12

Rating Date: 2011.04.12
ERF Version: Provisional
INES Rating Level: 7

For more detailed information about the ERF, including the related Event and press releases as well as on-site participation in forum discussions, please visit the NEWS Web site at:

http://www-news.iaea.org/news/

Y/367

Wittick, Brian

From: Wittick, Brian
Sent: Tuesday, April 12, 2011 7:42 PM
To: 'bannai-toshihiro@meti.go.jp'; 'satoh.takashi@tepco.co.jp'; 'nei-hisanori@meti.go.jp'; 'oshima-toshiyuki@meti.go.jp'; 'koyama-masaómi@meti.go.jp'
Cc: Casto, Chuck; Collins, Elmo; 'y-uemura@simul.co.jp'; Emche, Danielle
Subject: NRC Meetings for 13 April 2011
Attachments: NRC Meetings 13-April-2011.docx

Dear Bannai-san and Satoh-san,

Please find the schedule for NRC meetings today (attached). If you have any questions or concerns, please let me know.

Recently in the NISA/TEPCO meetings, there has been agreement about holding more "engineer to engineer" meetings on an as-needed basis. NRC is looking forward to such meetings. Let's keep one another on cc about those meetings and in close communication.

I am planning to be in Tokyo for three weeks. I look forward to meeting you, perhaps at a NISA/TEPCO meeting later this week.

Regards,
Brian

Y/368

U.S. Nuclear Regulatory Commission Meetings
Wednesday, 13 April 2011

Time	Organization-Topic	Location
1100	NISA & TEPCO - Daily Status	TEPCO
1400	NISA Confinement Working Group	NISA
1600	MELCOR discussion	NISA

Wittick, Brian

From: Wittick, Brian
Sent: Wednesday, April 13, 2011 5:31 AM
To: Casto, Chuck; Collins, Elmo
Subject: AREVA Activity List.docx
Attachments: AREVA Activity List.docx

As requested. I will update as I find additional information.

Y/369

AREVA Activity List

Activity/Goods	Quantity	Status	Recipient
Personal Radiation Dosimeter	130	Accepted	TEPCO
Radiation Detector	7	Accepted	TEPCO
Radiation Measurement Vehicle	4	Accepted	TBD
Protective Masks	3379	Accepted	TEPCO
Protective Masks	3000	Accepted	TEPCO
Mask Replacement Filters	9065	Accepted	TEPCO
Protective body suits	10000	Accepted	TEPCO
Safety Experts	8	Accepted	VARIOUS
Water Decontamination Project	N/A	Negotiation	TEPCO

Effective: April 13, 2011

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 13, 2011 7:47 AM
To: Andersen, James
Subject: RE: Heads up: NRR is prepared Fukushima Presentation

Wilco.

From: Andersen, James
Sent: Wednesday, April 13, 2011 7:33 AM
To: Merzke, Daniel
Cc: Landau, Mindy
Subject: FW: Heads up: NRR is prepared Fukushima Presentation

Dan, can you take a look at the attached and see if it would work if Bill needs to brief Senator Mikulski on Monday. If so, make any minor modifications as needed. Thanks.

Jim A.

From: Landau, Mindy
Sent: Tuesday, April 12, 2011 4:05 PM
To: Andersen, James
Cc: Rihm, Roger
Subject: FW: Heads up: NRR is prepared Fukushima Presentation

NRR prepared this presentation on the Japan event and I think we can modify as needed and use it for Bill's briefing for Senator MIKULSKI. Any comments? Which EA are we assigning to this?

From: Wertz, Trent
Sent: Tuesday, April 12, 2011 4:02 PM
To: Landau, Mindy
Cc: Nelson, Robert
Subject: RE: Heads up: NRR is prepared Fukushima Presentation

Mindy,

Here is the presentation with speaker notes. Eric gave it to the National Governor's Association on 4/4. We also used a portion of it today in a meeting with officials from NYC. Please let me know if you have any questions.

Trent

Y/370

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 13, 2011 8:23 AM
To: Dudek, Michael
Subject: RE: FYI - PARs for Deputies Meeting Rev 19a (2).docx

Thanks, Michael. Any progress on locating the Global Assessment? I think Chuck Casto was working on this, and it may just be a slide presentation, from rumors I've heard. Let me know what you can find. Thanks.

Dan

From: Dudek, Michael
Sent: Wednesday, April 13, 2011 7:42 AM
To: Merzke, Daniel
Subject: FYI - PARs for Deputies Meeting Rev 19a (2).docx

Dan,

Here is one of the documents for distribution, as appropriate. OUO at this time.

Michael I. Dudek

Michael Dudek | Technical Assistant | NSIR/Division of Preparedness & Response | U.S. NRC
11555 Rockville Pike, Rockville, MD 20852 | ☎ (301) 415-6500 | 🖂: Michael.Dudek@nrc.gov

4/371

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 13, 2011 10:32 AM
To: Dudek, Michael
Subject: Release of Global Assessment to the CAs

Michael, I spoke to Marty about the reluctance of the ET to release the Global Assessment to the CAs. He said there's no reason to withhold it from the CAs, as long as we stress to them that it is a draft document only. I told him that's the emphasis I placed on the re-entry criteria document, and he was fine with that. If you could get me the document soon, I'd appreciate it. Thanks a lot.

Dan

Y/372

Merzke, Daniel

From: Merzke, Daniel
Sent: Wednesday, April 13, 2011 4:17 PM
To: Bradford, Anna; Thoma, John; Baggett, Steven; Tadesse, Rebecca; Kock, Andrea
Subject: Interagency Meetings on Cleanup Standards and Re-Entry Criteria

One of the Commission offices requested information on all currently scheduled interagency meetings in which the NRC is being asked to participate in with other federal agencies relating to Protective Action Guidelines and cleanup levels in this country as well as re-entry guidance for US citizens in Japan. At this time, the only meeting I know for sure is being led by EPA on 4/21, and it's concerning the working group paper being developed for long-term cleanup criteria, which was one of the PLE topics. There is supposed to be a Deputies meeting to make a decision during the last week of April/first week of May, but it hasn't been scheduled, yet, and I'm hearing the due date for the paper got extended to 4/29, so it may get pushed back even further.

So far there are no meetings scheduled with external stakeholders on the re-entry issue to Japan. I just attended an alignment meeting on the draft re-entry paper, and it looks like the plan is to hopefully get it finalized by Friday. Then it will be rolled out to external stakeholders for comment. If that results in an interagency meeting, I'll try to remember to let you know when that is scheduled. Other than that, I know of no other interagency meetings on these topics. If I hear more, I'll let you know.

Dan

Y/373

Khanna, Meena

From: Hiland, Patrick
Sent: Wednesday, April 13, 2011 7:22 AM
To: NRR_DE Distribution
Subject: FW: FWD FYI: NEI Talking Points Comparing Chernobyl and Fukushima

FYI, if you recall the Chernobyl event and want to see a comparison to the ongoing event at Fukushima, the below info was generated by the Nuclear Energy Institute.

NEI

From: NEI Response Center
Sent: Tuesday, April 12, 2011 3:11 PM
Subject: NEI Talking Points Comparing Chernobyl and Fukushima

NEI
NUCLEAR ENERGY INSTITUTE

April 12, 2011

Talking Points
Comparing Chernobyl and Fukushima

As the situation at the Fukushima Daiichi nuclear power plant continues, some are comparing events there to the 1986 accident at the Chernobyl reactor in the Soviet-era Ukraine. The Japanese government raised the crisis level from 5 to 7 on the International Nuclear and Radiological Event Scale, the same rating as the Chernobyl accident. Yet the accidents at the Chernobyl and Fukushima reactors are starkly different. Notably, the reactor designs are completely different; and to date, the public health consequences at Fukushima are much less severe.

Accident Conditions

- The Fukushima event has been rated 7 on the International Nuclear and Radiological Event Scale, the same level as the 1986 Chernobyl accident. Even so, Japanese authorities estimate that radiation released at Fukushima is only 10 percent of the amount released from the Ukrainian plant. A level 7 event, the highest on the rating scale, is considered a "major accident." It applies to an event with "a major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures," according to the International Atomic Energy Agency, which sponsors the ratings. The Japanese government set the rating, which it considers "provisional" and subject to change.

- Chernobyl was an old Soviet-design reactor, with less stable characteristics and no robust containment structures like most power reactors worldwide. Unconventional reactor operations at Chernobyl resulted in a runaway power surge followed by steam and hydrogen explosions and a sustained fire in the reactor. Absent a containment structure, the explosions propelled radioactive material from the reactor core high into the atmosphere and across

Y/374

eastern and western Europe for at least 10 days.

- The magnitude 9.0 earthquake and tsunami that struck the Fukushima Daiichi reactors were much stronger than the reactors were built to withstand. The resulting loss of on- and off-site electricity temporarily halted cooling of the fuel in the reactor cores and in the used fuel pools. There have been explosions at three of the reactors as a result of hydrogen buildup, but the reactor fuel remains inside the primary containment structures. Although some damage to the uranium fuel is expected, there have not been releases of radiation into the atmosphere at the levels seen during the Chernobyl accident.

Emergency Response

- The uncontrolled release of Chernobyl reactor's fission products was exacerbated by the failure of Soviet authorities to take immediate action to protect surrounding populations. The most discernible health effect from Chernobyl—thyroid cancer in children—could have been mitigated by the early and widespread use of radiation protection procedures such as distribution of potassium iodide and control of the food supply in affected areas.

- By contrast, the Japanese authorities took early steps to evacuate people from a 12.5-mile zone around the Fukushima plant. Authorities also distributed potassium iodide to residents near the plant and restricted the transport and sale of milk (the main source of radioactive iodine intake), leafy vegetables and other food from the region. The Japanese government is monitoring and reporting radiation levels to citizens on an ongoing basis and is providing information and health protection instructions to the public.

- Besides child thyroid cancer, no other health effects have been detected in the populations around Chernobyl, according to a 2008 report of the United Nations Scientific Committee on the Effects of Atomic Radiation.

- Based on all information to date, no health effects are expected among the Japanese people as a result of the events at Fukushima.

Long-Term Health Effects

- The unique nature of the Chernobyl accident resulted in widespread airborne dispersion of radioactive cesium as fallout, which has a half-life of 30 years. The incident left the area in a 30 kilometer radius around the facility as a long-term restricted zone.

- Although measurements of radioactivity in the air and water near the Fukushima plant have been evident at varying levels, wide dispersion of radioactive materials has not occurred at the facility. While there may be localized spots that will require monitoring and remediation, it is unlikely that any significant areas of land in Japan will have long-term restrictions.

Nuclear Energy Institute
1776 I Street NW, Suite 400
Washington, DC 20006
www.nei.org

P: 202.739.8000
F: 202.785.4019
Emergency Off-Hours: 703.644.8805

E: NEIResponseCenter@nei.org
Twitter: http://twitter.com/neiupdates

Wittick, Brian

From: Wittick, Brian
Sent: Thursday, April 14, 2011 2:26 AM
To: 'thomas.stevens@areva.com'
Subject: AREVA Activity List.docx
Attachments: AREVA Activity List.docx

Dear Tom,

It was a pleasure to meet you today and I look forward to working with you in assisting our Japanese colleagues. Attached is the list I generated and we discussed. Request your assistance to validate the list, especially with regard to assistance activities that would be of the service or consultant type.

Thanks again.
Brian Wittick

Y/375

AREVA Activity List

Activity/Goods	Quantity	Status	Recipient
Personal Dosimeters	130	Complete	TEPCO
Radiation Detectors	7	Complete	TEPCO
Radiation Measurement Vehicles	4	Complete	TEPCO?
Protective Masks	3379	Complete	TEPCO
Protective Masks	3000	Complete	TEPCO
Mask Replacement Filters	9065	Complete	TEPCO
Anti-C's	10000	Complete	TEPCO
Expert Consultants		Complete	GOJ and TEPCO
Water Decontamination Project	N/A	Negotiations in progress	TEPCO

Effective: April 13, 2011

Wittick, Brian

From: Wittick, Brian
Sent: Thursday, April 14, 2011 7:28 PM
To: Lupold, Timothy; Meighan, Sean
Subject: Arrival information

Tim and Sean,

Hopefully this is not too late to catch you. When you arrive at the Tokyo airport as you walk out of baggage you will see a counter with an orange and white sign that says limousine. Go to the counter and ask for a ticket to "Hotel Okura"; it will be about 30,000 YEN, which is the cheapest you will find. The Limousine buses pick up are out front.

When you check in you should get comp breakfast coupons for your duration. Feel free to call or email me when you arrive with questions.

If you are interested it would be beneficial to meet with you at breakfast at 0630. We can then make arrangements for bringing you to the embassy.

Thanks,
Brian

Y1376

Ross, Robin

From: Wertz, Trent on behalf of Leeds, Eric
Sent: Thursday, April 14, 2011 10:14 AM
To: Wertz, Trent
Subject: FW: NRC's Daily Assessment of Conditions at Fukushima Daiichi
Attachments: NRC Daily Assessment of Daiichi - 4-11-11.pdf

N 5IA

From: Salay, Michael
Sent: Monday, April 11, 2011 2:50 AM
To: Jaczko, Gregory
Cc: Borchardt, Bill; Weber, Michael; Virgilio, Martin; Casto, Chuck; Leeds, Eric; RST01 Hoc
Subject: NRC's Daily Assessment of Conditions at Fukushima Daiichi

Dear Chairman,

Attached please find the NRC Japan Team's Daily Assessment of conditions at the Fukushima Daiichi nuclear power plants and spent fuel pools. There are no changes of note today.

If you have any questions, please don't hesitate to ask.

Best regards,
Mike Salay
NRC Japan Team

Y\377

NRC's Daily Assessment of Conditions at Fukushima Daiichi Nuclear Power Plant

Unit 1		Today	Yesterday
Vessel	Cooling	Challenged ↔	Challenged ↔
Vessel	Integrity	Intact ↔	Intact ↔
Containment	Flooding	Inc./Needed ↔	Inc./Needed ↔
Containment	Integrity	Challenged ↔	Challenged ↔
Spent Fuel Pool	Cooling/Level	Adequate ↔	Adequate ↔
Spent Fuel Pool	Integrity	Intact ↔	Intact ↔

Unit 3		Today	Yesterday
Vessel	Cooling	Adequate ↔	Adequate ↔
Vessel	Integrity	Failed ↔	Failed ↔
Containment	Flooding	Challenged ↔	Challenged ↔
Containment	Integrity	Failed ↔	Failed ↔
Spent Fuel Pool	Cooling/Level	Challenged ↔	Challenged ↔
Spent Fuel Pool	Integrity	Challenged ↔	Challenged ↔

Unit 2		Today	Yesterday
Vessel	Cooling	Challenged ↔	Challenged ↔
Vessel	Integrity	Failed ↔	Failed ↔
Containment	Flooding	Inc./Needed ↔	Inc./Needed ↔
Containment	Integrity	Failed ↔	Failed ↔
Spent Fuel Pool	Cooling/Level	Adequate ↔	Adequate ↔
Spent Fuel Pool	Integrity	Intact ↔	Intact ↔

Unit 4		Today	Yesterday
Spent Fuel Pool	Cooling/Level	Challenged ↔	Challenged ↔
Spent Fuel Pool	Integrity	Failed ↔	Failed ↔

		Today	Yesterday
Protective Measures	Exposure Risk	Low ↔	Low ↔

April 11, 2011

Methodology for Developing the Fukushima Daiichi Daily Assessment Report

PURPOSE: The report is prepared to provide a qualitative high level assessment of daily conditions at Fukushima Daiichi that the U.S. Ambassador can use to assess the safety of American citizens in Japan.

DISCLAIMER: The development of the daily assessment report includes a number of inputs. Some of these are objective, such as plant data provided by TEPCO, while others are subjective, such as engineering insights from the NRC's reactor and protective measures specialists in Japan. It should be recognized that there are many unknowns and uncertainties associated with having a complete understanding of conditions in each of the Daiichi reactors and spent fuel pools. As such, this tool represents the collective judgment of the NRC staff in Japan based on all available data.

For each of the major plant parameters listed below, the NRC staff assesses its status daily and bins it into one of the three categories listed. The staff uses the listed plant information and conditions in making its assessment. The arrows on the report indicate the relative trend in plant conditions from the previous day.

1. Reactor Pressure Vessel
    a. Cooling – Adequate, Challenged, or Inadequate.
        i. Flow or Injection Rate
        ii. Reliability of Injection
        iii. Source of Water
    b. Integrity – Intact, Challenged, or Failed.
        i. Temperature indications
        ii. Pressure readings
2. Primary Containment
    a. Flooding Status – Complete/Not needed, Challenged, or Incomplete/Needed.
        i. Water Level
        ii. Sources
        iii. Injection capacity/rate
    b. Integrity - Intact, Challenged, or Failed.
        i. Pressure readings
        ii. Bypass evaluations
        iii. Temperature indications
3. Spent Fuel Pools
    a. Cooling/Level – Adequate, Challenged, or Inadequate.
        i. Flow or Injection Rate
        ii. Reliability of Injection
        iii. Source of Water
    b. Integrity – Intact, Challenged, or Failed. Due to limited available data, this assessment relies strongly on the NRC team's engineering judgment.
4. Protective Measures – Exposure Risk to American citizens in Japan outside the U.S. government's recommended 50-mile evacuation zone.
    a. Low – 50-mile recommendation remains sufficient
    b. Medium – New information has raised questions regarding the sufficiency of the 50-mile recommendation.
    c. High – 50-mile recommendation is no longer sufficient due to changing plant condition

Ross, Robin

From: Wertz, Trent on behalf of Leeds, Eric
Sent: Thursday, April 14, 2011 10:17 AM
To: Wertz, Trent
Subject: FW: NRC's Daily Assessment of Conditions at Fukushima Daiichi
Attachments: NRC Daily Assessment of Daiichi - 4-9-11.pdf

N SIR

From: Salay, Michael
Sent: Saturday, April 09, 2011 2:39 AM
To: Salay, Michael; Jaczko, Gregory
Cc: Borchardt, Bill; Weber, Michael; Virgilio, Martin; Casto, Chuck; Leeds, Eric; RST01 Hoc
Subject: NRC's Daily Assessment of Conditions at Fukushima Daiichi

Dear Chairman,

Attached please find the NRC Japan Team's Daily Assessment of conditions at the Fukushima Daiichi nuclear power plants and spent fuel pools. There are no changes of note today.

If you have any questions, please don't hesitate to ask.

Best regards,
Mike Salay
NRC Japan Team

Y/378

NRC's Daily Assessment of Conditions at Fukushima Daiichi Nuclear Power Plant

Unit 1		Today	Yesterday
Vessel	Cooling	Challenged	Challenged
		↔	↓
	Integrity	Intact	Intact
		↔	↔
Containment	Flooding	Inc./Needed	Inc./Needed
		↔	↔
	Integrity	Challenged	Challenged
		↔	↔
Spent Fuel Pool	Cooling/Level	Adequate	Adequate
		↔	↔
	Integrity	Intact	Intact
		↔	↔

Unit 3		Today	Yesterday
Vessel	Cooling	Adequate	Adequate
		↔	↔
	Integrity	Failed	Failed
		↔	↔
Containment	Flooding	Challenged	Challenged
		↔	↔
	Integrity	Failed	Failed
		↔	↔
Spent Fuel Pool	Cooling/Level	Challenged	Challenged
		↔	↔
	Integrity	Challenged	Challenged
		↔	↔

Unit 2		Today	Yesterday
Vessel	Cooling	Challenged	Challenged
		↔	↓
	Integrity	Failed	Failed
		↔	↔
Containment	Flooding	Inc./Needed	Inc./Needed
		↔	↔
	Integrity	Failed	Failed
		↔	↔
Spent Fuel Pool	Cooling/Level	Adequate	Adequate
		↔	↔
	Integrity	Intact	Intact
		↔	↔

Unit 4		Today	Yesterday
Spent Fuel Pool	Cooling/Level	Challenged	Challenged
		↔	↔
	Integrity	Failed	Failed
		↔	↔

		Today	Yesterday
Protective Measures	Exposure Risk	Low	Low
		↔	↔

Methodology for Developing the Fukushima Daiichi Daily Assessment Report

PURPOSE: The report is prepared to provide a qualitative high level assessment of daily conditions at Fukushima Daiichi that the U.S. Ambassador can use to assess the safety of American citizens in Japan.

DISCLAIMER: The development of the daily assessment report includes a number of inputs. Some of these are objective, such as plant data provided by TEPCO, while others are subjective, such as engineering insights from the NRC's reactor and protective measures specialists in Japan. It should be recognized that there are many unknowns and uncertainties associated with having a complete understanding of conditions in each of the Daiichi reactors and spent fuel pools. As such, this tool represents the collective judgment of the NRC staff in Japan based on all available data.

For each of the major plant parameters listed below, the NRC staff assesses its status daily and bins it into one of the three categories listed. The staff uses the listed plant information and conditions in making its assessment. The arrows on the report indicate the relative trend in plant conditions from the previous day.

1. Reactor Pressure Vessel
    a. Cooling – Adequate, Challenged, or Inadequate.
        i. Flow or Injection Rate
        ii. Reliability of Injection
        iii. Source of Water
    b. Integrity – Intact, Challenged, or Failed.
        i. Temperature indications
        ii. Pressure readings
2. Primary Containment
    a. Flooding Status – Complete/Not needed, Challenged, or Incomplete/Needed.
        i. Water Level
        ii. Sources
        iii. Injection capacity/rate
    b. Integrity - Intact, Challenged, or Failed.
        i. Pressure readings
        ii. Bypass evaluations
        iii. Temperature indications
3. Spent Fuel Pools
    a. Cooling/Level – Adequate, Challenged, or Inadequate.
        i. Flow or Injection Rate
        ii. Reliability of Injection
        iii. Source of Water
    b. Integrity – Intact, Challenged, or Failed. Due to limited available data, this assessment relies strongly on the NRC team's engineering judgment.
4. Protective Measures – Exposure Risk to American citizens in Japan outside the U.S. government's recommended 50-mile evacuation zone.
    a. Low – 50-mile recommendation remains sufficient
    b. Medium – New information has raised questions regarding the sufficiency of the 50-mile recommendation.
    c. High – 50-mile recommendation is no longer sufficient due to changing plant condition

Ross, Robin

From: Wertz, Trent on behalf of Leeds, Eric
Sent: Thursday, April 14, 2011 10:15 AM
To: Wertz, Trent
Subject: FW: NRC's Daily Assessment of Conditions at Fukushima Daiichi
Attachments: NRC Daily Assessment of Daiichi - 4-10-11.pdf

NSIR

From: Salay, Michael
Sent: Sunday, April 10, 2011 3:01 AM
To: Jaczko, Gregory
Cc: Borchardt, Bill; Weber, Michael; Virgilio, Martin; Casto, Chuck; Leeds, Eric; RST01 Hoc
Subject: NRC's Daily Assessment of Conditions at Fukushima Daiichi

Dear Chairman,

Attached please find the NRC Japan Team's Daily Assessment of conditions at the Fukushima Daiichi nuclear power plants and spent fuel pools. There is one change of note today. Temperatures in the upper drywell and under the vessel of Unit 3 are slowly trending up. This is reflected by a down arrow in the attached for integrity of the Unit 3 containment. We will continue to discuss these issues with NISA and TEPCO.

If you have any questions, please don't hesitate to ask.

Best regards,
Mike Salay
NRC Japan Team

Y/379

~~Official Use Only~~

NRC's Daily Assessment of Conditions at Fukushima Daiichi Nuclear Power Plant

Unit 1		**Today**	**Yesterday**
Vessel	Cooling	Challenged	Challenged
		↔	↔
	Integrity	Intact	Intact
		↔	↔
Containment	Flooding	Inc./Needed	Inc./Needed
		↔	↔
	Integrity	Challenged	Challenged
		↔	↔
Spent Fuel Pool	Cooling/Level	Adequate	Adequate
		↔	↔
	Integrity	Intact	Intact
		↔	↔

Unit 2		**Today**	**Yesterday**
Vessel	Cooling	Challenged	Challenged
		↔	↔
	Integrity	Failed	Failed
		↔	↔
Containment	Flooding	Inc./Needed	Inc./Needed
		↔	↔
	Integrity	Failed	Failed
		↔	↔
Spent Fuel Pool	Cooling/Level	Adequate	Adequate
		↔	↔
	Integrity	Intact	Intact
		↔	↔

Unit 3		**Today**	**Yesterday**
Vessel	Cooling	Adequate	Adequate
		↔	↔
	Integrity	Failed	Failed
		↔	↔
Containment	Flooding	Challenged	Challenged
		↔	↔
	Integrity	Failed	Failed
		↓	↔
Spent Fuel Pool	Cooling/Level	Challenged	Challenged
		↔	↔
	Integrity	Challenged	Challenged
		↔	↔

Unit 4		**Today**	**Yesterday**
Spent Fuel Pool	Cooling/Level	Challenged	Challenged
		↔	↔
	Integrity	Failed	Failed
		↔	↔

		Today	**Yesterday**
Protective Measures	Exposure Risk	Low	Low
		↔	↔

Methodology for Developing the Fukushima Daiichi Daily Assessment Report

PURPOSE: The report is prepared to provide a qualitative high level assessment of daily conditions at Fukushima Daiichi that the U.S. Ambassador can use to assess the safety of American citizens in Japan.

DISCLAIMER: The development of the daily assessment report includes a number of inputs. Some of these are objective, such as plant data provided by TEPCO, while others are subjective, such as engineering insights from the NRC's reactor and protective measures specialists in Japan. It should be recognized that there are many unknowns and uncertainties associated with having a complete understanding of conditions in each of the Daiichi reactors and spent fuel pools. As such, this tool represents the collective judgment of the NRC staff in Japan based on all available data.

For each of the major plant parameters listed below, the NRC staff assesses its status daily and bins it into one of the three categories listed. The staff uses the listed plant information and conditions in making its assessment. The arrows on the report indicate the relative trend in plant conditions from the previous day.

1. Reactor Pressure Vessel
    a. Cooling – Adequate, Challenged, or Inadequate.
        i. Flow or Injection Rate
        ii. Reliability of Injection
        iii. Source of Water
    b. Integrity – Intact, Challenged, or Failed.
        i. Temperature indications
        ii. Pressure readings
2. Primary Containment
    a. Flooding Status – Complete/Not needed, Challenged, or Incomplete/Needed.
        i. Water Level
        ii. Sources
        iii. Injection capacity/rate
    b. Integrity - Intact, Challenged, or Failed.
        i. Pressure readings
        ii. Bypass evaluations
        iii. Temperature indications
3. Spent Fuel Pools
    a. Cooling/Level – Adequate, Challenged, or Inadequate.
        i. Flow or Injection Rate
        ii. Reliability of Injection
        iii. Source of Water
    b. Integrity – Intact, Challenged, or Failed. Due to limited available data, this assessment relies strongly on the NRC team's engineering judgment.
4. Protective Measures – Exposure Risk to American citizens in Japan outside the U.S. government's recommended 50-mile evacuation zone.
    a. Low – 50-mile recommendation remains sufficient
    b. Medium – New information has raised questions regarding the sufficiency of the 50-mile recommendation.
    c. High – 50-mile recommendation is no longer sufficient due to changing plant condition

Ross, Robin

From: Wertz, Trent on behalf of Leeds, Eric
Sent: Thursday, April 14, 2011 10:35 AM
To: Wertz, Trent
Subject: FW: Speech: Side Event on Fukushima Daiichi Accident, 5th Review Meeting of the Convention on Nuclear Safety, Prepared Remarks of NRC Chairman Gregory B. Jaczko, April 4, 2011, Vienna, Austria
Attachments: s-11-011.docx

OPA

From: OPA Resource
Sent: Monday, April 04, 2011 1:33 PM
To: Ash, Darren; Barkley, Richard; Batkin, Joshua; Bell, Hubert; Belmore, Nancy; Bergman, Thomas; Bollwerk, Paul; Bonaccorso, Amy; Borchardt, Bill; Bozin, Sunny; Brenner, Eliot; Brock, Terry; Brown, Boris; Bubar, Patrice; Burnell, Scott; Burns, Stephen; Carpenter, Cynthia; Chandrathil, Prema; Clark, Theresa; Collins, Elmo; Couret, Ivonne; Crawford, Carrie; Cutler, Iris; Dacus, Eugene; Dapas, Marc; Davis, Roger; Dean, Bill; Decker, David; Dricks, Victor; Droggitis, Spiros; Flory, Shirley; Franovich, Mike; Gibbs, Catina; Haney, Catherine; Hannah, Roger; Harbuck, Craig; Harrington, Holly; Hasan, Nasreen; Hayden, Elizabeth; Holahan, Gary; Holahan, Patricia; Holian, Brian; Jacobssen, Patricia; Jaczko, Gregory; Jasinski, Robert; Jenkins, Verlyn; Johnson, Michael; Jones, Andrea; Kock, Andrea; Kotzalas, Margie; Ledford, Joey; Lee, Samson; Leeds, Eric; Lepre, Janet; Lew, David; Lewis, Antoinette; Loyd, Susan; Magwood, William; McCrary, Cheryl; McGrady-Finneran, Patricia; McIntyre, David; Mensah, Tanya; Mitlyng, Viktoria; Monninger, John; Montes, David; Nieh, Ho; Ordaz, Vonna; Ostendorff, William; Owen, Lucy; Powell, Amy; Quesenberry, Jeannette; Reddick, Darani; Regan, Christopher; Reyes, Luis; Riddick, Nicole; RidsSecyMailCenter Resource; Riley (OCA), Timothy; Rohrer, Shirley; Samuel, Olive; Satorius, Mark; Schaaf, Robert; Schmidt, Rebecca; Scott, Catherine; Screnci, Diane; Shaffer, Vered; Shane, Raeann; Sharkey, Jeffry; Sheehan, Neil; Sheron, Brian; Siurano-Perez, Osiris; Steger (Tucci), Christine; Svinicki, Kristine; Tabatabai, Omid; Tannenbaum, Anita; Taylor, Renee; Temp, WDM; Uhle, Jennifer; Uselding, Lara; Vietti-Cook, Annette; Virgilio, Martin; Virgilio, Rosetta; Walker-Smith, Antoinette; Weaver, Doug; Weber, Michael; Weil, Jenny; Werner, Greg; Wiggins, Jim; Williams, Evelyn; Zimmerman, Roy; Zorn, Jason
Subject: Speech: Side Event on Fukushima Daiichi Accident, 5th Review Meeting of the Convention on Nuclear Safety, Prepared Remarks of NRC Chairman Gregory B. Jaczko, April 4, 2011, Vienna, Austria

Office of Public Affairs
US Nuclear Regulatory Commission
301-415-8200
opa.resource@nrc.gov

Y/380

NRC NEWS

U.S. NUCLEAR REGULATORY COMMISSION

Office of Public Affairs Telephone: 301/415-8200
Washington, D.C. 20555-0001
E-mail: opa.resource@nrc.gov Site: www.nrc.gov
Blog: http://public-blog.nrc-gateway.gov

No. S-11-011

Remarks as Prepared for Delivery
U.S. Nuclear Regulatory Commission Chairman Gregory B. Jaczko
Side Event on Fukushima Daiichi Accident
5th Review Meeting of the Convention on Nuclear Safety
April 4, 2011
Vienna, Austria

I would like to reiterate my condolences to all those who have been affected by the earthquake and tsunami in Japan. Our hearts go out to all who have been dealing with the aftermath of these natural disasters, and we are mindful of the long and difficult road they will face in recovering. We know that the people of Japan are resilient and strong, and we have every confidence that they will come through this terrible time and move forward, with resolve, to rebuild their vibrant country.

I made a brief visit to Japan last week. I wanted to convey a message of support and cooperation to our Japanese counterparts there and to assess the ongoing situation. I also met with senior Japanese government and TEPCO officials, and consulted with a team of experts from the U.S. Nuclear Regulatory Commission who went to Japan as part of our assistance effort.

NRC Response to Japan Events

I'd like to take a few minutes to address the response of the NRC to the tragic events in Japan, and then to briefly describe how we plan to proceed.

On Friday, March 11, when the earthquake and tsunami struck, the NRC's headquarters Operations Center began operating on a 24-hour basis to monitor and analyze events at nuclear power plants in Japan. At the request of the Japanese government, and through the United States Agency for International Development (USAID), the NRC sent a team of its technical experts to provide on-the-ground support, and we have been in continual contact with them since that time. And, within the United States, the NRC has been working closely with other Federal agencies as part of our government's response to the situation.

Shortly after 4:00 AM (Washington, DC time) on Friday, March 11th, the NRC Emergency Operations Center made the first telephone call to inform NRC management of the earthquake and the potential impact on U.S. plants. We went into monitoring mode at our

Emergency Operations Center, and the NRC's initial focus was on the possible impacts of the tsunami on U.S. plants and radioactive materials on the West Coast, and in Hawaii, Alaska, and U.S. Territories in the Pacific.

We were in communication with our licensees and our resident inspectors at Diablo Canyon Power Plant and San Onofre Nuclear Generating Station in California, and the Radiation Control Program Directors for California, Washington, Oregon and Hawaii.

On that same day, we began interactions with our Japanese regulatory counterparts and dispatched two experts to Japan to help at the embassy in Tokyo.

By Monday, March 14, we had dispatched a total of 11 NRC staff to Japan. We have subsequently rotated in additional staff to continue on-the-ground assistance in Japan. The areas of focus for this team are: 1) to assist the Japanese government and respond to requests from our Japanese regulatory counterparts; 2) to support the U.S. Ambassador and the U.S. government assistance effort.

On Wednesday, March 16, we collaborated with other U.S. government agencies and decided to advise American citizens to evacuate within a 50-mile range around the plant. We believed this decision was a prudent course of action, and would be consistent with what we would do in a similar situation in the United States. This evacuation range was predicated on the information that we had available at the time, which indicated the possibility that reactor cores and spent fuel pools may have been compromised.

We have been working with an extensive range of stakeholders regarding the Japan situation, including the White House, Congressional staff, our state regulatory counterparts, a number of other federal agencies, and the international regulatory bodies around the world.

Steps Already Taken

The NRC's program of continuous improvement in the future will include lessons learned from the events in Japan. We already have begun enhancing inspection activities through temporary instructions to our inspection staff, including the resident inspectors and the inspectors in our four Regional offices.

We've also issued an information notice to licensees to make them aware of activities they should undertake to verify that their capabilities to mitigate conditions due to severe accidents—including the loss of significant operational and safety systems—are in effect and operational. Specific conditions include a total loss of electric power, flooding, and damage from seismic events.

On their own initiative, the Institute of Nuclear Power Operations (INPO) issued a Level I Event Report (highest level) to its members on March 15, identifying four actions requiring written responses. Those include walkdowns and verifications of capabilities to address large fires and explosions; severe accident management guidelines; mitigation of station blackout conditions; internal and external flooding, and fire and flooding events that could be impacted by a concurrent seismic event.

NRC Plans Moving Forward

While we are confident about the safety of U.S. nuclear power plants, our regulatory agency has a responsibility to the American people to undertake a systematic and methodical review of the safety of our domestic facilities, in light of the natural disaster and the resulting nuclear situation in Japan. Examining all available information is an essential part of that effort.

On March 21, my fellow Commissioners and I established a senior level task force to conduct a comprehensive review of our processes and regulations to determine whether the agency should make improvements to our regulatory system.

This review will be conducted in a short-term and a longer-term timeframe. The short-term review has already begun, and will identify potential or preliminary near-term operational or regulatory issues. A longer-term review will begin as soon as we have sufficient information from Japan. That review will be completed in six months from the beginning of the evaluation. The task force's reports will be publicly available.

The task force will evaluate all technical and policy issues related to the event to identify additional potential research, generic issues, changes to the reactor oversight process, rulemakings, and adjustments to the regulatory framework that should be pursued by the NRC. We also expect to evaluate issues that may involve multiple U.S. Government agencies, such as emergency preparedness. We will seek input from all key stakeholders during this process. Based on what we learn in our review, we will take all of the appropriate actions that are necessary to ensure the continuing safety of the American people.

We will also continue to communicate closely with our regulatory counterparts throughout this process. As we navigate lessons-learned efforts in the months ahead, international cooperation takes on new importance. The IAEA has a significant role to play in facilitating information-sharing among countries as we undertake this process. To that end, we commend Director General Amano's announcement of the Agency's intention to host a ministerial-level conference in June. We are also pleased to support the IAEA as it works to address and incorporate the events at Fukushima into its activities in various technical disciplines, as well as continuing its work in areas that have already been identified as nuclear safety and security priorities.

Over the next few days, contracting parties to the Convention on Nuclear Safety will have the opportunity to present information on their nuclear safety programs and receive feedback from their counterparts. This review process provides us with an important venue to address the events in Japan and begin to formulate plans for short- and long-term cooperation. But in addition, it continues to serve a critical purpose in generally advancing nuclear safety worldwide. We are pleased to be part of this process.

We commend the IAEA staff for its hard work in preparing for the Convention review meeting and continuing to facilitate the provision of assistance to the Japanese people. I appreciate the opportunity to address you this evening.

Ross, Robin

From: Wertz, Trent on behalf of Leeds, Eric
Sent: Thursday, April 14, 2011 11:02 AM
To: Wertz, Trent
Subject: FW: RESPONSE - Assessment of the need for protective actions in Tokyo

---

From: Weber, Michael
Sent: Saturday, April 02, 2011 4:55 PM
To: Casto, Chuck; Leeds, Eric; Collins, Elmo
Cc: Virgilio, Martin; Evans, Michele; Carpenter, Cynthia; Blount, Tom; Sheron, Brian; McGinty, Tim; Ross-Lee, MaryJane; McDermott, Brian
Subject: RESPONSE - Assessment of the need for protective actions in Tokyo

The Chairman advised from yesterday's Principals Meeting that the consensus was that they already had sufficient dose projections for a wide variety of scenarios. The additional runs requested by the Ambassador would not add sufficient value beyond the information that we already had, including some very conservative forecasts.

From: Casto, Chuck
Sent: Saturday, April 02, 2011 4:46 PM
To: Leeds, Eric; Collins, Elmo
Cc: Weber, Michael; Virgilio, Martin; Evans, Michele; Carpenter, Cynthia; Blount, Tom; Sheron, Brian; McGinty, Tim; Ross-Lee, MaryJane; McDermott, Brian
Subject: Re: FYI: Assessment of the need for protective actions in Tokyo

Will advise embassy. Thanks.

Chuck

From: Leeds, Eric
To: Casto, Chuck; Collins, Elmo
Cc: Weber, Michael; Virgilio, Martin; Evans, Michele; Carpenter, Cynthia; Blount, Tom; Sheron, Brian; McGinty, Tim; Ross-Lee, MaryJane; McDermott, Brian
Sent: Sat Apr 02 12:04:41 2011
Subject: FYI: Assessment of the need for protective actions in Tokyo

Chuck & Elmo – It looks like the "pessimistic" source term will not be run by NARAC. See below.

From: PMT09 Hoc
Sent: Saturday, April 02, 2011 11:26 AM
To: PMT07 Hoc; ET07 Hoc; Leeds, Eric; Hoc, PMT12
Subject: Assessment of the need for protective actions in Tokyo

A hypothetical source term (ST) was developed to provide the Ambassador with "worst case" dose information (Pessimistic source term for US Embassy in Tokyo 3/30/11). NARAC was expected to perform the dose calculation when directed by NSC/OSTP. Parameters of the source term were specified by NSC. RES delivered the ST and it was forwarded to NARAC on 3/31/11 @1012 hrs via email.

NRC was asked by the site team to encourage NSC to have NARAC to run the dose calc. However, PMT was contacted on 4/2/11 by Chuck Donnell of NSC to inform us that NSC/OSTP management, Drs. Fedder and Holdren determined that the ST need not be run. Previous hypothetical STs and dose calculations have provided contain enough information for the Embassy to determine radiological protective actions and travel advisories.

C. Donnell indicated that OSTP thinking was that radiological protective actions should not be necessary in Tokyo and need not be the basis for travel advisories in at least that region. PMT thinking is aligned with this; given:

- plant status,
- the likelihood of significant degradation,
- the distance to Tokyo,
- the prevailing wind directions and
- the availability of many channels of radiological information that would provide hours to days of warning before increasing radiation levels could reach Tokyo.

Ross, Robin

From: Wertz, Trent on behalf of Leeds, Eric
Sent: Thursday, April 14, 2011 11:25 AM
To: Wertz, Trent
Subject: FW: Presentation from Japan Nuclear Technology Institute to NRR today
Attachments: 石川先生寄稿（電気新聞　英文）.doc; Accident at Fukushima Daiichi (その１) rev.2 2011.3.24.ppt; Accident at Fukushima Daiichi (その２) rev.2 2011.3.24.ppt

REL

From: Brown, Frederick
Sent: Friday, March 25, 2011 5:11 PM
To: RST01 Hoc
Cc: Ruland, William; Skeen, David; Hiland, Patrick; Case, Michael; Dudes, Laura; Uhle, Jennifer; Holian, Brian; Hoc, PMT12
Subject: Presentation from Japan Nuclear Technology Institute to NRR today

RST coordinator – please have these files added to the RST chronology for preservation. PMT may be interested in the second power point presentation.

There are some movies that are too large to e-mail, I'll try to figure out how to transfer them (currently on NRR G: drive in folder "Temp").

They note a large U-3 PV/RCS pressure spike on 3/13 and a primary containment pressure spike on 3/14.

They said that U-1 (none of the units) had a concrete roof – our understanding of the rubble on U-1 is apparently incorrect.

They said that TEPCO does not normally use a checkerboard fuel arrangement for the hot fuel in the pool.

U-1 thru 4 EDGs and switch gear located in ocean side of turbine building in rooms below grade. Totally flooded. The Unit 6 EDG that continued to operate is an air cooled unit. They do not know if the Rx Buildings had any actual flooding.

My impression is that they relied on elevation for flood control (no discussion of water-tight boundaries).

The SW pumps were apparently exposed (tsunami was estimated at 14 meters, with a design basis of 10)

U-1 did have an isolation condenser and no RCIC, the other units did have RCIC. Batteries for RCIC lasted 10 hours.

They believe U-4 explosion from H2, and they have a heat-up "plot" for the SFP showing saturation temperature in less than 2 days from loss of power. They also believe that some reflood would have occurred to refueling gate damage. That said, with this heat-up curve, that water would not have lasted long either? They believe that picture 2-17 shows a flooded pool after the explosion.

They were equivocal on the containment vent path used and the "hardened" nature of the vent. The stack is where the venting should have occurred, but they understand that something does not make sense.

They had B5b-like connections that they used for the temporary fire pump tie-in to the primary systems.

Y/381

Published on Mar.18.2011 : The Denki shinbun(The Electric Daily News)

Dr. Michio Ishikawa
Chief Adviser (Former President & CEO)
Japan Nuclear Technology Institute(JANTI)

Estimation of "Status of reactor cores at Fukushima"

This is my emergency estimation about what could be happening at reactor cores at Fukushima, what could happen next and what actions can be taken, based on the facts and developments at the time of the Three Mile Island nuclear accident.

Please bear in mind that I live in the quake-affected city of Hitachinaka. Three whole days of power blackouts up until March 14 left me incommunicado with the outside world. The only source of information was radio broadcast. I had no idea what was happening in the world until the television came on finally in the evening of March 14. Hence, I am a little short on facts and figures. This article describes a scenario that I have put together based on limited facts. Please excuse me for any minor mistakes.

First of all, the state of reactor cores. Knowledge from the TMI accident indicates that reactor cores behave very differently depending on whether they are under or above the water level. This is a relevant point for Fukushima, so let me go into more detail.

The submerged part of the fuel rods is cooled with water, and can maintain a sound state. There is no argument on this point.

On the other hand, the exposed part of the fuel rods is surrounded by steam, and in a poor condition for heat removal. With the temperature increasing gradually with decay heat, the fuel rods begin reacting with steam at around 900 degrees Celsius, oxidizing claddings. This reaction generates strong heat, causing a localized increase of temperature in the immediate area. At around 1300 degrees Celsius, the reaction becomes more active, and the temperature rise on the claddings becomes unstoppable. The claddings become coated with thin oxide film (zirconium dioxide) on the outside, as well as on the inside due to oxygen removal from fuel pellets (uranium dioxide).

In other words, thin oxide film coats the claddings, made of zircaloy, both inside and out. It should be noted that the oxide film has a higher fusing point than the cladding material, zircaloy, whose fusing point is approx. 1800 degrees Celsius. When zircaloy melts, it drips down between the films to form a puddle. The oxide films on both sides become fused together and pressed onto fuel pellets with the pressure of the reactor. At this stage, a fuel rod can be likened to fuel pellets wrapped in cling wrap. Oxide film is resilient at high temperature, and seals in radiation even with some disfigurement to the fuel rods, keeping them upright in water. This is why no radiation was released from exposed fuel rods at Fukushima. It was no case of measurement error.

This condition changes at the moment when water is added to the core. Oxide film becomes weaker as the temperature drops, and shrinks when cooled down. Fuel rods disintegrate into individual fuel pellets and collapse (not melting), scattering in the reactor water as if a toy box is tipped over. They can stay scattered in water because the submerged part of fuel rods is still sound. This is what happened at the reactor core in the TMI accident.

Collapsed fuel rods are cooled as long as they are submerged in water, thanks to the cooling effect of water flowing through the debris (communication path). Consequently, fuel pellets stay in the state of debris without melting.

Summing up, the exposed top part of fuel rods generated hydrogen and collapsed, but the debris was kept cool, retaining the pellets' radiation containing effect.

The problem lied with the submerged part of the fuel. Water turns into steam as it cools fuel rods. However, in this case, the flow of steam was blocked with the debris, and could not escape, forming a steam zone immediately below the debris. This created a condition similar to the exposed fuel above water. Under water, heat dissipation performance was substantially worse. Heat from cladding oxidization built up and melted fuel rods, initiating meltdown. However, the meltdown temperature was believed to be around 2300 degrees Celsius, which was the fusing point of the ternary alloy of uranium, zirconium and oxygen, rather than the uranium dioxide's fusing point of 2800 degrees Celsius. This meltdown temperature was not high enough to melt concrete, and therefore could not cause a "China Syndrome" scenario.

Since the underside of the meltdown was touching cooling water, it turned into a hard crust state, much like cast iron. Yet, immediately above that, melted fuel flowed in the side direction, came in contact with the core shroud, made of thin stainless steel, and put holes through it. Fuel that dripped from the holes formed balls measuring 15–20 centimeters in diameter, which were later found at the bottom of the reactor core.

This is how the core meltdown occurred at TMI. The Fukushima plants are showing similar core behaviors. One of the similarities is the fact that the top 2 meters of fuel rods have become exposed above the reactor water for an extended period of time. Cesium and other fission products were released as a result of fuel rods disintegrating upon the injection of seawater. The formation of hydrogen led to explosions, as has widely been reported. The reactor core at TMI was cooled and stabilized after one week. Fukushima will also be successfully brought under control.

The difference between TMI and Fukushima is the existence of a steam-water separator at the top part of the reactor core, because Fukushima uses the BWR system. This structure serves as resistance to releasing steam from the core to the top part of the pressure vessel. It therefore keeps steam in the core, undermining the injection of seawater. Compared to the example of TMI, BWR has a design that may make it difficult to cool the molten core.

Another difference is the use of channel box in nuclear fuel. This could turn out to be a positive or a negative. Yet, it is not a deciding factor, considering that the core has a similar meltdown behavior. In this article, I assume that the positive offsets the negative.

One more major difference is the fact that TMI's reactor core was stabilized with the use of the primary coolant pump (equivalent to the recirculation pump at Fukushima). With PWR, the primary cooling system is clearly separated and insulated from the turbine system. A turbine condenser, which has a high cooling capacity, would never suffer radiation contamination with the activation of a primary coolant pump. This powerful cooling ability successfully halted the meltdown and stabilized the core.

However, with BWR, simply activating a recirculation pump would do no more than agitating the reactor water unless a condenser is also used. The pump alone does not contribute to lowering the core temperature. However, using the condenser runs the risk of sending highly contaminated reactor cooling water to the turbine building, which has only limited shielding facilities. Whether the authorities can make this decision marks a turning point in the on-going efforts to bring the reactors to stability.

The three functions of nuclear safety are to "shut down", "cool down" and "contain". This also represents the order of importance in these safety actions. At Fukushima, all reactors shut down. The next step is to cool them down. For this purpose, motor power to send water is needed more than anything else. The installation of temporary power source is the task of utmost urgency.

Let me move on to the issue of hydrogen explosions. Such an explosion also rocked the TMI accident. A massive explosion occurred in the containment vessel some ten hours after the accident started. The amount of hydrogen involved in the explosion, according to the post-accident calculation, was equivalent to the amount generated if about half of the fuel claddings became oxidized. This corresponds to the case at Fukushima Daiichi Unit-1 and Unit-3, where fuel rod exposure was reported to be about 50%. In the case of TMI, there was no damage to the containment vessel. In Fukushima, explosions occurred outside the containment vessels, destroying reactor buildings.

In the TMI accident, approx. 1,000 area residents became exposed to radiation at the rate of up to 100 mrem (1 mSv), and 1 mrem (0.01 mSv) on average. The level of radiation when the ventilation operation was conducted to depressurize the containment vessel, was reported to be approx. 1.2 rem (12 mSv) in the skies above the station site, which is similar to the level recorded at the time of ventilation at Fukushima. The radiation dose recorded in the skies above Fukushima Daiichi Unit-4, is said to be 400 mSv. This is because of the loss of water in the spent fuel storage pool, and is set to decrease once the water level is restored. It is still not impossible to keep radiation leak to a minimum in Fukushima, just as in the case with TMI.

Slightly off the topic, there are some people who call the Fukushima case as another Chernobyl. It is unclear what their arguments are. As far as radiation emergency is concerned, there is no possibility that the Fukushima case could cause contamination of the international scale experienced at Chernobyl. This is because of the absence of a graphite fire, which sent radiation high into the air to reach the jet stream. In addition, the low temperature of cooling water means only the radioactive materials with a low boiling point, such as noble gas and iodine, could be released into the atmosphere. The situation is nothing like what happened at Chernobyl.

This summarizes my estimation of the state of accident at Fukushima Daiichi Nuclear Power Station's Units-1–3. I have nothing but respect for all the personnel who continue to fight the desperate fight to bring the plant under control and alleviate the extent of the emergency under the current condition with all power sources swept away in the Tsunami. It is regrettable that the situation has escalated to explosions and damage of reactor buildings. Another task still remains to stabilize the reactors. I wish to send my support for those people on the frontline. Situations change in emergencies like this every minute. I am prepared to provide as much cooperation as possible despite my old age.

(wrote on Mar.15.2011)

What happened in the TEPCO Fukushima Daiichi Nuclear Power Station

March 24, 2011

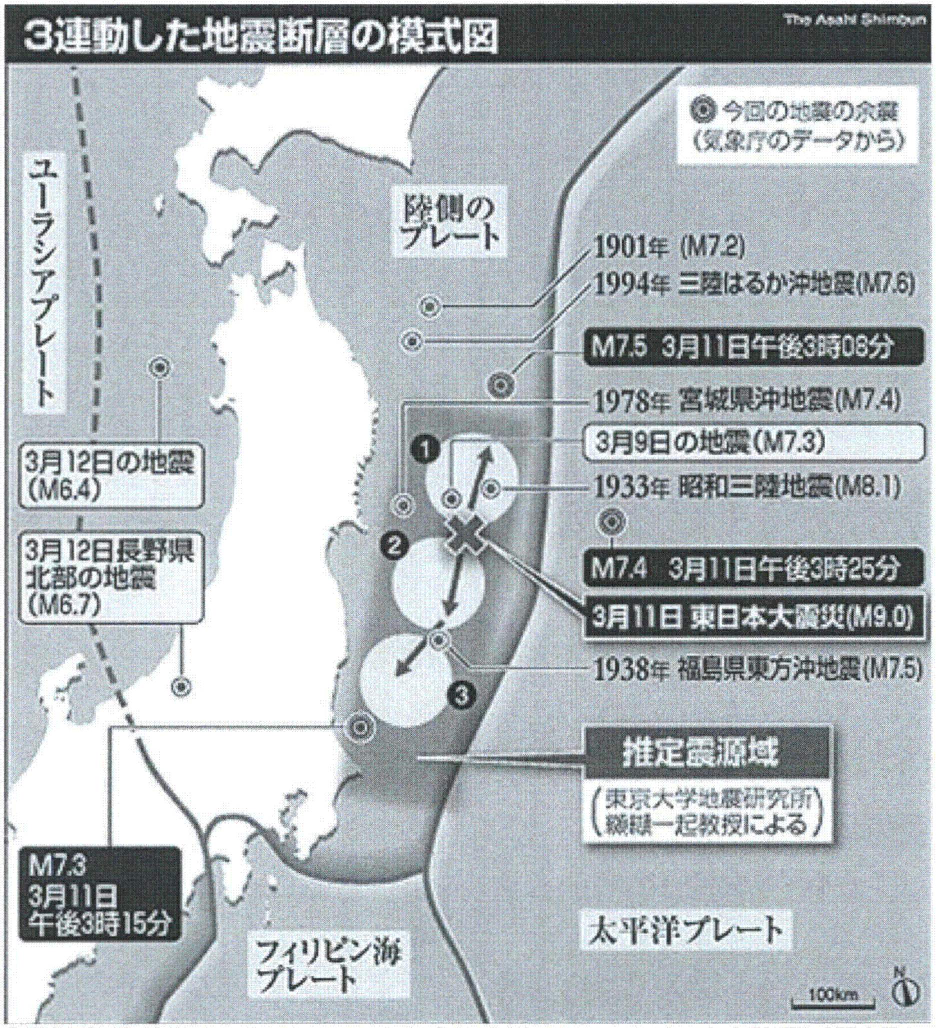
Japan Nuclear Technology Institute

Program

0. Opening Remark	: 15 min.
1. 2011 Tohoku-Pacific Ocean Earthquake and Tsunami	: 20 min.
2. Current Status of Fukushima Daiichi Nuclear Power Station	: 50 min.
3. Core Damage Estimation	: 20 min.
4. Spent Fuel Damage Estimation about Unit-4 SFP	: 20 min.
5. Radiation Exposure and Monitoring Data	: 20 min.
6. Discussion	: 30 min.

1. 2011 Tohoku-Pacific Ocean Earthquake and Tsunami

2011 Tohoku - Pacific Ocean Earthquake



Asahi Shinbun (14/03/2011)

Magnitude ９．０

Date Friday, March, １１，２０１１

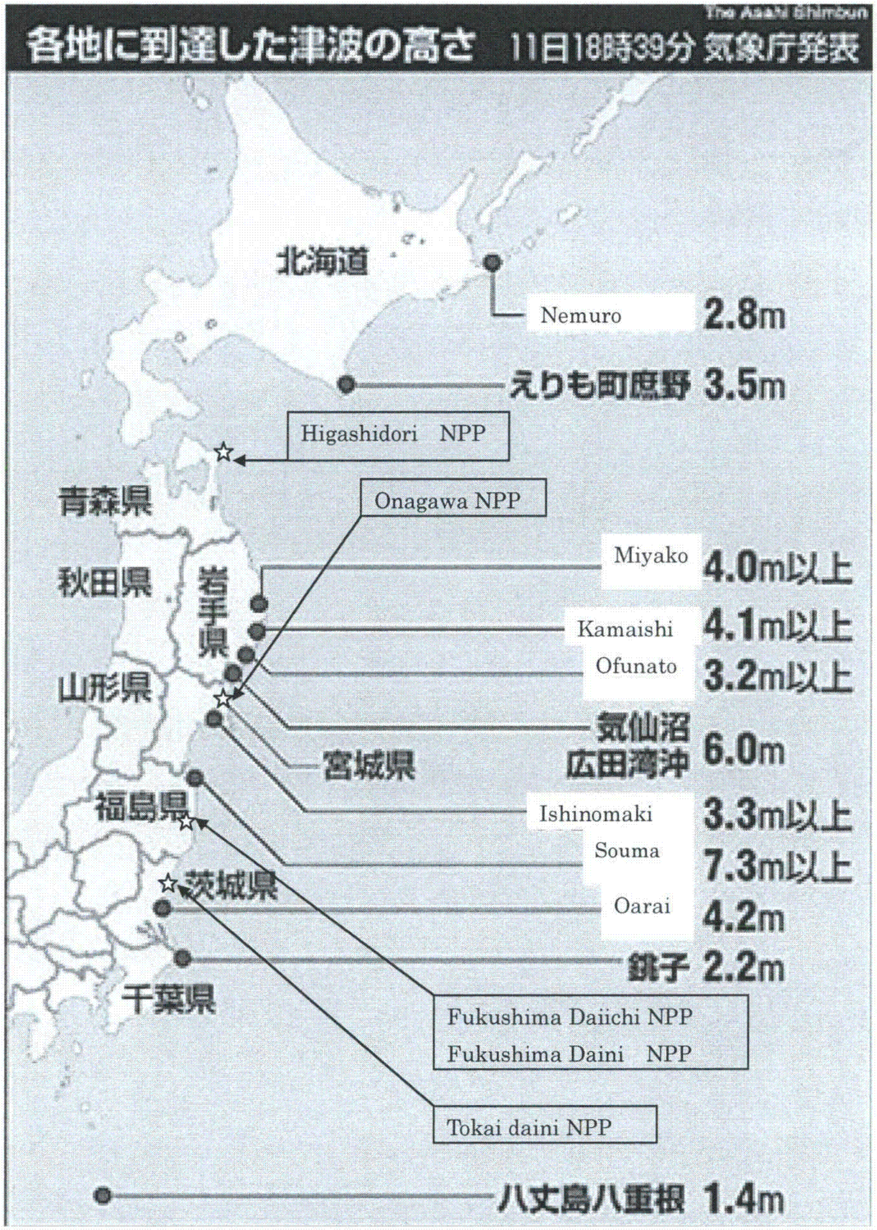
Time ０２：４６ **PM at epicenter**

Location 38.3° N, 142.4° E

Depth 24Km

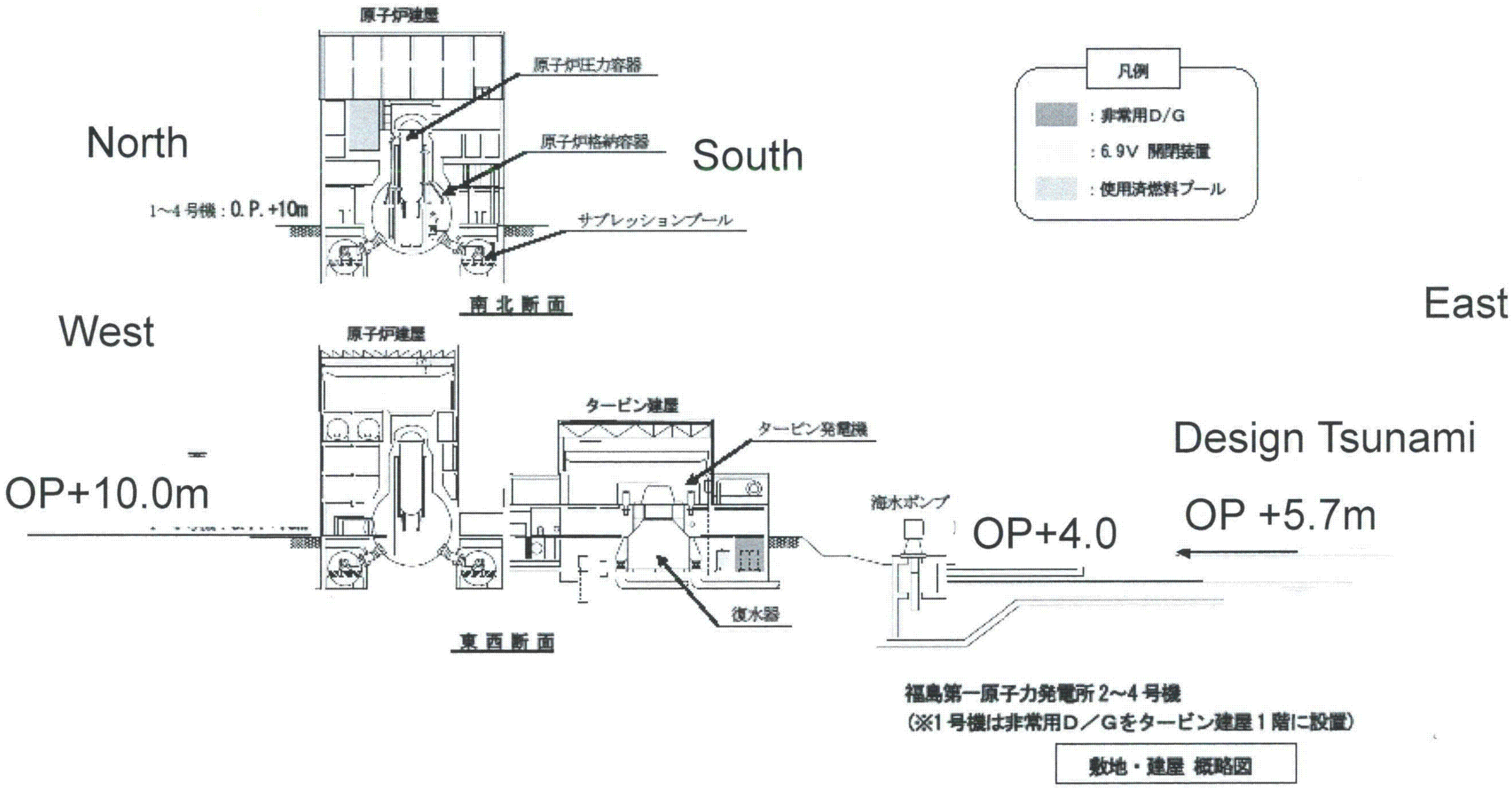
Maximum Intensity 7

(Kurihara City, Miyagi)



Asahi Shinbun (14/03/2011)に加筆

Fukushima Daiichi Nuclear Power Plants (schematic drawing)

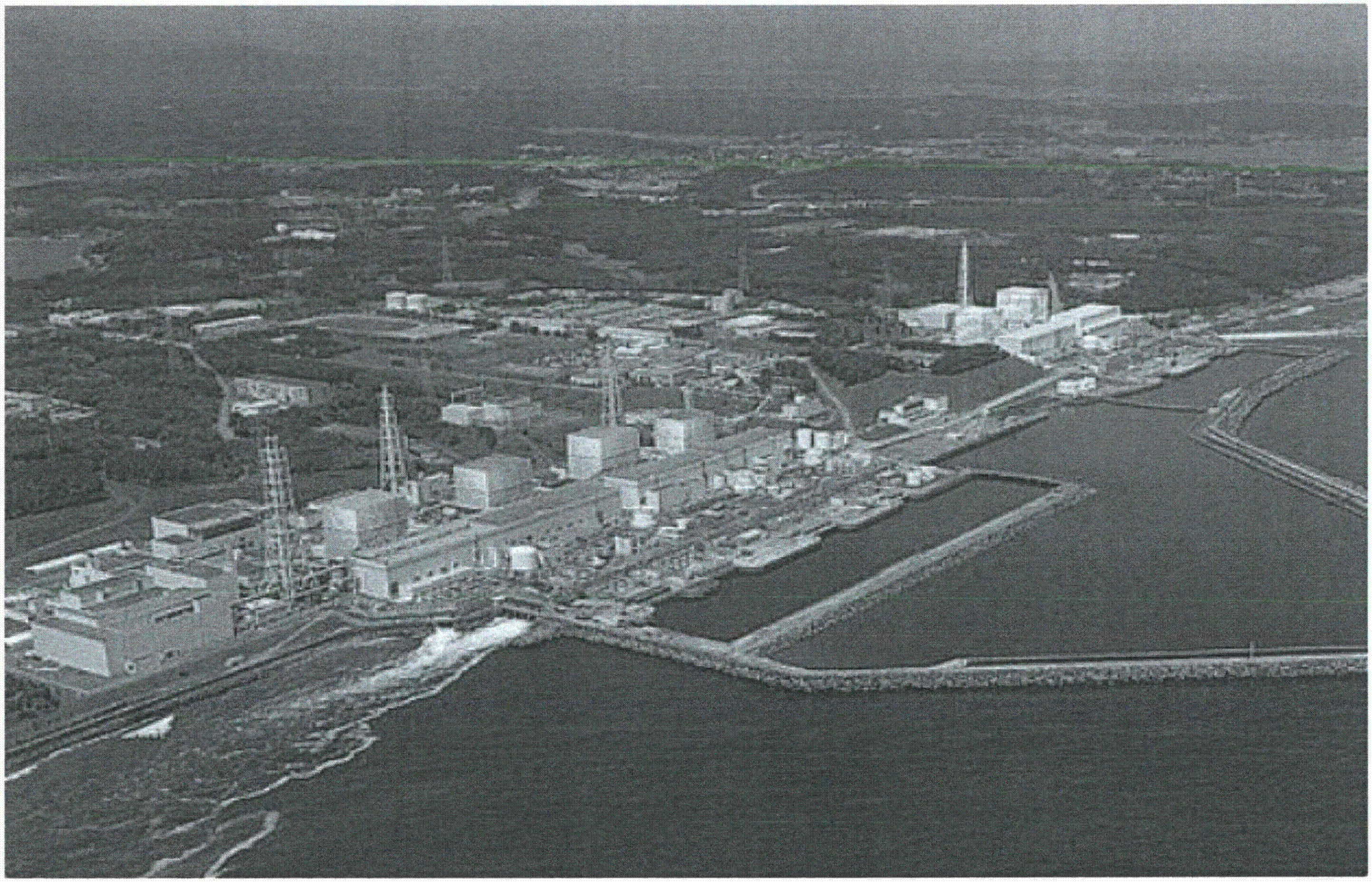


2. Current Status of Fukushima Daiichi Nuclear Power Station

Status of NPPs

Power Station	Unit	MWe	Condition
HigashiDori	1	1,100	Refuel Outage
Onagawa	1	524	Operating→ Scram→ Cold Shutdown
	2	825	Reactor Start→ Scram→ Cold Shutdown
	3	825	Operating→ Scram→ Cold Shutdown
Fukushima Daiichi	1	460	*Operating→ Scram→ Damaged*
	2	784	*Operating→ Scram→ Damaged*
	3	784	*Operating→ Scram→ Damaged*
	4	784	Refuel Outage → *Spent Fuel Damaged*
	5	784	Refuel Outage → Cold Shutdown
	6	1,100	Refuel Outage → Cold Shutdown
Fukushima Daini	1	1,100	Operating→ Scram→ Cold Shutdown
	2	1,100	Operating→ Scram→ Cold Shutdown
	3	1,100	Operating→ Scram→ Cold Shutdown
	4	1,100	Operating→ Scram→ Cold Shutdown
Tokai Daini	—	1,100	Operating→ Scram→ Cold Shutdown

Overview of Fukushima Daiichi Nuclear Power Station



Summary of Fukushima Daiichi NPPs

Unit	1	2	3	4	5	6
Type	BWR-3	BWR-4	BWR-4	BWR-4	BWR-4	BWR-5
PCV Model	Mark-1	Mark-1	Mark-1	Mark-1	Mark-1	Mark-2
Electric Output (MWe)	460	784	784	784	784	1100
Commercial Operation	Mar. 1971	Jul. 1974	Mar. 1976	Oct. 1978	Apr. 1978	Oct. 1979
Emergency DG	2	2	2	2	2	3
Electric Grid	275kV×4				500kV×2	
Plant Status on 11^{th} Mar.	In Operation	In Operation	In Operation	Refueling Outage	Refueling Outage	Refueling Outage

Fukushima Daiichi Unit-1
(BWR-3, Mark-1, 460Mwe, in Operation)

March 11 · Automatic scram due to the Earthquake

- Loss of offsite power
- **<u>2 Emergency DGs became inoperable by Tsunami</u>**
- Rx Core was being cooled by Isolation Condenser
  - Rx water level down

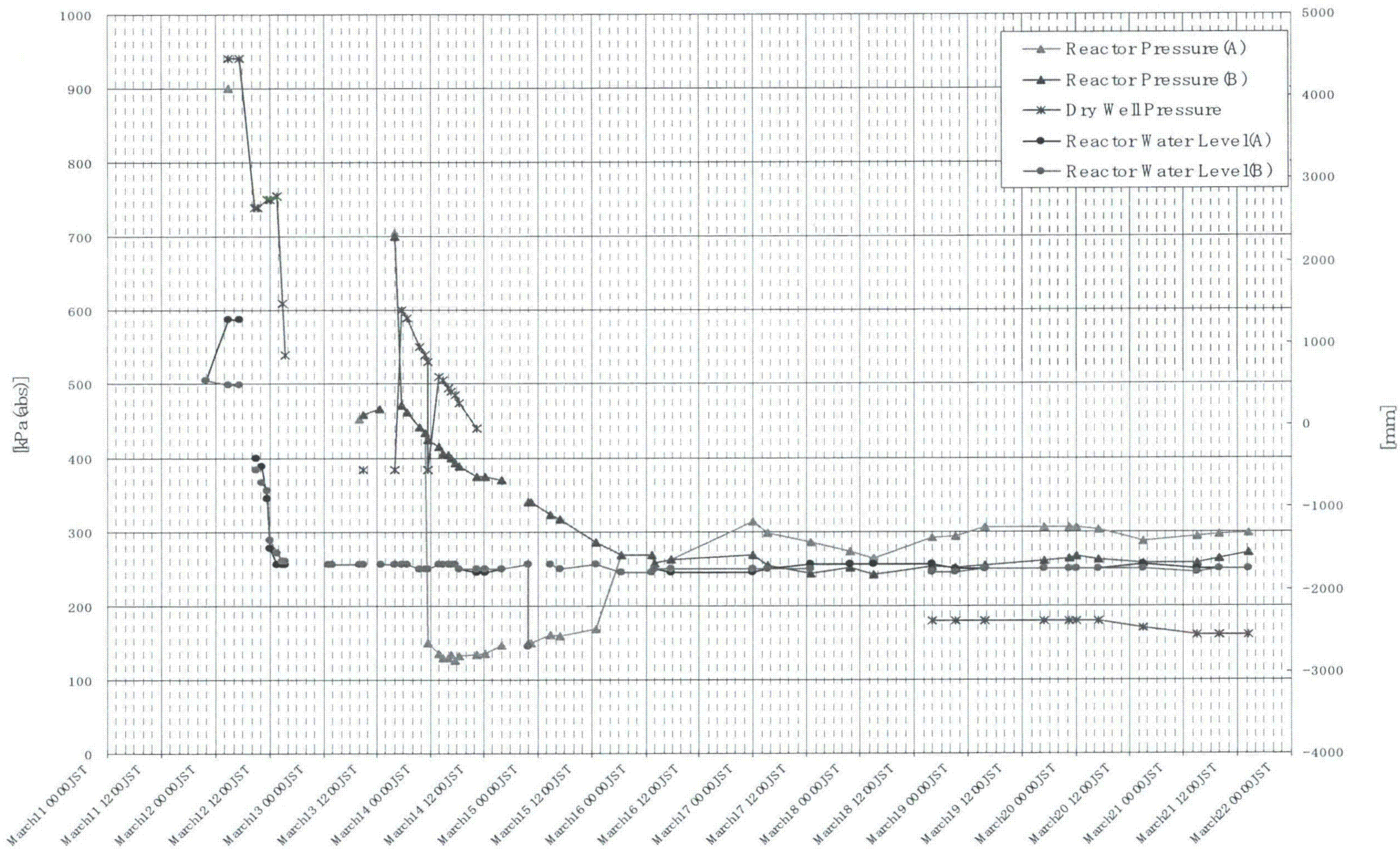
March 12 · PCV vent

- **<u>A hydrogen explosion</u>** occurred at Rx Building
- Seawater injection to Rx core was started

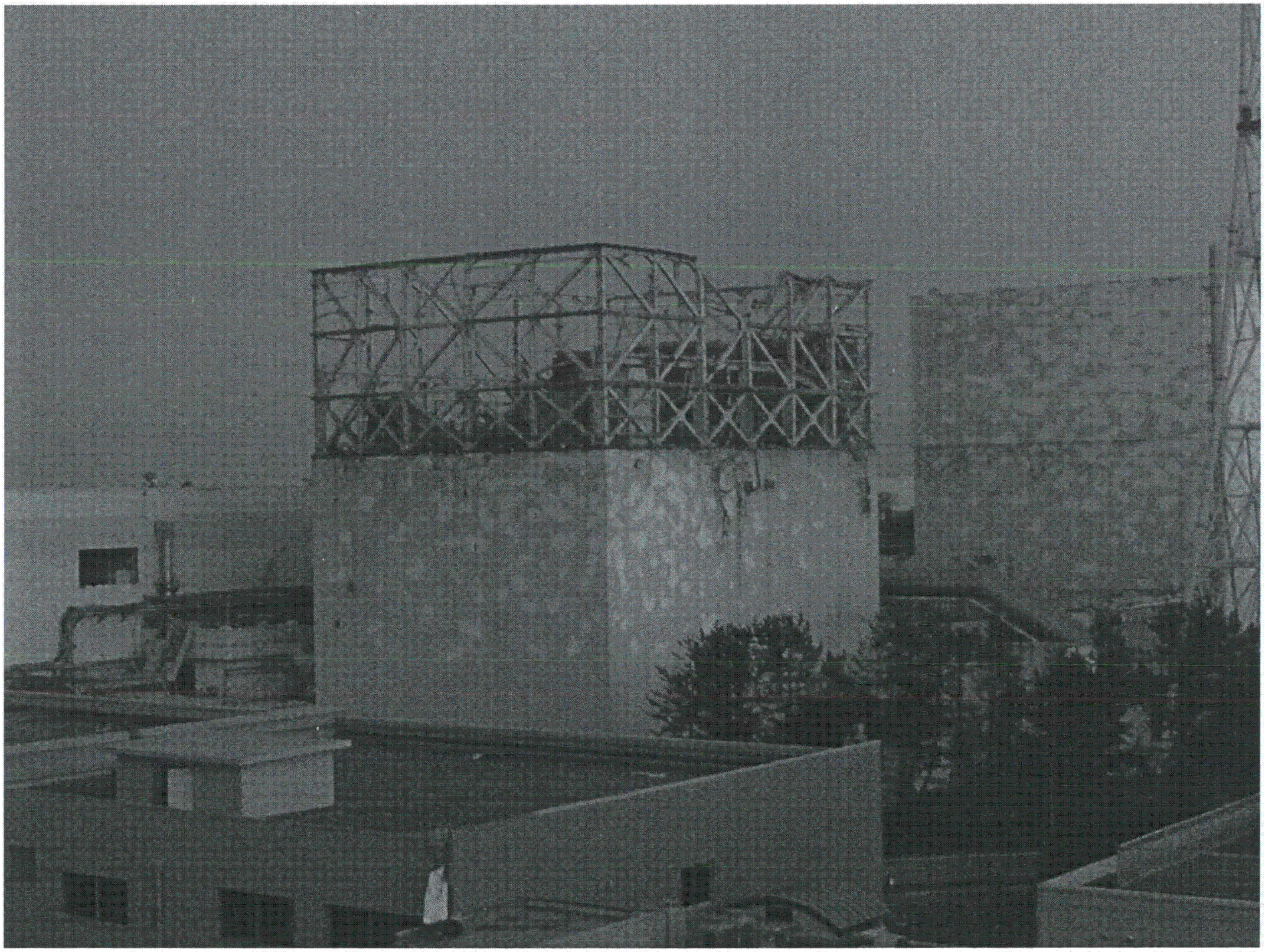
[Current Status, as of March 23]

- Rx Water Level : TAF-1,750 mm, -1700 mm
- Rx Pressure : 0.38 MpaG, 0.358 MpaG
- PCV Pressure : 0.36 Mpaabs

Unit-1 Plant Parameters



Rx Building of Unit 1 （March 12）



Fukushima Daiichi Unit-2
(BWR-4, Mark-1, 784Mwe, in Operation)

March 11 ・Automatic scram due to the Earthquake

・Loss of offsite power

・**2 Emergency DGs became inoperable by Tsunami**

・Rx Core was being cooled by RCIC

March 14 ・Blowout Panel of Rx Building was opened

・Loss of Rx cooling function

・Rx water level down

March 15 ・PCV vent

・**A sound of explosion was heard around Supression Chamber**

・Seawater injection to Rx core

・White smoke (steam) was first observed

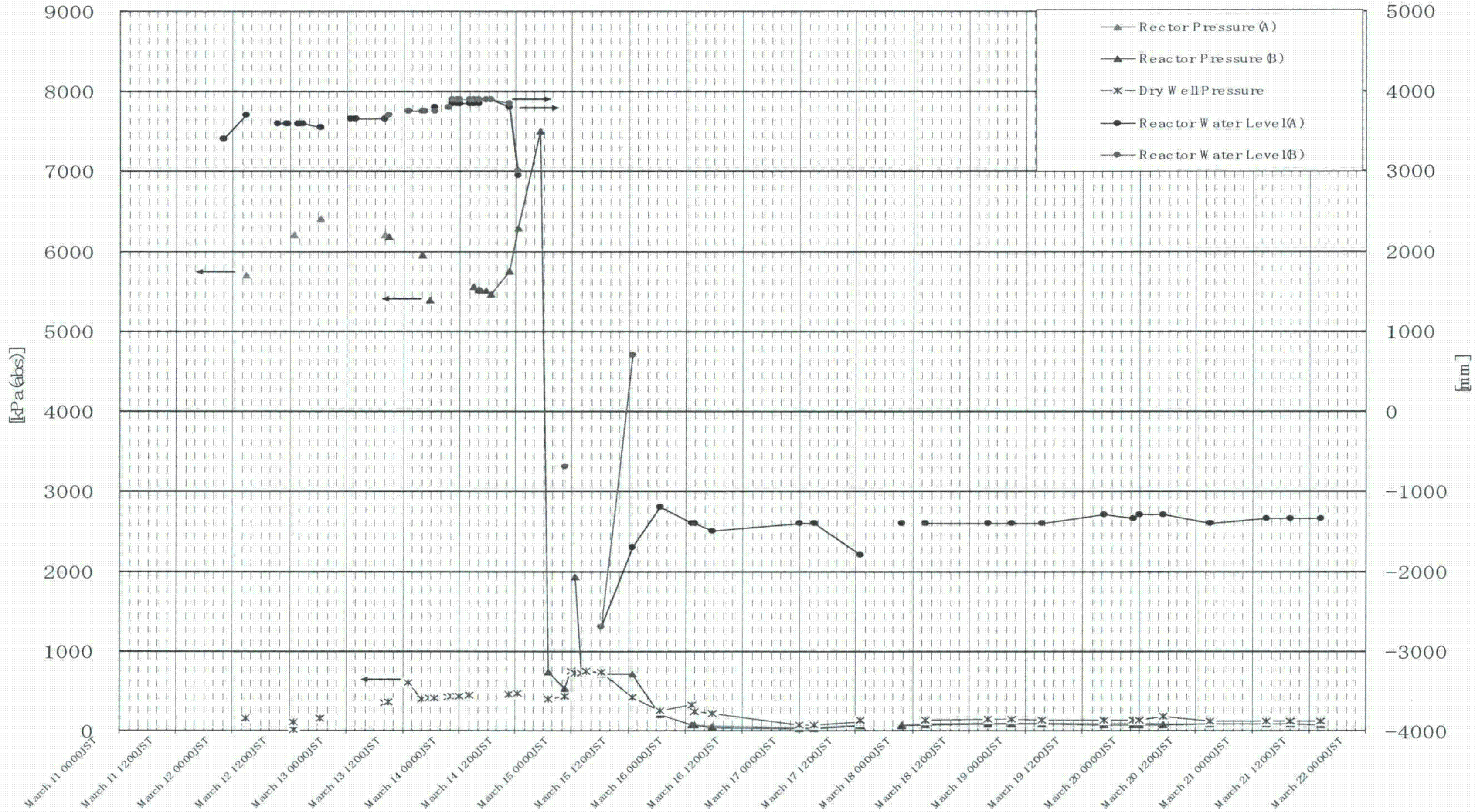
March 20 ・Water spray to Spent Fuel Pool was started

Fukushima Daiichi Unit-2
(BWR-4, Mark-1, 784Mwe, in Operation)

[Current Status, as of March 23]

- Rx Water Level : TAF-1,250 mm
- Rx Pressure : -0.036 MpaG
- PCV Pressure : 0.11 Mpaabs

Unit-2 Plant Parameters



Fukushima Daiichi Unit-3
(BWR-4, Mark-1, 784Mwe, in Operation)

March 11 ・Automatic scram due to the Earthquake

・Loss of offsite power

・**<u>2 Emergency DGs became inoperable by Tsunami</u>**

・Rx Core was being cooled by RCIC

March 13 ・Loss of Rx cooling function

・PCV vent

・Rx water level down

・Seawater injection was started

March 14 ・PCV pressure rose unusually

・**<u>A hydrogen explosion occurred around Rx Building</u>**

March 15 ・White smoke (steam) was being generated from Rx building

March 16 ・White smoke intensified

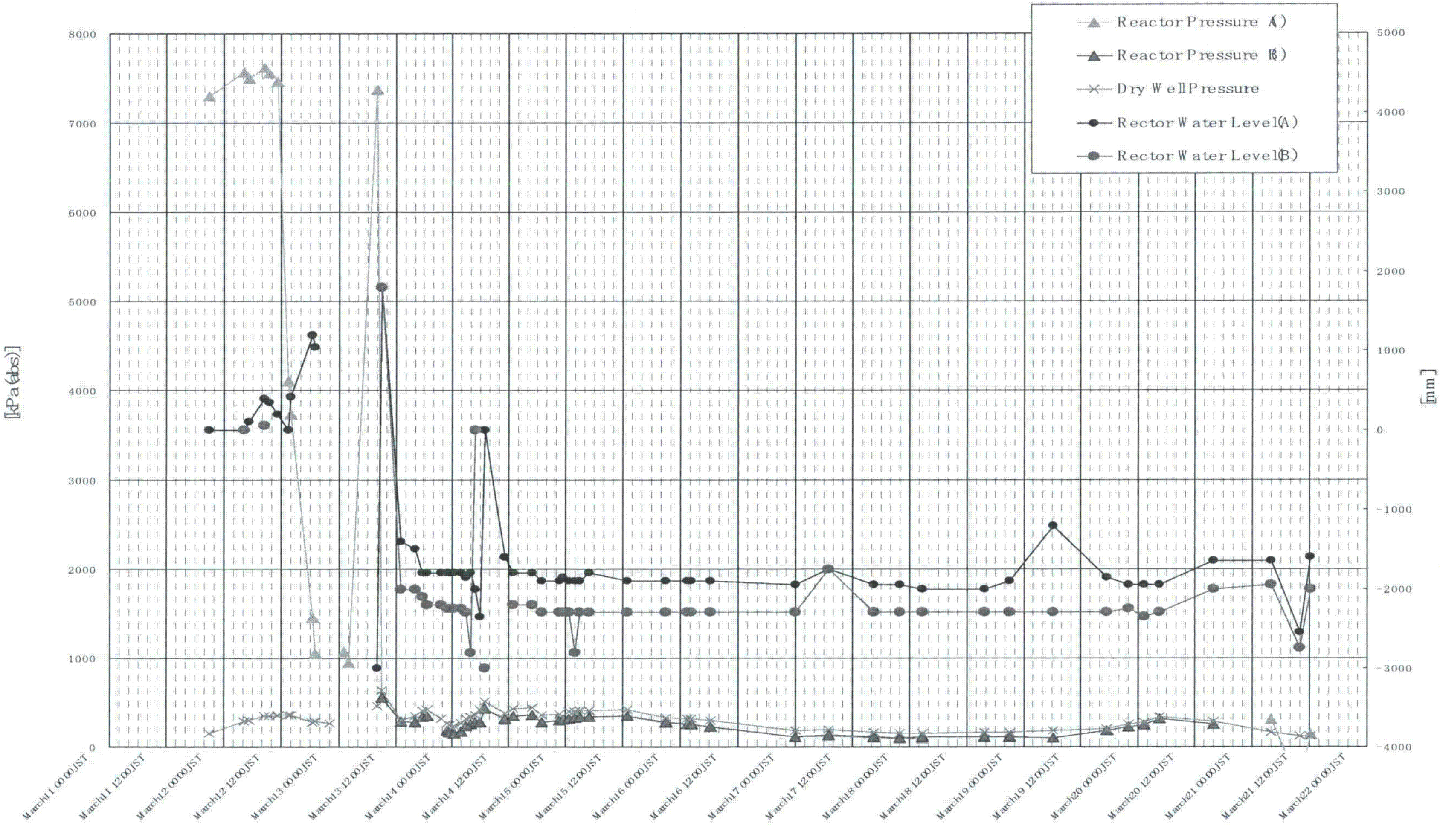
March 17 ・Water spray to Spent Fuel Pool was started

Fukushima Daiichi Unit-3
(BWR-4, Mark-1, 784Mwe, in Operation)

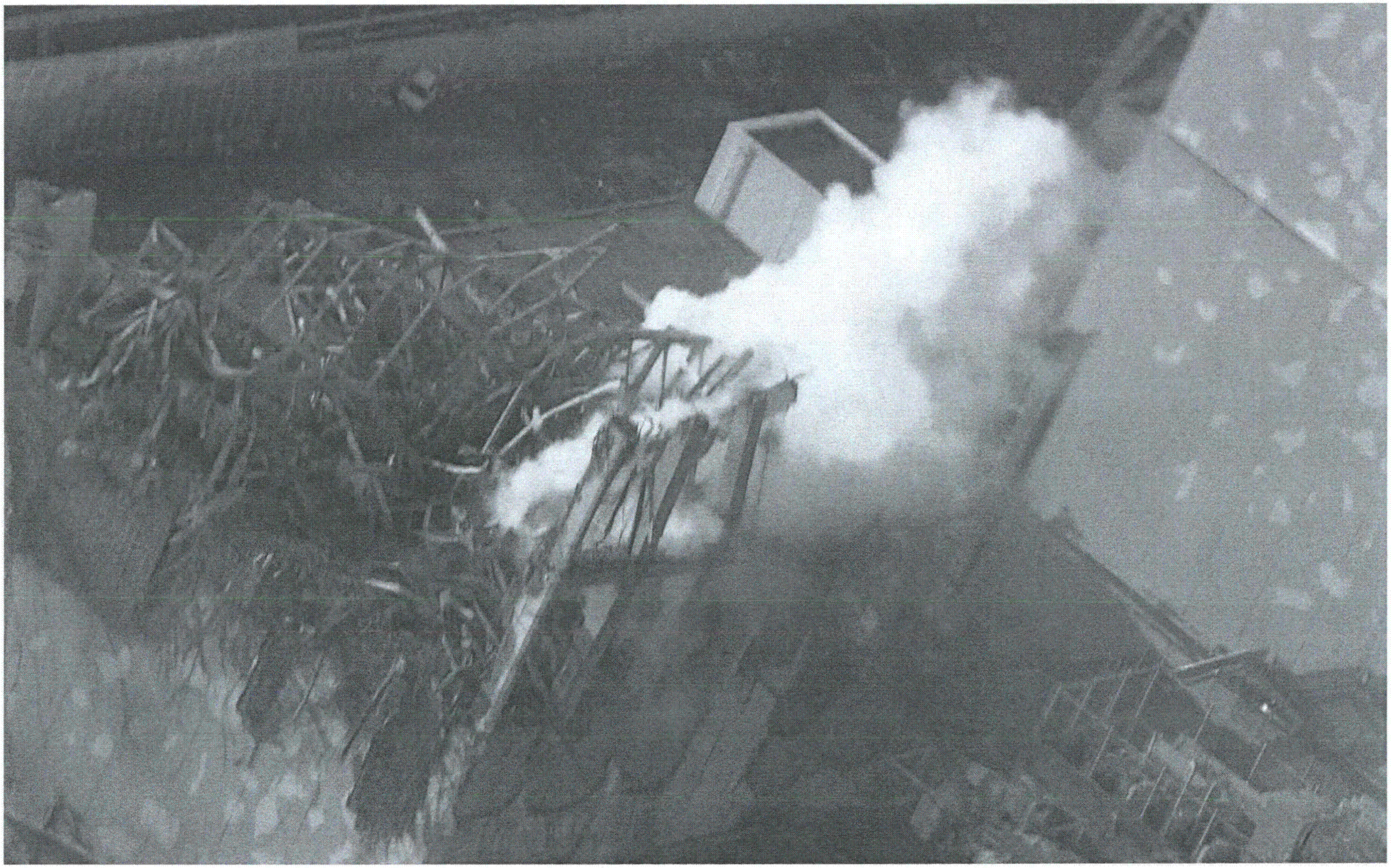
[Current Status, as of March 23]

- Rx Water Level : TAF-1,800 mm, -2,300 mm
- Rx Pressure : ～-0.104 MpaG, 0.034 MPaG
- PCV Pressure : ～0.100 MPaabs

Unit-3 Plant Parameters



Rx Building of Unit 3 (March 16)



Fukushima Daiichi Unit-4
(BWR-4, Mark-1, 784Mwe, in periodic refueling outage)

* All Fuels in Core were transferred in Spent Fuel Storage Pool

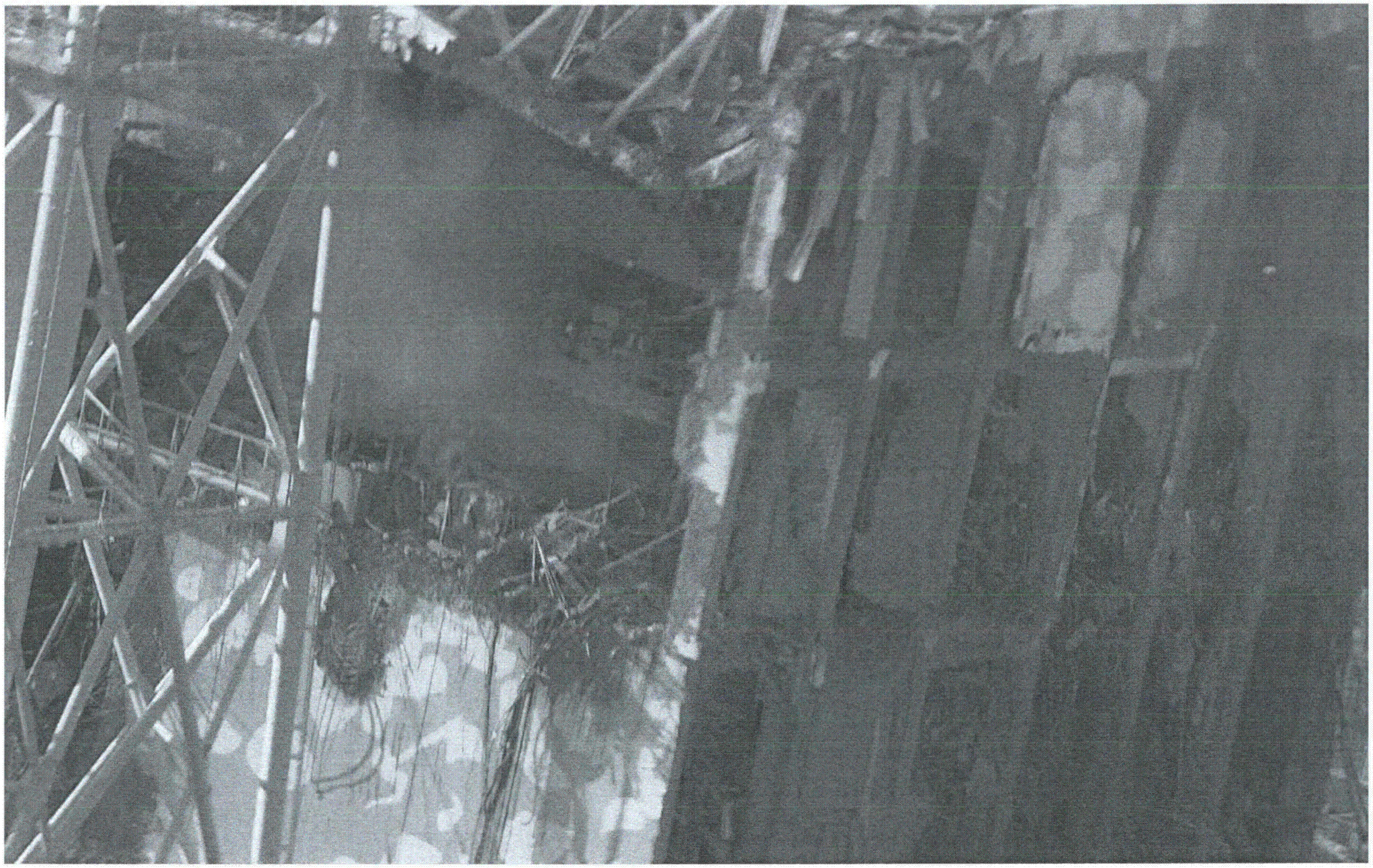
March 15 ・ Rx building was damaged
・ Fire outbreak
March 16 ・ Fire outbreak
March 20 ・ Water spray to Spent Fuel Pool was started

[Current Status]
・ Water spray to Spent Fuel Pool is being continued

Rx Building of Unit 3 & Unit 4

Rx Building of Unit 4 (March 16)

Spent Fuel Pool of Unit 4 (March 16)



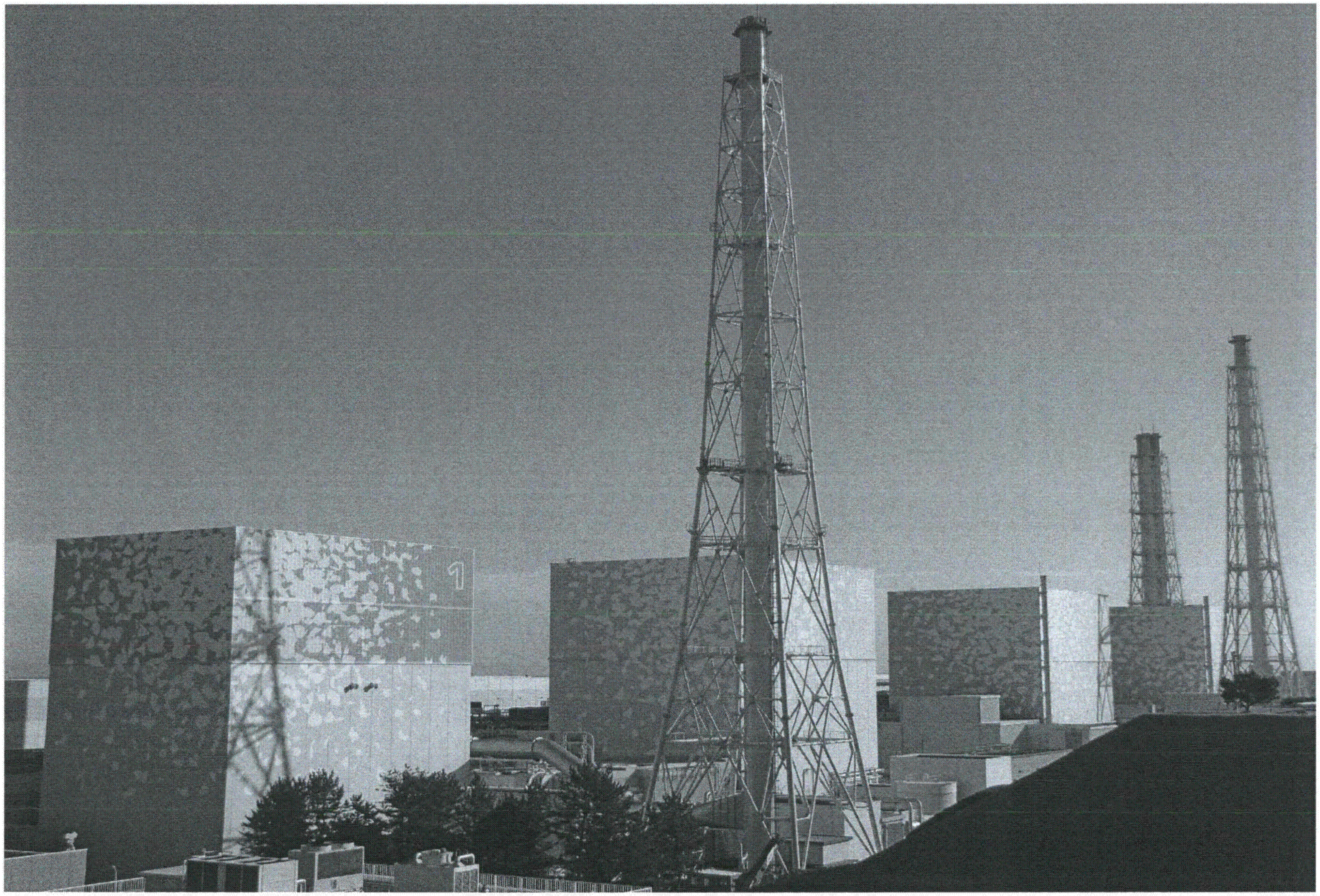
Fukushima Daiichi Unit-5
(BWR-4, Mark-1, 784Mwe, in periodic refueling outage)
Fukushima Daiichi Unit-6
(BWR-5, Mark-2, 11,00Mwe, in periodic refueling outage)

March 11 ・1 Emergency DG for Unit 6 is opearable

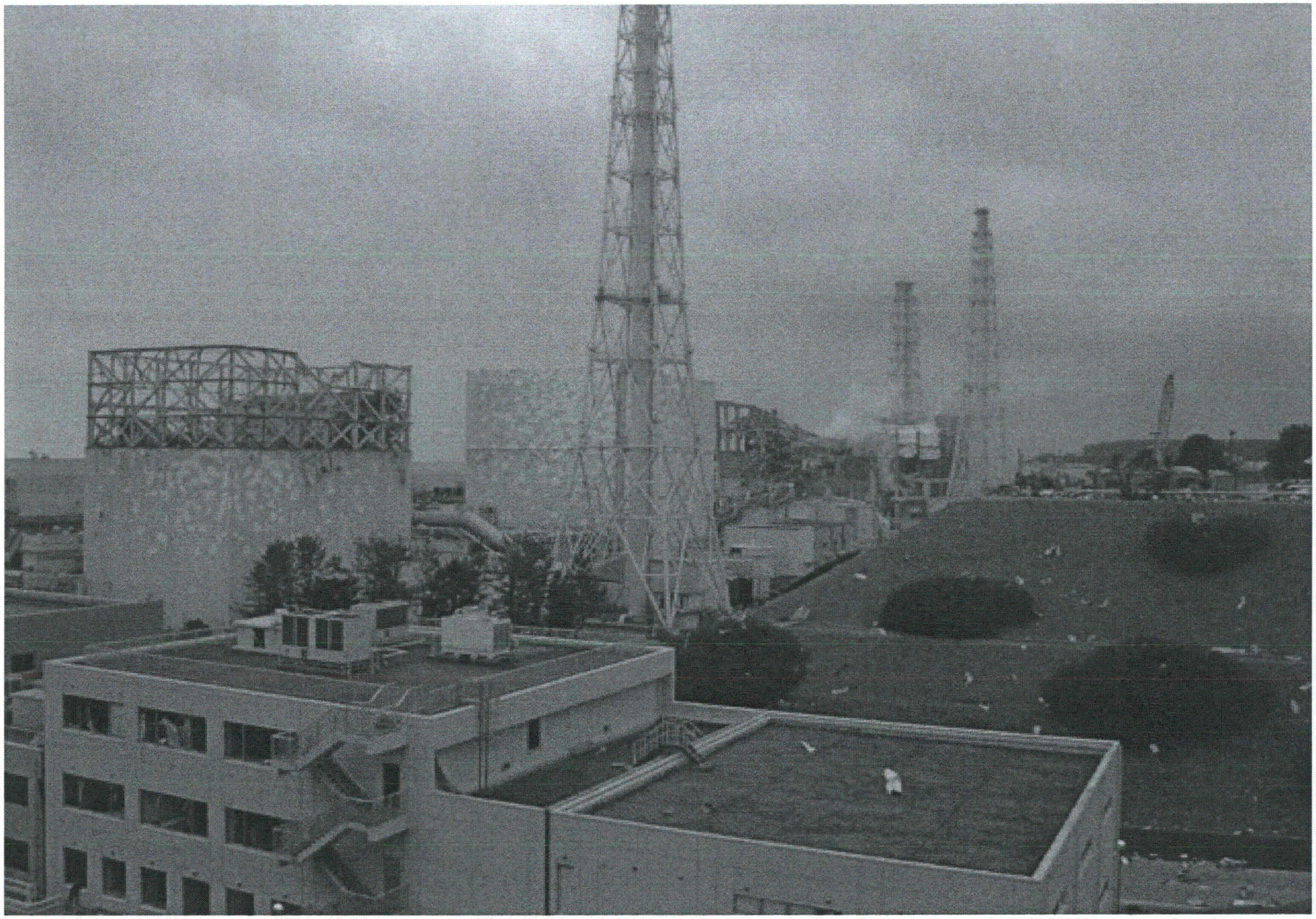
March 19 ・2nd Emergency DG for Unit 6 started operation
・1 RHR Pump for Unit 5 started operation
・1 RHR Pump for Unit 6 started operation

March 20 ・Unit 5 Cold Shutdown
・Unit 6 Cold Shutdown

Overview of Unit 1～4 （Before Accident）



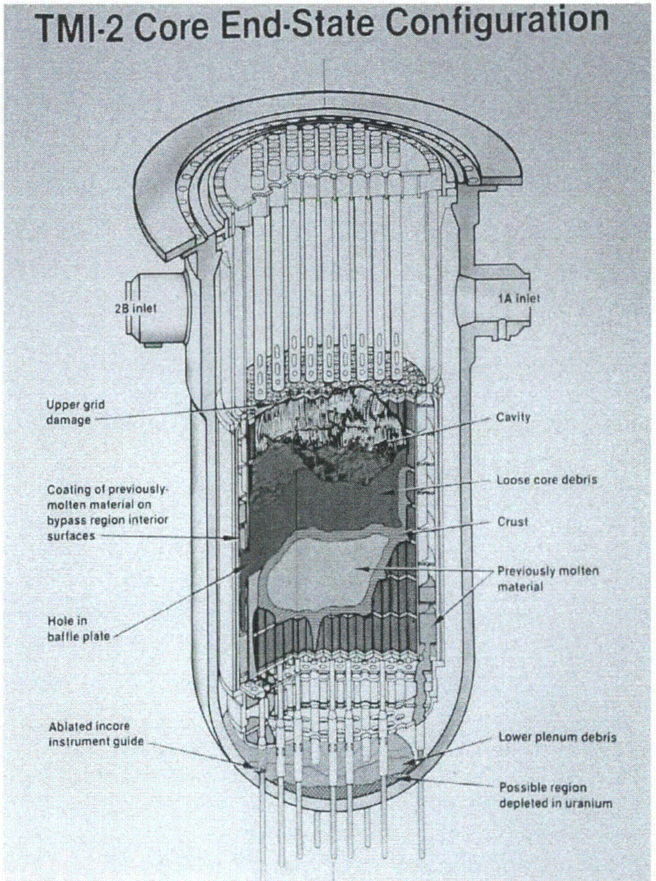
Overview of Unit 1～Unit 4 （After Accident）

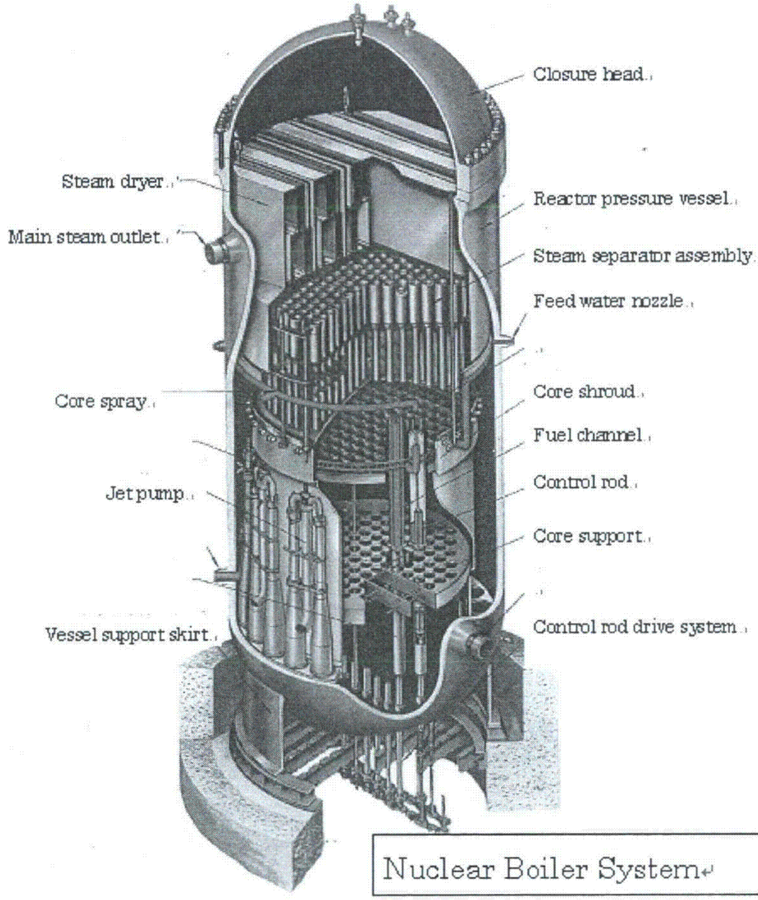


Video

3.Core Damage Estimation

Reactor Core





Nuclear Boiler System

[Ref.: D.W.Akers, et al : Core Materials Inventory and Behavior : ANS Meeting Full Paper, November 1988]

4.Spent Fuel Damage Estimation about Unit 4 SFP

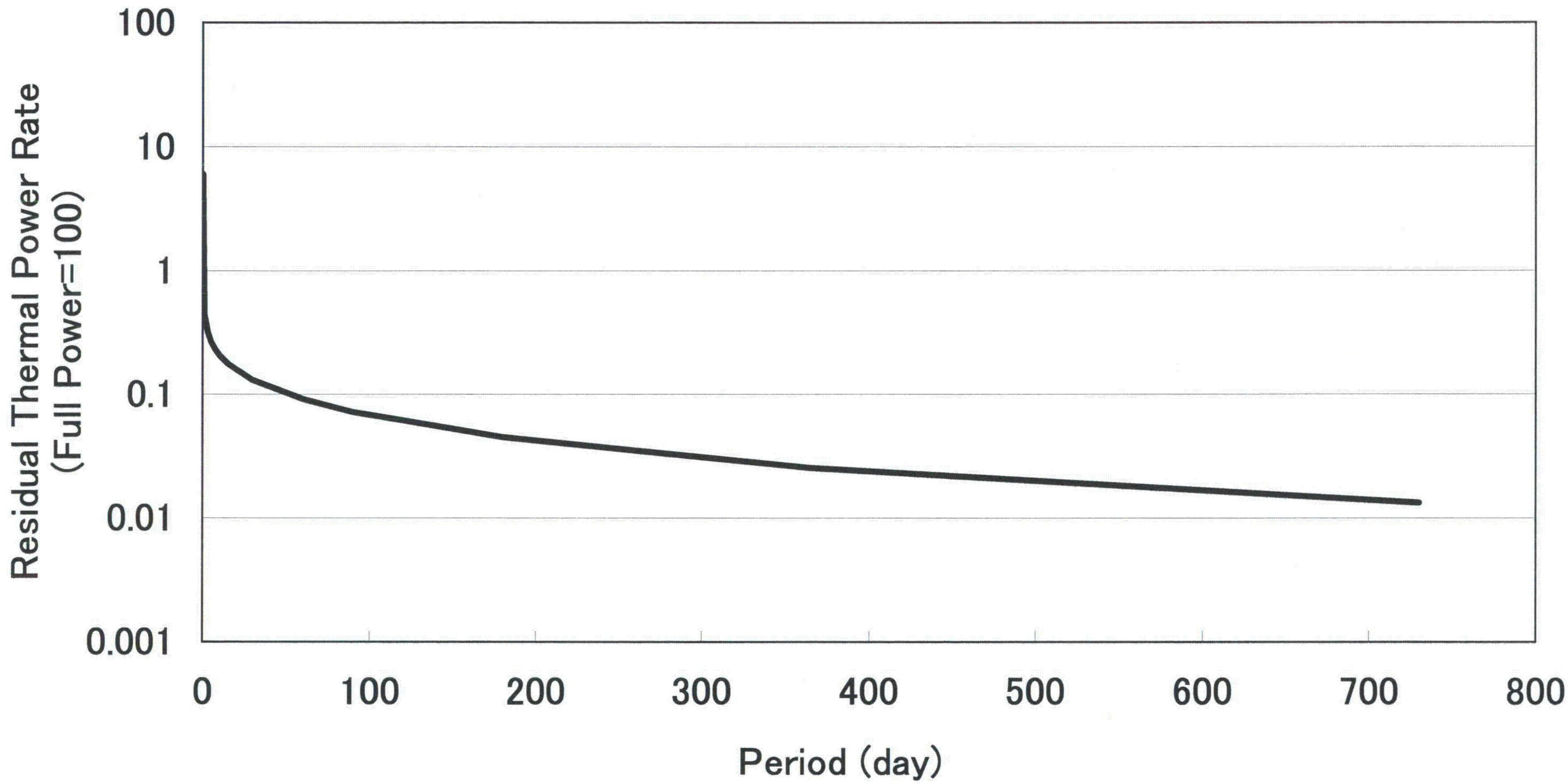
Situation of Spent Fuel Pool

4- 1

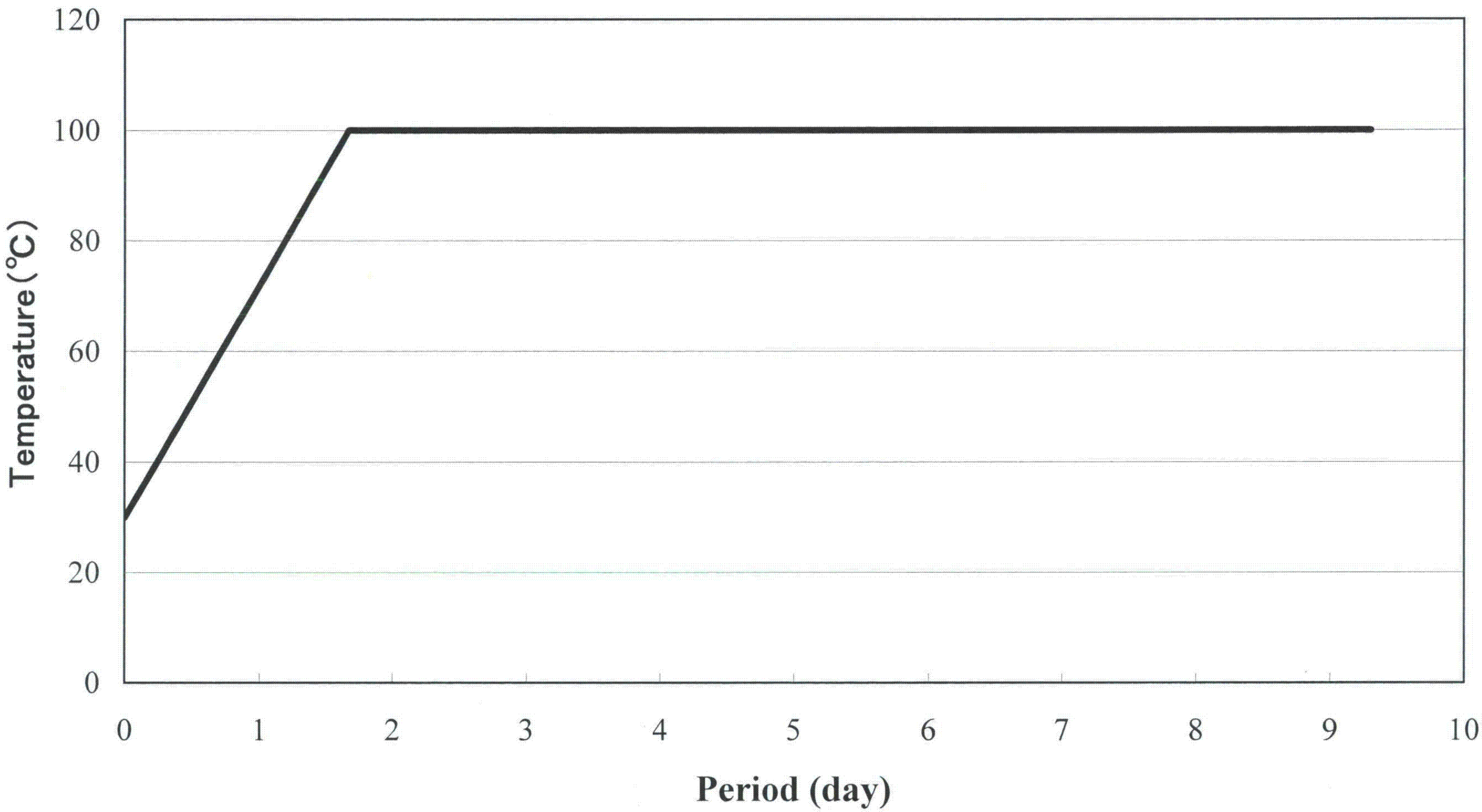
Unit	1	2	3	4	5	6
Number of Fuel Core	400	548	548	-	548	764
SF Pool	292	587	514	1,331	946	876
Thermal Power (kcal)	6E4	4E5	2E5	2E6	7E5	6E5
Water Volume (m3)	1,020	1,425	1,425	1,425	1,425	1,497

[Ref: Asahi Newspaper 2011/3/19]

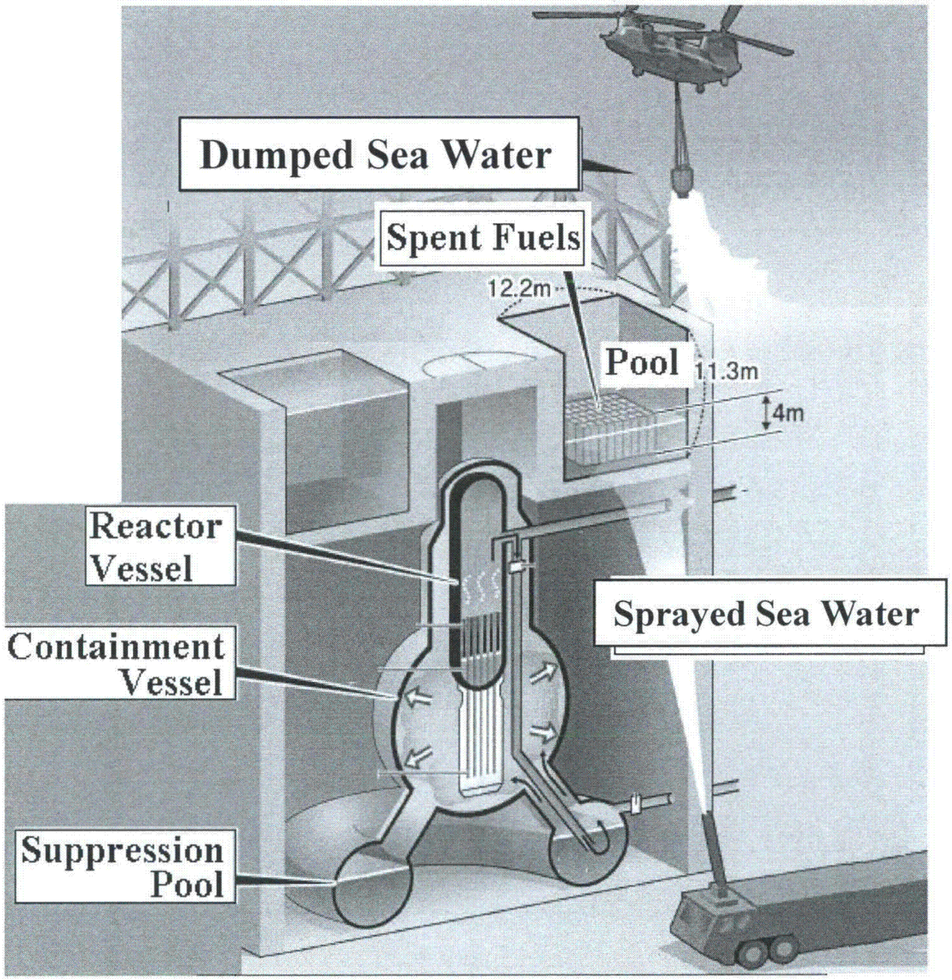
Residual Thermal Power Decrease



Temperature of SP Pool (Unit 4)



Cooling of Spent Fuel Pool



[Ref: Asahi Newspaper 2011/3/18]

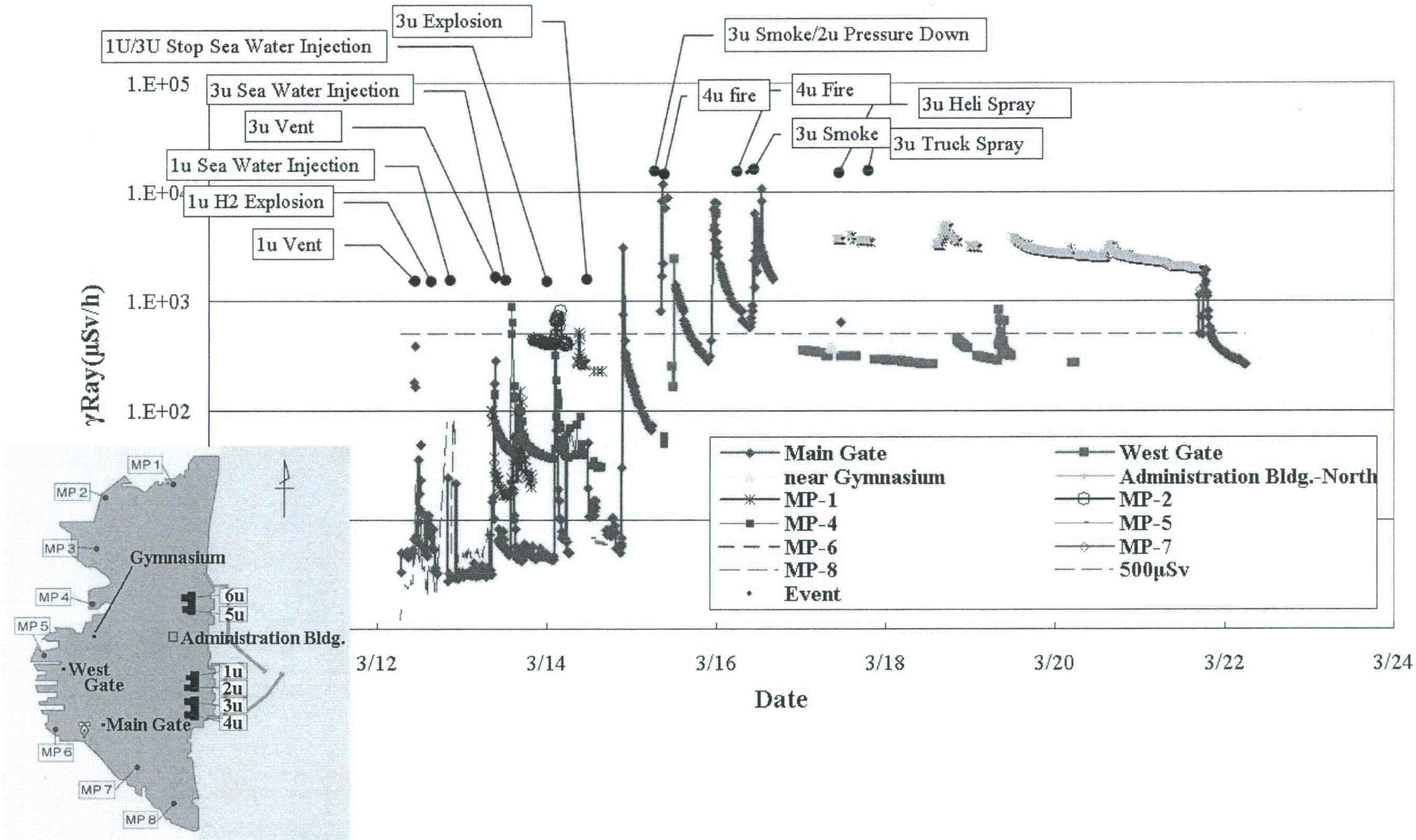
Spray Water on Unit 3.
17th AM: Dumped Sea Water from a helicopter (4 times)
17th PM: Sprayed Sea Water from large-size fire engines

Spray Water on Unit 4.
20th AM: Sprayed Sea Water from large-size fire engines

[Report of Prime Minister of Japan and his Cabinet 2011/3/20 22:00 P1/32]

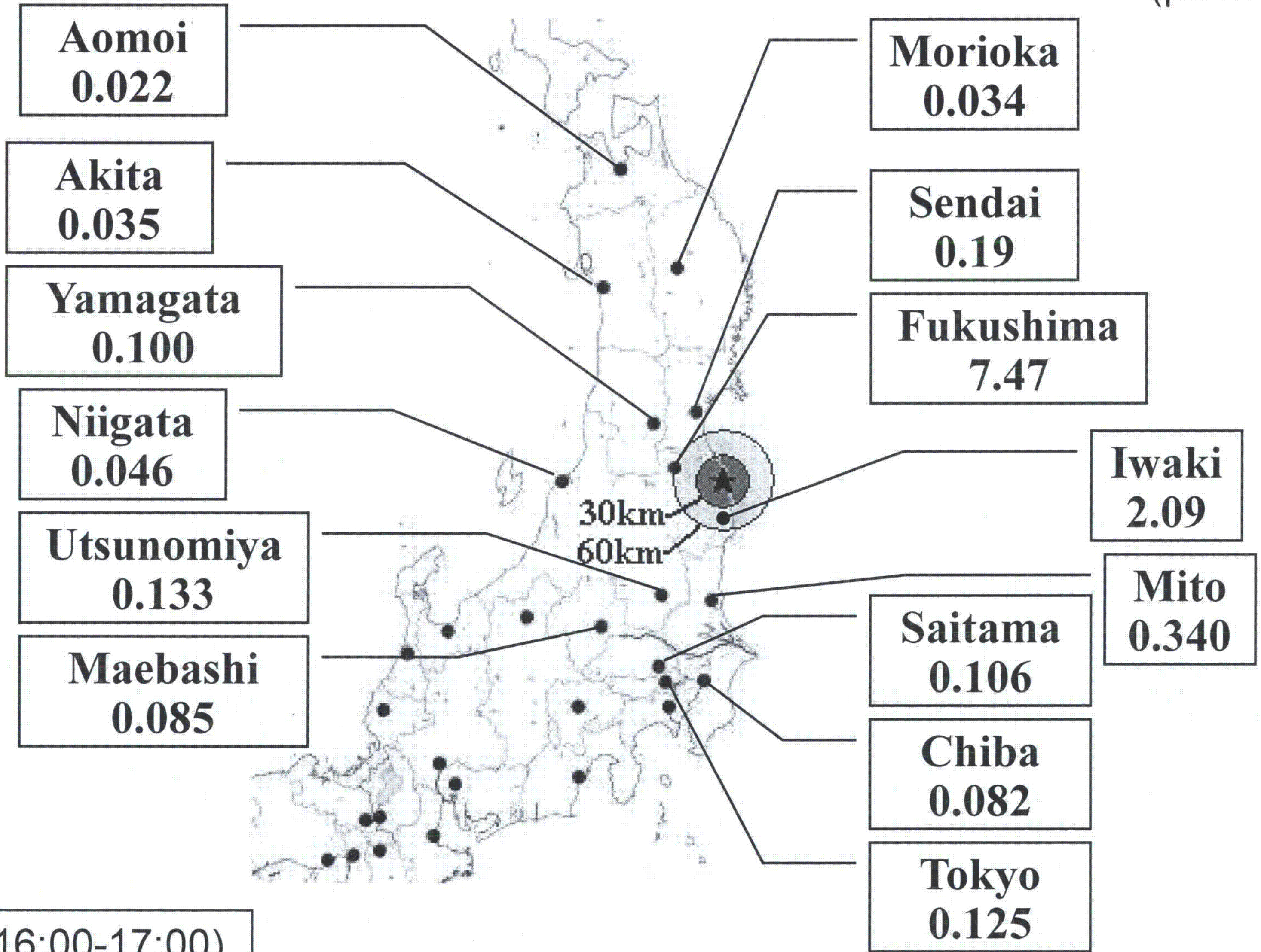
5.Radiation Exposure and Monitoring Data

Radiation Dose at Power Station



Radiation Dose at East Japan

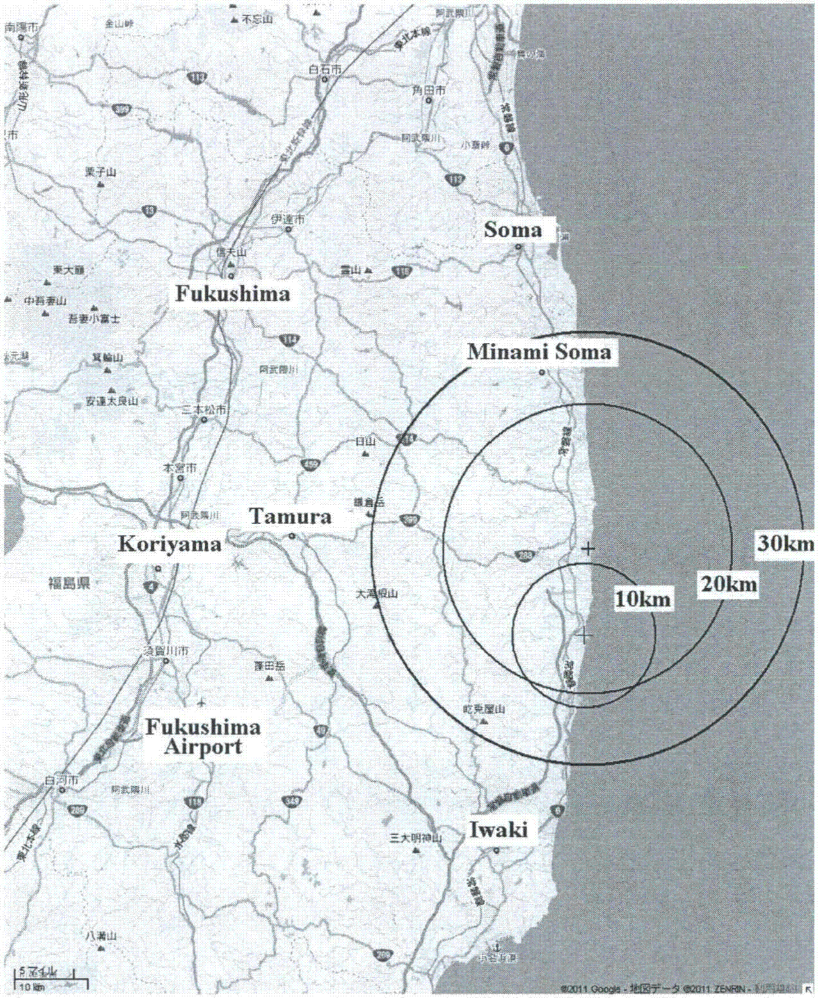
(μSv/h)



21th (16:00-17:00)

5-3

Evacuation Advice of Government



11th 20:50: Evacuate from 2km sphere

21:23: Evacuate from 3km sphere

~ 6,000 persons

12th 05:44 : Evacuate from 10 km sphere

> 50,000 persons

18:25: Evacuate from 20 km

>170,000 persons

[Report of Prime Minister of Japan and his Cabinet 2011/3/20 22:00 P10/32]

Radiation Contamination

Food Contamination (20th March)

Element	Food	Prefecture	Radiation (Bq)
Iodine	Milk	Fukushima	932~1,510
	Spinach	Ibaragi	6,100~15,020
Cesium	Spinach	Ibaragi	524

The government requested that the contaminated food (Spinach, Milk) do not be distributed in the market on 20th March.

The Radioactive Material (Co, Cs) was detected in the sea water near NPP on 22th March.

Victim and Damage

	Dead	Missing	Evacuated
Total	6,911	19,370	403,975
Near NPPs			
(1)Onagawa			
Onagawa	-	4,500	5,500
Ishinomaki	~1,000	400	40,600
(2)Fukushima			
Soma	105	-	4,000
Minami Soma	176	100	5,700
Iwaki	145	-	6,500
Fukushima	-	-	8,000
Koriyama	-	-	5,400
Tamura	-	-	3,400

[Ref: Asahi Newspaper 2011/3/19]

6.Discussion