NRA
Nuclear Regulation Authority

Reducing Risk at Fukushima Dai-ichi NPS

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Workshop on Decommissioning of Nuclear Power Plants

Hotel Grand Hill Ichigaya Tokyo, Japan
April 8, 2015

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.

18 February, 2015

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

Issue	Objective
Contaminated water	Avoiding leakage of contaminated water from tanks etc.
Radioactive waste	Preventing scattering of radioactive waste during decommissioning processes
Effective dose at the site boundary (estimated value)	Managing off-site effective dose during decommissioning processes
Spent fuel	Removing fuel from Spent Fuel Pools (SFPs)
Earthquake / Tsunami	Site and environmental protection from Earthquake / Tsunami
Work environment	Enabling a sustainable work environment for decommissioning
Examining the inside of the facilities	Understanding the internal situation of the damaged facilities

2015

2016

2017

2019

(year)

Contaminated water

- Removing high-radioactive contaminated water from the sea-side pipe trenches (Units 2-4) (Mar. 2015; Unit 2)
- Treating high-radioactive contaminated water in tanks (May. 2015)
- ・Completing removal of tanks lacking concrete foundations and/or dikes (Apr. 2015)
  ・Removing contaminated water from bolt-joint tanks
- Preventing the outflow of contaminated groundwater into the sea by completing the sea-side underground impermeable wall including sub-drain control systems
- Accurately controlling the levels of groundwater and stagnant contaminated water in R/Bs and T/Bs
- 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)
- 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.

Radioactive waste

- Starting operation of incineration plants for miscellaneous radioactive waste e.g. protective clothing (Oct. 2015)
- Starting operation of incineration plants for felled trees
- Extending the capacity of storage and volume reduction plants for rubbles, etc.
- Managing secondary waste from treatment of contaminated water e.g. sledges in the High Integrity Container(HIC)s, etc.

Effective dose at the site boundary (estimated value)

- Managing the additional effective dose to 2mSv/year* or less by continuous radiation monitoring and by treating high-radioactive contaminated water etc. (Mar. 2015)
- Managing the additional effective dose to 1mSv/year* or less (Mar. 2016)

*Estimated value

Spent fuel

- Completing fuel removal operation at Unit 4 SFP (Dec. 2014)
- Completing construction of Unit 3 R/B cover and completing fuel removal facility
- Completing fuel removal operation at Unit 3 SFP
- Completing construction of Unit 1 R/B cover and completing fuel removal facility
- Completing fuel removal operation at Unit 1 SFP

Earthquake / Tsunami

- Scientifically providing the greater earthquake/tsunami model, and establishing the basic protection plan that corresponds to this model
- Preventing the outflow of stagnant contaminated water anticipating the recurrence of the 2011 Tsunami
- Implementing the site protection measures following the established plan

Work environment

- Building the large resting facility (Mar. 2015)
- Building the food-service center (Mar. 2015)
- Managing a work environment not requiring full-face mask respirators excluding the vicinity of R/Bs etc. (May. 2015)
- 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)

Examining the inside of the facilities

- Examining the process of accumulation of contaminated water in R/Bs, etc.
- Characterizing nuclides in water passing through the reactors
- Analyzing the contamination of the inside of R/Bs, etc.
- Directly observing inside of Primary Containment Vessels(PCVs) and Reactor Pressure Vessels(RPVs)

[Note]
Completed measures:
Measures in progress or in preparation:
Measures (Timing TBD):

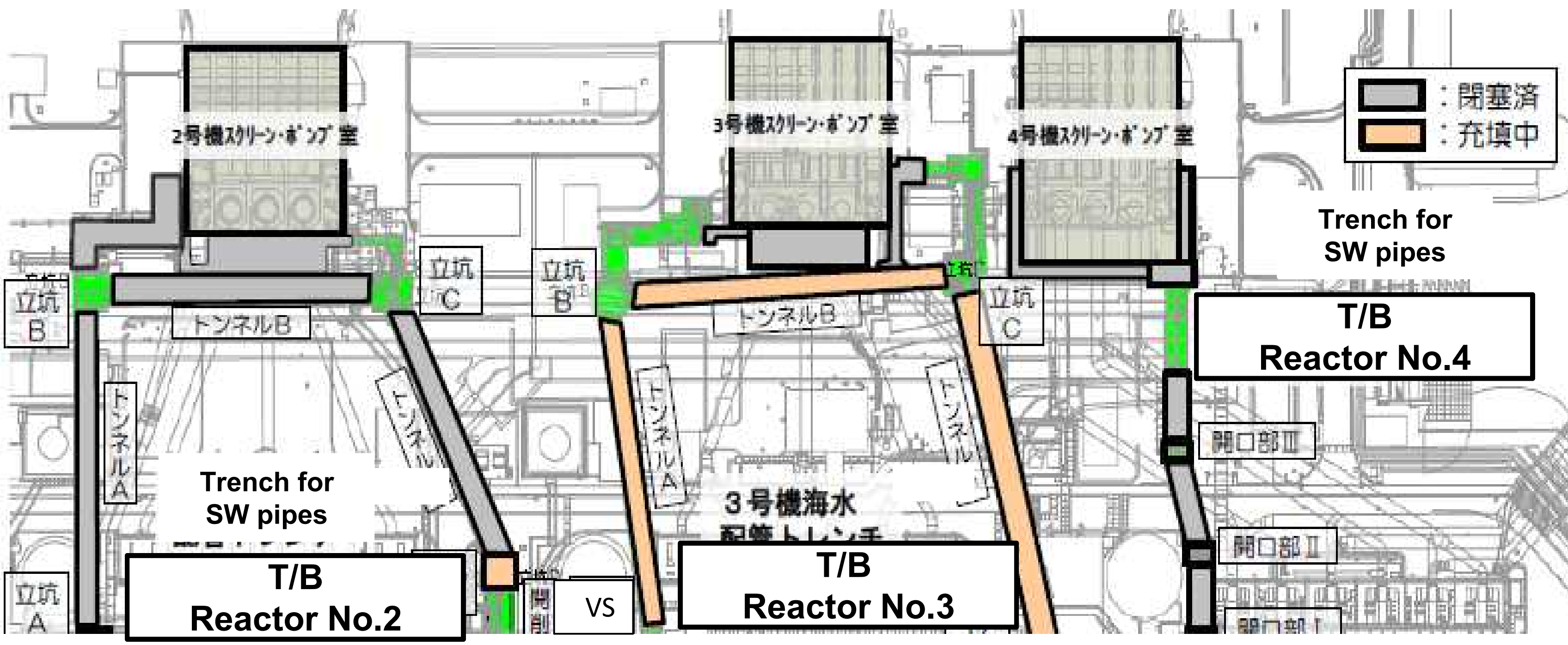
This presentation covers;

- ✓ 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.

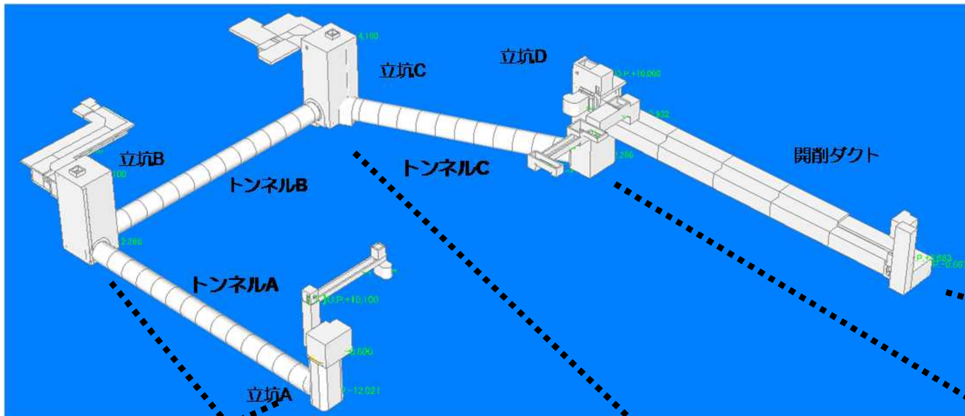
① Underground Trenches

- ✓ 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., ~10^{15} Bq of Cs-137 in Unit 2 trenches

(estimated in July 2013)

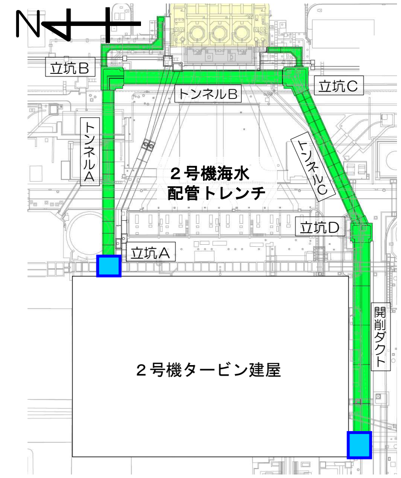


①立坑からの閉塞材料投入により，トンネルの閉塞開始。
②トンネルを閉塞後に、③立坑の閉塞を実施
④立坑B下部の砕石層を閉塞し、閉塞完了

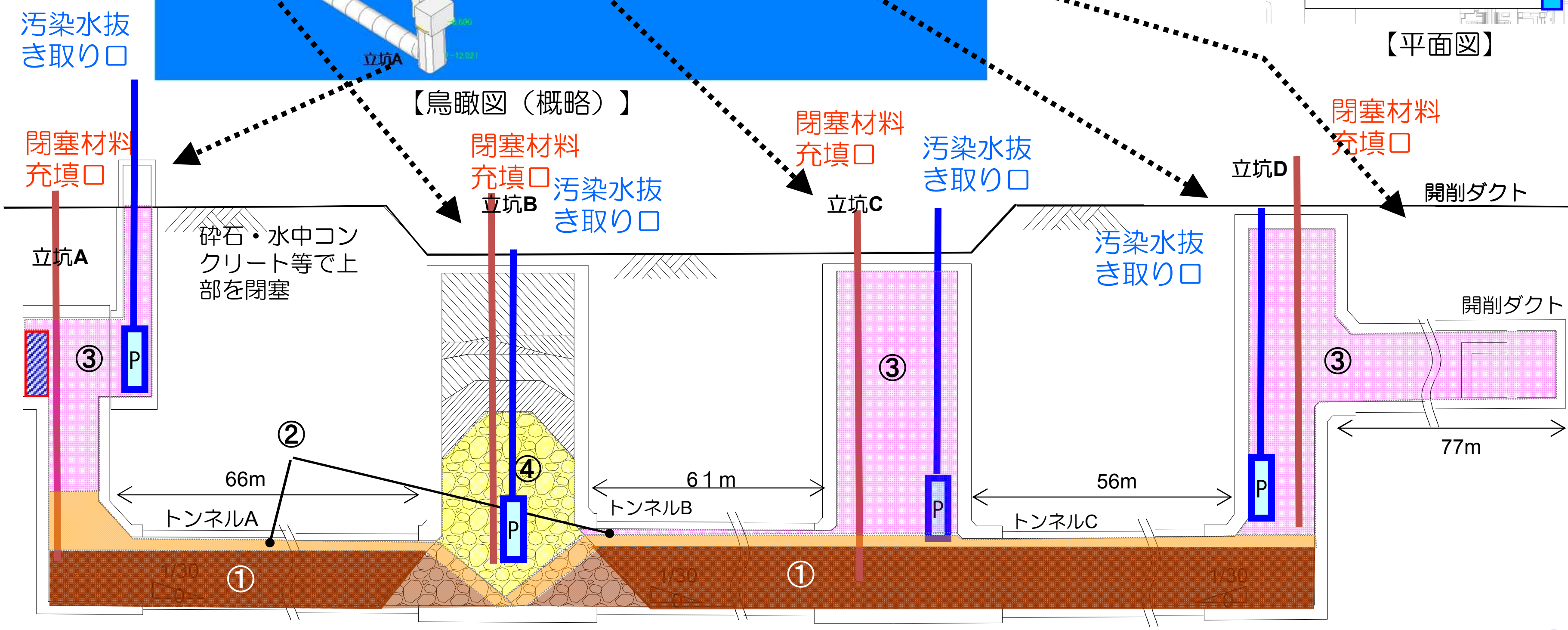


【鳥瞰図（概略）】

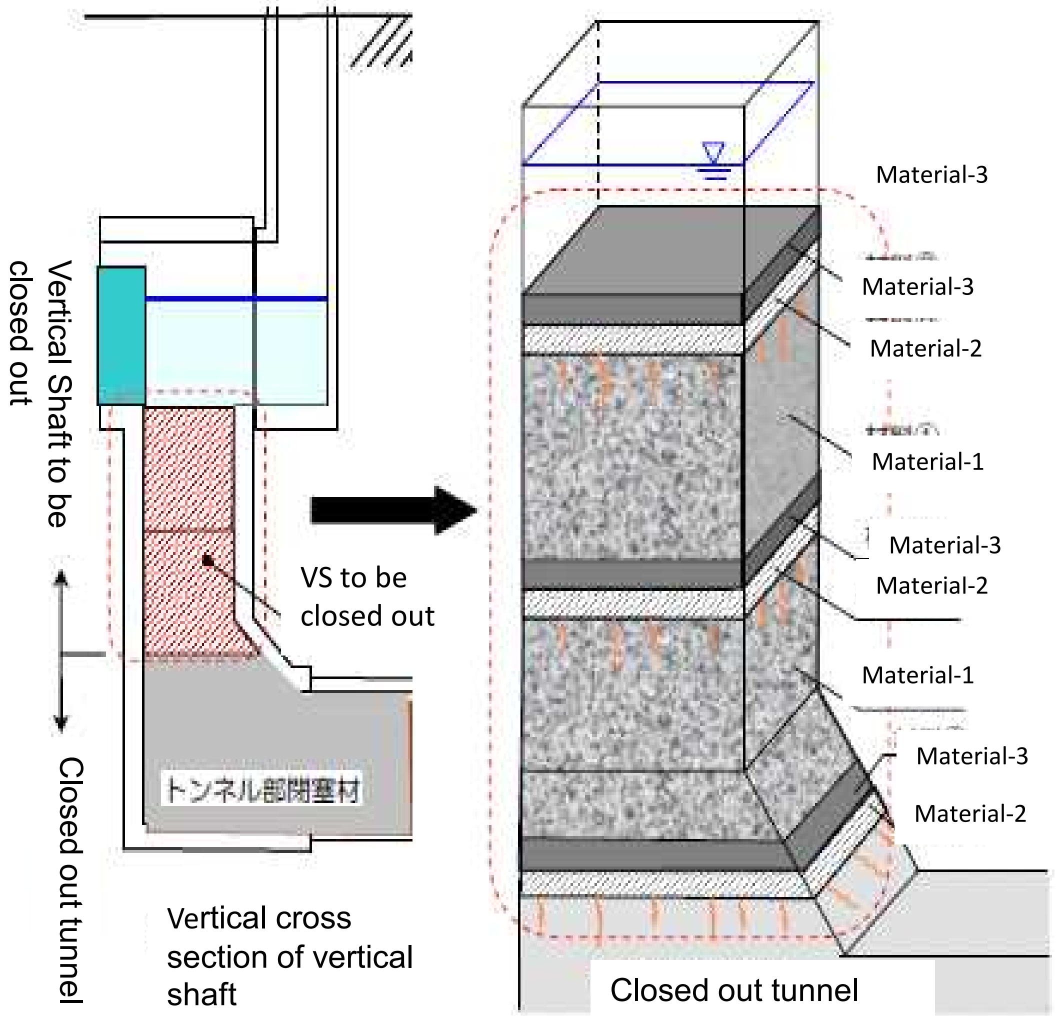
※ポンプで汚染水が抜き取りきれず、残水する可能性が想定され、各立坑に抜き取り口が必要



【平面図】



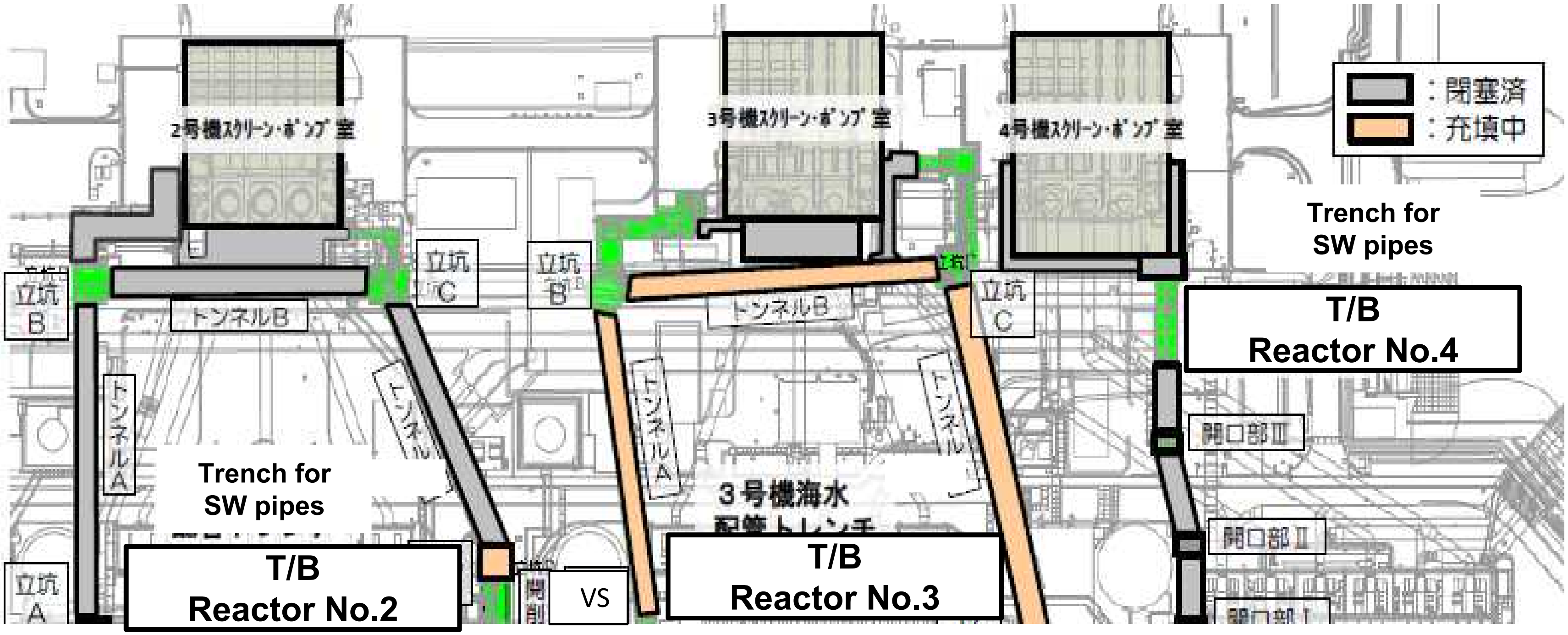
※施工ステップで色分けをしているが同一材料により打設



Vertical cross section of vertical shaft

Image of the work closing out with each material

Work Progress



as of Feb 6th

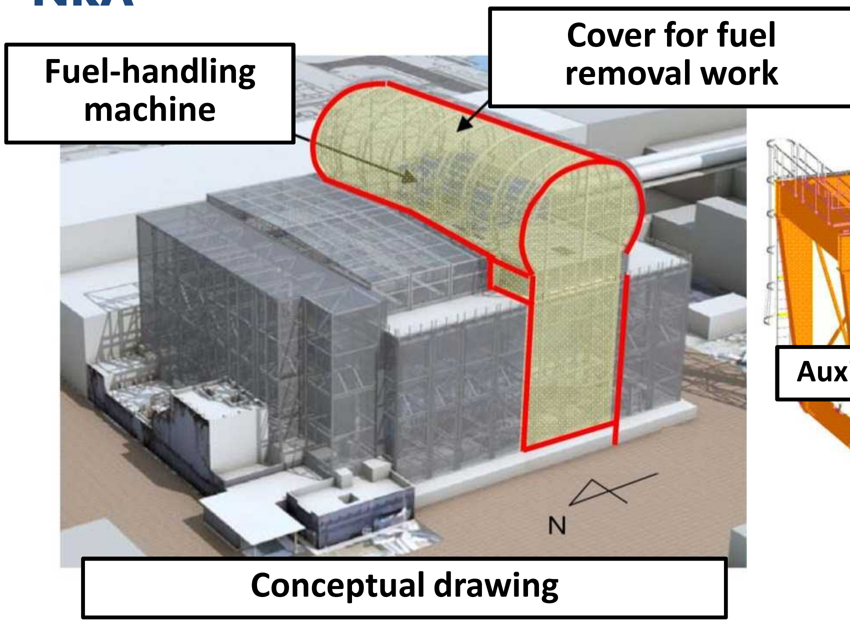
	Unit 2	Unit 3	Unit 4
Residual water	~1,890 m^3	~3,480 m^3	~440 m^3
Cemented	~2,610 m^3	~2,320 m^3	~460 m^3

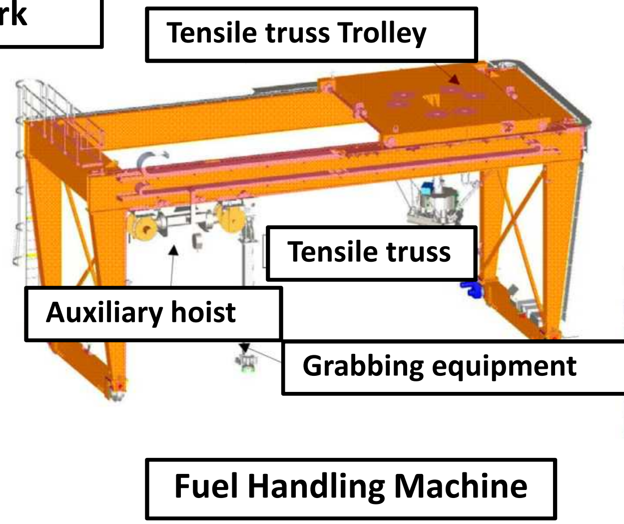
② Spent Fuel Pool

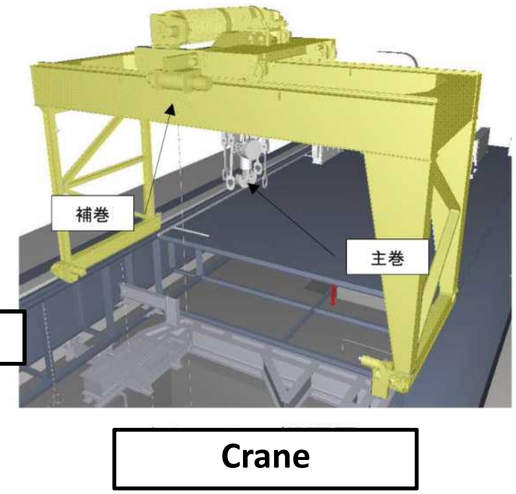
- ✓ Fuel removal from spent fuel pool of Unit 4 was completed on December, 2014. This corresponds to ~49% reduction of spent fuel assemblies in spent fuel pools of Units 1 thru 4.

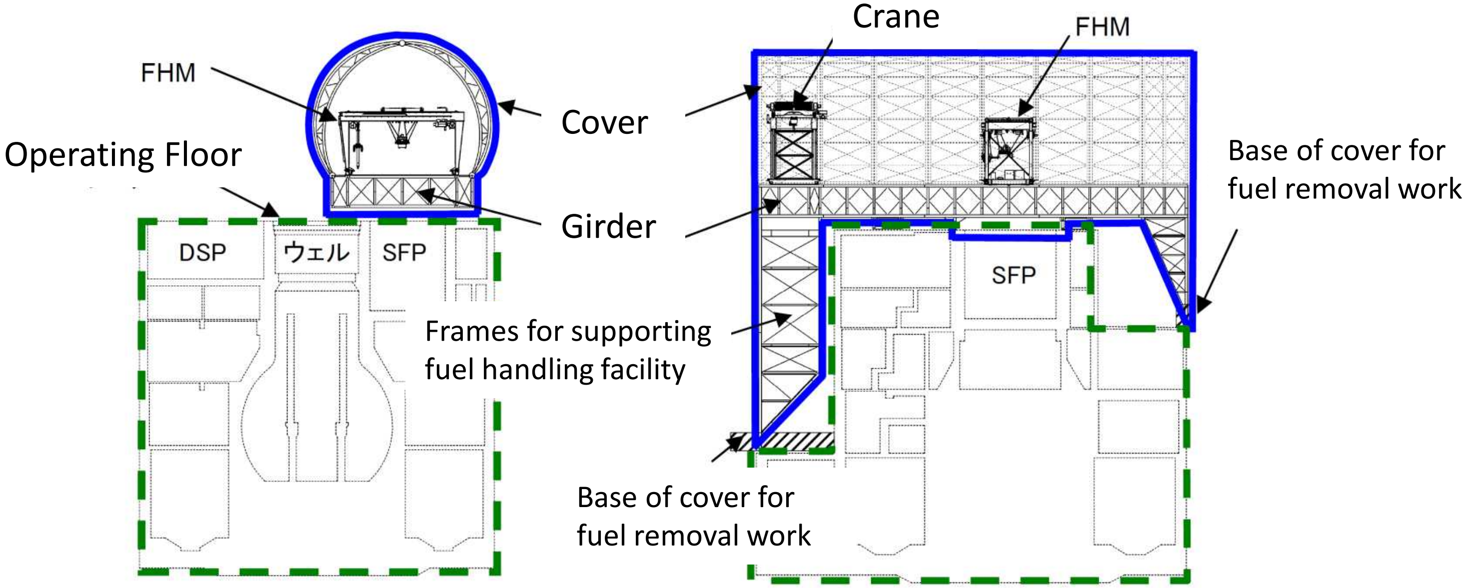
Unit	1	2	3	4
Capacity	900	1240	1220	1590
SFA	**292**	**587**	**514**	**1331**
FFA	100	28	52	202
Total	392	615	566	1533

Fuel-handing machine and crane for Unit 3 SFP



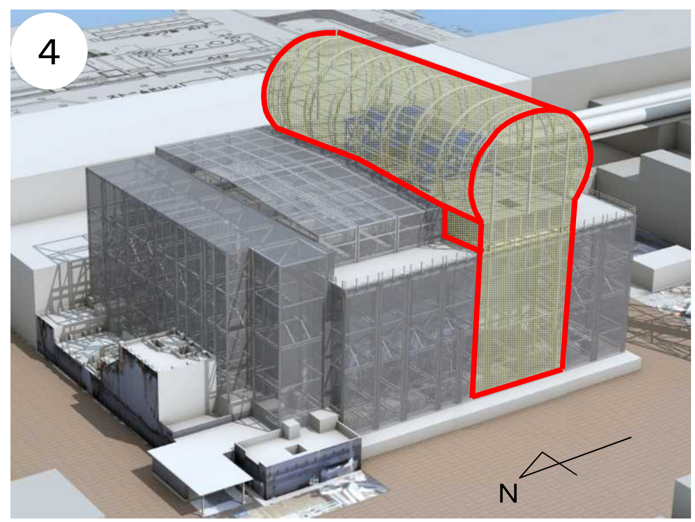






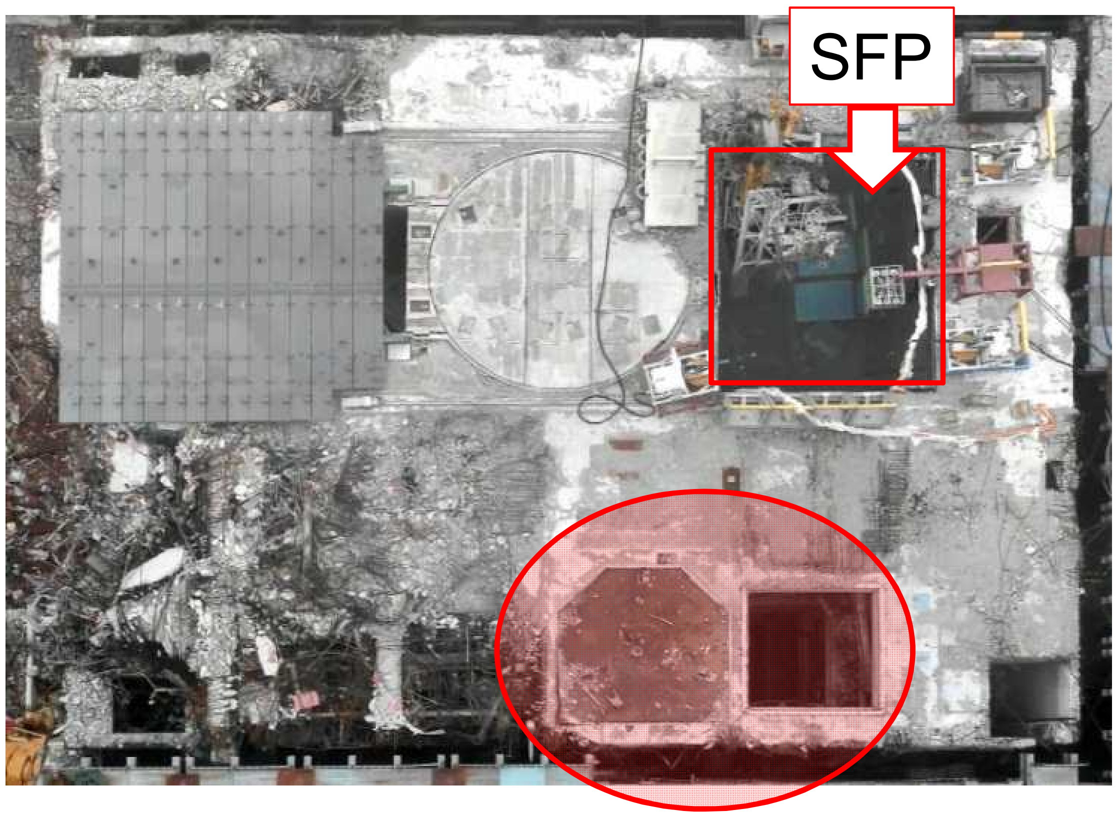
断面図（南北方向）　　断面図（東西方向）

Fuel-handing machine and crane for Unit 3 SFP



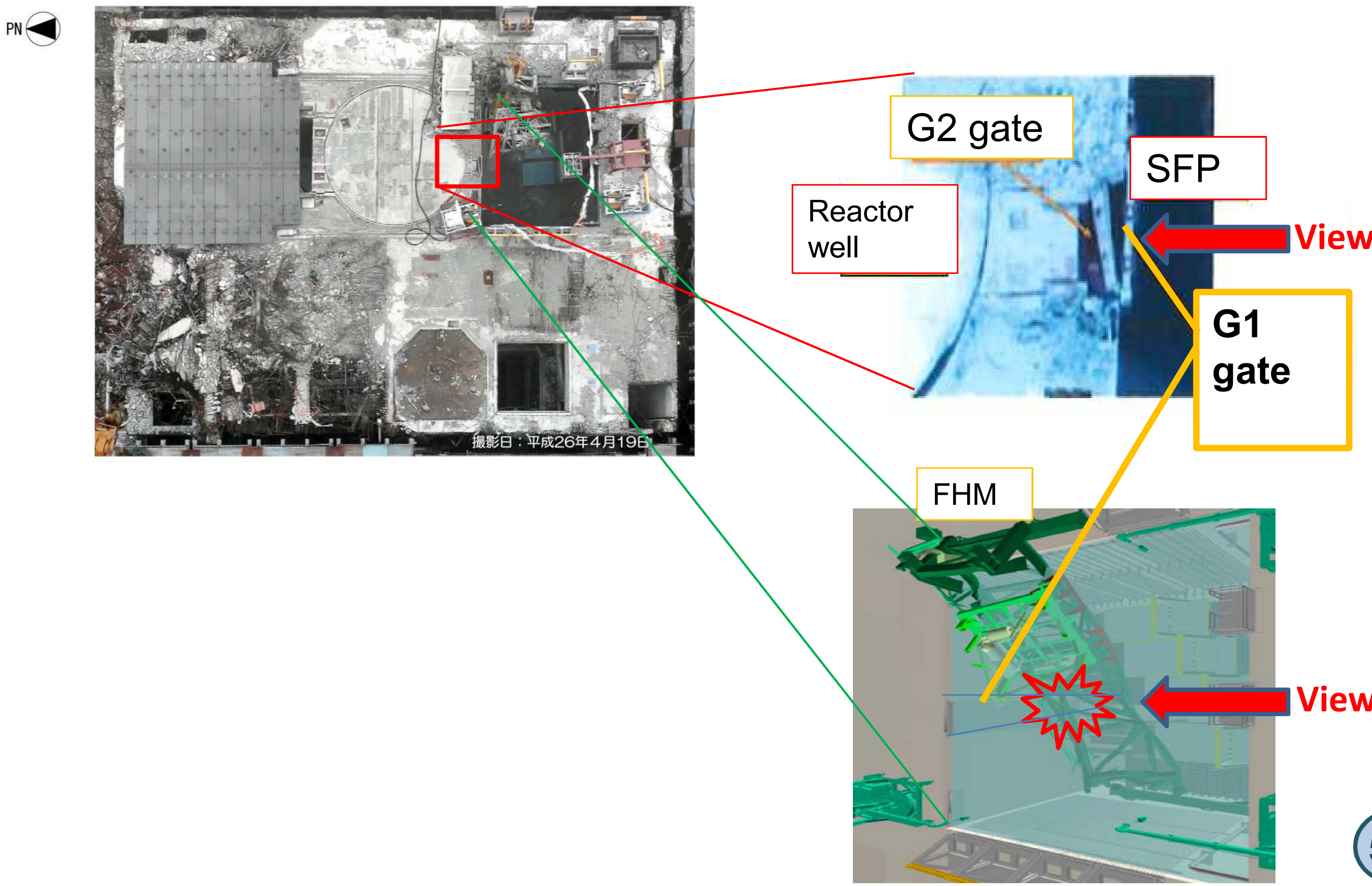
Fuel removal from Unit 3 SFP

- ✓ 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.



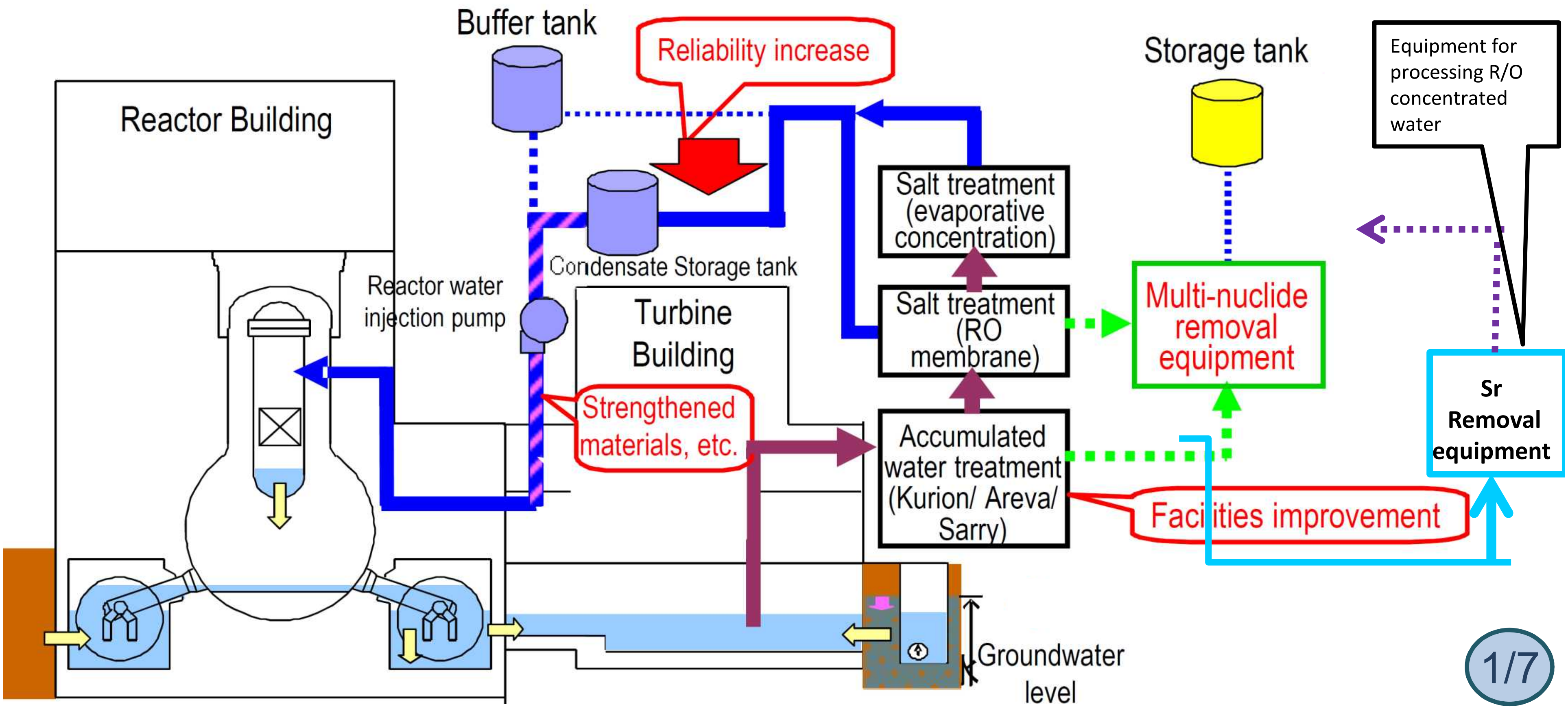
Relatively high dose rate

Unit 3 SFP Gate



③ 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

Contaminated water in reactor/turbine buildings
Cs137: ~10^7 Bq/L, Sr90:~10^7 Bq/L

dated SARRY/Kurion

current SARRY/Kurion

Salt treatment/condensation with RO membrane

Intermediate A (Cs reduced)
Cs137: ~10^4 Bq/L, Sr90:~10^8 Bq/L

Sr reduction

Intermediate B (Cs & Sr reduced)
Cs137: ~10^3 Bq/L, Sr90:~10^{6or7} Bq/L

Multi-nuclides removal with ALPS

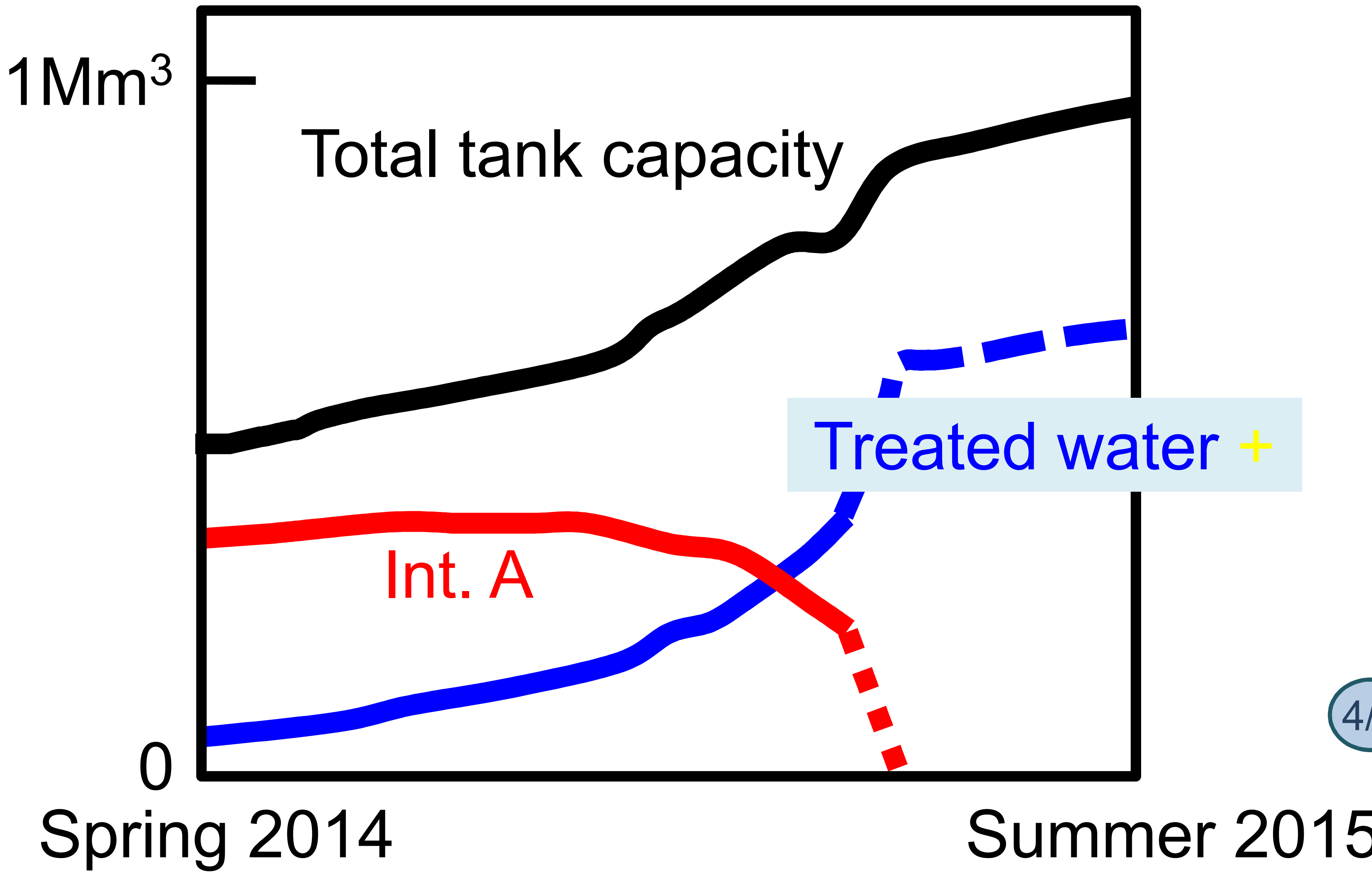
Treated water
Cs137: ND, Sr90: ND, but Tritium: ~10^6 Bq/L

Water decontamination system

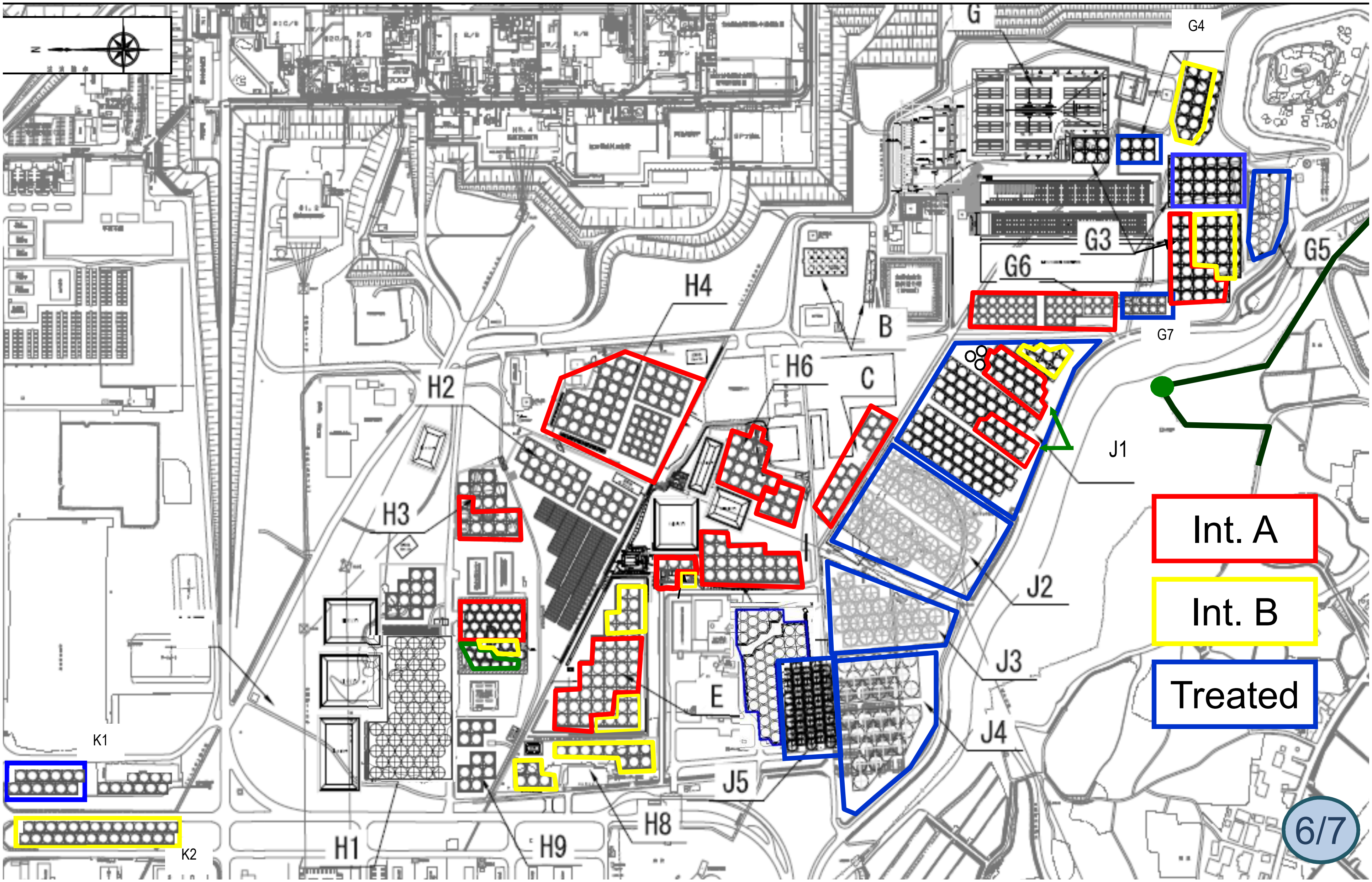
ALPS	250m^3/d x 3 units
Improved ALPS	250m^3/d x 3 units
High-performance ALPS	500m^3/d x 1 unit
R/O water treatment	500m^3/d
Mobile Sr removal*	300m^3/d x 2 units 480m^3/d x 4 units
SARRY	600m^3/d x 2 units
Kurion	300m^3/d x 3 units

*Circulation processing

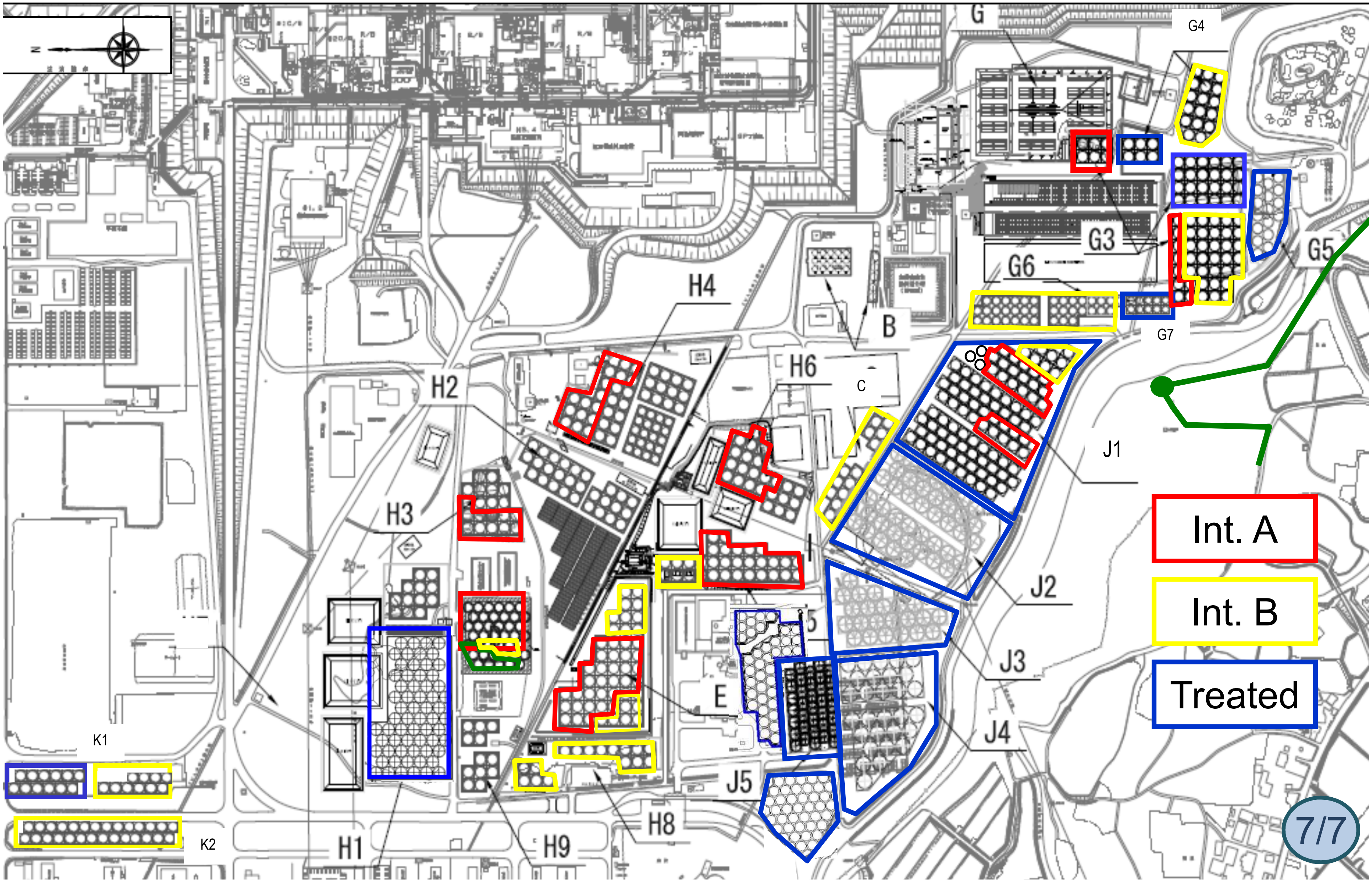
Water storage



March 12, 2015

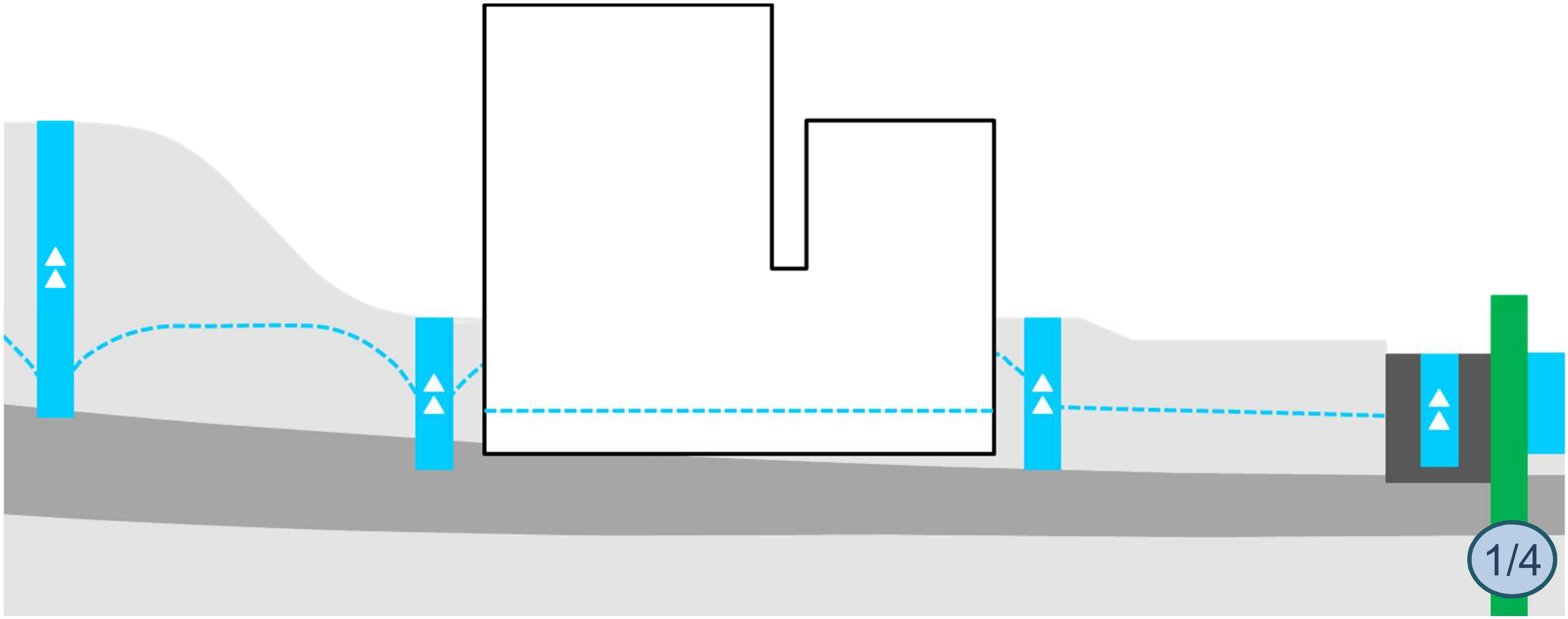


Achieving less than 1 mSv/y at border

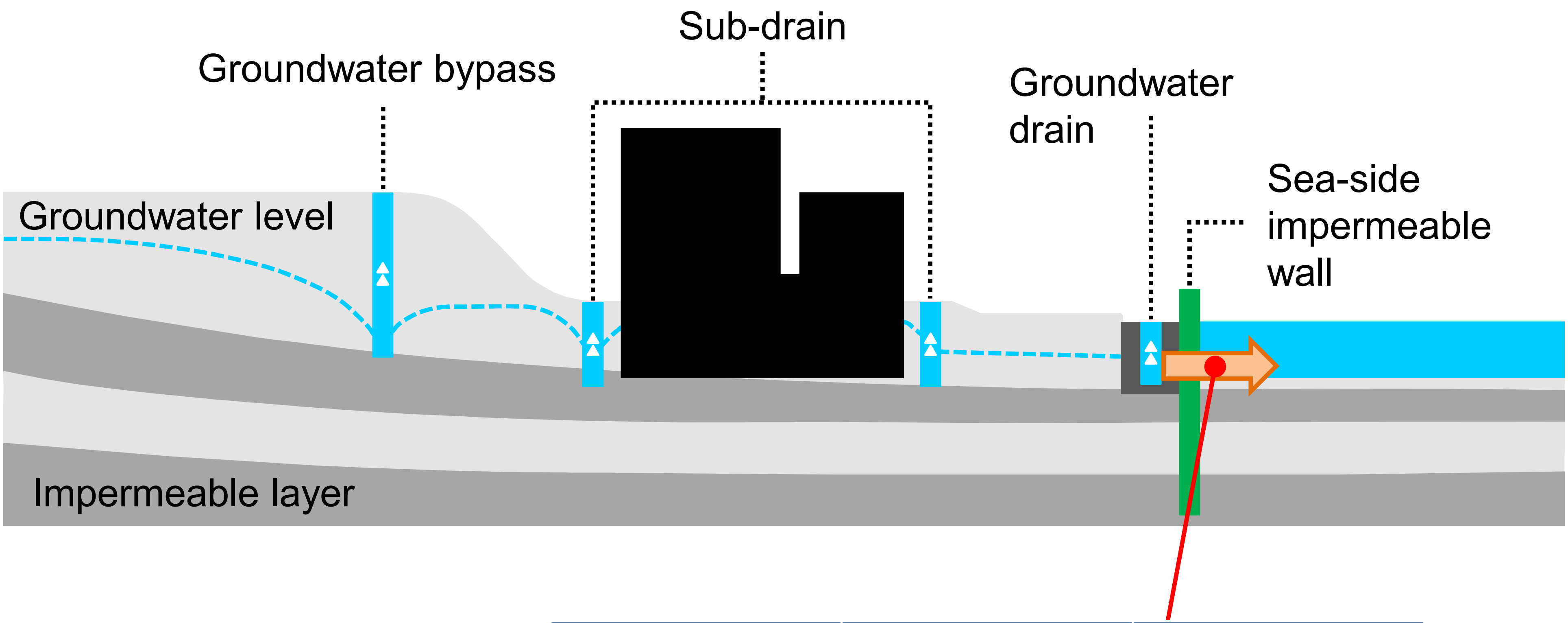


4 Reduction of groundwater inflow

- 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.



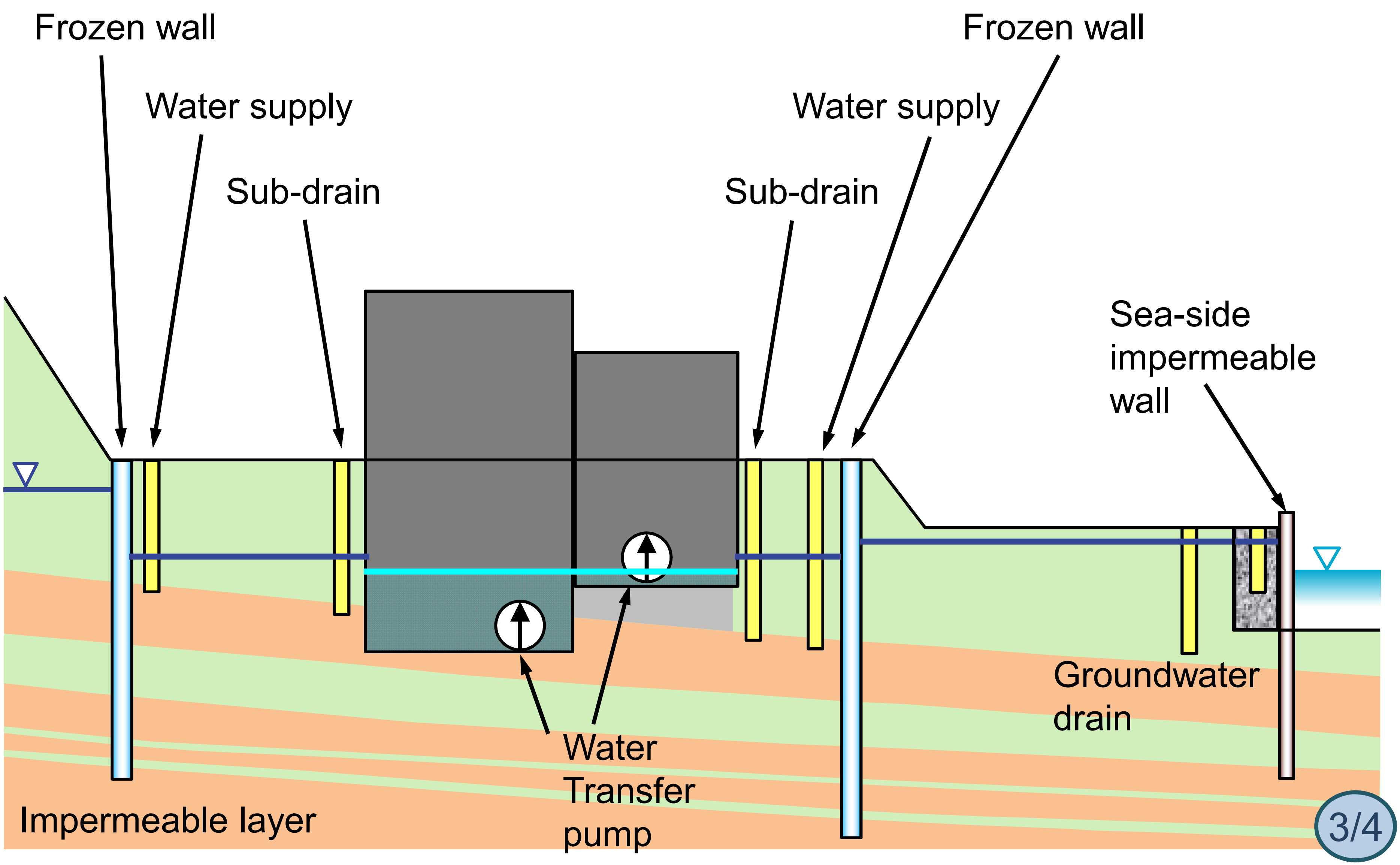
Sub-drain and sea-side impermeable wall

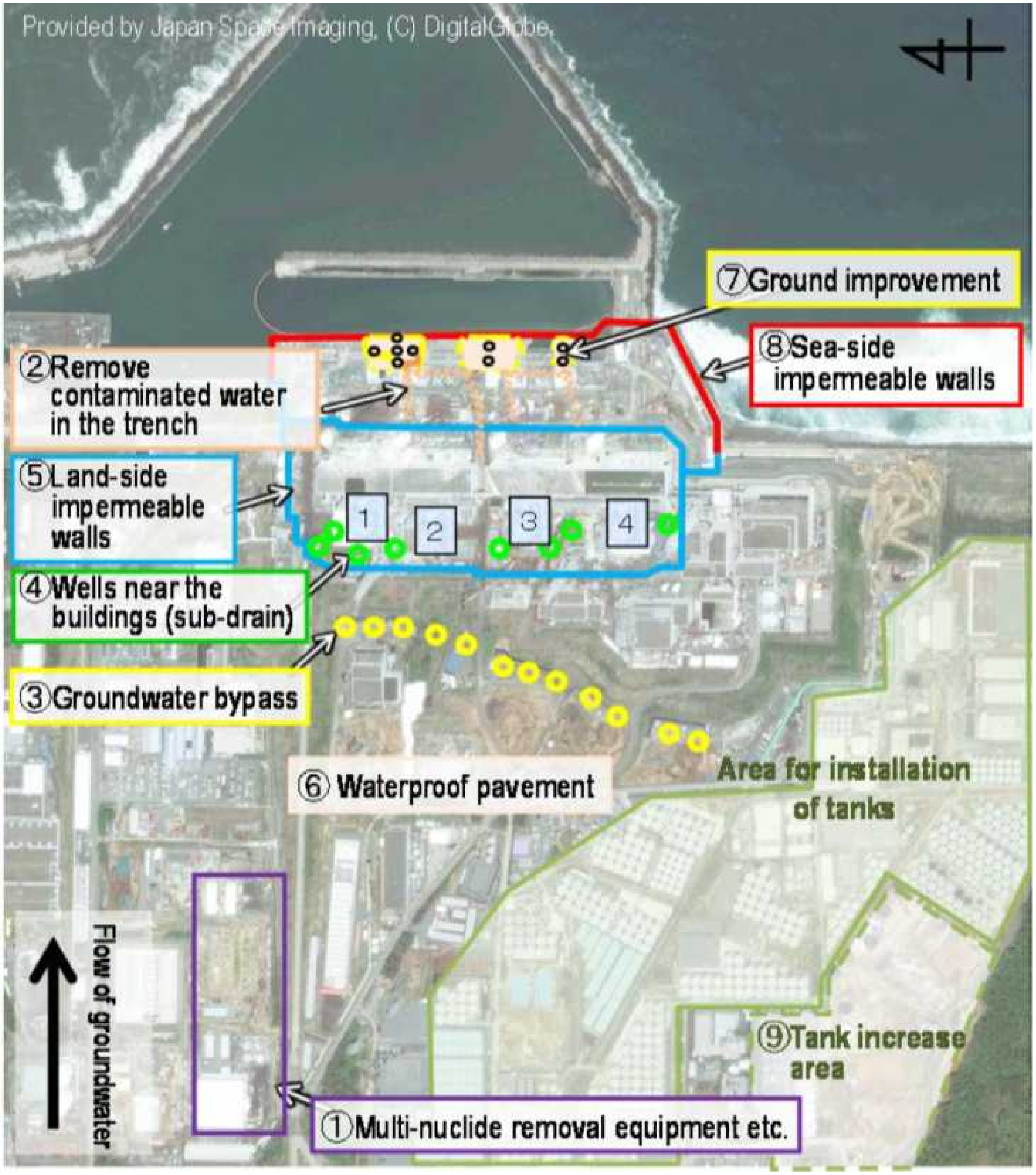


	in 314 days	Bq/day
Cs-137	3.8×10^{11}	1.2×10^{9}
Sr-90	8.5×10^{11}	2.7×10^{9}

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

Land-side impermeable walls




Provided by Japan Space Imaging, (C) DigitalGlobe
⑦Ground improvement
⑧Sea-side impermeable walls
②Remove contaminated water in the trench
⑤Land-side impermeable walls
1
2
3
4
④Wells near the buildings (sub-drain)
③Groundwater bypass
⑥ Waterproof pavement
Area for installation of tanks
⑨Tank increase area
Flow of groundwater
①Multi-nuclide removal equipment etc.

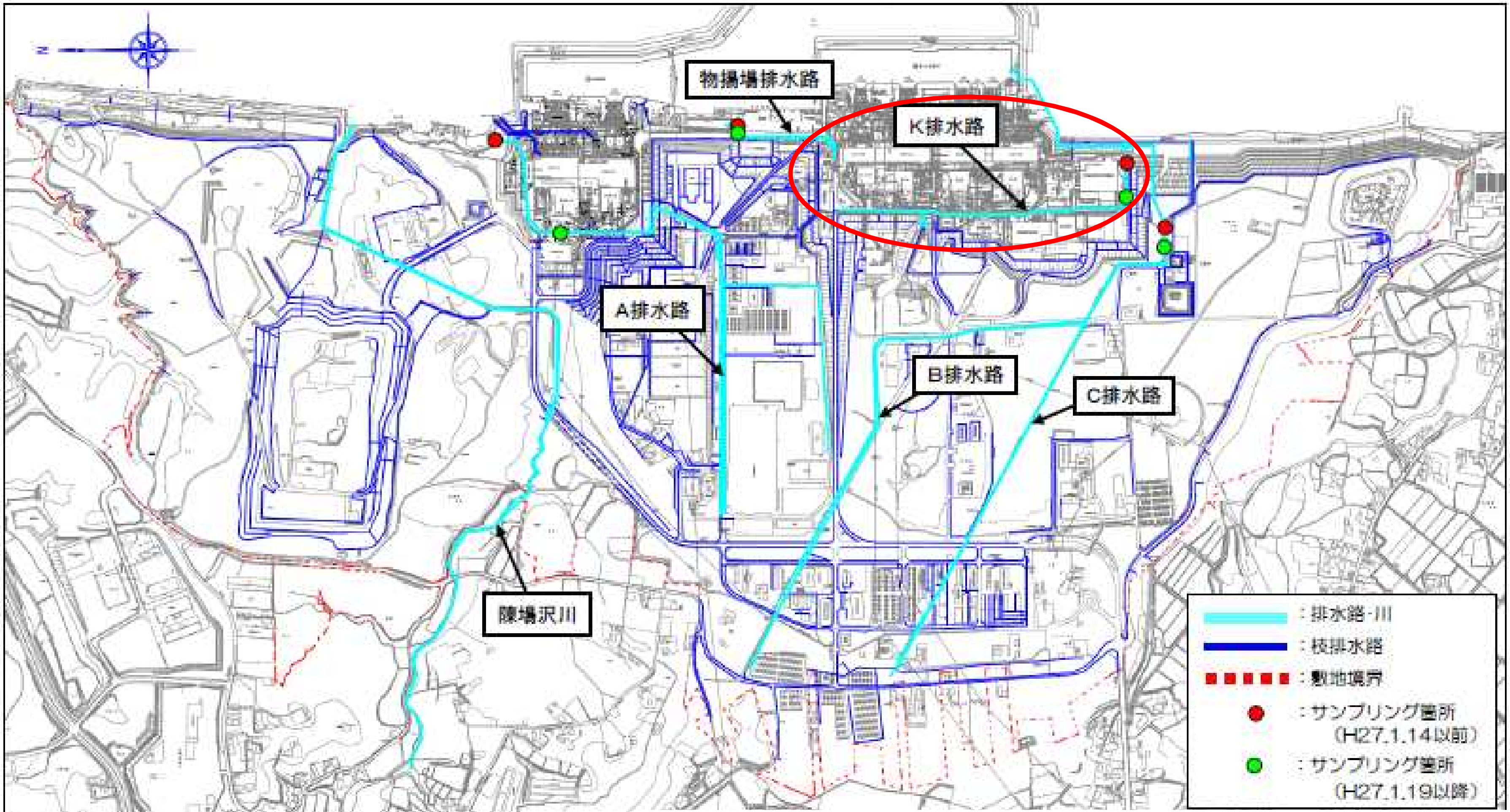
Other issues

- ✓ 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



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

Ditch “K”	in 314 days	Bq/day
Cs-137	1.5×10^{11}	4.8×10^{8}
Sr-90	1.5×10^{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)

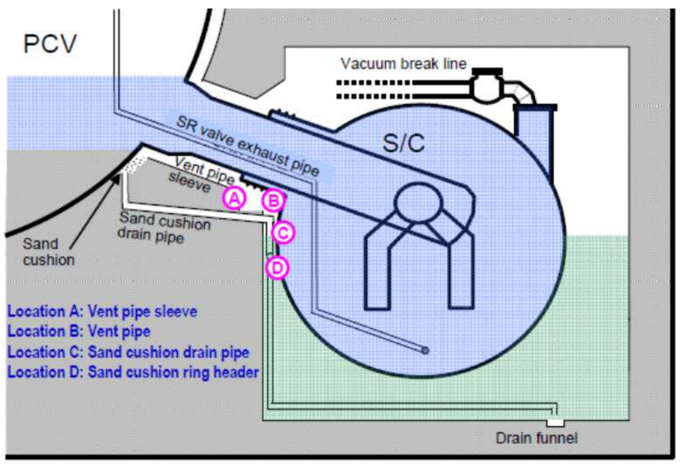
●Equipment for monitoring dust level at vicinity of reactors (3 spots)

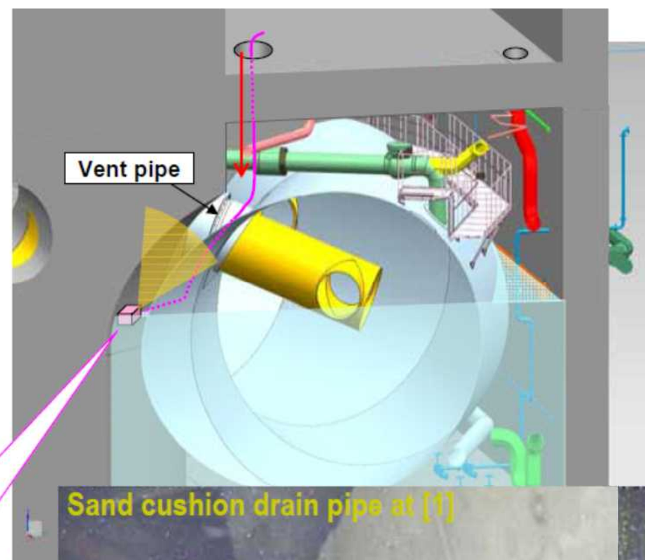
○Equipment to be installed additionally by Mach 2015 (2 spots)

Total of 10 areas are to be monitered

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

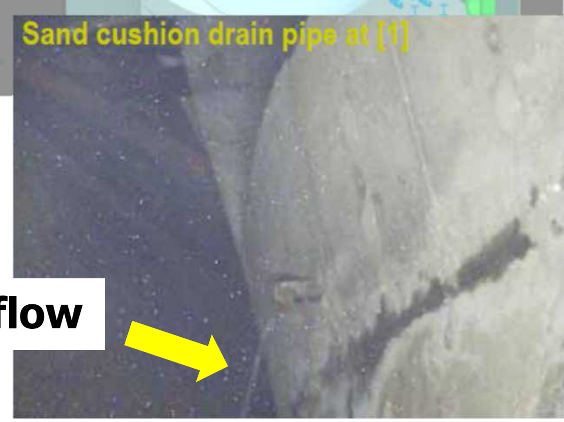




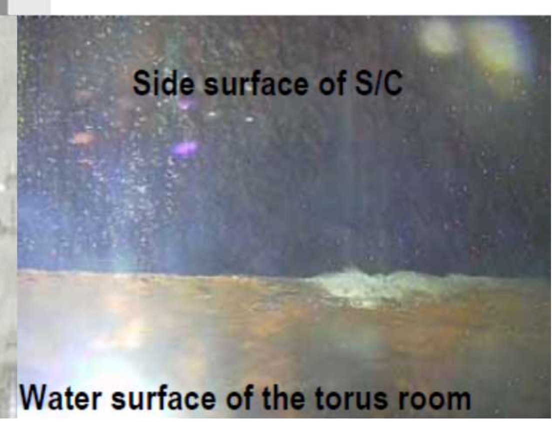
Unit 1

Investigation of water leak location from PCV done by TEPCO

Surface boat



Leak flow



Source: TEPCO
handouts_131113_11-e.pdf

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.