Dismantlement of Unit 1 Reactor Building Cover for Fuel Removal at Fukushima Daiichi Nuclear Power Station

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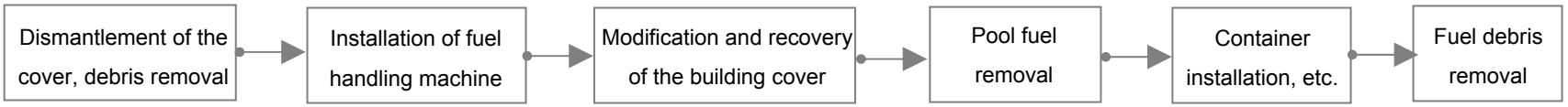
Overview

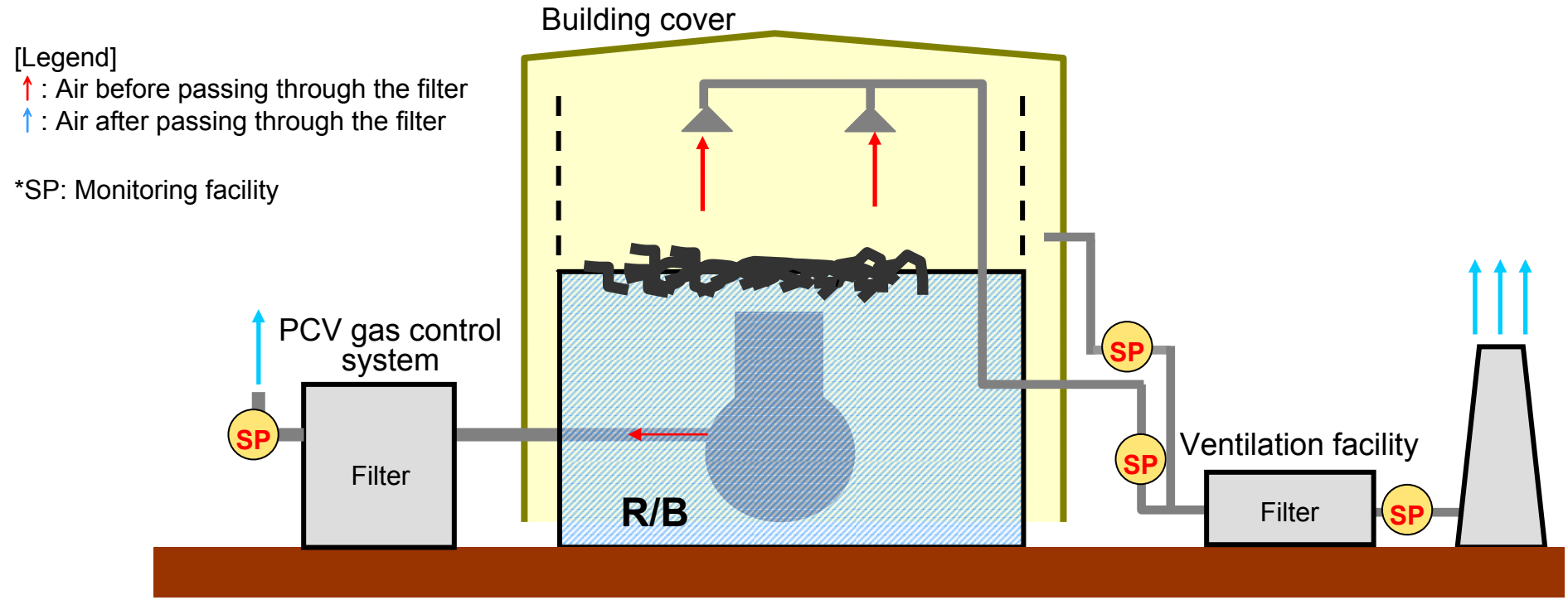
- At Unit 1 of Fukushima Daiichi Nuclear Power Station, a cover was installed over the Reactor Building in October 2011 for the purpose of preventing radioactive materials from being released.
- Even now, debris is still scattered on the operation floor in the Reactor Building.
- In order to accelerate decommissioning, the removal of pool fuels and fuel debris needs to be implemented ahead of schedule.
- The debris accumulated on the operation floor needs to be removed first in order to realize the early implementation of fuel removal.
- In order to proceed with debris removal, the cover installed on the Reactor Building needs to be dismantled.
- The dismantlement of the cover is considered to have little impact on the radiation exposure dose at site boundaries attributable to the radioactive materials released from Units 1-3 Reactor Buildings (0.003mSv/year, as of the end of March 2013).
- Based on the above, the Reactor Building cover will be dismantled for debris removal from the operation floor.

(Reference: Fuel removal procedure)



1. Installation of Unit 1 Reactor Building Cover

- Cover was installed over the Reactor Building in October 2011 for the purpose of preventing radioactive materials from being released.
- The air in the building is drawn into the ventilation facility installed on the building cover at the ceiling and passes through the filter installed outside of the cover for radioactive material removal before being released into the atmosphere.
- Monitoring facility is installed for the purpose of monitoring the radioactivity density inside the building cover.
- After the building cover installation, the PCV gas control system was installed in December 2011 to prevent radioactive materials from being released from the PCV.



Structure overview

2. Current Condition of Unit 1 Reactor Building (1)

- Even now, debris is still scattered on the operation floor inside the building cover.

Building cover

Photo taken in October 2011

Full-view of the operation floor (northwest side)

Photo taken around June 2011

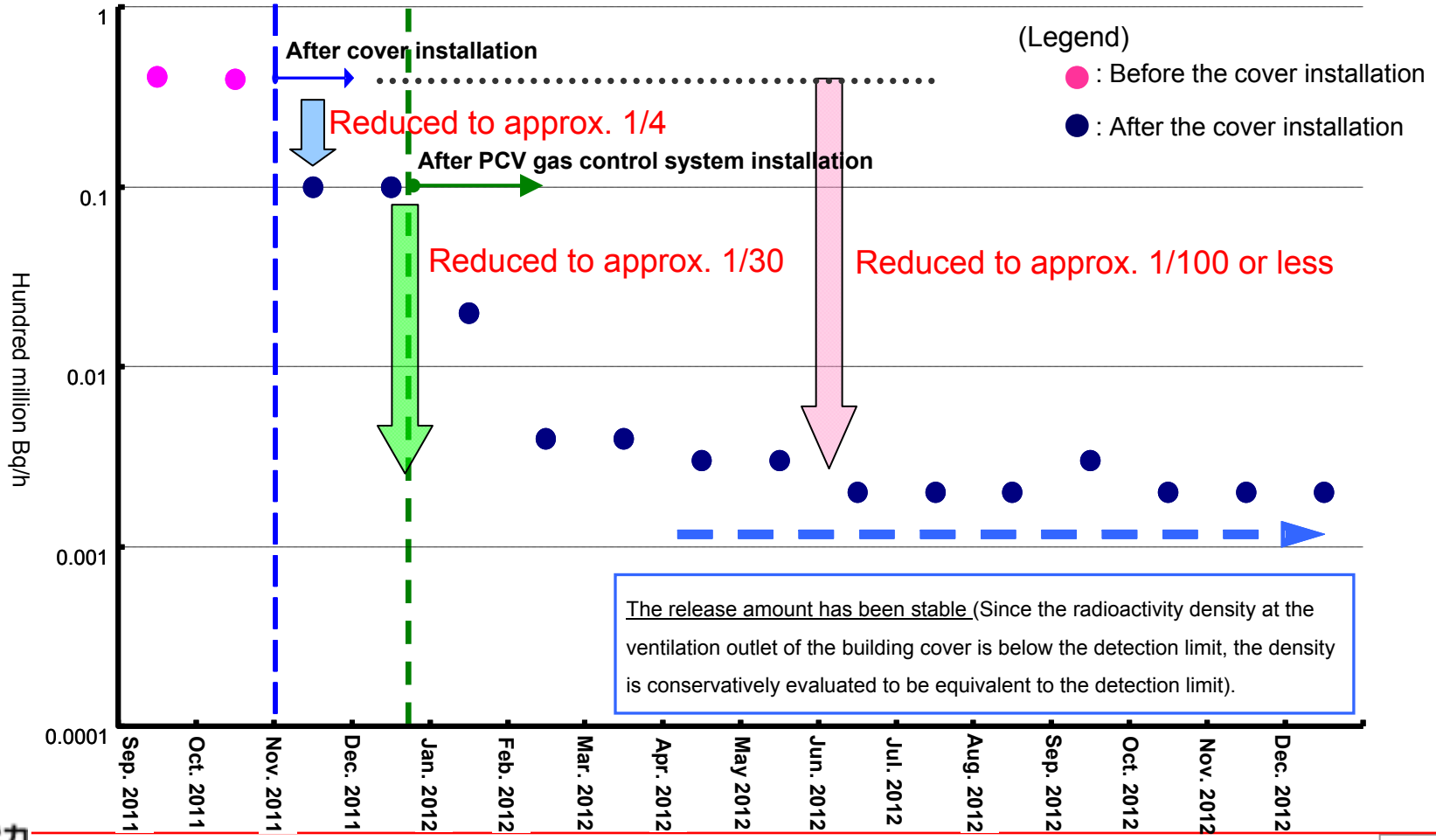
Condition of the operation floor

Photo taken in October 2012 (during the investigation of the operation floor utilizing a balloon)

Photo taken in October 2012 (during the investigation of the operation floor utilizing a balloon)

3. Current Condition of Unit 1 Reactor Building (2) (Comparison of Radioactive Release Amounts Before and After the Building Cover Installation)

- The current radioactive release amount is approx. 1/100 or less compared to before the building cover installation.
  - The release amount was reduced to approx. 1/4 as a result of building cover installation.
  - The release amount was reduced to approx. 1/30 due to the “decrease in radioactive materials released as a result of continuous reactor cooling” and the “installation of PCV gas control system”.



4. Estimated Radiation Dose at Site Boundaries After the Dismantlement of the Building Cover

- The current radioactive release amount is significantly lower compared to before the building cover installation due to the “decrease in radioactive materials released as a result of continuous reactor cooling” and the “PCV gas control system in operation”.
- Though the radiation dose at site boundaries is estimated to increase after the building cover dismantlement, there will be little impact on the radiation dose at site boundaries attributable to the radioactive materials released from Units 1-3 (0.03mSv/year) considering that measures to prevent radioactive release will be implemented (see page 7 and later).

Condition of Unit 1	Radiation dose at site boundaries attributable to the radioactive release from Unit 1	Radiation dose at site boundaries attributable to the radioactive release from Units 1-3
Before the building cover installation (October 2011)	Approx. 0.1mSv/year	Approx. 0.2mSv/year
Before the building cover dismantlement (average in FY 2012)	Approx. 0.0006mSv/year	Approx. 0.03mSv/year
After the building cover dismantlement (estimate)	Approx. 0.001mSv/year*	Approx. 0.03mSv/year

After the building cover is removed, the radioactive release amount at Unit 1 is estimated to be equivalent to that at Unit 3 where debris removal is ongoing to prepare for the cover installation for fuel removal. Due to this, the release amount at Unit 1 may fluctuate by one digit compared to that at Unit 3 (*0.0001-0.001-0.01mSv/year).

5. Radiation Doses in the Surrounding Area

- The radiation doses attributable to the radioactive release from Unit 1 after the building cover dismantlement are estimated as follows.
  Exposure dose at 5km from Fukushima Daiichi NPS: Approx. 0.0001mSv/year (Approx. 0.00002 μSv/h)
  Exposure dose at 10km from Fukushima Daiichi NPS: Approx. 0.00005mSv/year (Approx. 0.000006 μSv/h)
- Based on the above, the building cover dismantlement is considered to have little impact on the surrounding areas.

Location	Dose rate (μSv/h)		Location	Dose rate (μSv/h)	
	Before dismantlement*1	Before dismantlement*2		Before dismantlement*1	Before dismantlement*2
Fukushima Prefectural Office (Momijiyama Park)	0.622	Same as the left	Hirono Town Government Office	0.138	Same as the left
Koriyama City Hall	0.383		Iitate Village Government Office	0.749	
Iwaki City Hall	0.140		Katsurao Village Government Office	0.280	
Okuma Town Government Office (Ono)	3.542		Minamisoma City Hall	0.284	
Futaba Town Government Office (Shinzan gymnasium)	4.410		Tamura City Hall (Funehiki day-care center)	0.104	
Tomioka Town Government Office (Tomioka)	2.600		Kawauchi Village Government Office	0.101	
Naraha Town Government Office	0.198		Kawamata Town Government Office	0.205	
Namie Town Government Office	0.138		Aizuwakamatsu City Hall	0.100	

*1 As of 12:00 AM on May 1, 2013 (Source: Nuclear Regulation Authority website)
*2 Estimate

6. Measures to Prevent Radioactive Release (1)

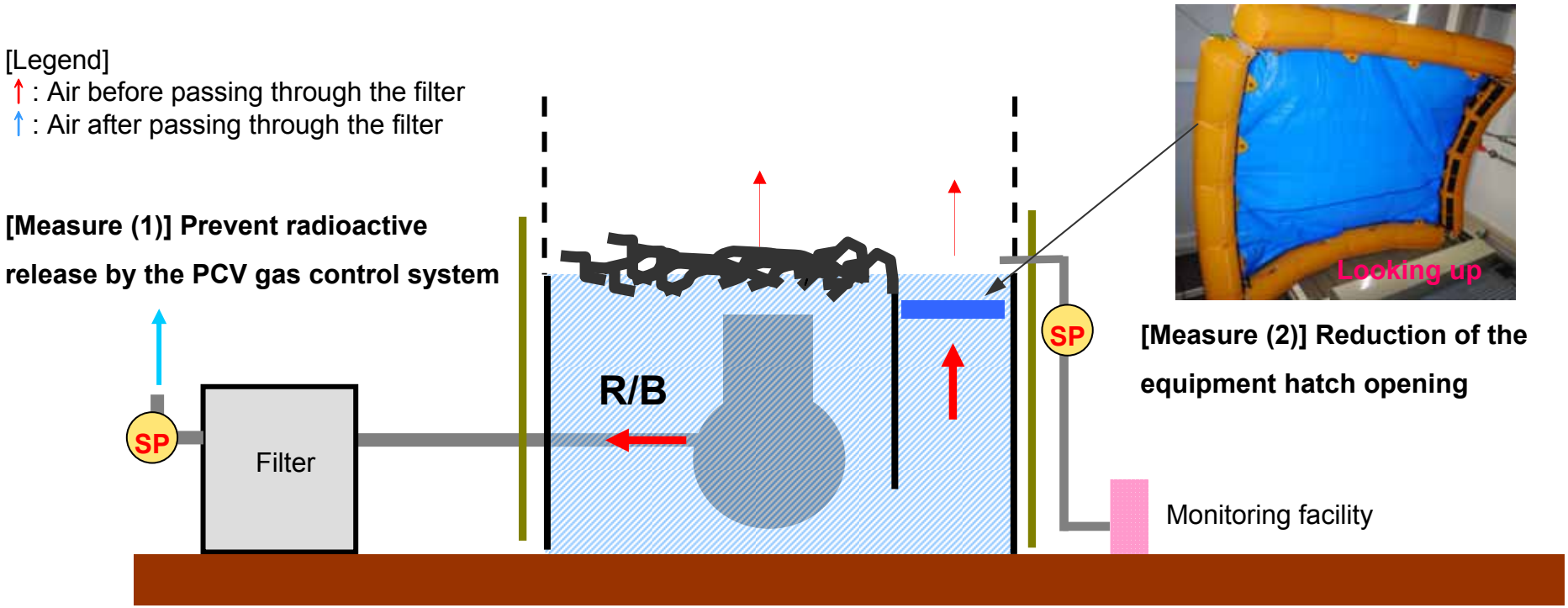
[Measure to prevent radioactive release continuously implemented]

Radioactive release is continuously prevented by the PCV gas control system in operation.

[Measure (1)]

[Measure to prevent radioactive release from the Reactor Building (Newly implemented)]

Radioactive release is mitigated through reducing the opening in the Reactor Building. [Measure (2)]



Structure overview

6. Measures to Prevent Radioactive Release (2)

[Monitoring of radioactivity density]

The monitoring facility on the building cover has been partially relocated* to continuously monitor the radioactivity density (except for the relocation period). [Measure (3)]

[Measure to prevent radioactive release during debris removal]

During debris removal, anti-scattering agent will be sprayed onto the building to prevent radioactive release (similarly to other units). [Measure (4)]

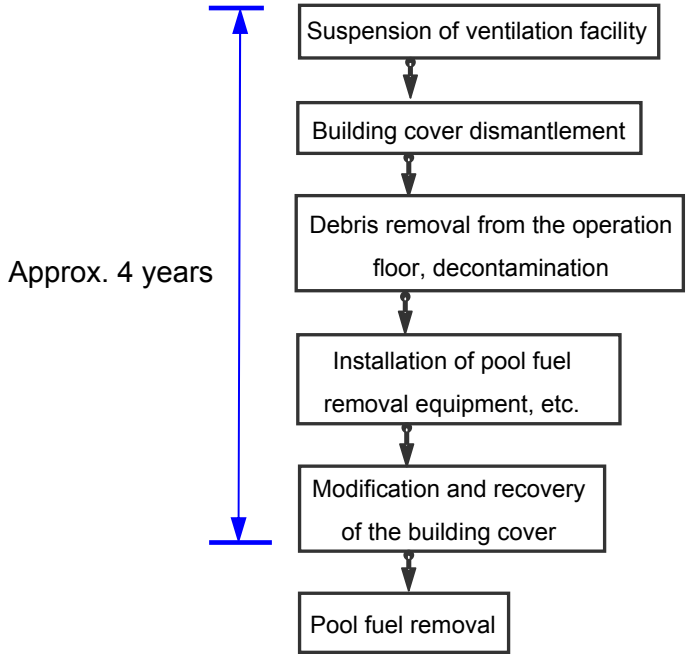
[Measure (4)] Spraying anti scattering agent

Structure overview

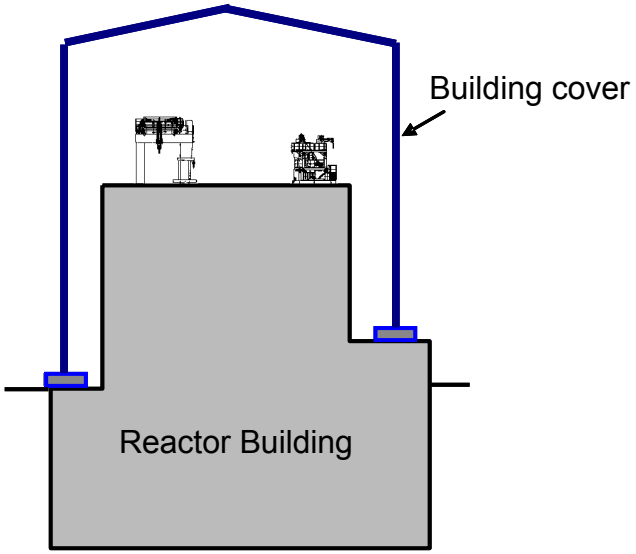
*The relocation of the monitoring facility is being discussed in detail.

7. Summary

- The building cover will be dismantled for debris removal from the operation floor.
  - Radioactive release is continuously prevented by the PCV gas control system.
  - The monitoring facility on the building cover has been partially relocated to continuously monitor the radioactivity density (except for the relocation period).
  - Radioactive release is mitigated through reducing the opening in the Reactor Building.
  - During debris removal, anti-scattering agent will be sprayed onto the building to prevent radioactive release.
- In prior to the building cover dismantlement, the ventilation facility is planned to be suspended around mid FY 2013.
  - The building cover dismantlement is planned to be started 3 to 5 months after the suspension of the ventilation facility (The ventilation facility will be relocated after being suspended. The building cover dismantlement is planned to be started after the land development is completed to allow for access of the large heavy machinery used for dismantling).
- After the installation of pool fuel removal equipment, the building cover will be recovered in about 4 years.



Pool fuel removal procedure



Simulated image of recovered building cover*

*The plan of building cover modification is being discussed in detail.

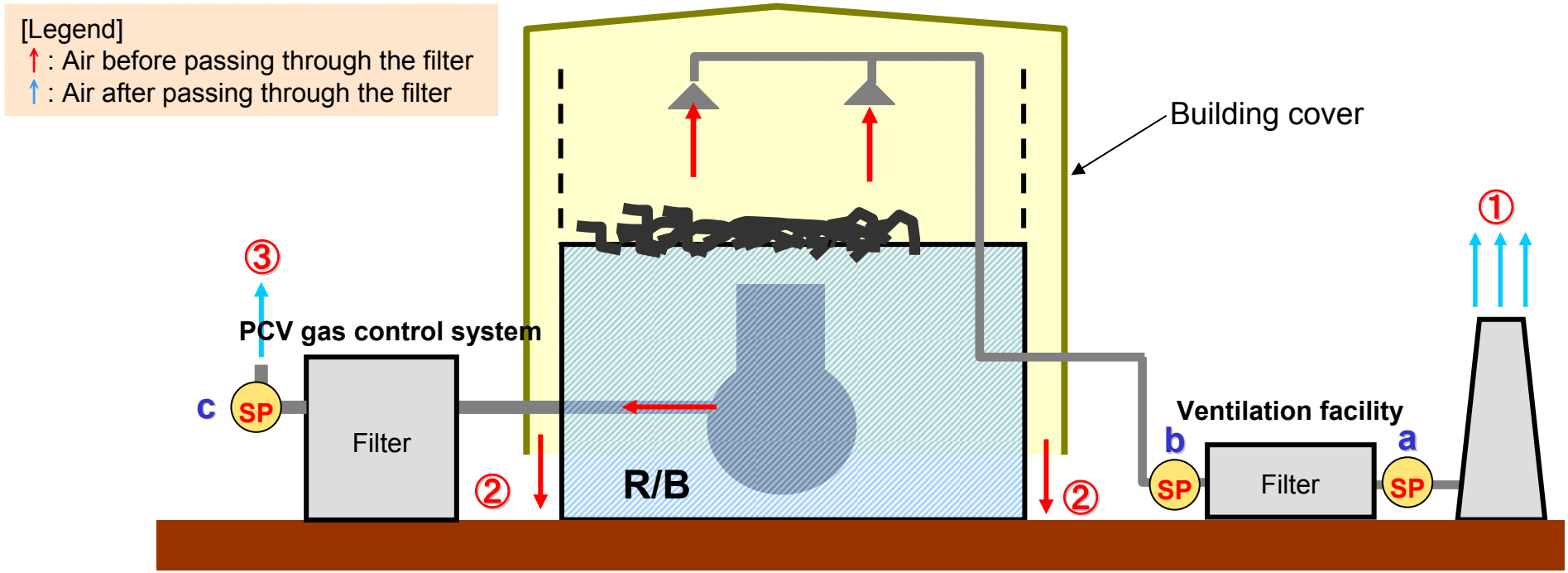
(Reference) Current Process of Radioactive Release and Evaluation Method

- The radioactive release amounts evaluated for each location (①–③) are summed up.
- The radioactivity densities at the sampling points (SP) (a-c) are used for evaluation.
- The evaluation locations and the densities used for evaluation are as follows.

① Exhaust air from the cover system filter outlet: Radioactivity density at the outlet [a] x flow rate (approx. 40000m^3/h)

② Leakage from the cover openings: Radioactivity density inside the cover [b] x leakage amount

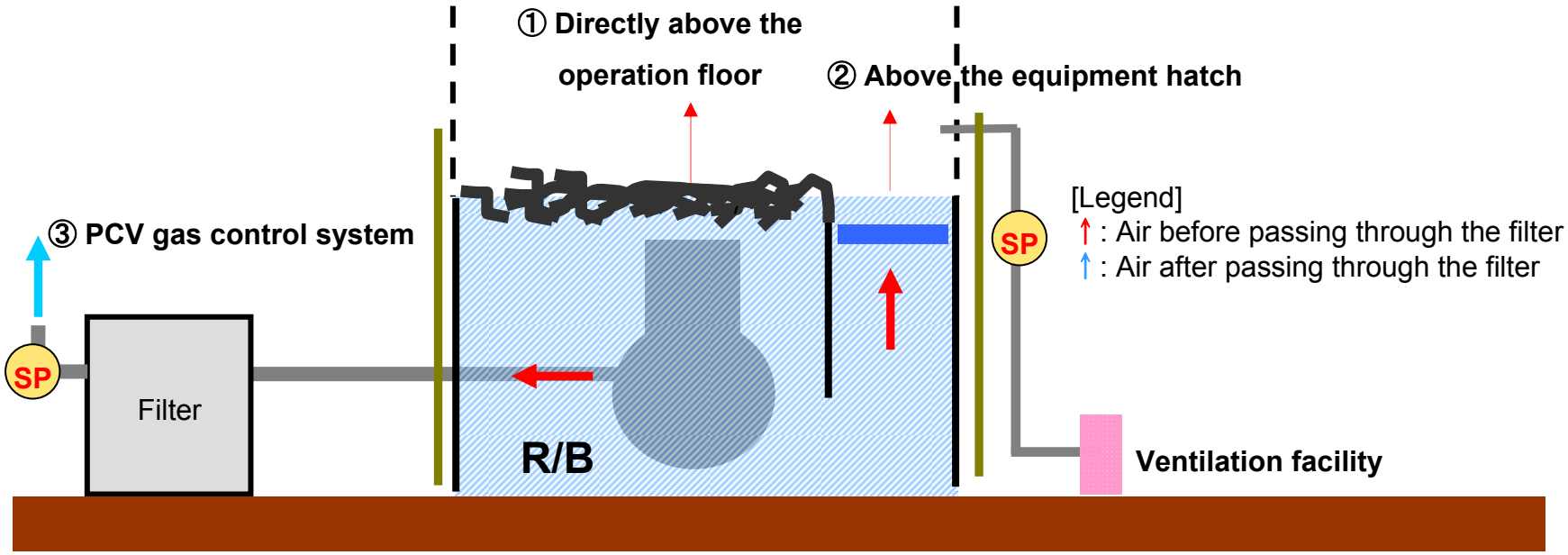
③ Exhaust air from the PCV gas control system outlet: Radioactivity density at the outlet [c] x flow rate (28m^3/h)



Structure overview

(Reference) Process of Radioactive Release and Evaluation Method After the Building Cover Dismantlement

- After the building cover dismantlement
  - The following 3 paths of radioactive release will be evaluated similarly to Unit 3.
    - ①Directly above the operation floor: Radioactivity density of the dust directly above the operation floor x amount of steam generated
    - ②Above the equipment hatch: Radioactivity density of the dust above the equipment hatch x air volume in the equipment hatch
    - ③PCV gas control system: Radioactivity density at the outlet x flow rate: remains the same as before the building cover dismantlement



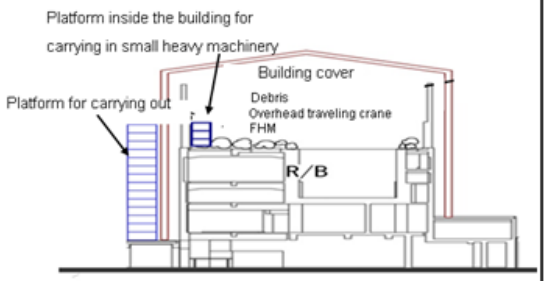
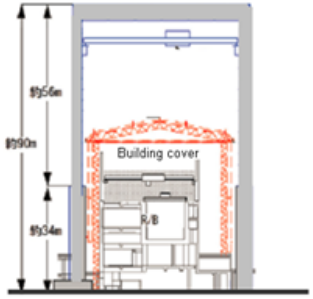
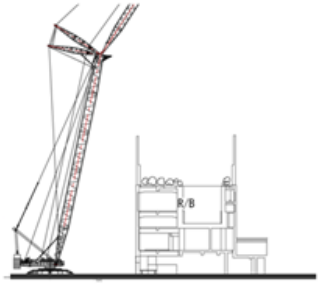
Structure overview

(Reference) Comparison of Debris Removal Methods

[Comparison of debris removal methods]

1. Debris removal inside the building cover
2. Building cover dismantlement and debris removal performed in the container installed outside of the building cover
3. Debris removal after the building cover is dismantled

Overview of debris removal methods for Unit 1 at Fukushima Daiichi Nuclear Power Station (Draft)

	Method 1 (Debris removal inside the building cover)	Method 2 (Debris removal inside the container)	Method 3 (Debris removal after the building cover is dismantled)
Simulated image of the building			
Overview of debris removal procedure	The following procedure is implemented via remote-control operation. 1. Construct a platform in the north side of the building cover. 2. Carry in small heavy machinery from the shutter opening in the north side.	1. Install a container. 2. Dismantle the building cover (by utilizing the overhead traveling crane inside the container). 3. Remove the debris on the operation floor, the overhead traveling crane and the FHM (by utilizing the overhead traveling crane inside the container).	1. Dismantle the building cover. 2. Remove the debris on the operation floor by utilizing a large crane and small heavy machinery.

(Reference) Evaluation of Debris Removal Methods

[Evaluation of debris removal methods]

1. Technically infeasible in terms of safety
2. Pool fuel removal will be significantly delayed (more than 5 years) due to the large-scale container construction and technical/constructional challenges.
3. Debris removal can be implemented at the earliest timing though the radioactive release mitigation is not as effective as the methods above.

		Method 1 (Debris removal inside the building cover)	Method 2 (Debris removal inside the container)	Method 3 (Debris removal after the building cover is dismantled)
Evaluation	Radioacvie release amount compared to current	Good: No change	Good: No change	OK: Though an additional radioactive release to the atmosphere is expected due to the building cover dismantlement, there will be little impact on the radiation dose at site boundaries.
	Effectiveness of radioactive release mitigation during debris removal	Good: Effective	Good: Effective	OK: Though radioactive debris, etc. will be scattered via wind/rain due to the building cover dismantlement, no significant change was found with the radioactive release amount during debris removal performed at other unit. The radioactive release amount will be continuously monitored utilizing the monitoring system installed on the building cover.
	Technical feasibility	Not good: Difficult to avoid the risk of debris falling into the pool as protection cannot be installed over the pool before starting debris removal. Safety cannot be secured during work implemented via remote control operation with debris being scattered.	OK: Though the method may be technically feasible, the container building surrounding the building cover being about 90m tall causes technical and constructional challenges such as difficulty to ensure seismic safety and large-scale container construction under high radiation dose.	Good: Technically feasible
	Timing of pool fuel removal	N/A: Technically infeasible	Not good: The third phase (pool fuel removal will be significantly delayed (more than 5 years))	Good: The second phase
	Overall evaluation	N/A: Technically infeasible	OK	Good