Lessons Learned from the Fukushima NPS Accidents

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IAEA,OECD/NEA ISOE Committee 7th Chairman
JNES
Wataru MIZUMACHI

Contents

1.North East Japan Earthquake and Tsunami

4th Largest Earthquake in the World

At 14.46 Magnitude 9.0 Earthquake

14.51 Largest Tsunami (39.8m height)

133 feet high : ten story building

So far , 20 thousands people were killed.

300 billion US Dollar damage is estimated.

No one is killed by the radiation at Fukushima


死者・不明者 2100人超
津波到達時
11日
津波注意報
注意報解除
小笠原
宮古市
岩手
＜宮城交通＞尚絅学院大線（県庁市役所前行き新道経由）運行中

Stack Height
120m(400ft)

3 Louvers for
Emergency D/G

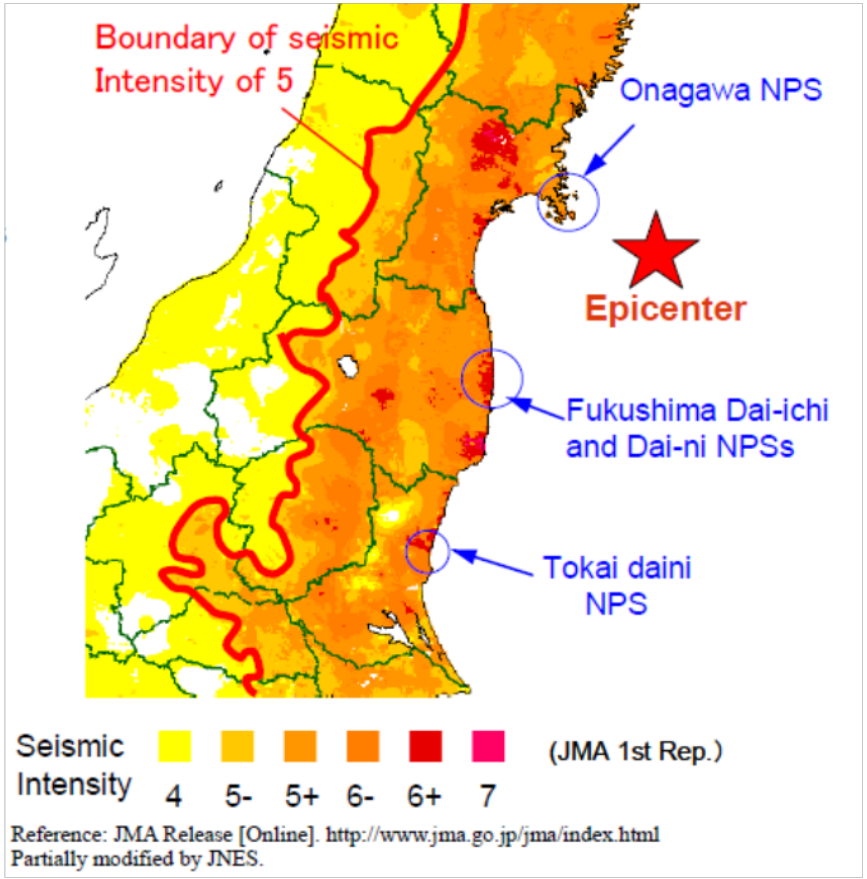
Top of Tsunami
40m(130ft)

Height of Tsunami
15m(50ft)

2. Fukushima Dai-ichi NPS Accident

2011 off the Pacific coast of Tohoku Earthquake

- Occurred 14:46 March 11, 2011
- Magnitude:9.0 Mw
- Epicenter location: 38º 10''N and 142º 86''E, and 23.7km in depth



Reference: JMA Release [Online]. http://www.jma.go.jp/jma/index.html
Partially modified by JNES.

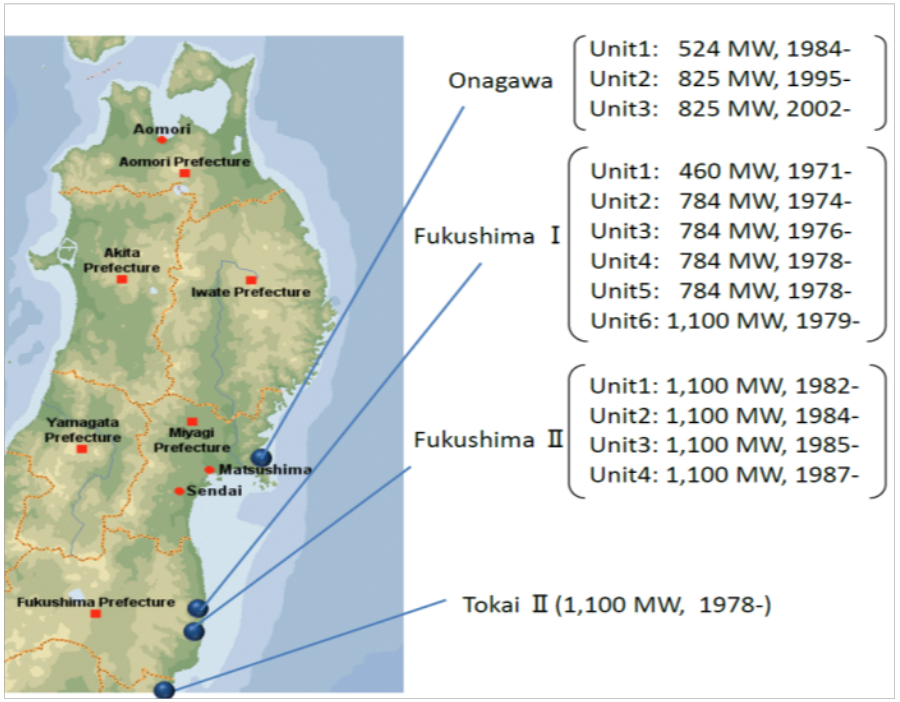

Source: Fire and Disaster Management Agency

- East coast of northern area in the main island of Japan is seriously damaged
- As of August 11, 15,810 people are dead and 4,613 people are missing according to the Fire and Disaster Management Agency

Nuclear reactors near epicenter of the earthquake

March 11, 14:46, The earthquake occurred

- **11 reactors under operation were automatically shut down**
  - Onagawa 1,2,3
  - Fukushima Dai-ichi 1,2,3
  - Fukushima Dai-ni 1,2,3,4
  - Tokai Dai-ni
- **3 reactors under periodic inspection**
  - Fukushima Dai-ichi 4,5,6



Location of the Nuclear Installations

Around 1 hour later, after tsunami hit theNPSs above

- **Following reactors went to cold shut down**
  - Onagawa 1,2,3 : External power and sea water pumps were alive
  - Fukushima Dai-ichi 5,6: Emergency DG was alive
  - Fukushima Dai-ni 1,2,3,4: External power was alive
  - Tokai Daini: Emergency DG was alive

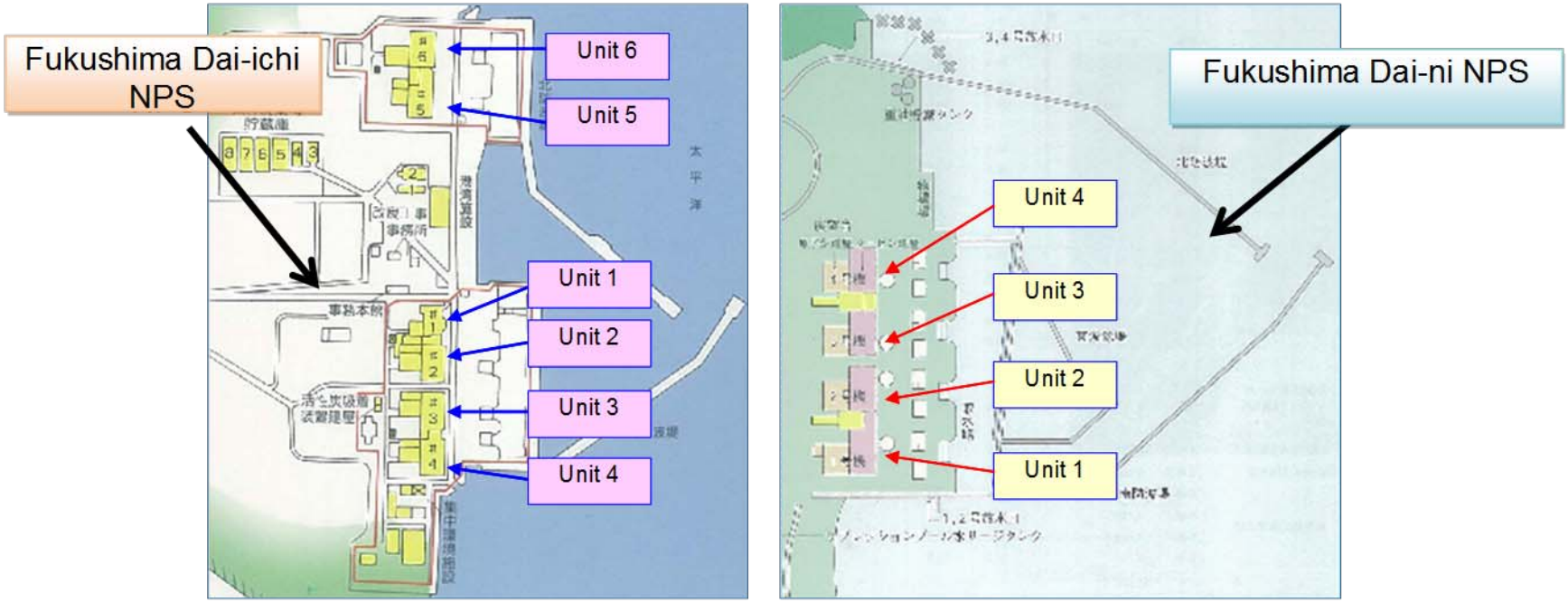
- **The problems came with Fukushima Dai-ichi 1,2,3 and 4.**

Location of NPSs within Fukushima

Fukushima Dai-ichi NPS

Fukushima Dai-ni NPS

Layouts of Fukushima Dai-ichi and Fukushima Dai-ni



Summary of Fukushima Dai-ichi NPS

Items	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
BWR 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 (MW_e)	460	784	784	784	784	1100
Max. pressure of RPV	8.24MPa	8.24MPa	8.24MPa	8.24MPa	8.62MPa	8.62MPa
Max. Temp of the RPV	300°C	300°C	300°C	300°C	302°C	302°C
Max. Pressure of the CV	0.43MPa	0.38MPa	0.38MPa	0.38MPa	0.38MPa	0.28MPa
Max. Temp of the CV	140°C	140°C	140°C	140°C	138°C	171°C(D/W) 105°C(S/C)
Commercial Operation	1971,3	1974,7	1976,3	1978,10	1978,4	1979,10
Number of DG	2	2 *	2	2 *	2	3*
Electric Grid	275kV x 4				500kV x 2	
Plant Status on Mar. 11	In Operation	In Operation	In Operation	Refueling Outage	Refueling Outage	Refueling Outage

* One Emergency DG is Air-Cooled

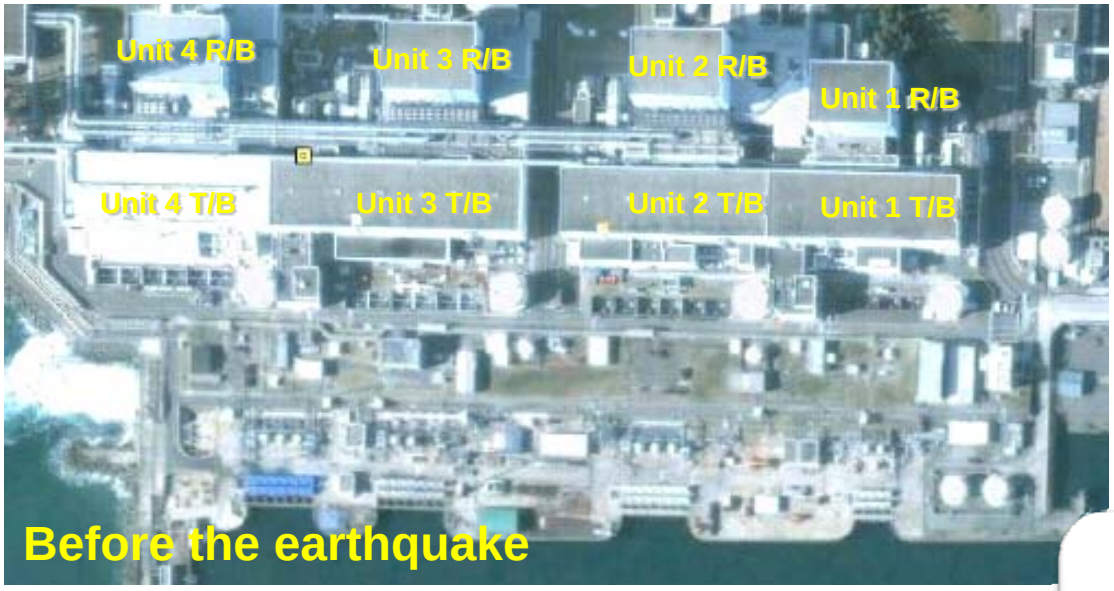
Source: Application document of license for establishment of NPS

Collapsed Tower

- **Damage of external power supply systems of the Fukushima Dai-ichi and Dai-ni NPSs**

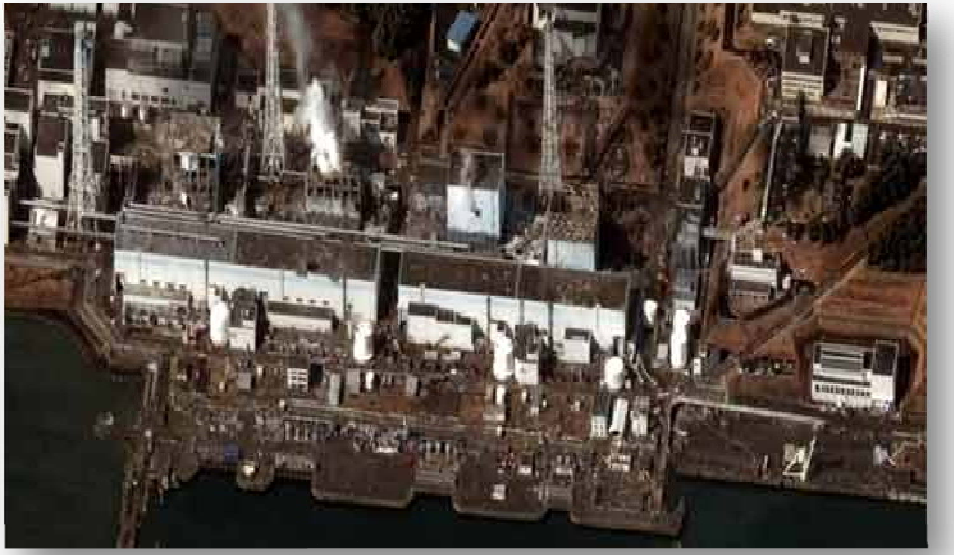
Tsunami getting over seawall

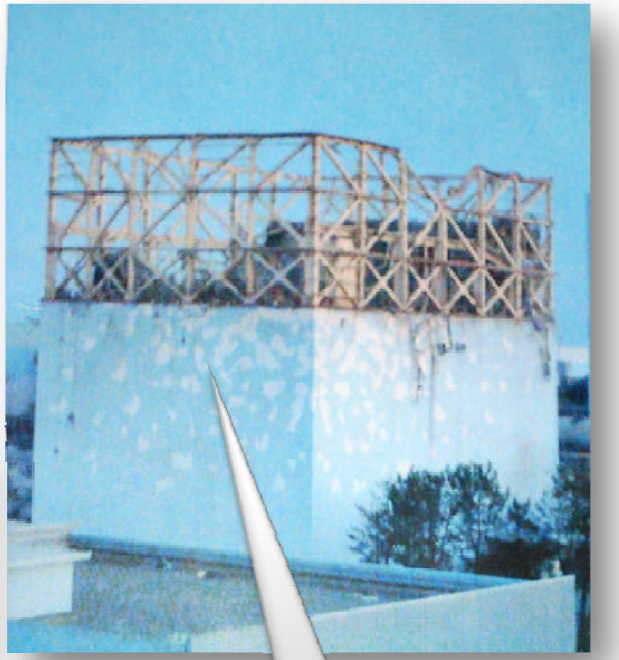
Satellite view of Fukushima Dai-ichi NPS



Source: Google Earth

Damage of reactor buildings





Unit 1

Unit 4

Natural Nuclear Fission happened on Nov 2

- TEPCO found the Xenon -135 in PCV of Fukushima Unit No 2.
- The half life of Xenon-135 is short as 5 days and TEPCO made the mistake to declare the criticality.
- The quantity of the Xenon-135 was 0.00001 Bequere/cm2 and TEPCO changed it to the natural nuclear fission in the very small area of the melted fuel which occurs even in the normal operation in the core.

3. Japanese Official Interim Report on Accident Survey

Prime Minister formed Accident Survey Committee

- May 24, 2011 Japanese Cabinet authorized Accident Survey Committee headed by Dr. Hatamura, Professor Emeritus, Univ of Tokyo
- The Interim Report was published on Dec 26, 2011.
- They met 456 people from TEPCO,NSC,NISA, Mayors, and Cabinet Members except Former Prime Minister Kan
- Final Report including Kan's Action right after the accident will be published this summer.

Their first issue is Government one

- The Nuclear Hazard law indicates that the OSC (Off Site Center) which was constructed near every job site has every responsibility in the case of accident.
- However, OSC was not constructed as the seismic class A and then, the information infrastructure was damaged by the earthquake and there were lack of food, water, and electricity.
- Moreover, there was no air filter to protect the radioactive materials.
- Then the members in OSC had to escape from the center which should be the headquarter.

Japanese government should construct OSC to withstand against the big hazard like Fukushima and to maintain the habitability as soon as possible.

Big issues inside White House

- In the severe accident case, Japanese law determines Prime Minister should become the general controller and settle the main control office inside Japan White House.
- Mr. Kan did it ,but he settled two main control rooms. One is 5t floor where he controlled everything and another one located in the basement floor where main directors of the related offices gathered which is determined by the law.
- There was no communication between 5th and basement floor.

Communication issues in NISA

- In the case of the severe accident, there is the official manual which determines the way of the communication.
- The utility should report to NISA Emergency Response Center (ERC) and NISA should report to J White House.
- This rule did not work well this Fukushima case.
- NISA members in ERC should collect the accurate information and report it to the public. NISA remains the big issues on this.

Remaining issues in White House

- There are the law and manual in the case of the severe accident.
- However, these were not working well.
- In the final report they will report where the issues are in the White House in the case of the crisis management.
- They will continue to ask this issues to the government related people including Mr. Kan.

Issues right after the accident

(1) Mistake on Isolation Condenser of Unit No 1

- Not only the operators but also headquarter managers did not understand the function of IC well.
- This fact shows TEPCO is inadequate as the nuclear operator.
- This fact caused the delay of the water injection to the core and the PCV Vent operation.

Issues right after the accident

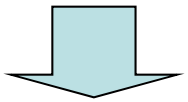
(2) Mistake on alternative core injection, Unit No 3

- Operator stopped HPCI manually at 2.42 on Mar 13 without taking the permission from the managers.
- As the result they failed to reduce the core pressure and to inject the alternative water to the core.
- This fact is the big problem on the crisis management.

Issues to prevent the hazard from spreading

(1) Issues on the monitoring at the first stage

- Monitoring data is important for the people to reduce the radiation exposure.
- This time the monitoring posts were broken by the Tsunami and the earthquake.
- The government was reluctant to open the monitoring data to the public.



The government should design the monitoring post to work properly during the earthquake.

Issues to prevent the hazard from spreading

(2) Issues of decision making on the evacuation

- The evacuation was determined only by the 5th floor in the White House.
- They did not use the SPEEDI result which calculated the radiation level in the local areas using the current weather effects.
- The evacuation plan was not presented to the local government.
- Then there were a lot of confusion in the local governments and the people.

Inadequate countermeasures against Severe Accident

(1) Issues to determine the height of Tsunami

a. The regulatory body

- There were no Tsunami experts in Nuclear Safety Commission which makes the regulation rules.

b. TEPCO

- TEPCO got the construction permit by 3.1m height of Tsunami in 1972 and revised to 5.7m in 2002.
- TEPCO reevaluated it in 2010 and got 15m height but they did not take any action because they thought the model was not adequate.

Hatamura committee highly recommends for NPPs to design against the severe accident for every NPPs.

Issues of nuclear regulatory organization

(1) They need the independency and transparency
- They need the responsibility to explain on the nuclear safety to the public.

(2) They need the strong organization responding rapidly and properly in the case of Severe Accident.

(3) They need the excellent specialists.
- In order to get the excellent specialists there are the needs for upgrading their careers and for the long training and for the personnel exchanges.

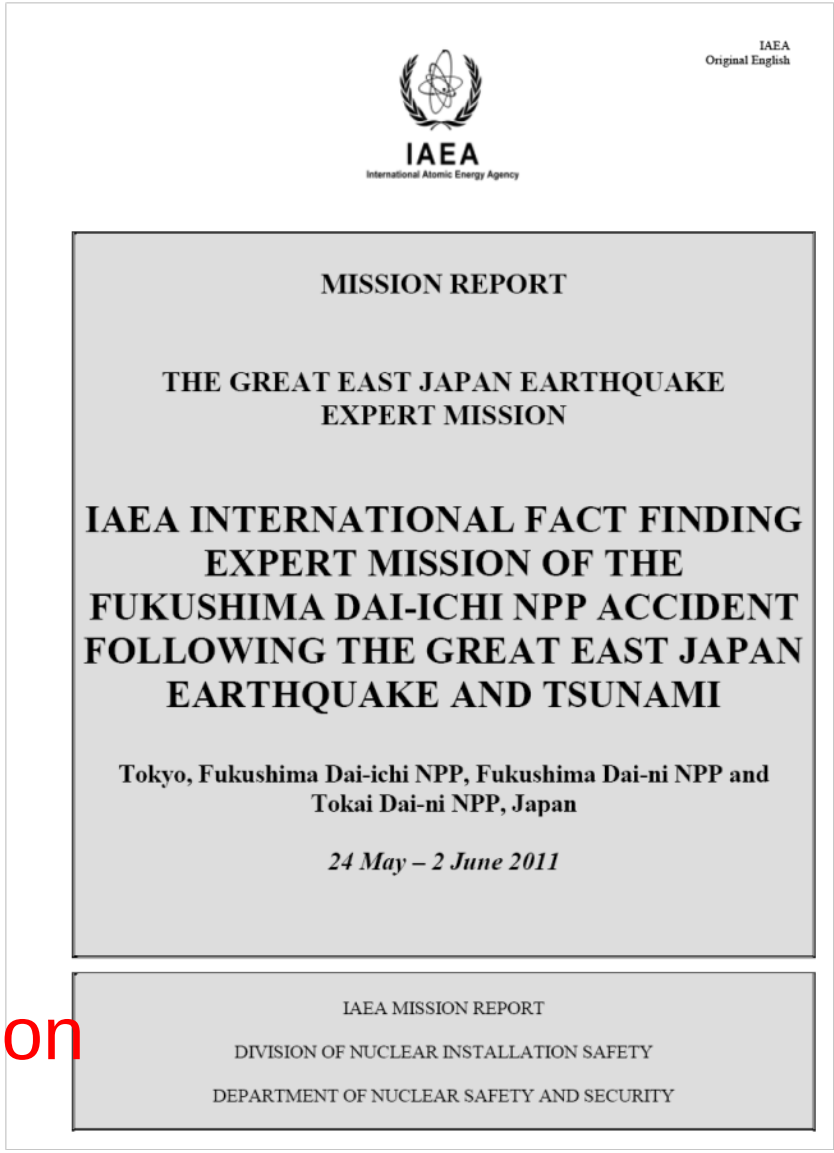
(4) There is the lack to watch the comprehensive view looking at the countermeasure on the severe accident

(5) They should regulate Severe Accident by the law.

4. IAEA Expert Group

IAEA Expert Group conclusion on Fukushima

- This June, IAEA expert group visited Fukushima.
- This group is composed by 18 experts from 12 countries headed by Mr Weightman from HSE, UK.
- There is Jennifer Uhle from USNRC.
- They summarized 15 conclusion and 16 recommendation.



IAEA
Original English

IAEA
International Atomic Energy Agency

MISSION REPORT

THE GREAT EAST JAPAN EARTHQUAKE
EXPERT MISSION

IAEA INTERNATIONAL FACT FINDING
EXPERT MISSION OF THE
FUKUSHIMA DAI-ICHI NPP ACCIDENT
FOLLOWING THE GREAT EAST JAPAN
EARTHQUAKE AND TSUNAMI

Tokyo, Fukushima Dai-ichi NPP, Fukushima Dai-ni NPP and
Tokai Dai-ni NPP, Japan

24 May – 2 June 2011

IAEA MISSION REPORT

DIVISION OF NUCLEAR INSTALLATION SAFETY

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY

IAEA Expert Group conclusion on Fukushima

1. There is a need to consider the periodic alignment of national regulations in particular of the impact of external hazards.
   (every ten years)
   For Fukushima, the original design condition of the tsunami was 3.1m high and in 2002 they revised to 5.7m and ACRS member indicated there is the evidence of 15m tsunami at Jorgan Earthquake in 869.
   The actual tsunami was 14.5m this time .

List of earthquakes in Japan

From Wikipedia, the free encyclopedia

This is a **list of earthquakes in Japan** with a magnitude of 7.0 or above or which caused significant damage or casualties. As indicated below, magnitude is measured on the Richter magnitude scale (M_L) or the moment magnitude scale (M_w), or the surface wave magnitude scale (M_s) for very old earthquakes. The present list is not exhaustive and reliable and precise magnitude data is scarce for earthquakes that occurred prior to the development of modern measuring instruments.

This list is incomplete; you can help by expanding it (http://en.wikipedia.org/w/index.php?title=List_of_earthquakes_in_Japan&action=edit).

～BC 200 Year

Yayoi Earthquake

Date	Magnitude	Name of quake	Japanese name	Rōmaj
November 29, 684	8.0–8.4 (unknown scale)	Hakuko Nankai earthquake	白鳳南海地震	Hakuk Nankai
June 5, 745	7.9 M_s	occurred at Minoh		
July13, 869	8.3 M	869 Sanriku earthquake and tsunami	貞観三陸地震	Jōgan s jishin

56th Emperor Seiwa

Present Emperor is 125th.

All victims by the Tsunami have no responsibilities.

I have all responsibility because the god punished my activities as the emperor.

Do not take any tax from these areas attacked by the tsunami.

I will pray at Ise Temple and the officers should go there and help

all victims.

Clean up the mass of rubble.

858～876 as Emperor

Jorkan Earthquake and Tsunami attacked the same area in 869.

IAEA Expert Group conclusion on Fukushima

2. Strengthen the management in the case of the severe accident.

The training and education are very important.

In Japan, there is the special training on the severe accident at the job site including the prime minister once a year. But it is a kind of ceremony which means that they do not believe the severe accident really happens.

The complicated structures and organizations can result in delay in urgent decision making.

Who is the boss in the case of SA?

- The site manager called the president and the chairman of TEPCO by phone.
- The prime minister said “I am the expert on the nuke.”
- IAEA representative from Slovenia pointed out Japan is such a country where they need the permission from the prime minister to make PCV Vent and insert the water into the core.

We should determine the captain in the case of SA like Mr. Harold Denton at TMI accident and so I will invite him to Tokyo this November

IAEA Expert Group conclusion on Fukushima

3. 2007 IRRS (Integrated Regulatory Review Service) indicated the complicated regulatory organizations.
   There is no answer on this issue from Japanese Government .

5. Impacts to the environment

Amounts of radioactive materials discharged to the atmosphere

Organization	I-131	Cs-137
NISA (JNES) (April)*	$1.3X10^{17}$	$6.1X10^{15}$
NISA (JNES) (May)*	$1.6X10^{17}$	$1.5X10^{16}$
NSC (JAEA)**	$1.5X10^{17}$	$1.2X10^{16}$

(Unit: Bq)

* NISA with assistance from JNES made this estimation based on the analysis of reactor status.

**NSC (Nuclear Safety Commission) with assistance from JAEA made this estimation based on the data of environmental monitoring and air diffusion calculation.

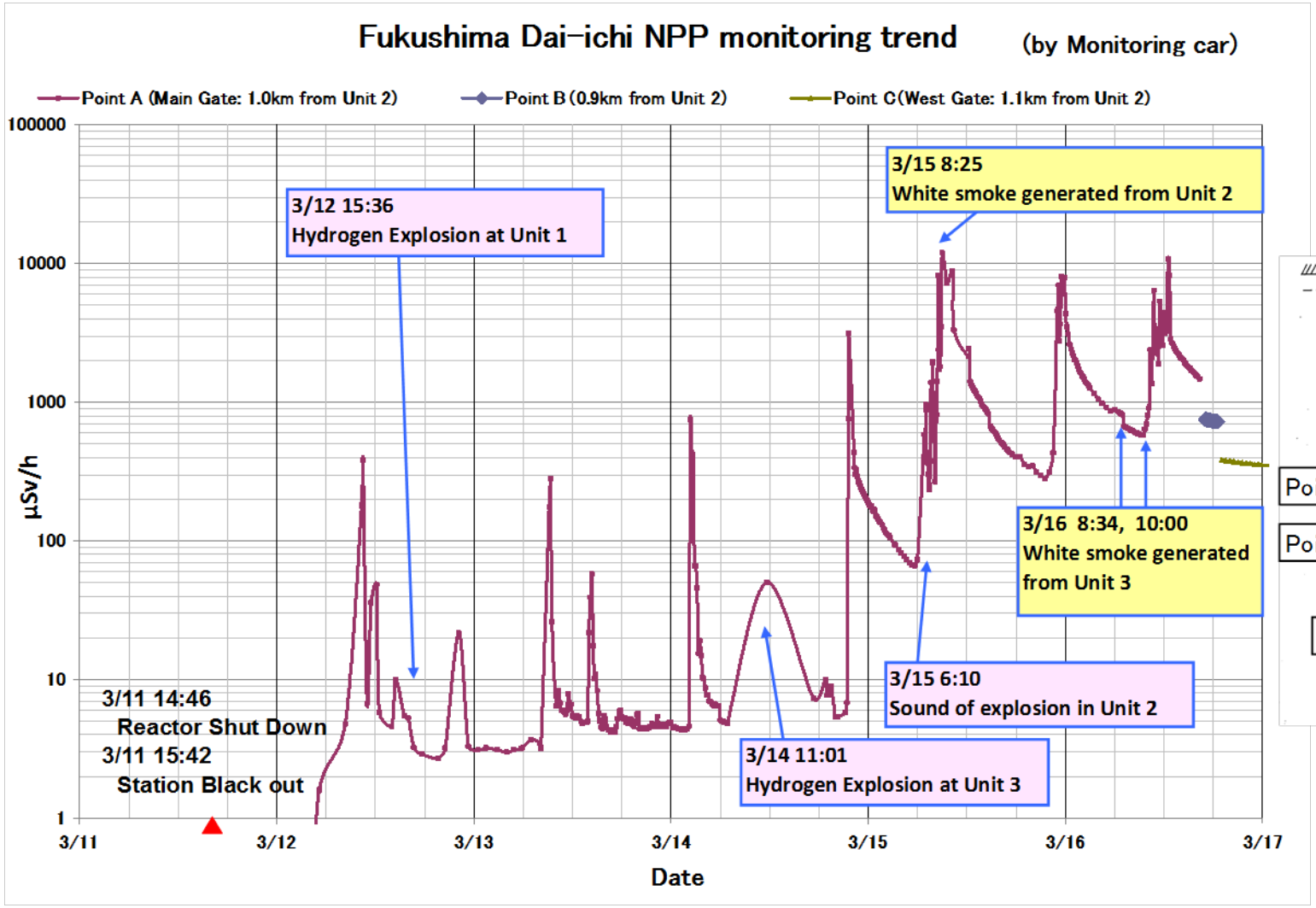
INES rating

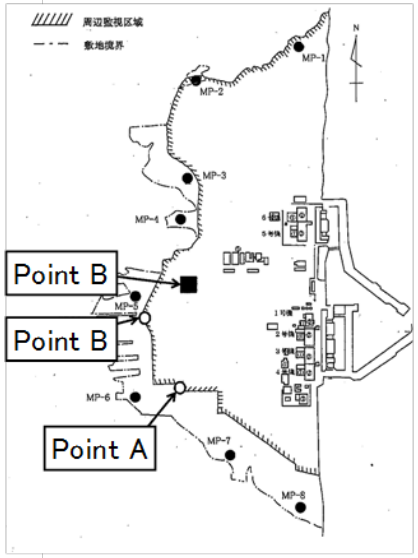
- NISA issued provisional INES ratings, based on “What is known” at the time.

1. At first, following units were rated as Level 3 based on “Defense in Depth” criteria about 10 hours later from the earthquake.
   - Fukushima Dai-ichi unit 1, 2 and 3, Fukushima Dai-ni Unit 1, 2 and 4
2. In the evening on March 12, the rating of Fukushima Dai-ichi Unit 1 was re-evaluated to Level 4 base on the “Radiological Barriers and Control” criteria.
3. On March 18, Fukushima Dai-ichi Unit 1, 2 and 3 were re-rated to Level 5 based on “Radiological Barriers and Control” criteria because the fuel damage was highly possible. Fukushima Dai-ichi Unit 4 was evaluated to Level 3 based on the “Defense in Depth” criteria.
4. On April 12, Fukushima Dai-ichi NPS was revised Level 7 based on the “People and Environment” criteria, as a result of discharged estimation.

- Official rating will be done after cause and countermeasures are identified.

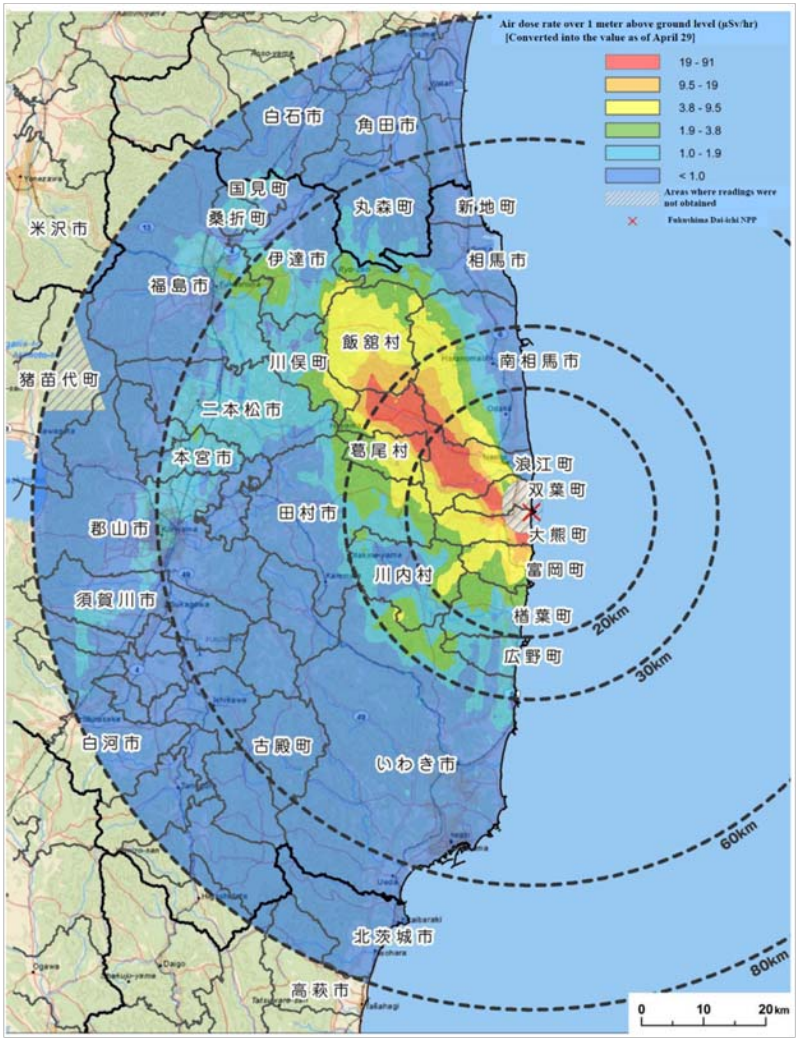
Radiation monitoring in the site





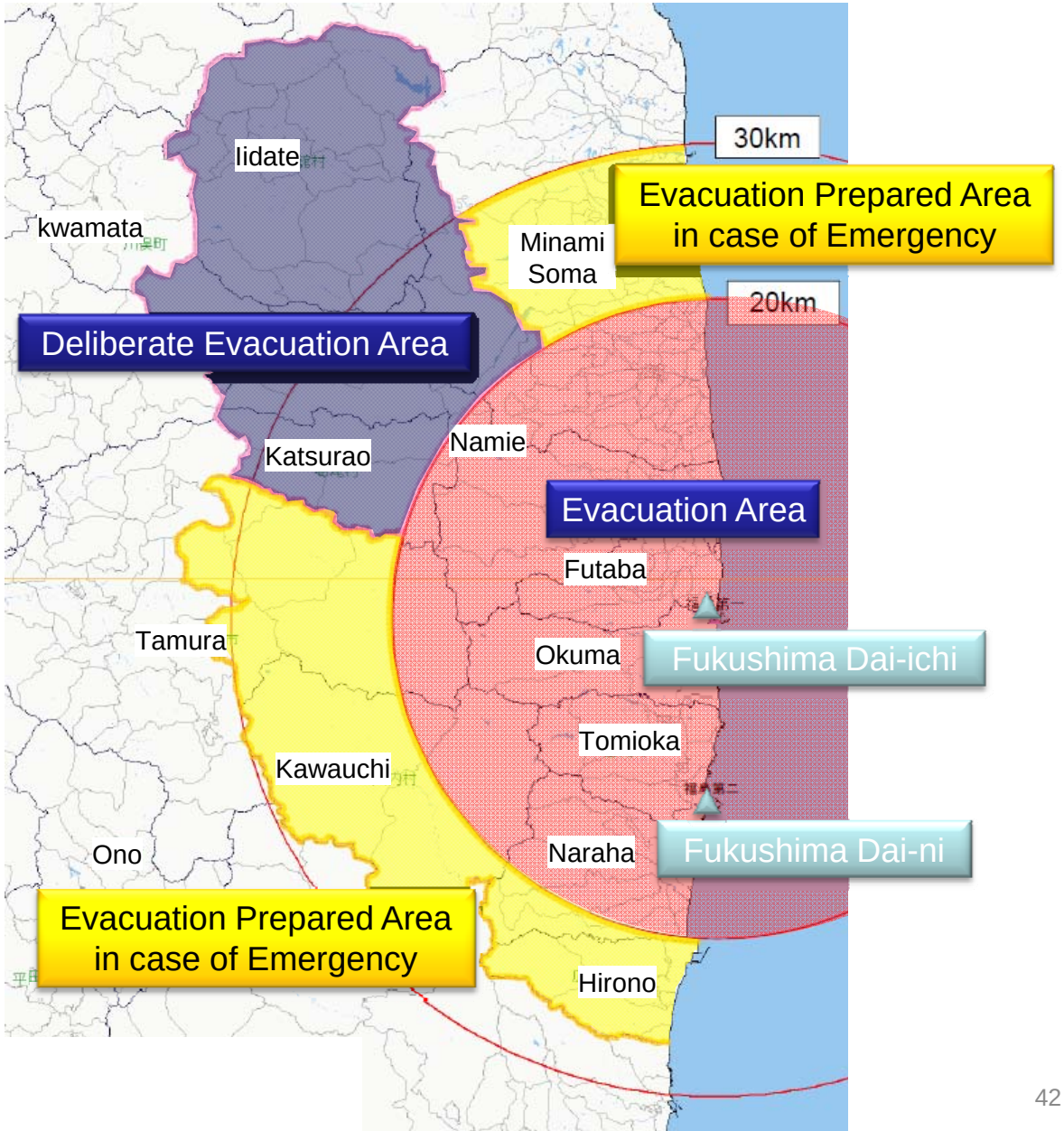
Result of airborne monitoring by DOE and MEXT

Readings of air dose monitoring inside 80km zone of Fukushima Dai-ichi NPS



Protected Areas

March 12-15	April 12	Present
Evacuation Area	→	→
In-house evacuation area (20~30 km radius)	→ Evacuation Prepared Area in case of Emergency	→
Area where radioactive materials to be accumulated at high levels	→ Deliberate Evacuation Area	→



In-house evacuation area excluding deliberate evacuation area was renamed as evacuation prepared area in case of emergency.
Deliberate evacuation area needed to establish for specific areas beyond 20km radius where radioactive materials are to be accumulated at high levels.

Number of sufferers

Area	Number of people
Evacuation area	About 78,000 (population in this area)
Deliberate evacuation area	About 10,000 (population in this area)

6.Radiation Exposure for the workers

Distribution of exposure dosage of workers engaged in emergency radiation work in the Fukushima-Daiichi of TEPCO

（Cumulative doses from March to November in 2011）

classification (mSv)	March - October			March - November			Fluctuation		
	TEPCO	Contractor	Total	TEPCO	Contractor	Total	TEPCO	Contractor	Total
Over 250	6	0	6	6	0	6	0	0	0
Over 200 - 250 or less	1	2	3	1	2	3	0	0	0
Over 150 - 200 or less	19	2	21	21	2	23	2	0	2
Over 100 - 150 or less	116	23	139	116	23	139	0	0	0
Over 50 - 100 or less	354	308	662	366	320	686	12	12	24
Over 20 - 50 or less	627	1,686	2,313	631	1,824	2,455	4	138	142
Over 10 - 20 or less	493	2,320	2,813	474	2,452	2,926	-19	132	113
10 or less	1,648	10,175	11,823	1,701	10,907	12,608	53	732	785
Total	3,264	14,516	17,780	3,316	15,530	18,846	52	1,014	1,066
Max. (mSv)	678.80	238.42	678.80	678.80	238.42	678.80	-	-	-
Ave. (mSv)	23.36	9.38	11.95	23.52	9.25	11.76	-	-	-

Dec 27, 2011

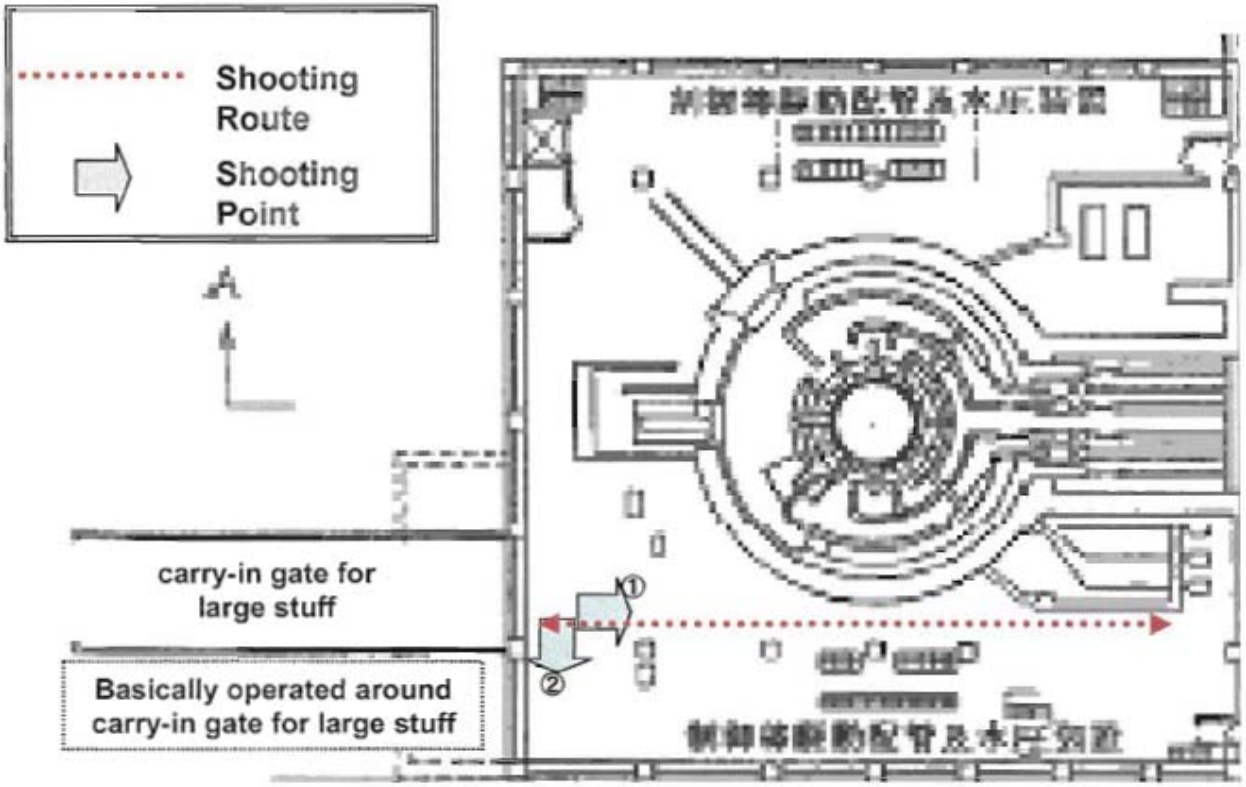
Radiation Exposure for the workers

Radiation exposure limit for the workers in the Emergency case by IAEA is 500mSv/year, but Japanese government determined the Limit as 250mSv/year.

The radiation exposure tables made by TEPCO show that there were 6 people above this limit on March, but there is no one who exceeded the limit after March.

But there 137 people above 100mSv and 2,683 people above 20mSv by August 31.

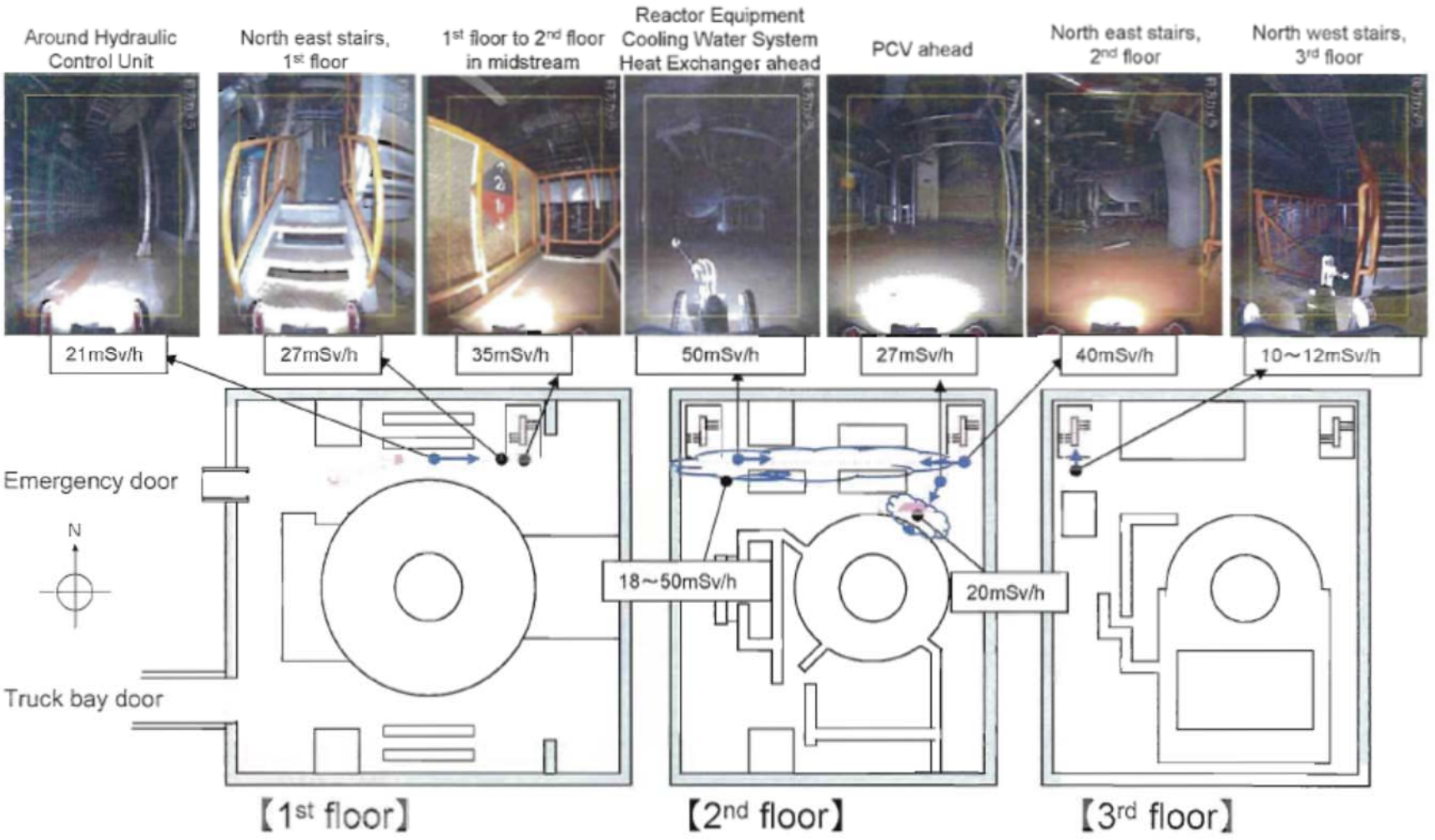
May 20th Dose-measurement Points by γ camera in the Reactor Building of Unit 1



Ground Plan of 1st Floor of the Reactor Building of Unit 1

Measurement Results of Dose Rate at Unit 2 Reactor Building of Fukushima Daiichi (conducted on July 8)

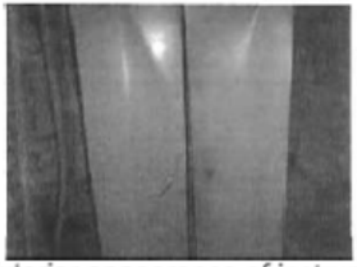
July 11, 2011
Tokyo Electric Power Company



Layout of buildings are image figures (scale size and layout are not reflected correctly)

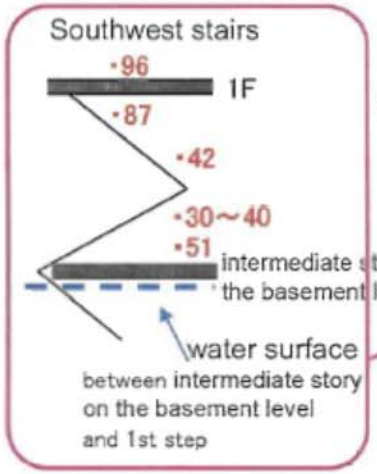
Result of radiation dose survey at reactor building of Unit 3 In Fukushima Daiichi Nuclear Power Station

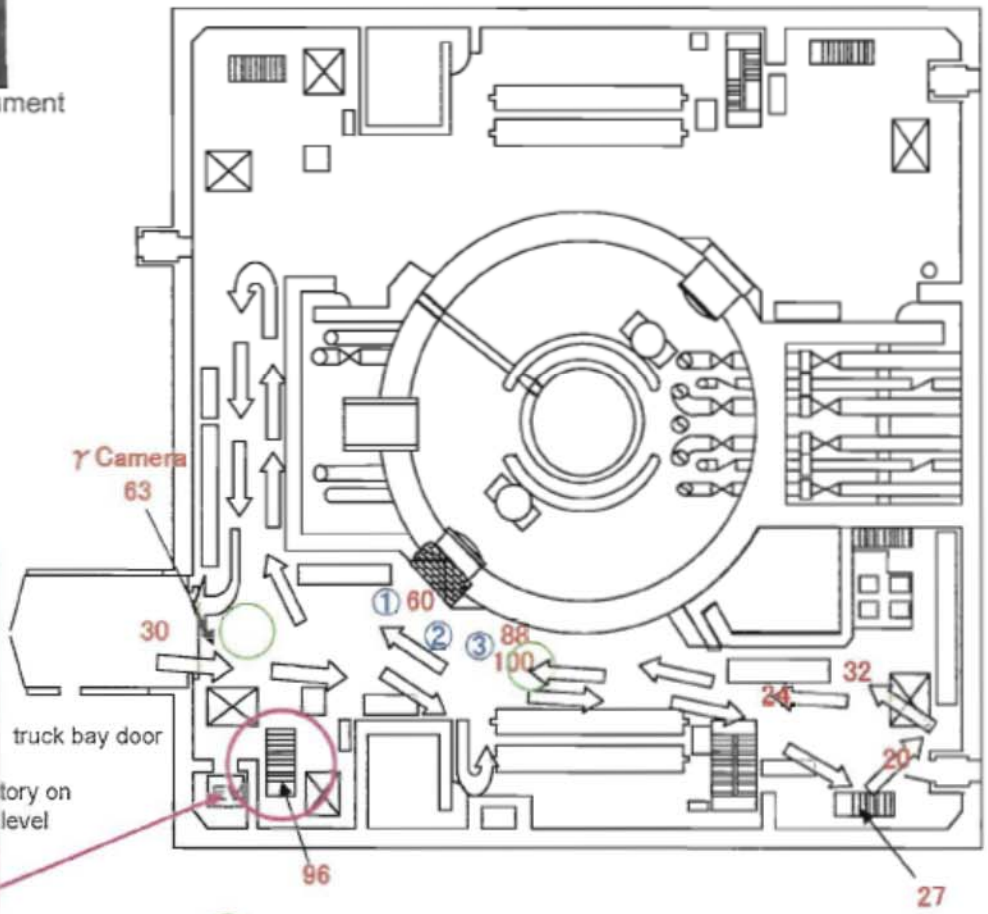
Date of survey : June 9, 2011 11 : 47 am ～ 0:14 pm
Number of Workers : Total 9 (TEPCO 5, Partner Company 4)
Dose : 5.88～7.96mSv
Area : South side and west side of first floor, reactor building of Unit 3



Exterior appearance of instrument panel (① area)

Ladder (② area)





: Area of dust sampling

Unit of the measurement : mSv/h

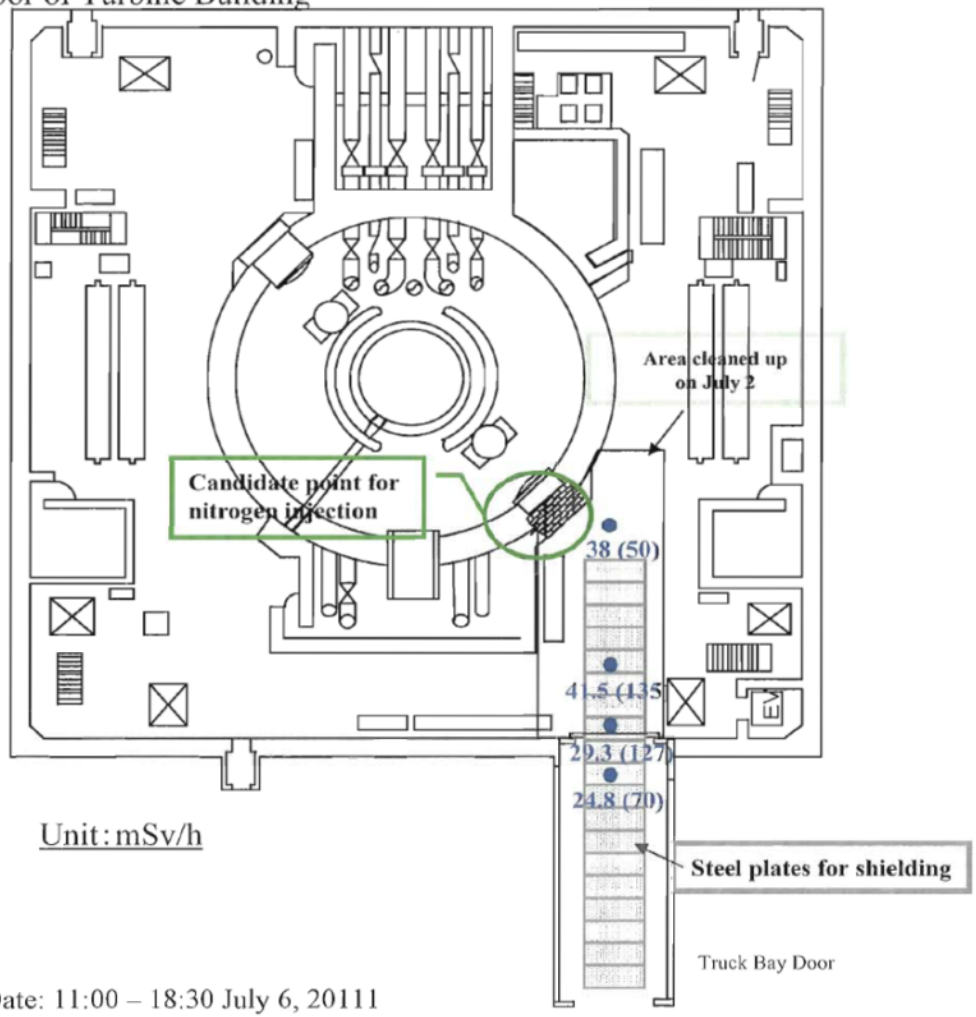
Upper section of Nearby Instrumentation rack (③ area)

Nearby Instrumentation rack (③ area)

July 7, 2011
Tokyo Electric Power Company

Result of radiation dose survey inside the Unit 3 Reactor Building at Fukushima Daiichi Nuclear Power Station

1st floor of Turbine Building



Unit: mSv/h

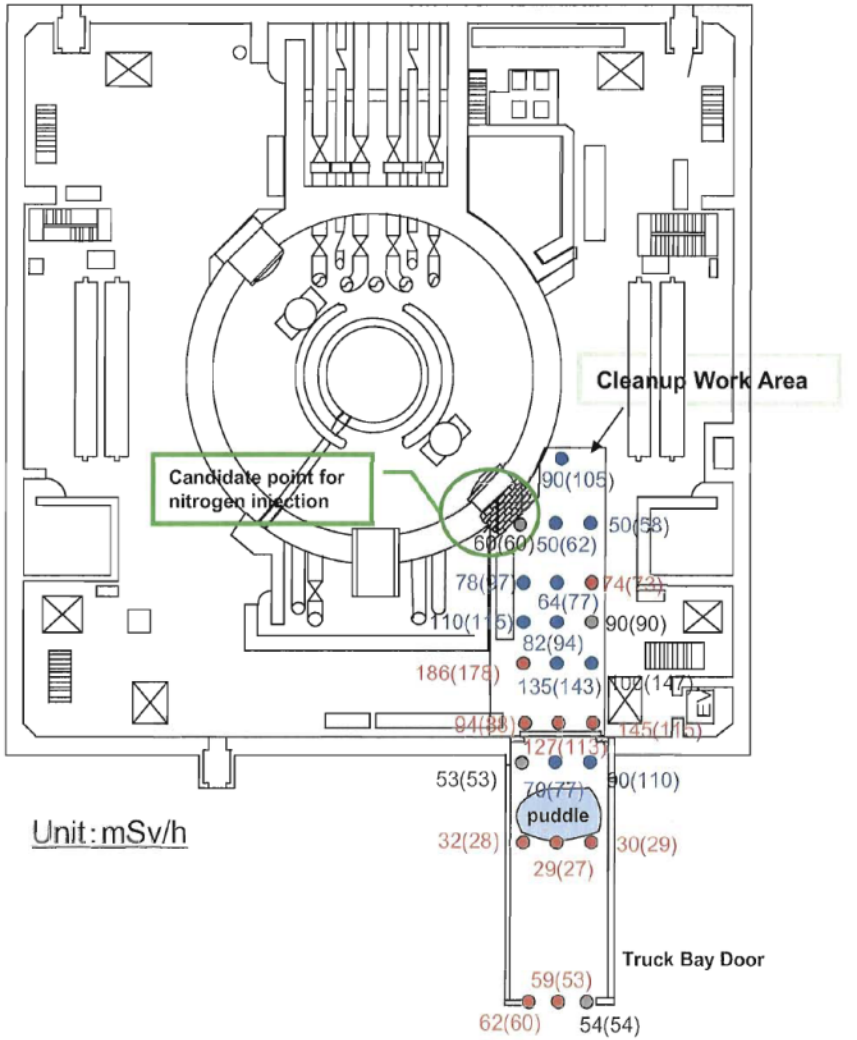
Survey Date: 11:00 – 18:30 July 6, 20111
Workers: 9 (TEPCO 5, Others 4)
Exposure dose: 2,41mSv～6.96mSv
Devices used : Warrior 1 unit, Packbot 1 unit
Survey Height : Approx. 2.5m high

(Notice)
The data in parentheses was measured on July 2.

July 3, 2011
Tokyo Electric Power Company

Result of radiation dose survey inside the Unit 3 reactor building in Fukushima Daiichi Nuclear Power Station

1st Floor of reactor building

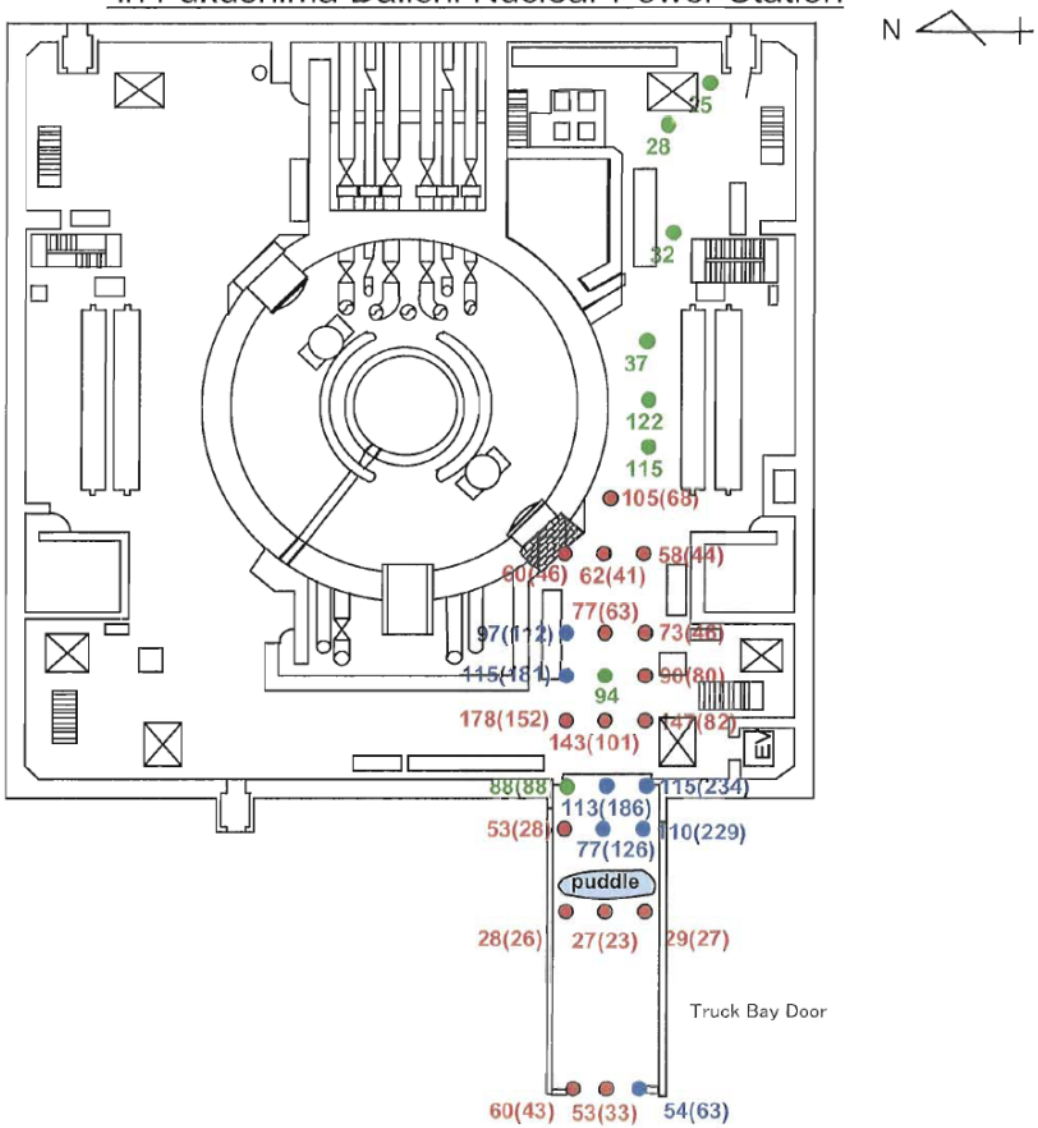


Survey Date: 10:59-12:14 on July 2, 2011
Workers: 5 (TEPCO 1, Others 4)
Exposure dose:1.10mSv～1.63mSv
Devices used : Packbot 2 units
Survey Height : Approx. 1m high

- Increase from survey on June 24
- No change from survey on June 24 (or previous data is not available)
- Decrease from survey on June 24

(note) data in the parenthesis is measured on June 24

Result of radiation dose survey inside the Unit 3 reactor building in Fukushima Daiichi Nuclear Power Station

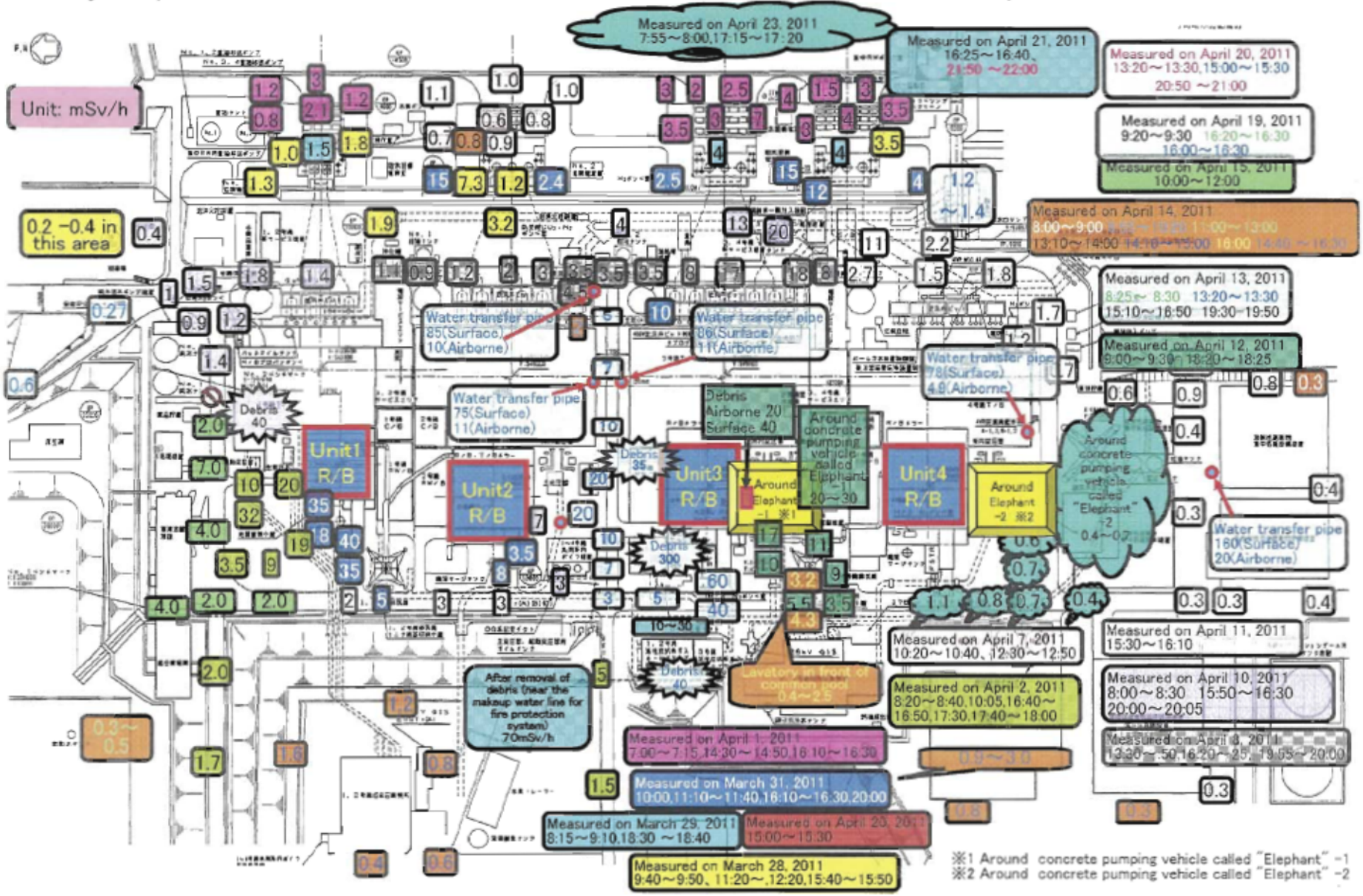


Survey Date: 10:31-12:42 on June 24, 2011
Workers: 5 (TEPCO 1, others 4)
Exposure dose: 1.17～1.76mSv
Devices used : Packbot 2 units
Survey Height : Approx. 1m high

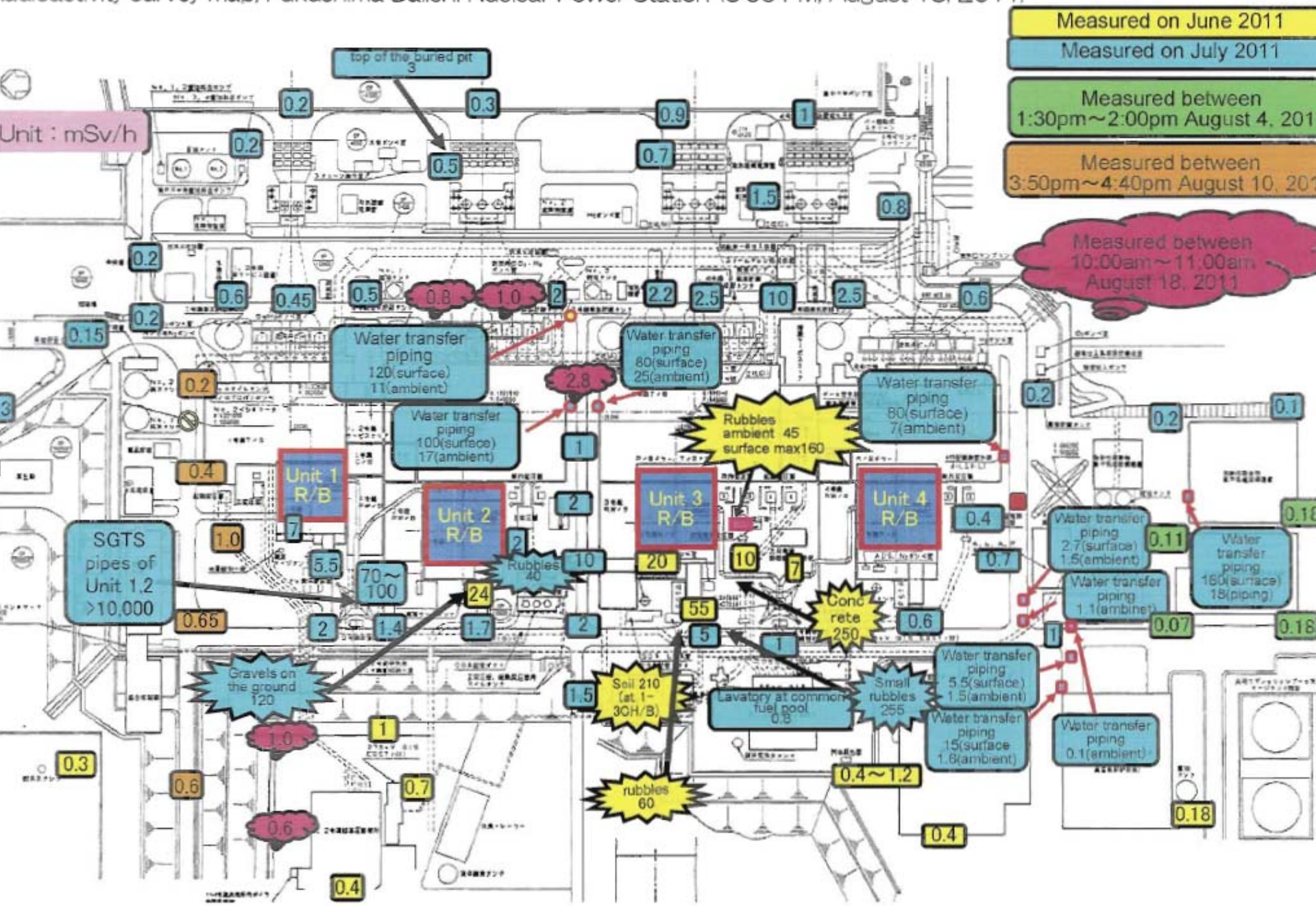
- Increase from previous survey
- No change from previous survey (or previous data is not available)
- decrease from previous survey

(note) data in the parenthesis is measured on June 8

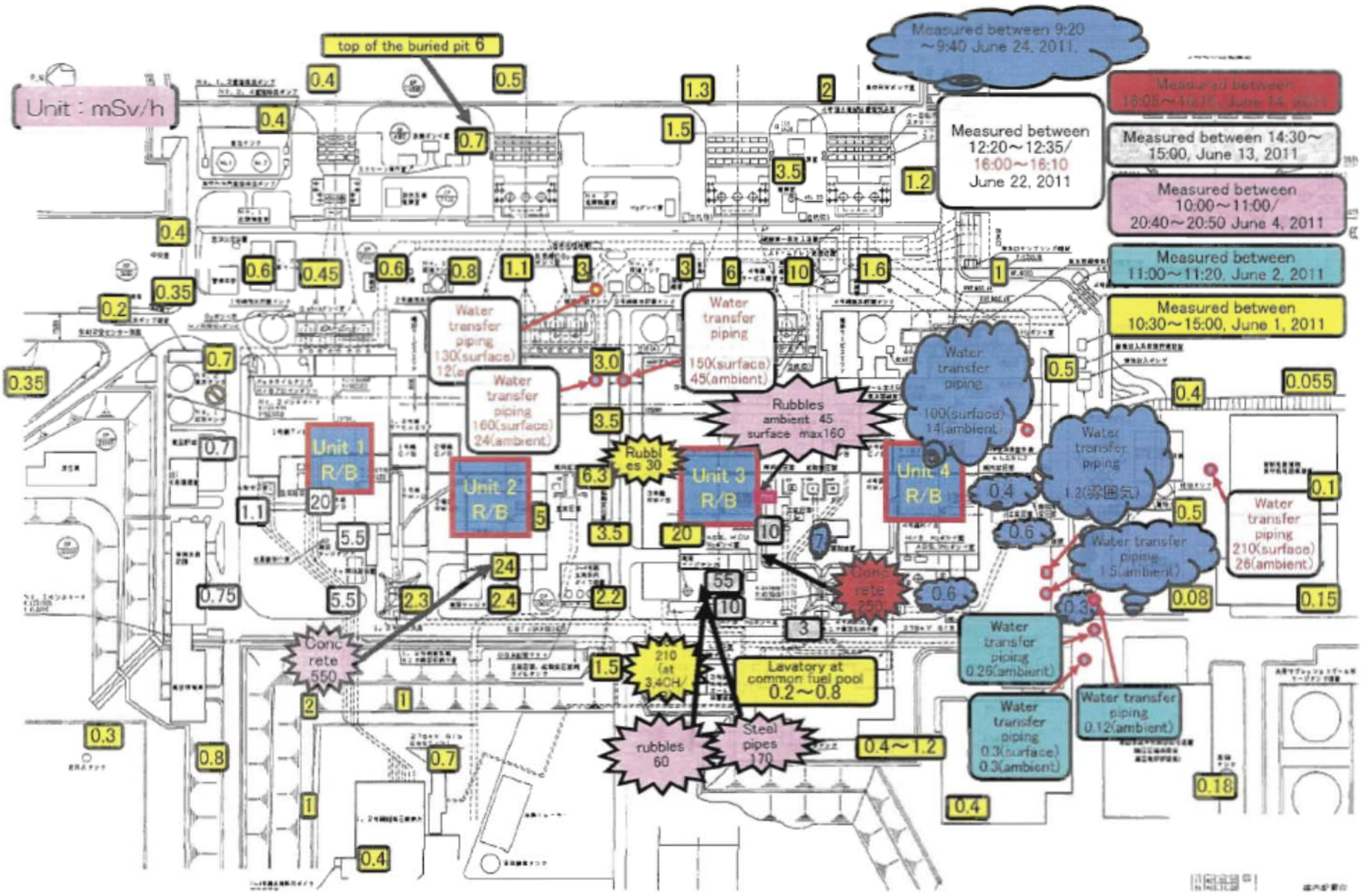
Survey map of Fukusima Daiichi Nucler Power Station as of 17:20 on April 23, 2011



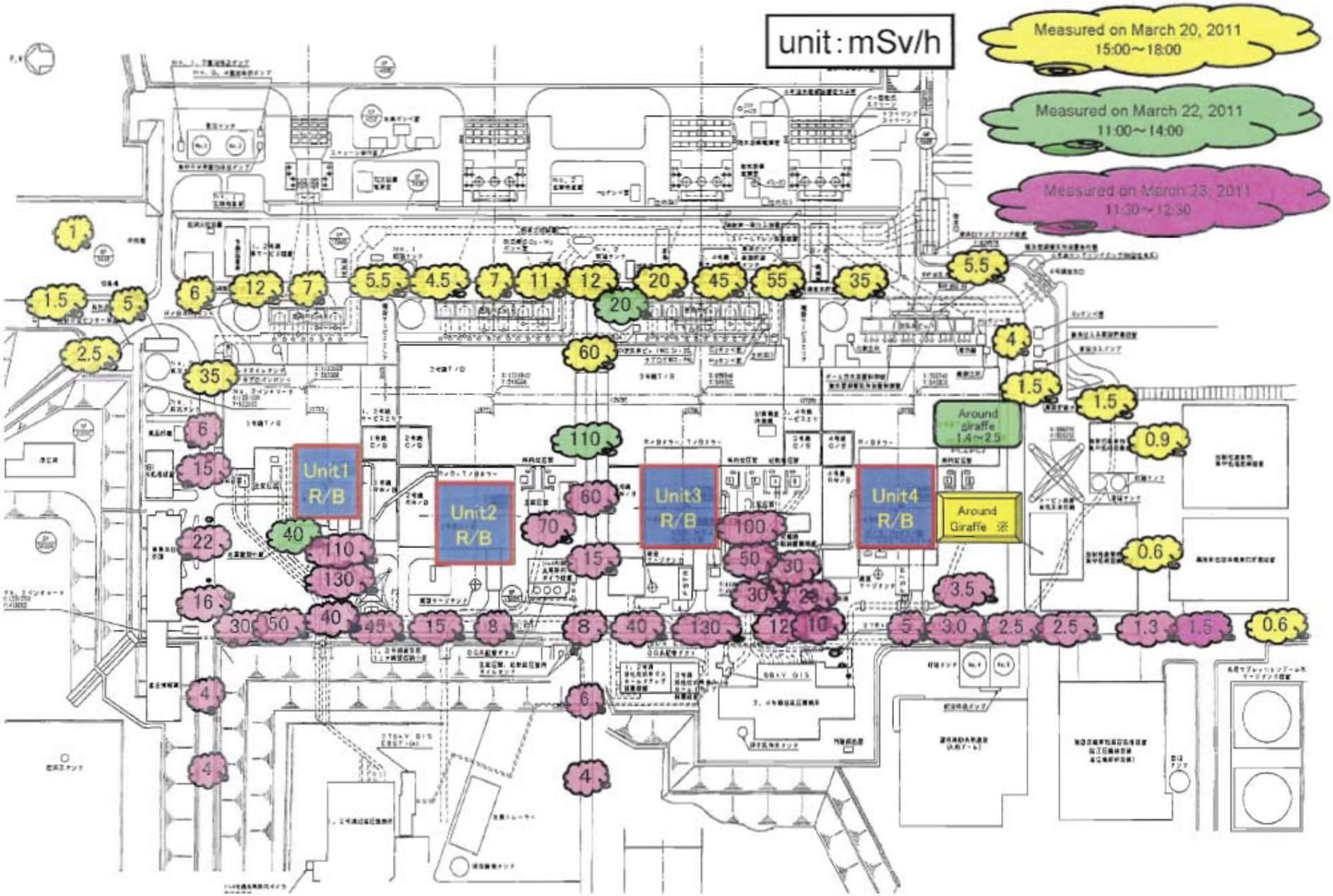
Radioactivity survey map, Fukushima Daiichi Nuclear Power Station (5:00 PM, August 18, 2011)



Radioactivity survey map, Fukushima Daiichi Nuclear Power Station (5:00 PM, June 24, 2011)

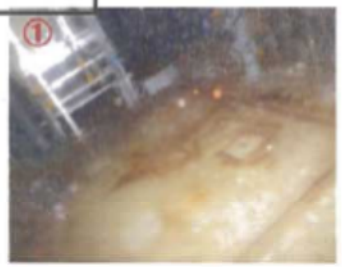


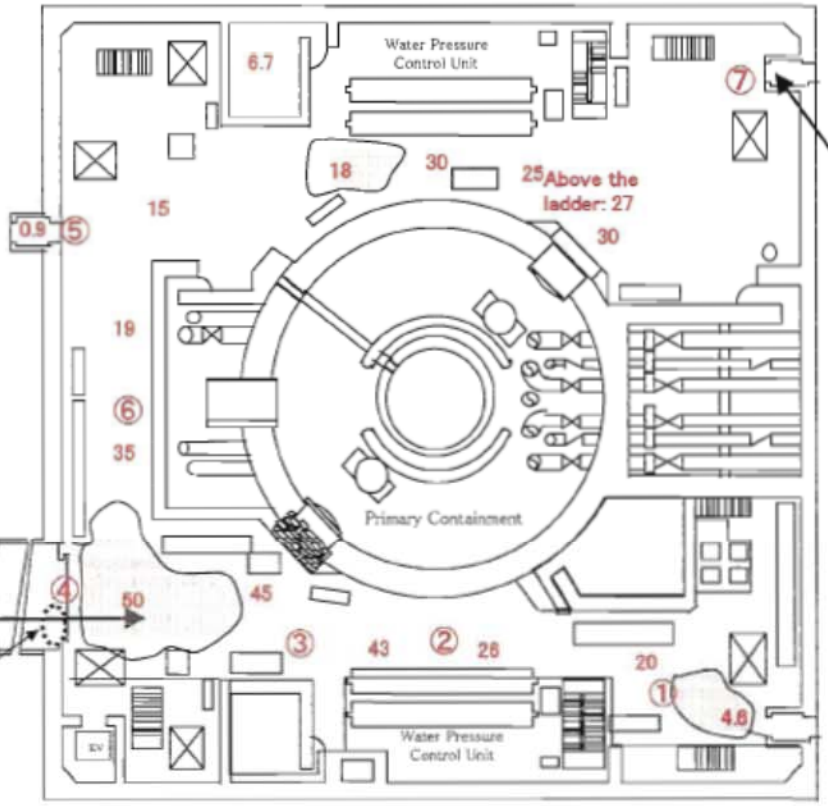
Survey map of Fukusima Daiichi Nucler Power Station on March 23, 2011



※ Around concrete pumping vehicle called "Giraffe"

Unit 2: The result of investigation of the inside the R/B (1st floor) and of radiation dose measurement.





Water dripping found around the upper side of the machine hatch (like light rain)

Inside door of carry-in gate for large stuff: partly open(approx. 1/3)

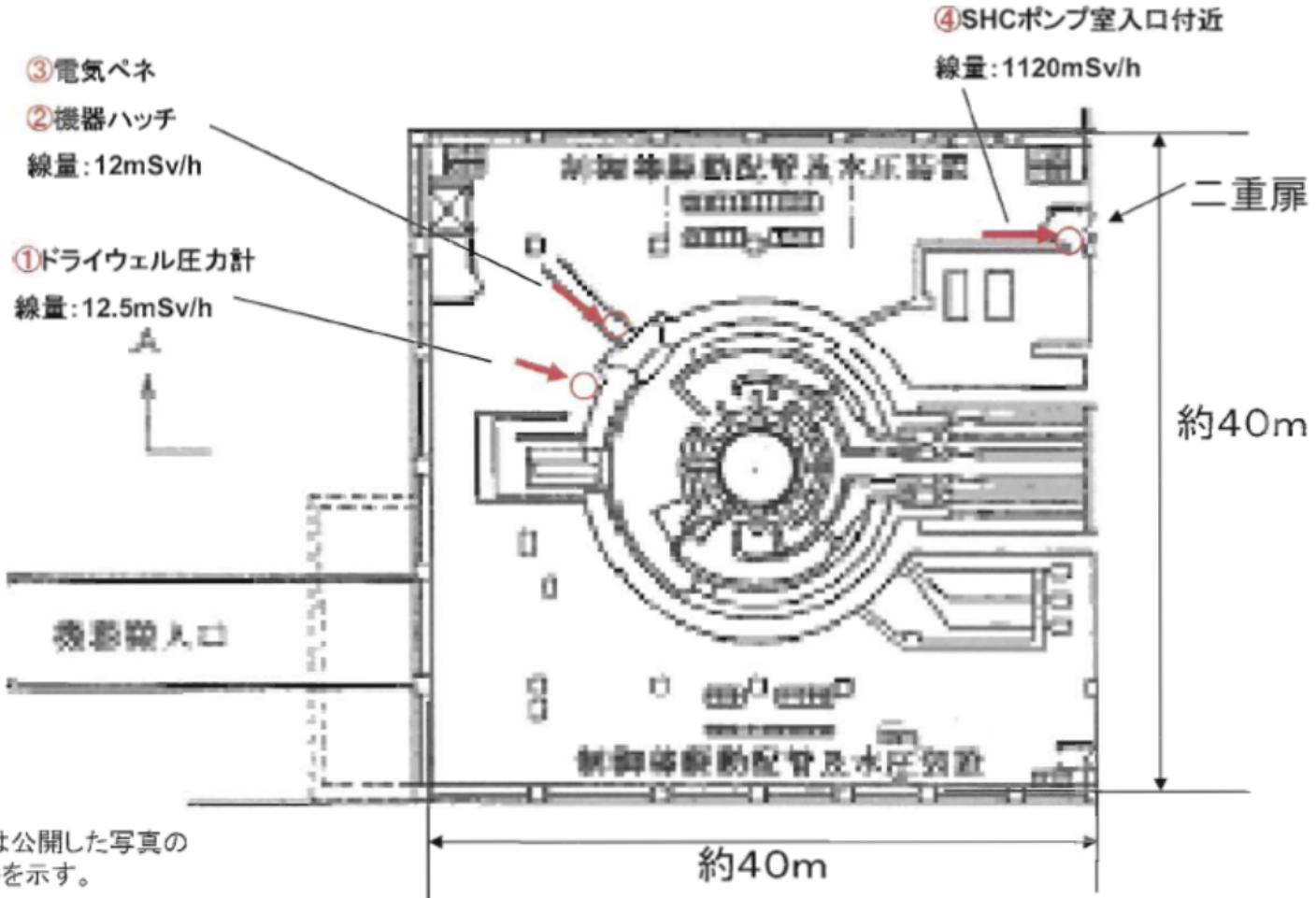
Inside door of air lock: Unable to be opend from inside.

: Puddle

Worker: 4 TEPCO employees
Equipment: Radiation protection suit
Tyvek
Anorak
Oxydem(oxygen tunk)
(weight: approx. 20kg)
Planned radiation dose: 10mSv
Actual radiation dose: 3.33 – 4.27mSv

< Investigation Result>
- Nuetron measurement result: 0mSv
- Surveyed all over the 1st floor, entering through the air lock in the south.
- The radiation dose data are shown in left.
- Temperature as well as humidity inside the building are both high.
- Sensible temperature rises as getting close to the northwest of the floor from the front of the carry-in gate for large stuff.
- Difficult for workers to stay in the area for more than 15 minutes due to physical capacity.

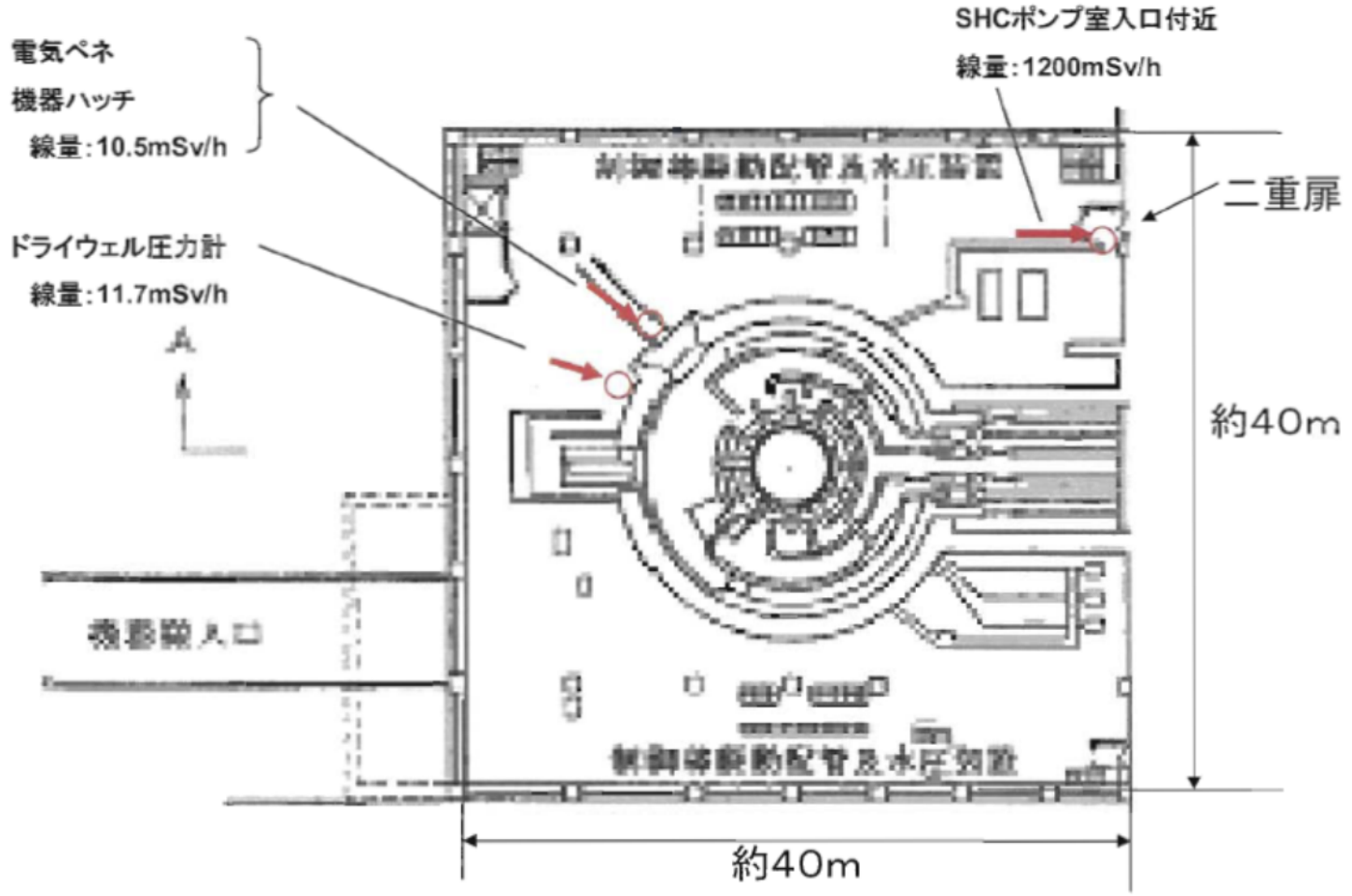
4月26日　1号機原子炉建屋内線量測定箇所及び測定結果



※①～④は公開した写真の
撮影順番を示す。

1号機原子炉建屋1階平面図

4月29日　1号機原子炉建屋内線量測定箇所及び測定結果

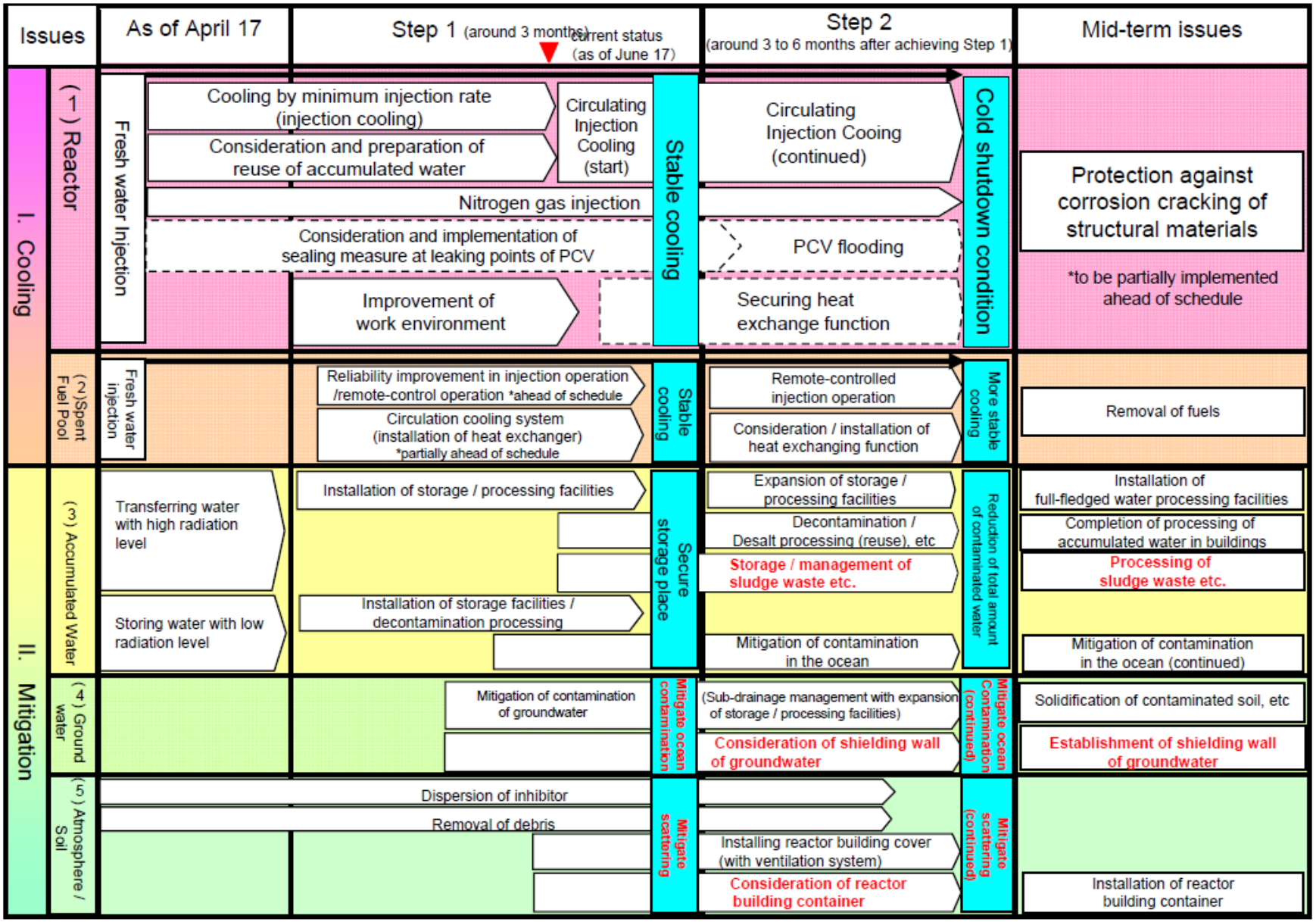


1号機原子炉建屋1階平面図

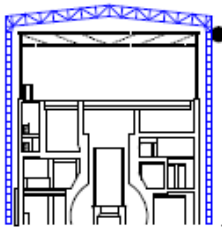
7. Future Efforts to Settle the Situation

Efforts to restore the Accident

Red colored: newly added to the previous version, Blue colored: modified from the previous version



Overview of Major Countermeasures in the Power Station as of June 17



Red colored: newly added to the previous version

piping | pumps | heat exchangers, water processing facilities

Reactor building cover (5, 50, 54, 55)

Full-fledged container (50, 56)

Cooling of spent fuel pool by external water injection (18, 22, 28)

Sampling of steam/pool water and measurement of radioactive materials (19)

Circulation cooling of spent fuel pool (23, 24, 25, 27)

Storage / management of sludge waste etc. (81)

Storage/process of low radiation-level water (33, 35, 40, 46)

Storage: tanks, megafloats, barges
Process: decontamination by zeolite

Lower the amount of steam generated (4)
Maintain and enhance countermeasures in Step 1 if needed (17)

Processing high radiation-level water (31,34,38,41,43,44)

Nitrogen gas injection (2, 11, 15)

Reactor Building

Tank

Water processing facility (Decontamination and desalt processing)

PCV venting (with filtration) (10)

Primary Containment Vessel (PCV)

Cooling at minimum water injection rate (7,12,14)
Reuse of processed water (45)
(Implement circulation cooling system)

Storage of high radiation-level water (30, 32, 37, 39, 42)

Flooding up to top of active fuel (3, 9)

Reactor Pressure Vessel (RPV)

Turbine Building

Steam Turbine

Additionally-installed Tank

Heat Exchanger

Centralized Waste Processing Building

Installation of heat exchangers (13)

Condenser

Injection of fresh water with pumps (1)

Suppression Chamber

Dispersion of inhibitor (47, 48, 52)
Removal of debris (49, 53)
Consideration of countermeasures for contaminated soil (51)

Processing of sub-drainage water after being pumped up (36)

Sealing the leakage location (6, 16)

Preventive measures against leakage of high radiation-level water (29)
Prevent contamination in the ocean (64)
Isolation of high-level radioactive water (65)

Prevent contamination of groundwater (66,67); Consideration of shielding wall of groundwater(68)

Seismic assessment (20),Continued monitoring (21),
(Unit 4) Installation of supporting structure under the bottom of spent fuel pool (26)

Improvement of life/work environment of workers(74,75); improvement of site environment(76)

Install various interconnecting lines of offsite power(8); enhance countermeasures against tsunami (69,70); planning of reinforcement work of each Unit (71); various countermeasures of radiation shielding (72,73)

Continue/Enhance monitoring (55~62), Consideration of necessary measures to reduce radiation dose (63)

Enhancement of radiation control (77,78); Enhancement of medical system (79,80)

Main points of Roadmap

Issues		Main points
I. Cooling	Reactor	• Nitrogen gas injection (Step I) • Circulation cooling system in which contaminated water accumulated in buildings is reused for reactor cooling (Step I, II)
	Spent fuel pool	• Circulation cooling system (Step I)
II. Mitigation	Accumulated water	• Installation of storage/processing facilities (Step I)
	Ground water	• Mitigation of contaminated ground water (Step I, II)
	Atmosphere /Soil	• Dispersion of inhibitor (Step I, II) • Removal of debris (Step I, II)

8.Responses at other Nuclear Power Stations

1. Emergency Safety Measures

- NISA instructed all electric power companies to implement emergency safety measures. (30 March)
- Based on the report from each electric utilities, NISA has confirmed that emergency safety measures had been appropriately implemented.(6 May)

2. Additional Emergency Safety Measures

- NISA and other relevant ministries are to improve and strengthen the emergency safety measures based on lessons learned from the accidents which are stated in the Government report to IAEA. (7 June)

3. Hamaoka NPS shutdown

- The government requested Chubu Electric Power Company to halt the operation of all units of Hamaoka NPS due to high possibility of large-scale tsunami resulting from the envisioned earthquake. (6 May)

4. Stress test

- The government announced to hold the stress test on NPPs. (6 July)

Outline of Emergency Safety Measures

Phase	Emergency Safety Measures	
	Short Term	Mid Term
Expected Time to Completion	Done	One to three years
Goals (Desired Level / Extent)	Preventing fuel damage and spent fuel damage even if (1)AC power supplies, (2)seawater cooling functions and (3)spent-fuel storage pool cooling functions are all lost.	Enhancing reliability of emergency safety measures (short term) (Securing/speeding up achievement of cold shutdown; measures against tsunami)
Examples of Specific Measures	【Securing Equipment】 ● Deploying power generator vehicles (to support cooling reactors and spent fuel pools) ● Deploying fire engines (to supply cooling water) ● Deploying fire hoses (to secure water supply routes from freshwater tanks, seawater pits, etc.) 【Preparing Procedural Manuals, Etc.】 ● Preparing procedural manuals for emergency responses utilizing the above-mentioned equipment 【Training to Respond】 ● Implementing training for emergency responses based on the procedural manuals 【Measures Against Flooding】 ● Measures to prevent flooding at reactor buildings assuming approx. 15-meter-high tsunami	【Measures Against Assumed approx.15-Meter Tsunami】 ●Building seawalls ●Installing water-tight doors 【Measures to Secure/Speed Up Achievement of Cold Shutdown】 ●Installation of air-cooled diesel power generators ●Securing back-up electric motors for seawater pumps ●Actions needed for other necessary equipment

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

Fuel Pool

Reactor Containment

Emergency Diesel Power Generator

External Power Supply

DC Power Supply (Battery)

Reactor Pressure Vessel

Alternative Water Injection

Reactor Core Isolation Cooling System

Emergency Reactor Cooling System

Pressure Suppression Chamber Cooling Pump

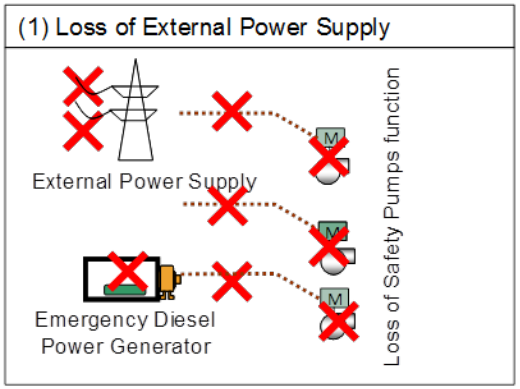
Ventilation Stack

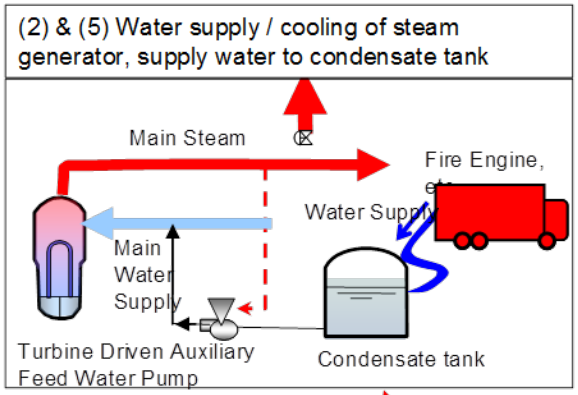
Sea Water Pump

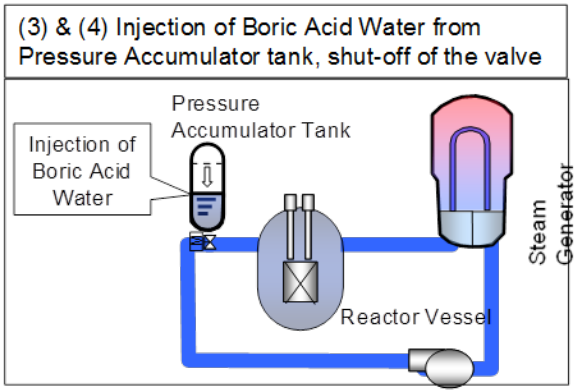
Pressure Suppression Chamber

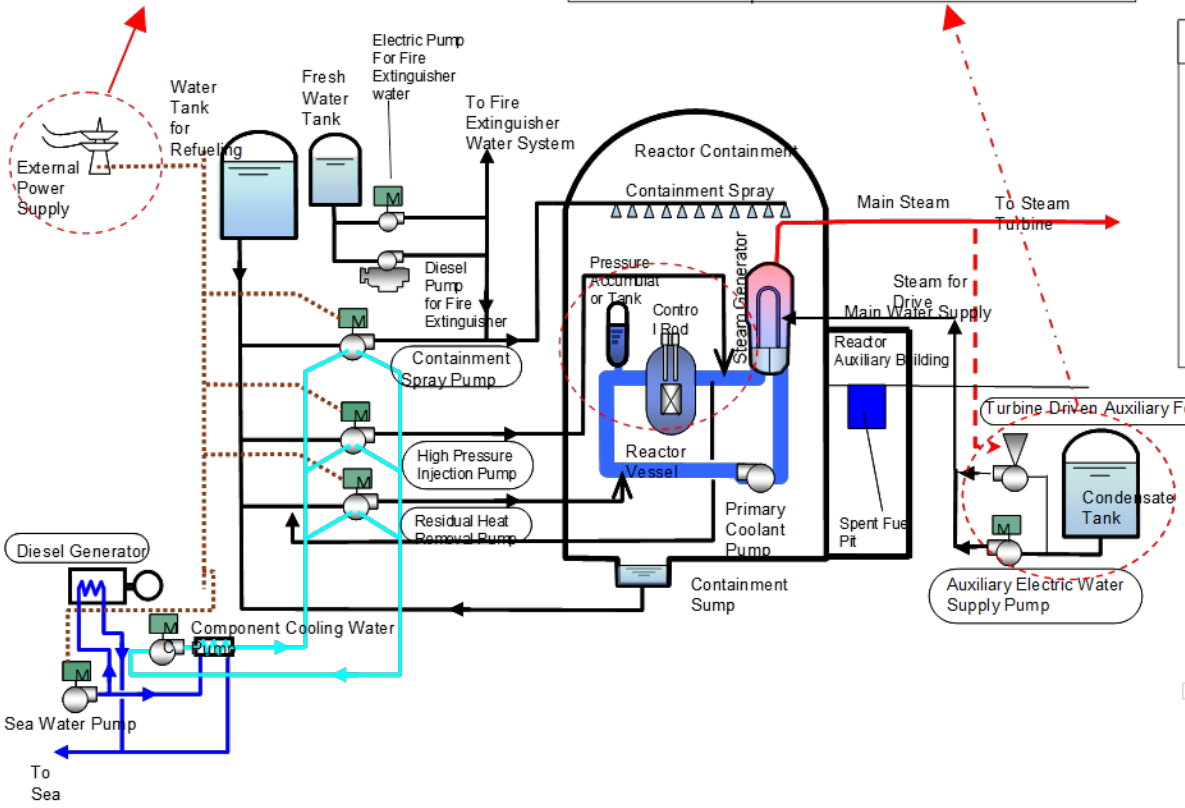
Pressure Suppression Chamber

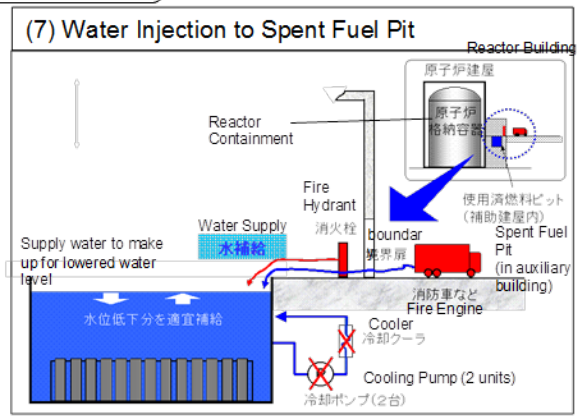
Series of Events and Countermeasures in case of tsunami, for PWR











浸水対策（関西電力の例）

扉のシール

配管貫通部のシール

津波から守るため浸水対策を実施

中央制御室に給電するために必要な設備（バッテリー室／メタクラ室）
蒸気発生器に給水するために必要な設備（ポンプ室／メタクラ室）

さらなる安全裕度向上対策（関西電力の例）

電源確保策の強化

【恒設非常用電源の追設】
（中長期で対応）

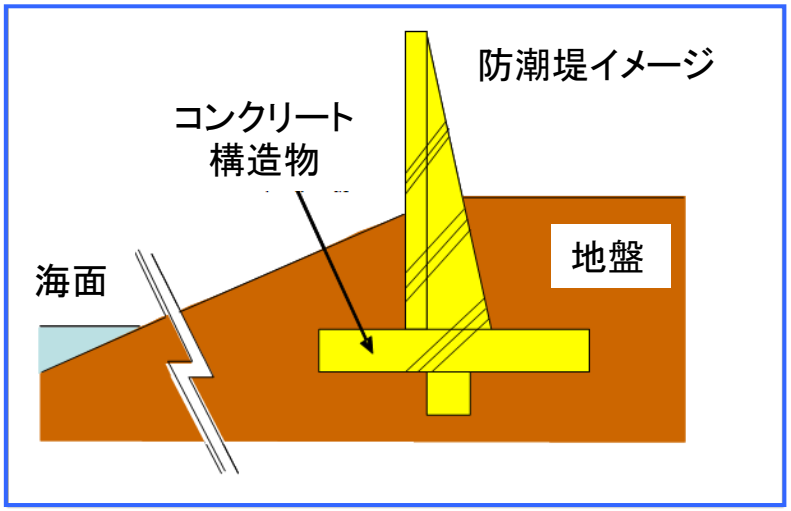
【送電線の強化】
（建替など中長期で対応）

水源確保策の強化

【仮設大容量海水ﾎﾟﾝﾌﾟの配備】
（平成23年12月予定）

【海水ﾎﾟﾝﾌﾟﾓｰﾀ予備品の配備】
（平成24年3月予定）

浸水対策の強化



【防潮堤の設置】
（中長期で対応）

○ 開閉所等を含む浸水対策
（中長期で対応）

（その他の対策）

○ 発電所アクセス道路の整備
（中長期で対応）

○ 免震事務棟の新設
（中長期で対応）

9.Conclusion on Fukushima Accident

1. Nuclear Power Plant contains a lot of the high radioactive materials and we should not release these to the public. Fukushima made the bad organizational mistakes in TEPCO and regulatory body.
2. We have to remember the basic safety philosophy of the nuke.
3. The complicated structures and organizations can result in delay in urgent decision making.
4. In the case of severe accident, the water , the electricity and the instrumentaion are essential.
5. Right now, the temperatures in the reactor cores were under 70 degree which mean stable.

Conclusion on Nuclear Renaissance

1. Before Fukushima accident, 438 new NPSs will be expected to start operation by 2025.
2. After Fukushima, Germany, Italy, Switzerland, Spain will quit the new construction of NPSs.
3. USA and Japan will delay the new construction.
4. China,India,Finland,and the new countries like Vietnam and UAE will continue to construct NPSs.
5. On Oct 30,2011 there are 7 billion people in the world and we need more energy. We have to make the required modifications for the public to feel the safety of the nuclear and continue its new constructions


Thank you for your attention
For more information, please visit:
www.isoe-network.net
www.nea.fr