Current Status of Fukushima and Chelnobyl Benchmark Visit

ISOE Fort Lauderdale Symposium

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IAEA,OECD/NEA ISOE Committee 7th Chairman

Severe Accident Management (SAM) Chairman

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2.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 , 19 thousands people were killed.

300 billion US Dollar damage is estimated.

No one has been 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
宮古市
岩手
小笠原
<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

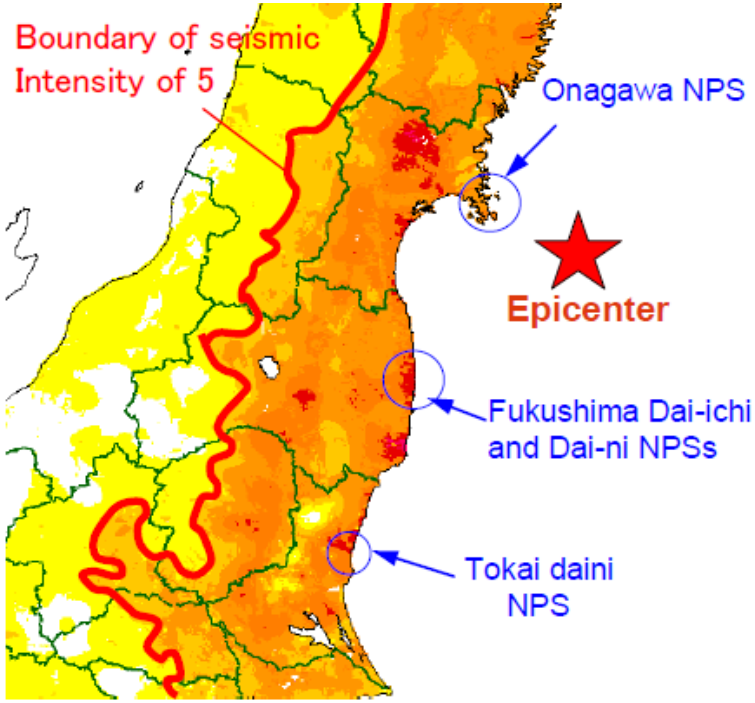
Top of Tsunami
40m(130ft)

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

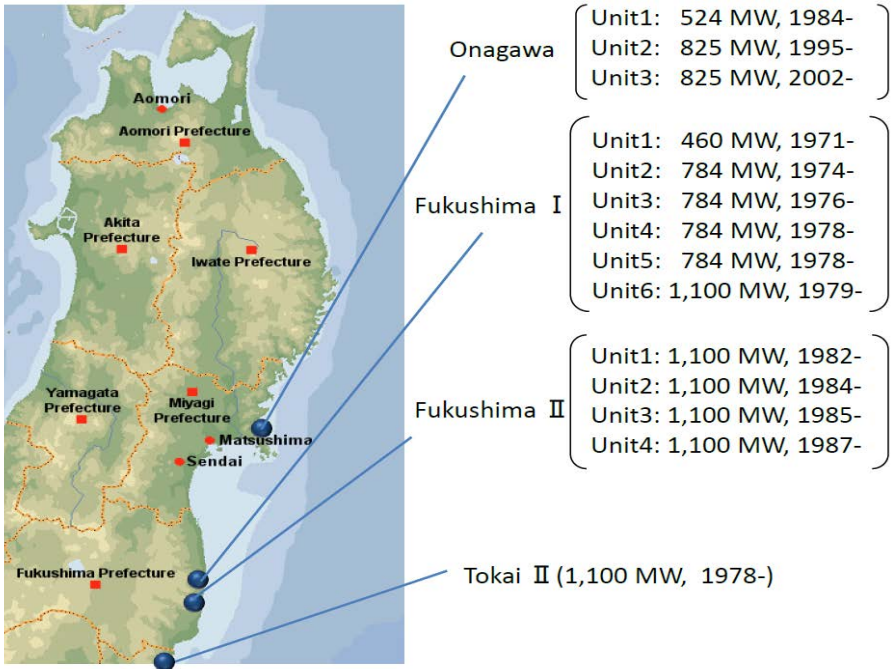
Onagawa NPS was safe

- Unit-1 is 524 MW BWR,Unit-2 and3 are 825 MW BWR
- One civil engineer insisted the ground level of Reactor Building should be above 14m from Pacific Ocean considering the past Jorgan Tsunami.
- Onagawa people are mainly fishermen. 1000 people were killed by Tsunami. 360 fishermen climbed up to Onagawa NPS to escape from Tsunami. The Site manager accepted them to the sport gym next to R/B where they stayed 3 months supported by the emergency foods and so on.
- JSME will give the awards to him on Nov 2 this year.

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.**

3. Current Status of Fukushima

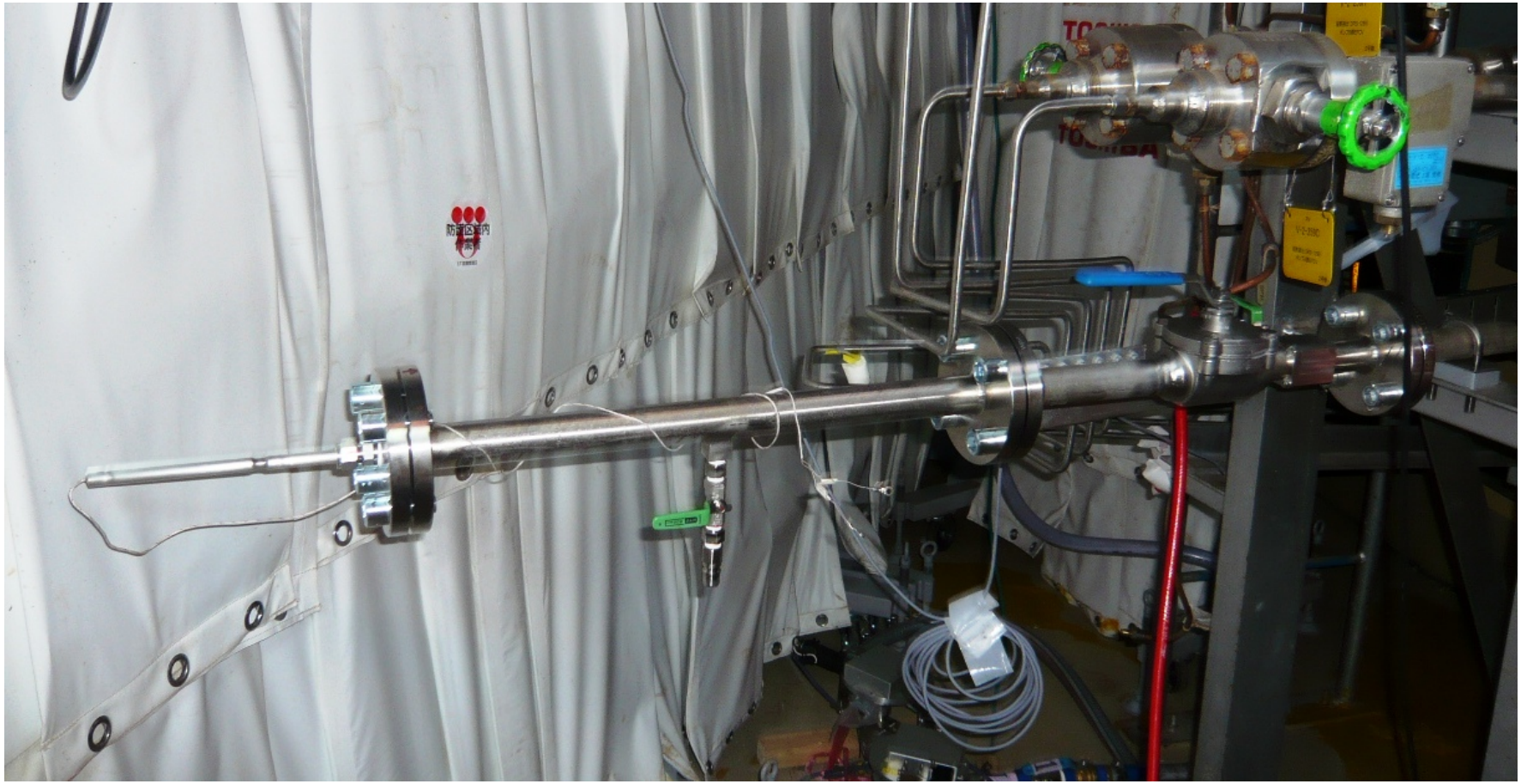
Current status of Fukushima NPPs

- Reactors: A condition equivalent to Cold Shutdown
  - Temperature of RPV bottom is, in general, below 100℃.
  - Release of radioactive materials from PCV is under control and public radiation exposure by additional release is being significantly held down.
    (Not exceed 1 mSv/y at the site boundary as a target.)
  - Mid-term Safety of Circulating Water Injection Cooling System

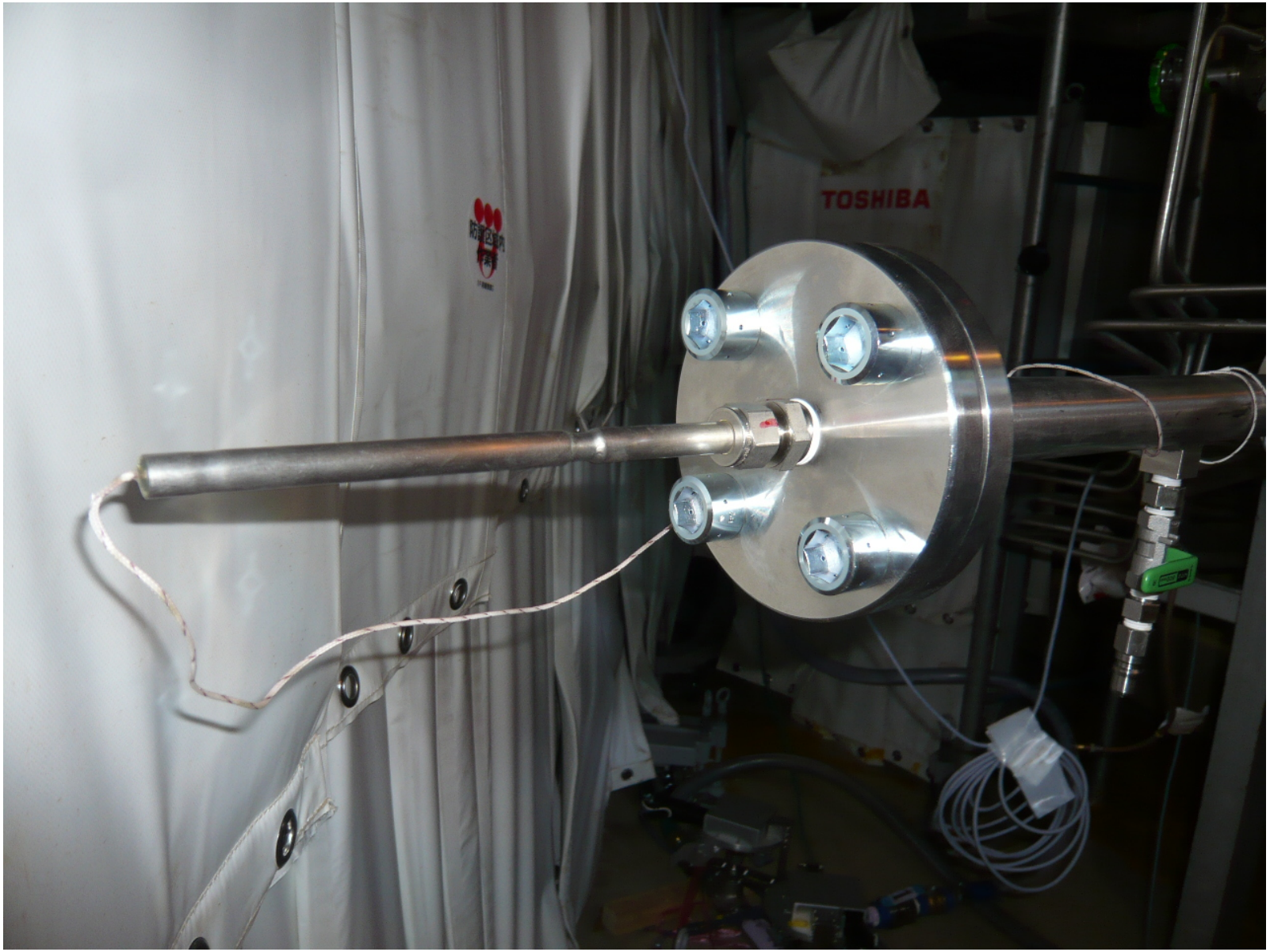
- Spent Fuel Pools: More stable cooling
  - Circulating Cooling System by installation of heat exchanger

- Radioactive Contaminated Water: Reduction of total amount
  - Full-fledged processing facilities
  - Desalination processing (reuse)
  - Storage
  - Mitigation of contamination in the ocean

1F2 New Temperature Gauge was instoled on Oct,2012



1F2 New Temperature Gauge was instoled on Oct,2012

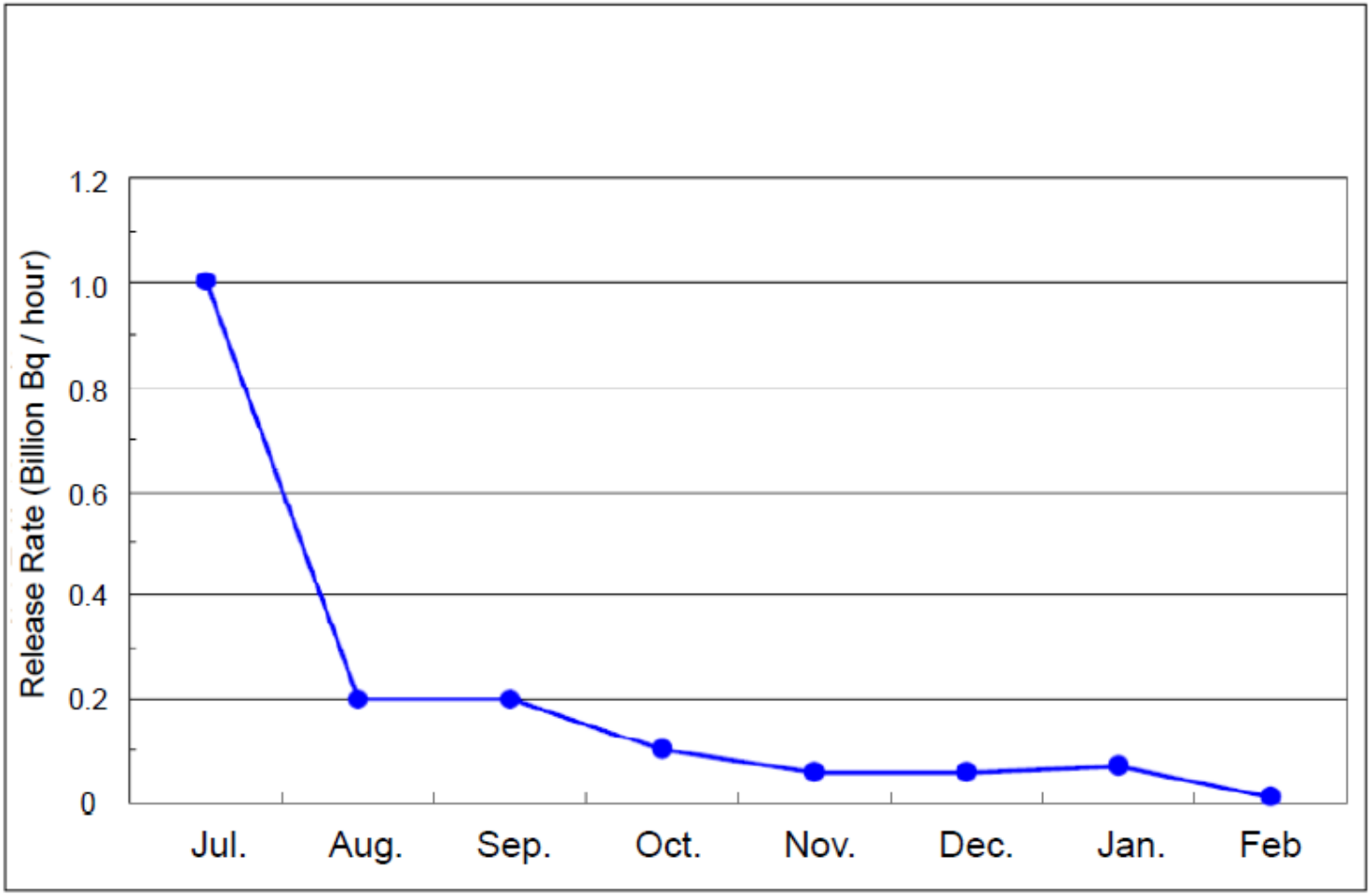


1F2 New Temperature Gauge was instoled on Oct,2012


ANN
NEWS
2号機
格納容器

Release Rate of Radioactive Materials from PCVs of Units 1-3

- Current total release rate of Cesium 134 and 137 from PCVs of Units1-3 is estimated to be approx. 0.01 billion Bq/h at the maximum. (1/77,000,000 of early stages of the accident)

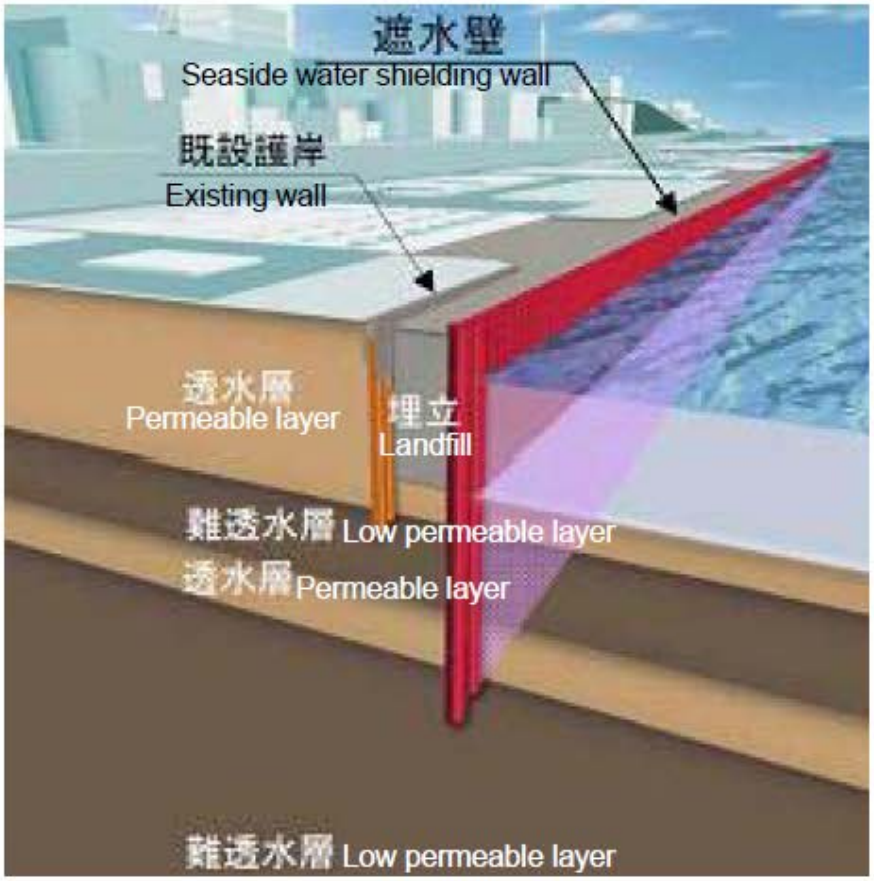


Construction of Water Shielding Wall

- A measure to prevent contamination of the ocean via the underground water.

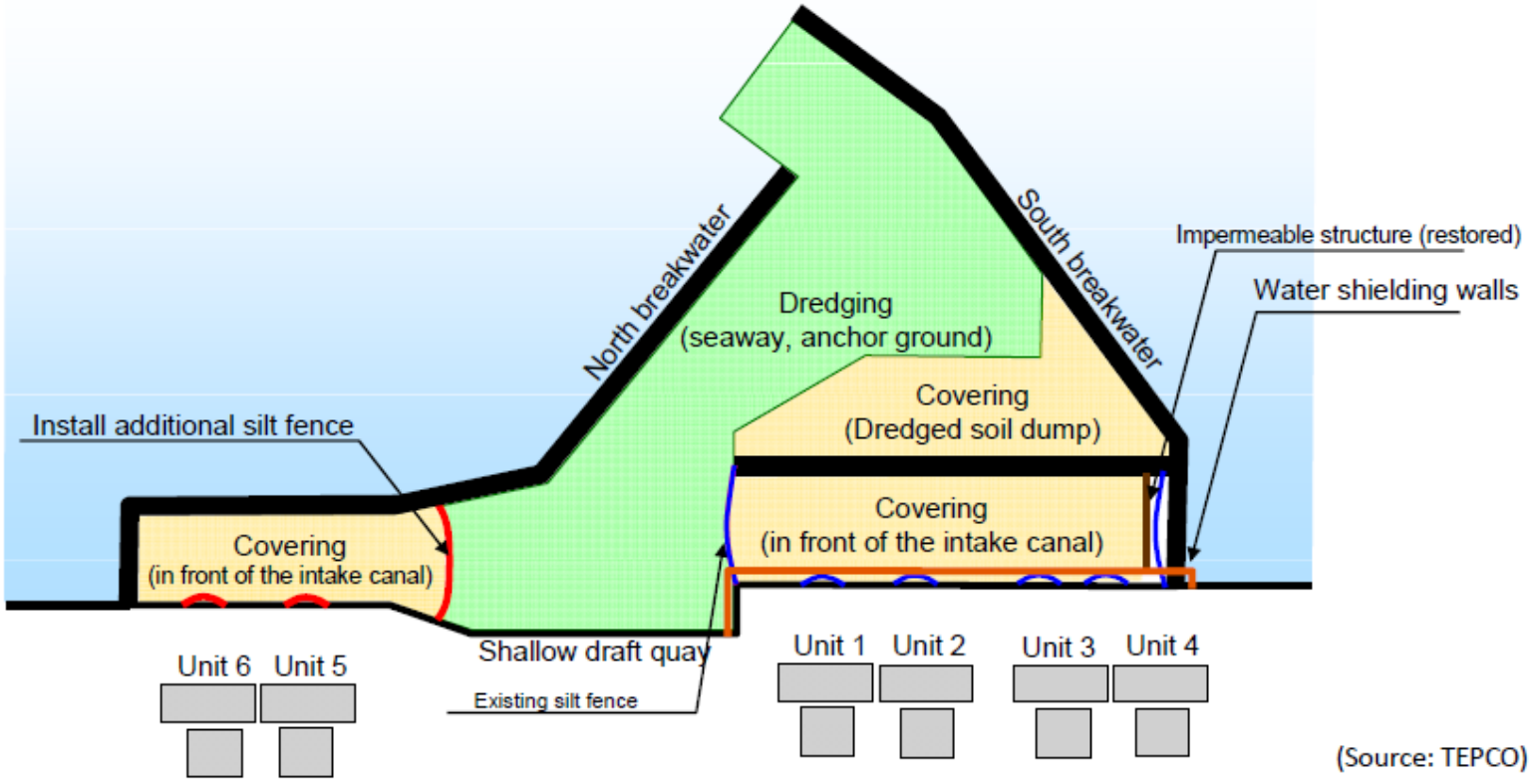
Image of water shielding walls

Cross-section view



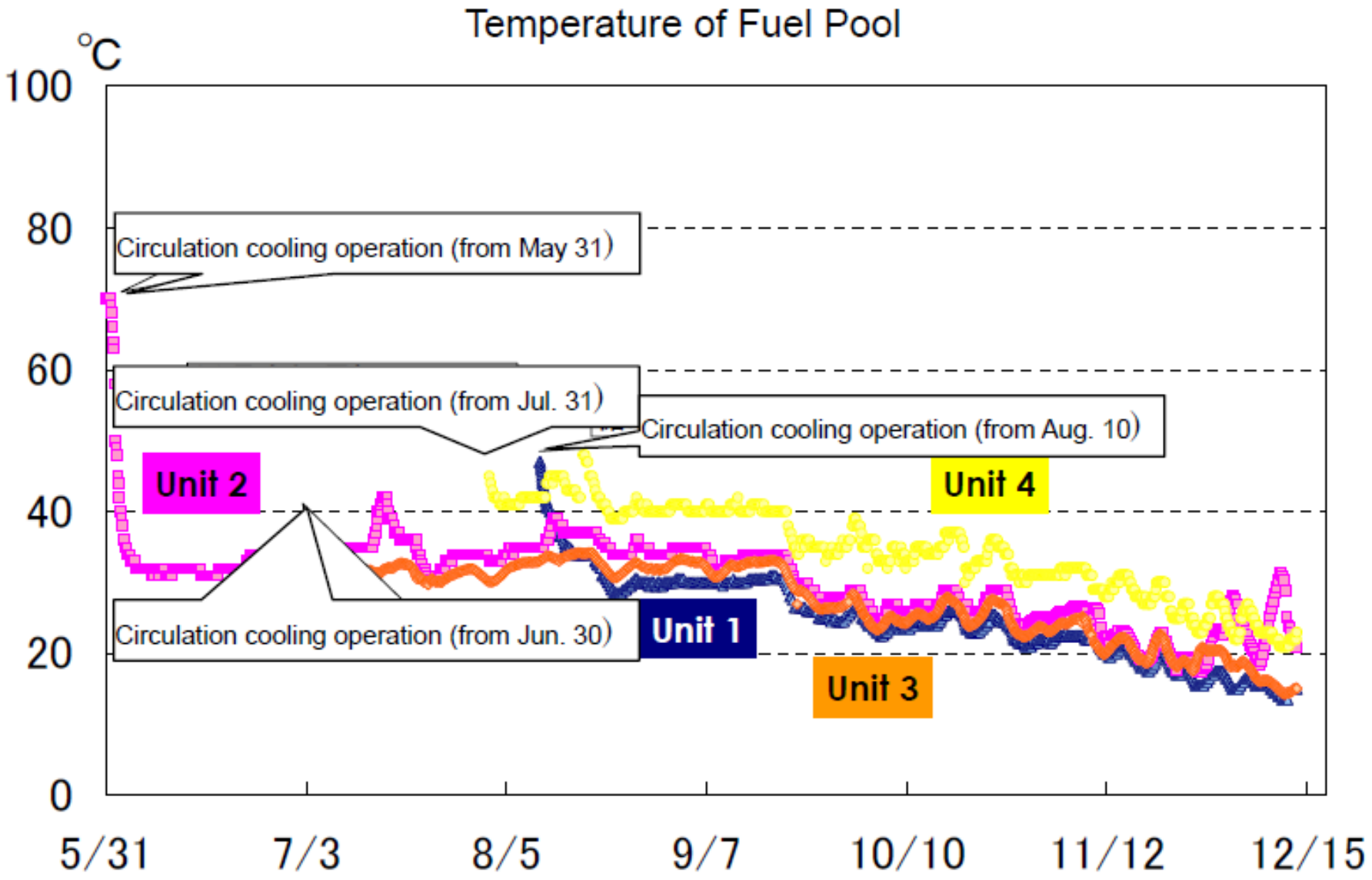
Start of Marine Soil Covering Construction at Inside Port

- High contaminated radioactive materials were detected from marine soil sampled at inside of the port
- To prevent contamination of the ocean outside of the port, marine soil in front of the intake canal is planned to be covered with solidified soil.



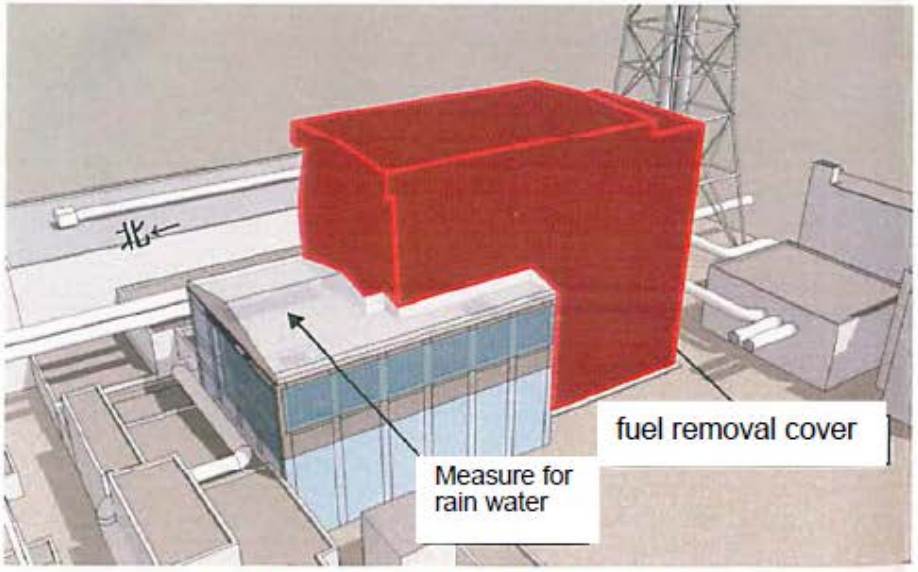
(Source: TEPCO)

Inside the Unit 4's Spent Fuel Pool

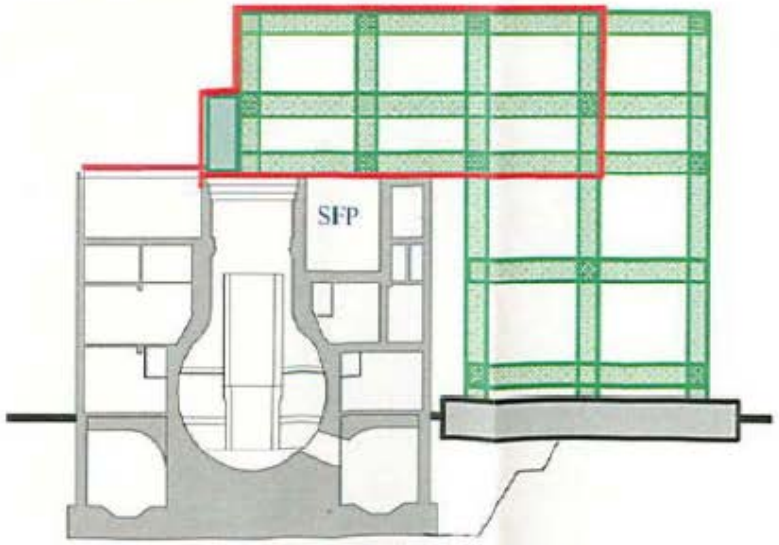

Temperature of Fuel Pool
℃
100
80
60
40
20
0
Circulation cooling operation (from May 31)
Circulation cooling operation (from Jul. 31)
Circulation cooling operation (from Aug. 10)
Circulation cooling operation (from Jun. 30)
Unit 2
Unit 4
Unit 1
Unit 3
5/31
7/3
8/5
9/7
10/10
11/12
12/15

Prepare for Fuel Removal from SFP of Unit 4

- Fuel removal are planned to be initiated in autumn 2013.
- Currently Rubble is being removed to prepare for the relevant works.
- Construction of covering structure will be initiated in spring 2013.

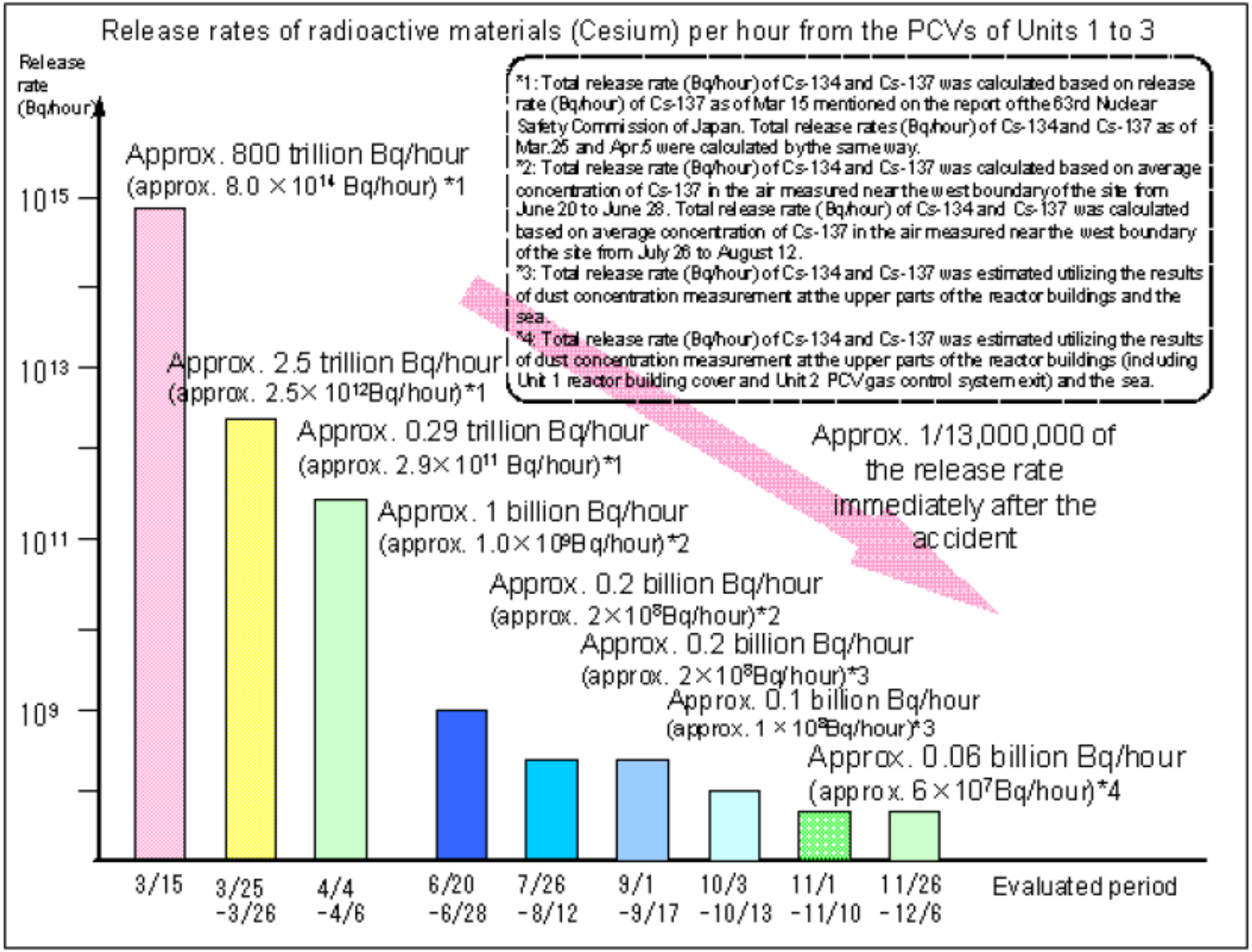


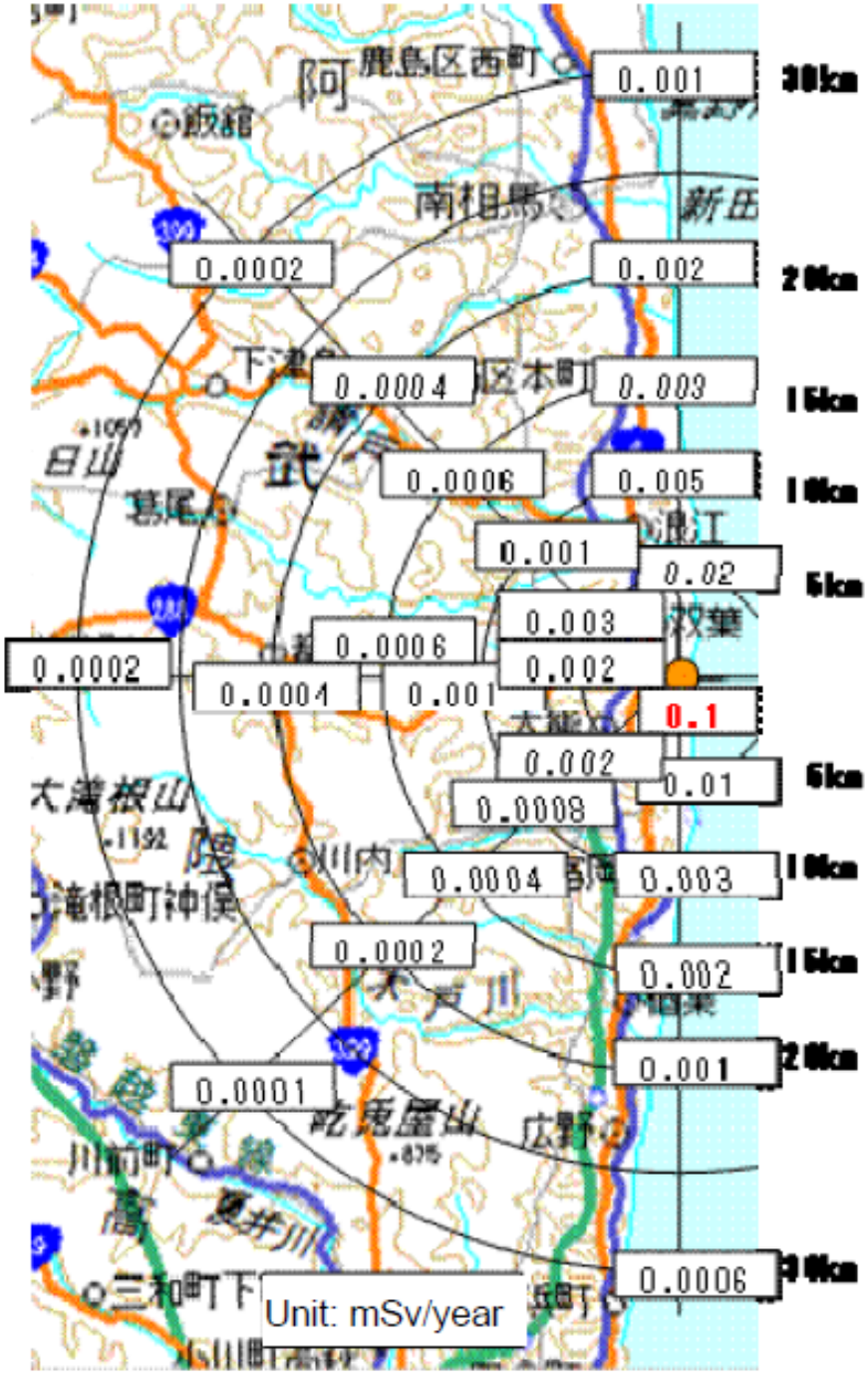
Building image of fuel removal cover



Cross-section diagram

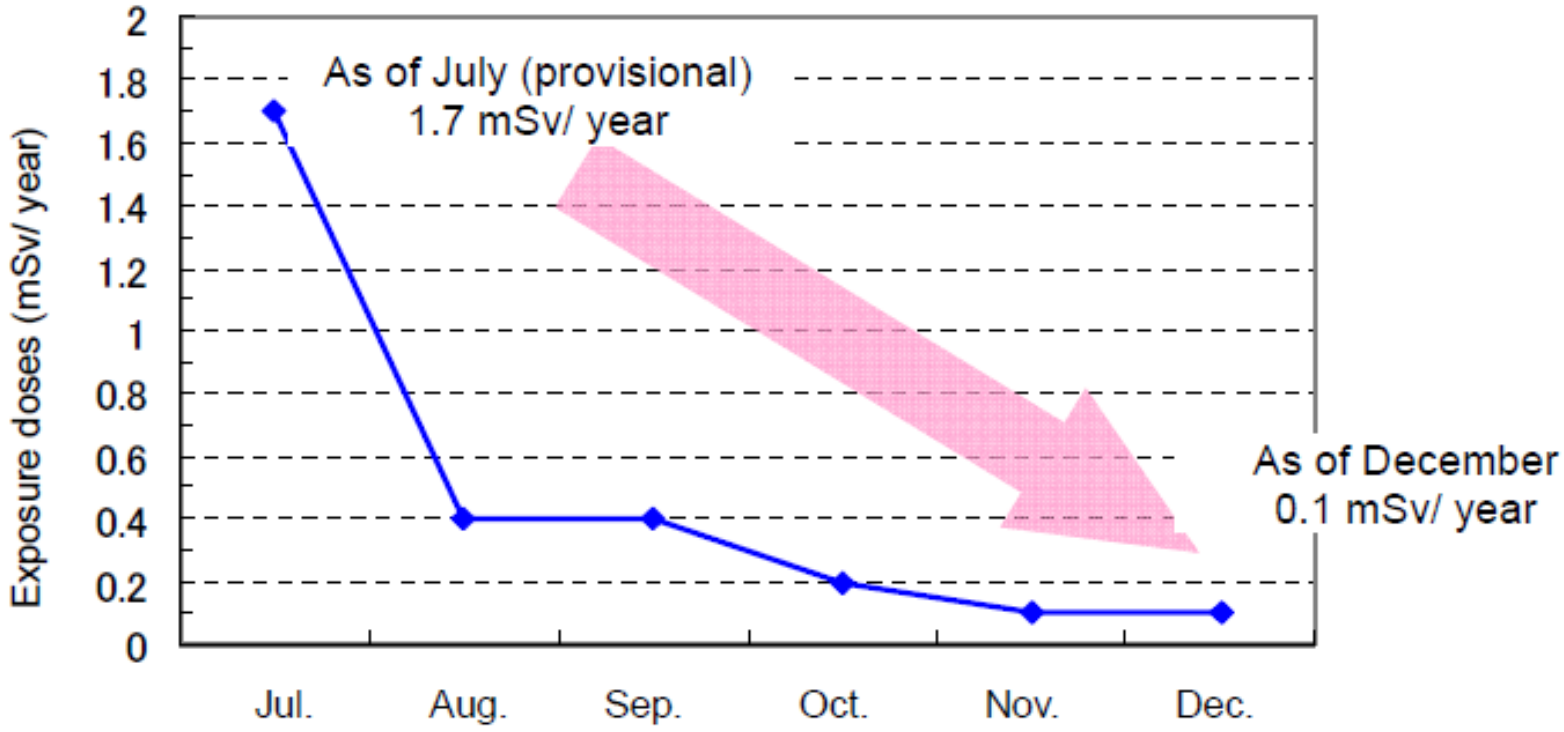
(Source: TEPCO)


Release rates of radioactive materials (Cesium) per hour from the PCVs of Units 1 to 3
Release rate (Bq/hour)
10^{15}
10^{13}
10^{11}
10^{9}
Approx. 800 trillion Bq/hour
(approx. 8.0 × 10^{14} Bq/hour) *1
Approx. 2.5 trillion Bq/hour
(approx. 2.5× 10^{12}Bq/hour)*1
Approx. 0.29 trillion Bq/hour
(approx. 2.9× 10^{11} Bq/hour)*1
Approx. 1 billion Bq/hour
(approx. 1.0× 10^{9}Bq/hour)*2
Approx. 0.2 billion Bq/hour
(approx. 2× 10^{8}Bq/hour)*2
Approx. 0.2 billion Bq/hour
(approx. 2× 10^{8}Bq/hour)*3
Approx. 0.1 billion Bq/hour
(approx. 1 × 10^{8}Bq/hour)*3
Approx. 0.06 billion Bq/hour
(approx. 6× 10^{7}Bq/hour)*4
*1: Total release rate (Bq/hour) of Cs-134 and Cs-137 was calculated based on release rate (Bq/hour) of Cs-137 as of Mar 15 mentioned on the report of the 63rd Nuclear Safety Commission of Japan. Total release rates (Bq/hour) of Cs-134 and Cs-137 as of Mar.25 and Apr.5 were calculated by the same way.
*2: Total release rate (Bq/hour) of Cs-134 and Cs-137 was calculated based on average concentration of Cs-137 in the air measured near the west boundary of the site from June 20 to June 28. Total release rate (Bq/hour) of Cs-134 and Cs-137 was calculated based on average concentration of Cs-137 in the air measured near the west boundary of the site from July 26 to August 12.
*3: Total release rate (Bq/hour) of Cs-134 and Cs-137 was estimated utilizing the results of dust concentration measurement at the upper parts of the reactor buildings and the sea.
*4: Total release rate (Bq/hour) of Cs-134 and Cs-137 was estimated utilizing the results of dust concentration measurement at the upper parts of the reactor buildings (including Unit 1 reactor building cover and Unit 2 PCV gas control system exit) and the sea.
Approx. 1/13,000,000 of the release rate immediately after the accident
3/15
3/25 -3/26
4/4 -4/6
6/20 -6/28
7/26 -8/12
9/1 -9/17
10/3 -10/13
11/1 -11/10
11/26 -12/6
Evaluated period


0.001
0.0002
0.002
0.0004
0.003
0.0006
0.005
0.001
0.02
0.003
0.0006
0.0002
0.002
0.0004
0.001
0.1
0.002
0.01
0.0008
0.0004
0.003
0.0002
0.002
0.001
0.0001
0.0006
Unit: mSv/year

Exposure doses in case the release rate from the PCVs of Units 1 to 3 at the time of the evaluation continues for one year (mSv/year)

(Excluding the effect of the already released radioactive materials)



Protected Areas

March 12-15 **April 12** **Present**

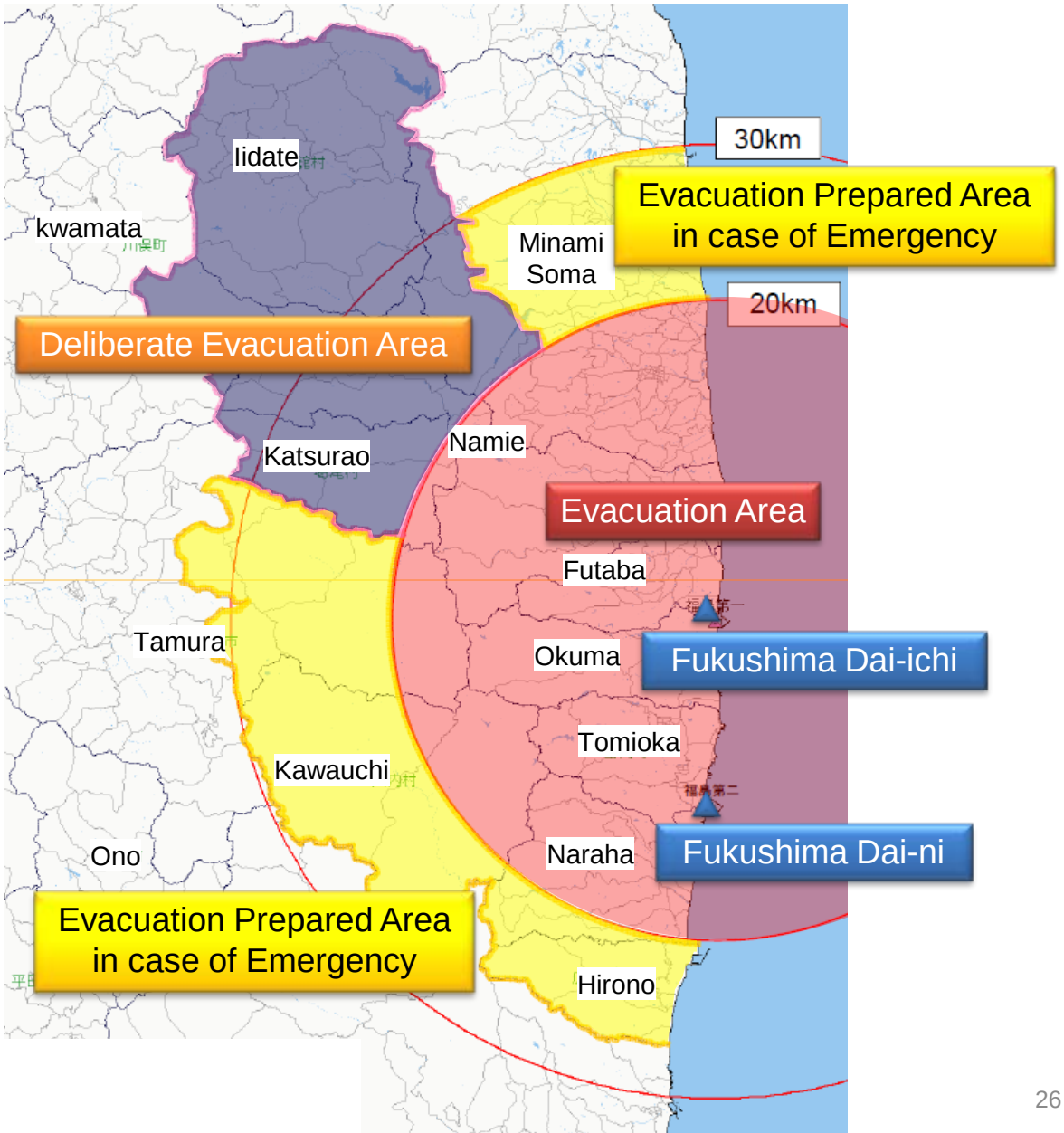
Evacuation Area

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



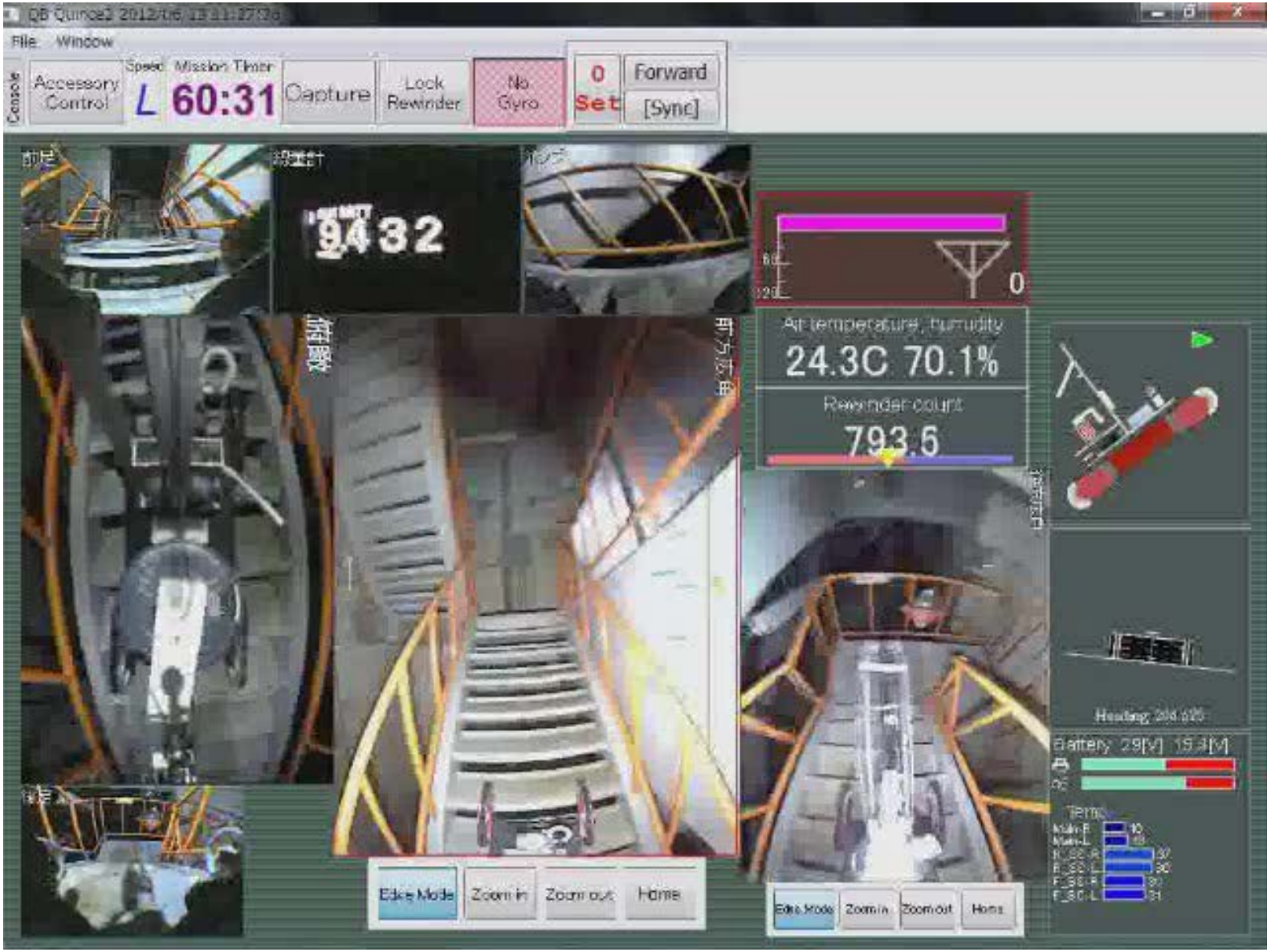
In-house evacuation area excluding deliberate evacuation area was renamed as evacuation prepared area in case of emergency.
Deliberate evacuation area needed to establish for specific areas beyond 20km radius where radioactive materials are to be accumulated at high levels.

1F1 Reactor Building
Operating Floor
on Oct 2012

1F4 RPV Head Removal on Oct 2012

1F4 Spent Fuels Removal from Spent fuel Pool

1F2 Inside Reactor Building


File Window
Console
Accessory Control
Speed Mission Timer
L 60:31
Capture
Lock Rewinder
No Gyro
0
Set
Forward
[Sync]
9432
0
Air temperature, humidity
24.3C 70.1%
Rewinder count
793.6
Edge Mode
Zoom in
Zoom out
Home
Edge Mode
Zoom in
Zoom out
Home
Battery 29[V] 15.3[M]
Temp

1F3 Above Operating Floor of R/B

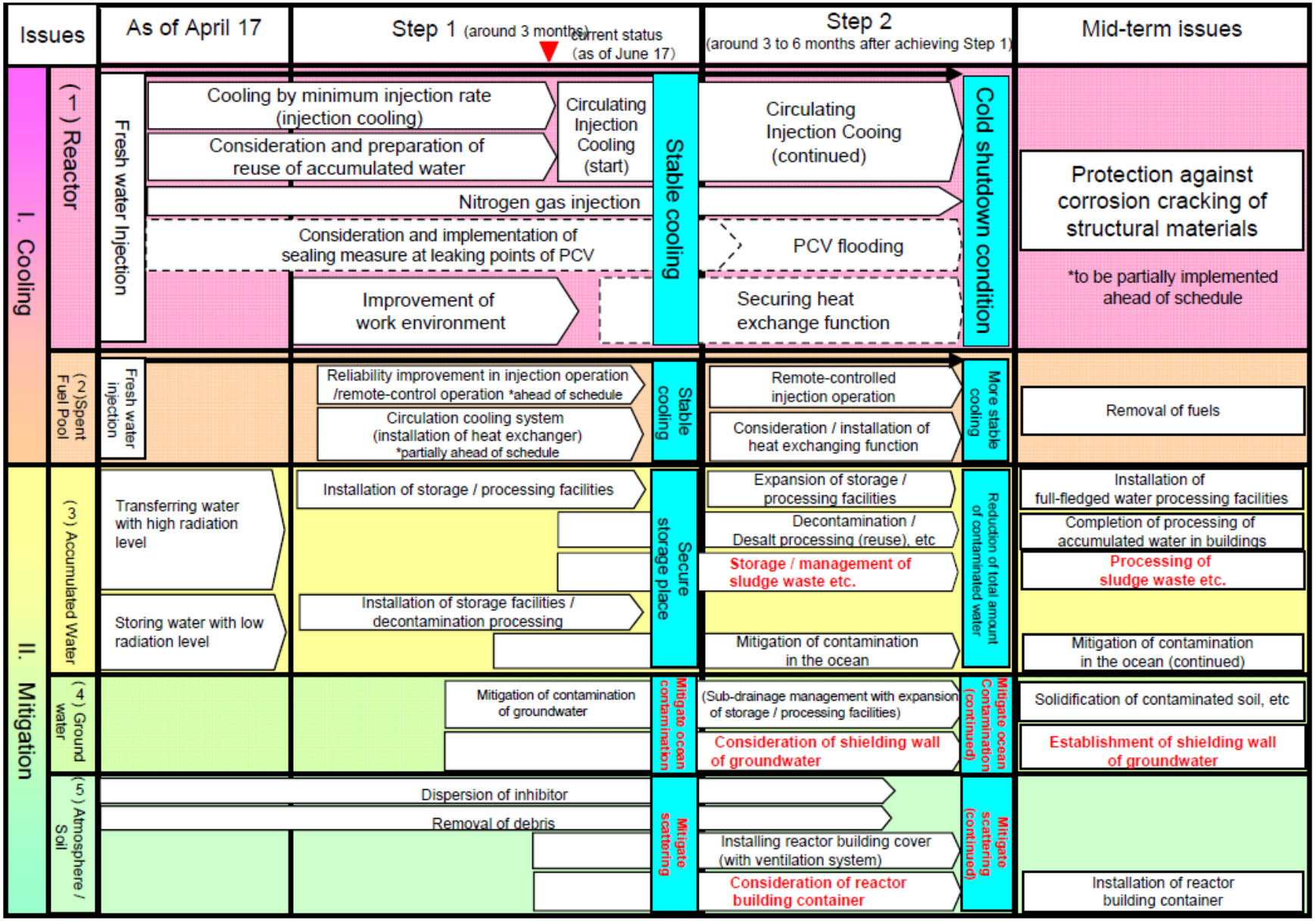
Classification (mSv)	March 2011-October 2012			March 2011-November 2012			Fluctuation		
	TEPCO	Contractor	Total	TEPCO	Contractor	Total	TEPCO	Contractor	Total
Over 250	6	0	6	6	0	6	0	0	0
200-250	1	2	3	1	2	3	0	0	0
150-200	22	2	24	22	2	24	0	0	0
100-150	117	17	134	117	17	134	0	0	0
75-100	212	62	274	217	65	282	5	3	8
50-75	296	399	695	300	415	715	4	16	20
20-50	603	2,929	3,532	600	2,973	3,573	-3	44	41
10-20	702	3,122	3,824	705	3,263	3,968	3	141	144
5-10	165	2,831	2,996	162	2,836	2,998	-3	5	2
1-5	797	5,608	6,405	814	5,710	6,524	17	102	119
1 or less	687	5,999	6,686	671	6,042	6,713	-16	43	27
Total	3,608	20,971	24,579	3,615	21,325	24,940	7	354	361
Max. (mSv)	678.80	238.42	678.80	678.80	238.42	678.80	-	-	-
Ave. (mSv)	24.61	9.66	11.85	24.69	9.71	11.88	-	-	-

Total radiation exposure from March 11th,2011 to November 30,2012

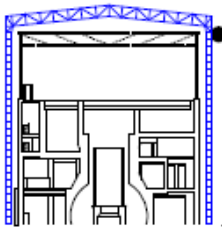
4. Future Efforts to Settle the Situation

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

Heat Exchanger

Additionally-installed Tank

Centralized Waste Processing Building

Installation of heat exchangers (13)

Condenser

Injection of fresh water with pumps (1)

Suppression Chamber

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

Sealing the leakage location (6, 16)

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

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)

5. Responses at Other Nuclear Power Stations

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

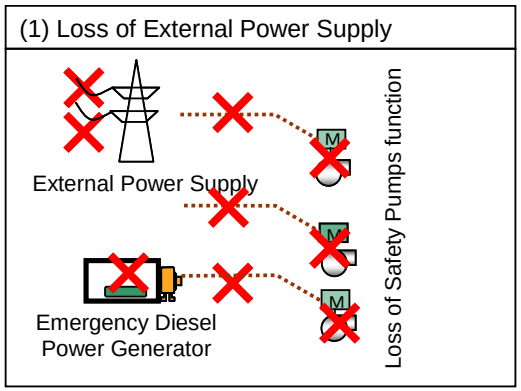
Ventilation
Stack

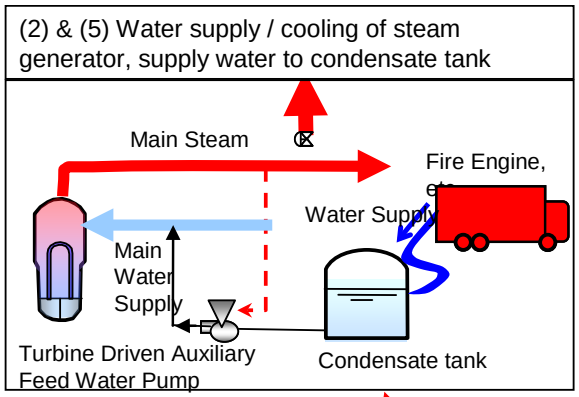
Sea Water Pump

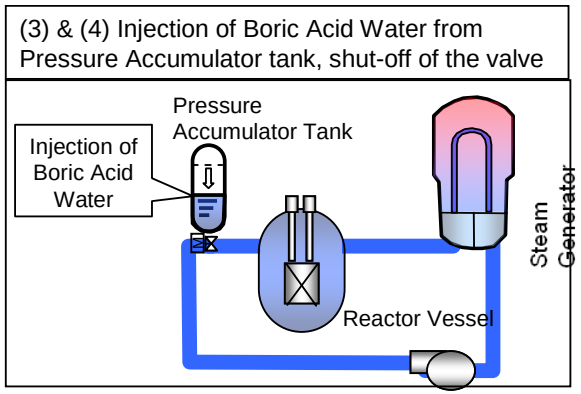
Pressure Suppression Chamber

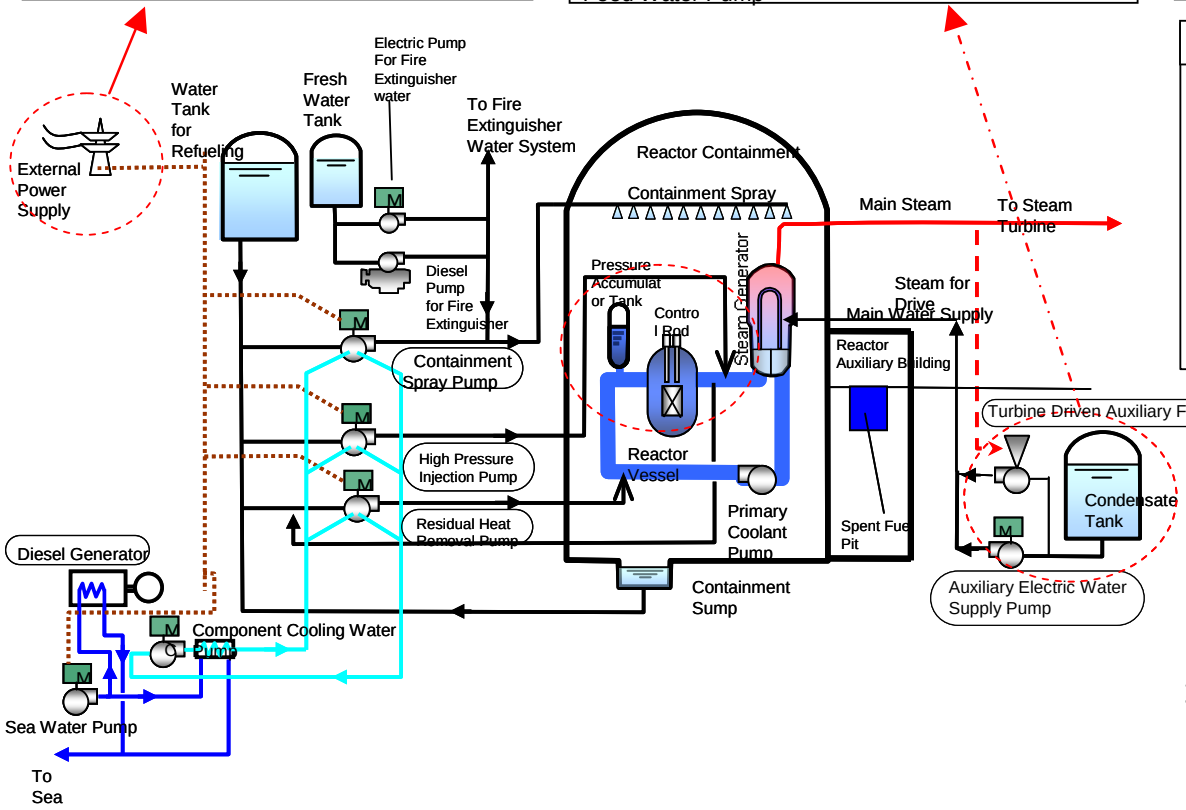
Pressure Suppression Chamber

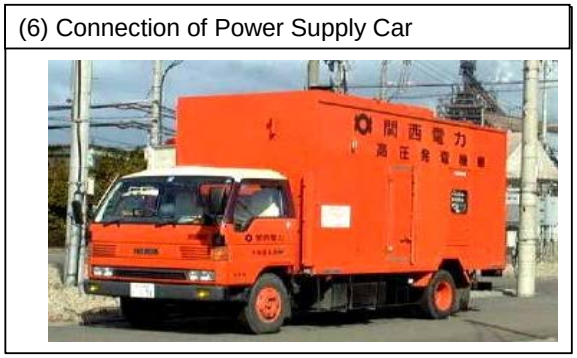
Series of Events and Countermeasures in case of tsunami, for PWR

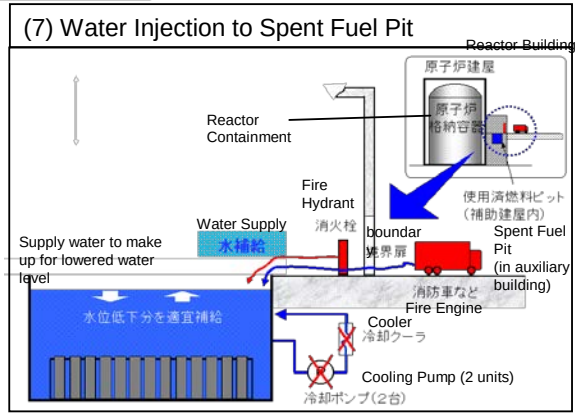












Electric Power Supply Car at Ikata NPS on Aug 2012

Portable Water Supply Pumps at Ikata NPS on Aug 2012

Under Water Pumps at Ikata NPS on Aug 2012

Anti-Seismic Rubbers under Main Office Building at Ikata NPS on Aug 2012

6.New Regulatory Body

NRA (Nuclear Regulation Authority) started Sept 19 ,2012

- Prime Minister instead of Japan' Parliaments assigned 5 commissioners.
- Mr. Tanaka ,First Chairman said

1. NRA will revise nuclear safety guide within this year including the severe accident management and countermeasure which was not included in the current one.
2. Early next year they will check all NPSs by the new one for the restart.

- Annual Budget is 630 Million Dollar
- Man Power : 480

Structure and functions of the NRA

For administrative purpose, the Nuclear Regulation Authority (NRA) is placed under the Ministry of the Environment (MOE).
However, independent personnel control from MOE is secured.
In the future independent budget will be secured.

NRA consists of :

- Commission

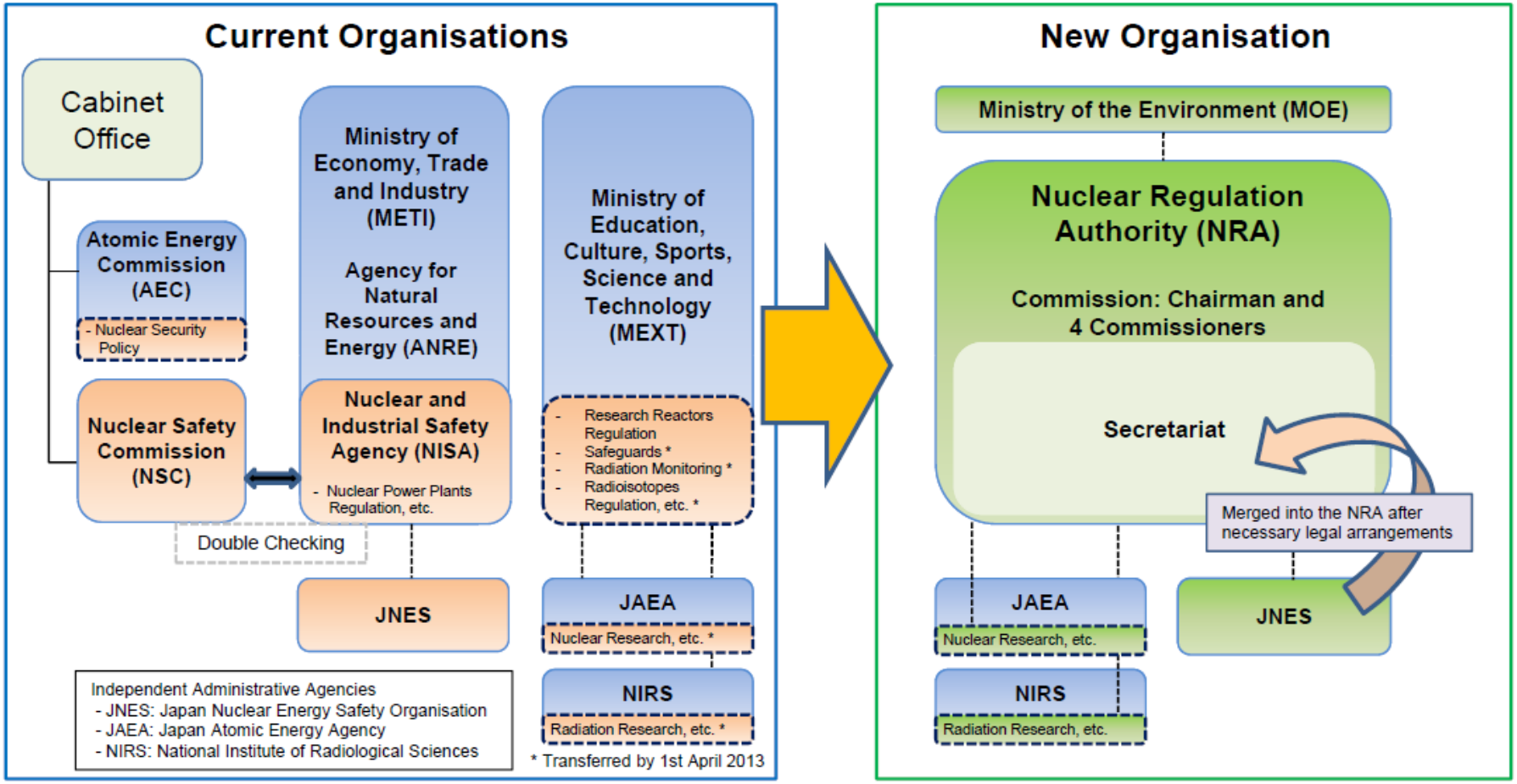
  One chairman and 4 commissioners are appointed by the Prime Minister after the approval of the National Parliament.

- Secretariat

  The NRA has a comprehensive function of nuclear regulation.

  - Nuclear Safety (from METI, MEXT and MLIT)
  - Nuclear Security (from METI, MEXT and AEC)
  - Nuclear Safeguards (from MEXT)
  - Radiation Monitoring (from MEXT)
  - Radioisotopes Regulation (from MEXT)

Independence: Separate nuclear regulation function and nuclear promotion function and establish the "Nuclear Regulation Authority (NRA)", as an independent commission body affiliated to the MOE. Chairman and Commissioners are appointed by the Prime Minister after the approval of the National Diet.
Integration: Integrate nuclear regulation functions, namely, nuclear safety, security, safeguards, radiation monitoring and radioisotopes regulation, into the NRA.



7. Chelnobyl Benchmark Visit on December, 2012


Dr. ElBaradei and I made the speech at Sep 11th memorial by International Security Society at Philadelphia Convention Center

2012. 10. 12
Best Alumni
Award from
Univ of Michigan

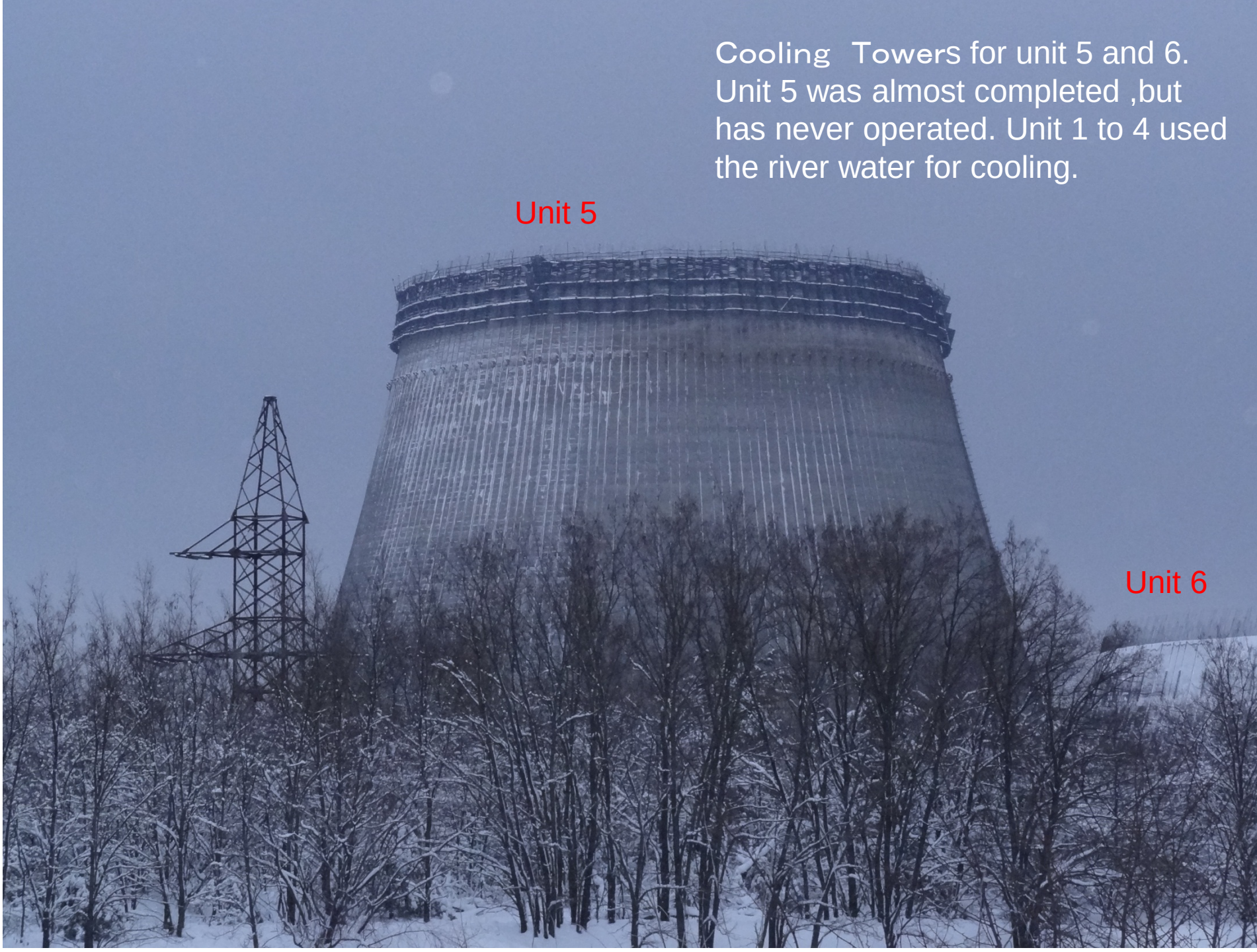
Congratulated by
Governer of
Michigan State,
Mr. Rick Snyder


Sarcophagus of unit 4
was piled up by
the concrete blocks.


The first stage of the new confinement steel structure was completed on last november. The total structure will complete In 2015 and the buget is 1.5 Billion dollar.This structure will be jacked up and slide on the rail.

There were holes on the steel roof.

Detail model inside the reactor building.


Cooling Towers for unit 5 and 6. Unit 5 was almost completed ,but has never operated. Unit 1 to 4 used the river water for cooling.
Unit 5
Unit 6


Slavutych City
Model and photo
24,720 people
are living

Embroidered Drawings from computerized photos

グ
Painting on glasses

Judo, Sacker and
Boxing players

Інструментальнае трыо ДШМ
г. Славуціч (Украіна)
у складзе:
Канстанцінава Дарына
Скляранка Руслан
Пліскунова Вікторыя
Є.М.Яновська з ученицями Дитячої школи мистецтв на уроці з класу фортепіанного ансамблю. 2007 р.
Інструментальне тріо Дитячої школи мистецтв (зліва направо): Д.Константинова, В.Плискунова, Р.Скляренко, лауреати конкурсу "Дебют-2005" і дипломанти міжнародного конкурсу камерних ансамблів у Білорусі (2006 р.). 2007 р.
Н.Ф.Солоднікова, завідуюча фортепіанним відділом Дитячої школи мистецтв, переможець конкурсу "Славутичанин року – 2005". 2007 р.
О.Л.Абраменко, викладачка Дитячої школи мистецтв, нагороджена знаком "За особистий внесок в розвиток міста". 2007 р.
Ансамбль гітаристів Дитячої школи мистецтв. 1-й зліва – В.А.Ілляшов, викладач. 2007 р.
В.А.Галинська, викладачка по класу струнно-смичкових інструментів дитячої школи мистецтв та В.Є. Грамоткіна, концертмейстер з ученицями. 2007 р.
"ДЕБЮ
ДИПЛО
Ансамбль гіта
Music
activities


Огни Славутича
ПАТРІСІЯ КААС
Painting
activities


Hospital Complex

Heaven for children

Radiological and Medical Research Center

Clinic and 600 in hospital

23,370 people are registered who received the radiation from Chelnobyl in Ukraine and should have the examination here once in two years.

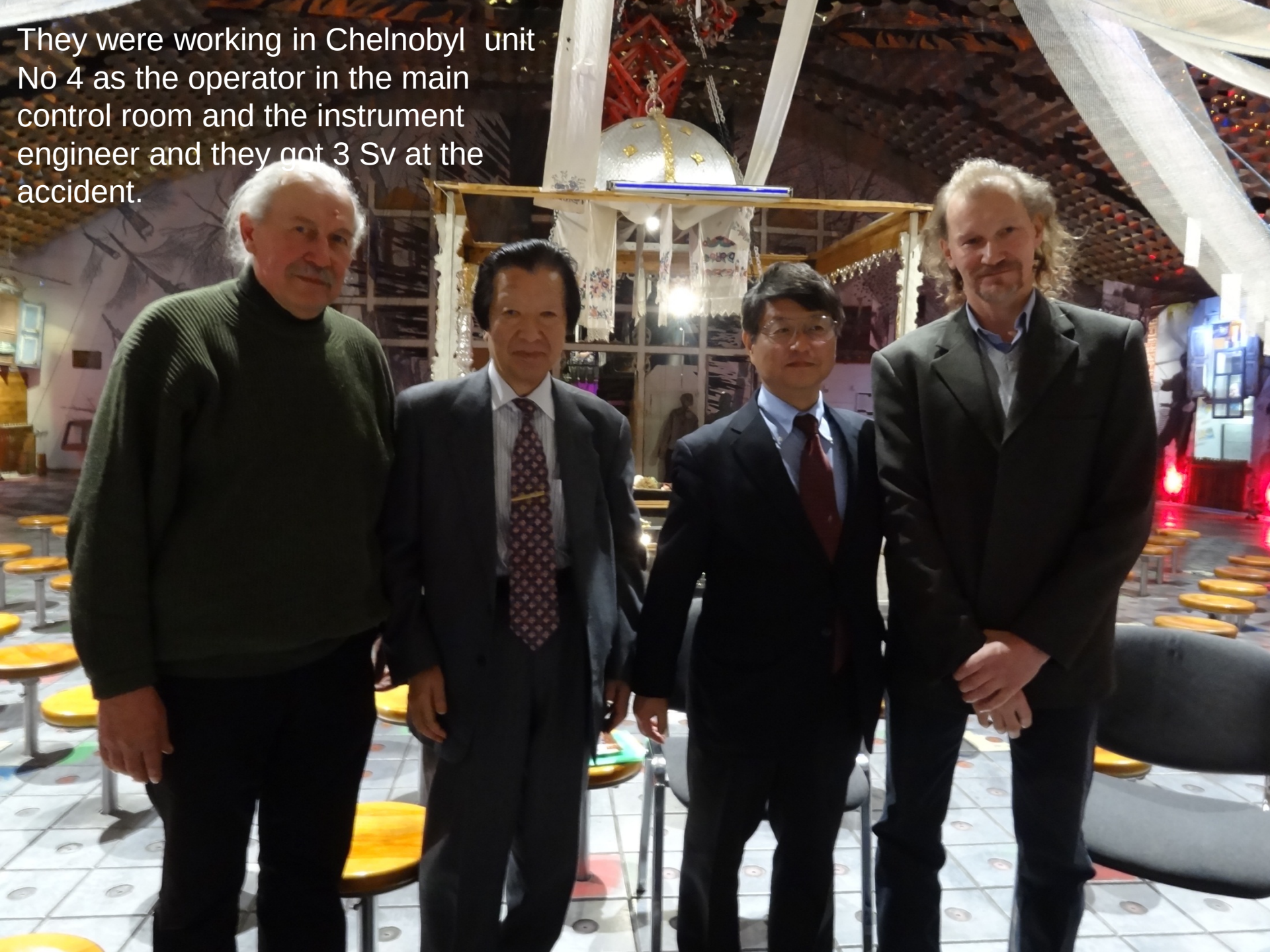

We have 23,370 people's database. The ratio of their sickness is same as the normal hospital. The ratio of cancer is same.

National Agricultural Radiation Research Cemter
Director General Dr. Kashparov

Powdered Prussian Blue which can exhaust the saesium from the caw to the ratio of 1/17 by eating them for 2 months

They developed Solid Prussian Blue with Salt because the caw likes salt.
They did not have to Kill the caw by these


ICELAND
SWEDEN
FINLAND
NORWAY
ESTONIA
LATVIA
LITHUANIA
UNITED KINGDOM
BELARUS
POLAND
GERMANY
UKRAINE
CZECH REP.
SLOVAKIA
FRANCE
MOLDOVA
HUNGARY
ROMANIA
SERBIA
BULGARIA
SPAIN
ITALY
PORTUGAL
GREECE
TURKEY


They were working in Chelnobyl unit No 4 as the operator in the main control room and the instrument engineer and they got 3 Sv at the accident.

Lessons Learned from Chelnobyl

- Ukraine Government stopped all 15 Nuclear Power Plants which produced 50% of the electricity.
- Black out happened and caused a lot of the economical damage during 1992 to 1994.
- Ukraine Government re-started all 15 NPPs after 2 years, but the economy damage still continues.
- They feeded the prussian blue to the caws to exhaust the saesium from their bodies. Then they did not have to kill the caws.
- They created the dreamy city called Slavutych near Chelnobyl before two years after the accident.

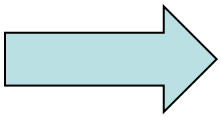
⇨ We have to learn a lot from Chelnobyl.

8.Conclusion on Fukushima Accident

1. There exist a lot of the high radioactive materials in the Nuclear Power Plants and we should not release these to the public.
2. Fukushima made the bad human and organizational mistakes.
3. We have to remember the basic safety philosophy of the nuke.
4. Although the severely strong earthquake attacked Fukushima, the plant was safely stopped and cooled the core and kept all radioactive materials inside.
5. Tsunami damaged everything.

Conclusion on Fukushima Accident (No 2)

6. There are two major mistakes in Fukushima. One is the organizational issue. IAEA clearly stated that the complicated structures and organizations can result in delay in urgent decision making. We have to learn from Security Society.
7. Second one is the hardware. In the case of severe accident, the water , the electricity and the instrumentaion are essential.
8. In the world, all utilities formed the new organizations for the severe accident and they have already added the core supply water, other electricity and so on ,and the safety grade of the all nuclear power plants improved so much.



We learned a lot from Fukushima. We have to operate the nuclear power plants safely to supply the good quality, large scale, economical, clean electricity to the public in the world.


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