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Issy-les-Moulineaux, France

OVER VIEW OF ACCIDENT OF FUKUSHIMA DAI-ICHI NPSs AND FUTURE PLANNING TOWARD D&D

16 NOVEMBER, 2011

Hiroshi RINDO
JAPAN ATOMIC ENERGY AGENCY

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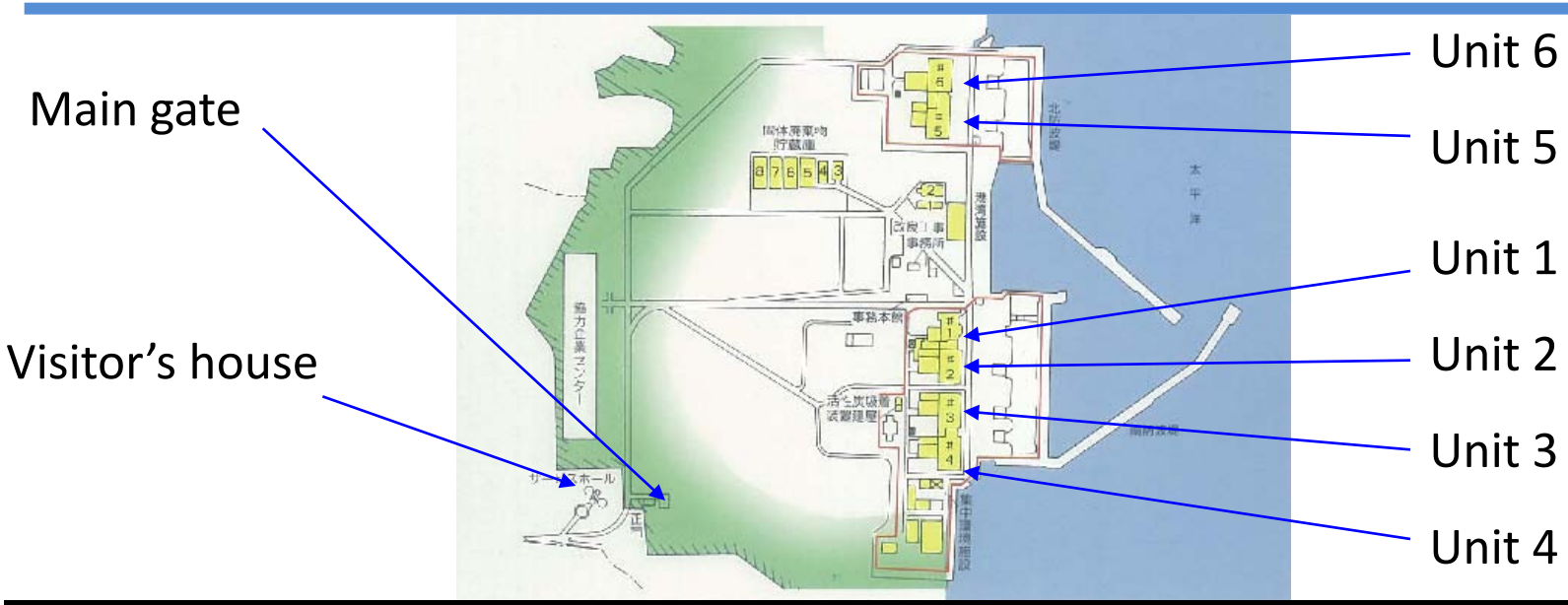
1. What's happened at Fukushima Dai-Ichi NPSs after the Earthquake and the Tsunami

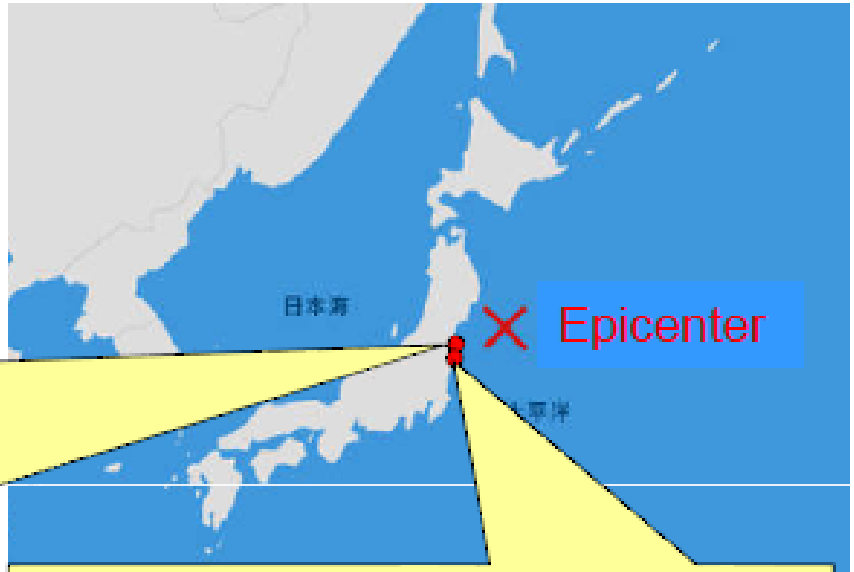
Overview of Fukushima Dai-Ichi NPSs



Location	Unit	In operation since	Plant type	Power Output (MW)	Main Contractor	Pre-earthquake status
Ohkuma	1	1971.3	BWR-3	460	GE	Operating
	2	1974.7	BWR-4	784	GE/Toshiba	Operating
	3	1976.3	BWR-4	784	Toshiba	Operating
	4	1978.10	BWR-4	784	Hitachi	Shutdown for maintenance Full core offloaded to spent fuel pool
Futaba	5	1978.4	BWR-4	784	Toshiba	Shutdown for maintenance
	6	1979.10	BWR-5	1,100	GE/Toshiba	Shutdown for maintenance

2011 off Tohoku Pacific Earthquake

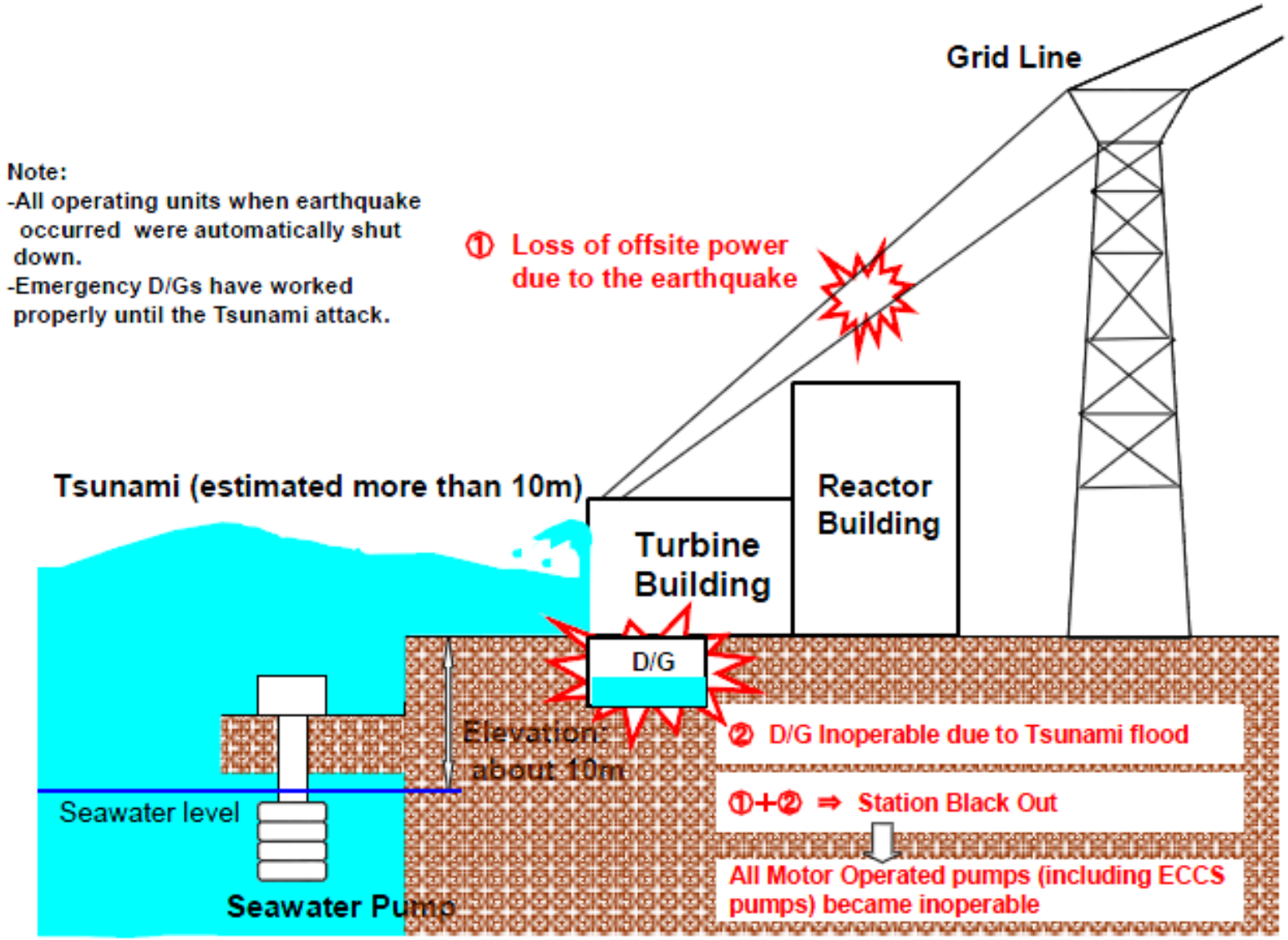
Fukushima Dai-ichi NPP



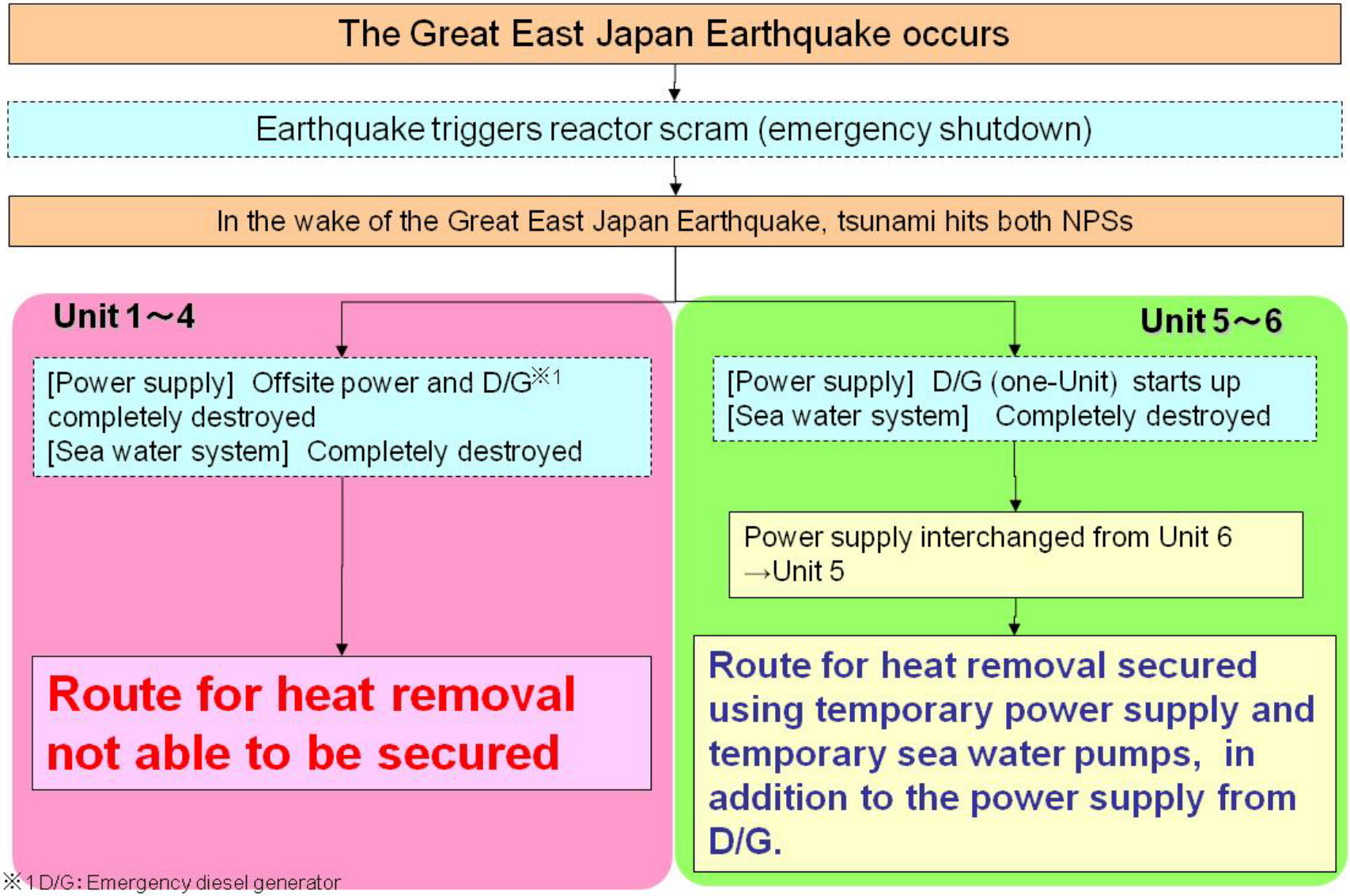
Fukushima Dai-ni NPP

- Occurred 14:46 March 11, 2011
- Magnitude:9.0 Mw
- Epicenter location: 38° 6"N and 142° 51"E, and 24km in depth
- It is said that the height of tsunami attacked Fukushima NPP was more than 14m

Major root of cause of the damage



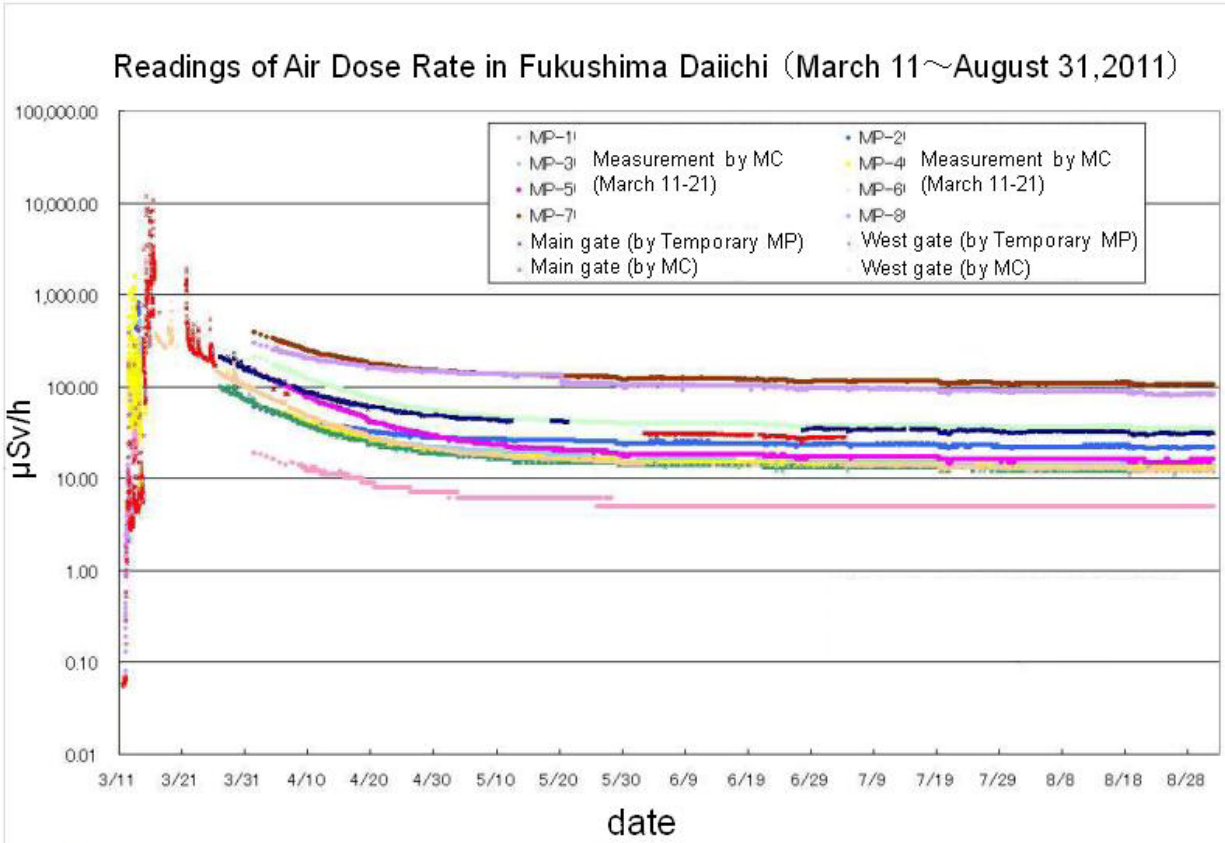
Influence by the earthquake and tsunami In Fukushima Dai-Ichi

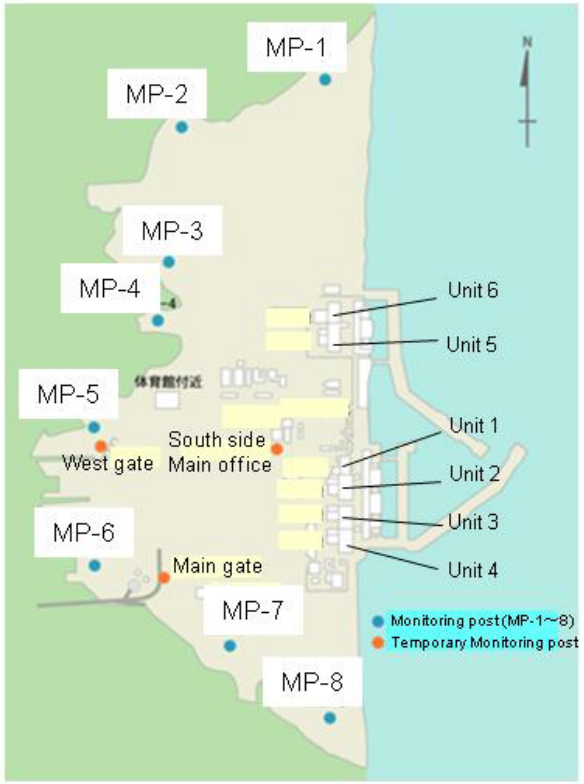


2. Progression after the accident of Fukushima Dai-Ichi NPSs

Air Dose Rate in Fukushima Dai-Ichi

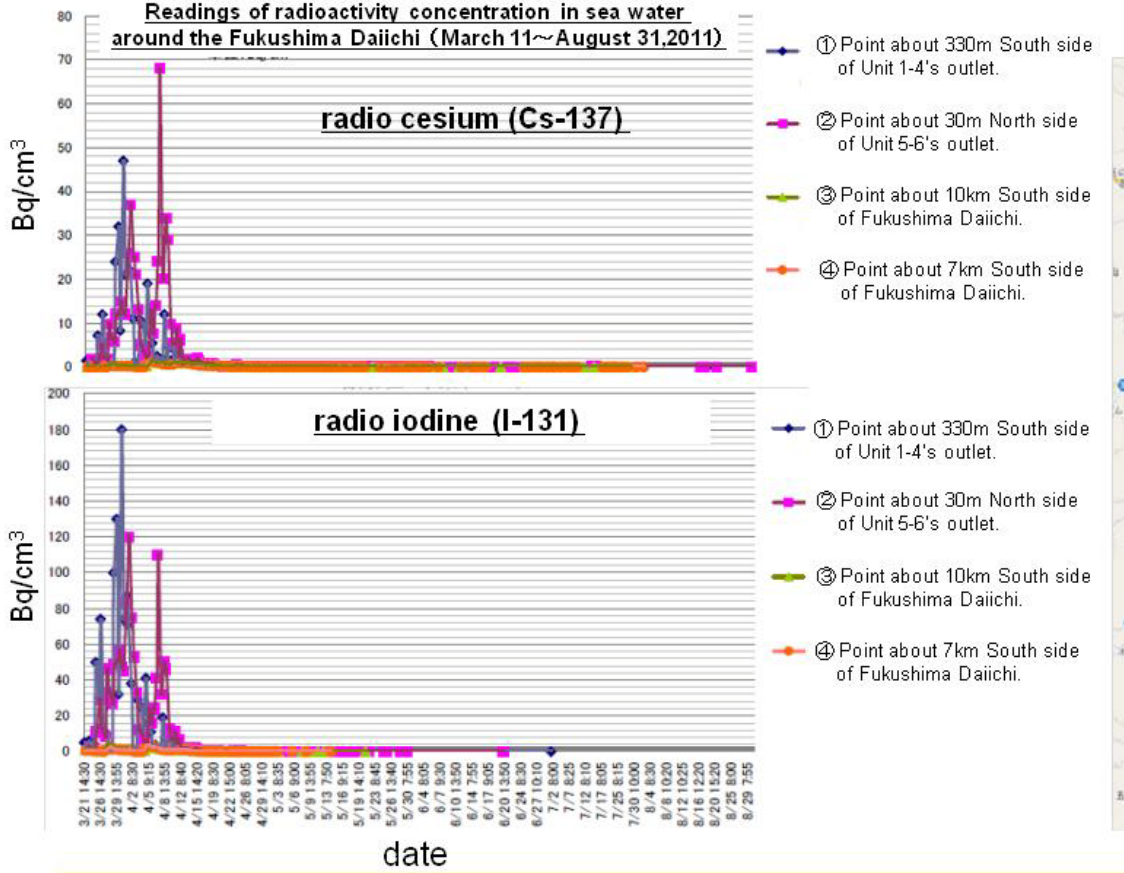
- Using the Monitoring post and Monitoring car (MC), the site boundary measure.





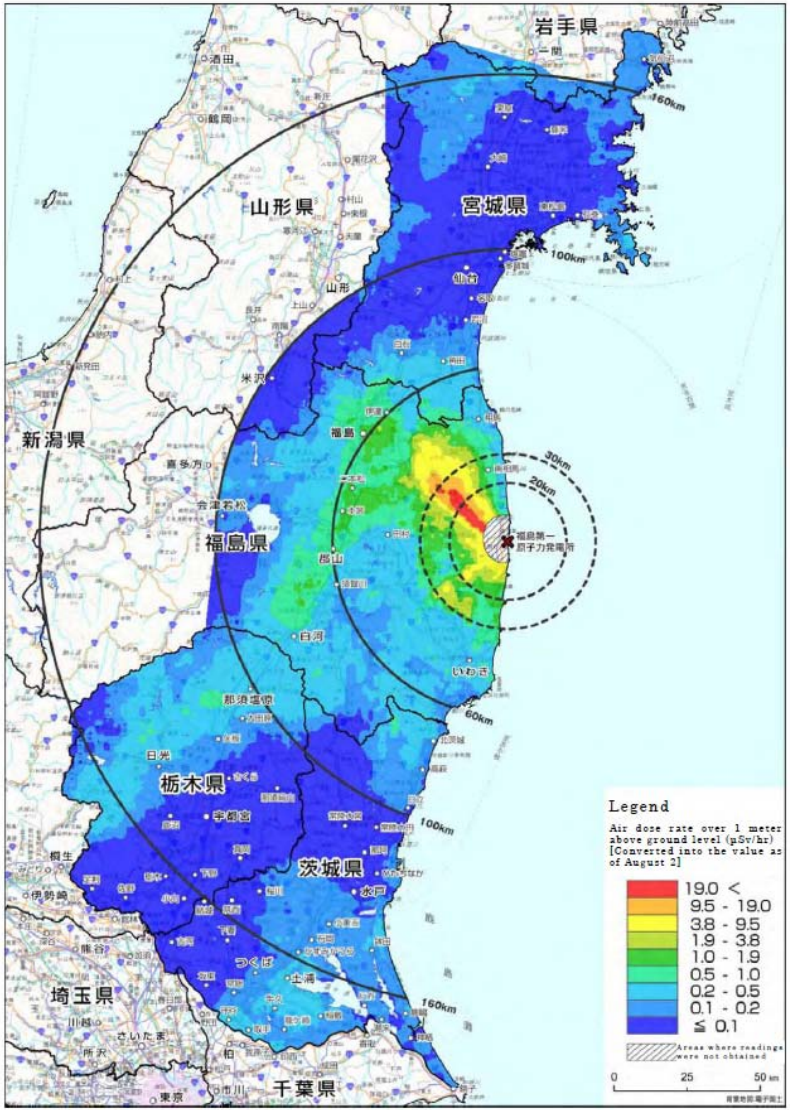
- The main gate about 1km away from Unit 2, temporary measure a value greater than 10,000μSv / h.
- Current Trends in the value of about 10 ~ 100μSv / h.

Radioactivity concentration in seawater

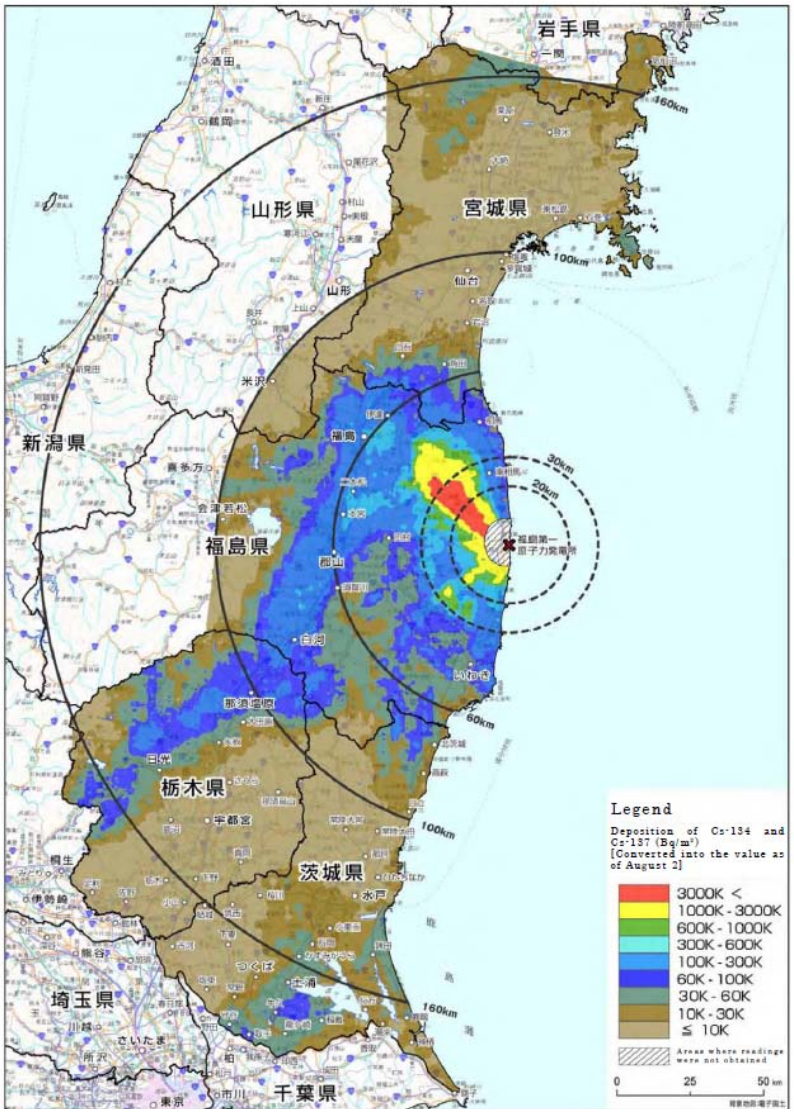


- (Cs-137) Point about 30m North side of Unit 5-6's outlet, the maximum (about 70Bq/cm3) observed.
- (I-131) Point about 330m South side of Unit 1-4's outlet, the maximum (about 180Bq/cm3) observed.

Results of aircraft monitoring

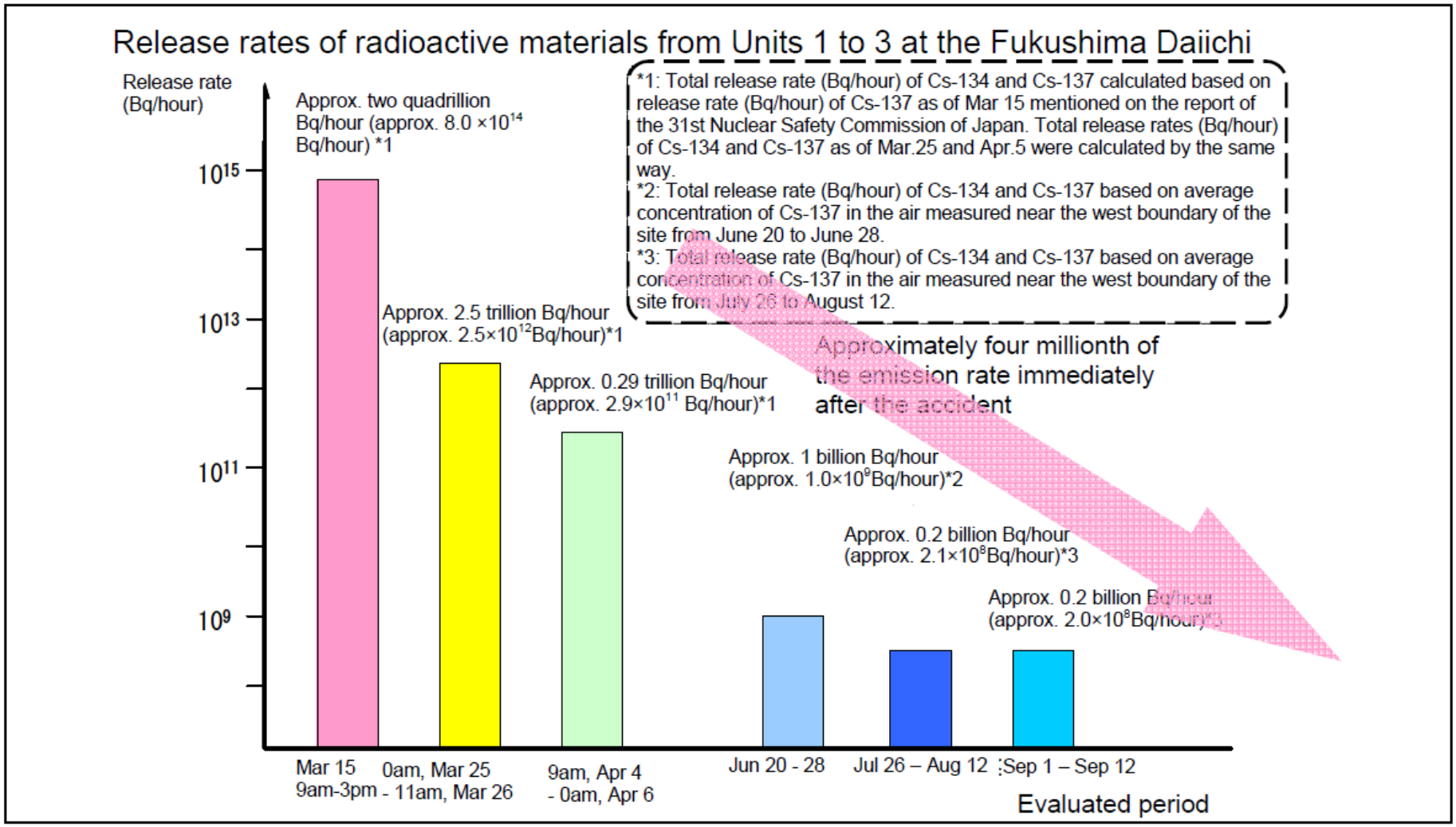


Results of aircraft monitoring
(Air dose rate over 1 meter above ground level; 2 Aug. '11)



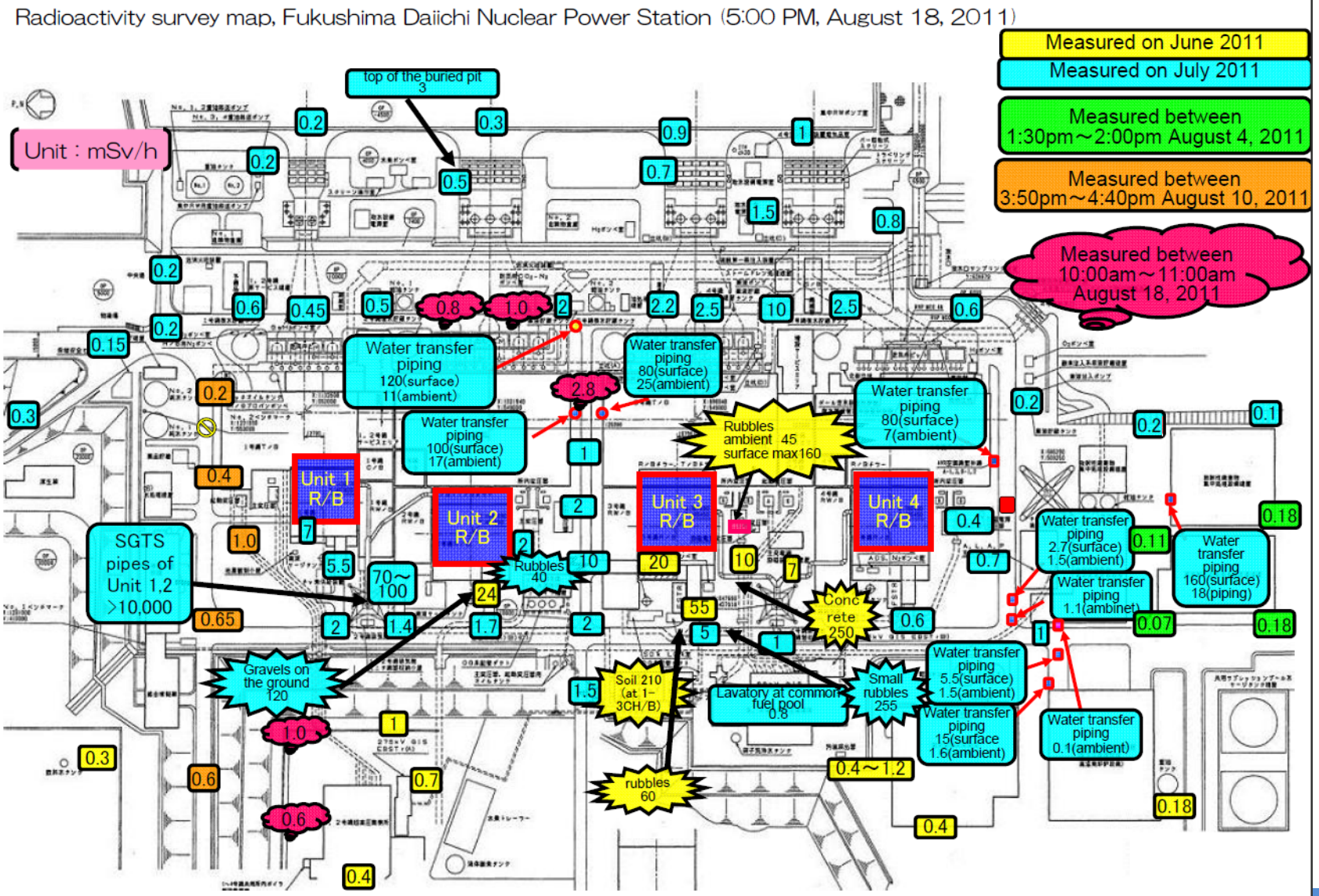
Results of aircraft monitoring
(Total of accumulative amount of Cs-134 and Cs-137; 2 Aug. '11)

Release rates of radioactive materials from Unit 1 to 3



3. Current On-site Status of Fukushima Dai-Ichi

Survey map

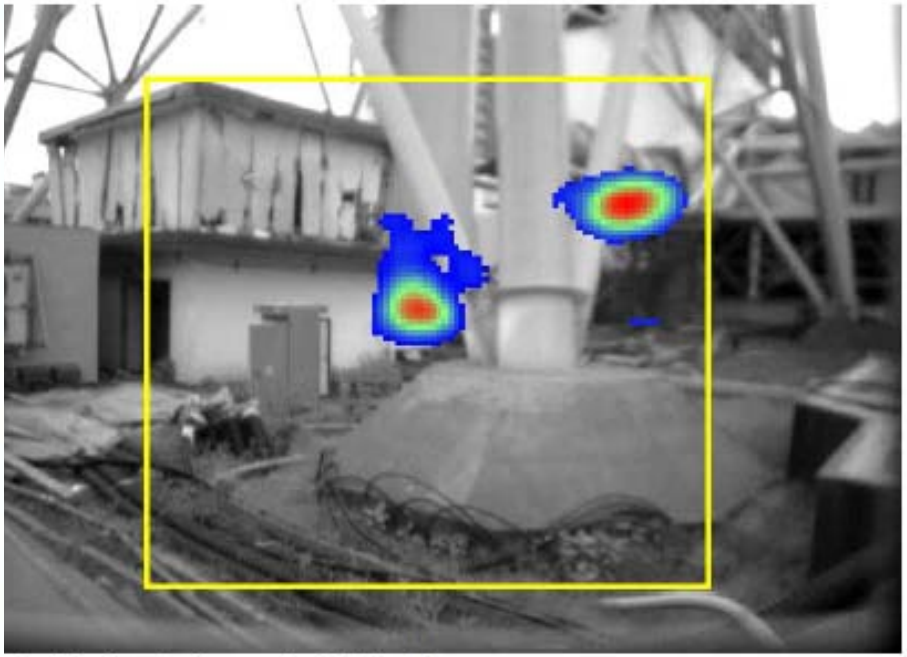

Radioactivity survey map, Fukushima Daiichi Nuclear Power Station (5:00 PM, August 18, 2011)
Measured on June 2011
Measured on July 2011
Measured between 1:30pm～2:00pm August 4, 2011
Measured between 3:50pm～4:40pm August 10, 2011
Measured between 10:00am～11:00am August 18, 2011
Unit : mSv/h
top of the buried pit 3
Water transfer piping 120(surface) 11(ambient)
Water transfer piping 100(surface) 17(ambient)
Water transfer piping 80(surface) 25(ambient)
Water transfer piping 80(surface) 7(ambient)
Rubbles ambient 45 surface max160
Unit 1 R/B
Unit 2 R/B
Unit 3 R/B
Unit 4 R/B
SGTS pipes of Unit 1,2 >10,000
Rubbles 40
Concrete 250
Gravels on the ground 120
Soil 210 (at 1~3CH/B)
Lavatory at common fuel pool 0.8
Small rubbles 255
rubbles 60
Water transfer piping 2.7(surface) 1.5(ambient)
Water transfer piping 1.1(ambinet)
Water transfer piping 160(surface) 18(piping)
Water transfer piping 5.5(surface) 1.5(ambient)
Water transfer piping 15(surface 1.6(ambient)
Water transfer piping 0.1(ambient)

Near the Main Exhaust Stack of Units 1 and 2 in Fukushima Dai-Ichi NPSs

August 5, 2001
TEPCO

Location: Stack drain pipe at the main exhaust stack of Units 1 and 2 (view from the east side)
Time: August 4, 2011, around 15:30
Photographed by: TEPCO

August 2, 2011
TEPCO

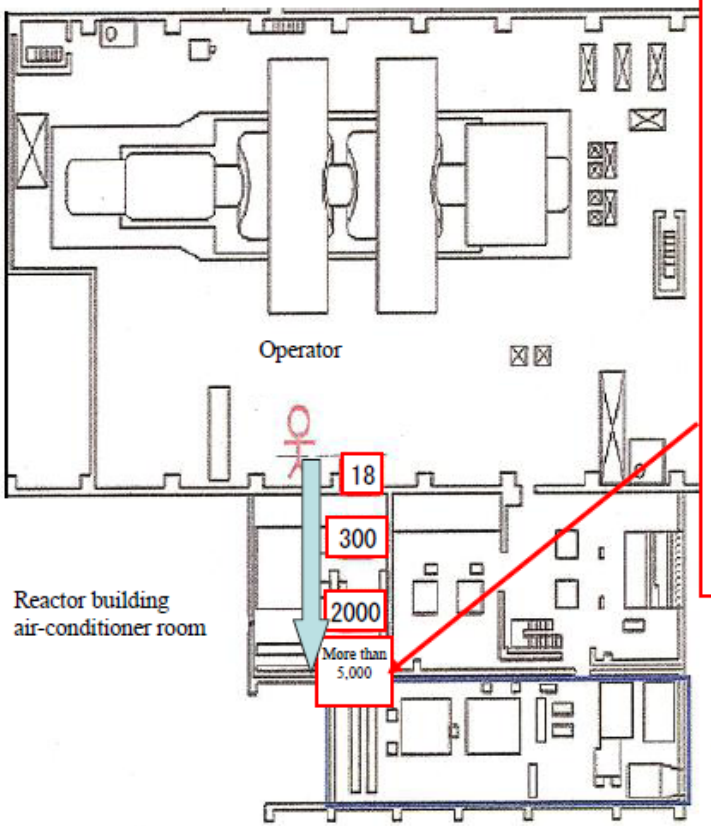


ıtion: Near the main exhaust stack of Units 1 and 2
e: July 31, 2011, around 16:00
ıographed by: TEPCO

High-dose detected area on the 2nd floor of Unit 1 turbine building

August 3, 2011
TEPCO

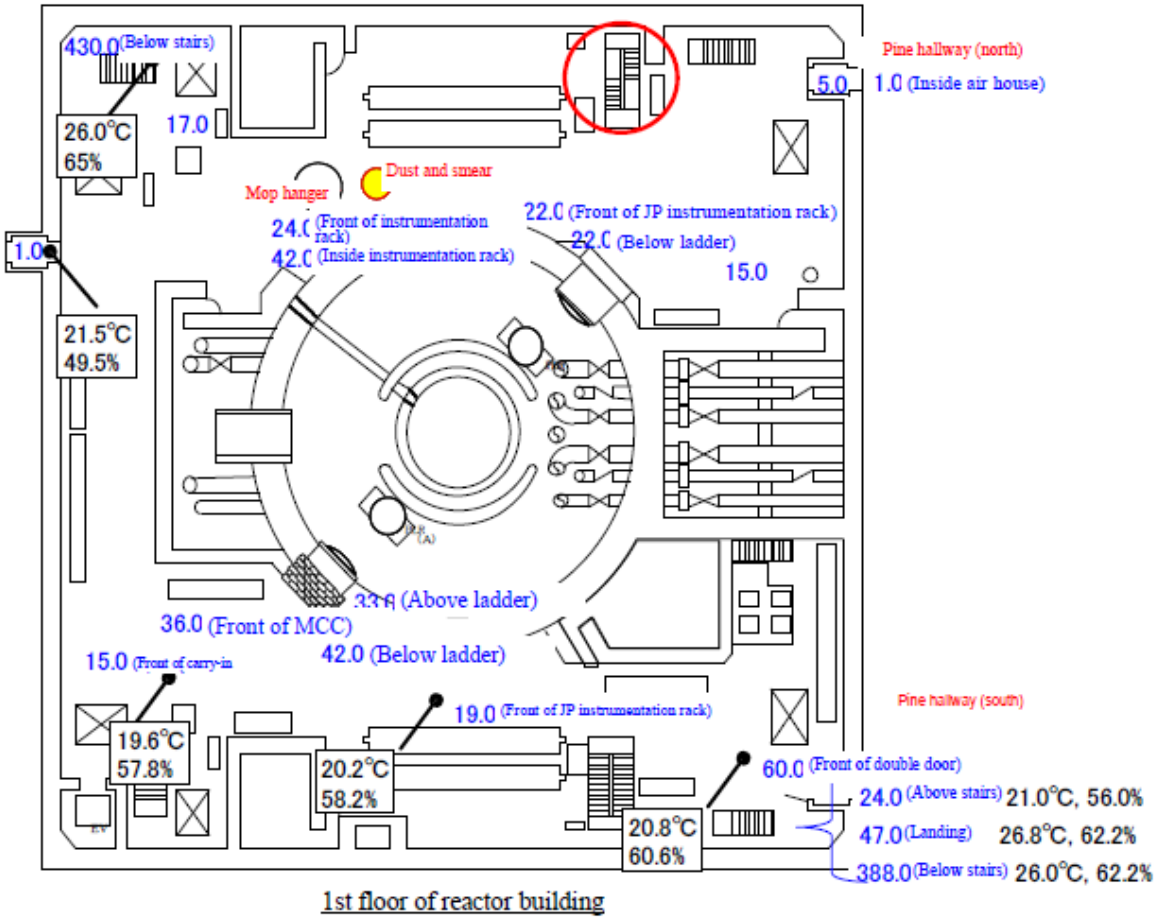
High-dose detected area on the 2nd floor of Unit 1 turbine building in Fukushima Dai-ichi NPS



Location: Near the entrance of the standby gas treatment system train room on the 2nd floor of Unit 1 turbine building
Time: August 2, 2011, Around 11:19 AM
Photographed by: TEPCO

Figure II-2-61 High-dose Detected Area on the 2nd Floor of Unit 1 Turbine Building in Fukushima Dai-ichi NPS

Dose rate of 1st floor of Unit 2 Reactor Building

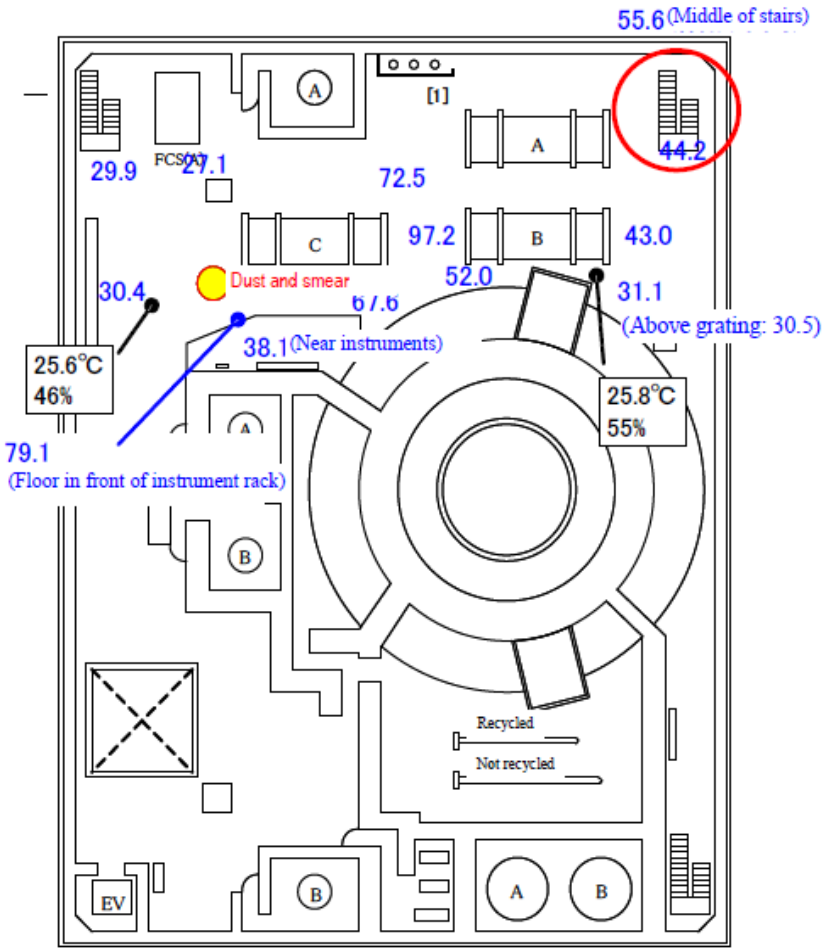


1st floor of reactor building

Northwest stairs (half basement)

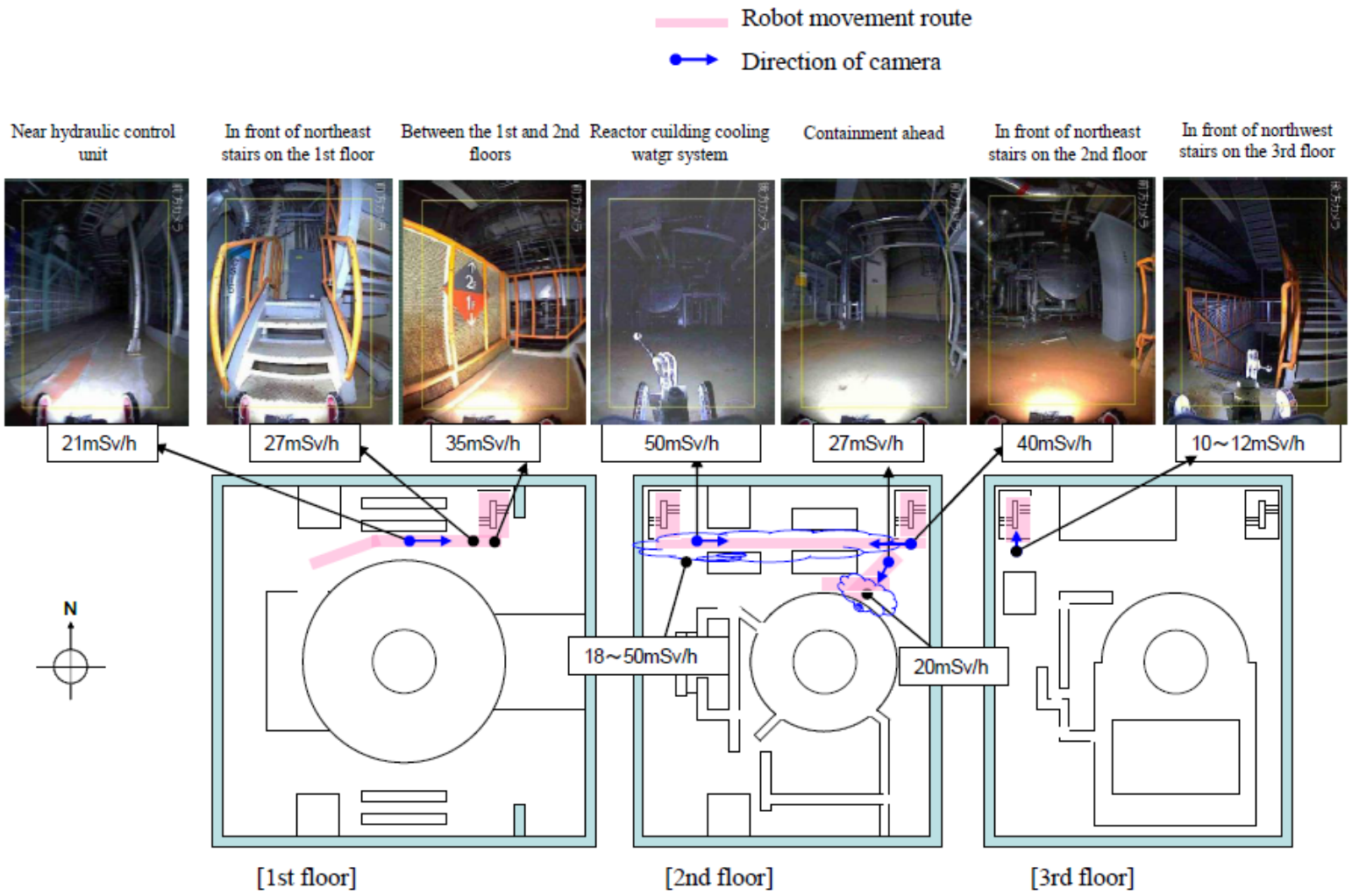
Southeast stairs (half basement)

Does rate of 2nd floor of unit 2 Reactor Building



Reactor instrumentation rack

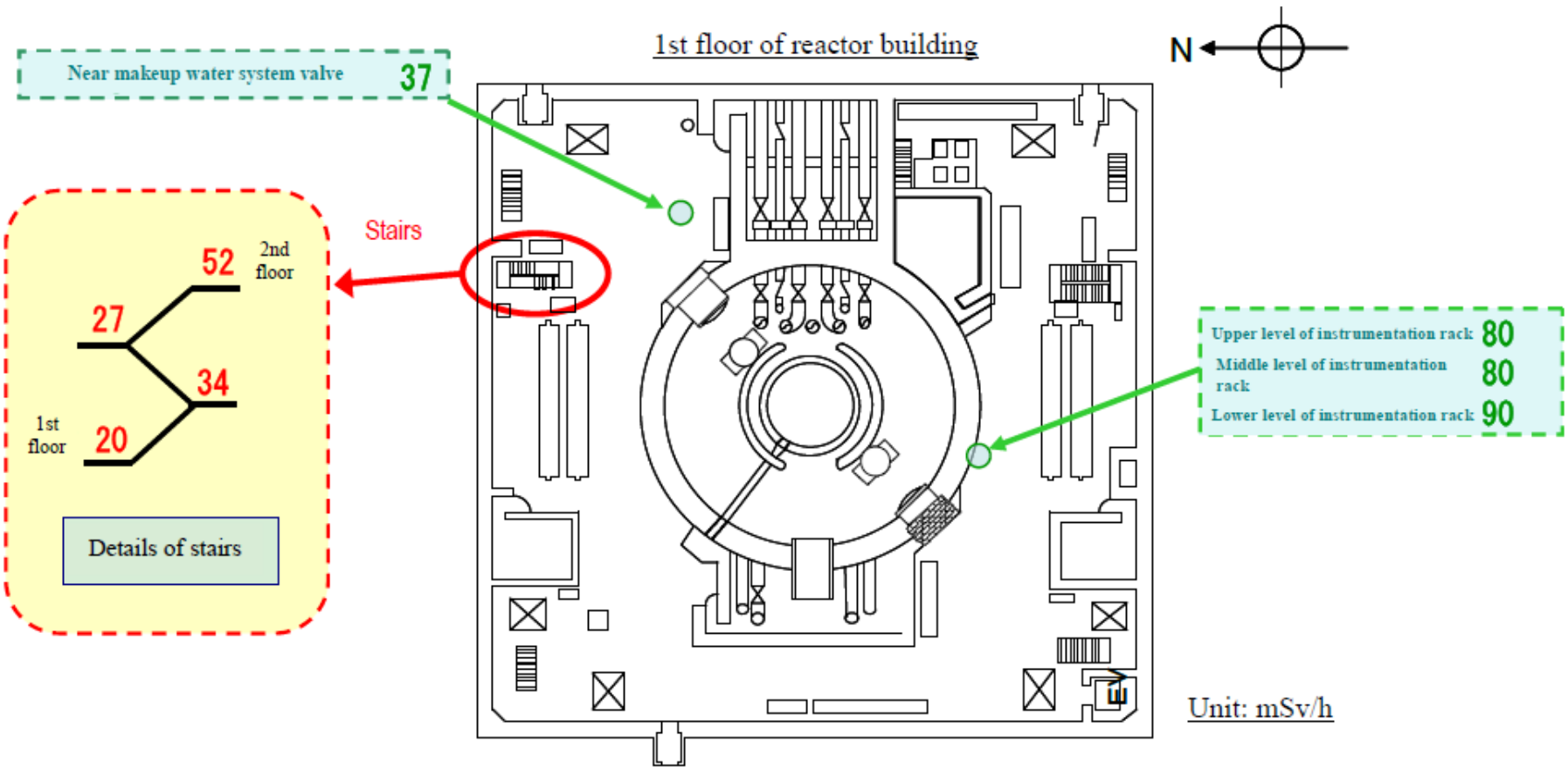
Results of Investigation inside the Roof of Unite 2 Reactor Building



Building layout is image (scale and layout are not accurate)

Figure II-2-65 Result of Investigation inside the Roof of Unit 2 Reactor Building in Fukushima Dai-ichi NPS

Results of Investigation inside Unite 3 Reactor Building

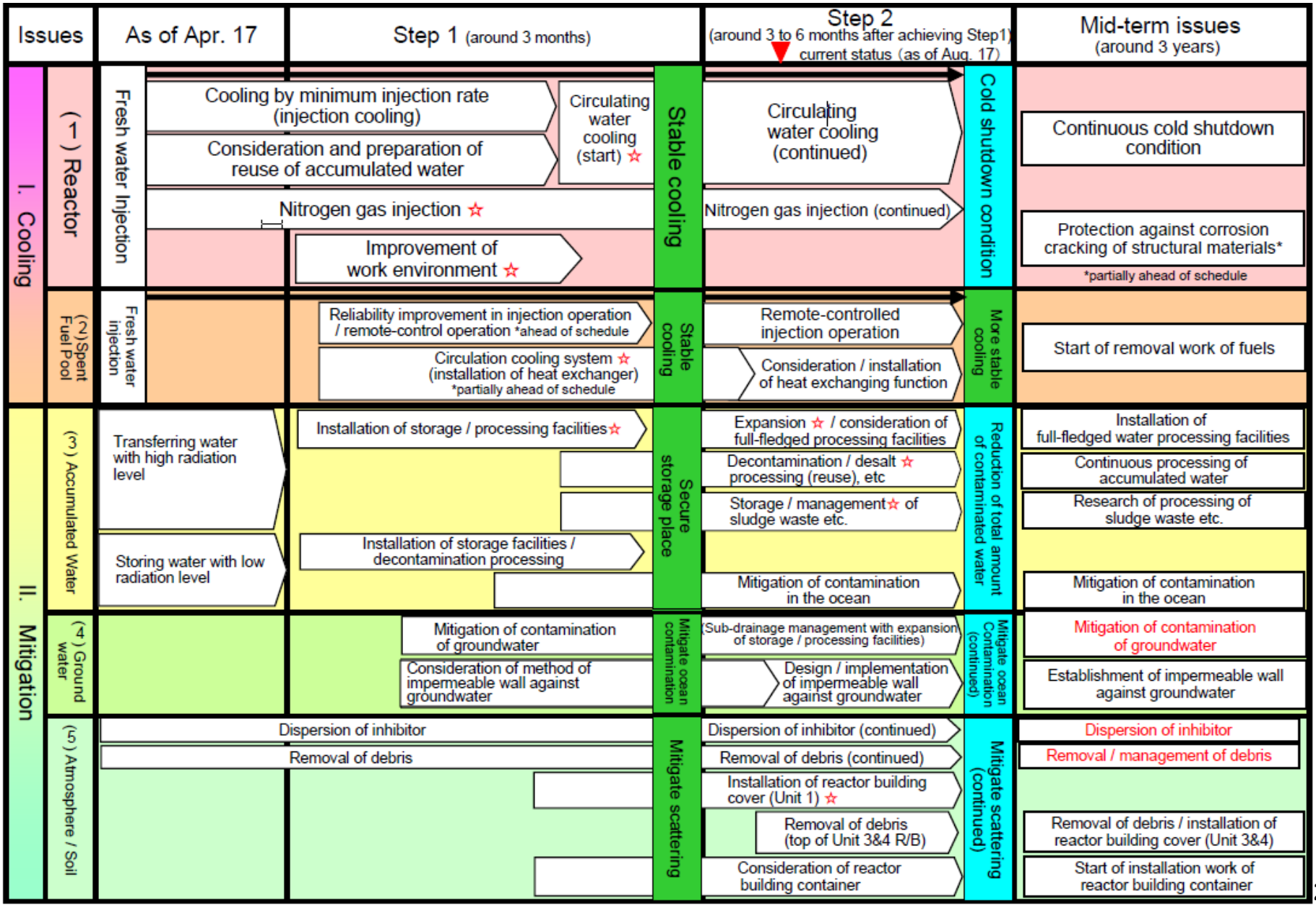


Red: On-the-spot investigation conducted by Quince on July 26
Green: On-the-spot investigation conducted by workers on July 27

* Building layout is image (scale and layout are not accurate)

4. Future Planning toward Decommissioning and Dismantling of Fukushima Dai-Ichi NPSs

Current Status of "Roadmap towards Restoration from the Accident at Fukushima Dai-Ichi Nuclear Power Station, TEPCO" (Revised on 20 Sep. '11)



Technical subjects of medium to long-term about the accident of Fukushima Daiichi NPSs

By Japan Atomic Energy Commission (14 September, '11)

Technical subjects about the accident of Fukushima Daiichi NPS are extracted, which used the period until removal of the fuel debris in a reactor is started

1.Removal work of fuels from Spent Fuel Pool (SFP).

- Handling technology of fuel in which was damaged and contained salt. (Handling, Washing, Inspection, Judgment of reprocessing possibility, etc)

2.The continuous measure towards Stabilization and Decommissioning.

- Remote decontamination technology of the high dose place in a building.
- Corrosion control technology of PCV and RPV.
- Processing technology of a high dose waste which occurred by operation of a water processing facilities.

3.Preparation of removal work of debris / Removal.

- Technology which specific and repair, water stops in a leakage part of PCV, and Implement technology of filling water. (Removal work of debris is most rational to carry out underwater.)
- Remote investigative technology of PCV and RPV.
- Development of debris extraction technology and a construction method
- Development of the technology of storing stably the debris fuel containing salt (storage can).
- Examination about suitable processing / disposal policy

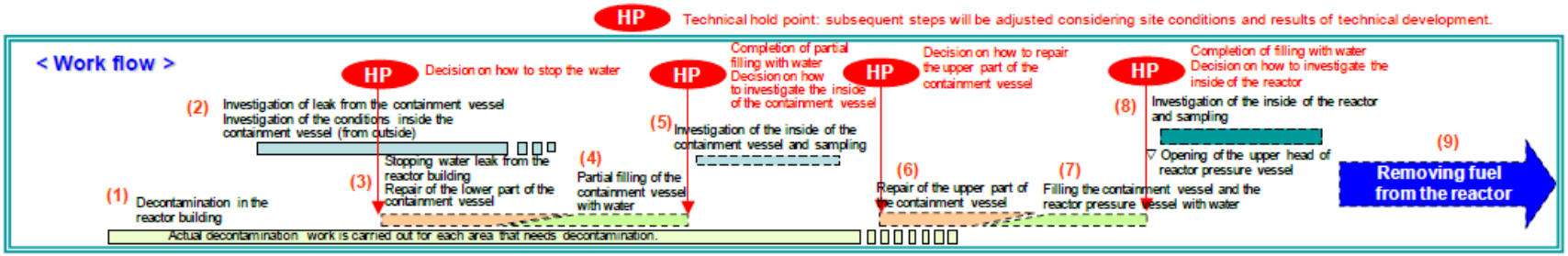
4. Processing and disposal of radioactive waste

- Processing / disposal technology for every occurring radioactive waste.

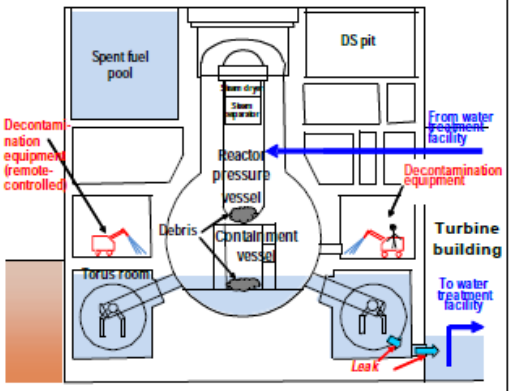
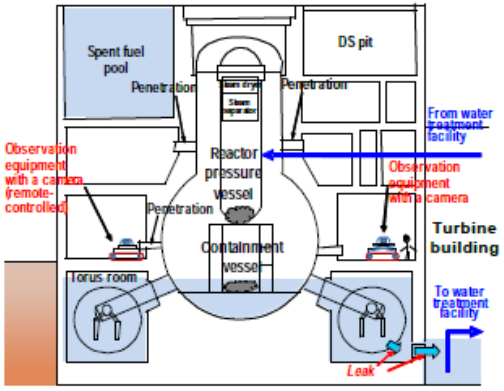
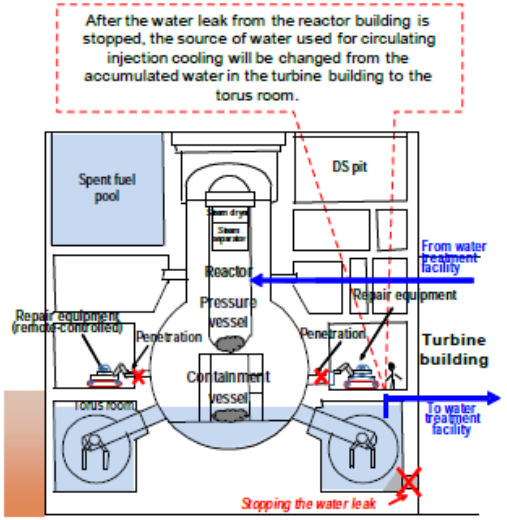
5. The elucidation of progress of an accident

- Development of the presumed technology of the inside situation of PCV after a severe accident.
- The advancement of the progress analysis technology of a severe accident phenomenon.

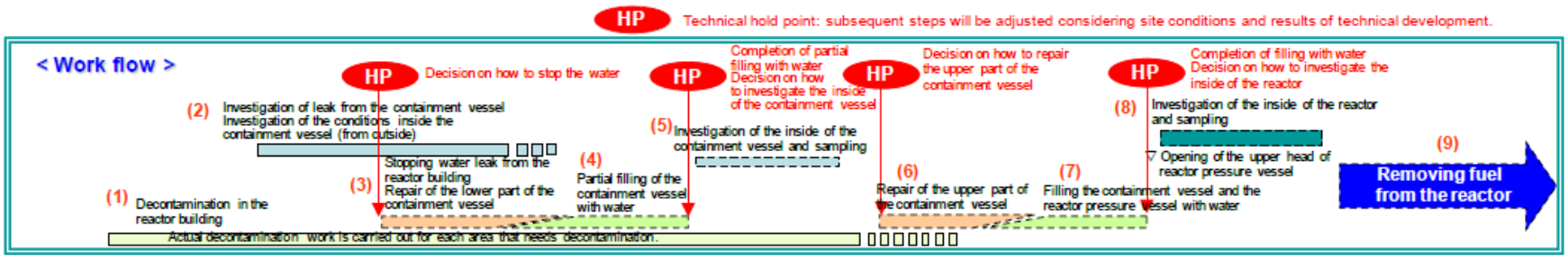
Conceptual Diagram of Work flow for Removal of Fuel from Reactor core (1/3)



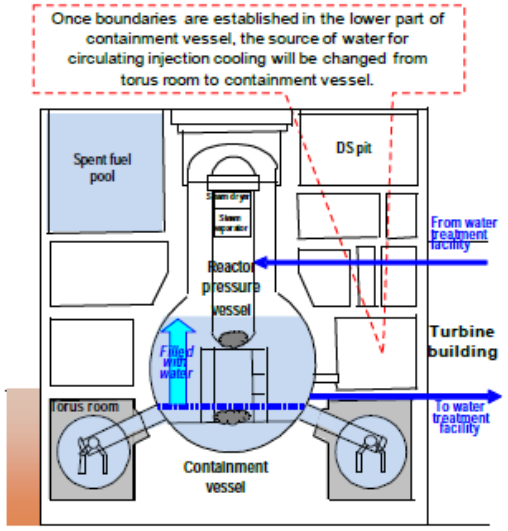
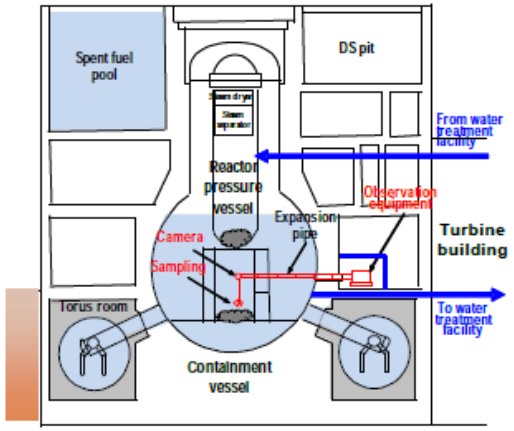
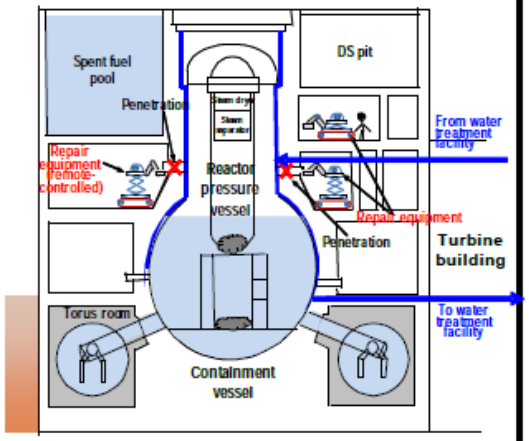
※For the technical development purpose, underwater fuel removal work was assumed in planning the work, as was in TMI case. The plan will be modified considering the actual situations and technical development.

Work	(1) Decontamination in reactor building (Successive decontamination as required for next steps)	(2) Investigation of leak from the containment vessel Investigation of the conditions inside the containment vessel (from outside)	(3) Stopping water leak from the reactor building Repair of the lower part of the containment
Conceptual diagram			
Details	The work area will be decontaminated using high-pressure water, coating, surface chipping, and so forth in order to provide greater access to the containment vessel.	Investigations will be conducted of leak in the containment vessel and the reactor building manually or using remote-controlled radiation dose measuring instruments, cameras, and other devices. The condition of the interior of the containment vessel will be investigated and estimated from outside through γ rays measurements, acoustic investigations, etc.	Since underwater work for removing damaged fuel is preferable in terms of radiation shielding, leaking points of containment vessel will be repaired to stop leakage. For that purpose, priority will be given to repairing the lower parts of containment vessel to facilitate inspection within containment vessel.
Points & issues to be considered in technological development	◆ High dose areas (some hundreds to 1000 mSv) ◆ Limited accessibility due to rubble in buildings • It is necessary to consider remote decontamination methods and other measures for locations with high-level radioactivity.	◆ Objects of investigation are in high dose area, in contaminated water, or in narrow space • Development of methods and equipment to investigate leak • Development of methods and equipment to investigate the condition of the inside of the containment vessel from outside	◆ Stop water leak under high dose and water-flowing conditions in parallel with core cooling by circulating water injection • Development of technology and methods to repair leak in containment vessel and reactor building and stop water leak • Examination and development of alternative measures

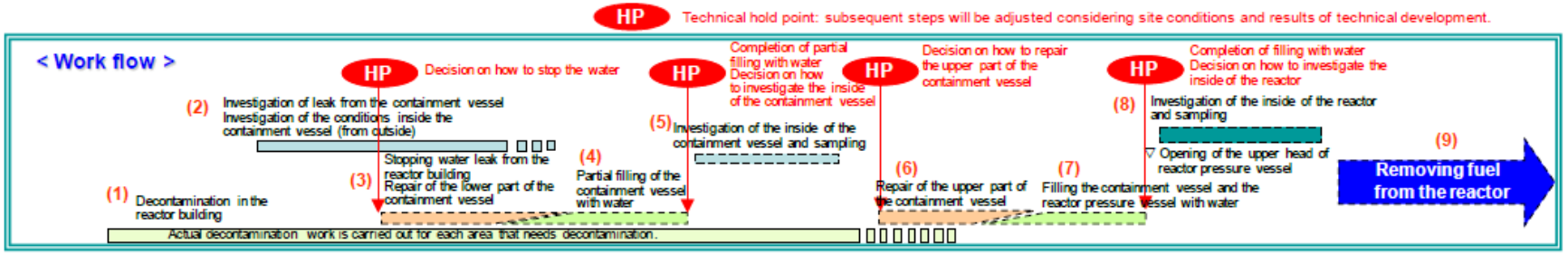
Conceptual Diagram of Work flow for Removal of Fuel from Reactor core (2/3)



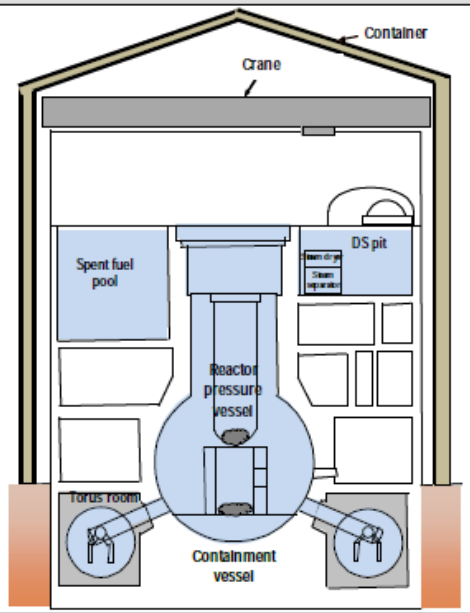
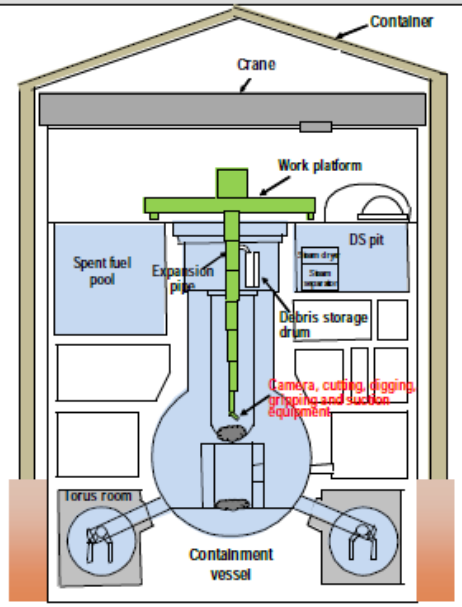
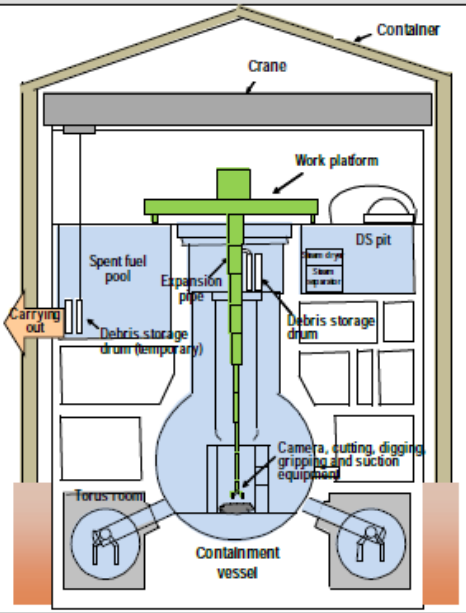
※For the technical development purpose, underwater fuel removal work was assumed in planning the work, as was in TMI case. The plan will be modified considering the actual situations and technical development.

Work	(4) Partial filling of the containment vessel with water	(5) Investigation of the inside of the containment vessel and sampling	(6) Repair of the upper part of the containment vessel
Conceptual diagram			
Details	The lower part of the containment vessel will partially be filled with water before investigations of the inside of the containment vessel begin.	The inside of the containment vessel will be investigated to identify the distribution of damaged fuel, which is presumed to have leaked out of the reactor pressure vessel, and to carry out sampling and other types of work.	In order to fill the containment vessel with water to its top, leak in the upper part of the containment vessel will be repaired manually or through remote control.
Points & issues to be considered in technological development	◆ Same note as that for (3) •The major premise is to build boundaries in the lower part of the containment vessel (including the plan of filling the torus room with grout materials).	◆ Limited accessibility due to high dose, difficult environment inside containment vessel (accumulated water, dropped damaged fuel, etc.) •Development of methods for remote investigations and sampling in the containment vessel where there is high-level radioactivity.	◆ Same note as that for (2) •Development of technology and methods for repairing leak in the containment vessel and stop the water leak (same as in Process (3))

Conceptual Diagram of Work flow for Removal of Fuel from Reactor core (3/3)



※For the technical development purpose, underwater fuel removal work was assumed in planning the work, as was in TMI case. The plan will be modified considering the actual situations and technical development.

Flow	(7) Filling the containment vessel and the reactor pressure vessel with water ⇒ Opening of the upper head of reactor pressure vessel	(8) Investigation of the inside of the reactor and sampling	(9) Removing fuel from the reactor
Conceptual diagram			
Details	After containment vessel and reactor pressure vessel are sufficiently filled with water for shielding purpose, the upper head of reactor pressure vessel will be removed.	The inside of the reactor will be investigated to ascertain the condition of the damaged fuel, structures in the reactor, etc., and sampling and other sorts of work will be performed.	Damaged fuel will be removed from the reactor pressure vessel and the containment vessel.
Points & issues to be considered in technological development	(The major premise is to build containment vessel boundaries in Process (6).)	◆Limited accessibility due to high dose, difficult environment inside containment vessel (accumulated water, damaged fuel, etc.) ・Development of methods for remote investigations and sampling in the reactor where there is high-level radioactivity	◆Further technological development might be needed depending on the situation (distribution) of damaged fuel ・Development of more advanced techniques and methods than used at TMI for removing fuel.

Technical Issues for Medium-and long term Actions -1)

by JAEC (Japan Atomic Energy Commission)

Item	Necessary of Implementation	Major Technical Issues
Removal of fuel assemblies from spent fuel pools(SFP)	1) About 3,100 (about 2,700 are SF) 2) All of them need to be removed from the reactor bldgs (RB).	1) Most of the fuel rods in the SFPs are assumed to be undamaged. 2) Some of them might be damaged or deformed by debris and other contaminant in the pools. 3) Seawater has been injected into the SFPs. *- How to handle the fuel rods damaged or exposed to seawater (handling, cleaning, inspection, possibility of reprocessing etc.*
Toward stabilization / decommissioning	1) Period to be required to remove the fuel in the reactor vessel 2) Core cooling, stable water treatment, ensuring of long-term integrity of RB and structures 3) Proper decontamination to improve work environment	1) Stable continuation of water-injection/circulation into the reactor vessel and treatment of cooling water *- How to process and dispose highly-radioactive secondary wastes generated from water treatment operation.* *- The method for remote decontamination to improve personnel accessibility for high-radiation area in the RB.* *- Assessment of the corrosion resistance of the reactor pressure vessel (RPV) and the primary containment vessel (PCV) and implementation of corrosion control measures as appropriate.*
Removal/preparation for removal of debris in the reactors	1) Part of debris might have leaked into PCV for Unit 1 to 3. 2) The properties, shape and location of the debris are unclear at present, investigation and study should be conducted.	1) Cooling water injected into the reactors are leaking into to the turbine bldgs through RPV and PCV and are being re-circulated after treatment. *- Removing the debris would be carried out under the water.* *- Leaking points have to be located and repaired before water-filling.* 2) The distribution of debris should confirmed and debris sampling should be carried out. *- Development of remote RPV/PCV interior inspection methods operable under high-radiation environment.* 3) Part of damaged fuel might have leaked into PCV (Unit 1 to 3) *- Development of more advanced techniques and methods than those used at TMI.*

Technical Issues for Medium-and long term Actions – 2)

by JAEC (Japan Atomic Energy Commission)

Item	Necessary of Implementation	Major Technical Issues
Removal/preparation for removal of debris in the reactors	Advancing the development of storage methods and treatment/disposal methods for removed debris	1) TMI debris is still in stable storage. This will be applied. *- Development of technology for stable storage of debris containing salt (storage drum)* *- Consideration on proper treatment and disposal measures.*
Treatment/disposal of radioactive wastes	Radioactive wastes from restoration and decommissioning should be treated and disposal.	1) Some of radioactive wastes being generated in the power plant are temporarily stored at site. *- Consideration on proper treatment and disposal measures based on the estimated amount and property evaluation of the expected wastes.*
Understanding of progress of accident	1) Understanding of the detailed sequence is helpful for better consideration the fuel removal procedures.	1) Development and analysis etc. *- Development of techniques to estimate the conditions in PCV (analysis and inspection from outside PCV)* *- Improvement of event progression analysis methods based on the results of the inspection in PCV and RPV and the results of sampling and analysis of debris.*

Source of information

(1) Japanese Government Website
http://www.kantei.go.jp/foreign/incident/index.html
(2) JAEC(Japan Atomic Energy Commission) Website
http://www.aec.go.jp/jicst/NC/eng/index.htm
(3) NISA (Nuclear and Industrial Safety Agency) Website
http://www.nisa.meti.go.jp/english/index.html
(4) TEPCO (Tokyo Electric Power Company) Website,
http://www.tepco.co.jp/en/index-e.html
(5) Report of the Japanese Government to the IAEA Ministerial Conference on Nuclear Safety
- The Accident at TEPCO's Fukushima Nuclear Power Plants –
June 2011
(6) Additional Report of the Japanese Government to the IAEA
- The Accident at TEPCO's Fukushima Nuclear Power Plants –
(Second Report) , September 2011

Conclusion

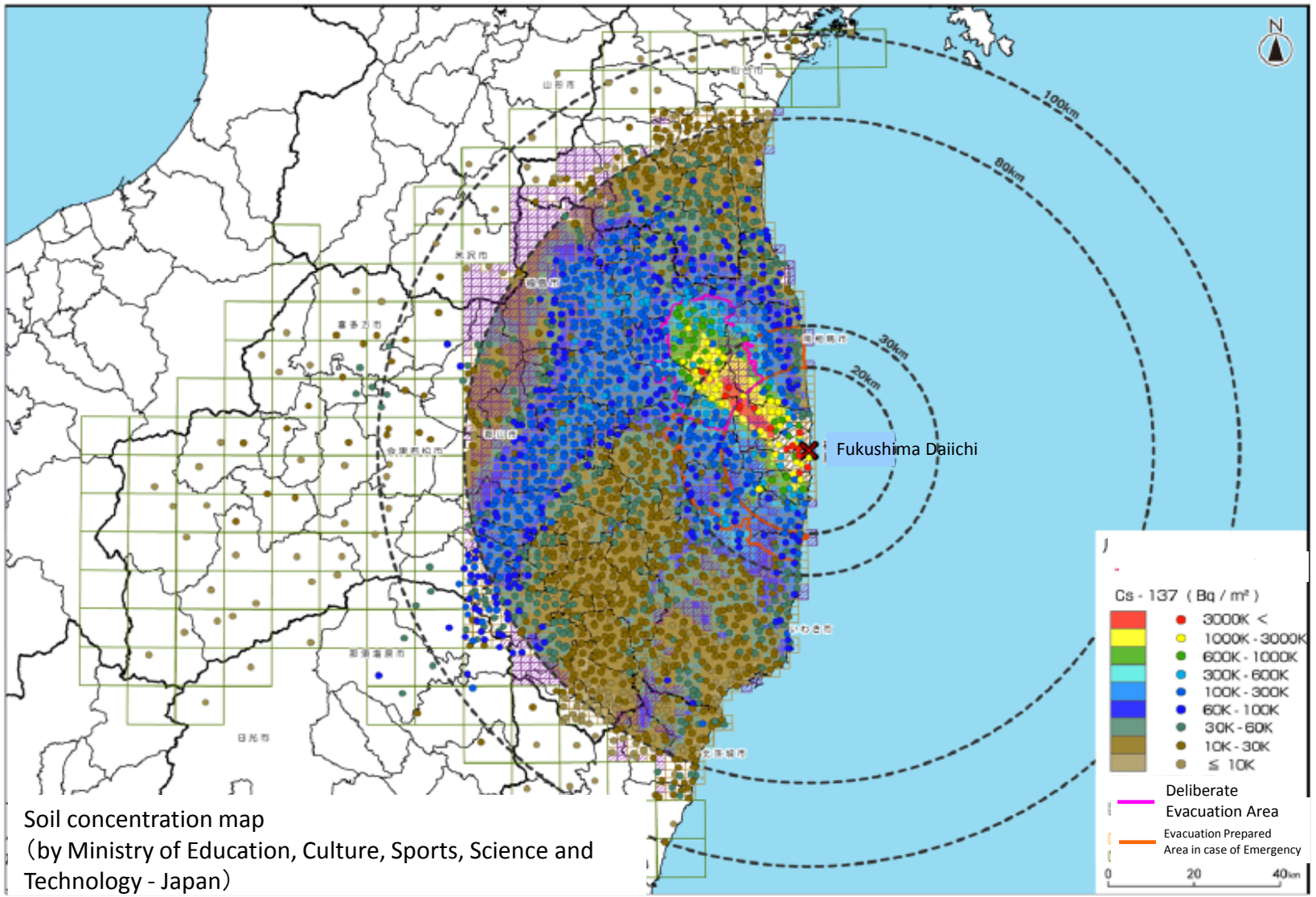
1. *Many people in Japan are engaged in on- and off-site remediation of Fukushima Dai-Ichi*
   - *Government (METI, MEXT, MOE, JAEC, NSC, and NISA etc.)*
   - *Local Government*
   - *Utilities, plant fabricators, general contractors*
   - *National organizations (JAEA, Universities, etc)*
2. *D&D of Fukushima Dai-Ichi NPSs will start after finishing Mid-term Issues (around 3 years)*
3. *International Cooperation is very important toward D&D of Fukushima Dai-Ichi NPSs.*

Thank you for your attention!

Thank you for your useful information !

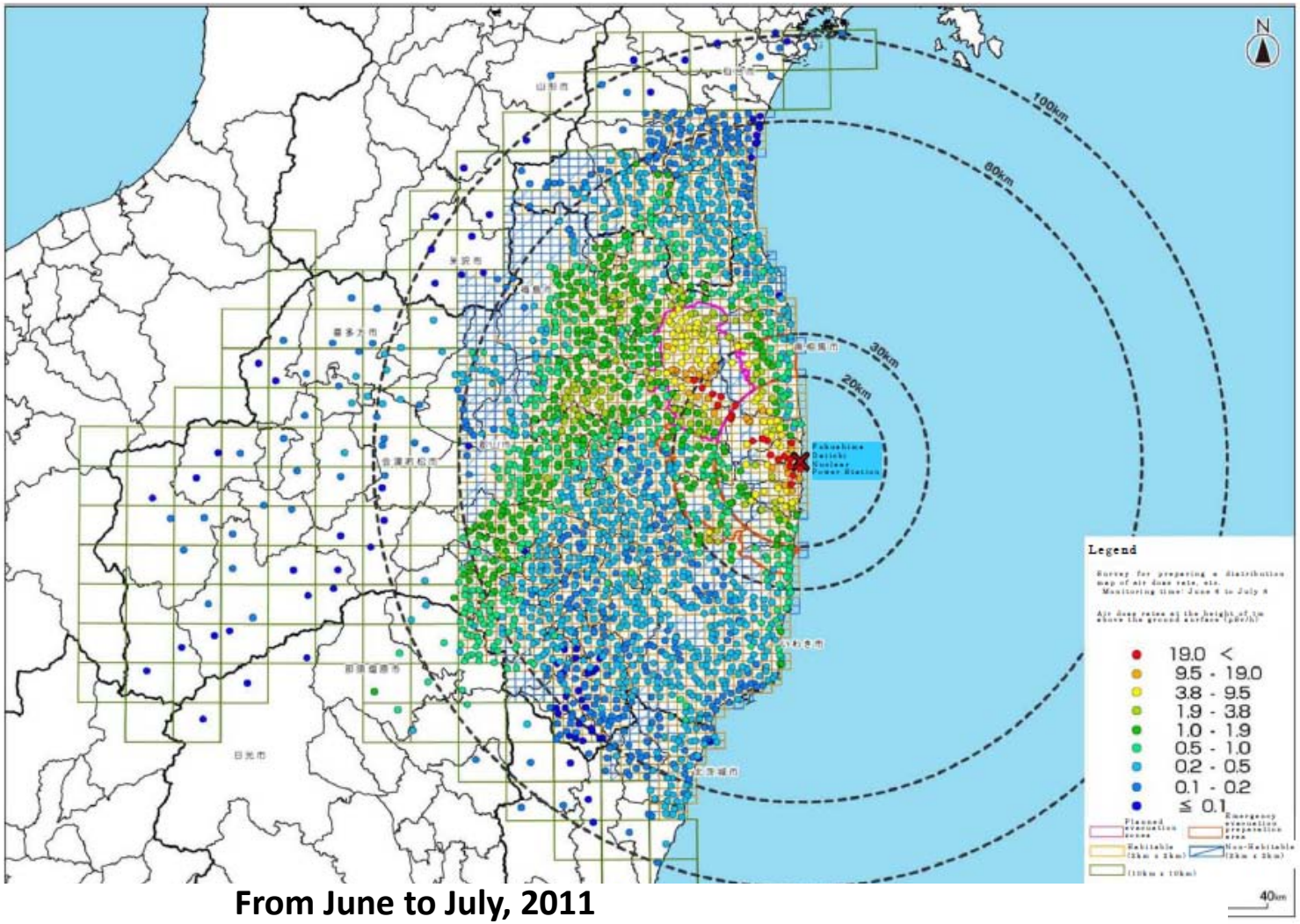
Appendix

Radioactivity concentration in soil (as of August 14th)



Soil concentration map
（by Ministry of Education, Culture, Sports, Science and Technology - Japan）

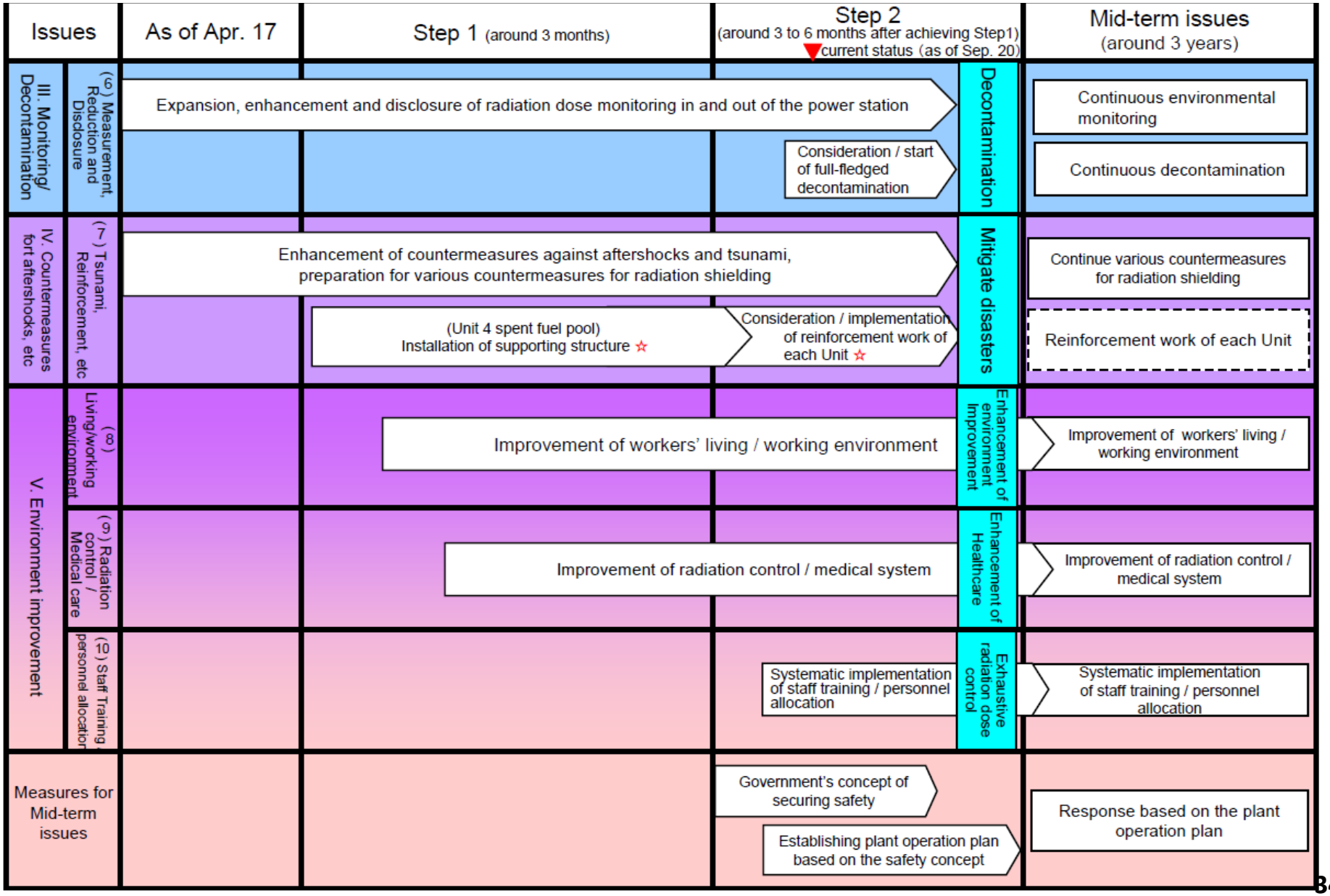
Map of air dose rates at points where soil samples were collected



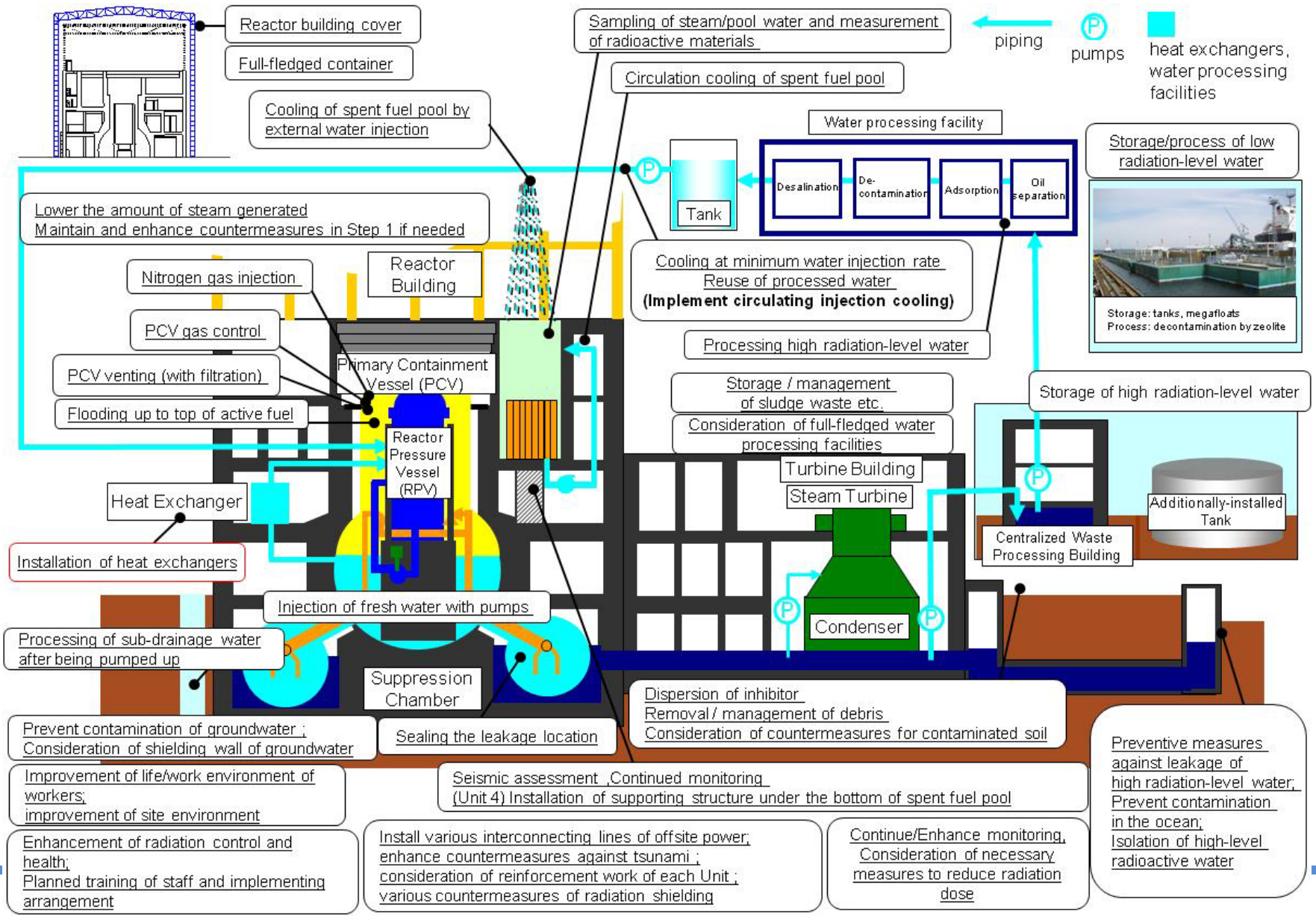
From June to July, 2011

Figure IV-3-1 Map of air dose rates at points where soil samples were collected

Current Status of "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station, TEPCO" (Revised on 20 Sep. '11)



Overview of Major Countermeasures in the Power Station



Current Status of Countermeasure (1)

Red frame: progressed countermeasures from the previous version, ☆: already reported to the government

Issues | Unit

<Step 2 (around 3 to 6 months after achieving Step1)>: Release of radioactive materials is under control and radiation dose is being significantly held down

Start of Step 2 (Jul. 17) — Current status (as of Sep. 20)

I. Cooling — (1) Reactor

Term to keep the amount of accumulated water and to improve reliability | Term to complete measures to improve reliability and reduce the amount of accumulated water | Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water

1

Implementation of circulating water cooling [Countermeasures 12,14,45] ☆

Construction of centralized monitoring system in the main anti-earthquake building

Injection of water required to achieve "stable cooling"

Injection of water enough to achieve cold shutdown

Nitrogen gas injection [Countermeasure 11] ☆

2

Implementation of circulating water cooling [Countermeasures 12,14,45] ☆

Construction of centralized monitoring system in the main anti-earthquake building

Injection of water required to achieve "stable cooling" (Inject water through core spray line in addition to feed water line (Sep. 15))

Change injection flow rate experimentally, and confirm transition of reactor temperatures

Injection of water enough to achieve cold shutdown

Nitrogen gas injection [Countermeasure 11] ☆

3

Implementation of circulating water cooling [Countermeasures 12,14,45] ☆

Construction of centralized monitoring system in the main anti-earthquake building

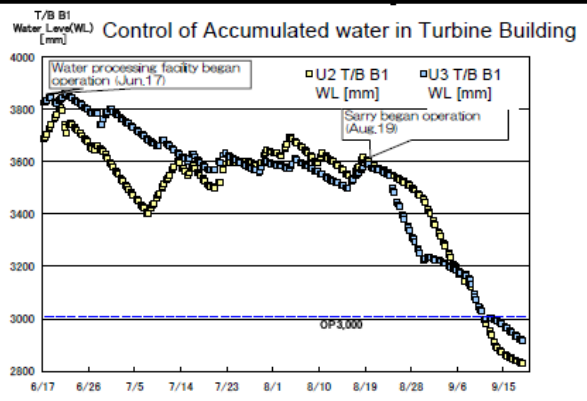
Injection of water required to achieve "stable cooling" (Inject water through core spray line in addition to feed water line (Sep. 1))

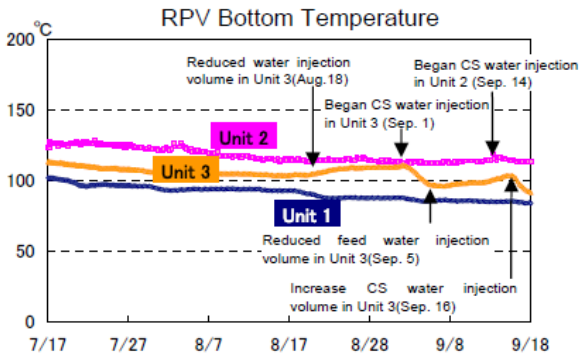
Change injection flow rate experimentally, and confirm transition of reactor temperatures

Injection of water enough to achieve cold shutdown

Nitrogen gas injection [Countermeasure 11] ☆

Target [ ] Cold shutdown condition

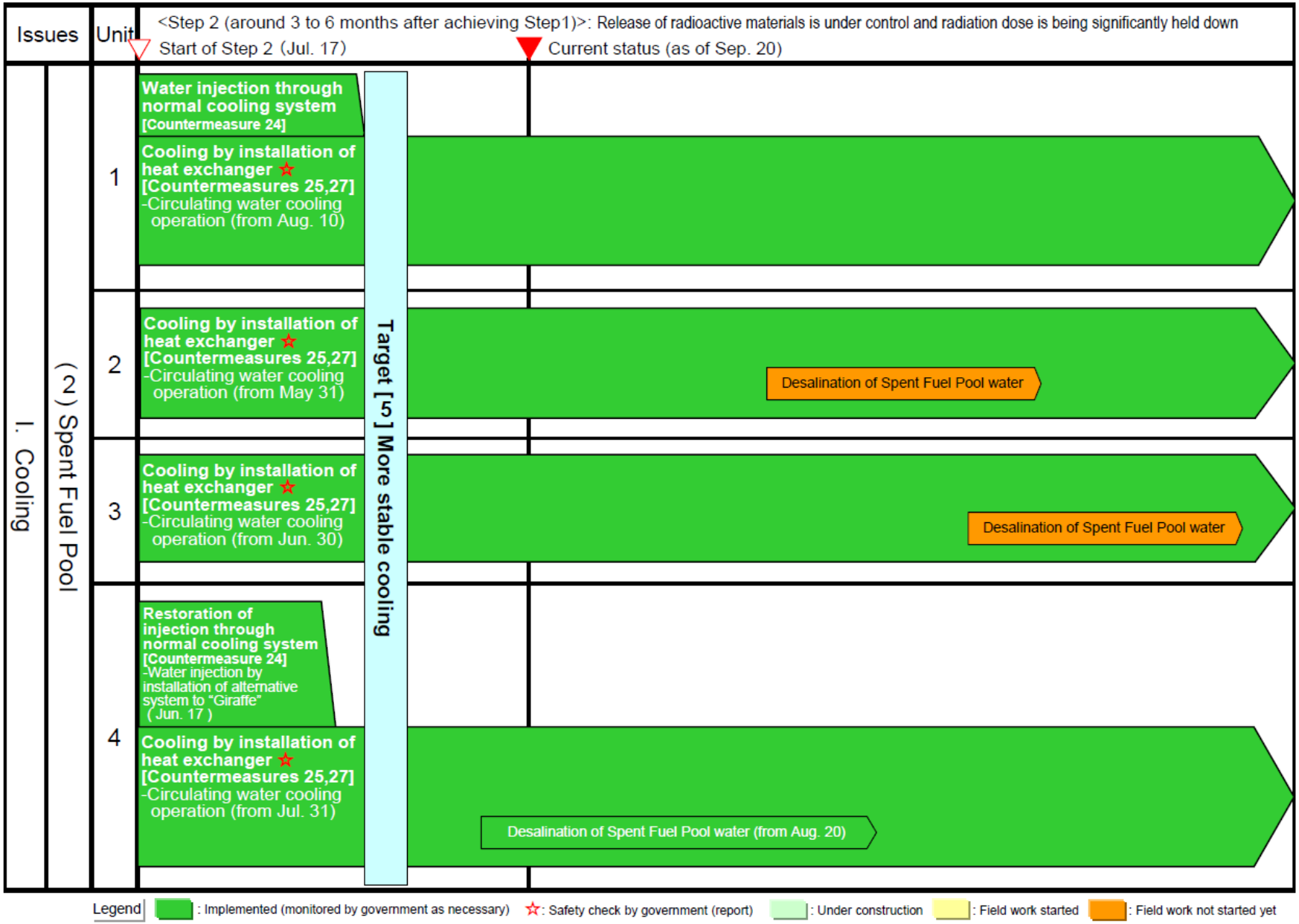




Legend: ■ : Implemented (monitored by government as necessary) ☆: Safety check by government (report) ■ : Under construction ■ : Field work started ■ : Field work not started yet

Current Status of Countermeasure (2)

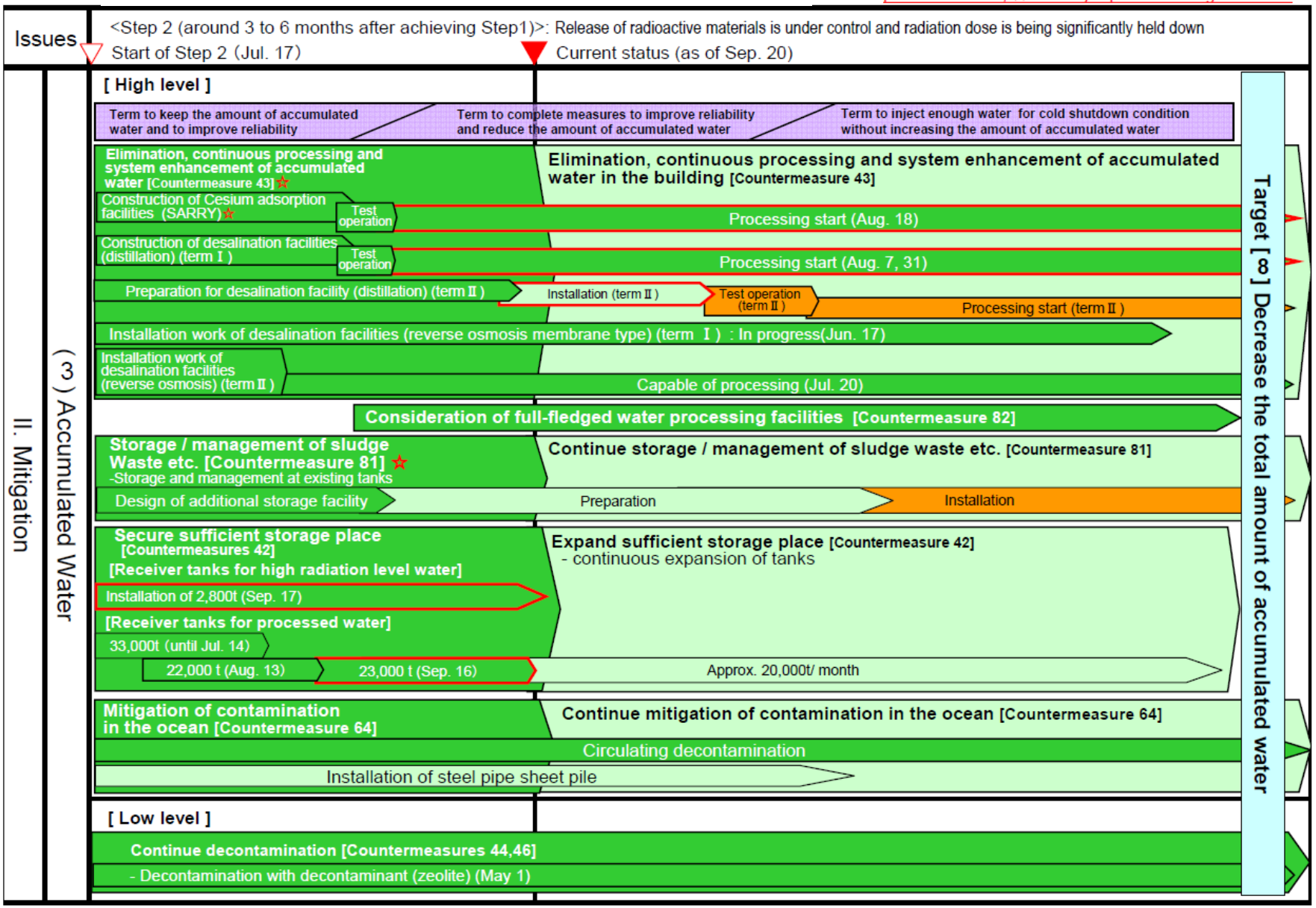
Red frame: progressed countermeasures from the previous version, ☆: already reported to the government



Current Status of Countermeasure (3)

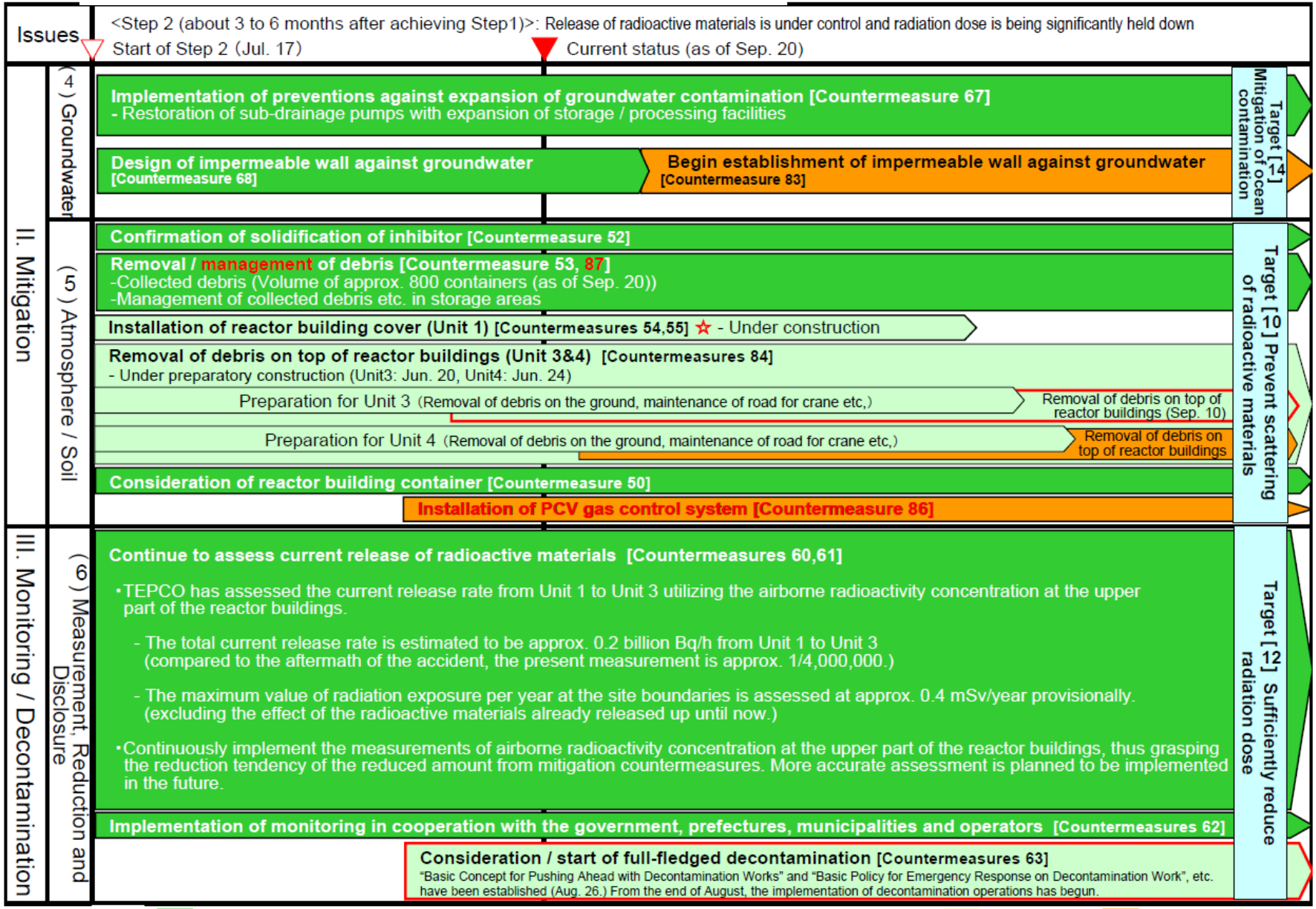
Red frame: progressed countermeasures from the previous version, ☆: already reported to the government

vi



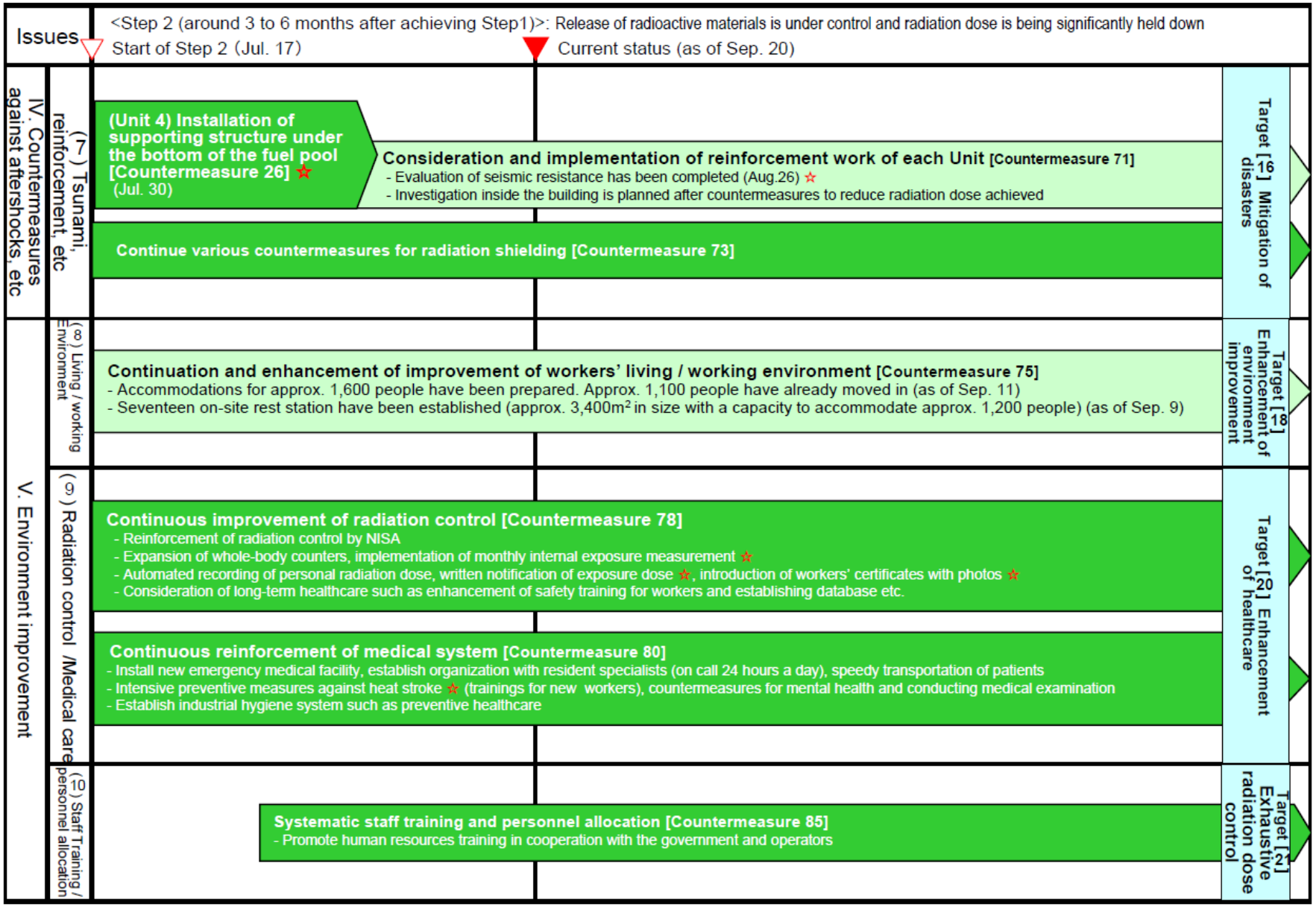
Current Status of Countermeasure (4)

Red colored letter: newly added countermeasures, Red frame: progressed countermeasures from the previous version, ☆: already reported to the government



Current Status of Countermeasure (5)

Red colored letter: newly added countermeasures, Red frame: progressed countermeasures from the previous version, ☆: already reported to the government



R &D Items for Medium- and Long-term Actions for Fukushima Daiichi NPSs (by JAEC)- (1)

	Subject	Action	Breakthrough Technology
Retrieval of Fuel from Spent Fuel Pool (SFP)	(Technical Challenge) ***Research on methods to deal with damaged saline fuel(handling, cleaning, inspection, availability for reprocessing, etc.***		
	1. Evaluation of the long-term integrity of fuel assemblies etc., in the SFP and the Common Pool.	*1) Evaluation of the long-term integrity of fuel assembly during storage* *2) Establishment of cleaning criteria for fuel assembly*	
	2. Establishment of Indicators on Possible Reprocessing	*Categorizing indicators will be identified in terms of their impact on the handling failed fuel, etc., and on chemical treatment processes, etc.., and criteria will be developed to determine possible reprocessing.*	
	3. Establishment of Method for Handling Failed Fuel	*1) Case research on failed fuel* *2)Examination of the impact of failed fuel, etc., on chemical treatment process, etc.* *3) Examination regarding the handling of failed fuel, etc.*	

R &D Items for Medium- and Long-term Actions for Fukushima Daiichi NPSs (by JAEC)- (2)

	Subject	Action	Breakthrough Technology
On going Efforts for Stabilization and Decommissioning	(Technical Challenge) *1) Study of remote decontamination methods to improve human accessibility o high radioactive areas in a building.* *2) Evaluation of corrosion resistance of the pressure vessel and the containment and implementation of corrosion control measures if necessary* *3) Study of treatment and disposal methods of high dose secondary waste generated from operation of the water treatment system*		
	4. Examination of Method for Decontamination to Access Buildings Interiors	*1) Establishment of decontamination plan according to estimates and surveys on the contamination status.* *2) Identification of decontamination techniques and decontamination planning.* *3) Decontamination testing using simulated contamination.* *4) Development of remotely operated devices to develop devices and systems that allow the possible measuring and decontamination techniques to be mounted on the existing traveling carriages.*	*Remote decontamination devices appropriate for different areas including high dose or narrow areas requiring decontamination*
	5. Assessment on the integrity of the Pressure Vessel and Containment Vessel against Corrosion	*1) Corrosion test of structural materials of RPVs and PCVs* *2) Corrosion test of RPV pedestal reinforcement* *3) Confirmation test of corrosion inhibitors for RPVs, and RPV pedestals* *4) Residual life evaluation and life extension evaluation of RPVs, PCVs, and RPV pedestal structure.* *5) Trial use of corrosion inhibitors in the actual plant (eligible material for effectiveness confirmation; PCV structural materials)*	
	6. R&D for Stable Disposal of Secondary Wastes Generated by Treatment of Contaminated Water	*1) Behavioral Assessment of waste zeolite, sludge, and concentrated liquid wastes.* *2) Safety evaluation regarding generation of hydrogen gas and heat generation.* *3) Establishment of a method for long-term storage taking into account the impact of seawater, heat generation, and high-level radioactivity, etc.* *4) Consideration of disposal of waste zeolite, sludge, and concentrated liquid wastes in the form waste packages.* *5) Characteristics evaluation of waste packages.* *6) Study if optimizating waste disposal method*	

R &D Items for Medium- and Long-term Actions for Fukushima Daiichi NPSs (by JAEC)- (3)

	Subject	Action	Breakthrough Technology
Preparation for Retrieval and Retrieval of Debris	(Technical Challenge) ***Development of technologies and techniques to identify and repair a leaking portion such as the containment and then create the boundary in order to fill the affected portion with water, since it is considered that failed fuel can be most reasonably discharged underwater for the purpose of shielding radiation.***		
	7. Development of Measures and Equipment for Investigation of Locations of Leaks in Containment Vessel	*1) Identification of all possible locations of leaks* *2) Study of existing techniques* *3) Development of techniques for identifying locations do leaks on PCVs.* *4) Development of remote inspection devices around PCVs.*	*Inspection devices to remotely identify leaking portions on PCVs in a narrow or high dose area.*
	8. Establishment of Measures to prepare for Water Filling (Repair, Sealing,etc.) and Development of Methods and Equipment	*1) Surveying catalogs of existing techniques* *2) Examination and development of materials and equipment for repair (seal materials, grout materials, etc.)* *3) Development of methods and techniques for repair (stopping of water) of supposed leaking locations.* *4) Development of robots for PCV remote repair.*	*Techniques to remotely repair (to stop water) leaking portions on PCVs under the situation of high dose and flowing water and repair devices*
	9. Development of Measures and Equipment for Investigation of the PCV Interior	1) Planning for Investigation based on the estimated states 2) Development of an access method and remote equipment 3) Measures to prevent dispersion of radioactive materials from inside PCVs. 4) Development of remote inspection equipment and techniques	1) Remote inspection technologies by entering PCVs with poor accessibility under the conditions of under interior situation and high dose. 2) Remote sampling technologies for fuel debris in PCVs.

R &D Items for Medium- and Long-term Actions for Fukushima Daiichi NPSs (by JAEC)- (4)

	Subject	Action	Breakthrough Technology
Preparation for Retrieval and Retrieval of Debris	10. Development of Measures and Equipment for Preliminary Survey of Reactor Interior	1) Study of existing techniques 2) Planning for investigation based on the estimation from fact findings and analyses conducted for the interior and exterior of PCVs. 3) Establishment of a method for get access to and investigate the inside of PCVs. 4) Development of remote investigation techniques under a high dose environment. 5) Development and Implementation of techniques to sample debris fuel	
	(Technical Challenge) ***Development of advanced removal technologies compared with the TMI accident that the core damage was limited within the pressure vessel.***		
	11. Development of Method and Equipment for Retrieving Fuel and Reactor Internals	*1) Surveying catalogs of existing techniques (including the verification of equipment whose performance was proven in TMI)* *2) Planning of a method for retrieval based on the results of preliminary surveys* *3) Development of techniques for remotely discharging in-vessel fuel debris* *4) Development of techniques for remotely discharging fuel debris in PCVs*	*Remote technology to discharge in-vessel fuel depending on the distribution of fuel debris* *Remote technology to discharge fuel debris in PCVs*
	12. Development of Techniques for Management of Criticality	*1) Evaluation of criticality* *2) Technologies for detecting re-criticality in the reactors* *3) Techniques for criticality prevention*	*Evaluation of criticality of in-vessel fuel depending on the distribution of fuel debris.* *Technology for preventing criticality*

R &D Items for Medium- and Long-term Actions for Fukushima Daiichi NPSs (by JAEC)- (5)

	Subject	Action	Breakthrough Technology
Preparation for Retrieval and Retrieval of Debris	13. Characteristic Tests Using Simulated Debris	*1) Preparation of simulated debris* *2) Evaluation of Characteristics of simulated debris* *3) Comparison with debris from TMI*	*Development of simulated in-vessel fuel debris taking into consideration the duration of melting, sweater injection, etc.*
	14. Property Analysis of Debris in Actual Reactors	*The property analysis of actual debris in the core will be carried out to establish techniques for collecting in-vessel fuel debris, review of treatment and disposal discharger duel and accident analysis.*	
	(Technical Challenge) 1) Development of technology (storage dram) to store stably 2) Review of appropriate measures for treatment and disposal		
	15. Development of Storage Drums for Debris	*1) Study of existing techniques* *2) Examination of storage systems for debris*	*Technology to store in-vessel fuel debris taking into consideration the treatment and disposal*