

Reducing Risk at Fukushima Dai-ichi NPS

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Workshop on Decommissioning of Nuclear Power Plants
Hotel Grand Hill Ichigaya Tokyo, Japan
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Introduction

- ✓ According to the amended Nuclear Regulation Act, the NRA designated the Fukushima Dai-ichi Nuclear Power Station as "Disaster-experienced Nuclear Power Plant" on November 7, 2012, which needs special measures to prevent further disaster and to ensure nuclear security.
- ✓ The NRA requested TEPCO to prepare an implementation plan regarding decommissioning processes for Units 1 thru 4, maintaining shut-down status for Units 5 and 6, monitoring plant status for Units 1 thru 6, physical protection, and others.
- ✓ In order to address risk concerns plainly, the NRA produced "Measures for Mid-term Risk Reduction" on February, 2015.

Measures for Mid-term Risk Reduction at TEPCO's Fukushima Daiichi NPS (as of February 2015)

Issue	Contaminated water	Radioactive	Effective dose at	Consult fixed	Earthquake /	Moult ansiranment	Examining the
	Contaminated water	waste	the site boundary (estimated value)	Spent fuel	Tsunami	Work environment	inside of the facilities
Objective	Avoiding leakage of contaminated water from tanks etc.	Preventing scattering of radioactive waste during decommissioning processes	Managing off-site effective dose during decommissioning processes	Removing fuel from Spent Fuel Pools (SFPs)	Site and environmental protection from Earthquake / Tsunami	Enabling a sustainable work environment for decommissioning	Understanding the internal situation of the damaged facilities
2015	Removing high- radioactive contaminated water from the sea-side pipe trenches (Units 2-4) (Mar. 2015; Unit 2) - Completing removal of tanks lacking concrete foundations and/or dikes (Apr. 2015) - Removing contaminated water from bolt-joint tanks Treating high- radioactive contaminated water in tanks (May. 2015) Preventing the outflow of contaminated groundwater int the sea by completing the sea- side underground impermeable wall including sub-drain contro systems Accurately controlling the levels of groundwater and stagnant contaminated	protective clothing (Oct. 2015)	Managing the additional effective dose to 2mSv/year* or less by continuous radiation monitoring and by treating high-radioactive contaminated water etc. (Mar. 2015)	Completing fuel removal operation at Unit 4 SFP (Dec. 2014)	Preventing the outflow of stagnant contaminated water anticipating the recurrence of the 2011 Tsunami Scientifically providing the greater earthquake/tsunami model, and establishing the basic protection plan that corresponds to this model	Building the large resting facility (Mar. 2015) Managing a work environment not requiring full-face mask respirators excluding the vicinity of R/Bs etc. (May. 2015)	Examining the process of accumulation of contaminated water in R/Bs, etc.
2016	Managing the increase of the total capacity of water in tanks by restraining the inflow of groundwater into Reactor Buildings(R/Bs) and Turbine Buildings (T/Bs)		additional effective dose to 1mSv/year* or less (Mar. 2016)		Implementing the site protection measures following the established plan	Completing on-site decontamination excluding the vicinity of R/Bs etc. (Mar. 2016) Facilitating administration of the workers by completing the new main office building (Aug. 2016)	in water passing through the reactors
2017	Reducing the volume of contaminated water in tanks by discharging the water after necessary treatment to the sea in accordance with the regulatory requirements, etc.	Starting operation of incineration plants for felled trees Extending the capacity storage and volume reduction plants for rubbles, etc.	of	Completing construction of Unit 3 R/B cover and completing fuel removal facility Completing fuel removal operation at Unit 3 SFP	e protection he established plan		Analyzing the contamination of the inside of R/Bs, etc. Directly observing inside of Primary
2019 (year)		Managing secondary wa from treatment of contaminated water e.g sledges in the High Integ Container(HIC)s, etc.	į.	Completing construction of Unit 1 R/B cover and completing fuel removal facility Completing fuel removal operation at Unit 1 SFP	[Note] Completed measures Measures in progres or in preparation: Measures (Timing TB	s 🗀	Containment Vessels(PCVs) and Reactor Pressure Vessels(RPVs)



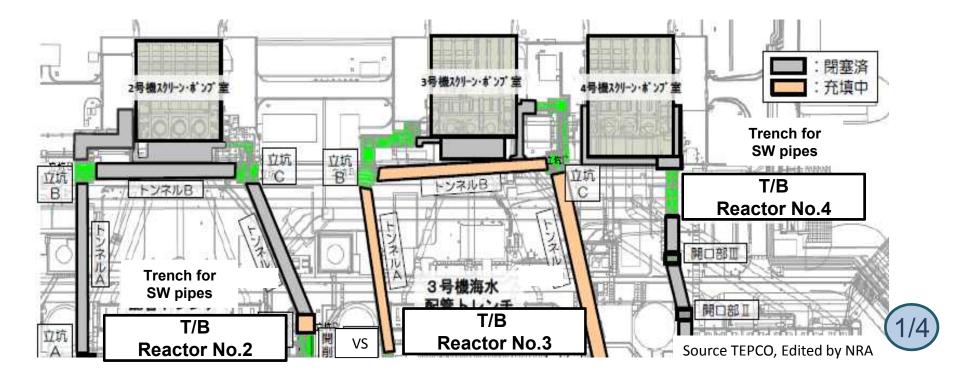
This presentation covers;

- Most significant concerns are;
 - Water removal and stabilization in underground trenches connected to the reactor turbine buildings on the seaward side,
 - Fuel removal from spent fuel pool of Units 1 thru 4,
 - Water decontamination and management of processed water, and
 - Water levels management in order to reduce inflow of ground water into reactor and turbine buildings.
- Another several issues regarding the decommissioning.



Underground Trenches

- The NRA considers that a risk of water leakage from underground trenches connected to the reactor turbine buildings on the seaward side is most significant.
- ✓ e.g., ~10¹⁵ Bq of Cs-137 in Unit 2 trenches
 (estimated in July 2013)



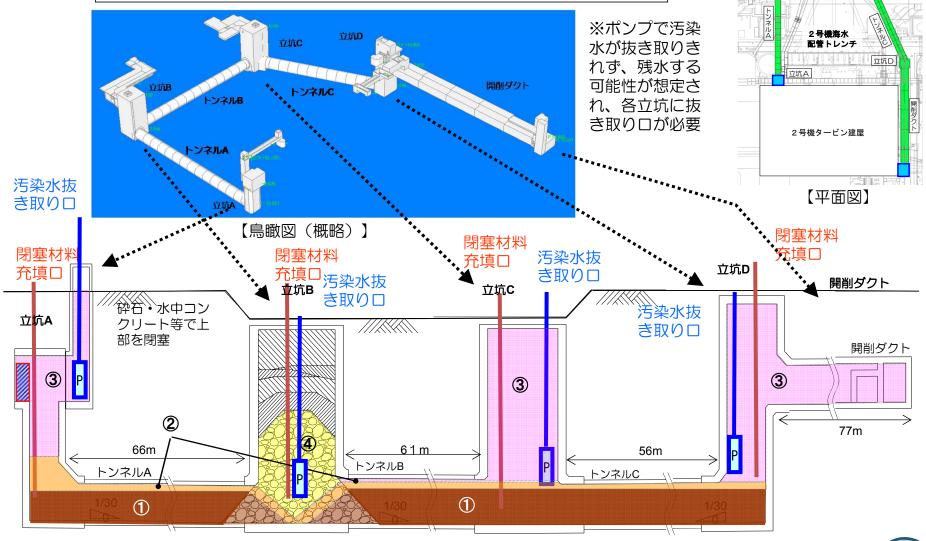
立坑C

トンネルB

NJ



- ①立坑からの閉塞材料投入により、トンネルの閉塞開始。
- ②トンネルを閉塞後に、③立坑の閉塞を実施
- ④立坑B下部の砕石層を閉塞し、閉塞完了



Source TEPCO



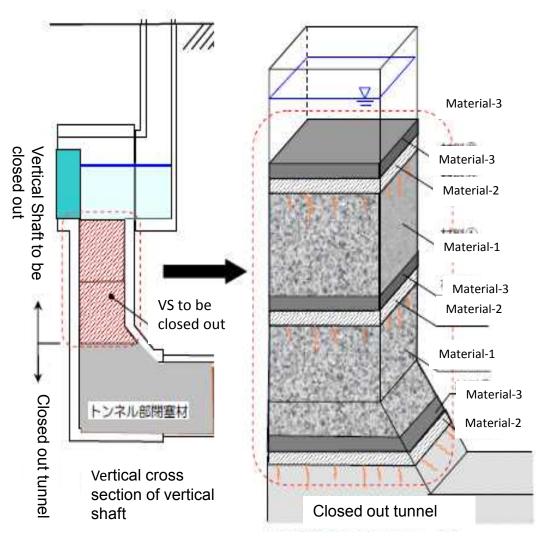
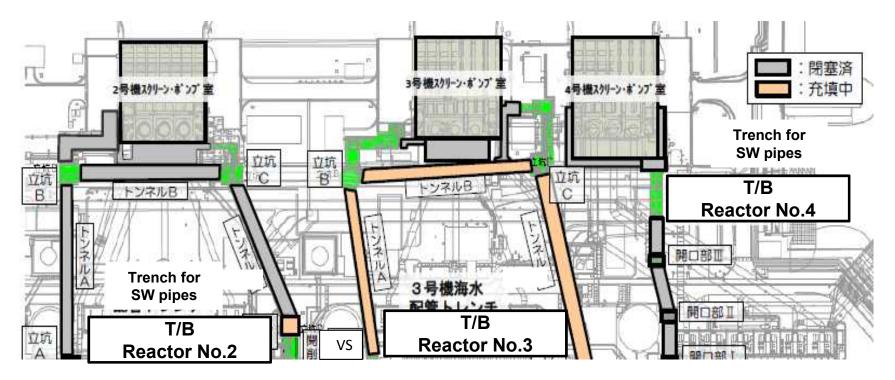


Image of the work closing out with each material



Work Progress



as of Mar 23rd

	Unit 2	Unit 3	Unit 4
Residual water	~1,890 m ³	~3,480 m ³	~440 m ³
Cemented	~2,610 m ³	~2,320 m ³	~460 m ³

Source TEPCO



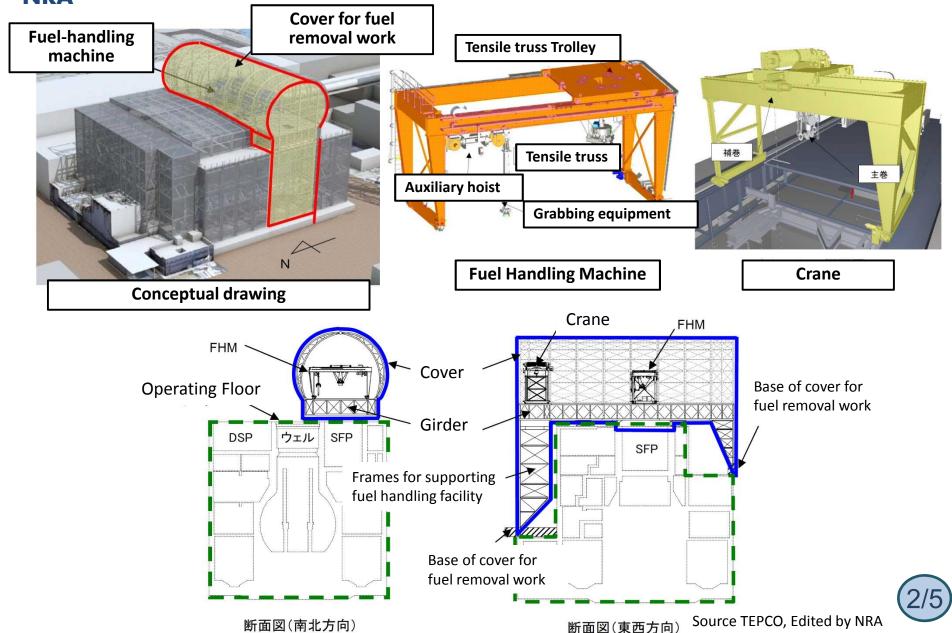
Spent Fuel Pool

✓ Fuel removal from spent fuel pool of Unit 4 was completed on December, 2014. This corresponds to ~49% reduction of spent fuel assemblies in spent fuel pools of Units 1 thru 4.

Unit	1	2	3	4
Capacity	900	1240	1220	1590
SFA	292	587	514	1331
FFA	100	28	52	202
Total	392	615	566	1533



Fuel-handing machine and crane for Unit 3 SFP

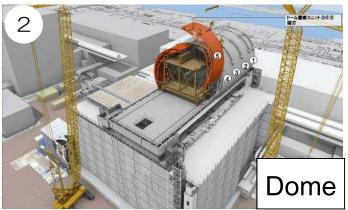




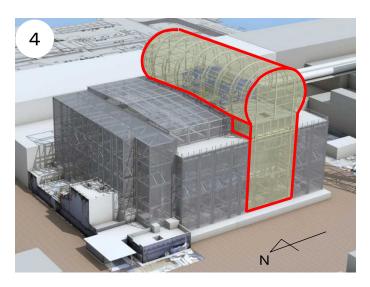
Fuel-handing machine and crane for Unit 3 SFP



XThis is just a plan.



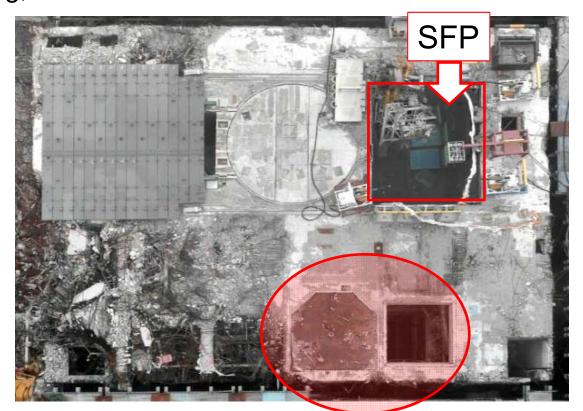






Fuel removal from Unit 3 SFP

- ✓ To be made with remote-control fuel-handing machine and crane
- Setting up rail and girder requires manned operation, so precedent arrangements, debris removal, decontamination and additional shielding, are needed.



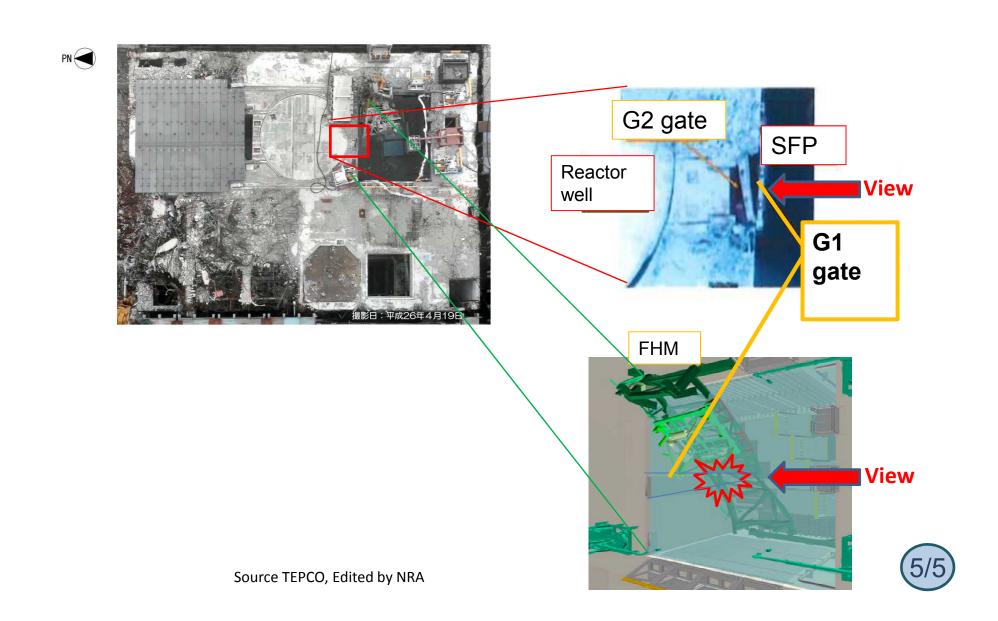
Relatively high dose rate

Source TEPCO, Edited by NRA





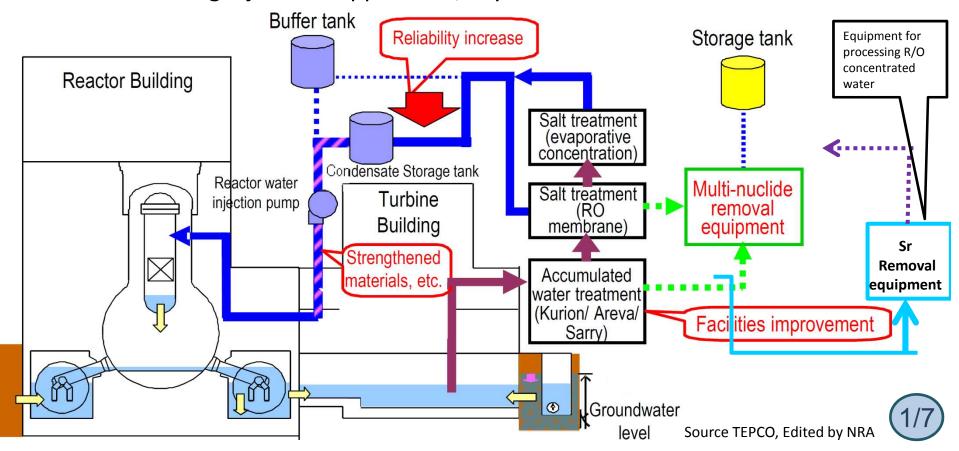
Unit 3 SFP Gate





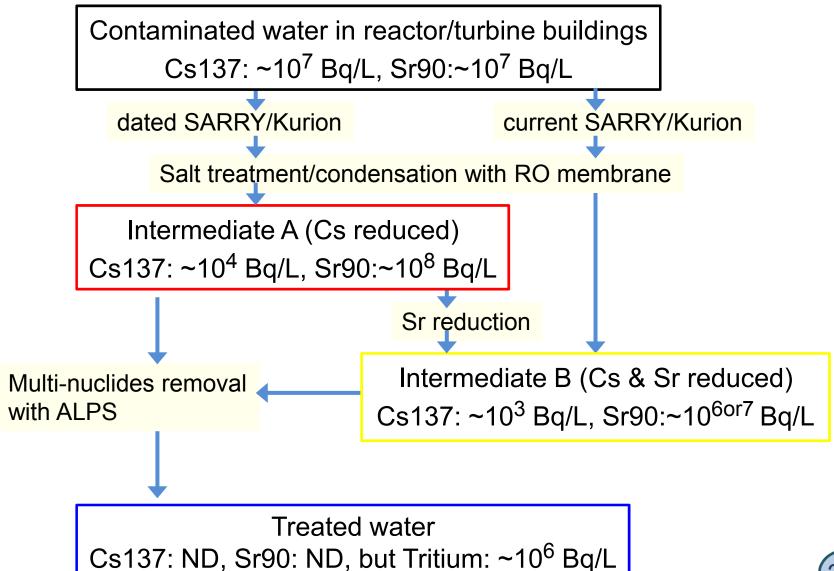
Water decontamination

- Contaminated water in R/Bs & T/Bs is treated and injected back to RPVs.
- App. 400m³/day of groundwater is intruding into R/Bs & T/Bs and it forces the capacity of tanks increase.
- Reactor cooling injection: App.300m³/day





Water decontamination process



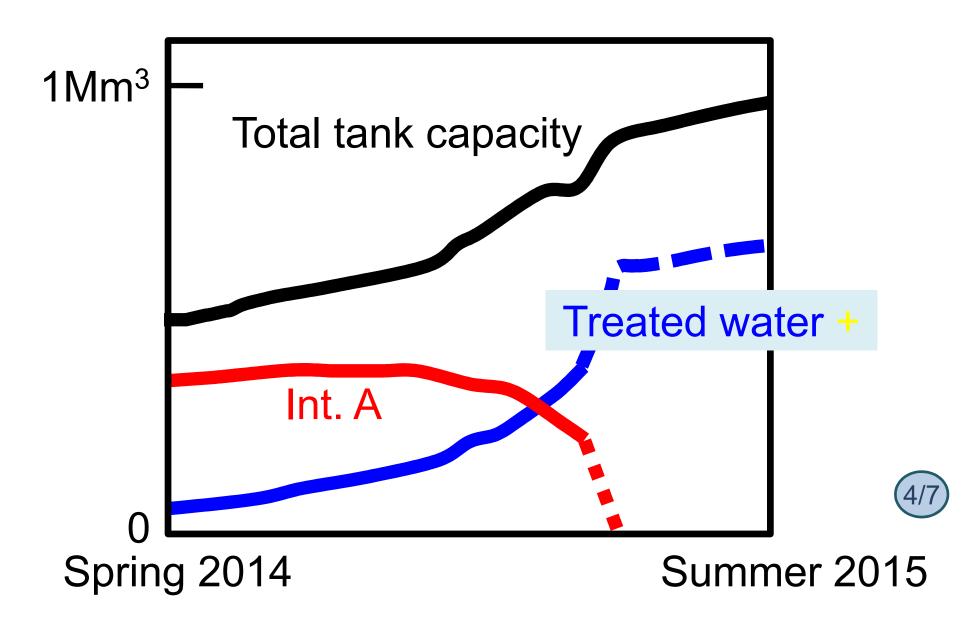


Water decontamination system

ALPS	250m ³ /d x 3 units
Improved ALPS	250m ³ /d x 3 units
High-performance ALPS	500m ³ /d x 1 unit
R/O water treatment	500m ³ /d
Mobile Sr removal*	300m ³ /d x 2 units 480m ³ /d x 4 units
SARRY	600m ³ /d x 2 units
Kurion	300m ³ /d x 3 units

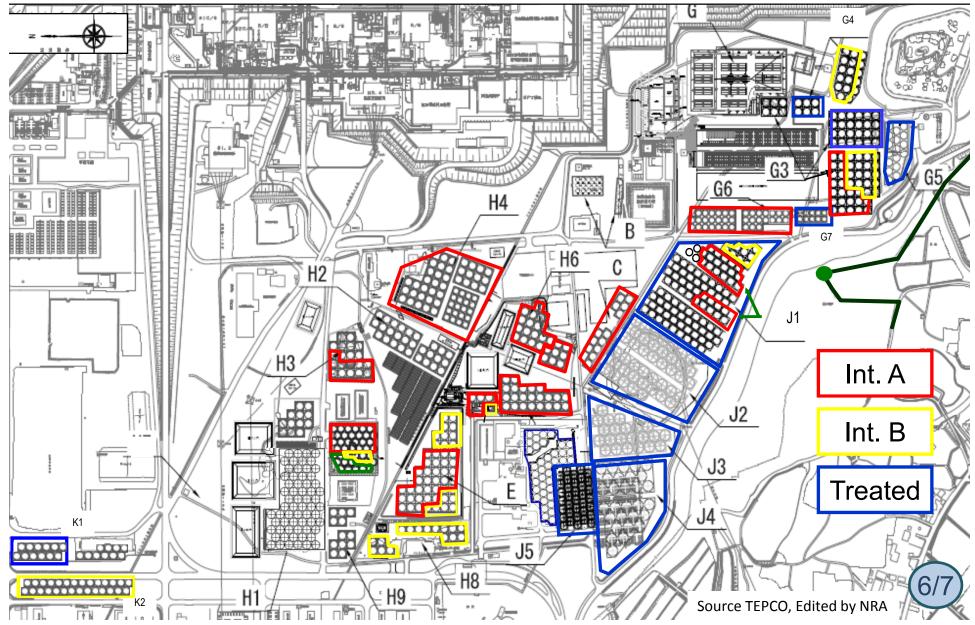


Water storage





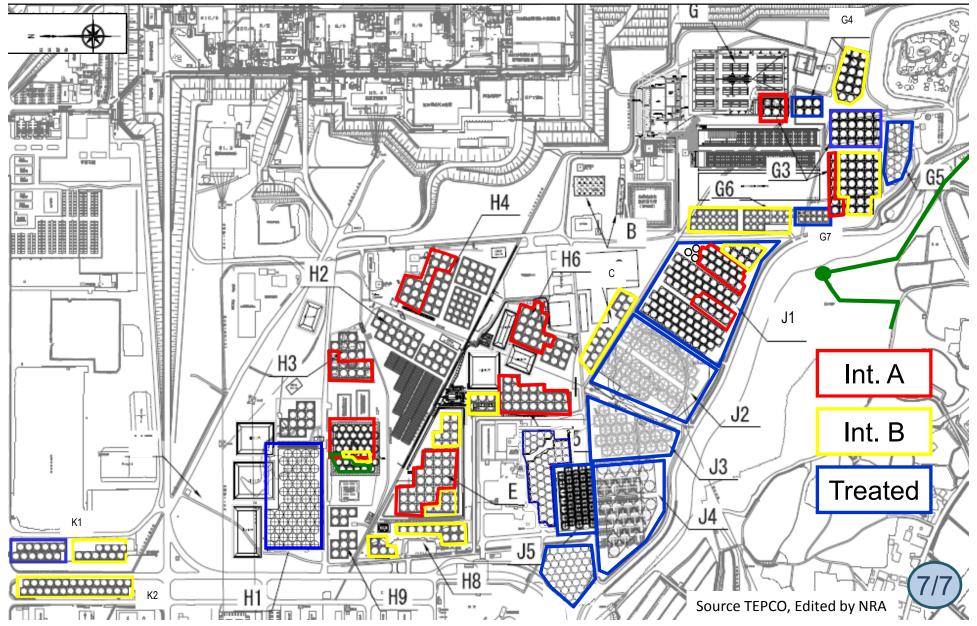
March 12, 2015







Achieving less than 1 mSv/y at border

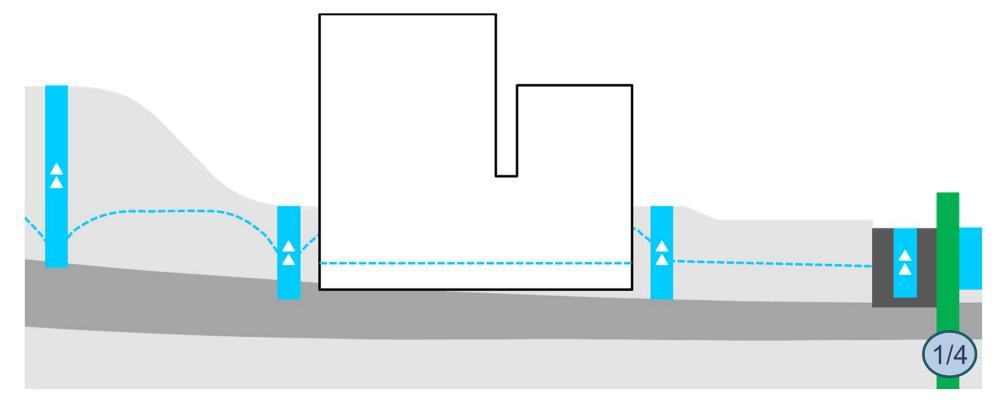






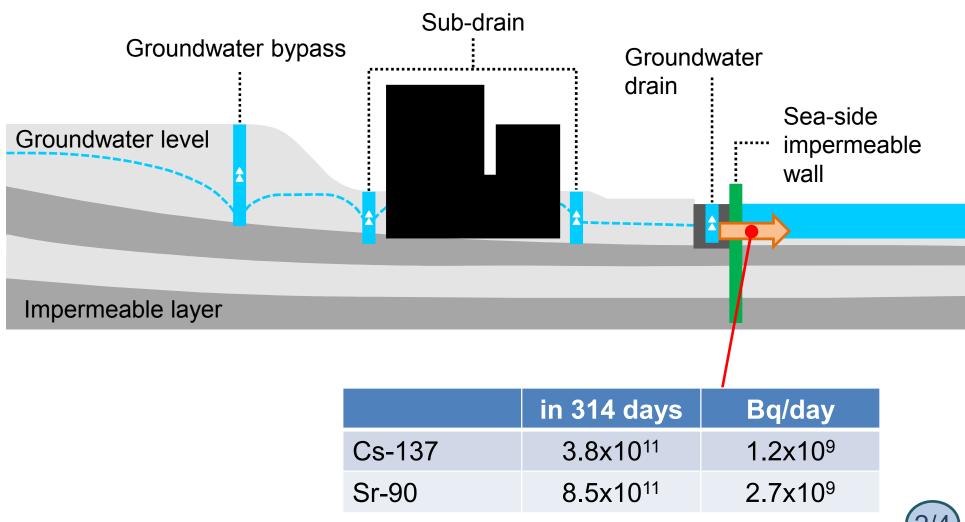
Reduction of groundwater inflow

- The water level in reactor/turbine buildings must be always lower than ambient groundwater level.
- ✓ The difference between the two levels, however, should be controlled at adequately small in order to reduce the inflow.





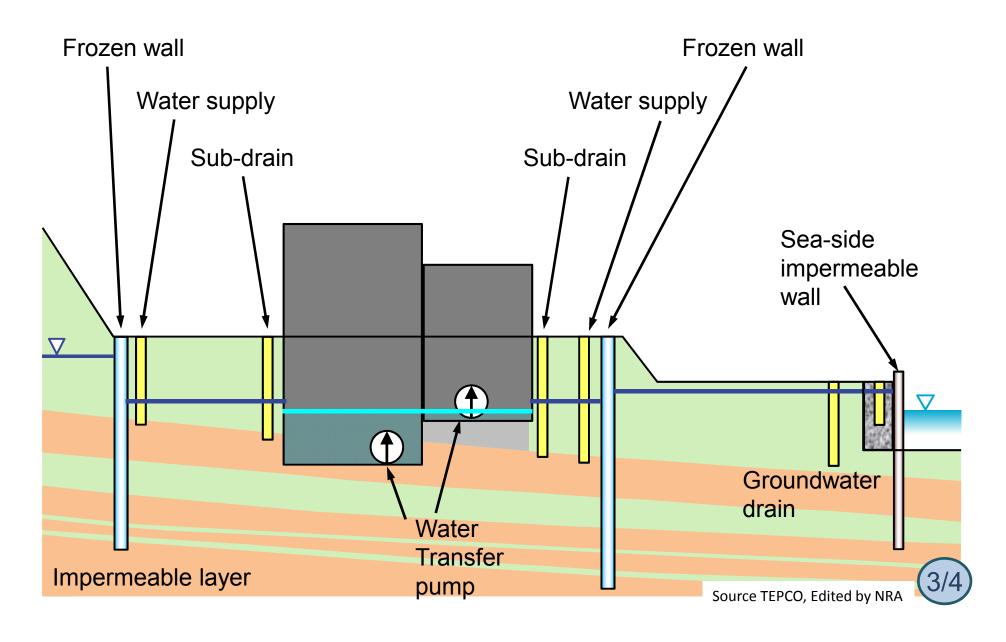
Sub-drain and sea-side impermeable wall



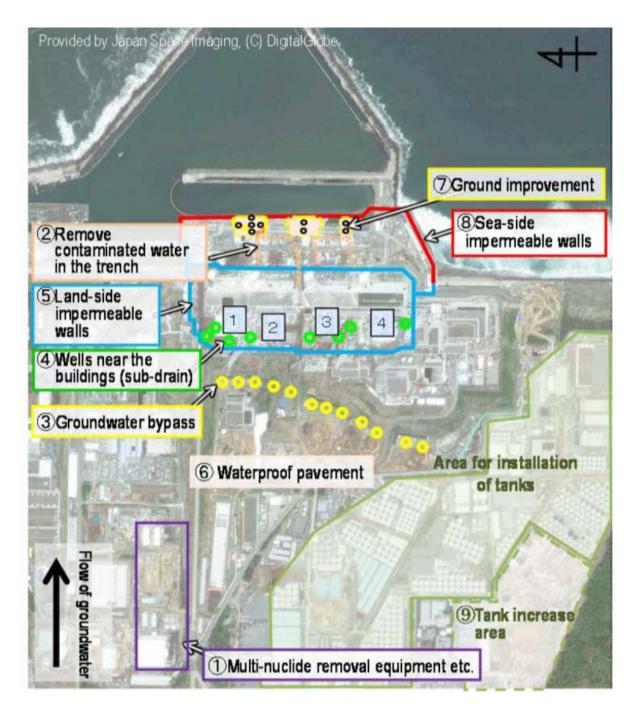
Estimation for a period from 4/16/2014 to 2/23/2015



Land-side impermeable walls











Other issues

- ✓ Protection against earthquake and tsunami
- ✓ Drainage ditches
- Work environment
- ✓ Facility investigation



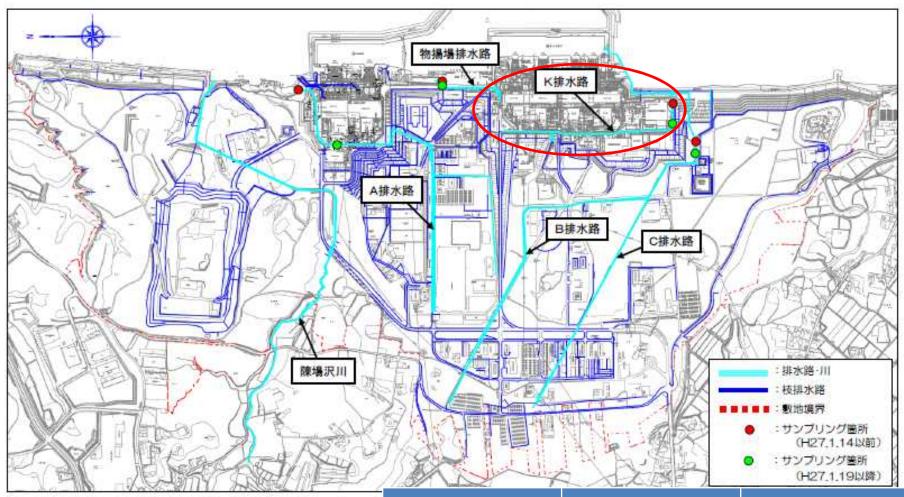
Earthquake and tsunami

- ✓ ~270gal and 3.122m; DB at initially licensed in 1966
- ✓ 600gal and OP+14.13m; aseismic design back-check in 2009 and re-evaluation in 2012 for outer-rise earthquake
- ✓ 900gal and OP+26.3m; under evaluation





Water in drainage ditches



Source TEPCO

Estimation for a period from 4/16/2014 to 2/23/2015

Ditch "K"	in 314 days	Bq/day
Cs-137	1.5x10 ¹¹	4.8x10 ⁸
Sr-90	1.5x10 ¹⁰	4.7×10^7





Work environment e.g., reduction of work area with full-face mask

Action to be made toward designating area colored with pink as an area in which wearing full-face mask is not necessary

- (1) Series of dust monitor equipment will be installed at appropriate spots and data from these monitors will be transmitted to the anti-earthquake building so as to monitor dust level in the building. (February or March 2015)
- (2) Get permission from the government after confirming that dust level is low enough. (March or April 2015)
- (3) Certain area is controlled as an area in which wearing full-face mask is not necessary. (In operation in May 2015)



In tank area, risk of taking concentrated salt water (highly contaminated with Sr) should be considered in addition to the risk regarding dust level.



Full-face mask unnecessary area



Future operation of Full-face mask unnecessary area is considered

• Equipment for monitoring dust level in an area in which wearing full-face mask is not necessary (5 spots)

Equipment for monitoring dust level at vicinity of reactors (3 spots)

OEquipment to be installed additionally by Mach 2015 (2 spots)

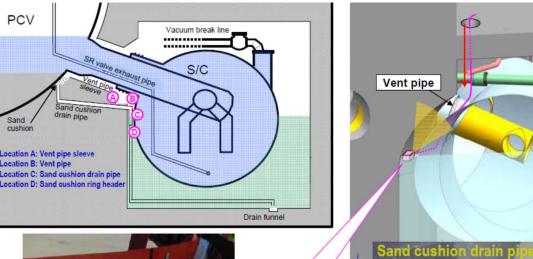
Total of 10 areas are to be monitered

Source TEPCO, Edited by NRA



Examining Inside of the Facilities

- Understanding the inside of R/Bs, Primary Containment Vessels (PCVs) and Reactor Pressure Vessels (RPVs)
 - Investigation of the flow paths in R/Bs, etc.
 - Analysis of water passing through the reactors
 - Analysis of the contamination of the inside of R/Bs, etc.
 - Direct observation of the inside of PCVs and RPVs



Unit 1

Investigation of water leak location from PCV done by TEPCO



Surface boat

Leak flow

Side surface of S/C

Source: TEPCO handouts 131113 11-e.pdf

Water surface of the torus room



NRA's challenge

- ✓ In order to keep reducing the risk existing at the Fukushima Dai-ichi, the NRA should regulate and promote the decommissioning processes at the same time.
- ✓ The important challenge is to maintain harmonization between the implementation and acceleration of the decommissioning and the protection of people and the environment during the processes.