Current Situation of Fukushima-Daiichi Nuclear Power Plants and Difficulties in the Defueling Plan

International Experts' Symposium on the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Plant Unit 1-4

March 14, 2012
Tokyo, Japan

Tokyo Electric Power Company

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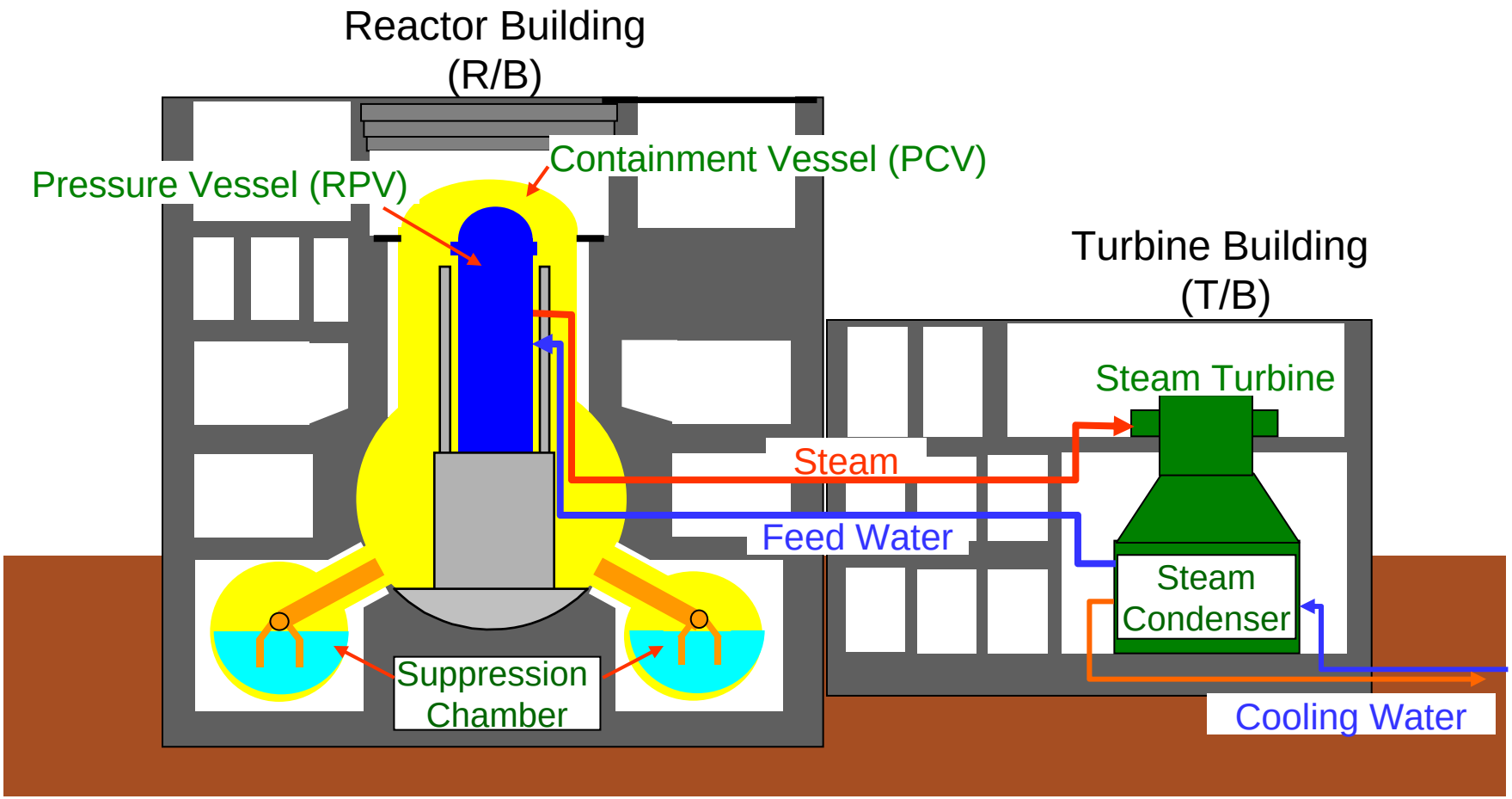
Overview Image of BWR-4



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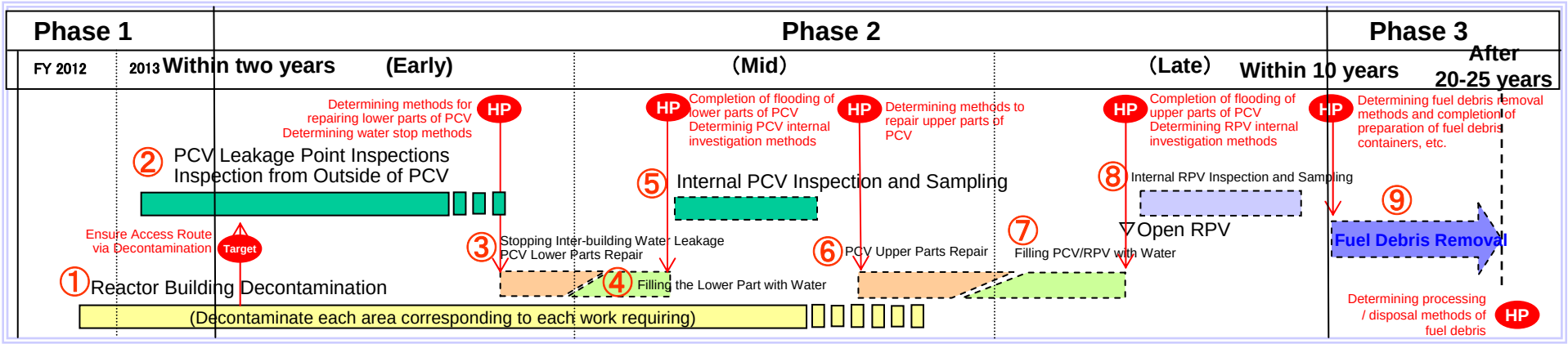
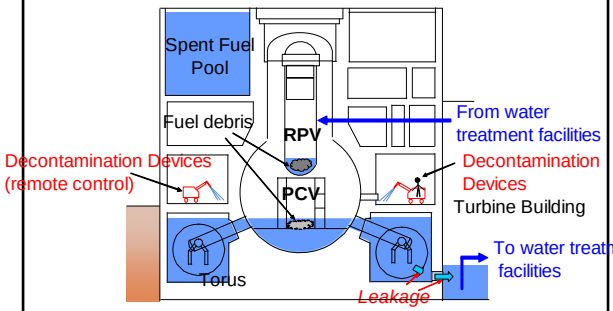
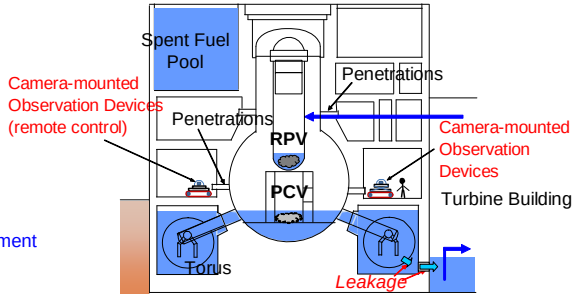
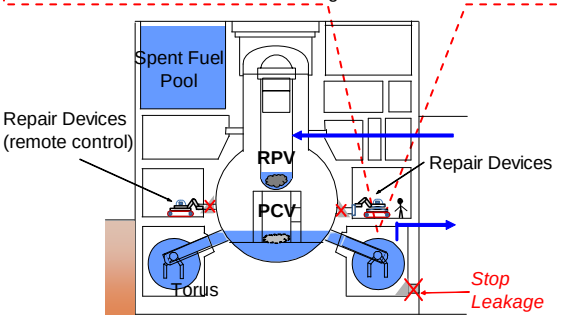
Work Steps Involved in Fuel Debris Removal（1/3）



Steps	① Reactor Building Decontamination (Decontaminate each area corresponding to each work following ② sequentially)	② PCV Leakage Point Inspections Inspection from Outside of PCV	③ Stopping Inter-building Water Leakage PCV Lower Parts Repair
Images			After achieving stopping inter-building water leakage, switch intake sources for circulating water cooling from accumulated water in turbine buildings to torus. 
Contents	In order to easily access PCVs, decontaminate work area via high-pressure washing, coating, and scraping, etc.	Inspect leakage points in the PCV and reactor building via manual or remote dose measurement, and camera, etc. Estimate and inspect the status of PCV inside via measurement of gamma ray from outside of PCV, and acoustic inspection, etc.	Repair PCV leakage points and then stop water leakage because it is believed that removing debris while underwater due to the excellent radiation shielding afforded will be the reliable method. First, repair points at lower parts of PCV for internal inspection.
Points to Note on Development	**◆The existence of areas of high dosage (several hundred to 1,000 mSv/h).** **◆Access restriction due to rubble scattered about inside R/B.** ・Remote decontamination methods corresponding to the above need to be considered and established.	**◆Inspection areas may be located in highly radioactive environments, under contaminated water, and in narrow parts.** ・Develop leakage point inspection methods and devices. ・Develop methods and devices for internal inspection from outside of PCV.	**◆While continuing water injection for circulating water cooling, stop water leakage under highly radioactive and water running conditions.** ・Develop technologies and methods to repair leakage points and stop water leakage. ・Consider and develop alternatives.

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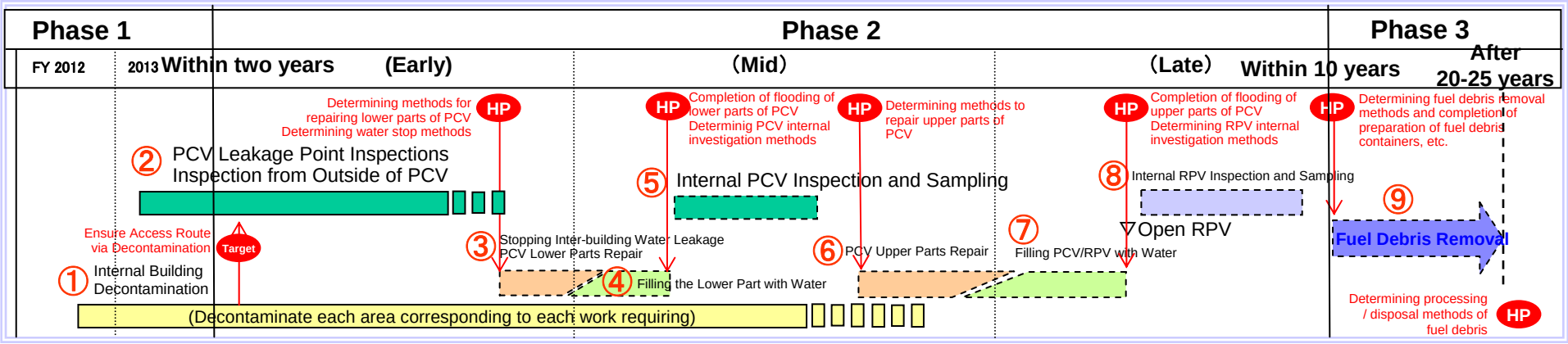
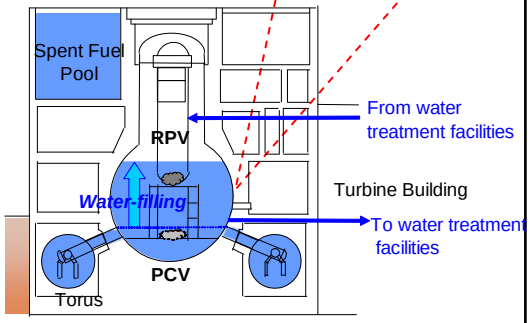
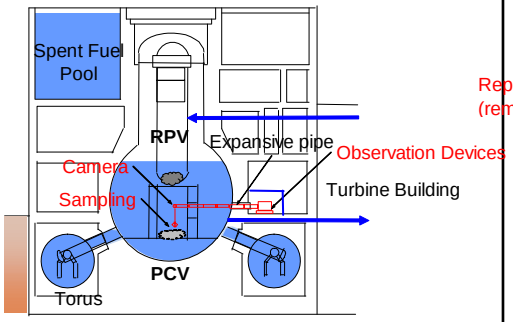
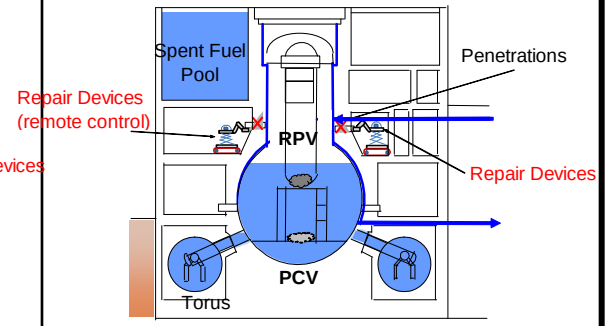
Work Steps Involved in Fuel Debris Removal（2/3）



Steps	④ Filling the Lower Part with Water	⑤ Internal PCV Inspection and Sampling	⑥ PCV Upper Parts Repair
Images	After achieving construction of boundaries at the lower parts of PCV, switch intake sources for circulating water cooling from torus to PCV. 		
Contents	Partially fill the lower parts of PCV with water before starting PCV internal inspection.	Ascertain distributions of fuel debris flowed from RPV by internal PCV inspections and samplings etc.	In order to fill the PCV full with water, repair leakage points at the upper parts of PCV by manual or remote methods.
Points to Note on Development	**◆Same as ③** ・Place top priority on the construction of boundaries at the lower parts of PCV (including filling torus with grout materials).	**◆ Access restriction due to high radioactive conditions and unknowing PCV internal conditions (thickness of internal water, existence of debris, etc.)** ・Develop remote inspection methods and sampling methods corresponding to the above.	**◆ Same as ②** ・ Develop technologies and methods to repair PCV leakage points and stop water leakage (same as ③).

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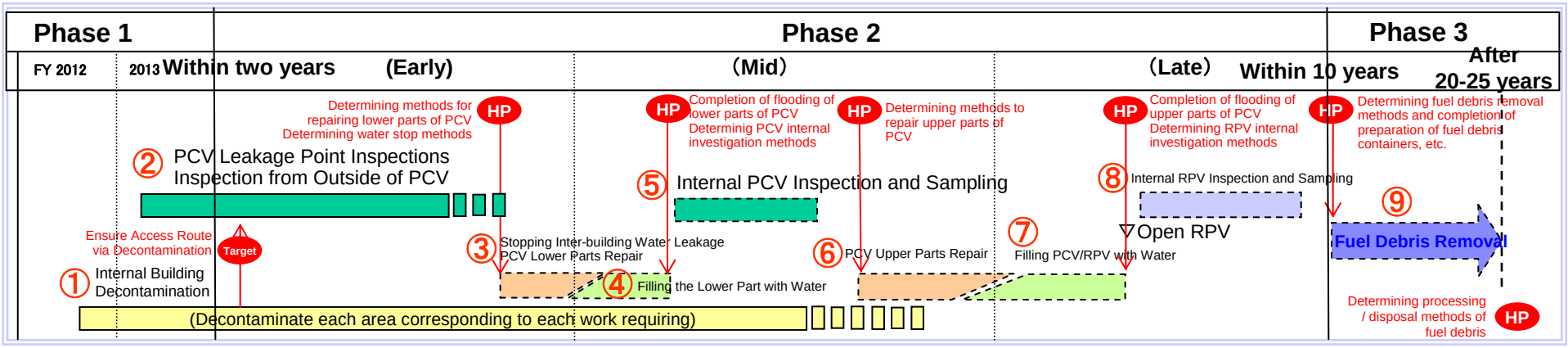
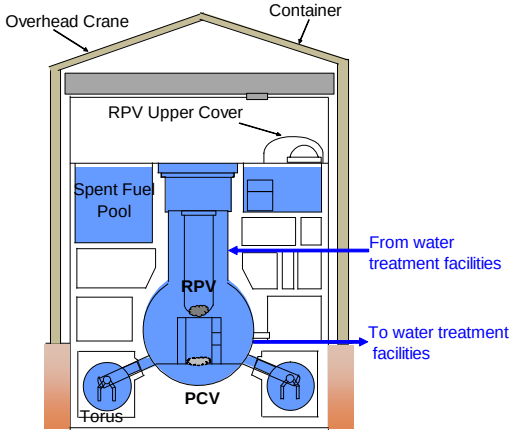
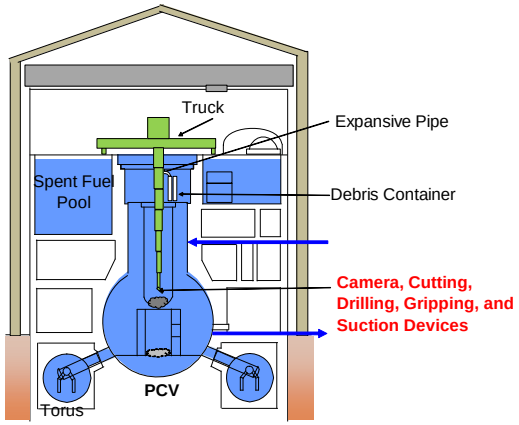
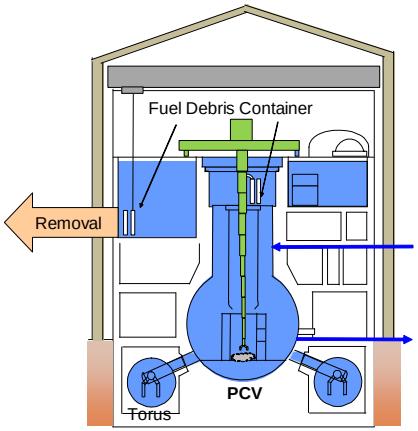
Work Steps Involved in Fuel Debris Removal（3/3）



Steps	⑦ Filling PCV and RPV with Water ⇒ Open the upper cover on RPV	⑧ Internal RPV Inspection and Sampling	⑨ Fuel Debris Removal
Images			
Contents	After filling PCV/RPV with water enough to ensure shielding, open the upper cover on RPV.	Ascertain conditions of fuel debris and internal RPV structures by internal RPV inspections and samplings etc.	Remove debris inside RPV and PCV
Points to Note on Development	(Place top priority on the construction of PCV boundaries as per ⑥)	◆Restricted access route due to high radioactive conditions and unknown internal RPV conditions (thickness of internal water, existence of debris, etc.) ・Develop remote inspection methods and sampling methods based on the above.	◆Expand technology development scope depending on distribution status of fuel debris (No experience of fuel removal of inside PCV at TMI) ・Develop more sophisticated technologies and methods than those of TMI

R&D Projects for Fuel Debris Removal

■ Remote Decontamination Technology

◆ **Purpose**

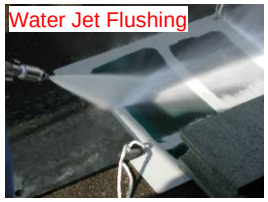
Reduce the radiation dose for following surveys and repair works

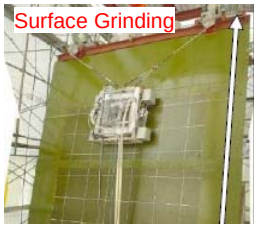
◆ **Challenging Points**

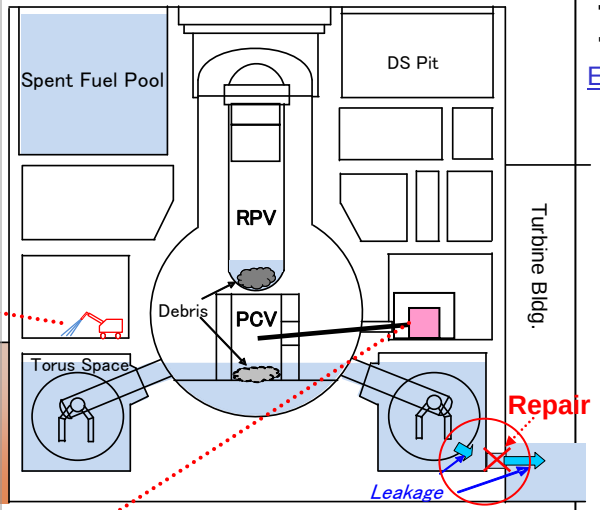
・Optimal decontamination way for each situation

・Remote control tech. for high radiation or restricted work space

Existing Techniques







■ Leakage Detecting Technology

◆ **Purpose**

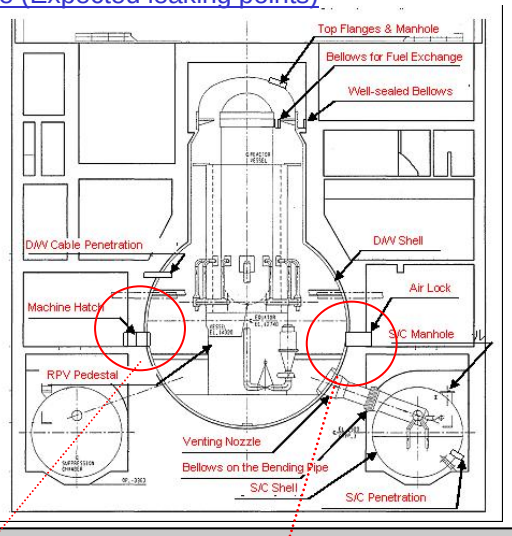
Detect the leaking points w/o high exposure

◆ **Challenging Points**

・High radiation, little space

・Remote checking/control system

Example (Expected leaking points)



■ Inner PCV Survey Technology

◆ **Purpose**

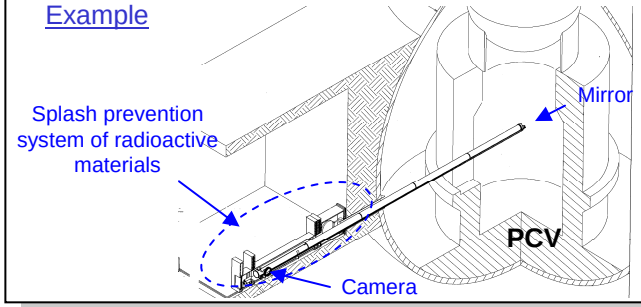
Survey the condition of PCV and RPV, and the location and property of debris

◆ **Challenging Points**

・Measuring instruments with remote control system under high temp., high humidity, and high radiation

・Splash prevention system

Example



■ Leakage Mending Technology

◆ **Purpose**

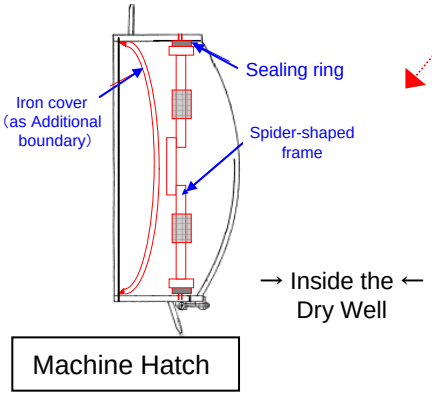
Develop the waterstops and leakage mending methods for various leakage points

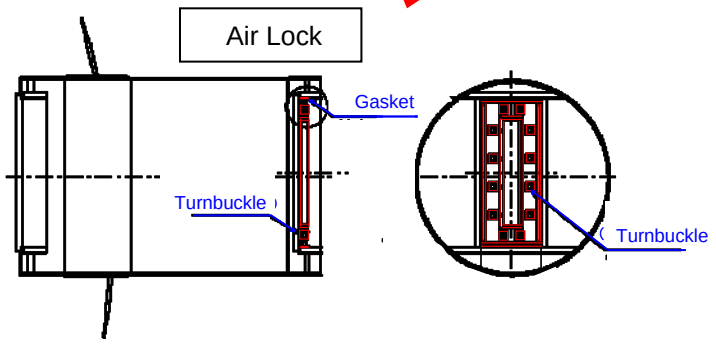
◆ **Challenging Points**

・Availability in the contaminated water

・Remote procedure/control

Example





Recent View of Fukushima Daiichi (Units 1 to 4)

As of 1/31/2012 10:24 (C)GeoEye / 日本スペースイメージング

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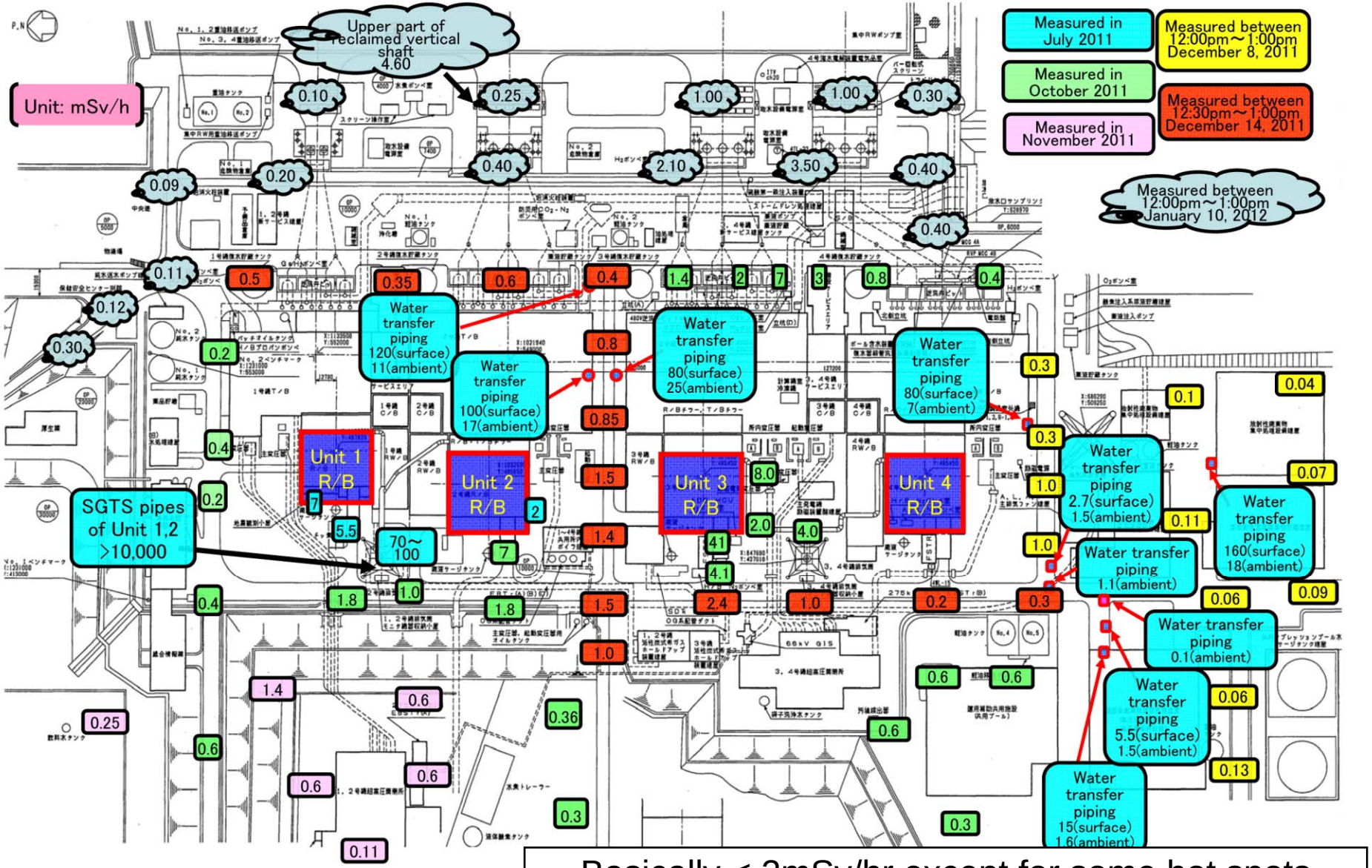
TEPCO

Dose Rate Map of Fukushima Daiichi Site (As of 5:00PM Jan.10, 2012)



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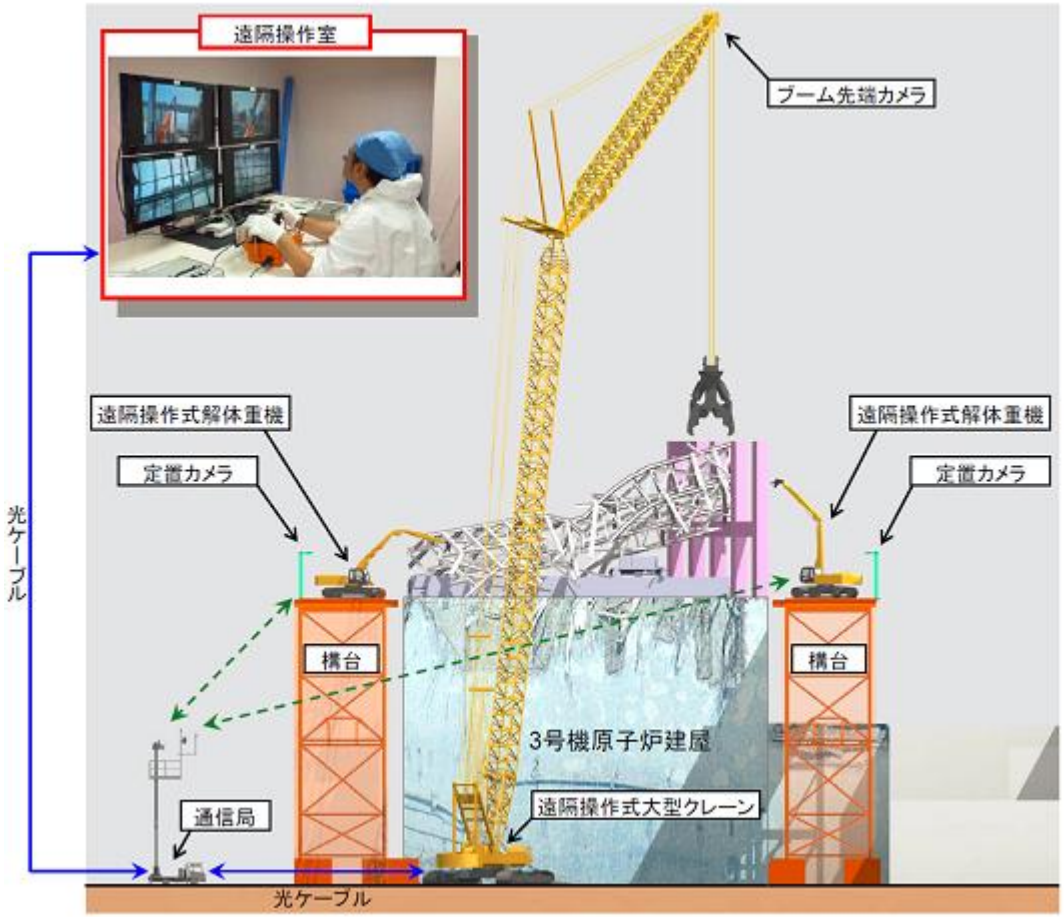
Debris Removal by Remote Operation



Debris on the top of R/B (Unit 3)

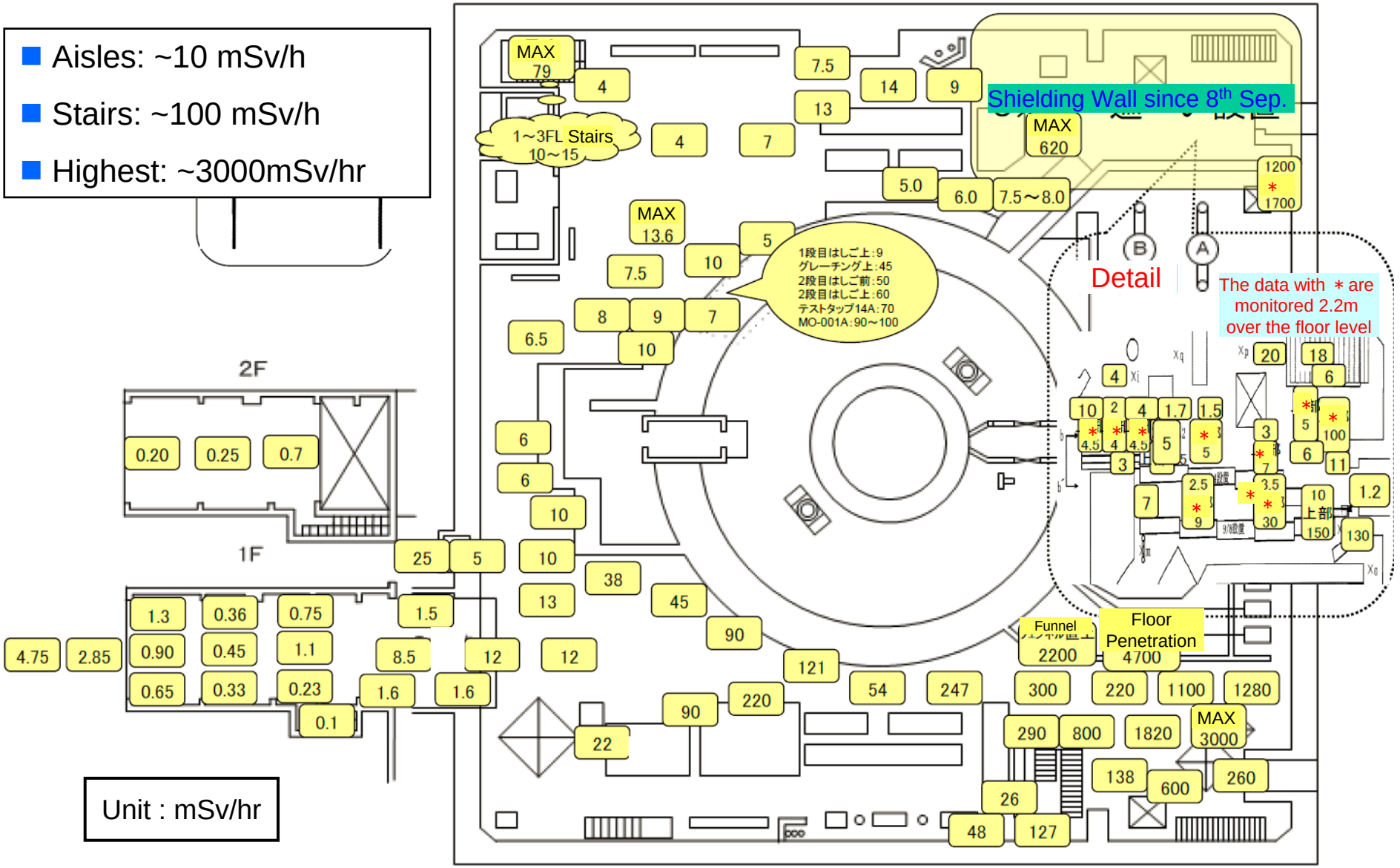
Debris on the ground

Dose Rate Maps
inside the Reactor Building (R/B)

Dose Rate Map of Inside of R/B (1st Floor of Unit 1)

Monitored from Apr. to Nov. 2011

- Aisles: ~10 mSv/h
- Stairs: ~100 mSv/h
- Highest: ~3000mSv/hr



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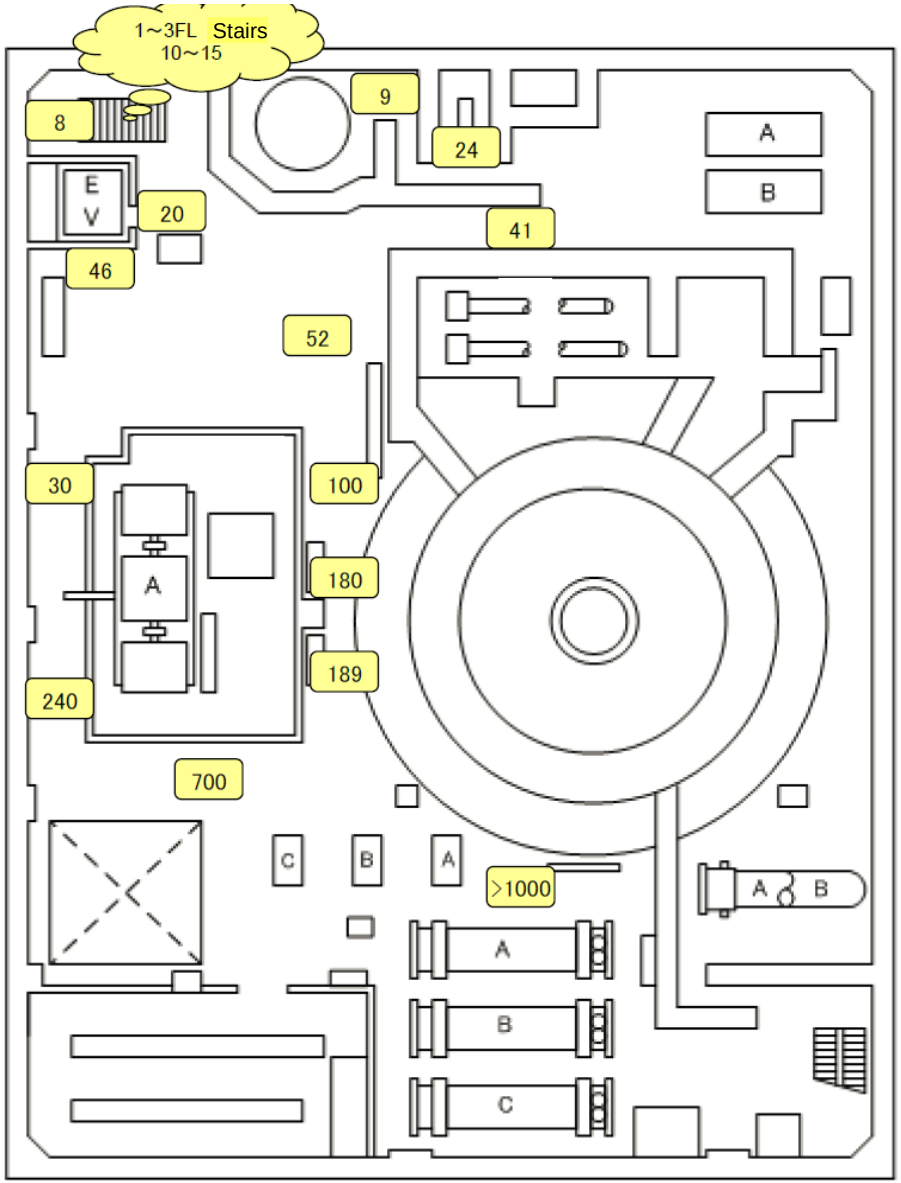
Dose Rate Map of Inside of R/B (2nd Floor of Unit 1)

Monitored from Apr. to Nov. 2011

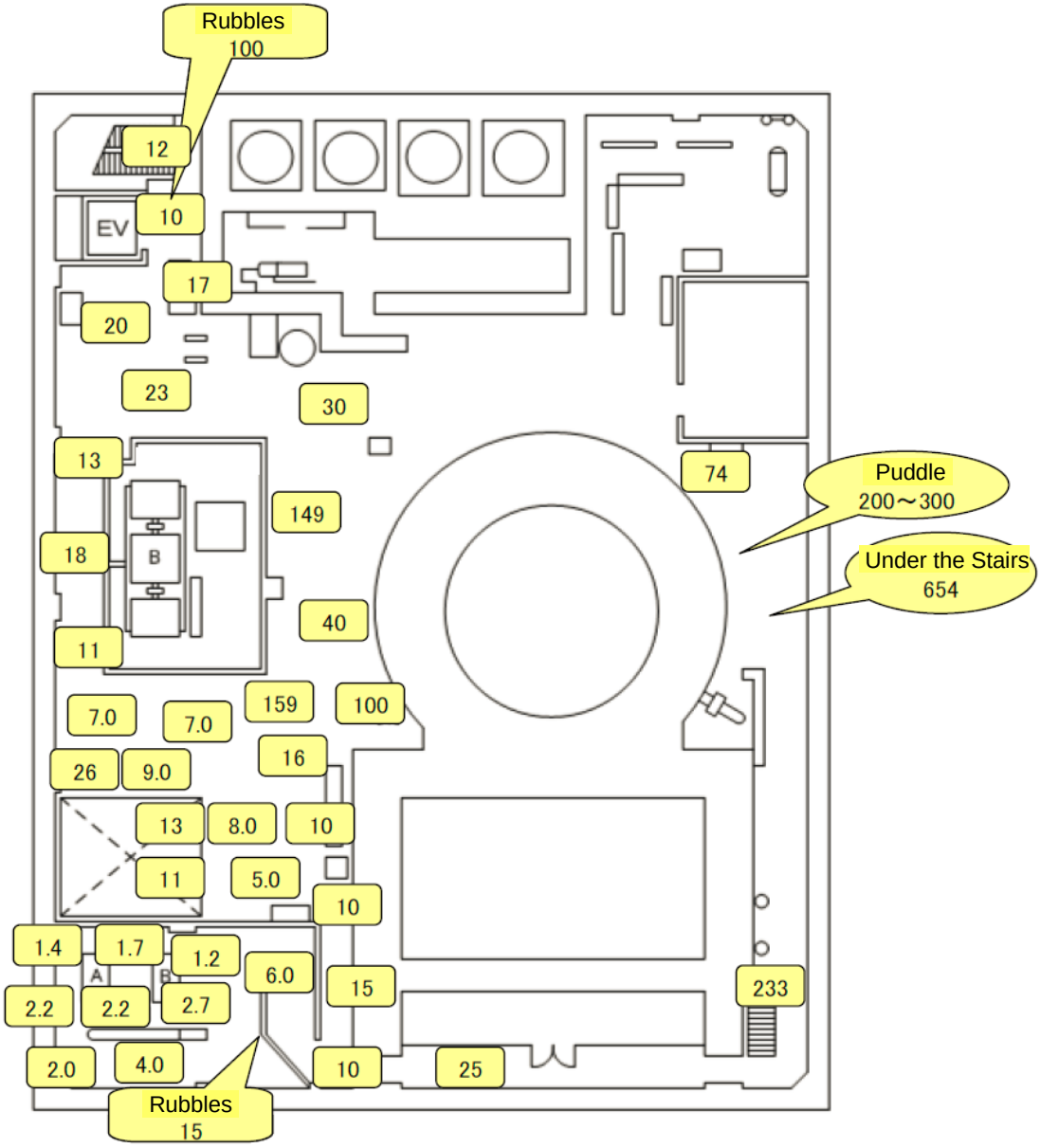
- Aisles: ~200 mSv/hr
- Highest: >1000 mSv/hr



Dose Rate Map of Inside of R/B (3rd Floor of Unit 1)

Monitored from Apr. to Nov. 2011

- Aisles: ~150 mSv/hr
- Water on the Floor: ~650 mSv/hr



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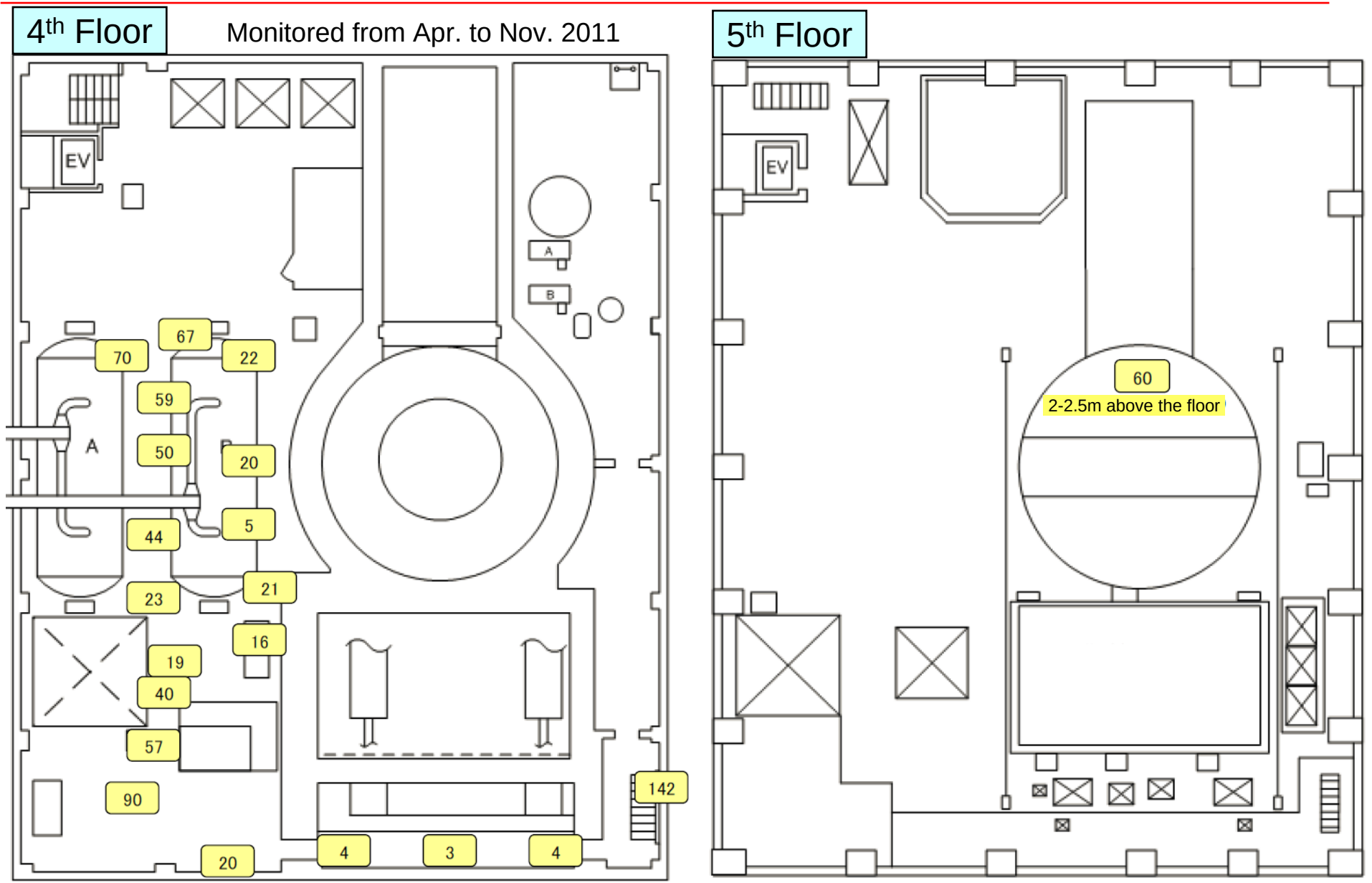
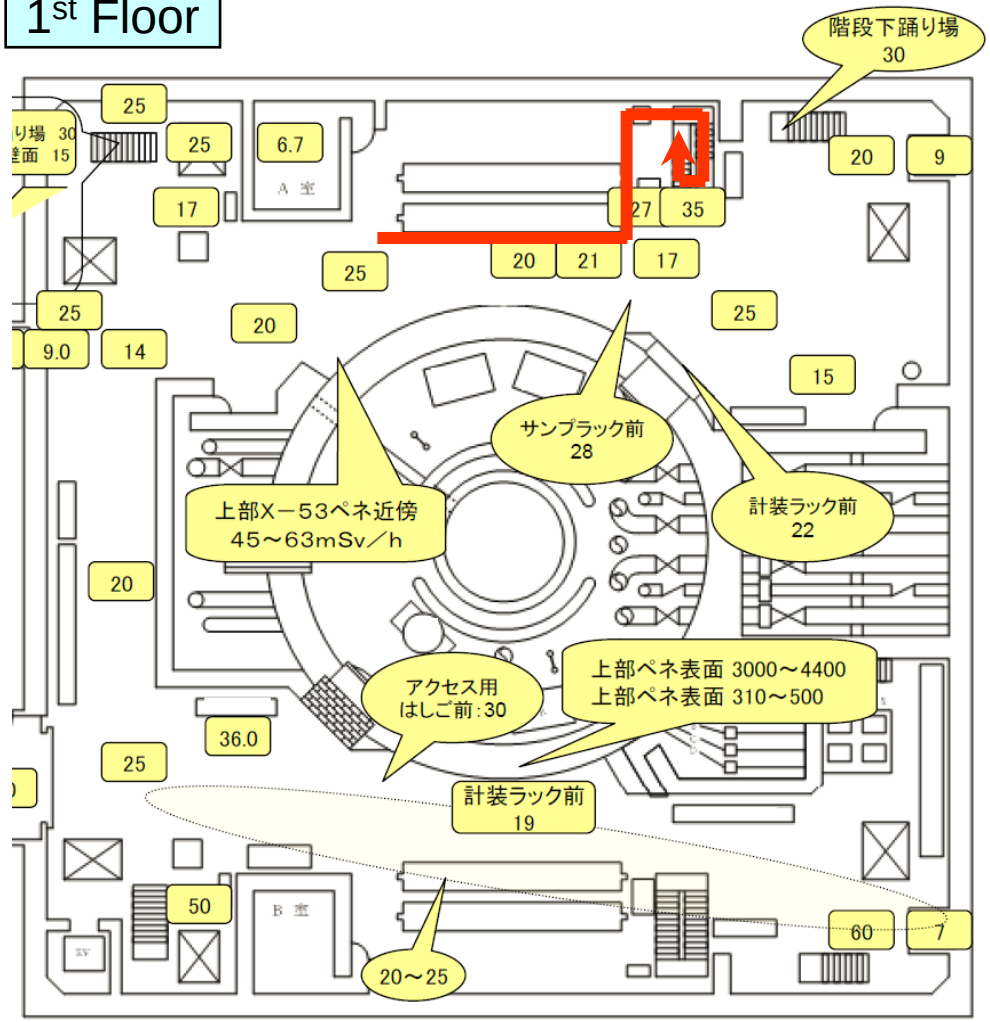
Dose Rate Map of Inside of R/B (4th & 5th Floor of Unit 1)



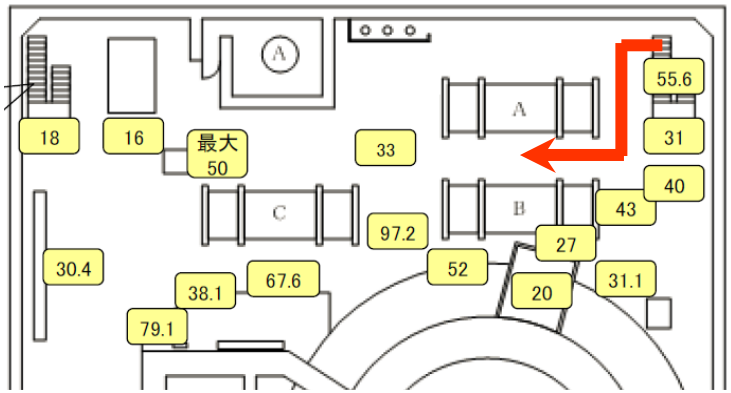
Current Status of inside the Reactor Building

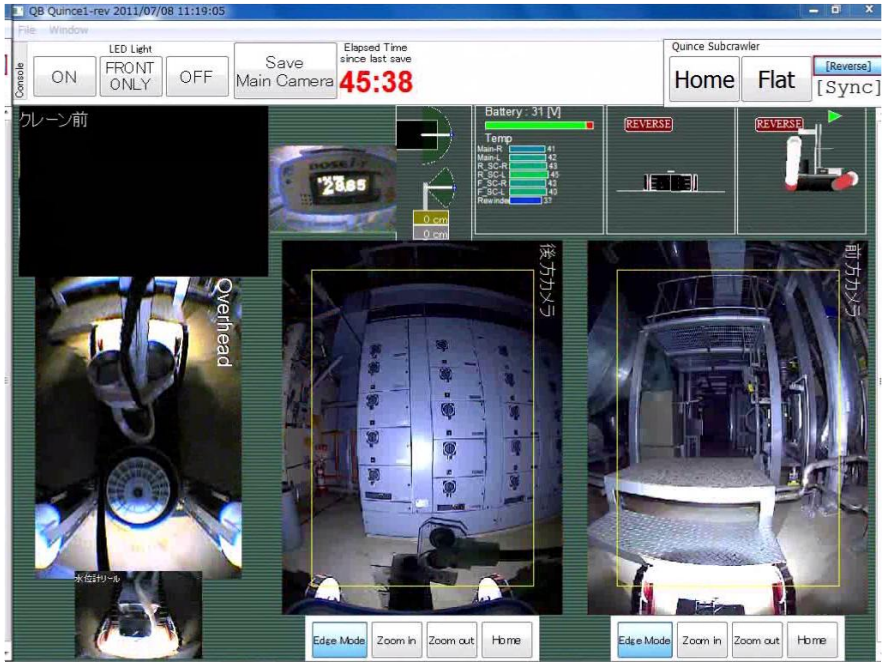
[Movie taken by Quince] Moving up the stairs (Unit 2)

1st Floor



2nd Floor





http://www.tepco.co.jp/en/news/library/movie-01e.html Jul. 8, 2011

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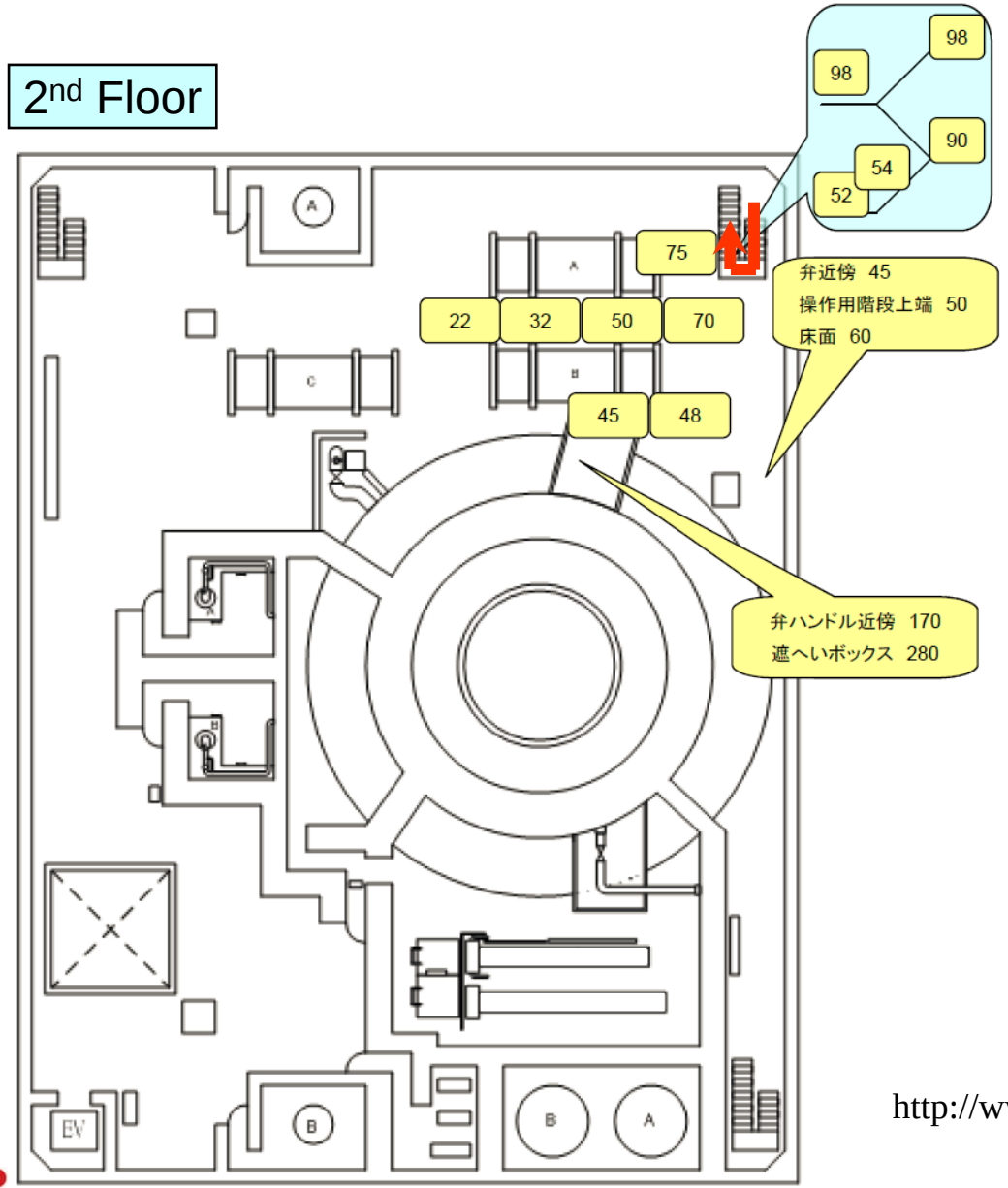
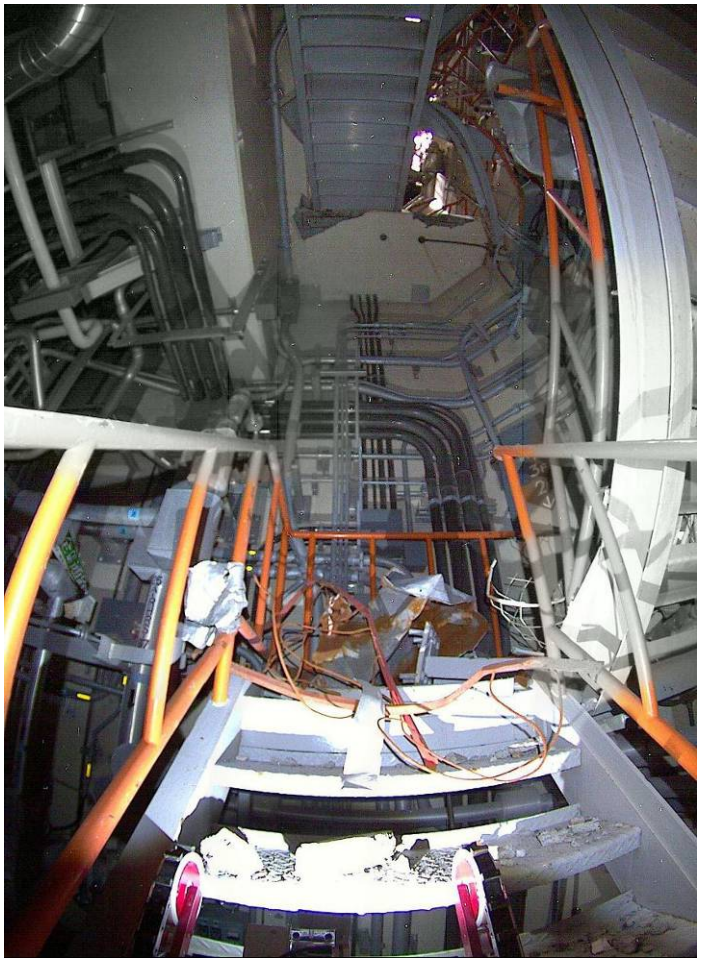
[Movie taken by Quince] Obstacles on the stairs (Unit 3)





http://www.tepco.co.jp/en/news/library/movie-01e.html

Jul. 26, 2011

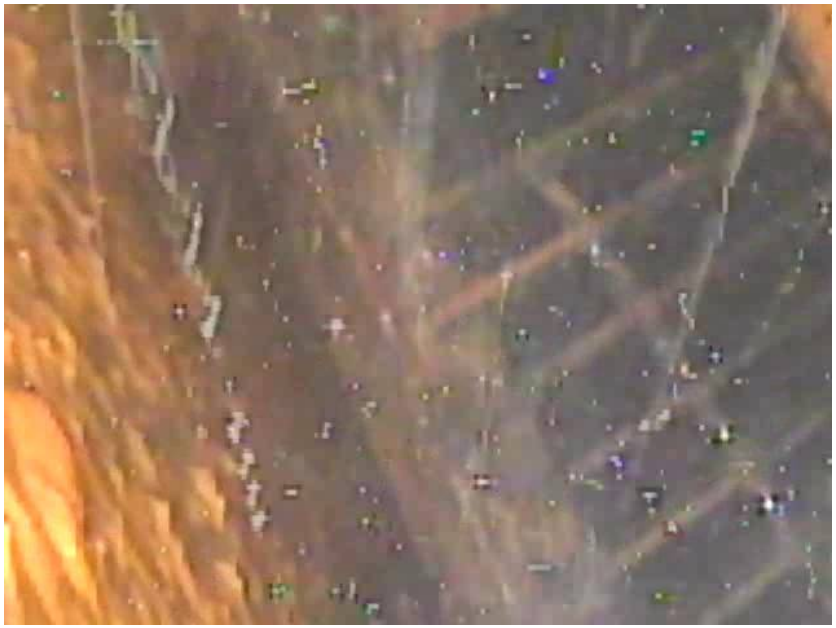
[Movie] Rubbles on 4th Floor (Unit 1)

Rubbles around the emergency steam condenser

http://www.tepco.co.jp/en/news/library/movie-01e.html

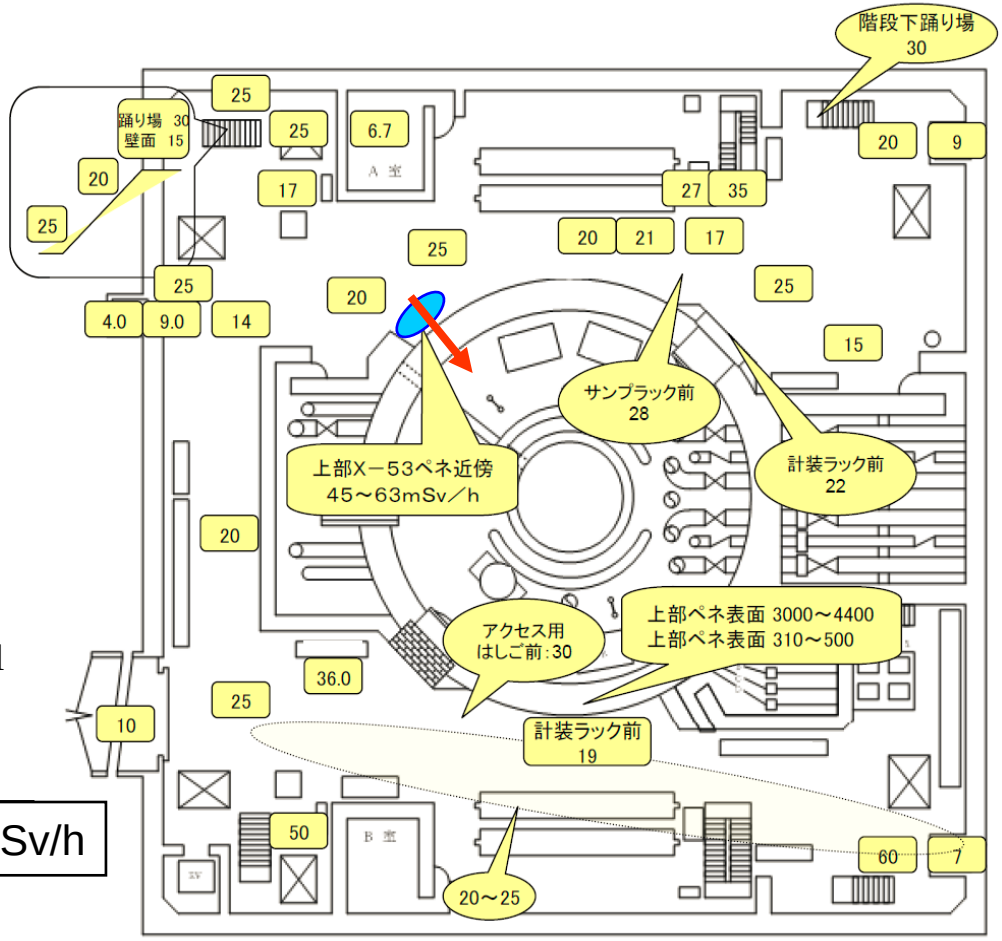
Oct. 18, 2011

[Movie] Inside of Pressure Containment Vessel (Unit 2)



http://www.tepco.co.jp/en/news/library/movie-01e.html

Jan. 19, 2012



- Primary objective (temperature measurement) was achieved successfully
- Water level was not confirmed within the reach of the fiber camera

[Movie] Normalcy of inside of a PCV (BWR-5)

Kashiwazaki-Kariwa, Unit 4 (BWR-5, 1100MW)

- PCV inside is crowded with a lot of facilities and pipe-lines packed in.
- The floor is not flat but has many steps.
- Units 1-4 of Fukushima Daiichi are BWR-4 plants and the space is significantly smaller than this movie

Summary of Dose Rate Survey of Inside of R/B

- Dose rates in the reactor buildings is from tens to hundreds mSv/hr in most areas.
- Thousands mSv/hr areas are existing due to some radiation source.
- Dose rate survey maps are similar among Unit 1 to Unit 3, even though the reactor building of Unit 2 did not experience a hydrogen explosion.
- The pipes lying on the floor/aisles, so the floors has some steps originally.
- Rubbles are scattered on the floor, which prevents the robots from running through the floor.
- Rubbles are also scattered on the stairs.

Technical Challenges for Defueling

Decontamination of Reactor Buildings

- Various targets of decontamination; floor, wall, ceiling….
- Not only structural objects, but puddles and atmospherics should be decontaminated.
- Technologies for coating or shielding the radiation sources will also required.

Inspection of Inner PCV & Leaking Points

- Most inspection (photographing, dose measurement, acoustic diagnostics) will be done in the contaminated water or in little/crowded space.
- Various situation such as high temp, high humidity, under water….
- All measurement instruments must have high tolerability to radiation and long distance control system

Repair Works for PCV & Leaking Points

- Leakage mending methods under the highly contaminated water
- Water injection to a reactor cannot be stopped during the PCV/leakage repair.