

Spent Fuel Storage at Fukushima Daiichi NPP



*International Conference on
Management of Spent Fuel from
Nuclear Power Reactors - An
Integrated Approach to the Back-
End of the Fuel Cycle
17th JUN 2015, Vienna*

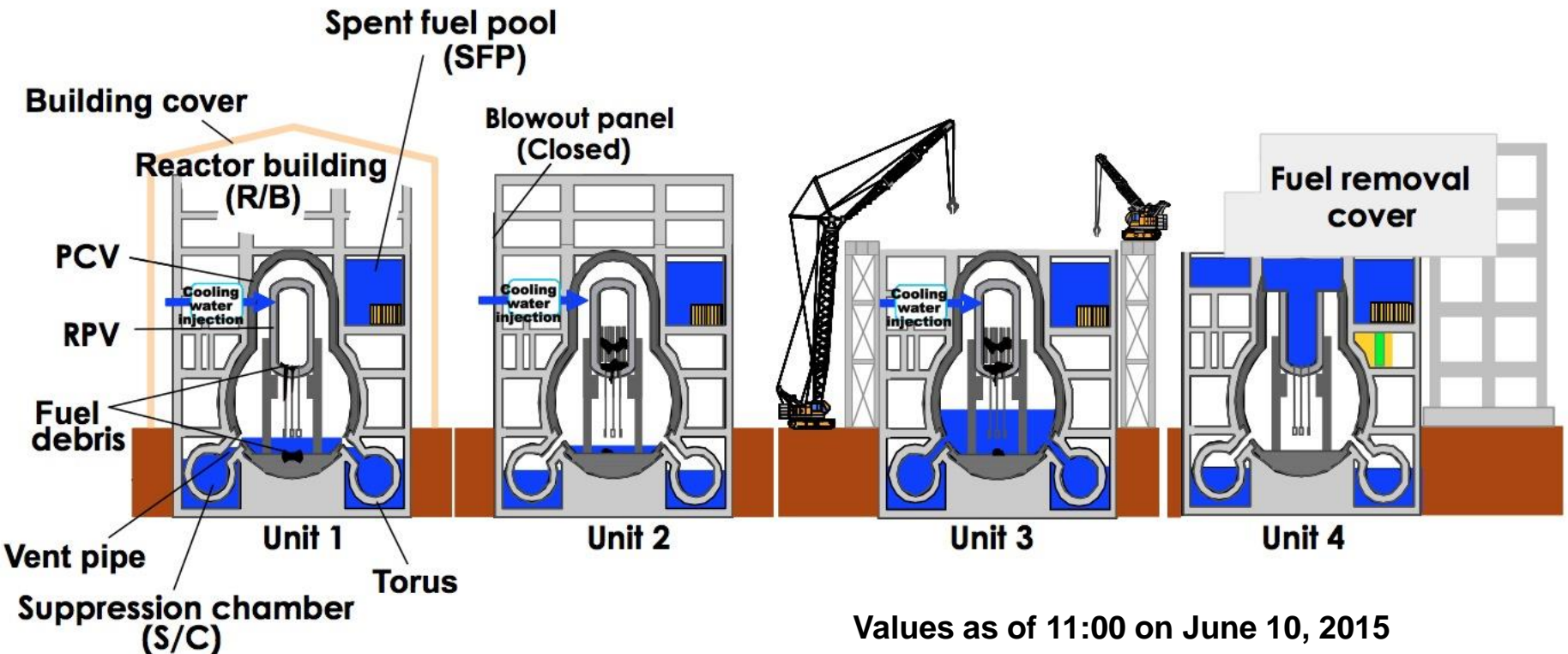
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General Issues

All Units maintain cold shutdown

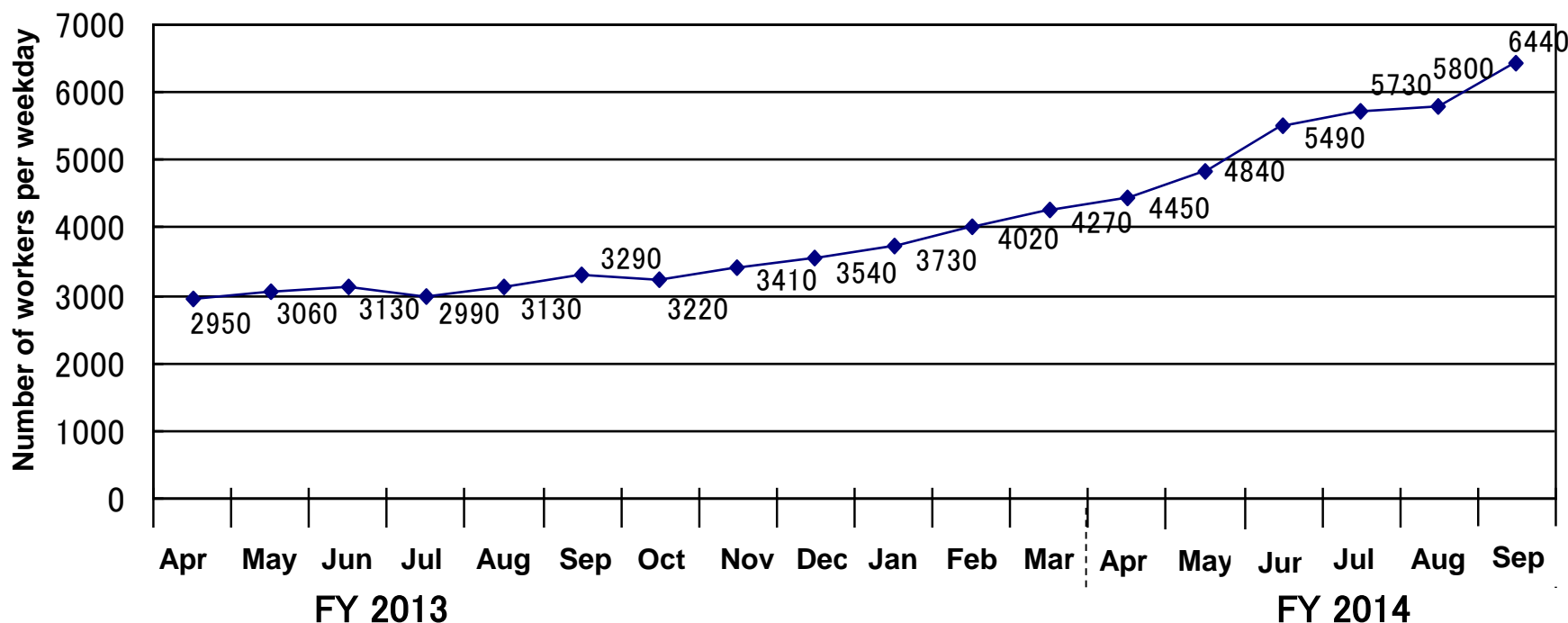


Values as of 11:00 on June 10, 2015

	RPV bottom temp.	PCV internal temp.	Fuel pool temp.
Unit 1	~23°C	~23°C	~24°C
Unit 2	~30°C	~31°C	~27°C
Unit 3	~27°C	~26°C	~22°C
Unit 4	No fuel, so monitoring not required	No fuel, so monitoring not required	~21°C

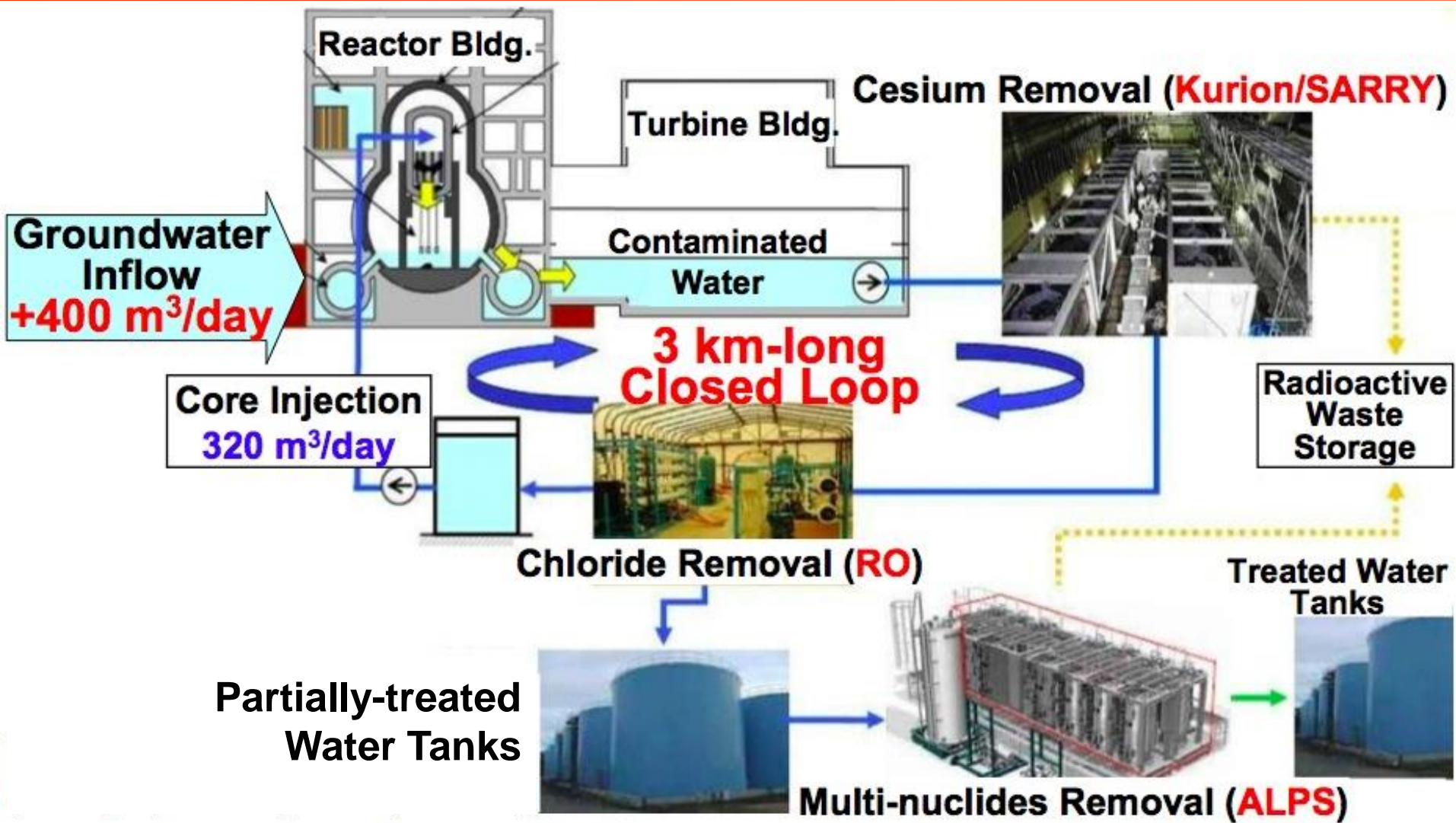
Number of workers

- The recent assumed average number of workers (contractors and TEPCO) per weekday is around 7,000.
- TEPCO continuously collects information from all contractors and does necessary arrangement to assure the number of workers for expected works in the future are sufficient.



Trend in the average number of workers per weekday (FY 2013 and 2014)

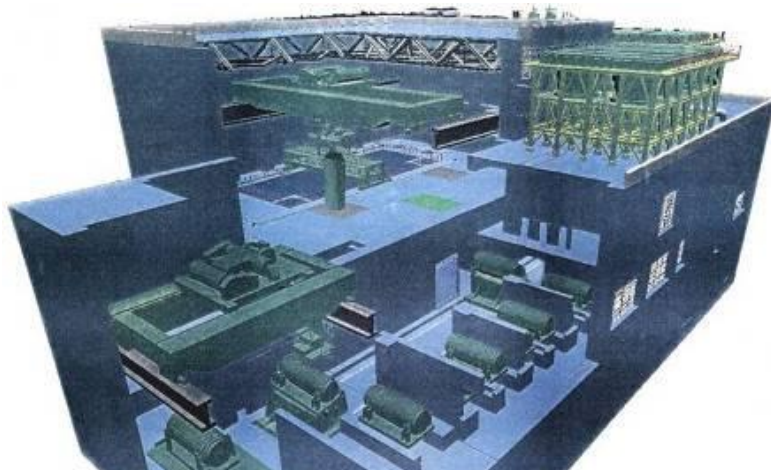
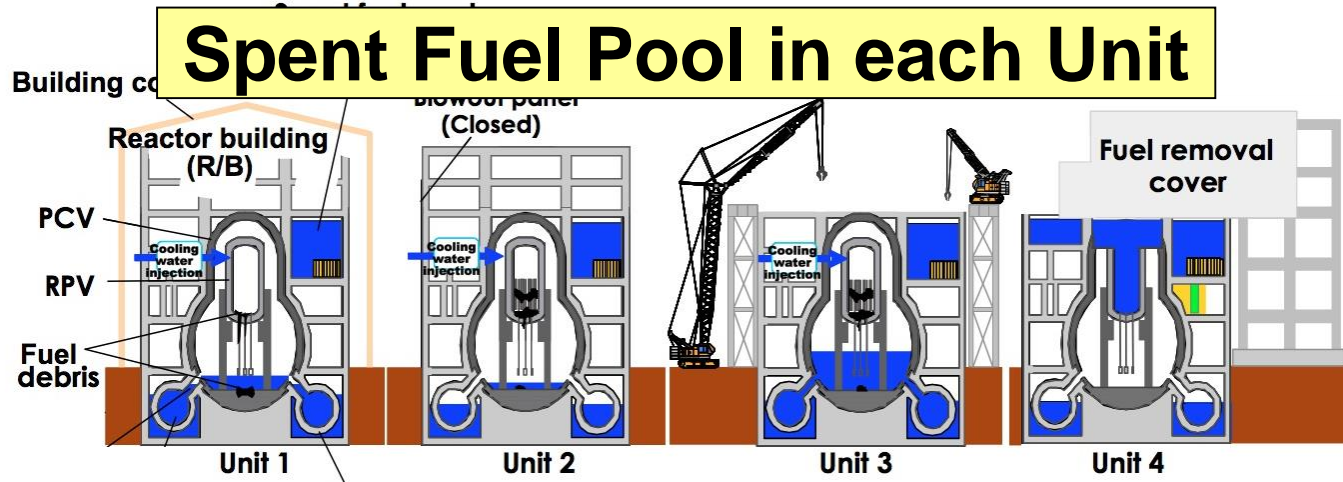
Circulating-Water Core Cooling System at 1F



➤ Increasing water inventory posing challenge

Spent Fuel Management Issues

SF Storage Options at Fukushima-Daiichi NPP

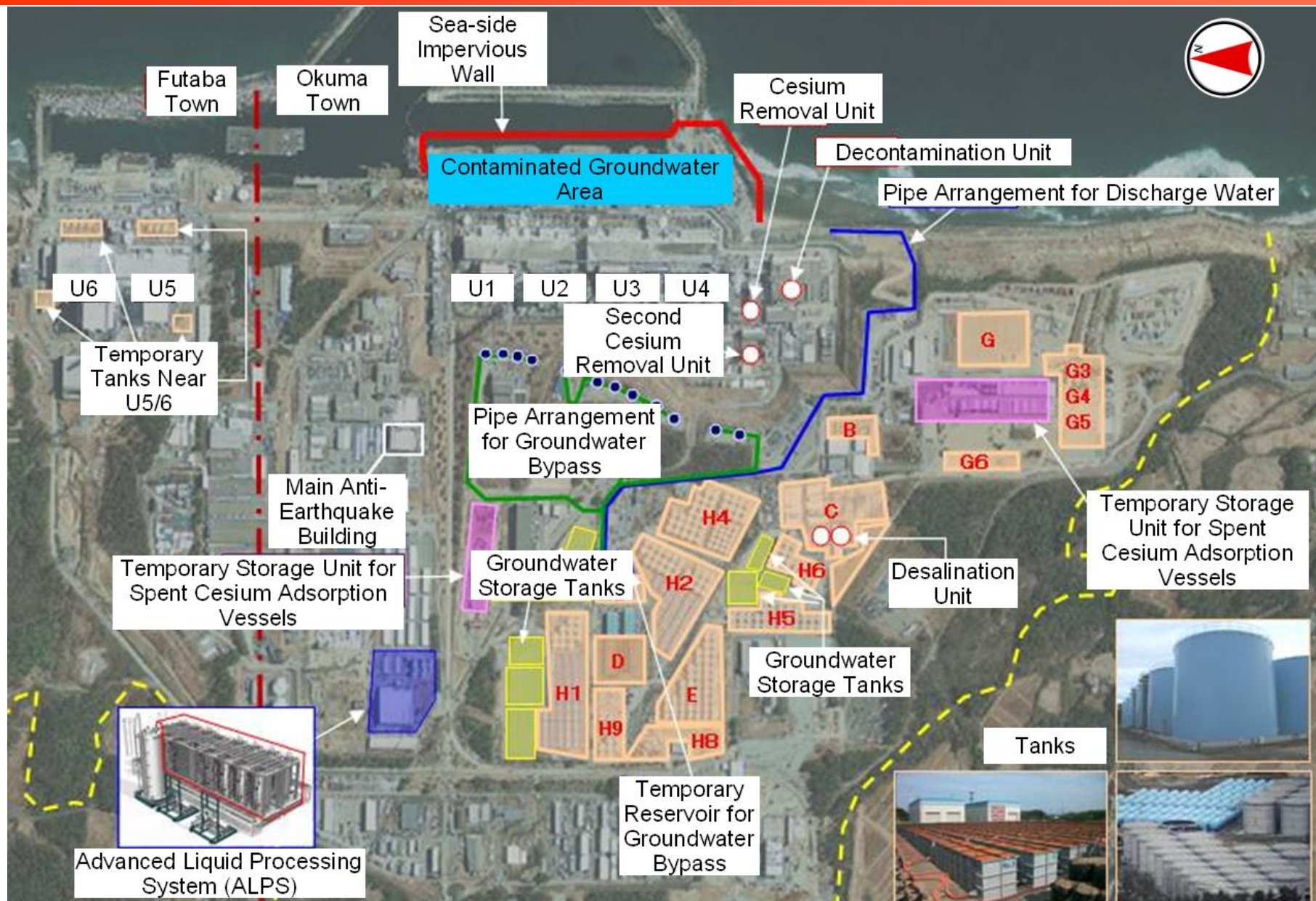


Common Fuel Storage Pool

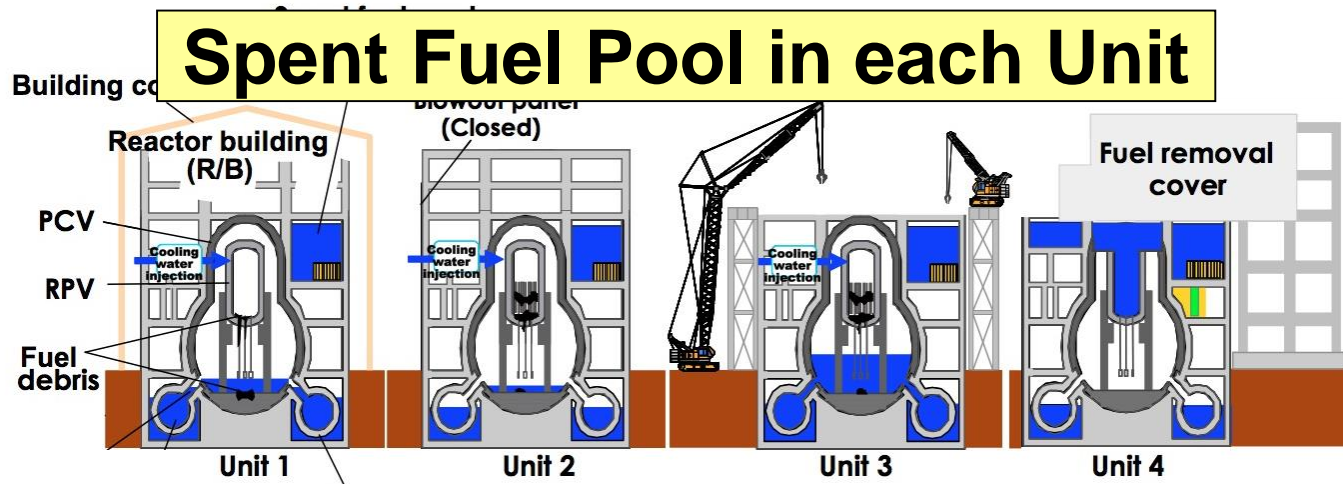


Cask Custody Building

Fukushima-Daiichi NPP Map



Recovery Operation since 11th March 2011



[Unit4 Chronology]

11th MAR 2011

SF1331 + FF204 in SFP (DH2.26MW)

Loss of Cooling Function by SBO

15th MAR 2011

Hydrogen Explosion

20th MAR 2011~

Raw Water Injection by Water Canon Vehicle

Vehicle & Fire Engine

22nd MAR 2011~

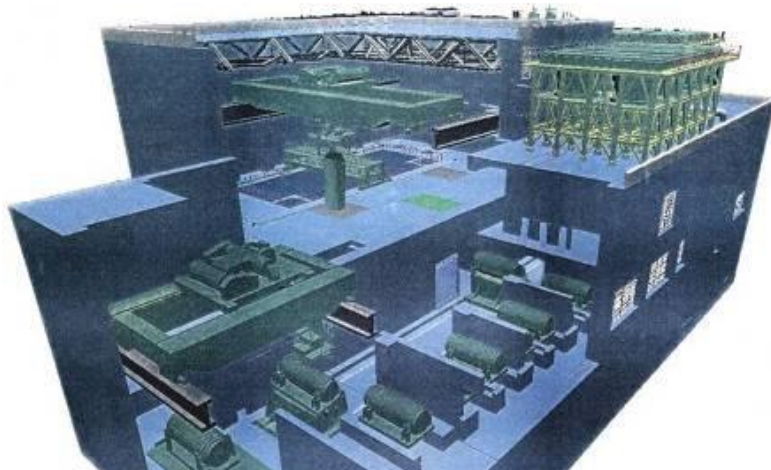
Sea/Pure Water Injection by Concrete Pump Vehicle

31st JUL 2011~

Recovered Cooling Function by Alternative water Circulation System

Recovery Operation since 11th March 2011 (cont'd)

[Chronology]	
11 th MAR 2011	SF6375 in SFP (DH1.13MW) Loss of Cooling Function by SBO
18 th MAR 2011	Sufficient Water Level confirmed
24 th MAR 2011~	Recovered Cooling Function by Water Circulation System with Temporary AC Power

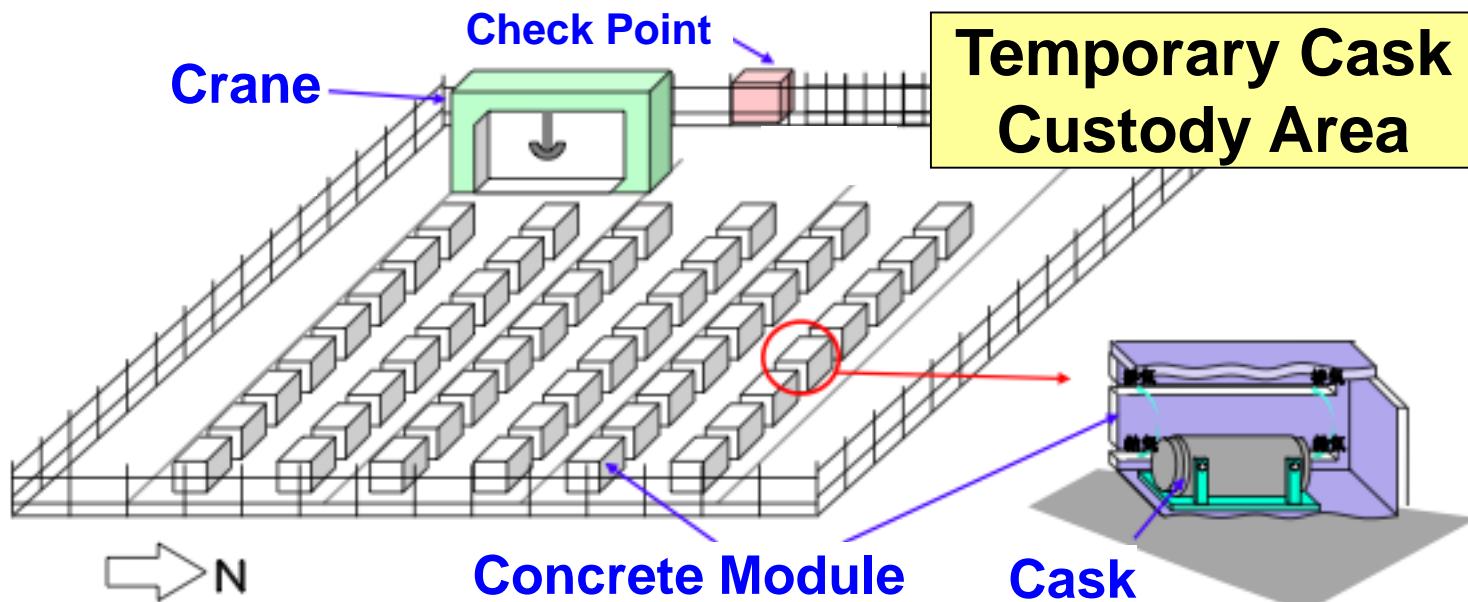


Common Fuel Storage Pool



Recovery Operation since 11th March 2011 (cont'd)

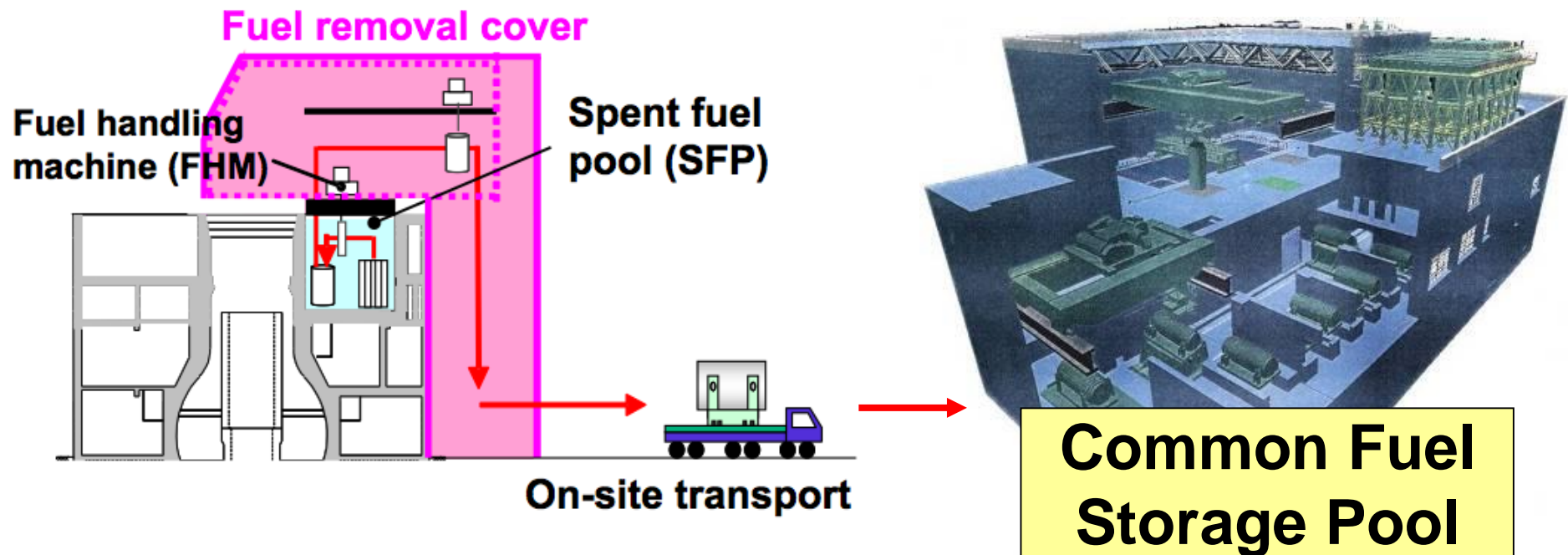
- [Chronology]**
- 11th MAR 2011** SF408 in 9 Dry Casks (DH2.26MW)
Sea Water/Debris Intrusion into Building
- 18th MAY 2013** Inspection completed
(Leak rate, Sealing condition, Inner Gas sampling, Rod Appearance, etc,)
- 21th MAY 2013~** Completed Transportation of 9 Casks to
New Temporary Storage Area



Unit 4 Spent Fuel Removal Project

Summary

- Unit 4 Fuel Removal work commenced on Nov. 18, 2013 after tangible/intangible preparation.
- The work had been completed on Dec. 22, 2014.
- In almost one year, all the 1533 fuels have been transported to the independent storage pool.



Debris Removal from upper Building

① Prior to Removal of debris
(Sep. 22, 2011)



② Debris Removal work
(May 28, 2012)



③ Debris Removal work
ended (Jul. 5, 2012)



④ Removal of containment Head
(Aug. 10, 2012)



⑤ Removal of Vessel
Head (Sep. 13, 2012)



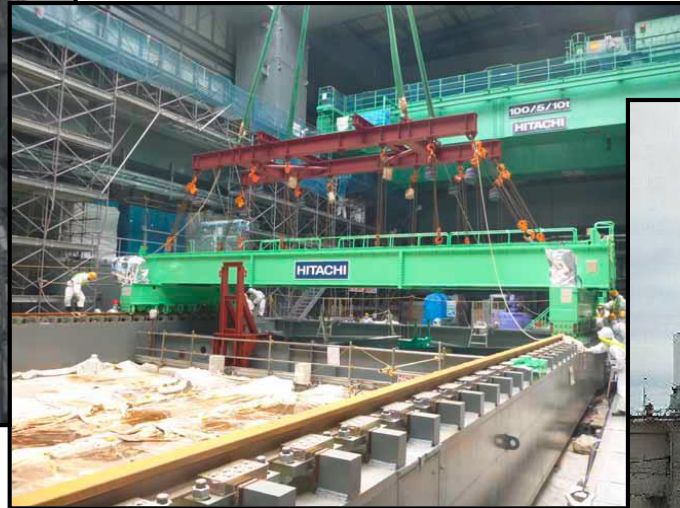
Construction of Structure for Fuel Removal



Construction of Structure for Fuel Removal (Cont'd)



⑤ Hoisting of Crane Structure (Jun. 7, 2013)



⑥ Fuel Handling Machine installed (Jul. 10, 2013)



⑦ Construction almost Completed (Jul. 20, 2013)

- Construction period: 11month
- Gross Weight : Approx. 4,900 ton
- W69m × L31m × H53m
- Safety Functions and Reliability similar to the existing plant fuel had been established

Debris Removal from inside SFP



Scattered Debris inside SFP

- Underwater Surveys
- Debris Removal one by one
- Various tools were used



① Removal of Large Debris
(Oct. 2, 2013)



② Suction of Debris on Fuel
Rack (Oct. 11, 2013)



③ After Suction Work
(Oct. 11, 2013)

Final Check before Fuel Removal Operation

- **Trial Operation using Dummy Fuel**
(Fuel Handling, Cask Transportation, etc.)
- **Emergency procedure also prepared, but eventually not used.**
(Example)
 - ✓ Fixation between fuel cladding and rack with small debris
 - ✓ Fall-down of cask
- **Verification by External Expert Panel**



Are there effects from "bulky and small removal operation?"

You can find the material at

<http://photo.tepco.co.jp/en/date/2013/201310-e/131030-02e.html>

To avoid operations on
(3) Response measures if debris does
If a change of load is detected, the operation is
If fuel assemblies become stuck with debris,
change crane to prevent damage.
If fuel assemblies become stuck with debris,
remove debris with specialized jig.

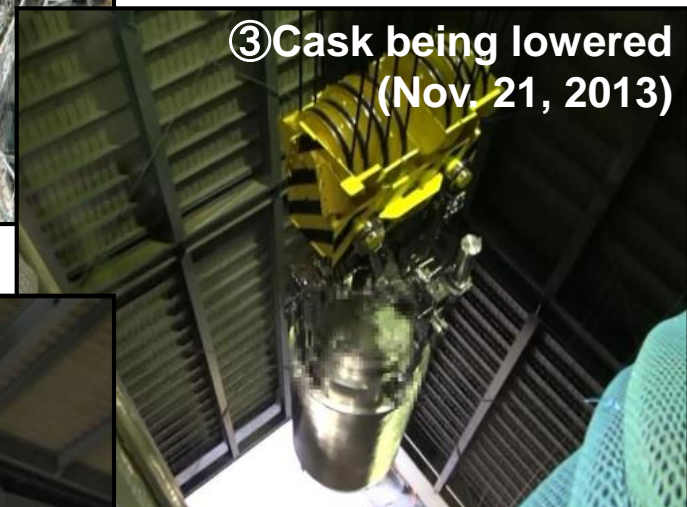
Fuel Removal/Transportation Operation



① Cask transferred to SFP
(Nov. 18, 2013)



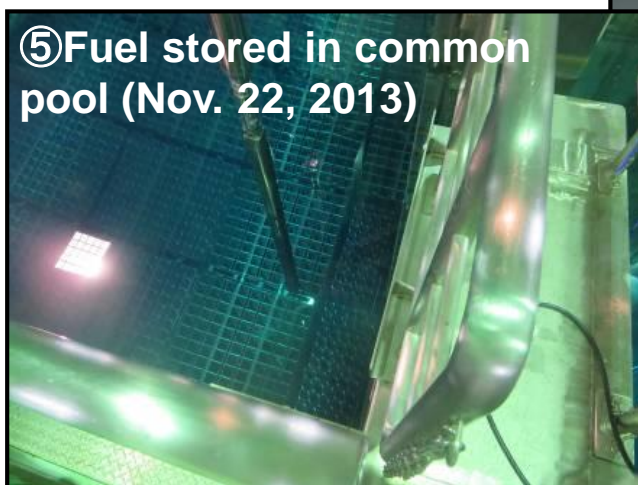
② Fuel removal work
(Nov. 18, 2013)



③ Cask being lowered
(Nov. 21, 2013)



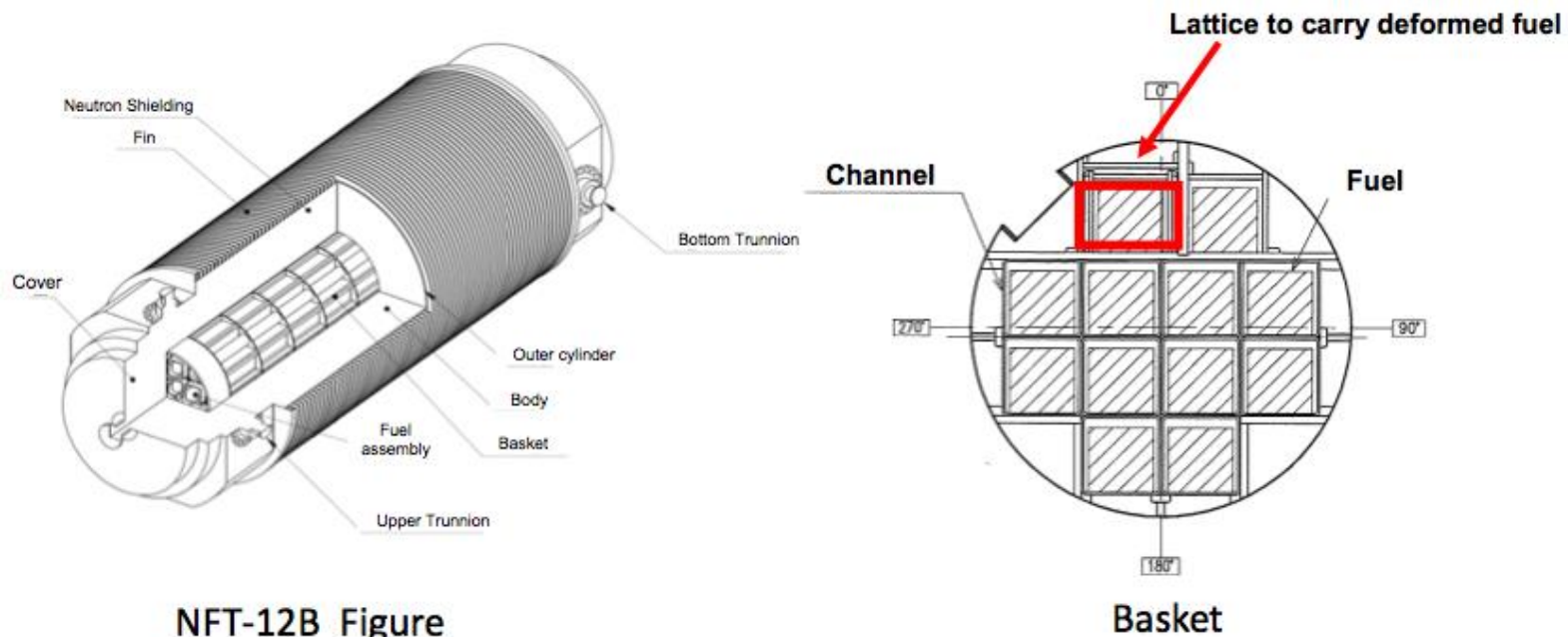
④ Loading onto trailer
(Nov. 21, 2013)



⑤ Fuel stored in common
pool (Nov. 22, 2013)

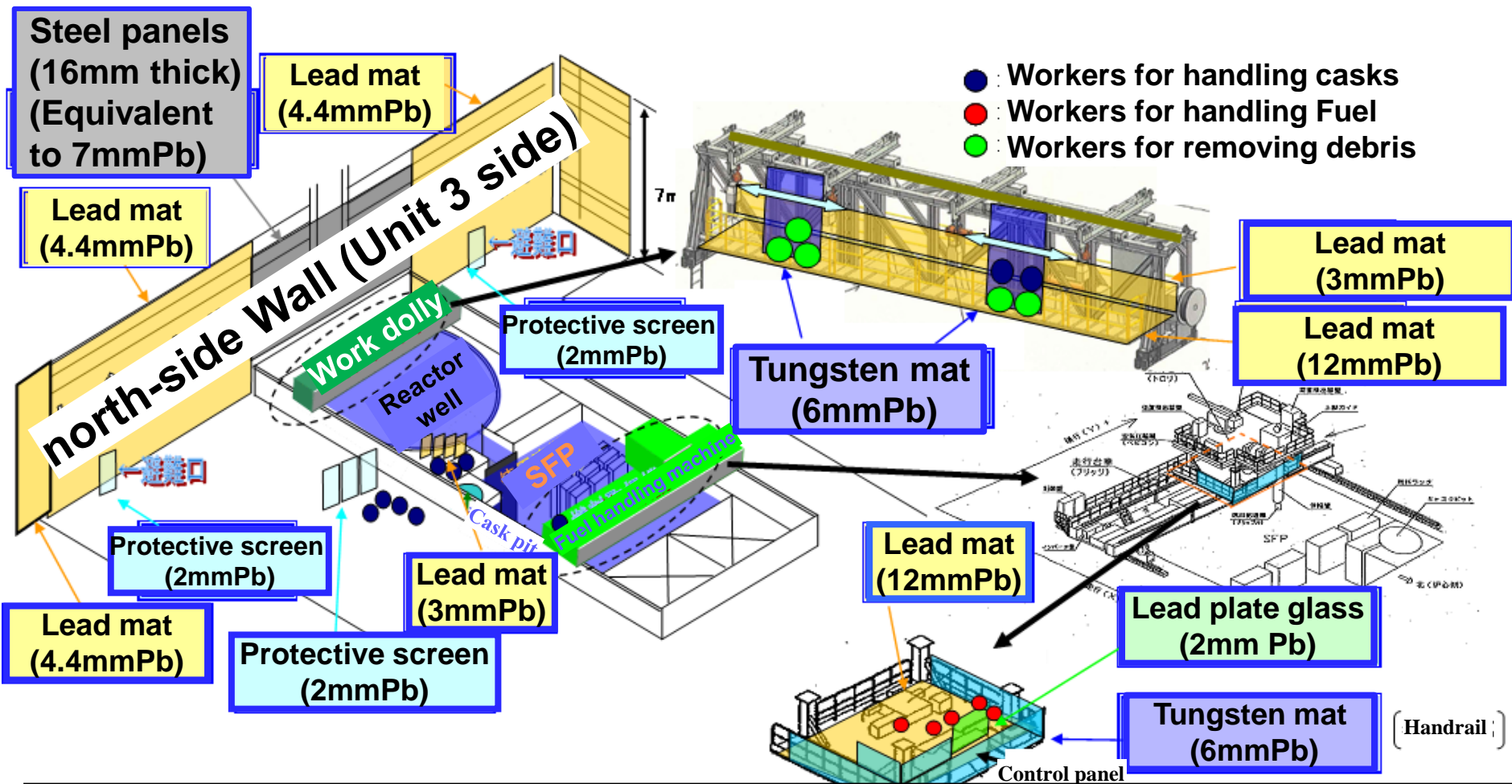
Considerations for the Safe Operation

- Performed carefully while conditions checked using an underwater camera or other devices.
- Fresh fuel was first transported to verify the procedures before SF removal
- 2 Leaking fuel assemblies and a deformed fuel assembly, which has been since before 3.11, were safely transferred by appropriate methods



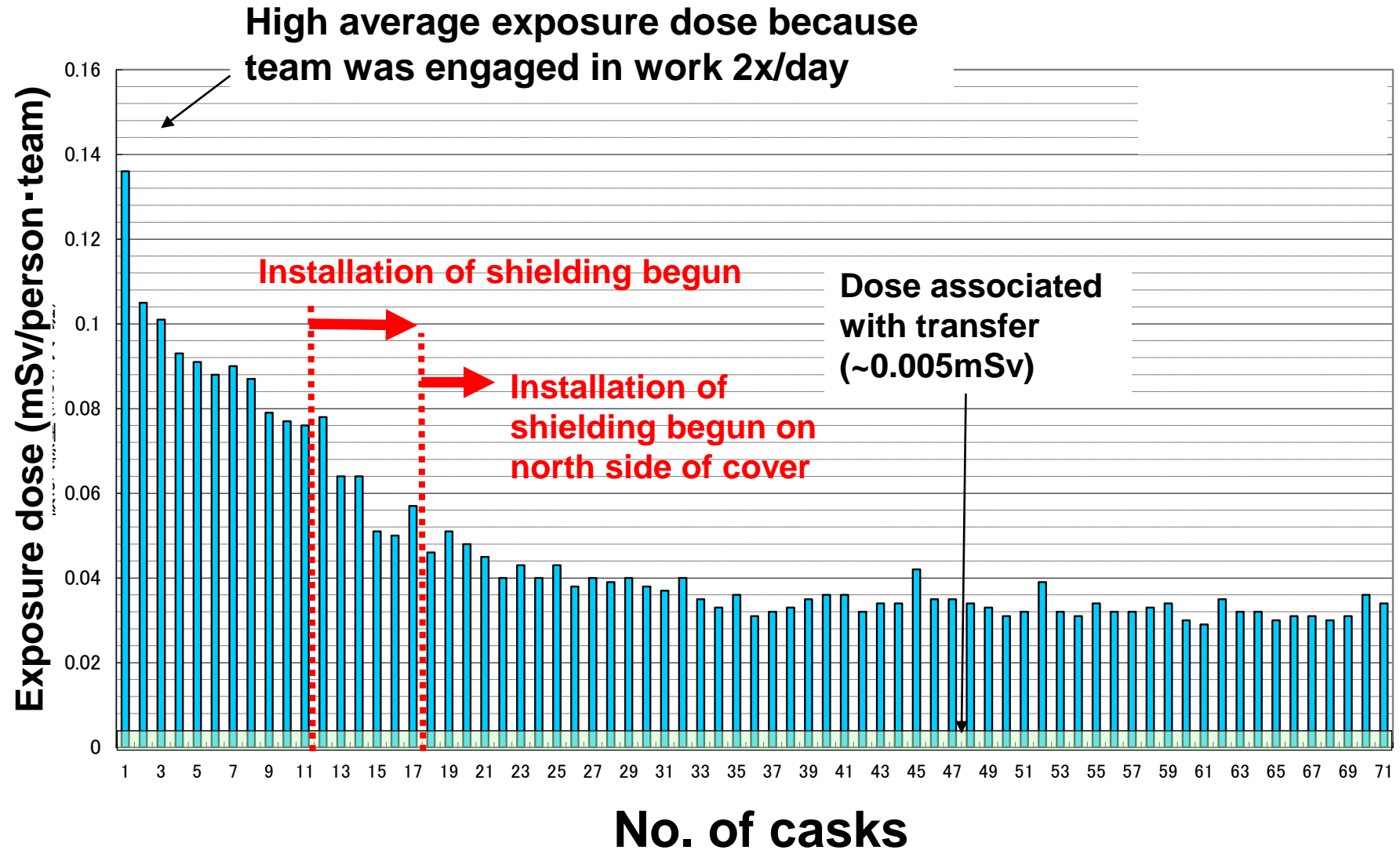
NFT-12B Figure

Dose Reduction Countermeasure

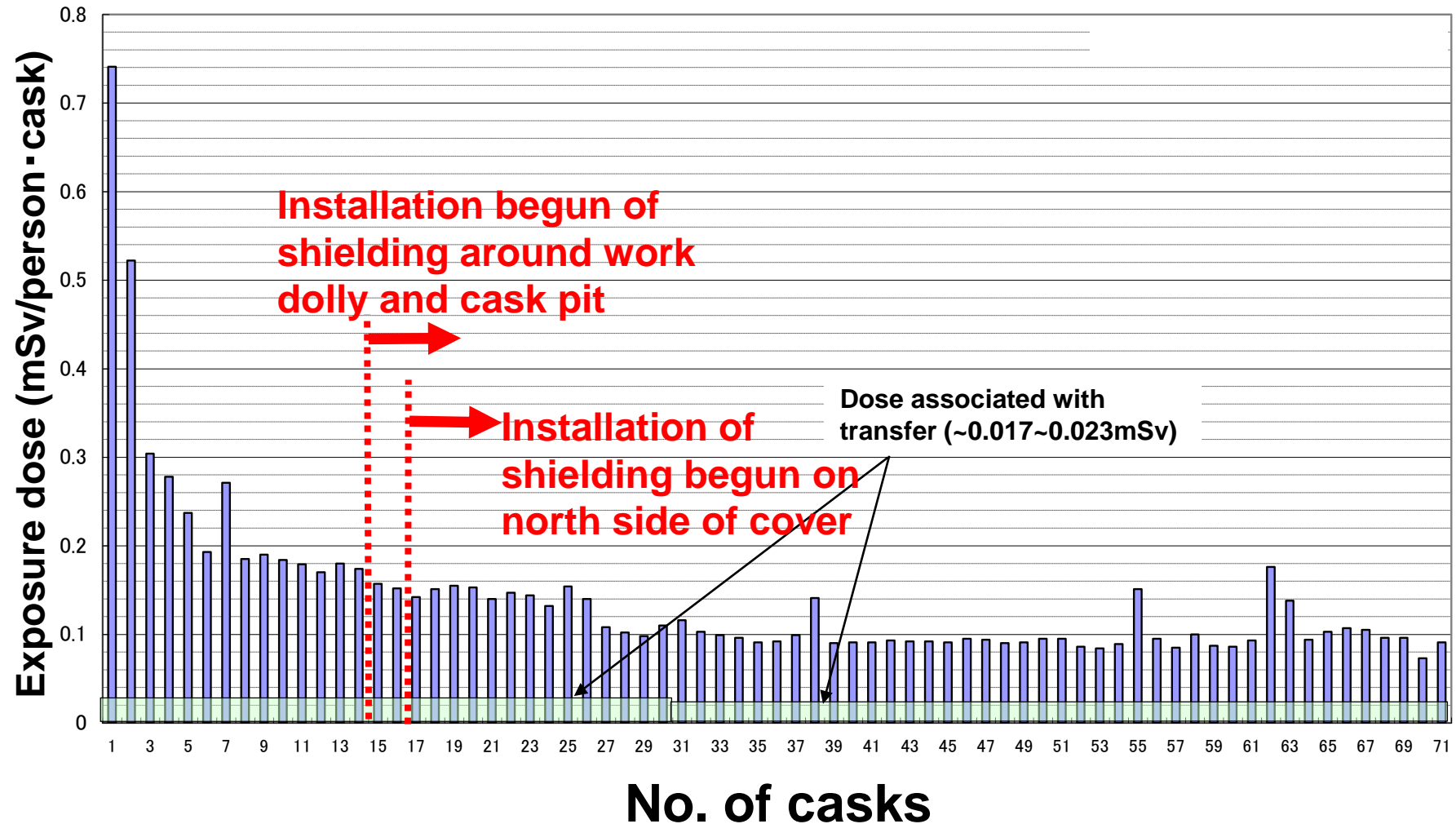


- Effective locations for the installation of shielding examined and those built.
- Finally could reduce the dose exposure of workers to a target level (one-third of the initial value)

(Ref) Dose Exposure when FHM Operation



(Ref) Dose Exposure when Handling Casks



(Ref) Dose difference between Unit 4 and 3

Measured : Feb. 2014 ~ Mar. 2015

Unit: mSv/h



Unit 4 Reactor Building 5F

(Ref) Dose difference between Unit 4 and 3 (cont'd)

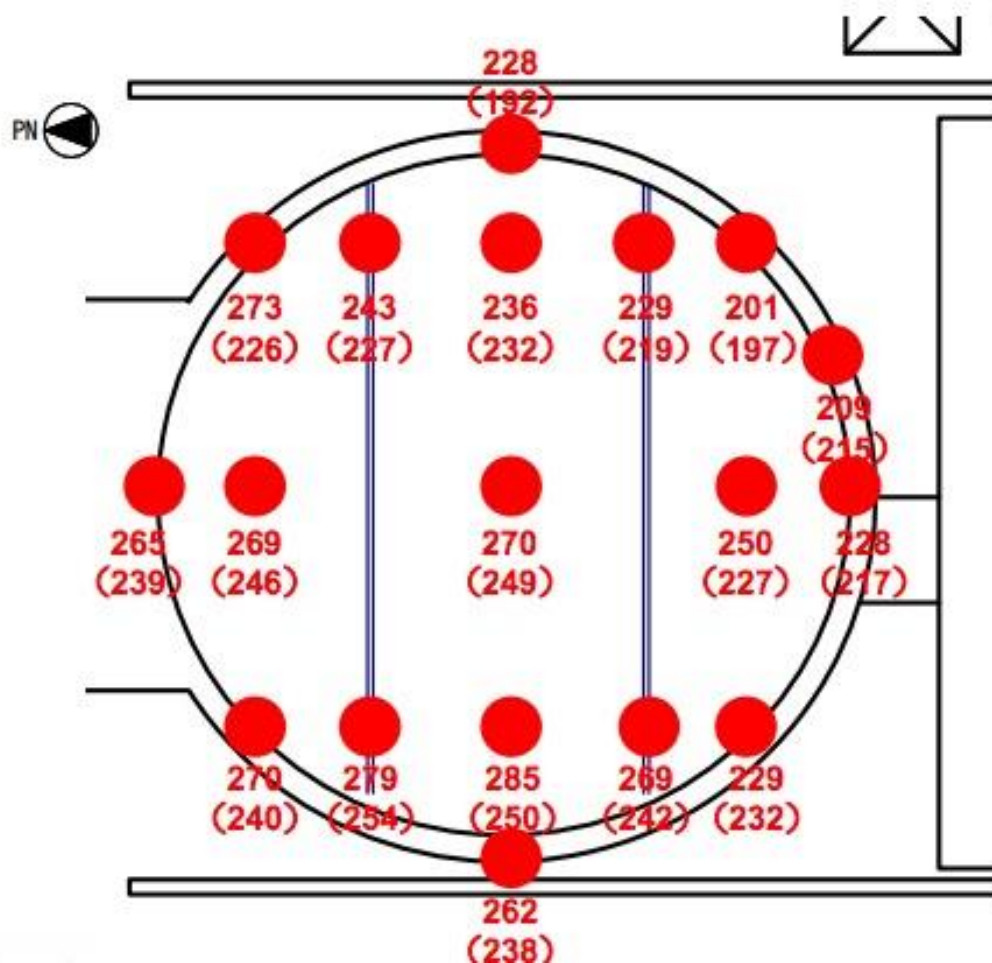
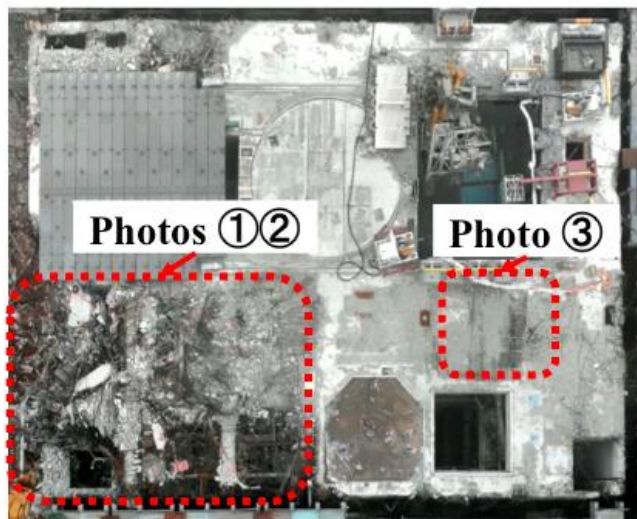


Figure in the upper line:
Atmosphere dose rate at 5 m (mSV/h)
measured on December 14, 2013
Figure in parenthesis in the lower line:
Atmosphere dose rate at 5 m (mSV/h)
measured on January 27, 2014

(Ref) Unit 3 Refueling Floor (Significant Damage Sustained)



Current Condition (May 2014)



Photo ③ Damage to concrete surface



Photo ① North side of R/B



Photo ② Northwest collapsed portion

Decommissioning Roadmap

Mid- to Long-Term Road Map Towards Decommissioning

**Cold Shutdown
Condition Achieved
(Dec., 2011)**

**Within
2 years**

**Within
10 years**

**30 to
40 years**

Phase-1

Phase-2

Phase-3

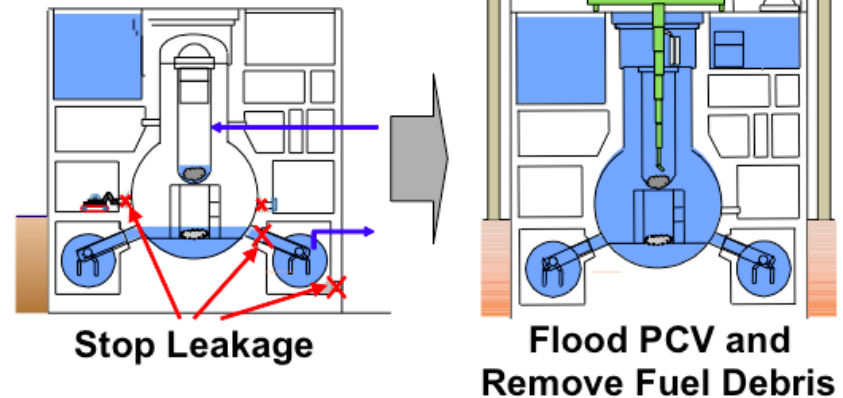
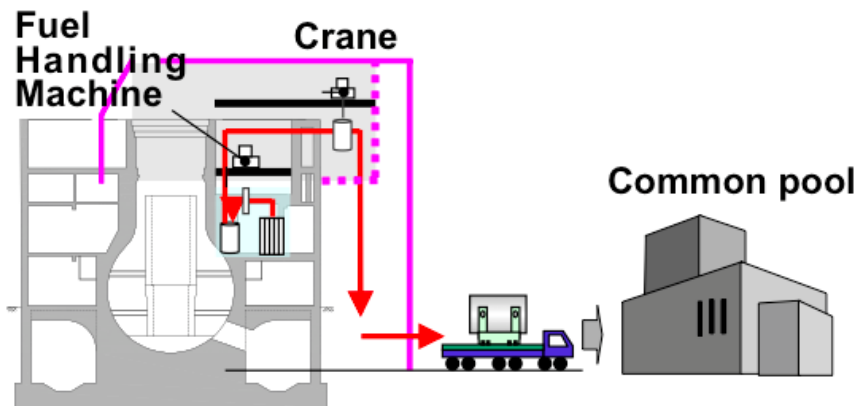
**Begin removal of
fuels from spent fuel**

**Begin removal of
fuel debris**

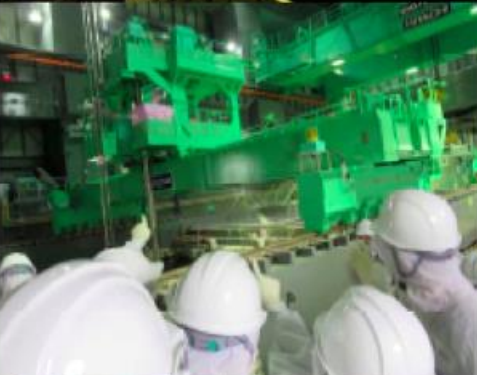
**Complete
decommissioning**

Unit 4 Nov. 2013

Today



**Global collaboration vitally important to tackle
this unprecedented undertaking**



***Thank you for your
attention***

