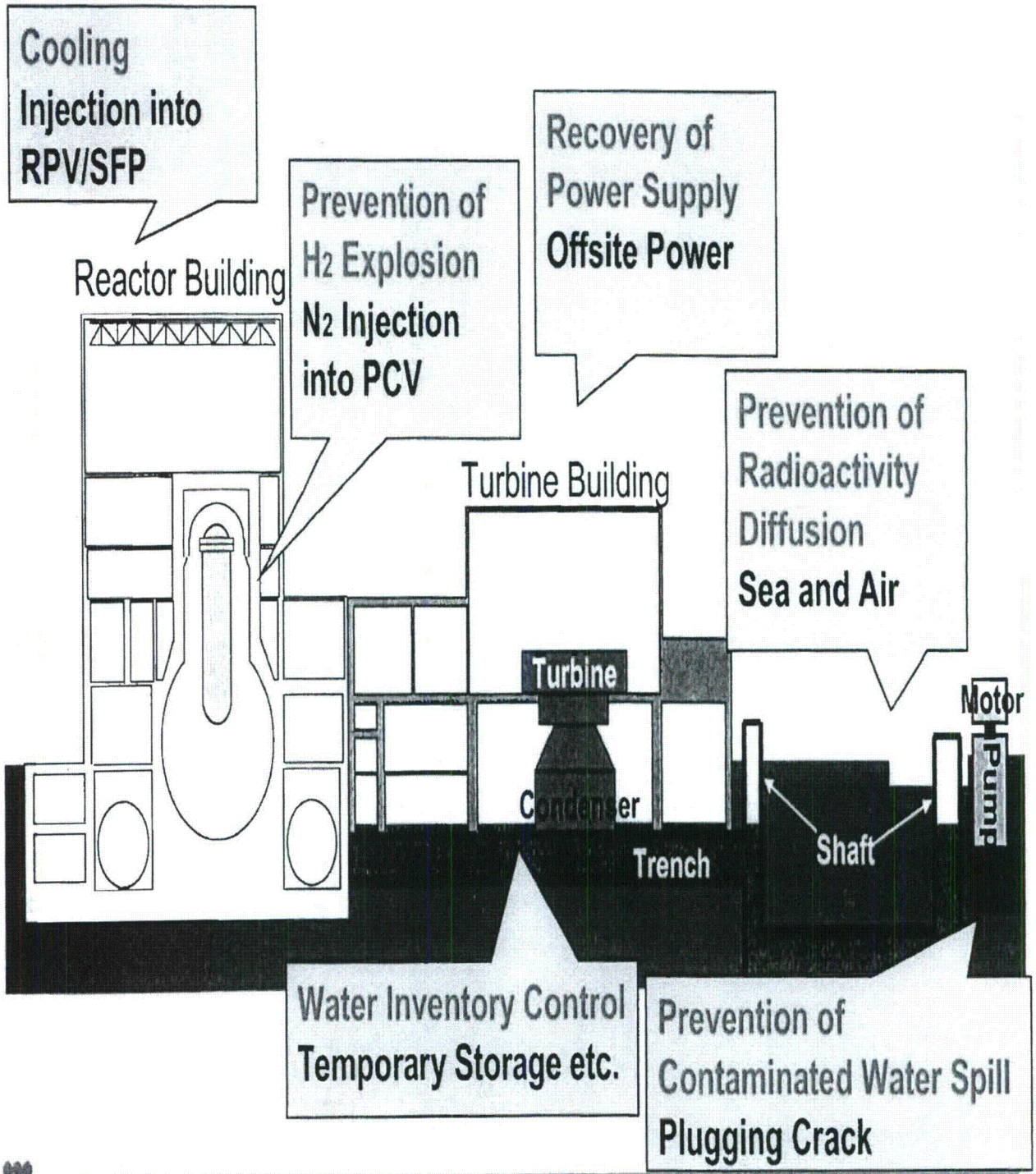
1. Recovery Actions

Overview of Recovery Actions

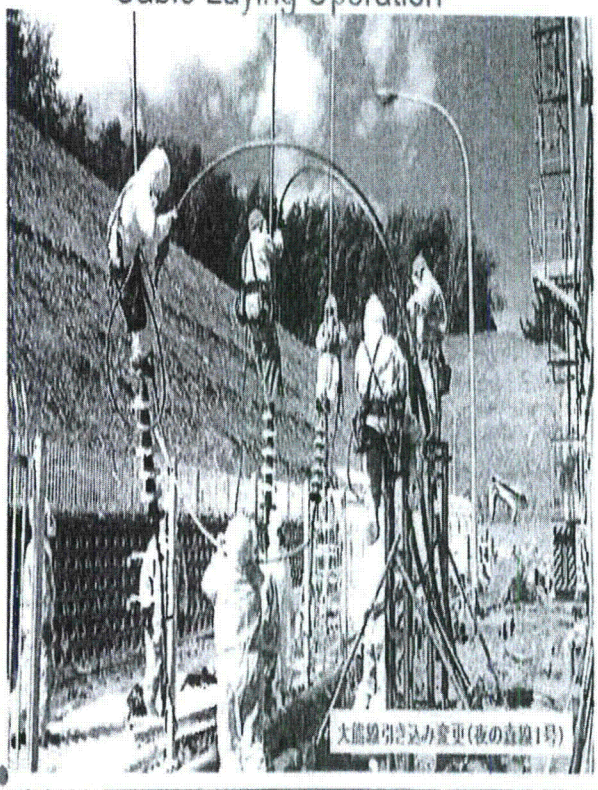


Recovery of Power Supply

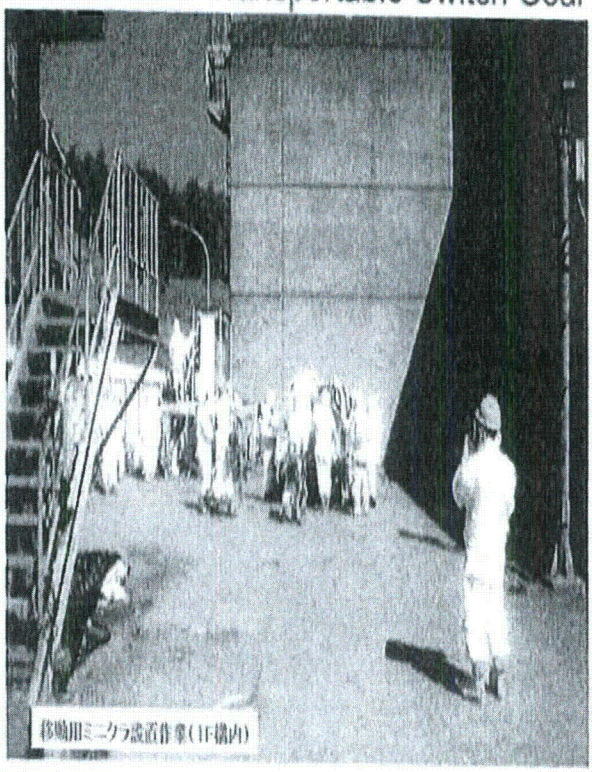
Recovery of Offsite Power

- Unit 5/6: Mar.20-21
- Unit 1: Mar.22
- Unit 2: Mar.20
- Unit 3: Mar.22
- Unit 4: Mar.22

Cable Laying Operation



Installation of Transportable Switch Gear



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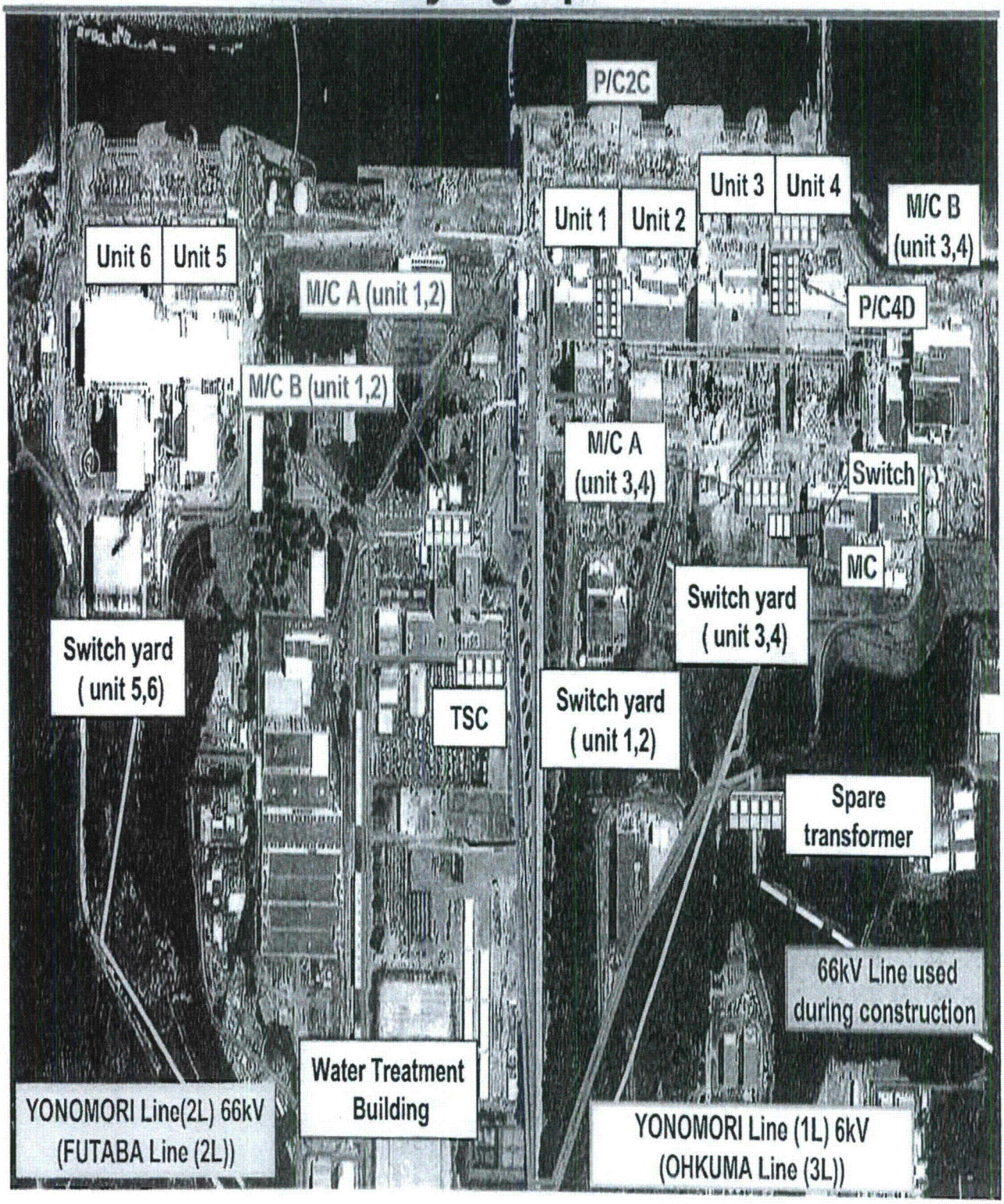
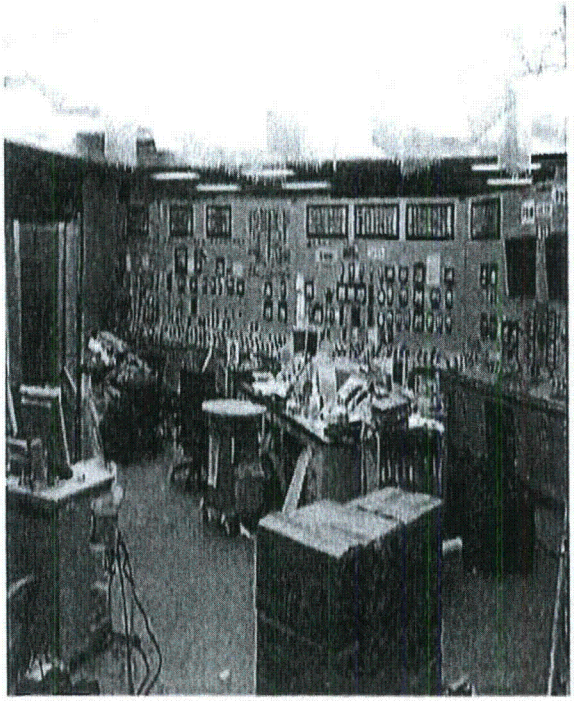
Cable Laying Operation



Recovery of Main Control Room Light

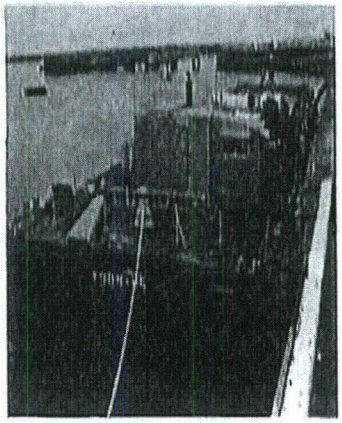
- Unit 3 : March 22
- Unit 1 : March 24
- Unit 2 : March 26
- Unit 4 : March 29



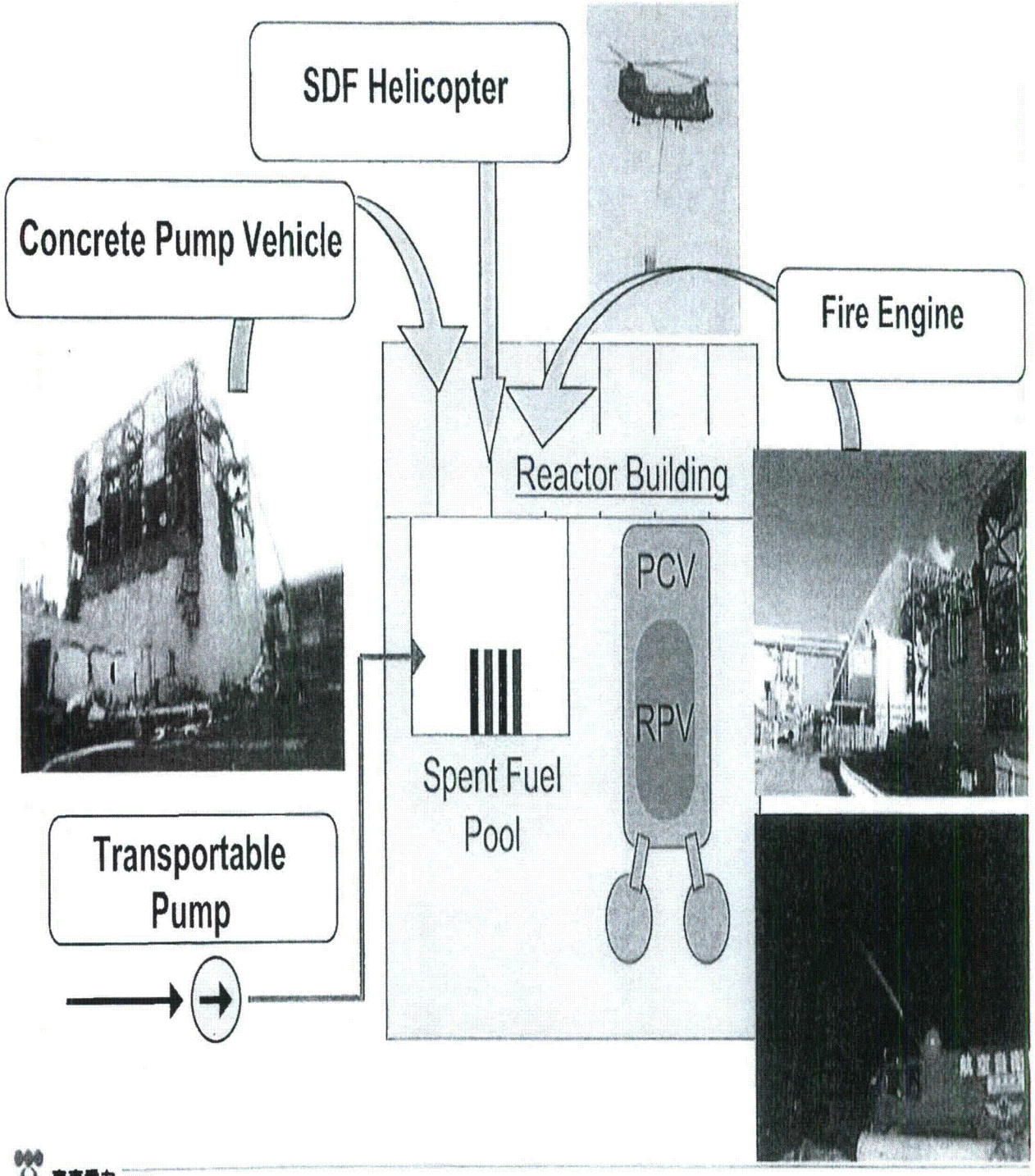
Unit 1

Cooling – Water Injection into RPV

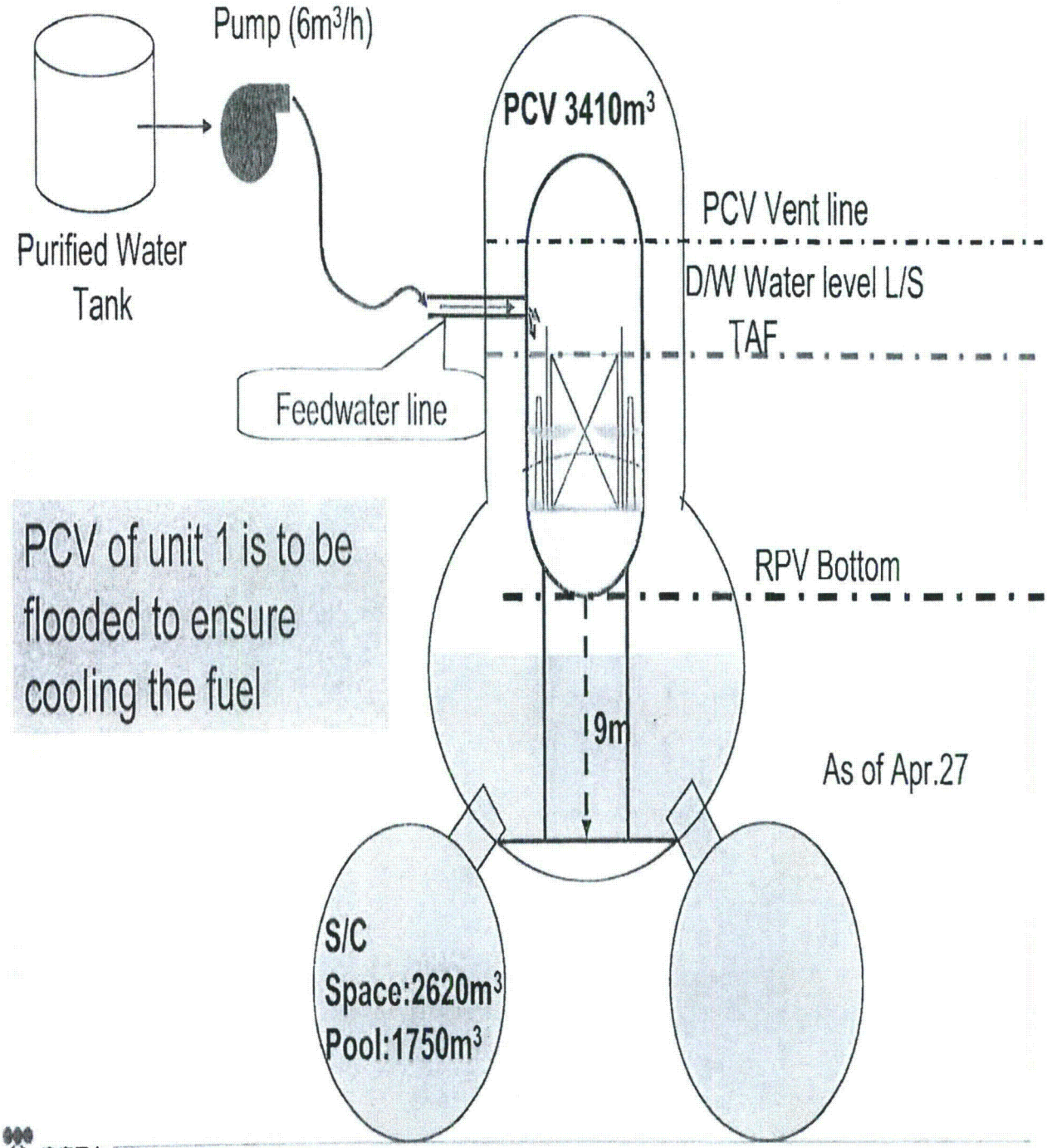
Freshwater carried by Barge Ship (Courtesy of US force)



Water Injection into Spent Fuel Pool

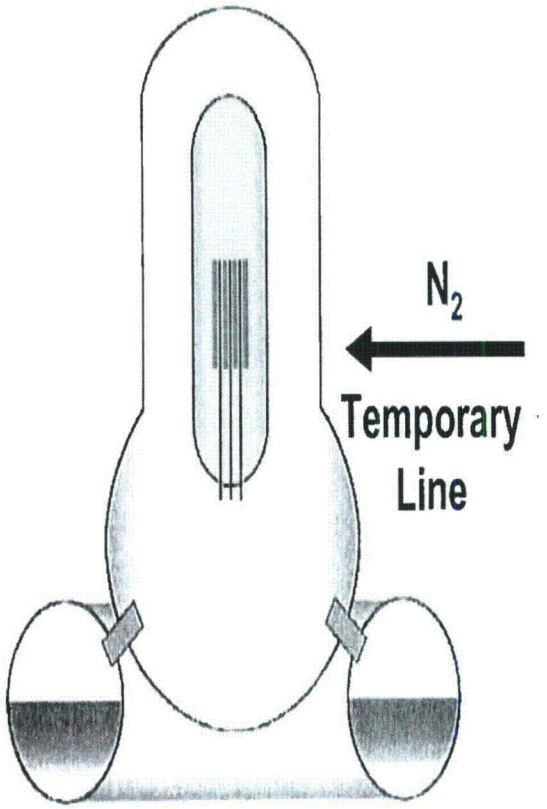


PCV Flooding (unit 1)

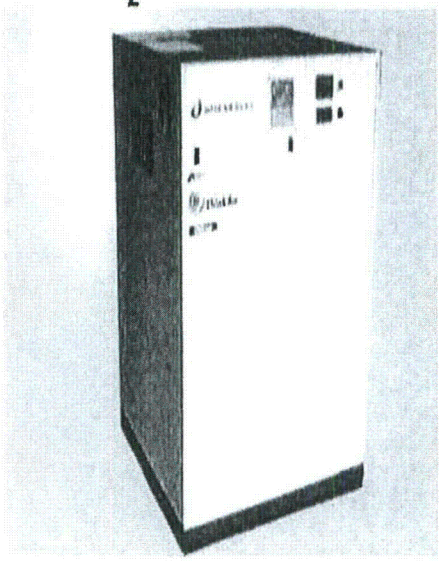


Prevention of Hydrogen Explosion

N_2 gas has been injected into unit 1 PCV to reduce the risk of a hydrogen explosion since Apr.7.

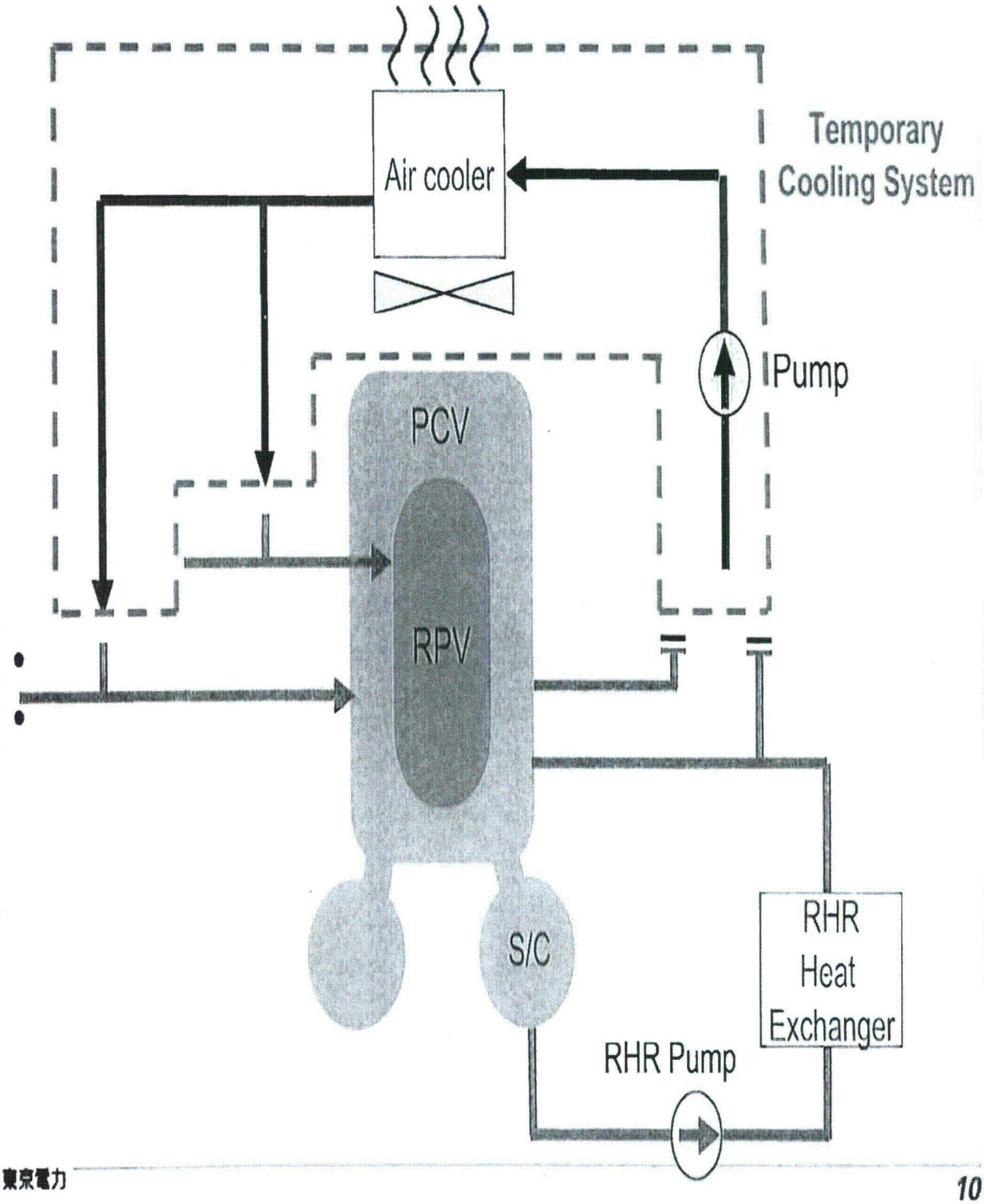


N_2 Generator



Max 14m^3/h, 0.6MPa

Temporary External Cooling System



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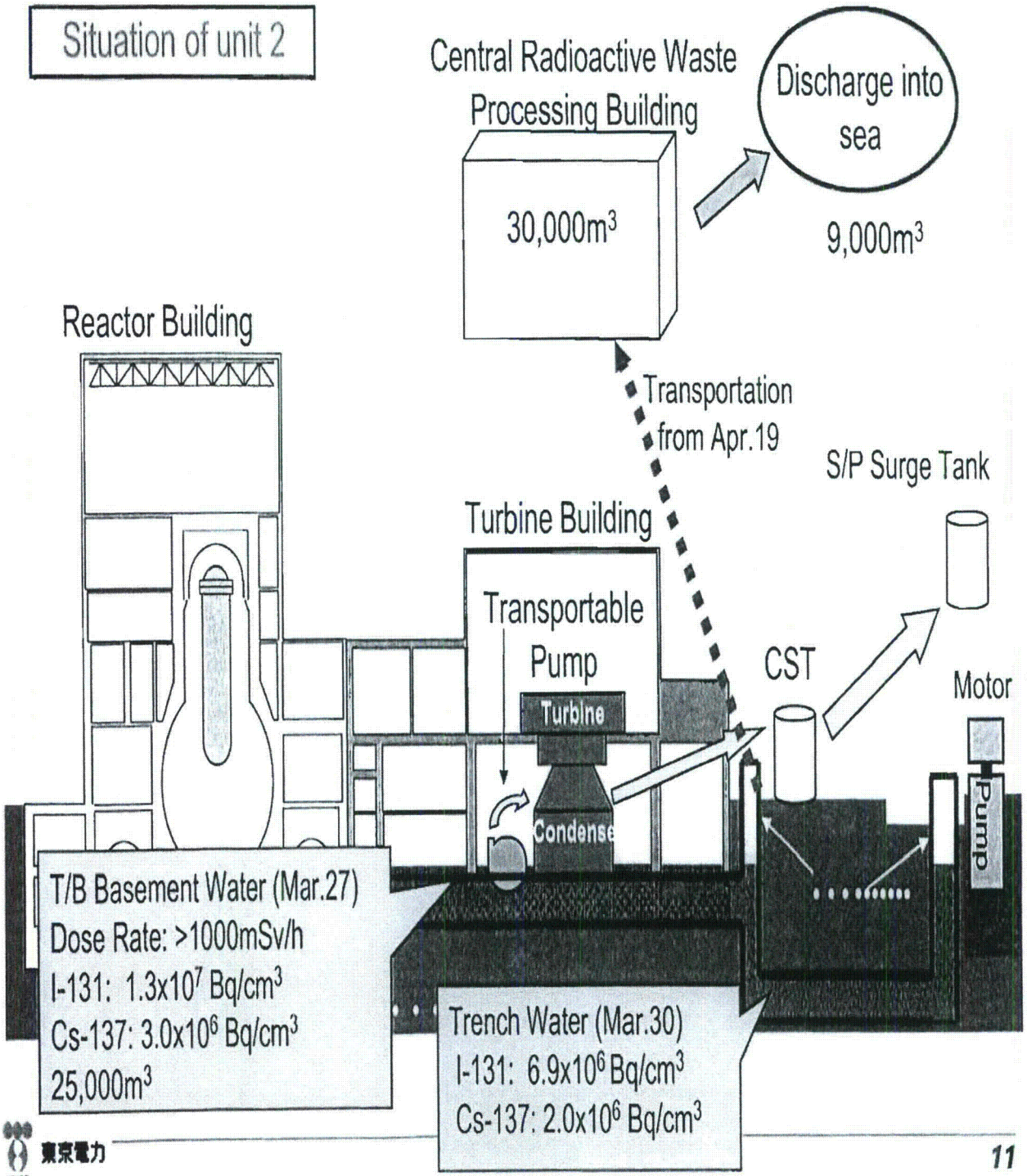
Water Inventory Control



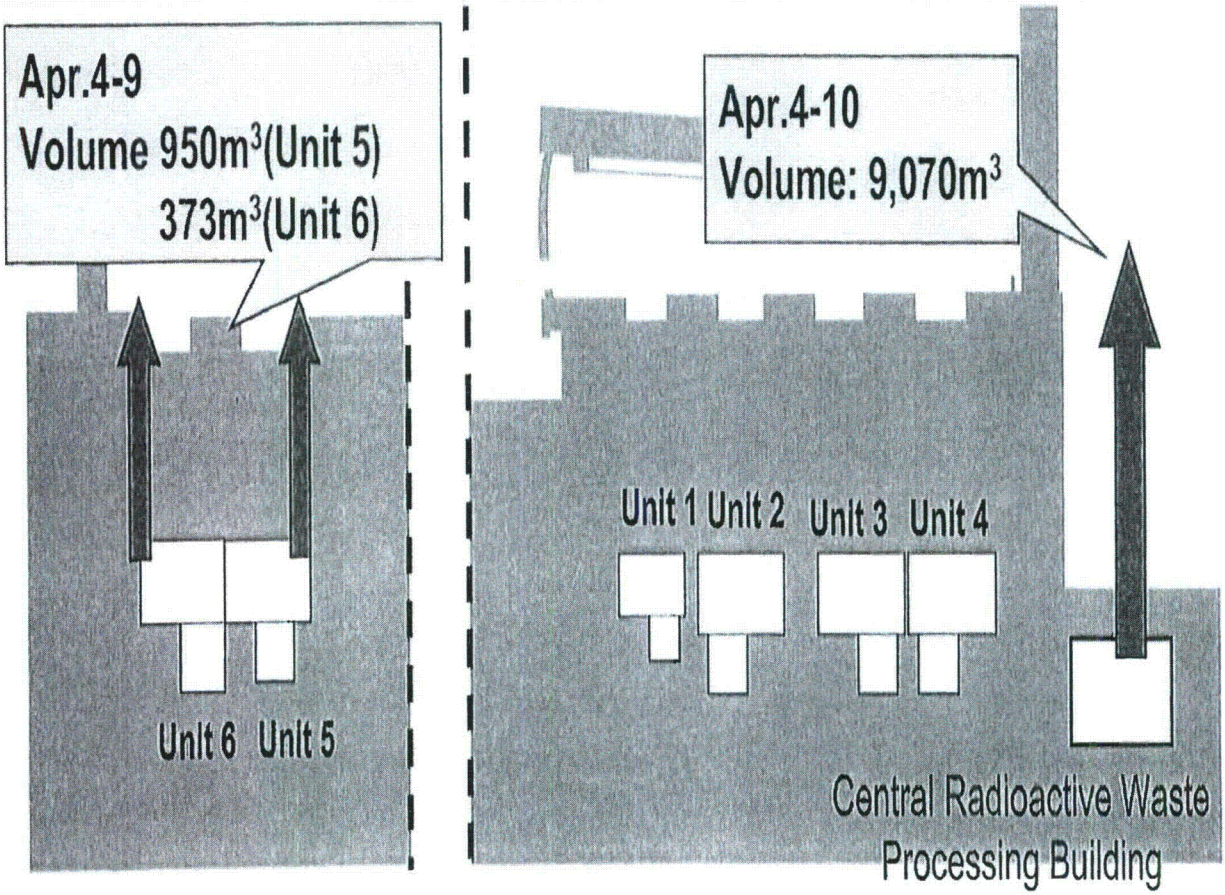
Emergency Discharge of Low Contaminated Water

Low contaminated water was discharged with authorization of the regulator.

- to avoid spill-over of highly contaminated water (more significant risk)
- to prevent sub drain leakage into unit 5 and 6

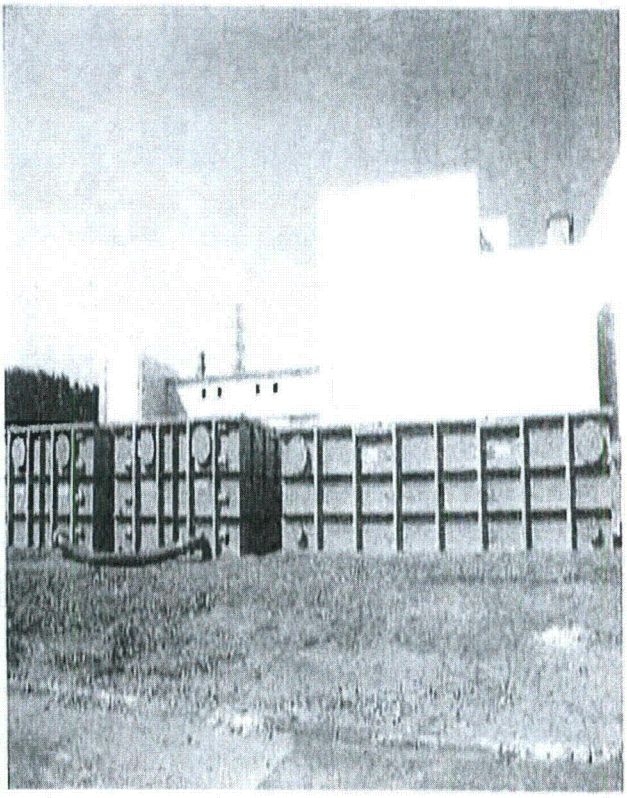
Total radioactivity was 1.5×10^{11}Bq and within planned yearly release under licensing (2.2×10^{11}Bq)

No significant change was recognized in seawater radiation during discharge.



Securing Storage Capacity

Mega Float: Vast Floating Structure
(currently under modification)
10,000m^3

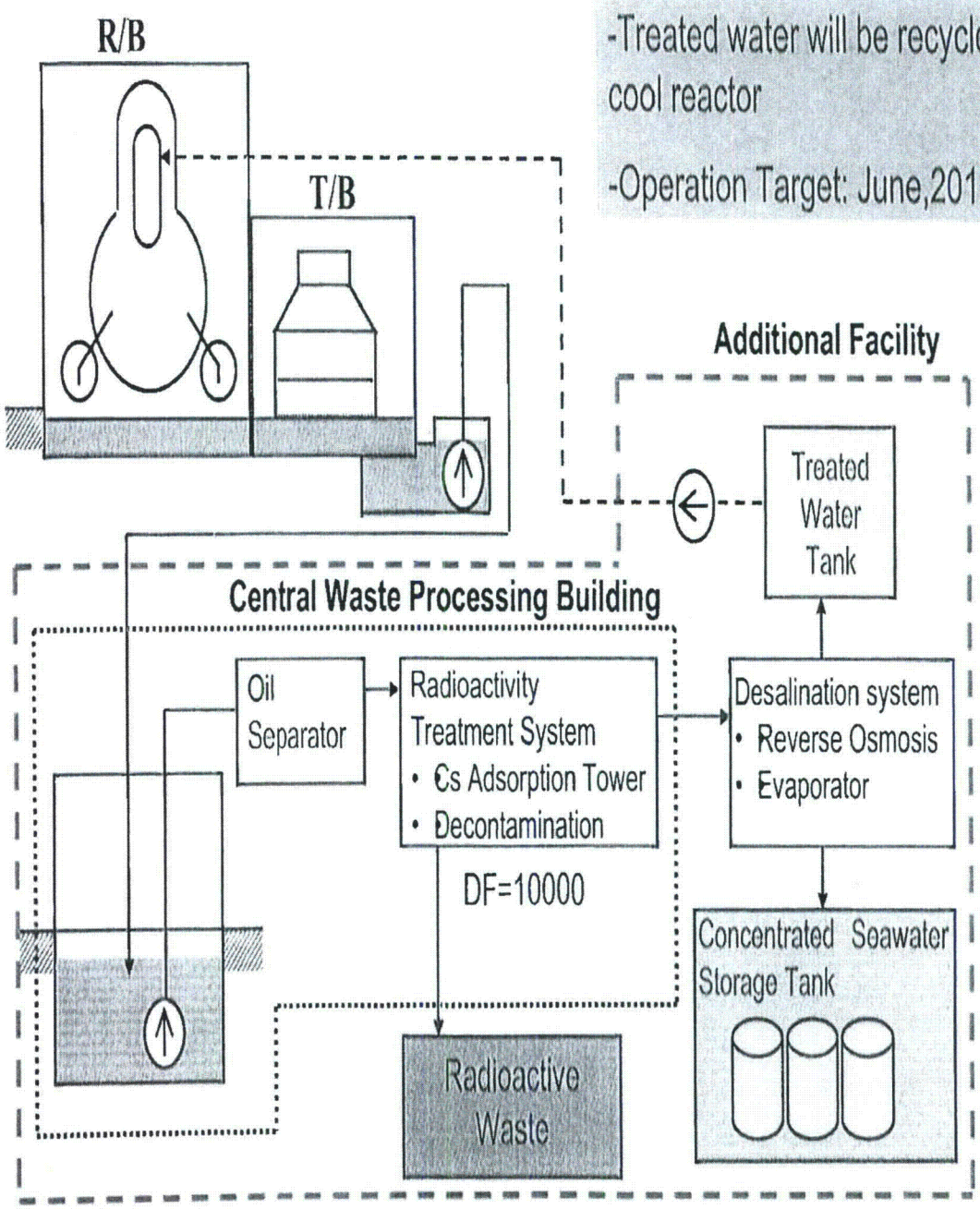


Temporary Storage Tank

Installation of Water Treatment Facility

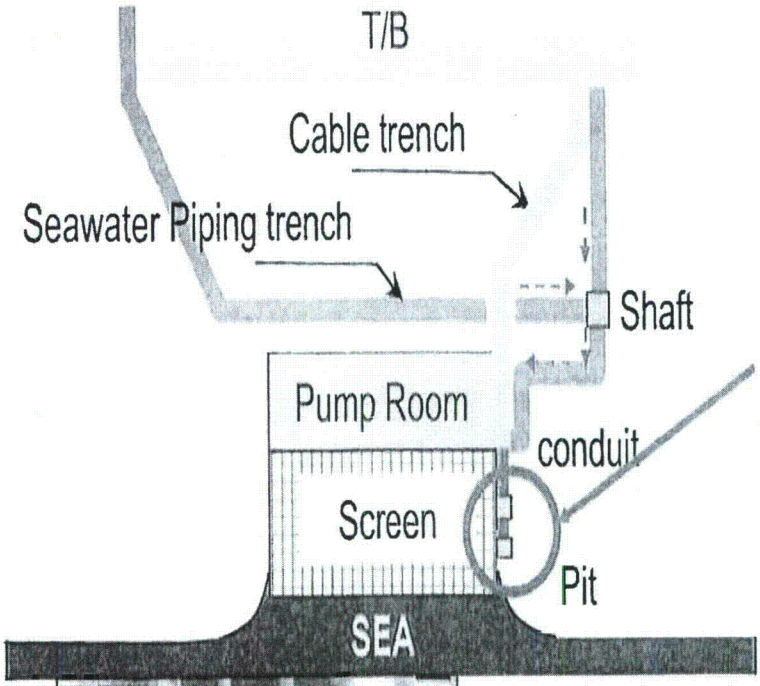
-Treated water will be recycled to cool reactor

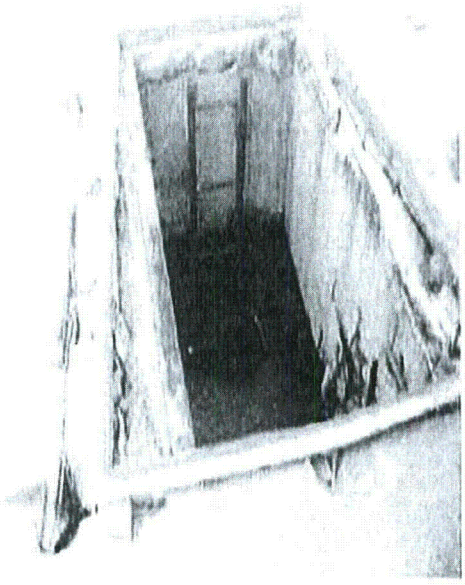
-Operation Target: June,2011

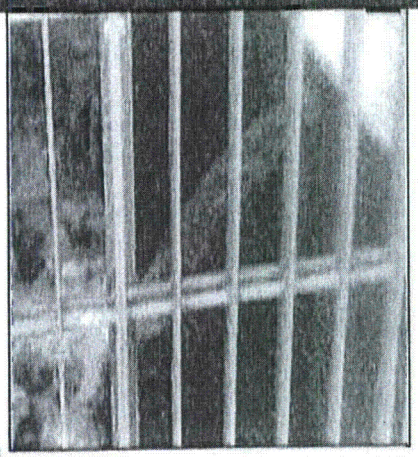


Prevention of Contaminated Water Spill

Highly contaminated water was found to leak into the sea through crack in the cable pit on Apr.2.







Dose rate• more than1,000mSv/h

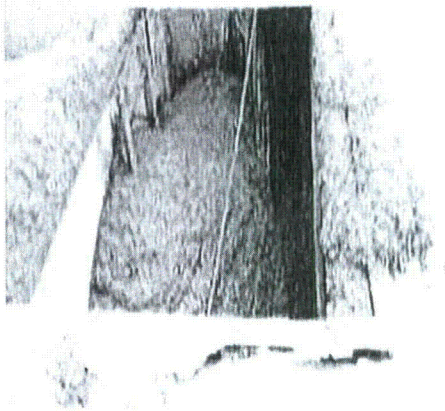
Radioactivity• •
- I-131 $5.4X10^6$ [Bq/cc]
- Cs-134 $1.8X10^6$ [Bq/cc]
- Cs-137 $1.8X10^6$ [Bq/cc]

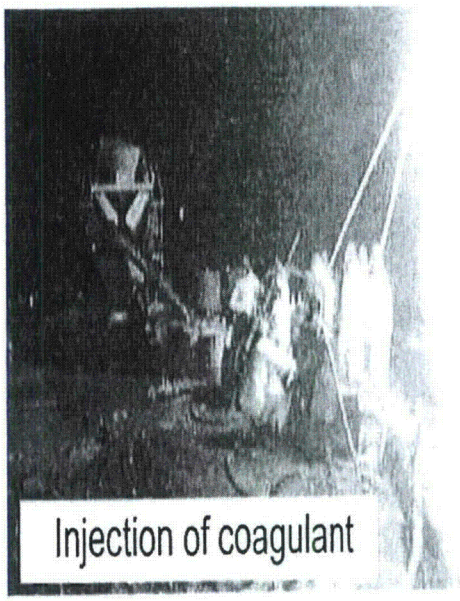
Prevention of contaminated water spill

Injection of coagulant successfully plugged water path on Apr.6.

Total radioactivity released was estimated to be **4.7X10**^{15} Bq

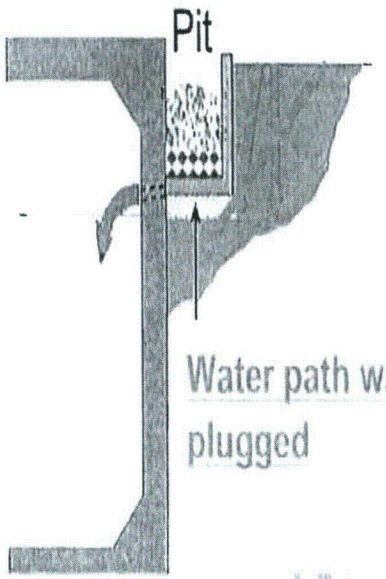
Pouring concrete did not work

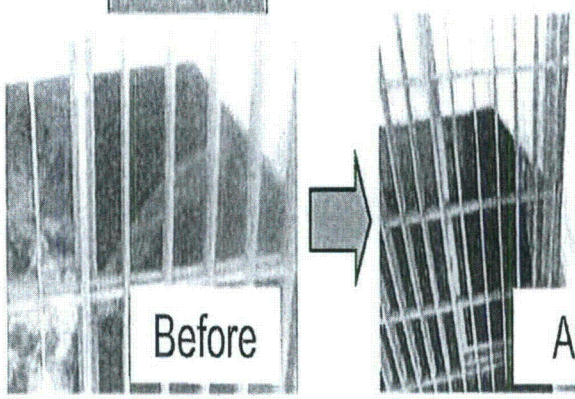




Injection of coagulant

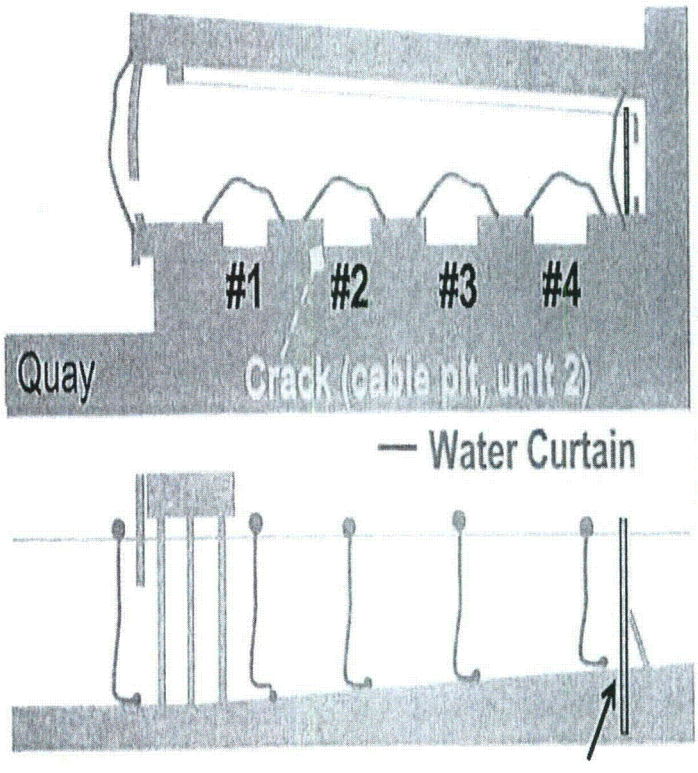
- Boring hole
- Injection of coagulant





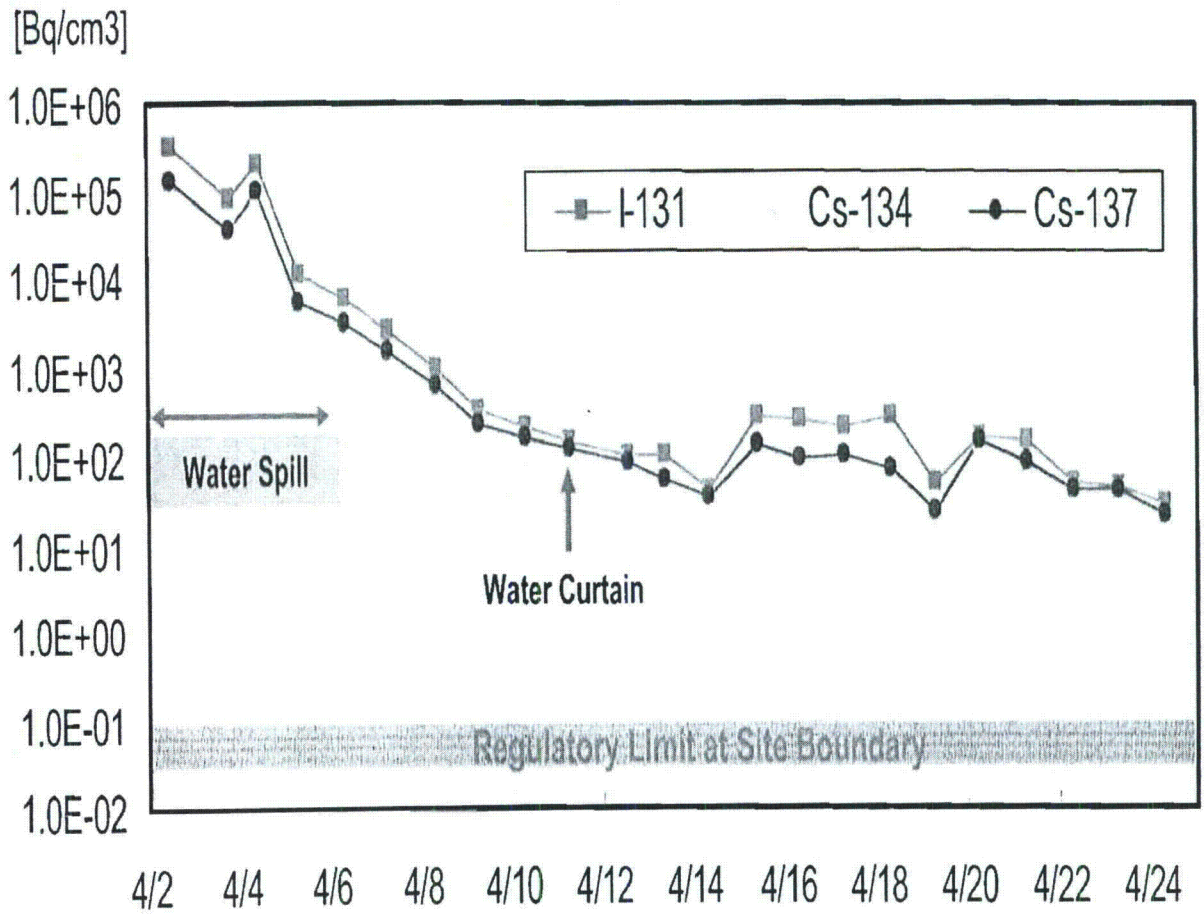
Prevention of Radioactivity Diffusion into sea

Water curtains and steel plates were installed into breakwater to prevent the contaminated water into the sea.



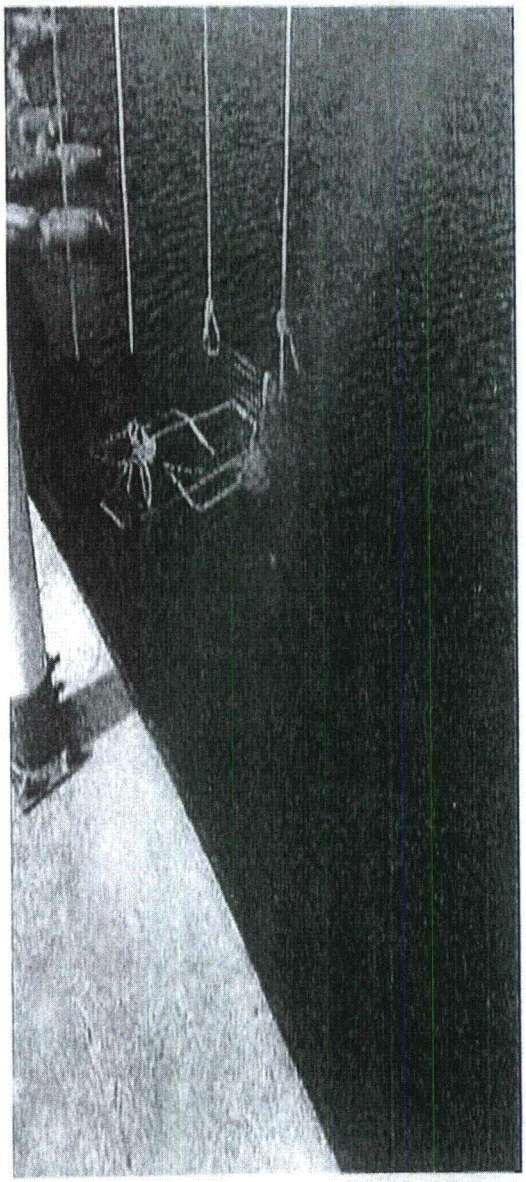
Monitoring Result (Seawater)

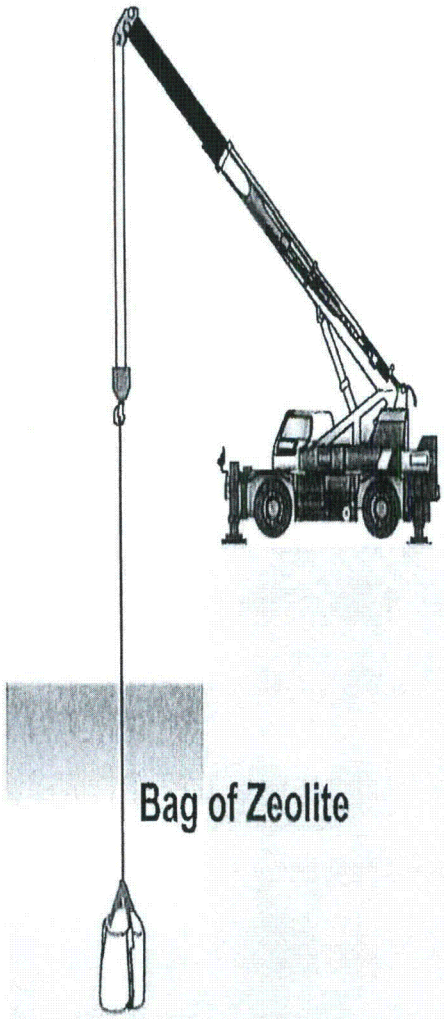
Radioactivity Concentration of seawater around the bar screen of Unit 2



Prevention of Radioactivity Diffusion into sea

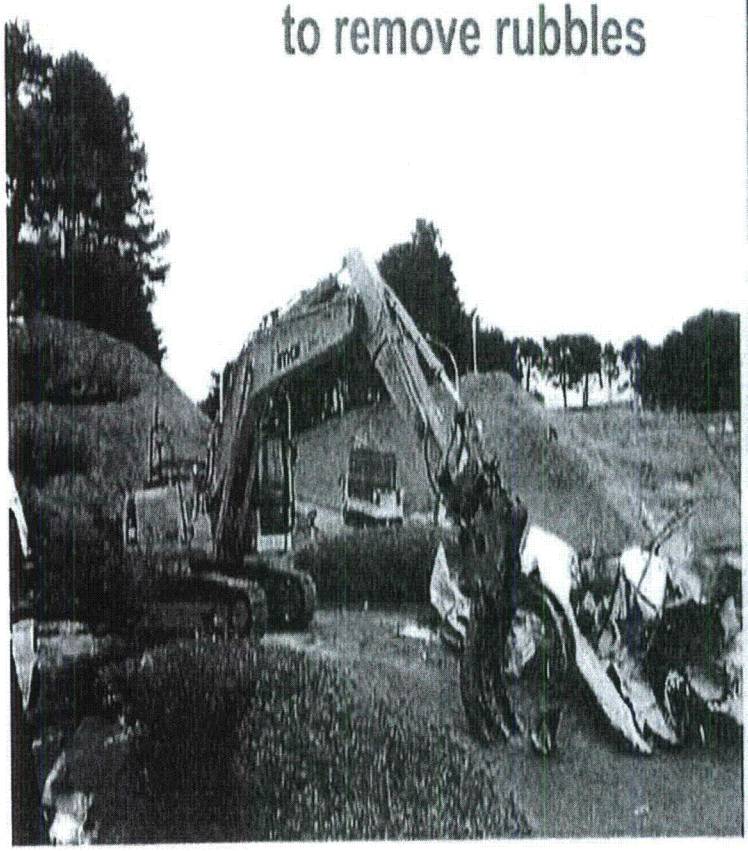
Bags of zeolite were placed in front of water intake screen to estimate absorption capability

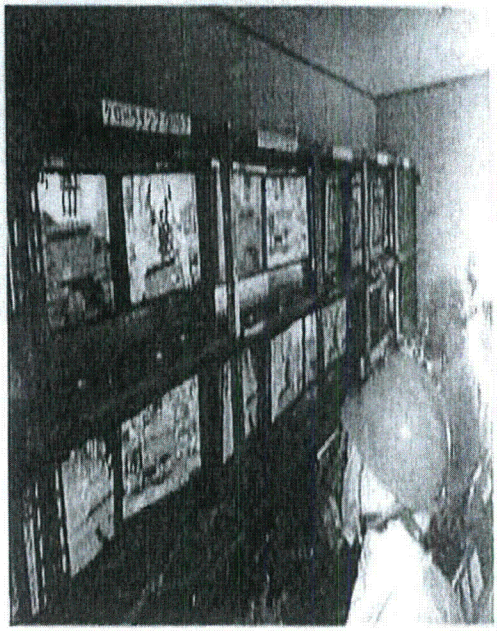




Remote-controlled Heavy Machinery

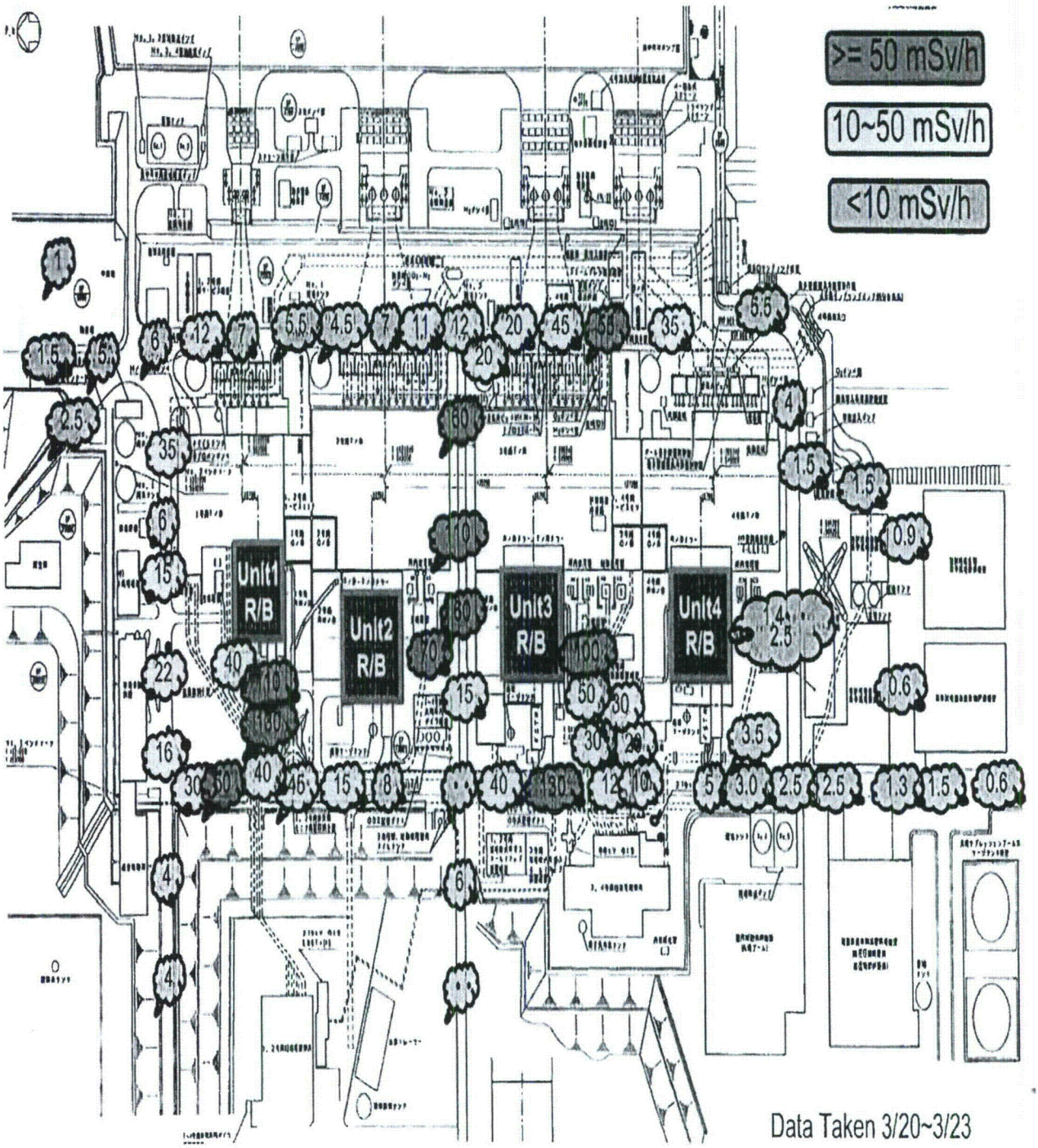
Unmanned excavator
to remove rubbles



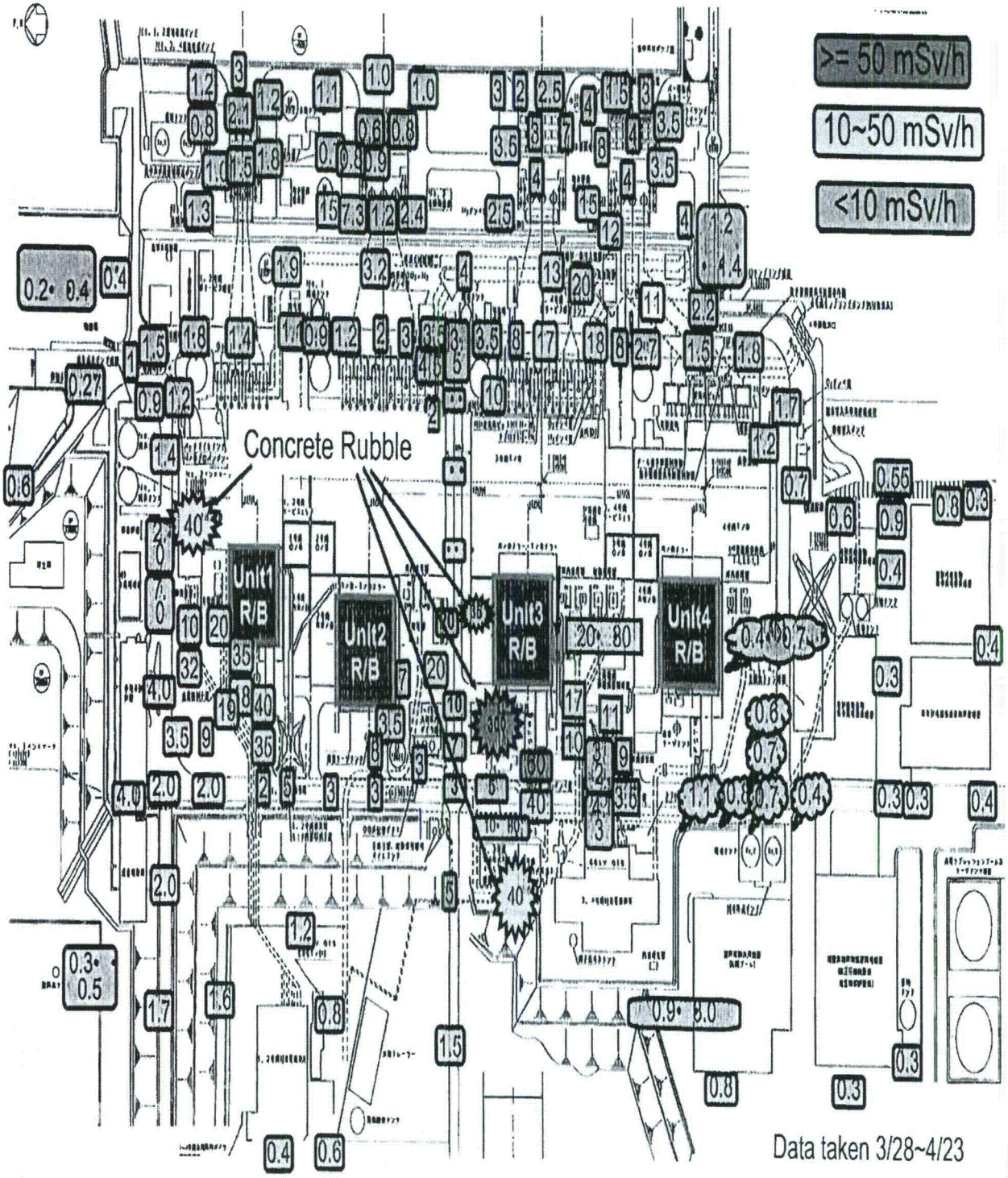


Operation
Console →

Radiation Survey Map (As of Mar.23 , 2011)



Radiation Survey Map (As of Apr.23 , 2011)

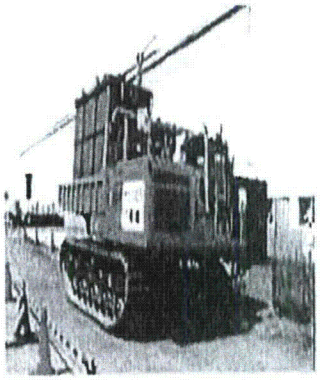


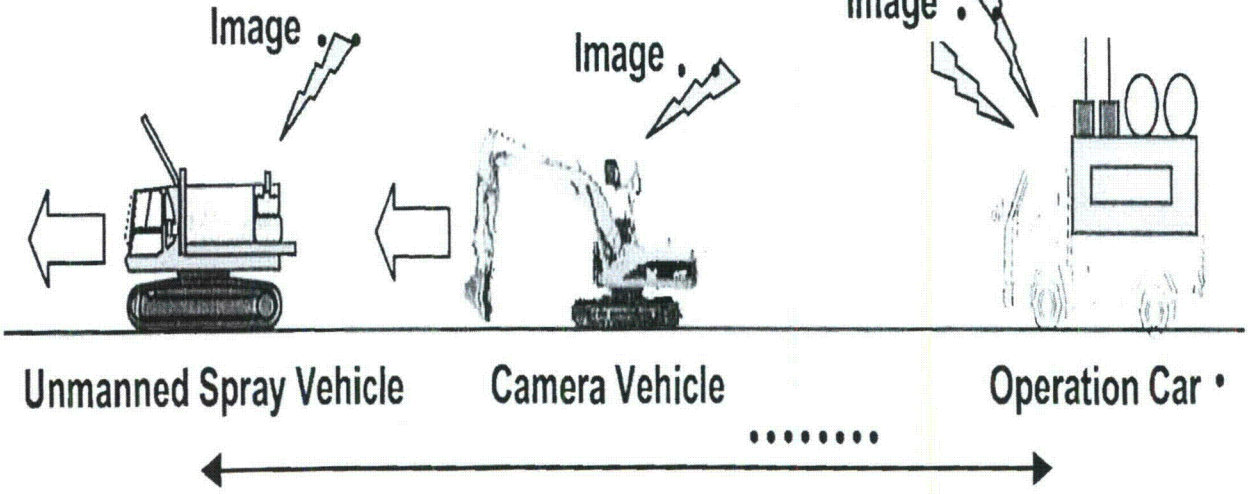
Prevention of Radioactivity Diffusion into Air

Synthetic resins have been sprayed onto the soil surface to prevent diffusion of radioactive material

Spraying by unmanned vehicle will have been conducted to cover 500,000m^3 area till the end of June

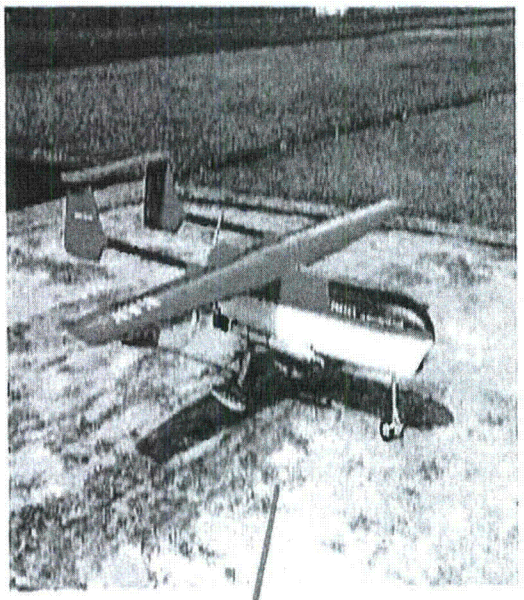
Trial Spraying





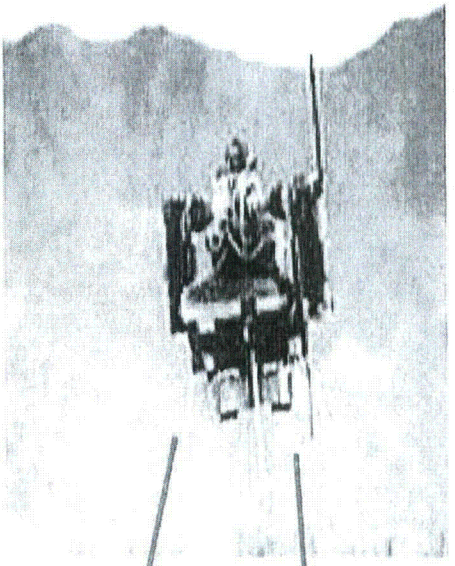
Visual Survey of Entire Site

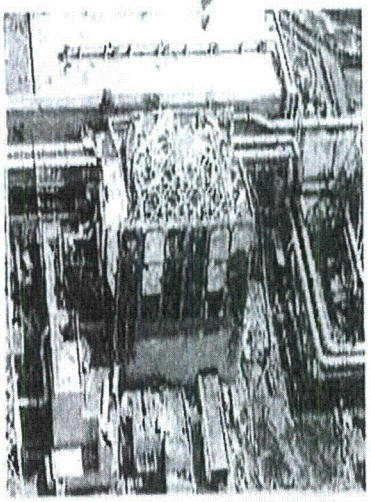
UAV (Unmanned Air Vehicle)



Unmanned Helicopter

T-Hawk (Honeywell)

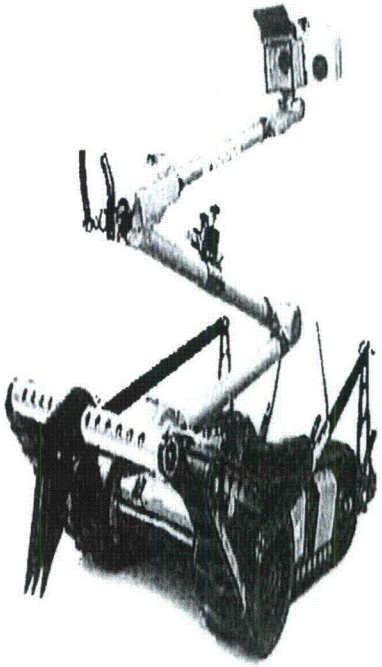


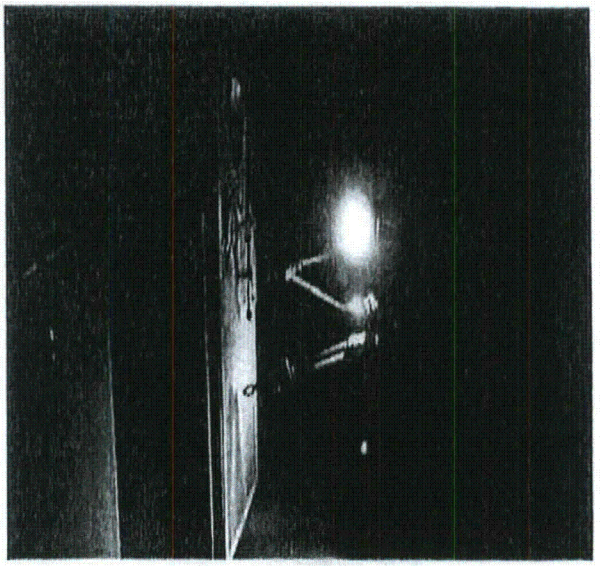


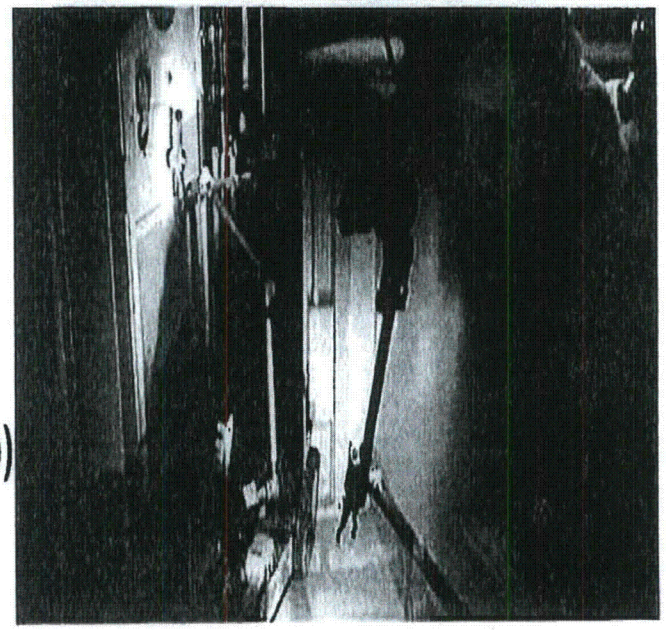
Robot Investigation of Reactor Building

Packbot

(courtesy of i-robot corporation)







Observed Dose Rate at R/B

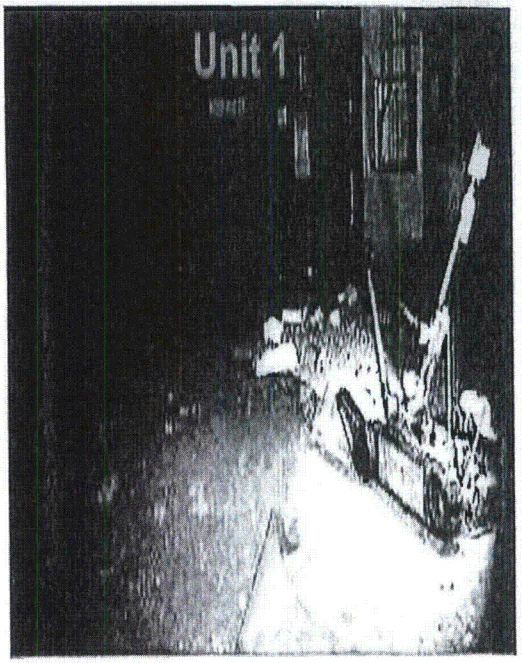
Unit 1: 10-49 mSv/h,

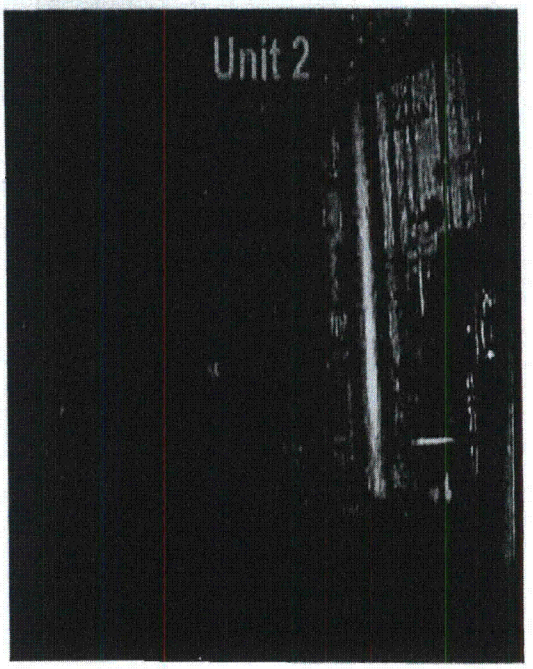
1120mSv/h (around SHC pp)

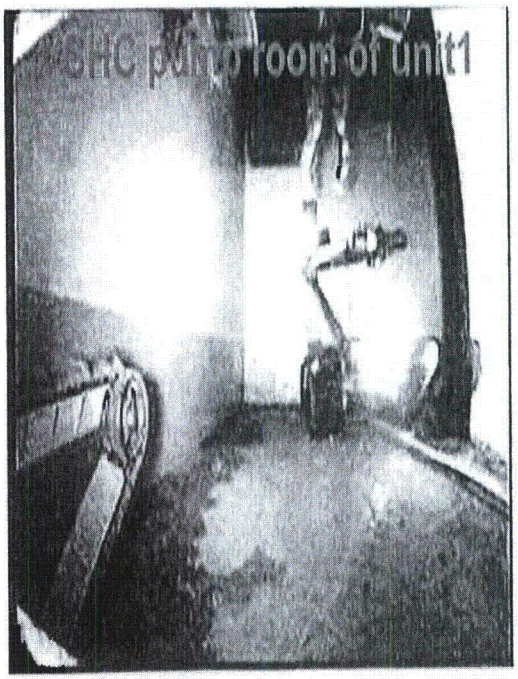
Unit 2: 4mSv/h

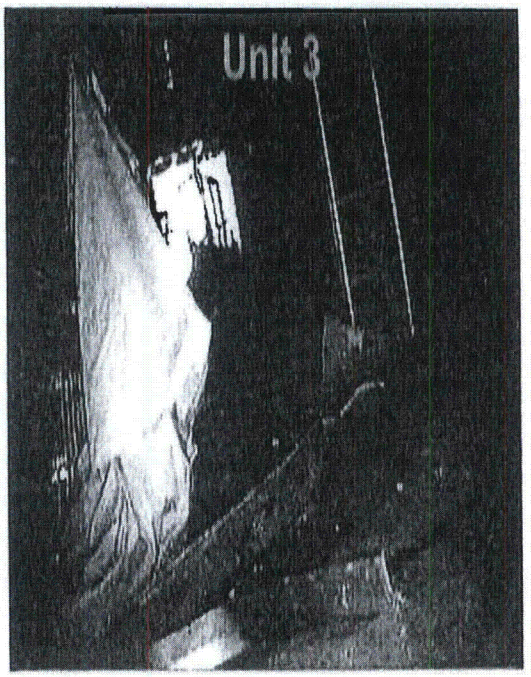
Unit 3: 28-57mSv/h

Inside Reactor Building

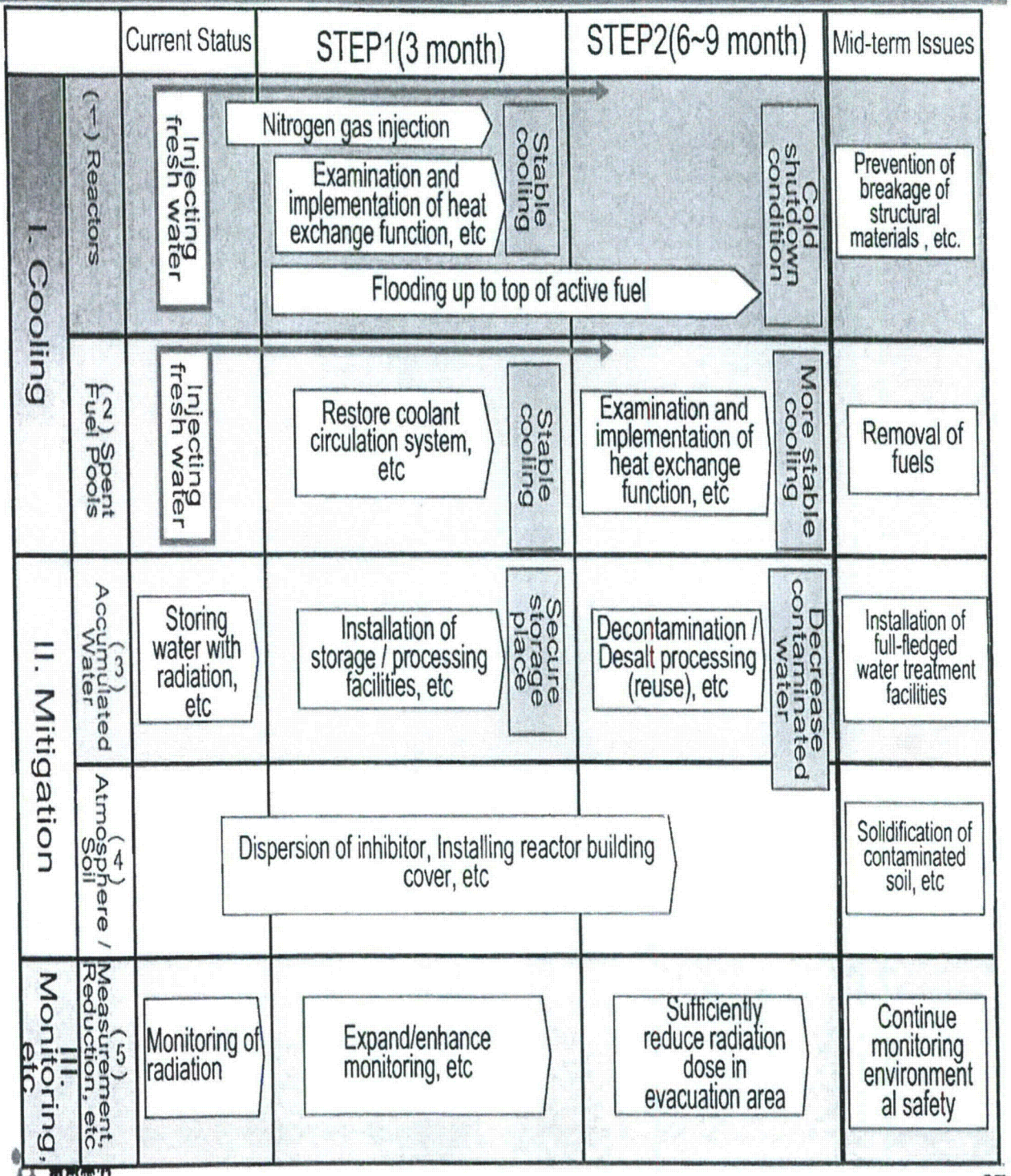








Roadmap for Immediate Actions (Apr.17)



東京電力

2. Organization for Emergency Response

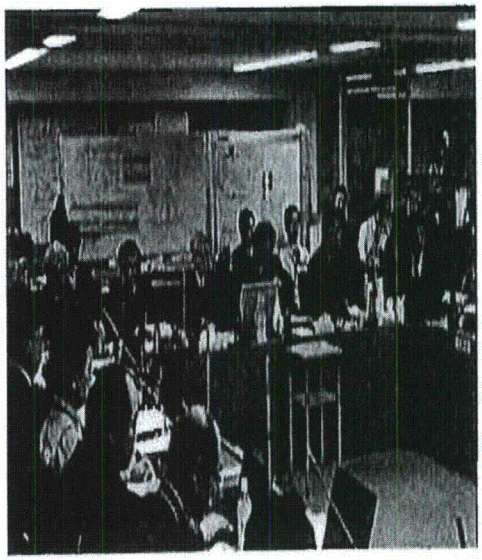
Consolidated Emergency Response Center

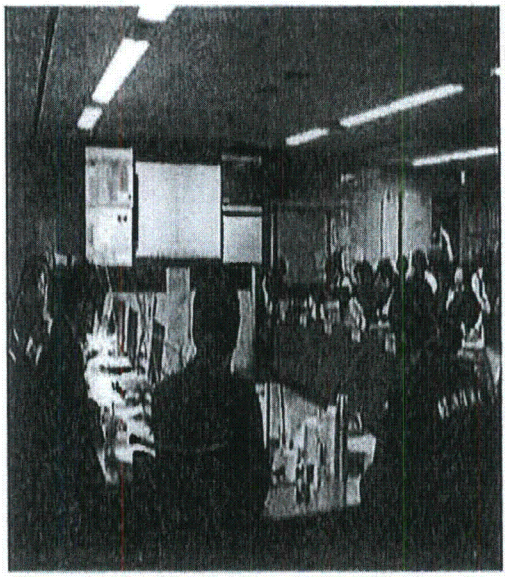
- Established on Mar.15 (4 days after quake) to facilitate crisis management
- Located at TEPCO corporate office
- Chief: Prime Minister of Japan

  Deputy Chief: Minister of Trade, Economy and Industry (METI)

  Chairman of TEPCO
- Other member includes liaisons from related ministries and organization:

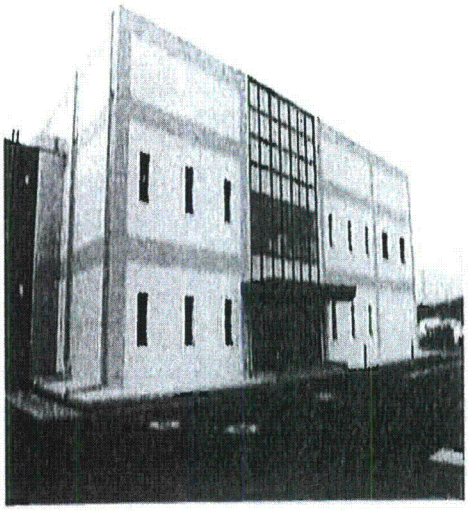
  Nuclear and Industrial Safety Agency (NISA), Ministry of Foreign Affairs (MOFA), Ministry of Defense, Prime Minister Office, Self Defense Force (SDF), Tokyo Fire Dept. etc





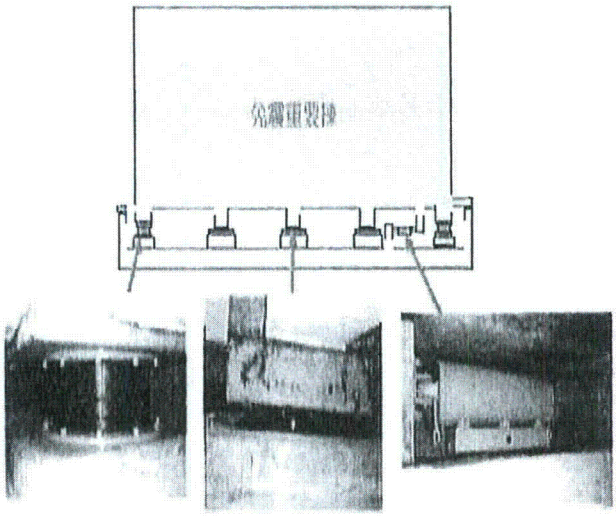
TEPCO Local Emergency Response Center

- •Designed based on experience of Kashiwazaki Kariwa Earthquake in 2007
- •Built with Base Isolated Structure.
- •Equipped with communication devices, teleconference system, etc.



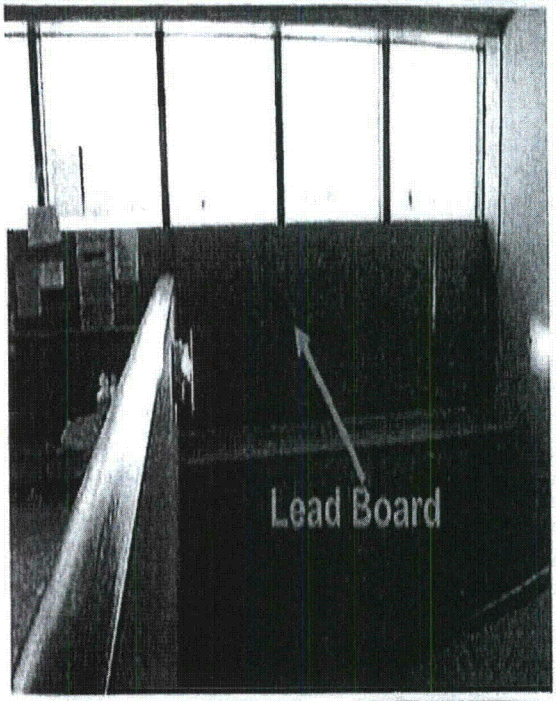
Total number of workers is about 1000-1200 per day

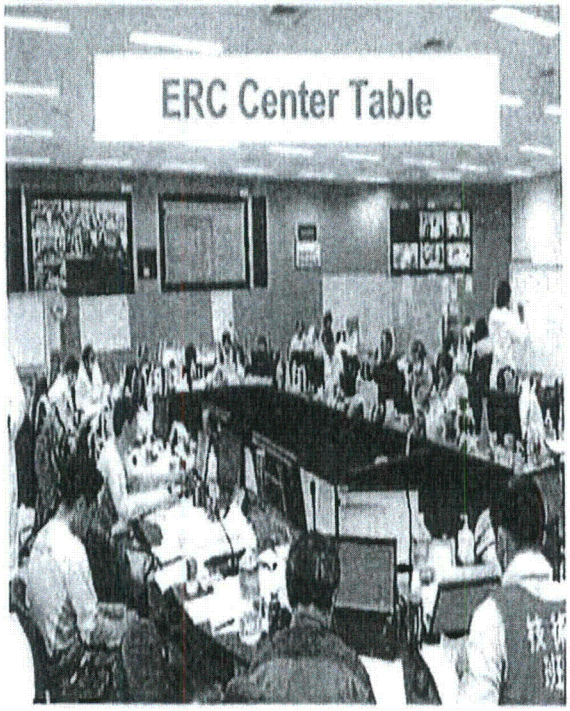
- **Base Isolated Structure**

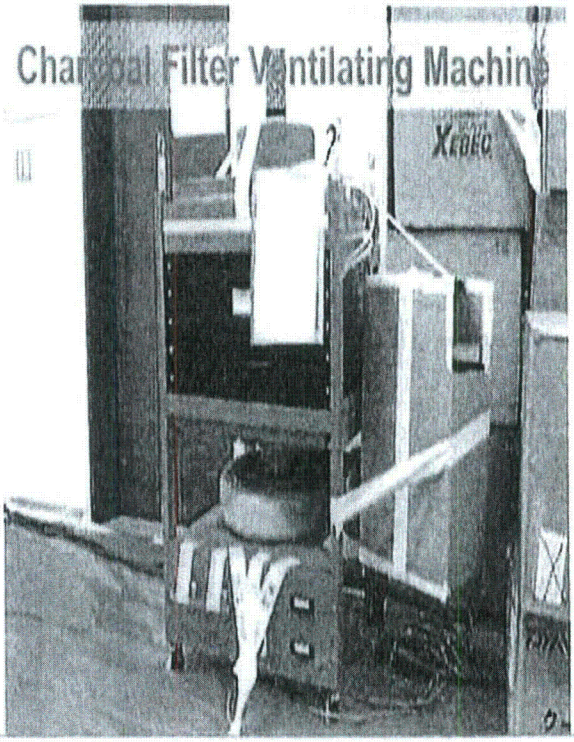


Laminated Rubber | Movable Bearing | Oil Dumper

Inside of TEPCO Local ERC



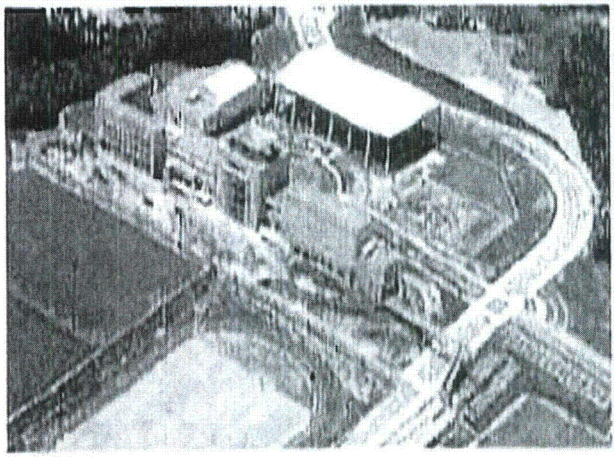


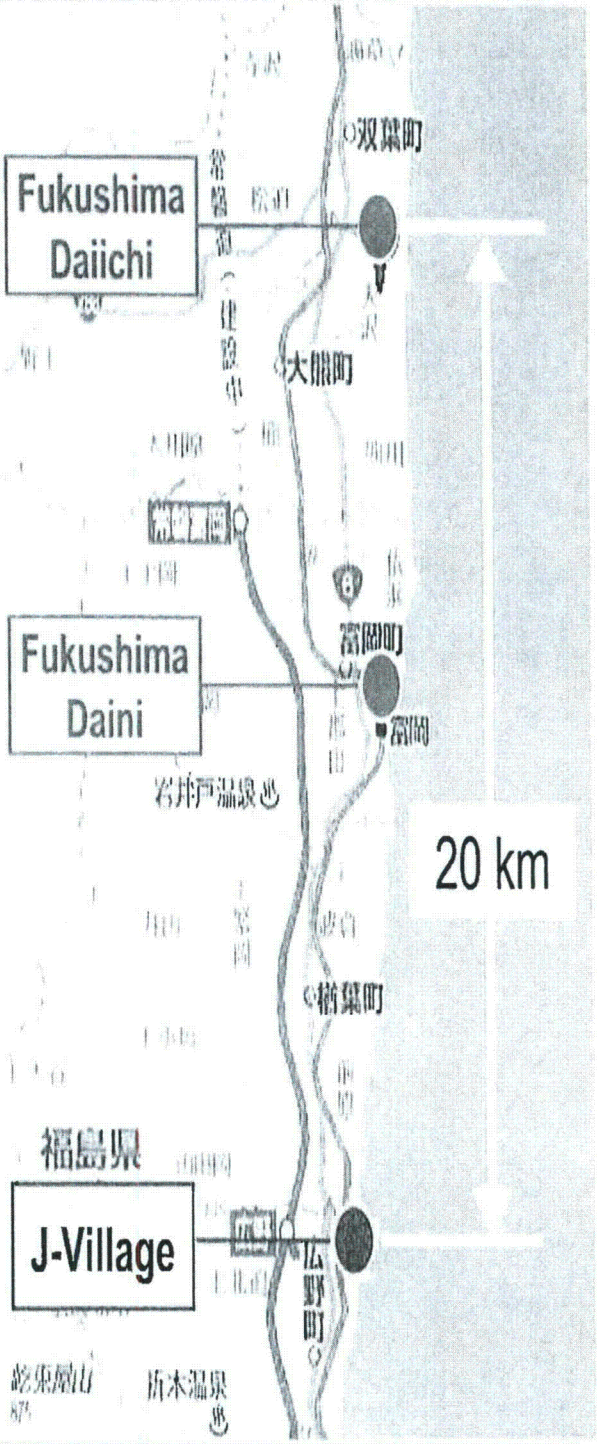


東京電力

Outline of J-Village

- Usually used as soccer field
- Base for recovery work and transportation
- Outpost for Self Defense Force and Fire Dept.
- Checkpoint for access to power plant
- Contamination checkpoint

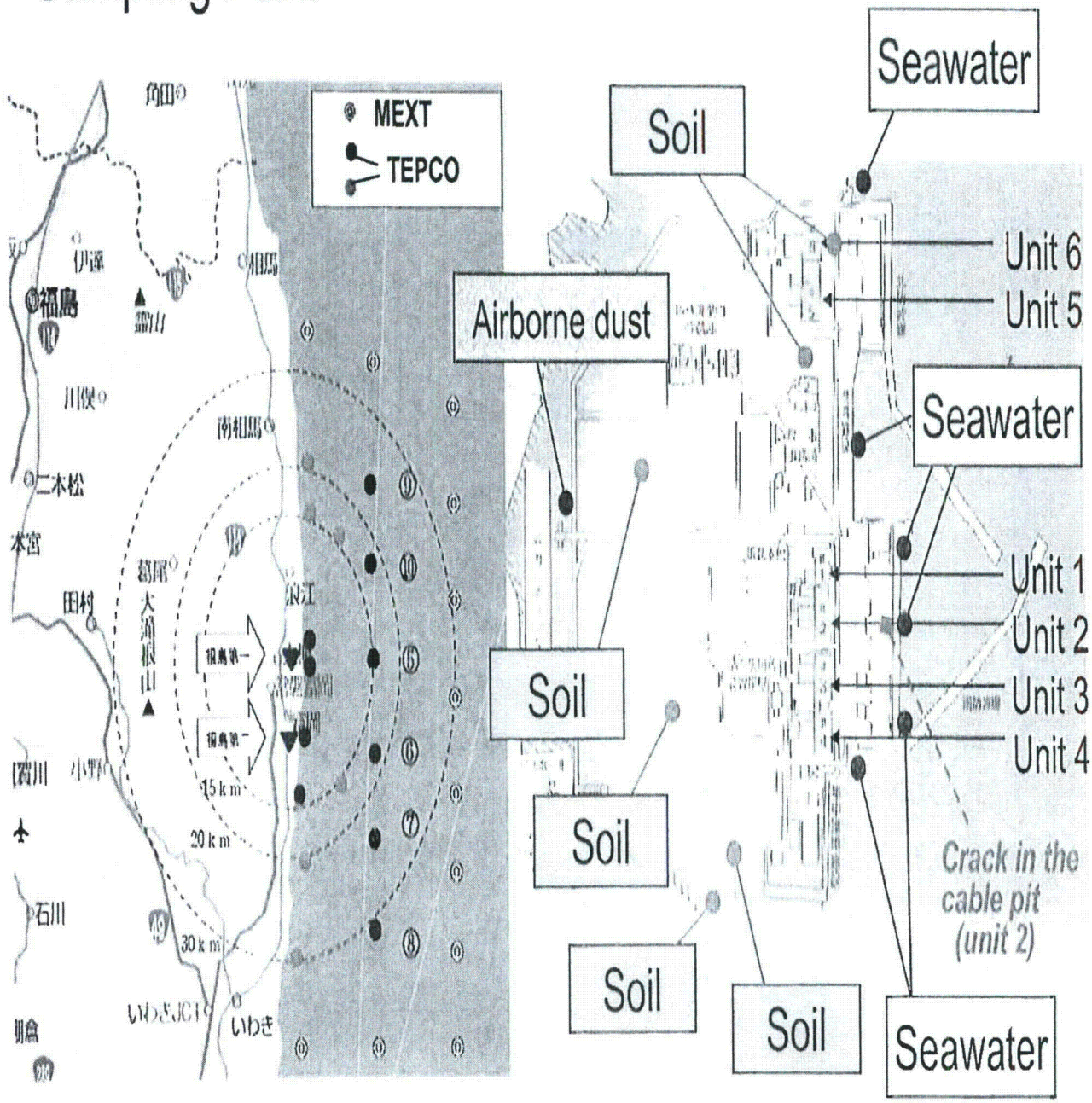




3. Environmental Impact

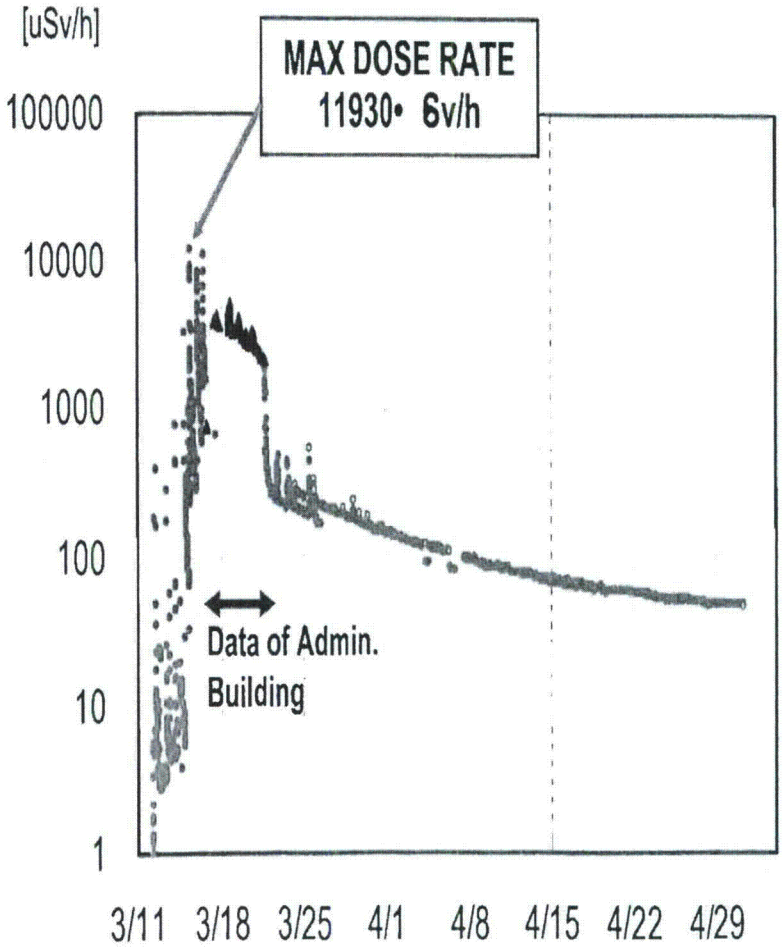
Radiation Monitoring

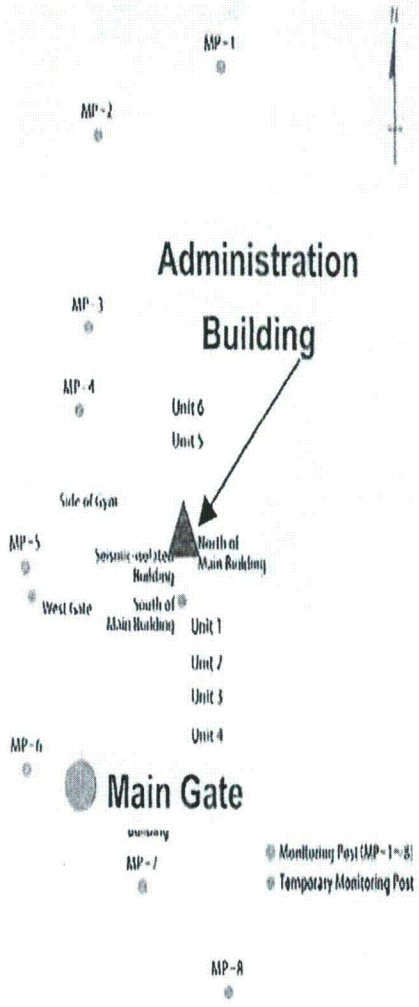
Sampling Point



Monitoring Result at Site Boundary

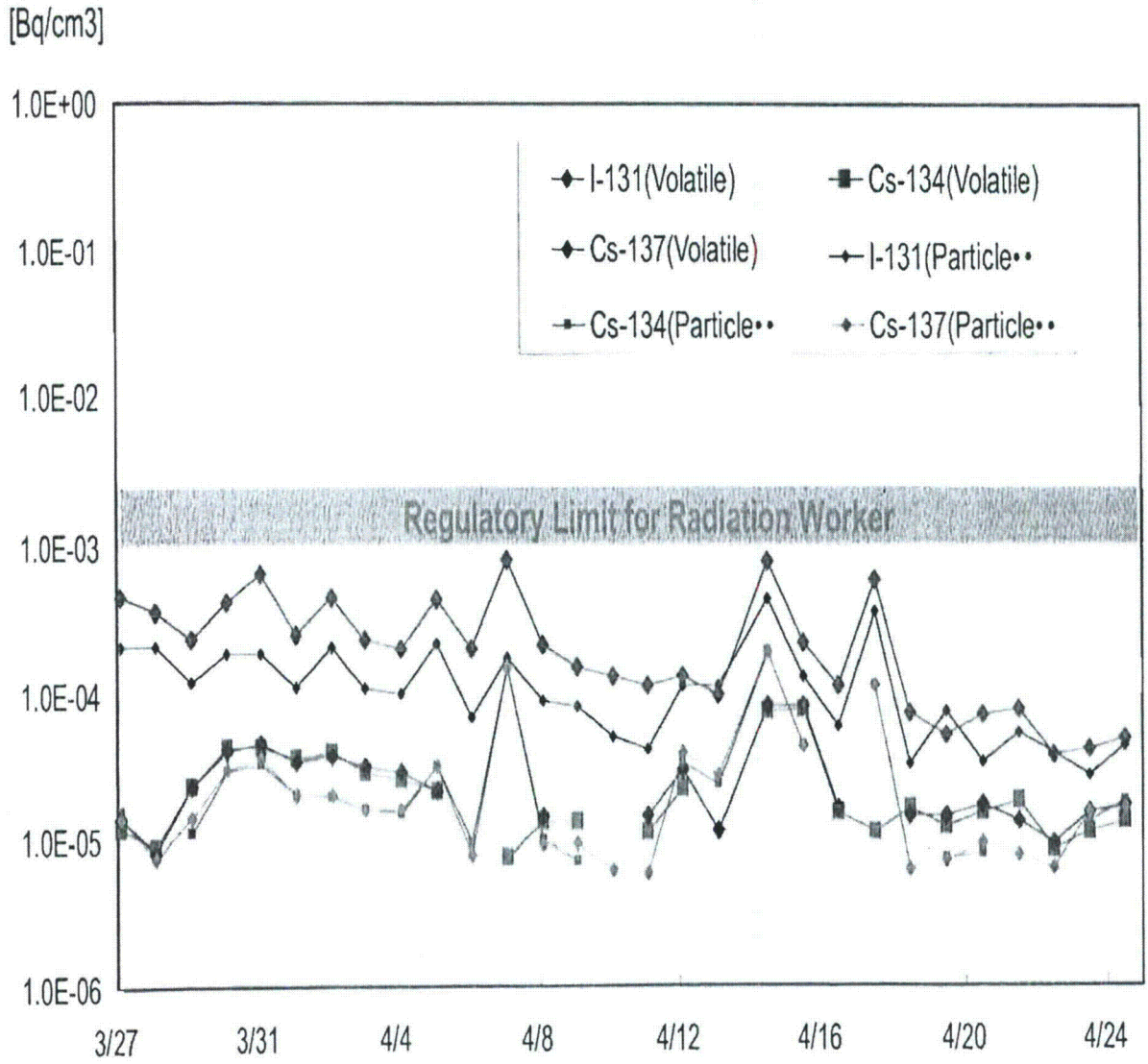
Dose rate (Main Gate)





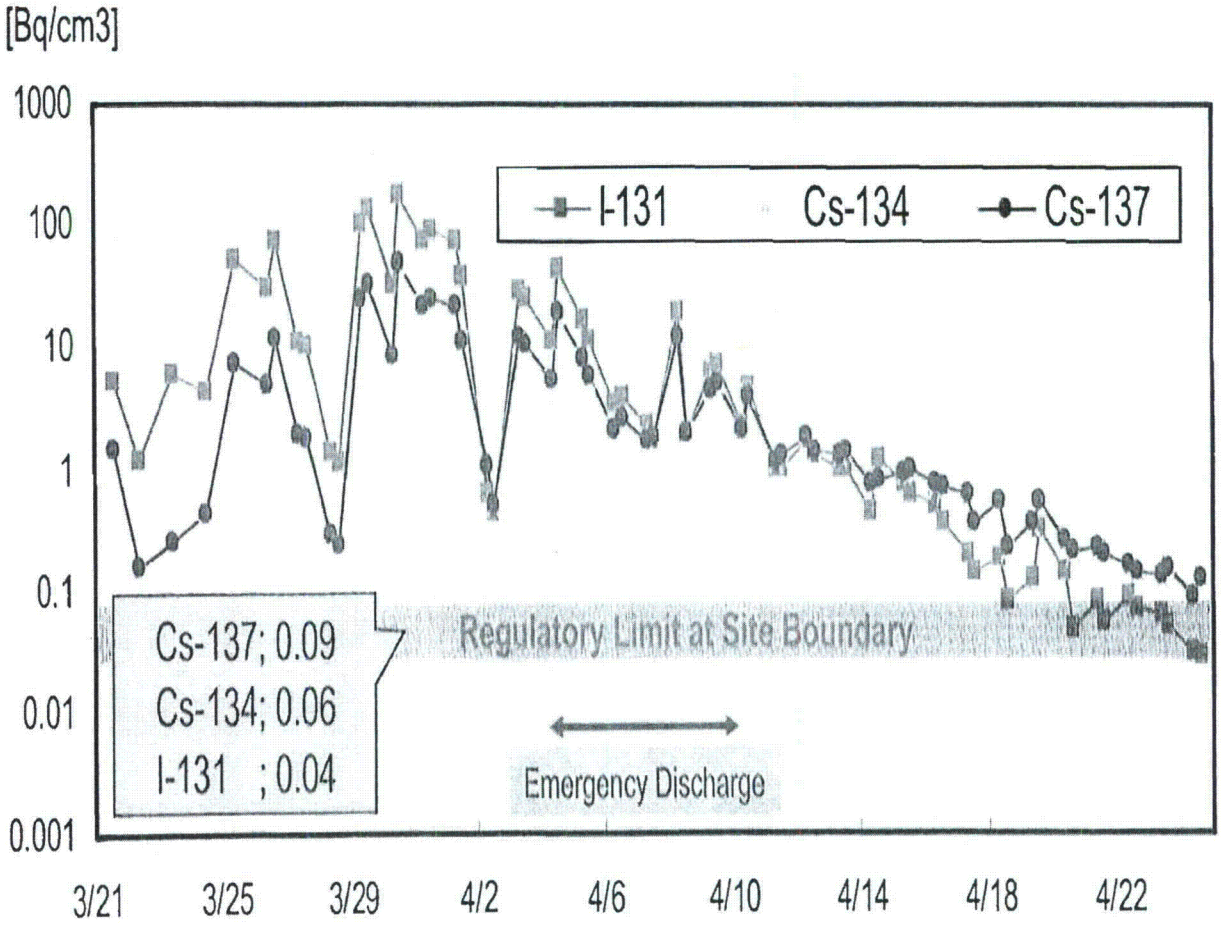
Monitoring Result (Airborne Dust)

Airborne Dust Nuclide Analysis (West Gate)



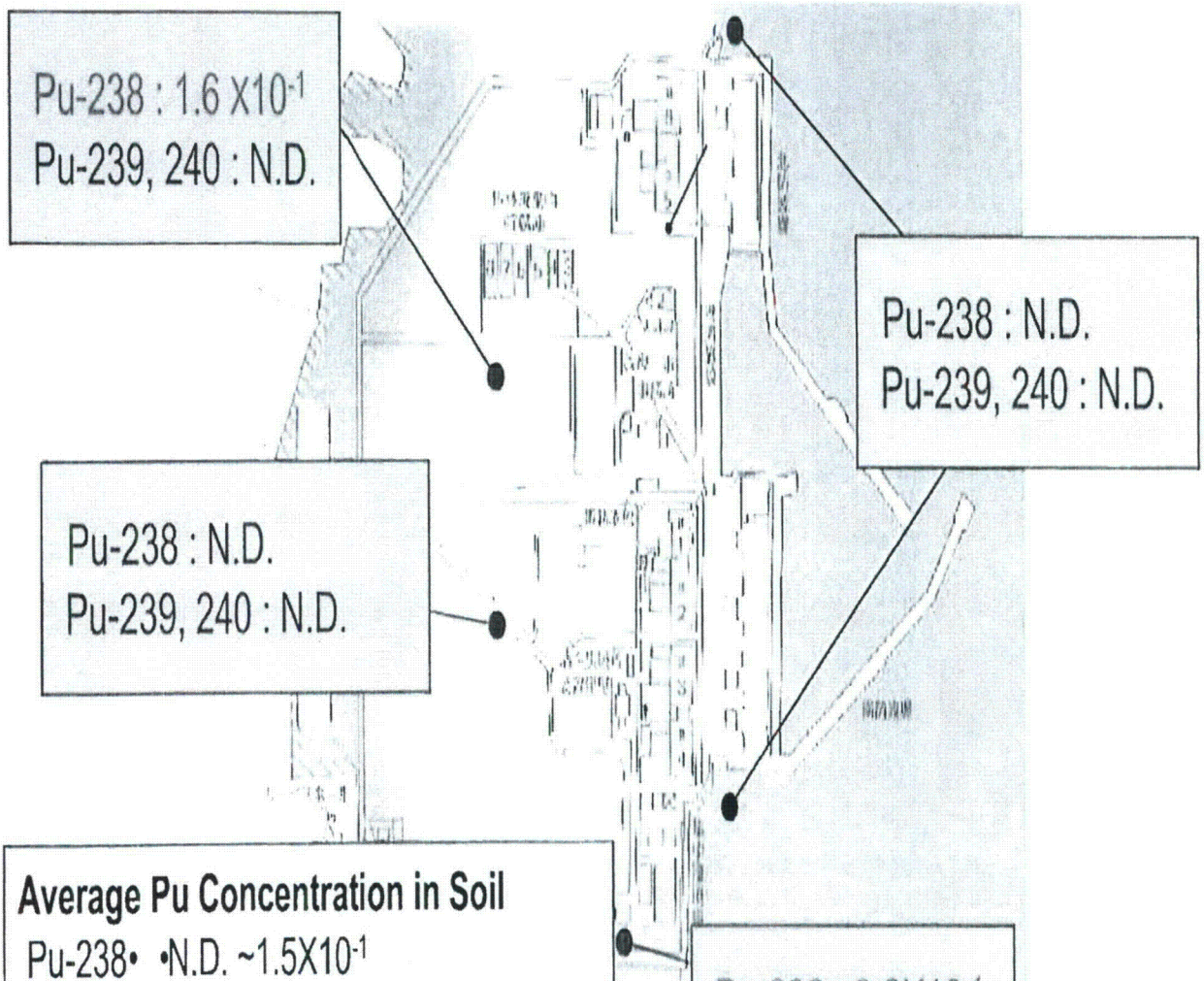
Monitoring Result (Seawater)

Radioactivity Concentration of seawater at the south of Unit 1-4 water discharge canal



Monitoring Result••Plutonium in Soil ••

Plutonium in Soil•Bq/kg•dry soil••



Average Pu Concentration in Soil

Pu-238• •N.D. ~1.5X10^{-1}

Pu-239, 240 : N.D.~4.5

- MEXT "Environmental Radiation Database" 1978~2008

Regulatory Dose Limit for Radiation Worker

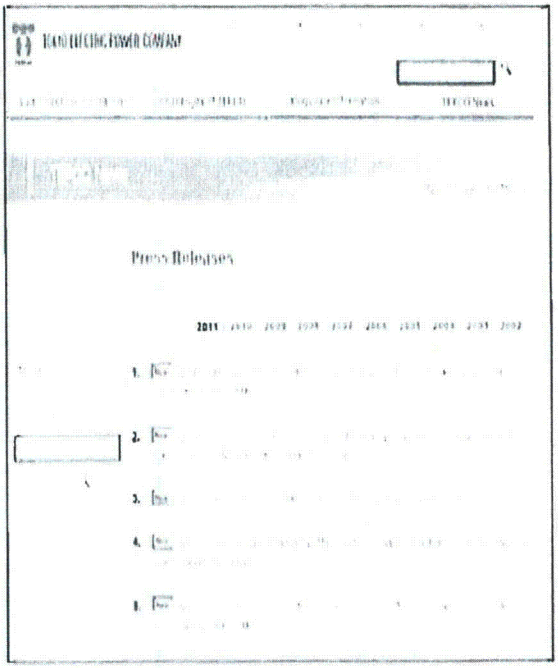
As of Apr.28, 2011

	Dose Limit	Number of workers exceeding limit
Normal Time	100mSv/5year 50mSv/year	• •
Emergency	100mSv	30 TEPCO 27 Contractor 3
Fukushima Accident (Special Measure)	250mSv	0

Quarterly dose for two female worker (17.55mSv, 7.49mSv) exceeded regulatory limit (5mSv).

Concluding Remarks

- We are now making utmost efforts to bring the situation under control with support from the society, related ministries, government and international organizations
- We are committed to sharing the lessons learned with the nuclear industry world wide, which we believe will contribute to the improvement of the safety of the nuclear power generation.
- We are going to keep you informed of any update in our English website.
  http://www.tepco.co.jp/en/index-e.html



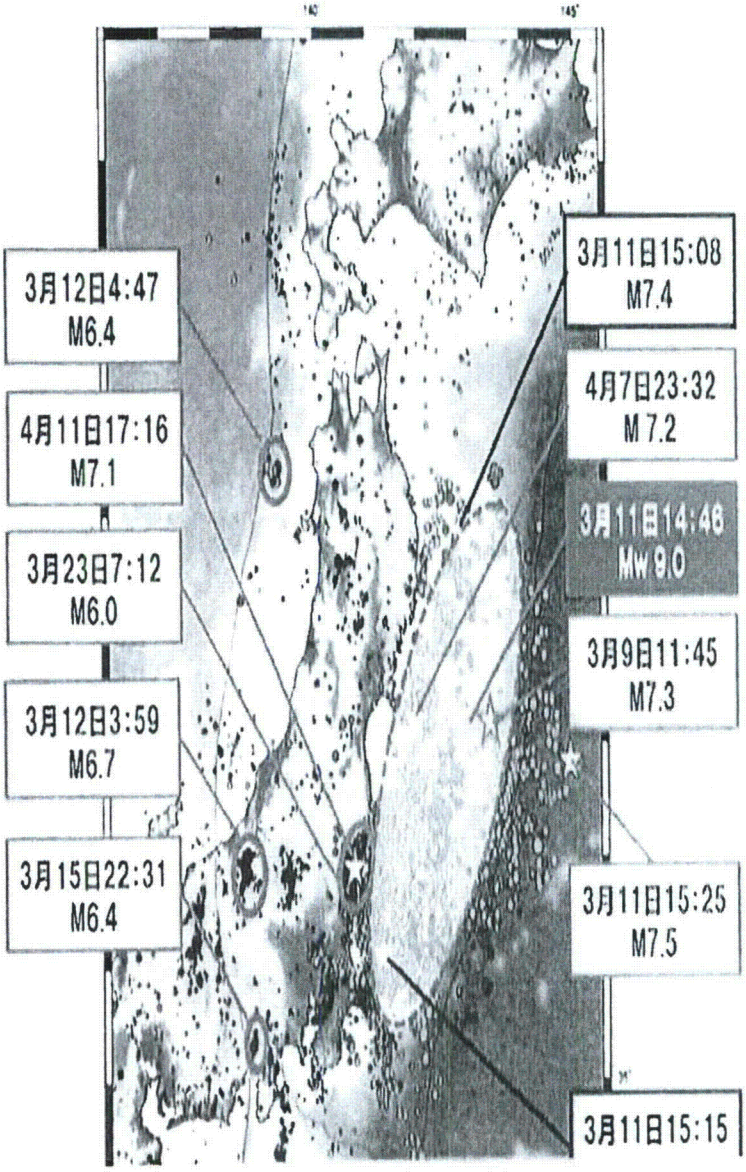
Fukushima Accident : An overview

Icapp2011, 3 May 2011 Akira OMOTO, University of Tokyo, JAPAN

[Note]

1. *The information contained here is preliminary and needs to be confirmed by the Accident Investigation Commission to be set up soon by the Government.*
2. *The views expressed here does not represent the official view by AEC nor U of Tokyo nor TEPCO.*

3.11 Earthquake and aftershocks



Statement by the Headquarter for Earthquake Research, *11March2011*

The Earthquake Research Committee evaluated earthquake motion and tsunami for the individual region off-shore of Miyagi prefecture, to the east off-shore south of Sanriku along the trench, and to the south off-shore of Ibaraki prefecture, but occurrence of the earthquake that is linked to all of these regions is "out of hypothesis".

[SOURCE]
http://www.jishin.go.jp/main/index-e.html The 2011 off the Pacific Coast of Tohoku Earthquake

http://outreach.eri.u-tokyo.ac.jp/eqvolc/201103_tohoku/eng/#mesonet
"Earthquake Research Institute, University of Tokyo, Prof. Takashi Furumura and Project Researcher Takuto Maeda"

3.11 Earthquake

Design basis earthquake and observed acceleration (Basement of Reactor/B)

Nr.	MWe	3.11 Observed (max. gal)			Design (Ss) (max. gal)		
		N-S	E-W	Vertical	N-S	E-W	Vertical
1Fuku1	460	460	447	258	487	489	412
1Fuku2	784	346	550	302	441	438	420
1Fuku3	784	322	507	231	449	441	429
1Fuku4	784	281	319	200	447	445	422
1Fuku5	784	311	548	256	452	452	427
1Fuku6	1100	298	444	244	445	448	415

Note 1: **Damage by the earthquake**: Not fully inspected but maybe not significant considering the KK earthquake (2007) where no damage to safety functions even though the observed acceleration exceeded design basis by factor 2-3 (Acceleration will not necessarily be damages indicators)

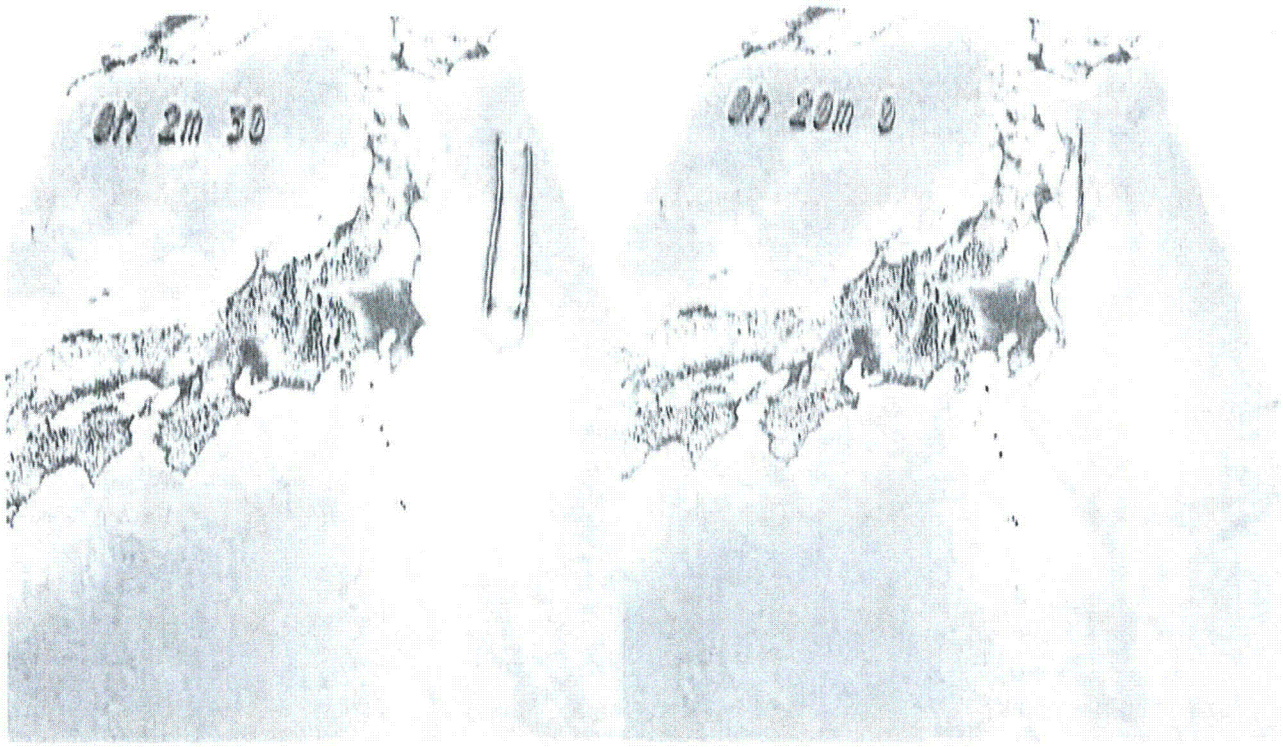
Note 2: **Scram set points** by acceleration (Basement of Reactor Building) Horizontal=135-150 gal, Vertical=100 gal

3.11 Tsunami

1F1-3 Plant response immediately after the earthquake

14.46 Earthquake followed by Reactor SCRAM, LOOP, EDGs start, IC/RCIC in operation

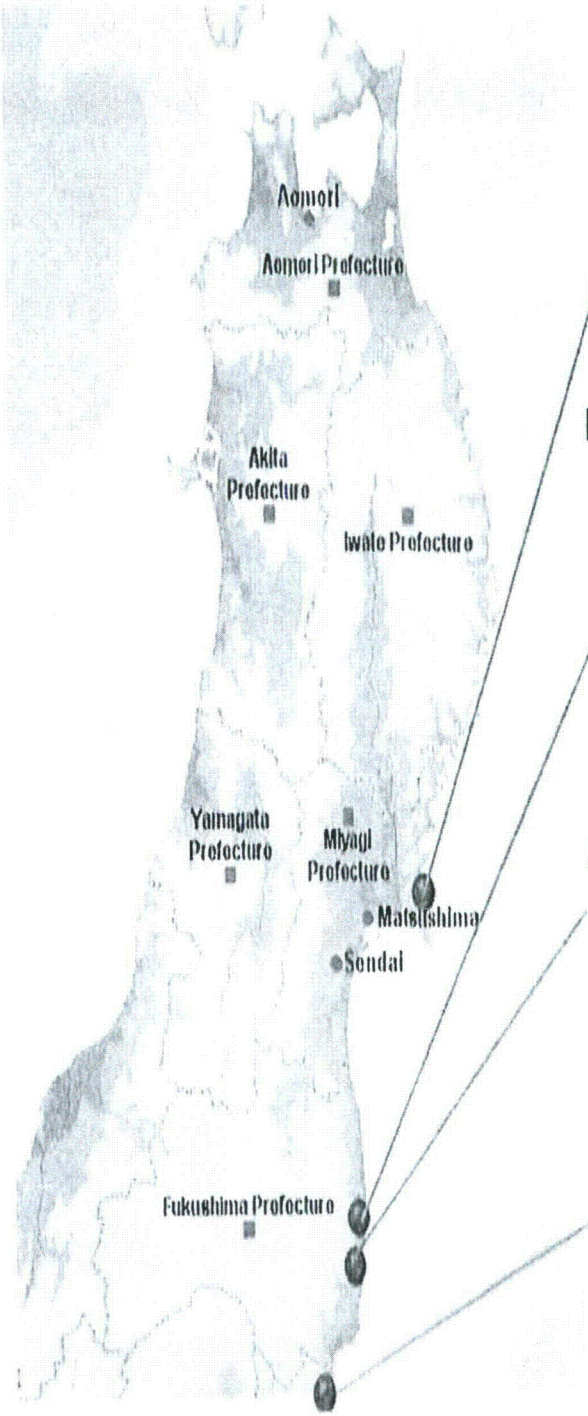
15.38-41 Tsunami followed by complete (AC/DC) blackout and (mostly) isolation from the Ultimate Heat Sink



http://outreach.eri.u-tokyo.ac.jp/eqvolc/201103_tohoku/eng/#mesonet

"Earthquake Research Institute, University of Tokyo, Prof. Takashi Furumura and Project Researcher Takuto Maeda"

14 NPPs along the coastal line affected by Tsunami



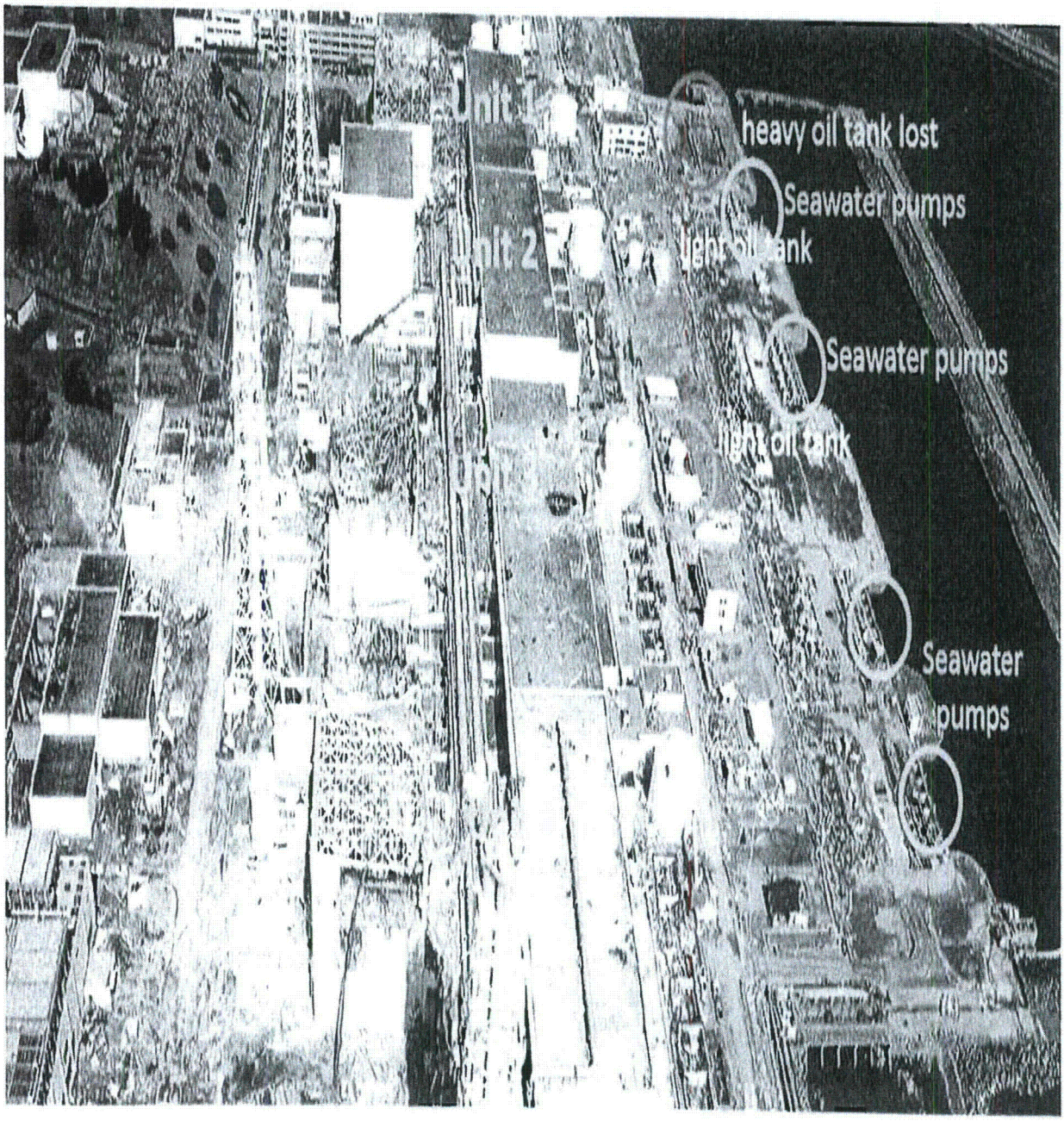
Onagawa
- Unit1: 524 MW, 1984-
- Unit2: 825 MW, 1995-
- Unit3: 825 MW, 2002-

Fukushima Ⅰ
- Unit1: 460 MW, 1971-
- Unit2: 784 MW, 1974-
- Unit3: 784 MW, 1976-
- Unit4: 784 MW, 1978-
- Unit5: 784 MW, 1978-
- Unit6: 1,100 MW, 1979-

Fukushima Ⅱ
- Unit1: 1,100 MW, 1982-
- Unit2: 1,100 MW, 1984-
- Unit3: 1,100 MW, 1985-
- Unit4: 1,100 MW, 1987-

Tokai Ⅱ (1,100 MW, 1978-)

Fukushima Dai-ichi Unit 1-4



Fuel damage or not ---- What made the difference?

(1) Elevation vs. Tsunami height

- Site ground level → saved Onagawa units
- Elevation of air intake/exhaust of EDG
- Location of EDG/EE room/battery

(2) Availability of power

- Offsite power → saved 2F site
- Air-cooled EDG coupled with the above 1) location/height
  → saved 1F6
  - Air-cooled EDG was added for 1F2,4,6 respectively in the 1990's as a part of SAM modifications.
- 1F3/5/6 battery located at a higher elevation, escaped flooding

(3) Implementation of AMG by using <u>then-available</u> resources
→ saved 1F5, SFPs (makeup water)

NOTE: Availability of UHS commensurate to decay heat level supports quick recovery but does not seem to be a decisive factor.

- 1F5/6 : Use of temporary seawater pump for RHR (units were in refueling outage)
- 2F4 : continued Rx water makeup under isolation from UHS until March 14th

Tsunami: NPP Design guidelines and probabilistic study

- ***Safety Design Guide (NSC) Nr. 2 [footnote]***
  - *"....Anticipated natural hazard includes flood, Tsunami ...."*
- ***Japan Society of Civil Engineers (JSCE) on Tsunami***
  - *Renewed concern over Tsunami by 1983, 1993 Tsunami experiences*
  - *2002 guidelines for NPPs from the Nuclear Civil Engineering Committee of JSCE*
    http://committees.jsce.or.jp/ceofnp/system/files/JSCE_Tsunami_060519.pdf

  1) Consideration of Tsunami sources along the plate boundary, uncertainty analysis and verification by the use of historical record;

  .... At the target site, the height of the design tsunami should exceed all the calculated historical tsunami heights.

  2) "....the design tsunami is compared with the historical records .... it is confirmed the height of the design tsunami that is obtained in this paper is twice that of historical tsunamis on an average"

  - *Modification in 2002 based on this guideline*
- ***Tsunami Probabilistic Hazard study***
  - *Probabilistic Tsunami hazard analysis (TEPCo, ICONE-14, 2006)*
  - *Methodology guide from JSCE Nuclear Civil Engineering Com. (2009)*
- ***IAEA DS417 (draft)***
  - *Includes guide on Tsunami analysis*

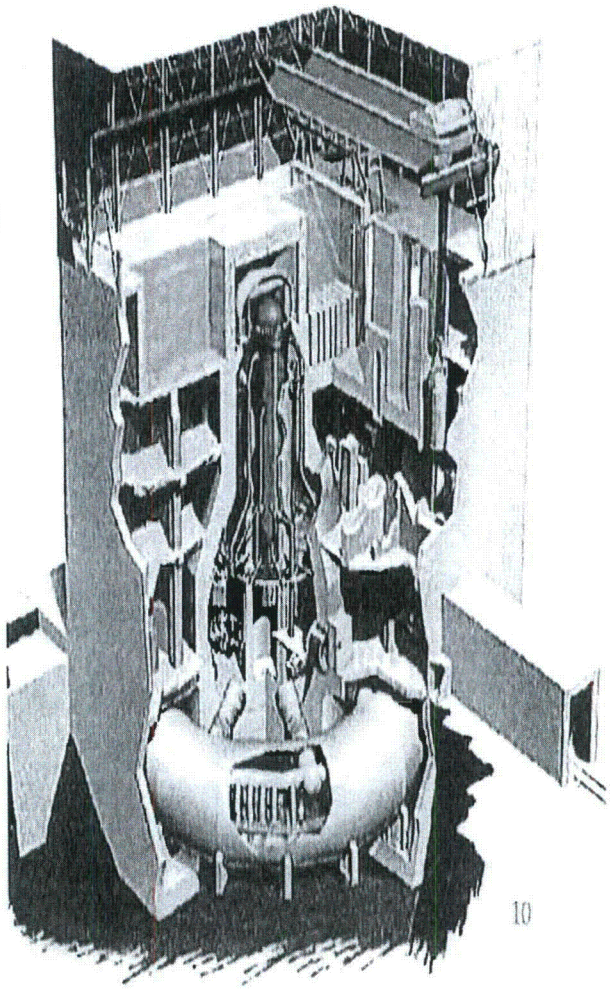
BWR/3,4 generation plant

BWR/3 (460MWe, 1Fuku1)

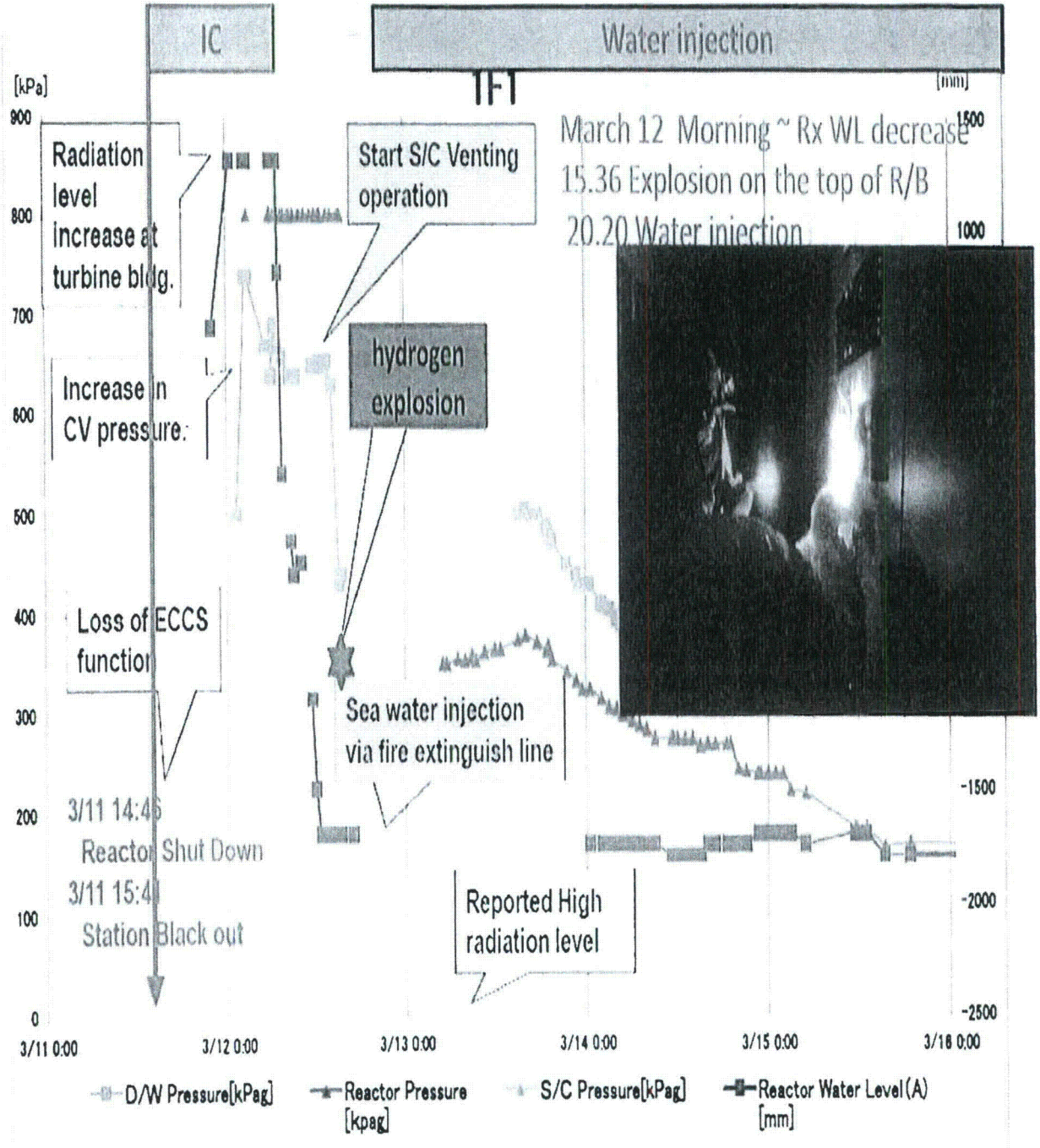
- Mark I Containment (Drywell + Torus-type Suppression Pool)
- SFP on top floor of the R/B
- Isolation condenser for passive core cooling (@Hi Pressure)
- Core Spray system (@Lo Pressure) after depressurization by SRV

BWR/4 (784MWe, 1Fuku 2,3,4 &5)

- Mark I Containment (Drywell + Torus-type Suppression Pool)
- SFP on top floor of the R/B
- RCIC (Reactor Core Isolation Cooling) & HPCI (High Pressure Core Injection) (@Hi Pressure)
- CS (Core Spray) & RHR/LPCI (@Lo Pressure) after depressurization by SRV

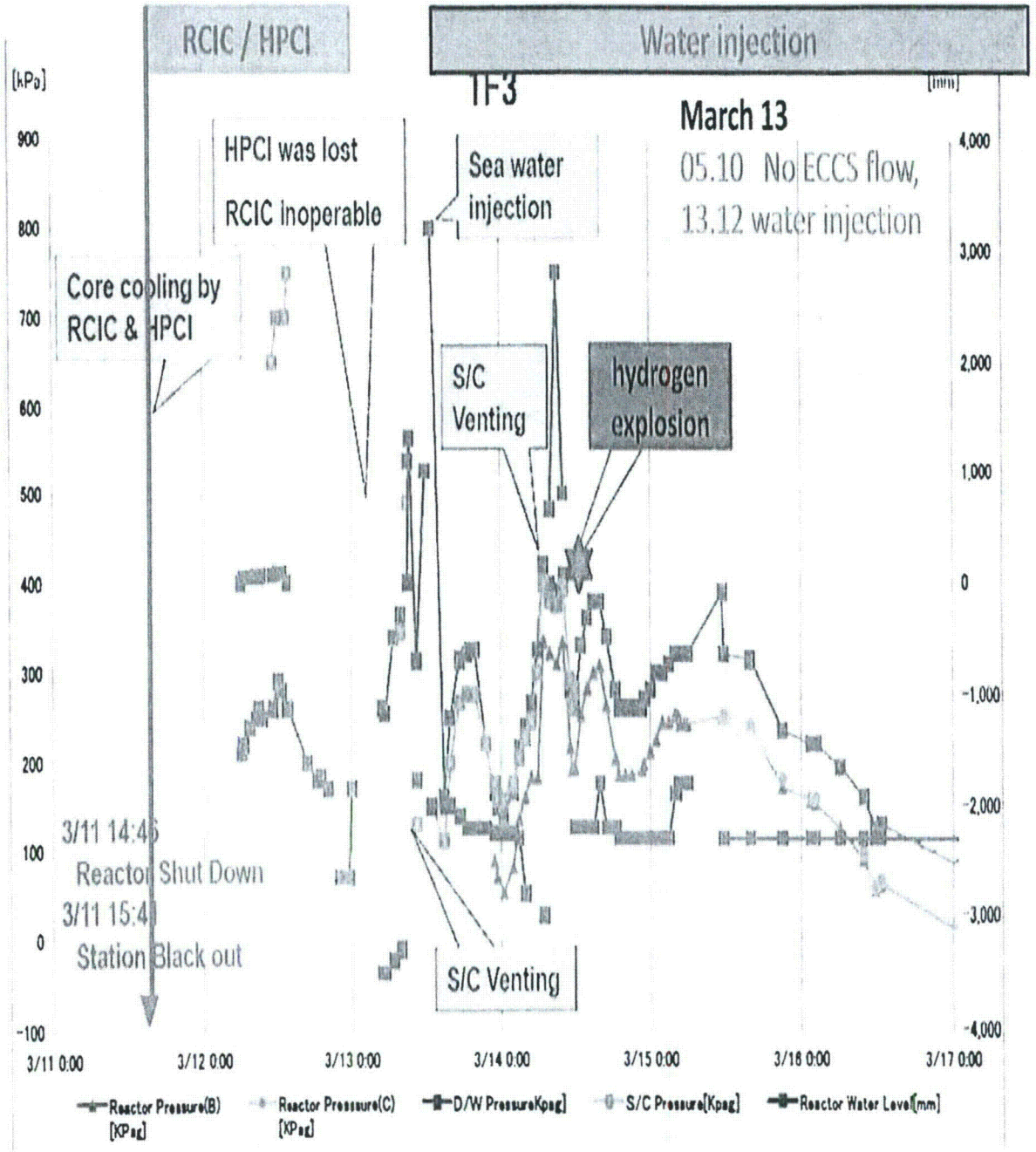


1Fuku1



[Based on NISA slide, IAEA Safety Convention Meeting, 2011April4]

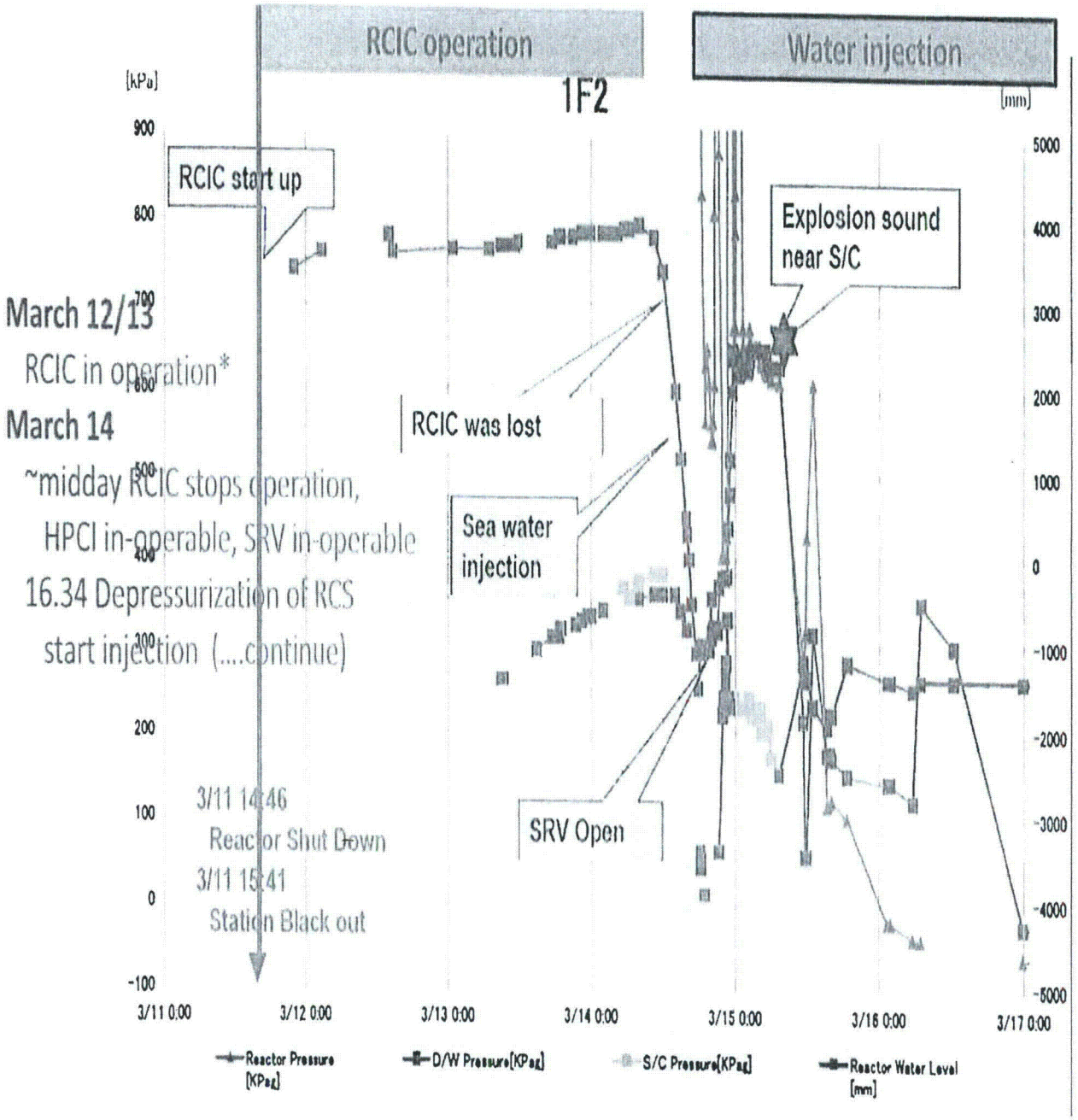
1Fuku3



12

[Based on NISA slide, IAEA Safety Convention Meeting, 2011April4]

1Fuku2

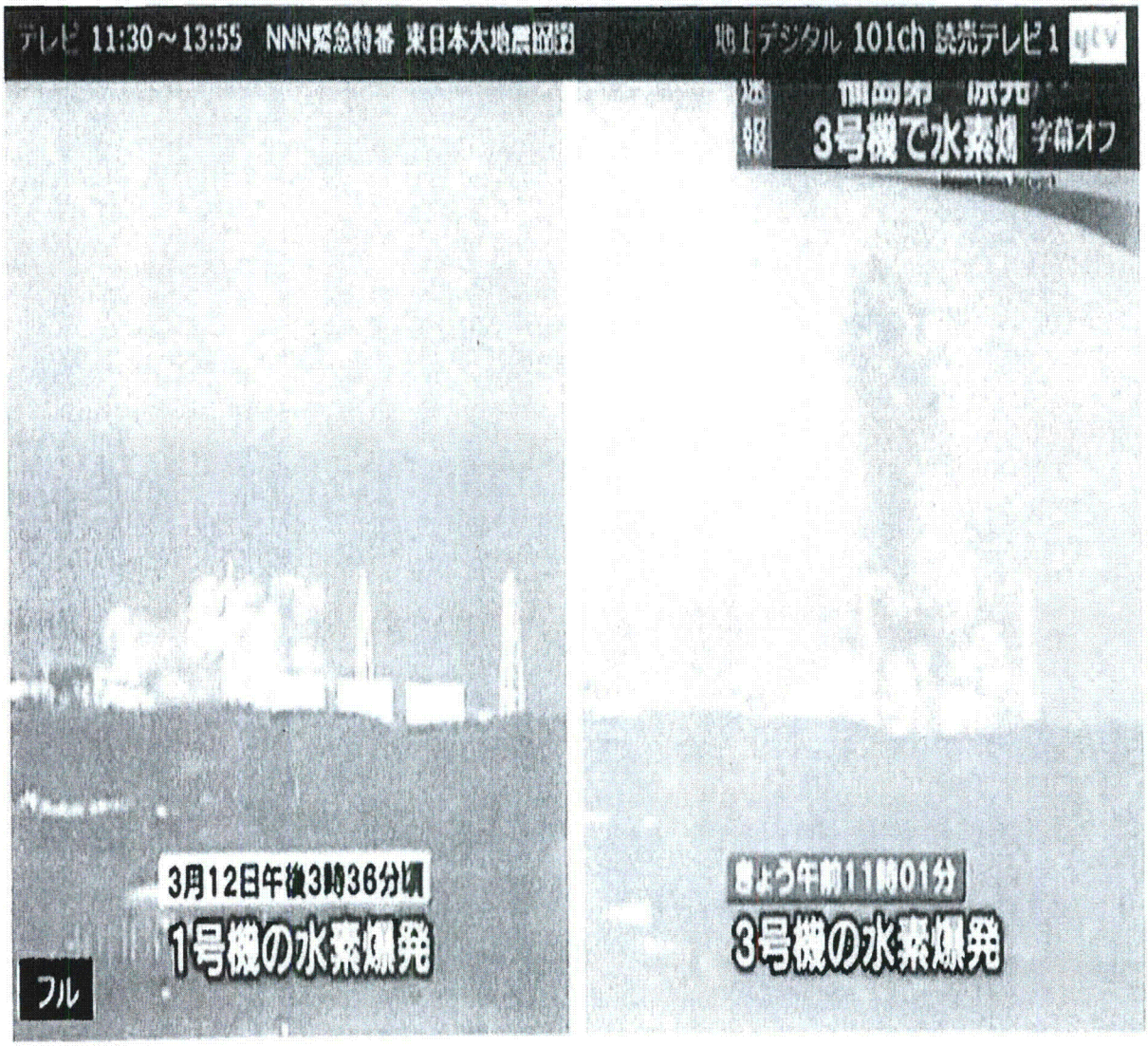


March 12/13
RCIC in operation*

March 14
~midday RCIC stops operation,
HPCI in-operable, SRV in-operable
16.34 Depressurization of RCS
start injection (....continue)

13

[Based on NISA slide, IAEA Safety Convention Meeting, 2011April4]

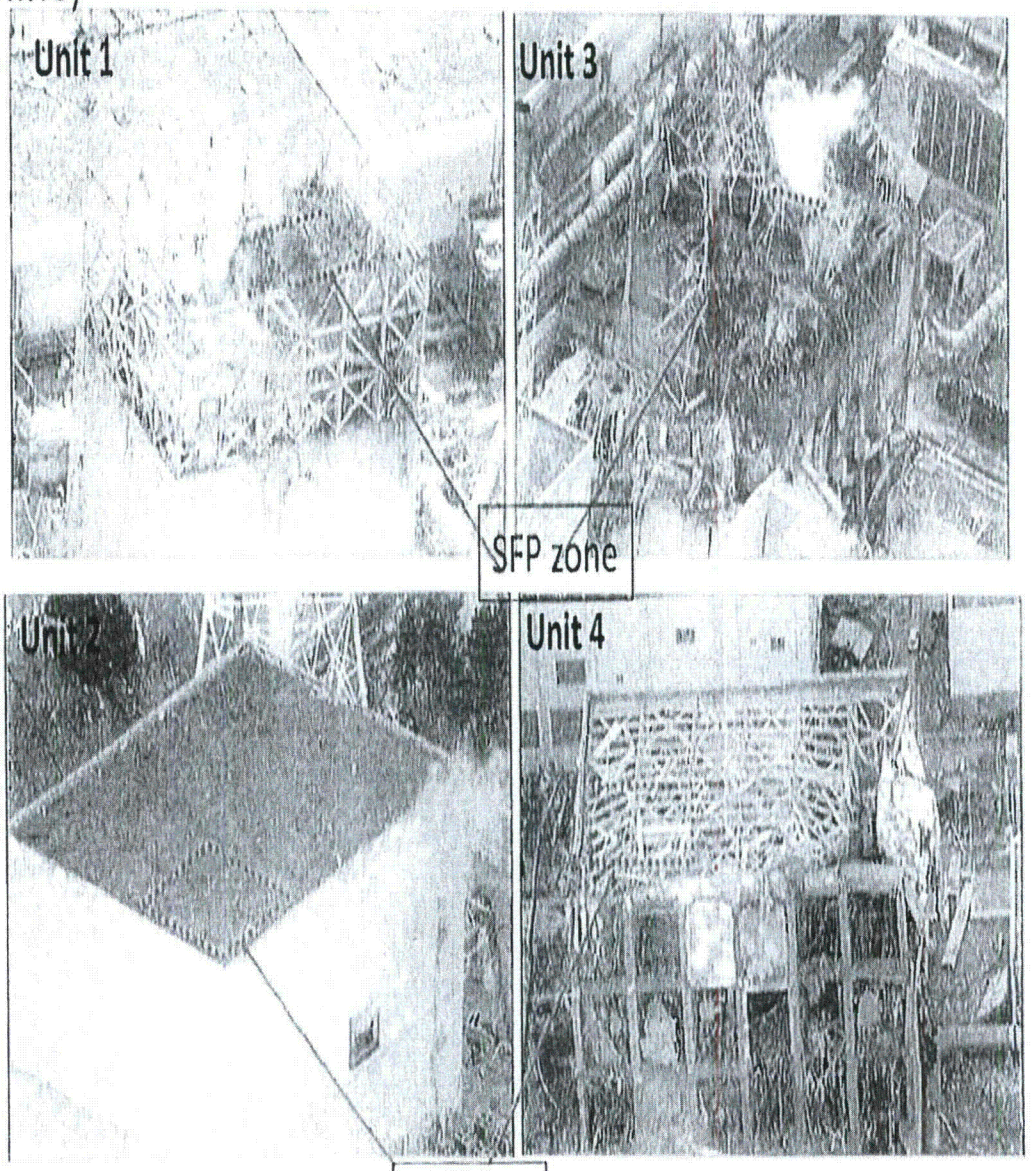

テレビ 11:30～13:55 NNN緊急特番 東日本大地震速報
地上デジタル 101ch 読売テレビ1
速報 3号機で水素爆 字幕オフ
3月12日午後3時36分頃
1号機の水素爆発
フル
あさう午前11時01分
3号機の水素爆発

Unit 1

Unit 3

Why H_2 explosion right after venting?

Possible Path 1 : Excessive leakage by over-pressure at CV flange/airlocks
Possible Path 2: Vent line→ SGTS→R/B (vent line merge with adjacent unit's line)

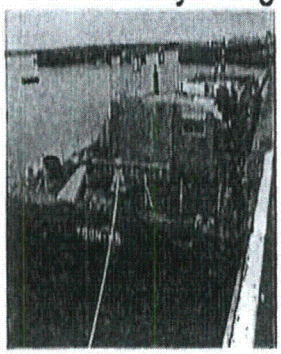


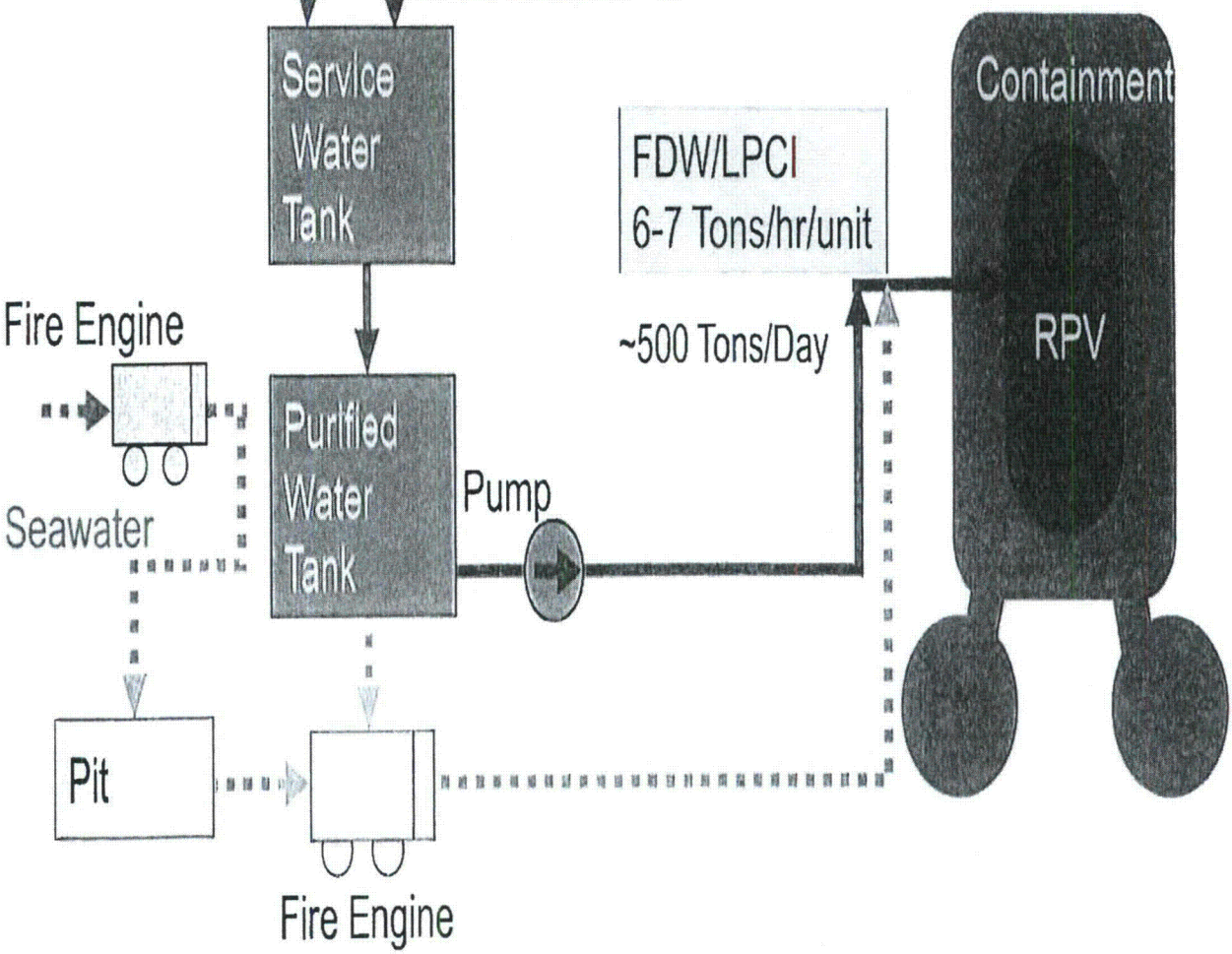
1F2 blowout panel opened by 1F3 blast, which released H_2

Water sample from SFP and photo indicate SFs in 1F4 most probably remain intact

Current : water Injection to the reactor core

Backup: Freshwater carried by Barge Ship (Courtesy of the US)



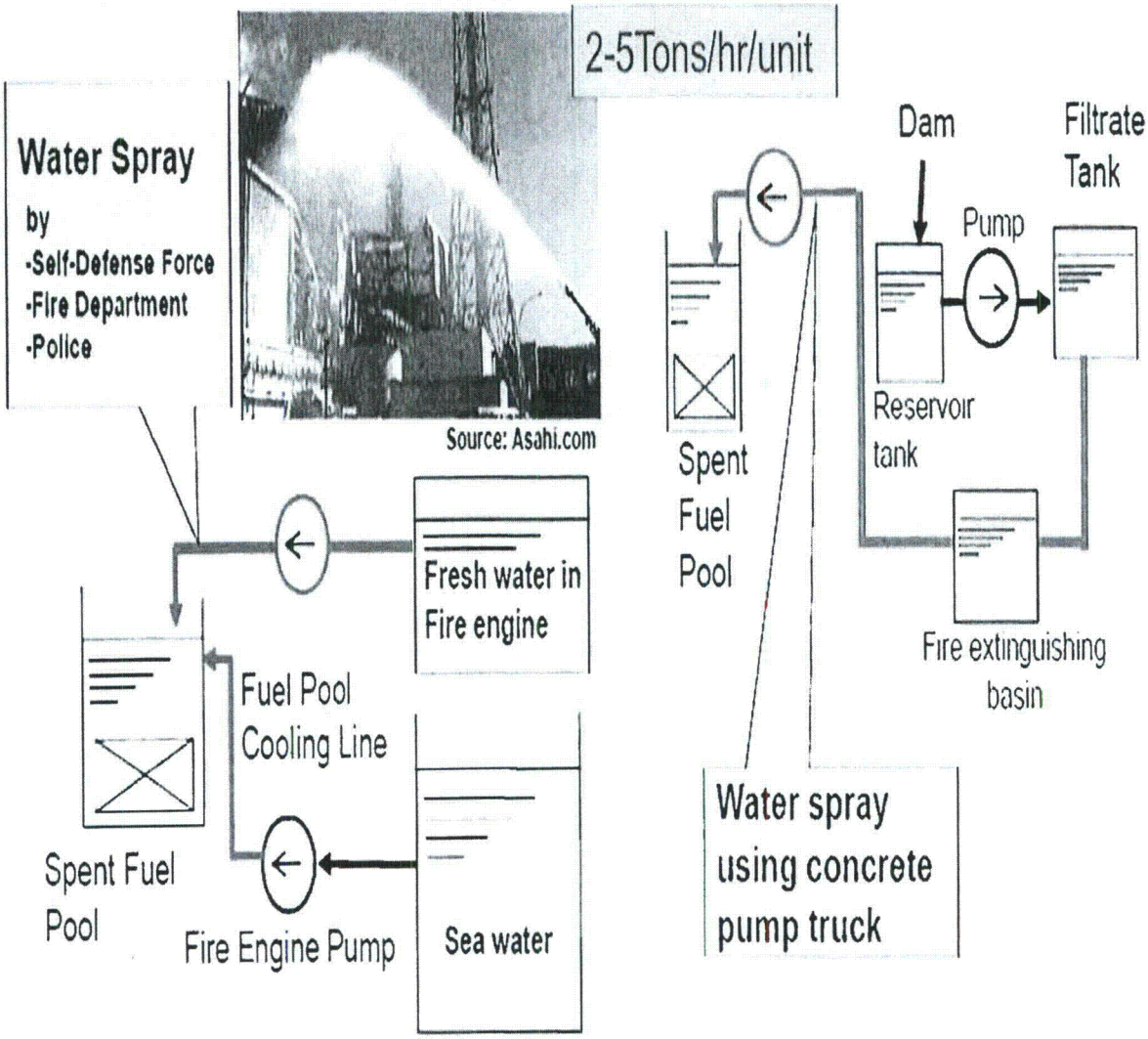


[SOURCE] NISA, IAEA Safety Convention Meeting, 2011April4

Current : Water Injection to SFP (Spent Fuel Pool)

【1st Stage】 Sea water injection

【2nd Stage】 Fresh water injection



1F1,3, 4: Similarly by occasional spray from above
1F2: Using FPC-MUW (w/o overhead spray)

17

[SOURCE] NISA, IAEA Safety Convention Meeting, 2011April4

Key near-term recovery actions

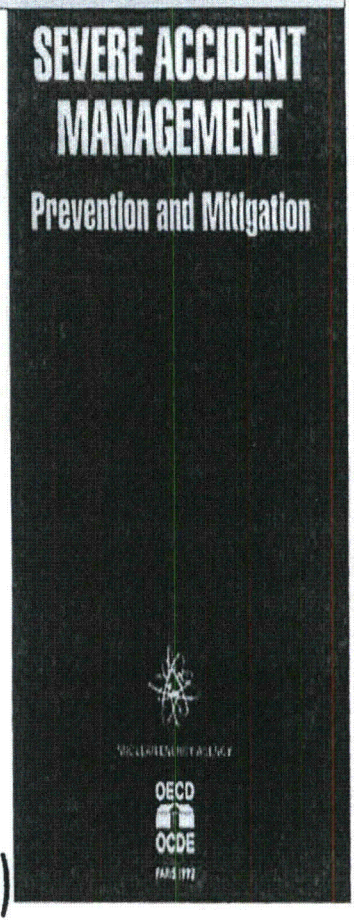
1. COOLING
   - ♦ Flooding the containment to a certain level & installation of heat exchanger to remove heat, *[challenge] working environment*
   - ♦ SFP cooling system (rather than spray and evaporation)

2. MINIMIZING AIRBORNE/LIQUID EFFLUENT
   - ♦ Recycling of water recovered from Tb/B through removal of radioactivity (France/US) and RO (Japan)
     ~1200 Tons/Day treatment
     ~500 Tons/Day treated water return to the reactors
   - ♦ Storage of contaminated water
   - ♦ Installation of R/B cover
   - ♦ Corrosion control (Deaeration of supply water, hydrazine)

3. MINIMIZING RESIDUAL RISKS
   - ♦ Aftershocks (Structural integrity of damaged R/B, Reliability of power/water supply)
   - ♦ Hydrogen

18

What SAM (Severe Accident Management) was in place?



(OECD/NEA)

In the aftermath of Chernobyl, OECD/NEA organized a series of meetings by SESAM (Senior Expert for Severe Accident Management)

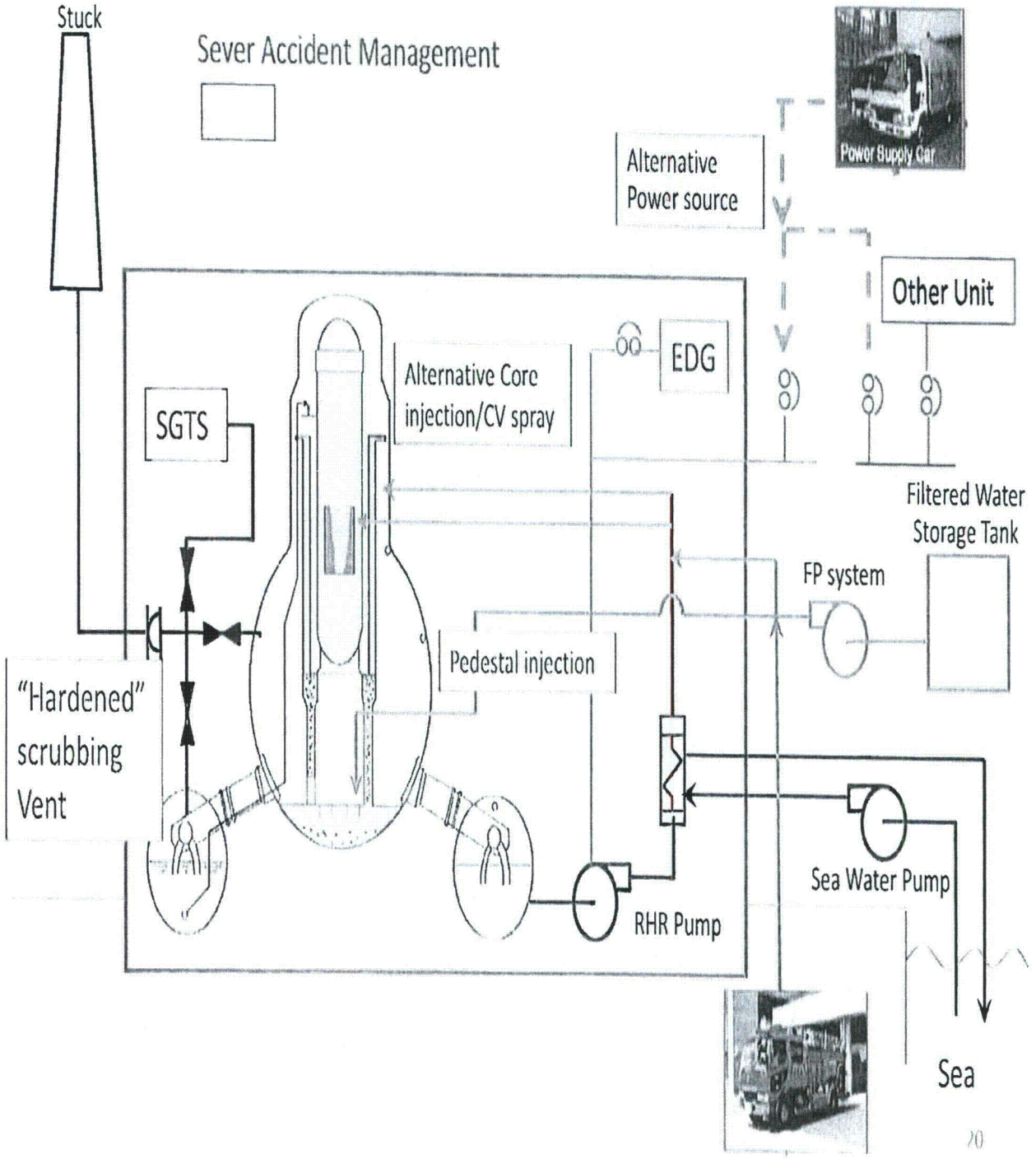
"Severe Accident Management": published in 1992

"Implementing Severe Accident Management in Nuclear Power Plants", published in 1996

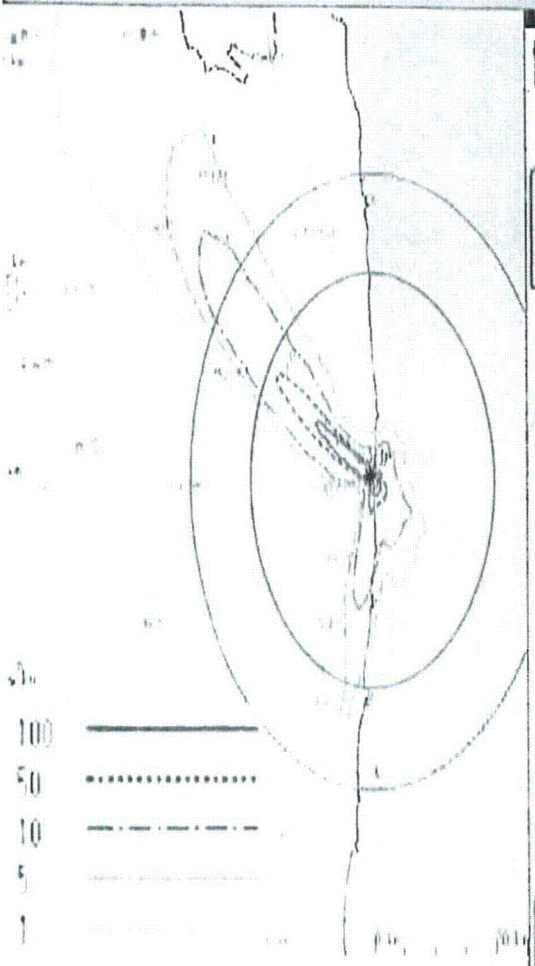
(Japan)

- NSC recommendation for SAM preparation (1992)
- SAM study followed by SAM Guide and modifications (hardened vent, injection to RPV and RPV-pedestal region etc)
- Technical basis for SAM by Utility/Industry/Academia (NSRI guideline, 1999, http://www.nsra.or.jp/safe/cv/index.html)
- Submittal of Utility report to Regulatory body after completion of modifications (2002) and AMG, followed by evaluation by NISA

What SAM (Severe Accident Management) was in place?

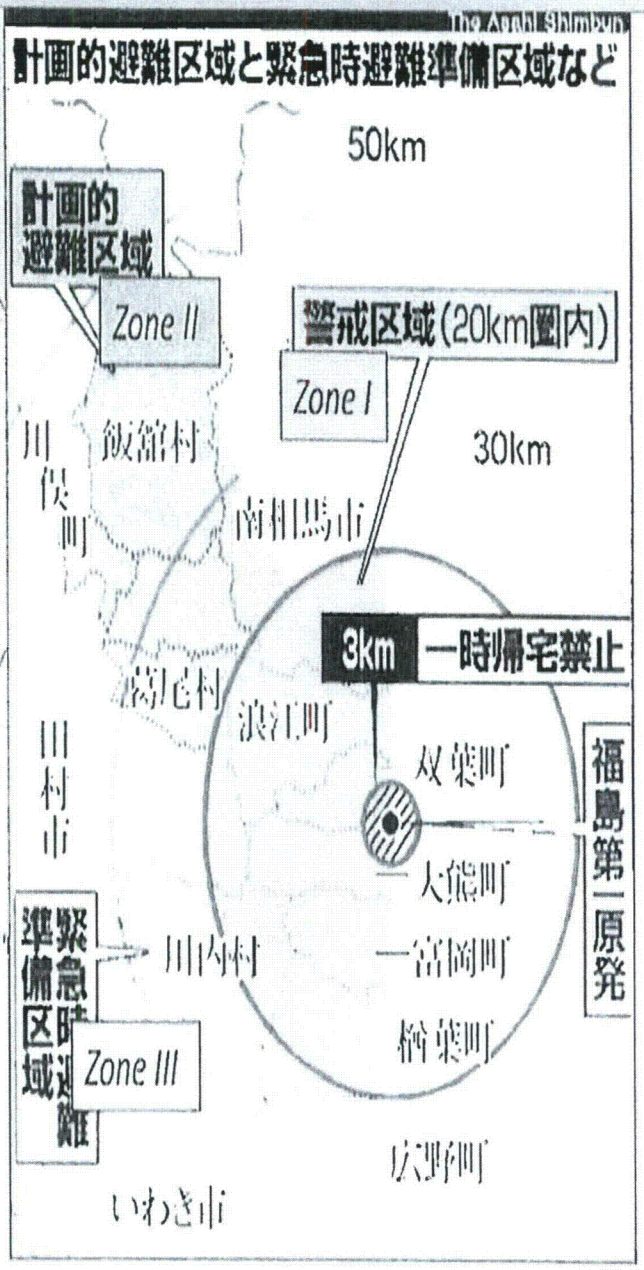


What offsite emergency plan was enacted?



(mSv)

SPEEDI calculation March 11-April24
Cumulative exposure to adult
http://www.nsc.go.jp/info/110425_top_siryo.pdf



Zone I (20km); "evacuation"
Zone II (North-west): "evacuation plan (in a month)"
Zone III (20-30km); "preparedness for evacuation"

What offsite Emergency Actions?

March 11

16-18: Notification of no confirmation of water injection & increase of CV pressure (TEPCO)
19:03: Government declared nuclear emergency. (Setup of Government Nuclear Emergency Response Headquarter and Local Emergency Response Center)
21.23: PM directed evacuation (3km radius) and sheltering (10km radius) of 1F site

March 12

5.44 : PM directed evacuation (10km radius) of 1F site
7.45: PM directed evacuation (3km radius) and sheltering (10km radius) of 2F site
17.39: PM directed evacuation (10km radius) of 2F site
18.25: PM directed evacuation (20km radius) of 1F site

March 15

11.00: PM directed sheltering (20-30km radius) of 1F site
Local Emergency Response Headquarter issued "direction to administer the stable Iodine during evacuation from the evacuation area (20 km radius)" to the Prefecture Governors and the heads of cities, towns and villages.

March 25

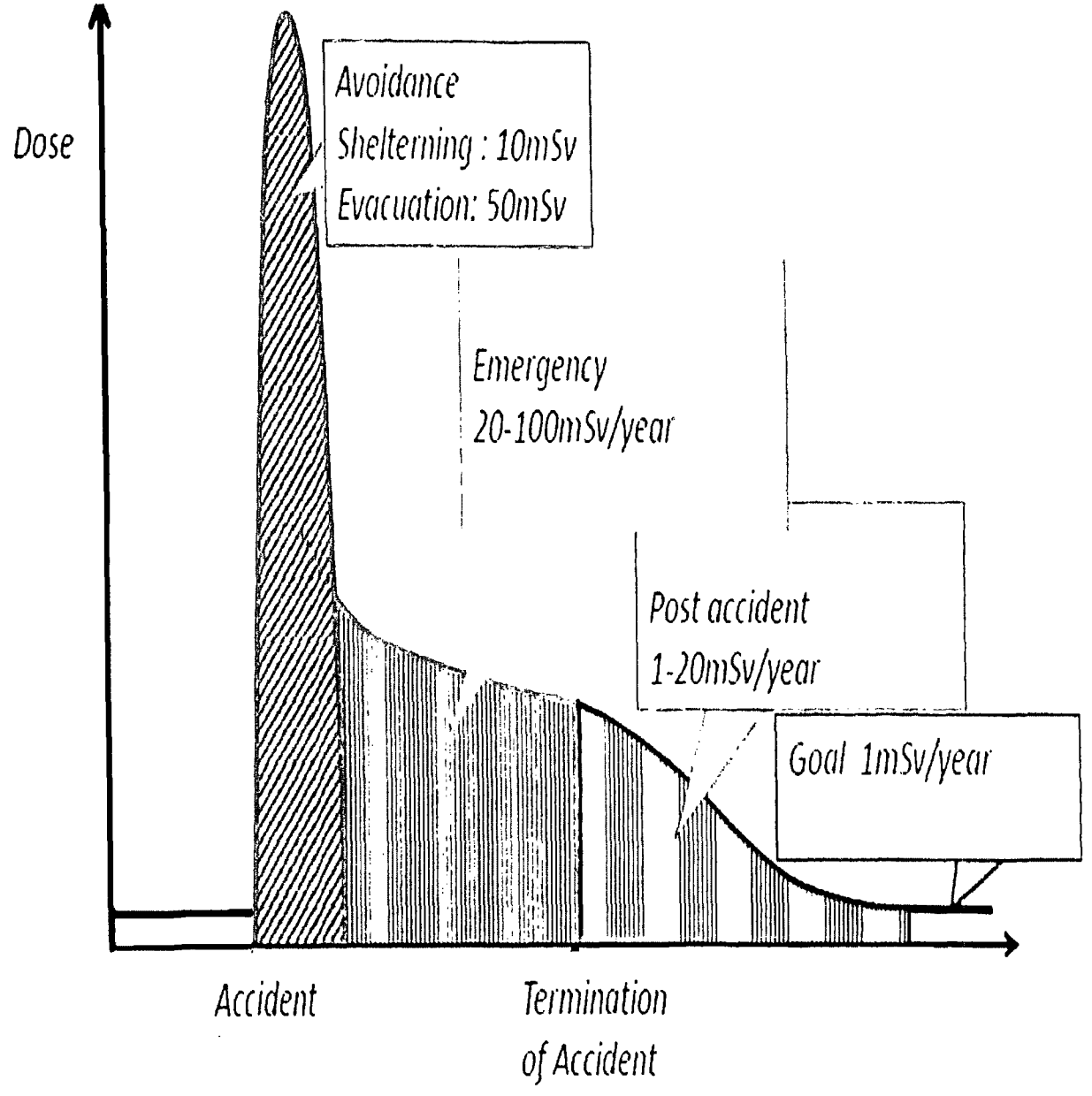
Chief Cabinet Secretary prompted voluntary evacuation (20-30km radius) of 1F site

April 11

Chief Cabinet Secretary set up an area of planned evacuation within 1 month to avoid exposure beyond 20mSv/yr and prompted preparation for evacuation (20-30km) of 1F site (reason: just in case of large release)

April 20

Chief Cabinet Secretary set-up of de-fact exclusion zone for 20km radius of 1F (Nr. of residents: 7,8000) and reduction of EPZ to 8km around 2F



[SOURCE] NSC, http://www.nsc.go.jp/info/20110411_2.pdf

What Ingestion control was placed?

- Control in place : March 19- , mostly lifted already but different from place to place and among products

- PM can direct limitation of transfer beyond the affected area (prefecture)

- Basis

(I-131)

I-131 equivalent in drinking water/milk < 300 Bq/kg (infant: 100Bq/kg)

I-131 equivalent in vegetable/sea-food< 2,000 Bq/kg

(Cs)

Cs in drinking water/milk < 200 Bq/kg

Cs in food< 500 Bq/kg

Why INES level 7? Declared by NSC/NISA on April 13th

Chernobyl: I-131 eq. 5.2 x [10(18)] Bq

Fukushima: I-131 eq. 0.3-0.6 x [10(18)] Bq

Estimated by reverse calculation using SPEEDI and ground contamination (outside) and Severe Accident ST Analysis (inside)

INES 2.2.2.Definition of levels based on activity released

Level 7: An event .....equivalent to a release to the atmosphere of more than several tens of thousands of tera[10(12)] Bqs of I-131

(SOURCE: INES User's Manual 2008 Edition)

	People and Environment	Radiological Barriers & Control	Defense-in-depth
7	**Major release**		
6	**Significant** release		
5	**Limited** release / Several deaths	**Severe damage**	
4	**Minor** release / One death	**Fuel** melt or damage	

What Nuclear Liability system in Japan?

1. Basics: Owner/Operator owes unlimited liability for compensation of nuclear damage, irrespective of the cause of accident
2. Two contracts: Owner/Operator-Insurance company (Liability insurance)
   Owner/Operator-Government (Indemnity Agreement)
3. If the compensation amount exceeds 1.2B$ (assuming 100yen/$), Government may come to support contingent on the Diet's decision
4. Not a signatory of Amended Paris nor Amended Vienna agreements nor CSC

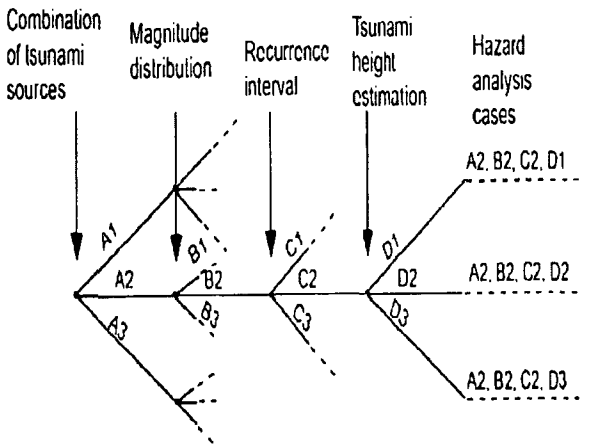
Owner/Operator's insurance	Indemnification Agreement	Government's arrangement
[Not cover Earthquake, Tsunami, Volcano Eruption]	1) Case of Earthquake, Tsunami, Volcano Eruption 2) Case of unknown cause during normal operation 3) Case of compensation request after 10 years	Case of extraordinary natural disaster or insurrection

What are the potential considerations for future designs and successful implementation of SAM ?

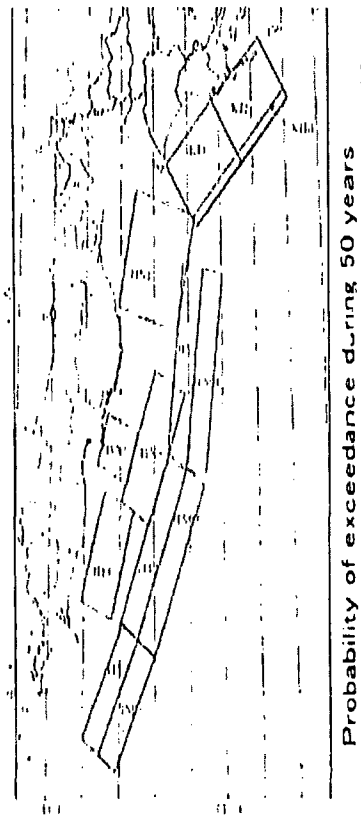
1. Design considerations against natural hazards

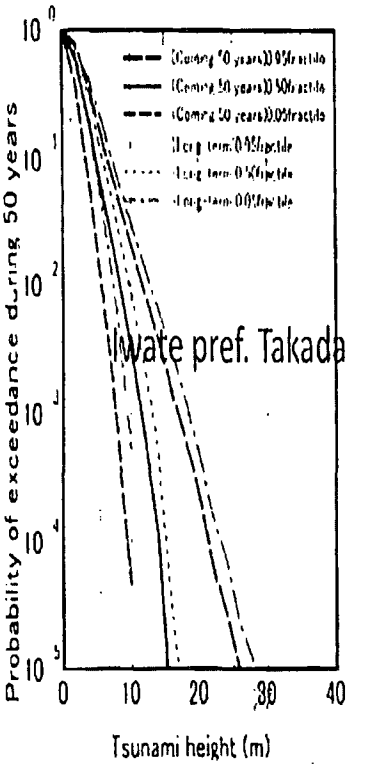
Personal observations

- Data compiled by reactor-year for internal events, while by year for natural hazards
- Use of logic tree and PSA for estimation where there is scarcity of data
  - logic tree representation of uncertain parameters
  - Tsunami source zone model
  - Probabilistic Tsunami hazard curve
- Building layout and elevation of Electric Equipment /EDG rooms
- ERC in robust building (seismic isolation after 2007 earthquake)



[SOURCE] T. Annaka et al, "A method Of Probabilistic Tsunami Hazard Analysis", Earthquake Engineering Symposium, 2006





Iwate pref. Takada

What needs to be considered for future designs and successful implementation of SAM ?

Personal observations

2. Diversity

a) Diversified Ultimate Heat Sink (UHS) of Residual Heat Removal and Emergency Equipment Cooling Systems

b) Diversified power & water supply: Air-cooled DG, Water from dam

3. Passive safety

a) Heat removal from reactor core/containment/SFP by Isolation Condenser, PCCS, external CV cooling, wall cooling etc

b) Preparations for "what if onsite recovery actions were disabled"

4. Consideration against extended time blackout

Battery in safe place and recharger of battery by small EDG

[Note] Some US plants with recharger of battery by small EDG

What needs to be considered for future designs and successful implementation of SAM ?

Personal observations

5. Improvements of SAM (Severe Accident Management)

a) Review and drill for the "use of all available resources (Apollo 13)"
- Provisions of Onsite or National Nuclear Crisis Center, under appropriate delineation of responsibility, transportation systems and storage of mobile equipments such as Fire Engines, portable sweater pumps, batteries, remote sensing devices, remote spray system, robotics etc & drill for use

b) Implementation of recovery actions in harsh radiation environment
- Provision of Temporary shielding, Remote handling machine, Remote water spray machine, remote sensing machines and cameras by unmanned plane, and others from National Crisis Center

c) Potential of detonation/deflagration of leaked hydrogen outside of the CV
- vent line pipe and SGTS line pipe
- "hydrogen deflagration/detonation in a BWR R/B" (NE&D 211,27-50)

d) Include "water inventory control" "water leak path analysis" (LWR)

e) Recovery actions: preparation for the worst & "defense in depth"

f) Structure of Emergency Management organization

What needs to be considered for future designs and successful implementation of SAM ?

Personal observations

6. SAM Operational aids

Real-time simulation of plant behaviour as an aid to decision-making from options and assess the current/future risks potentials, backed by precise accident data tracking system by recoding every plant behaviour and remedial actions

7. Accident instrumentation (CV water level etc) and sampling capability

Very limited data available (Rx-SC/DW pres/Rx-SC/DW temp/Rx WL)

8. Offsite management such as the use of exposure prediction system etc

9. Design considerations for **SFP**

- Potential of re-criticality of over-moderated SFP
- Location of SFP (Accessibility, Structural integrity, Aeroplane crash)
- Alternative heat removal method (cooling system and UHS)

10. Amendment of International safety standards and establishing international expert review of design/SAM (vs. national authority to license), global safety goal

What English information on web from Japan?

<Earthquakes and Tsunami>

Japan Meteorological Agency
http://www.jma.go.jp/jma/indexe.html
http://www.jma.go.jp/jma/en/2011_Earthquake.html
http://www.jma.go.jp/en/tsunami/
Geospacial Information Authority of Japan(partially in Japanese)
http://www.gsi.go.jp/ENGLISH/index.html

<Radiation Levels>

http://www.mext.go.jp/english/radioactivity_level/index.htm
http://www.bousai.ne.jp/eng/index.html
U.S. Department of Energy Releases Radiation Monitoring Data from Fukushima Area
http://www.energy.gov/news/10194.htm

Food and Water
http://www.mhlw.go.jp/english/topics/2011eq/index.html
Radioactive material level in tap water in Tokyo/day
http://ftp.jaist.ac.jp/pub/emergency/monitoring.tokyo-eiken.go.jp/monitoring/w-past_data.html

<Status of Nuclear Reactors>

Tokyo Electric Power:
http://www.tepco.co.jp/en/nu/fukushima-np/index-e.html#anchor02
-Radiation Levels measured by TEPCO
http://www.tepco.co.jp/en/nu/fukushima-np/f1/index-e.html
-TEPCO's explanation paper
http://www.tepco.co.jp/en/nu/fukushima-np/f1/images/f12np-gaiyou_e.pdf
-Influence of radioactive materials to the environment (prepared by TEPCO)
http://www.tepco.co.jp/en/nu/fukushima-np/f1/index2-e.html
-Photos for Press (TEPCO)
http://www.tepco.co.jp/en/news/110311/
Japan Atomic Industrial Forum
http://www.jaif.or.jp/english/
Japan Nuclear and Industrial Safety Agency
http://www.nisa.meti.go.jp/english/
Nuclear Safety Commission of Japan
http://www.nsc.go.jp/NSCenglish/geje/index.htm
Prime Minister's Office of Japan
http://www.kantei.go.jp/foreign/incident/index.html
NHK World in English
http://www3.nhk.or.jp/nhkworld/
NHK World TV
http://www3.nhk.or.jp/nhkworld/r/movie/

prepared by Shuichi IWATA((b)(6)) the University of Tokyo & Osamu MIZUTANI ((b)(6)) UAJC on April 21, 2011 for "Twenty-Five Years after Chernobyl Accident: Safety for the Future"

What English information on web from Japan?

<Assistances>

NHK Radio provides quake-related broadcast in 18 languages
http://www3.nhk.or.jp/nhkworld/english/radio/program/index.html

Assistance Manual for Foreigners in Times of Disaster by TICC
http://www.tokyo-icc.jp/english/information/howto.html

Transportation
http://www.mlit.go.jp/page/kanbo01_hy_001411.html

Ministry of Defense
http://www.mod.go.jp/e/index.html

National Police Agency
http://www.npa.go.jp/english/index.htm

National Institute of Radiological Sciences
http://www.nirs.go.jp/ENG/index.html

<Other Information Sources>

Atomic Energy Society of Japan
http://www.aesj.or.jp/en/

Japan Atomic Energy Agency
http://www.jaea.go.jp/english/index.shtml

International Atomic Energy Agency
http://www.iaea.org/newscenter/news/tsunamiupdate01.html

US Department of Energy Blog
http://blog.energy.gov/content/situation-japan

US Nuclear Regulatory Commission
http://www.nrc.gov/japan/japan-info.html

World Nuclear Association
http://world-nuclear.org/info/fukushima_accident_inf129.html

United States Environmental Protection Agency
http://www.epa.gov/japan2011/

Google Crisis Response
http://www.google.co.jp/intl/en/crisisresponse/japanquake2011.html

Photo Service
http://cryptome.org/eyeball/daiichi-npp/daiichi-photos.htm

American Nuclear Society
http://ansnuclearcafe.org/fukushima/

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What international supports were provided?

< International Supports for disaster recovery >

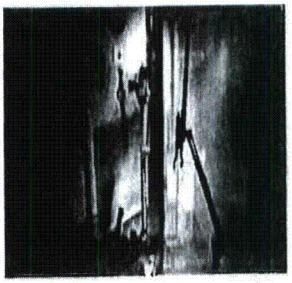
135 countries and regions as well as 39 international organizations have expressed their intentions to extend assistance. Rescue and medical support teams from 20 countries and regions (Australia, China, France, Germany, India, Indonesia, Israel, Italy, Mexico, Mongolia, New Zealand, the ROK, Russia, Singapore, South Africa, Switzerland, Taiwan, Turkey, the U.K., the U.S.) as well as and the UNOCHA, an IAEA expert team, and the WFP have arrived Japan and have been operating in disaster-stricken areas.

< Support from Governments>

[Australia] a special pump needed for cooling Reactor
[Canada] 154 radioactivity survey meters, 5,005 personal dosimeters
[Finland] 50 Radioactivity measuring monitors
[France] protective suits and masks(approx. 20,000 sets), 250 radiation measurement equipment, 10pumps, 5 power generators, 5 compressors, 3 environmental survey vehicles, an environmental survey towed vehicle, approx. boron(100tons)
[Korea] approx. 52 tons of boron
[U.S.A] Technical support from DoE, 10,000 radioactive-proof suits from USAID; 2 fire trucks, 5 pumps, 99 protective suits against nuclear, biological and chemical weapons, approx. 9 tons of boron, 1 large water spray pump unit, fresh-water transportation by a barge for carrying fresh water from the U.S. Forces. 31,000 Radiation dosimeters, NRC's experts support

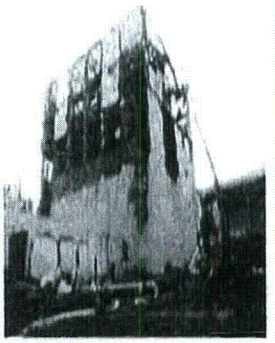
<Support from Industries> (Examples)

[Areva] Protective suits (approx. 10,000), protective masks(3,000), 2 experts, 2 monitoring cars etc
[iRobot in U.S.A] Packbot by iRobot worked inside the reactor building of Unit 3 on April 17.
[Rosatom in Russia] 400 Radiation dosimeters, protective masks(5,000)
[Sany Heavy Industry in China] 62 truck mounted concrete pump
[Putzmeister in Germany] Several long pumps including a 70m long pump
[Westinghouse/B&W/Shaw, GE] Proposal of the mid-term & long term plan



Packbot in reactor of Fukushima Daiichi Unit3

Putzmeister pump



Sany Heavy Industry pump

Heartful thanks to the international helping hands.

Never, Ever Again anywhere in the world