<Reference>

National Project ‘Development of a Remote Controllable Decontamination Technique inside the Reactor Buildings’

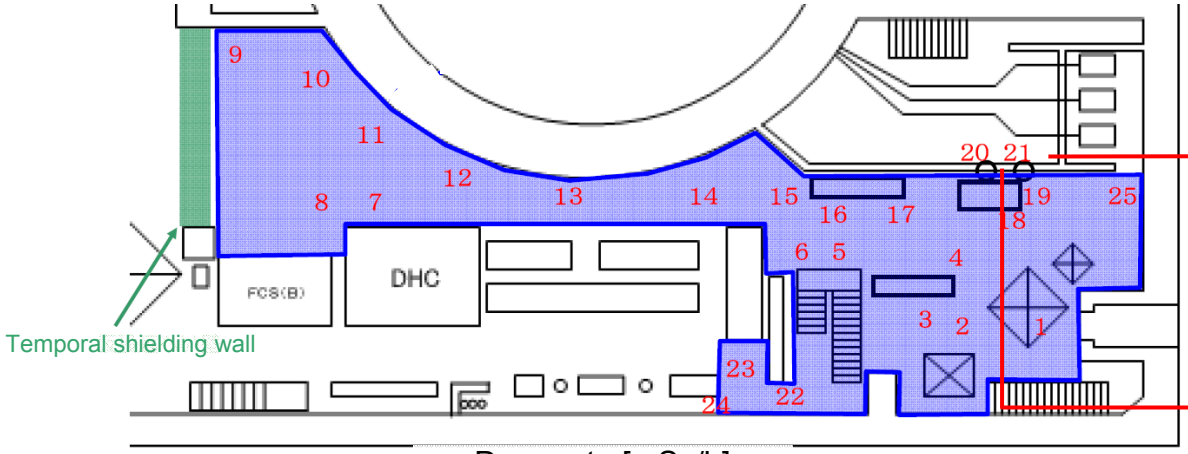
Investigation into Contamination Status in the South on the First Floor of the Unit 1 Reactor Building

December 18, 2013
Tokyo Electric Power Company

TEPCO 東京電力

1. Results of the previous investigations in the south on the first floor of the Unit 1 reactor building

- We conducted three investigations (June and October in 2011, and July 2012), obtained the data of radiation dose, and found the steam spouting from the torus room. (maximum 5,150mSv/h)
- In order to describe a more detailed plan for lowering dose, it is necessary to find the distribution of radiation dose and the dose data through the investigation with γ camera. Also, it is necessary to conduct a coring in order to determine if the penetration of contamination is present, for the steam blast was found in this area.



Penetration-part on the floor
(where a steam blast from the torus was found at first by the accident)

Equipment funnel

Dose rate [mSv/h]

Point	1	2	3	4	5	6	7	8	9	10	11	12	13
150cm*1	254	321	132	1900	881	290							
15cm*1	238	251	77	840	406	254	93*2	55*2	34*2	40*2	102*2	132*2	57*2
Point	14	15	16	17	18	19	20	21	22	23	24	25	
150cm*1		1110	1620	1050	345	538						130*3	
15cm*1	109*2	528	777	520	311	474	2070*4	5150*5	85*2	96*2	168*2		

*1: Above the floor *2: Approx. 60cm above the floor *3: Approx. 106cm above the floor *4 Above funnel *5 Above the penetration part on the floor

Figure 1. Results of investigation (July, 2012)

In the previous investigation, we measured the radiation dose at the height of 15 and 150 cm above the floor. We will measure at the height of 5 and 150 cm above the floor, and will take photos with γ camera.

2. Investigation area

- Dose rate will be measured at every 3-meter point at the height of 5 and 150 cm (represented as ・ at Figure 2) in the south on the first floor. We will take photos with γ camera at the four points (represented as × at Figure 2)
- At each point. we will take photos from all directions with γ camera with various angles of elevation and rotation.

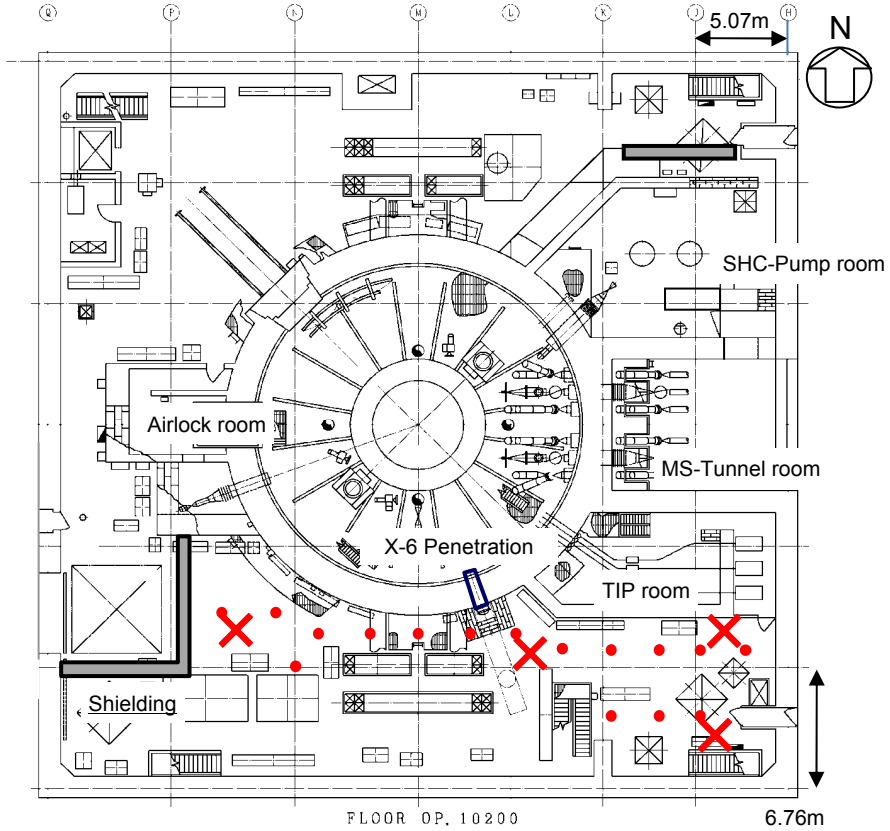


Figure 2. Investigation area (plan)

3. Structure of investigation apparatuses

- Robots and γ camera will be remote-controlled in the main anti-earthquake building via the network in Fukushima Daiichi NPS.
- The measuring robot (Warrior) will be equipped with dosimeters (at the height of 5 and 150cm above the floor) and γ camera. The relay robot will be used to support the travel and measure of the measuring robot (Packbot).
- Pan tilt machine will be installed under the γ camera in order to adjust the angle of elevation.

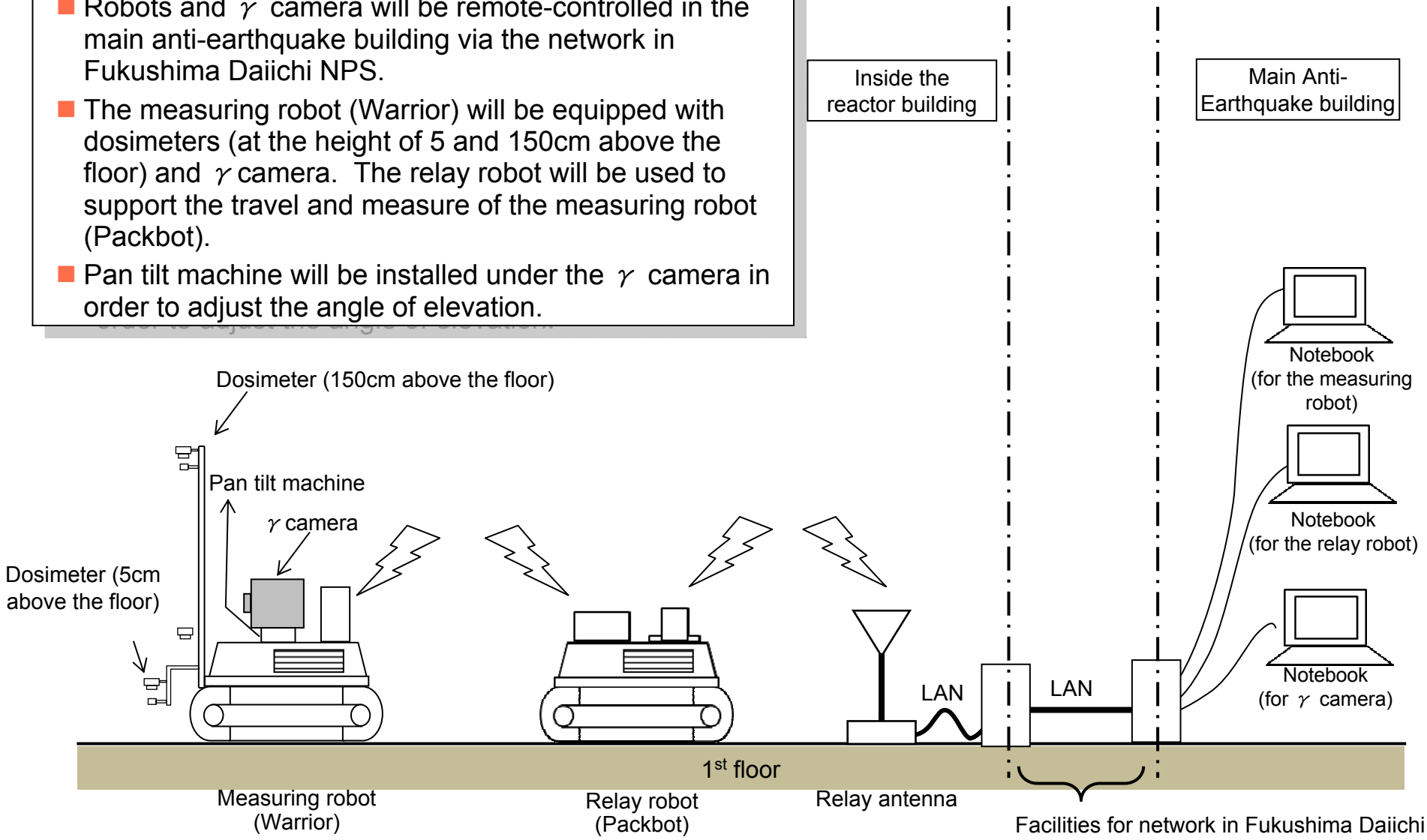


Figure 3. Structure of investigation apparatuses

4. Specifications of investigation apparatuses

- Specifications

Measuring robot: Warrior (made by i-Robot)
Weight: 222kg
Length: 889 mm　Width: 768 mm　Height: 438 mm
Operating time: 3 to 4 hours (with battery)
Traveling velocity: Max. 12.9km/h

Relay robot: Packbot (made by i-Robot)
Weight：Approx. 30kg
Length: 700 mm　Width: 530 mm　Height: 190 mm
Operating time: Approx. 8 hours (with battery)
Travelling velocity: Maxim 9.36km/h

Figure 4. Warrior

Figure 5. Packbot

5. Specifications of the γ camera

- A γ camera was developed by Hitachi Ltd. in the 'research and development project of unmanned system for disaster handling' of New Energy and Industrial Technology Development Organization (NEDO).
- Specification of the camera

Size: 340mm×430mm×467mm
Weight: Approx. 80kg
Measurable background dose rate (design point): 300mSv/h
Detector: CdTe semiconductor detector (16 pixel×16 pixel)
Distance correction function: Distance correction per pixel

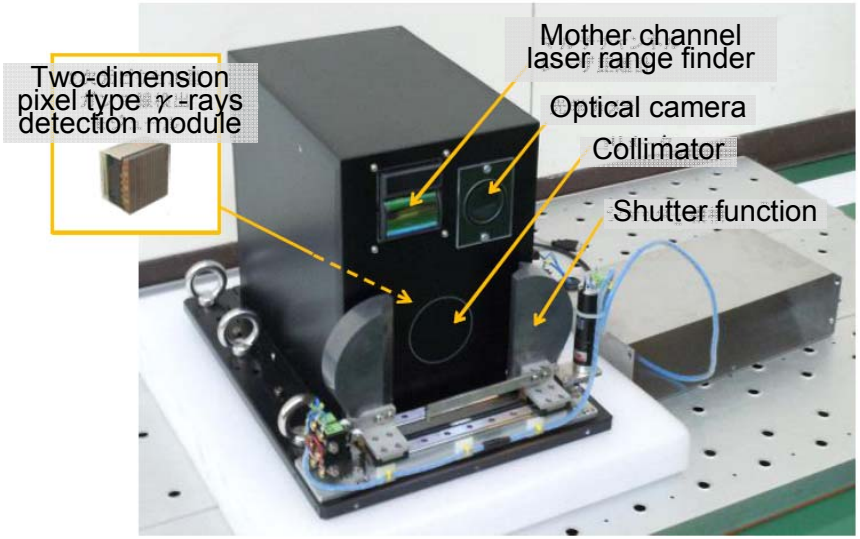


Figure 6. γ camera

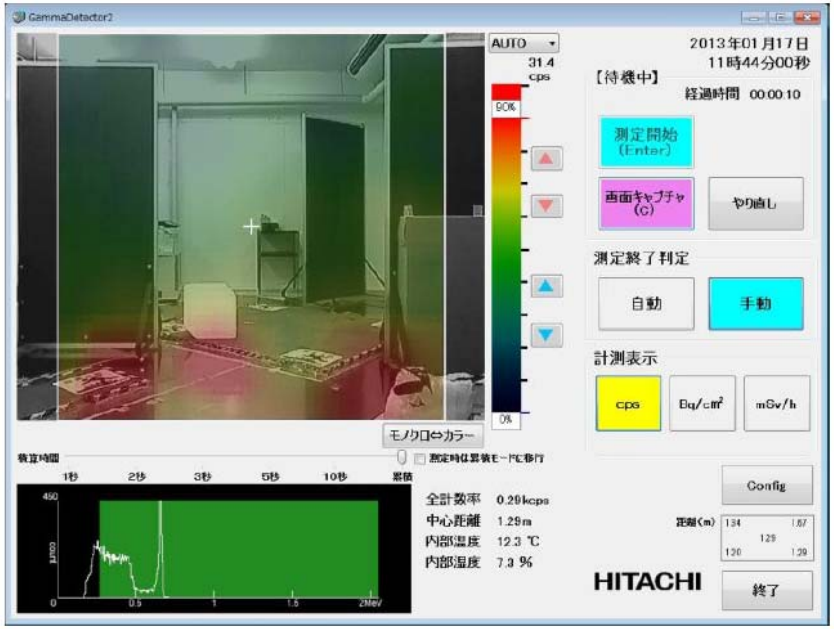


Figure 7. Operation screen of γ camera

6. Schedule

Table 1. Investigation schedule (plan)

Investigation area	Dec., 2013														Jan., 2014			Feb., 2014			Mar., 2014		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Early	Mid.	End	Early	Mid.	End	Early	Mid.	End
Investigation in the south (dose rate and γ camera)	Preparation work Investigation and tidying-up																							
Coring samples in the south																								
Forming a plan for lowering dose (including data assessment)																								
Work for lowering dose									Starting in the second half of FY2014															

[Reference] Needs for investigation in the south side on the first floor at Unit 1 reactor building

- In the south side on the first floor, investigations inside the primary containment vessel (PCV) (investigation inside the pedestal via the penetration X-6), investigation and repair work at PCV are planned in the second half in FY2015, requiring to form a decontamination plan.
- Specifying radiation dose via γ camera is necessary, in order to form a plan, in addition to measuring the dose rate.

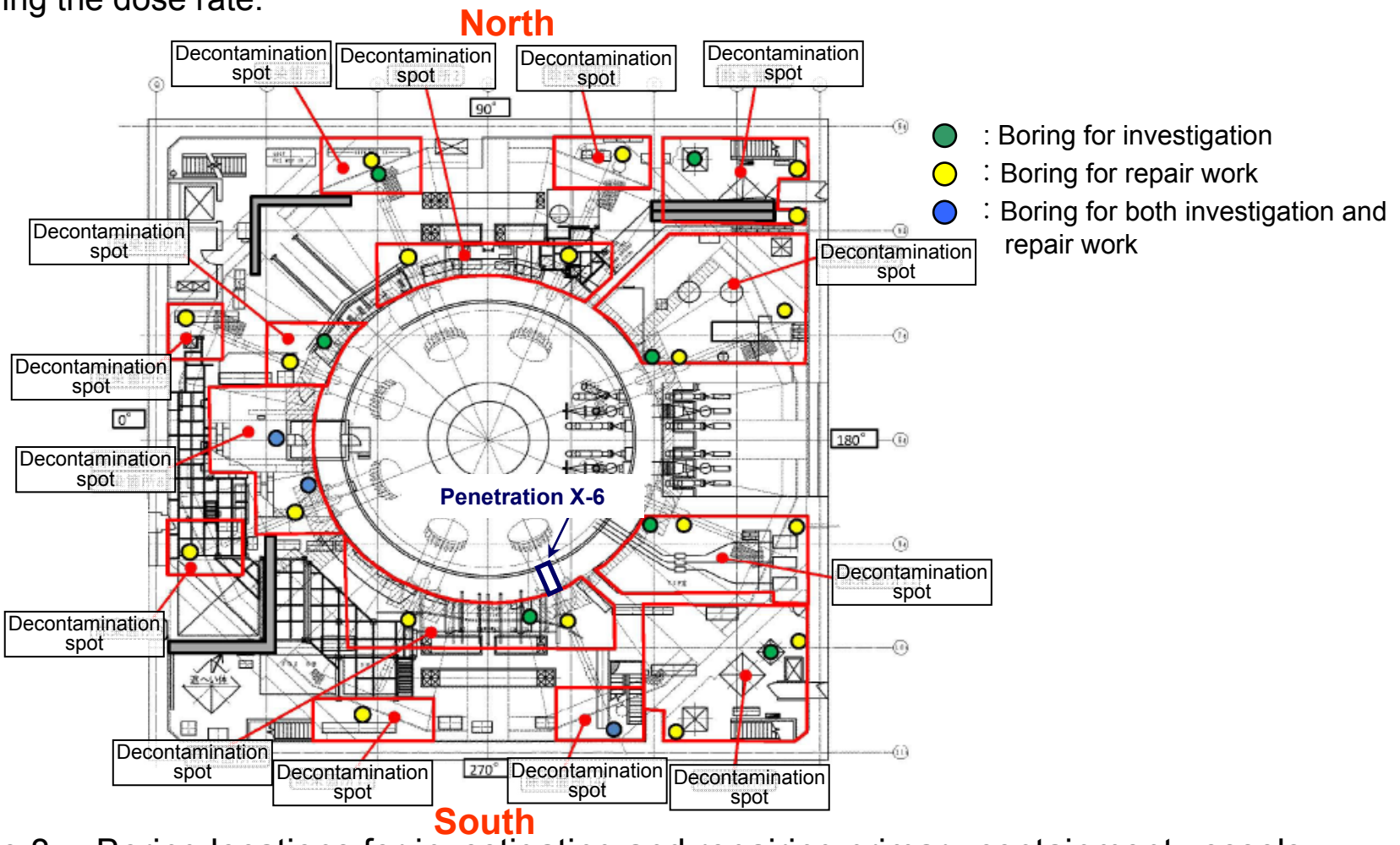


Figure 8. Boring locations for investigating and repairing primary containment vessels

[Reference] Coring method

The remote operated vehicle (ROV), 'MEISTeR' developed by Mitsubishi Heavy Industry has two arms: one arm equipped with core boring device and the other equipped with a chisel to cut core off
All the equipments run by electricity, therefore there is no danger of oil leak

Figure 9. Traveling on stairs

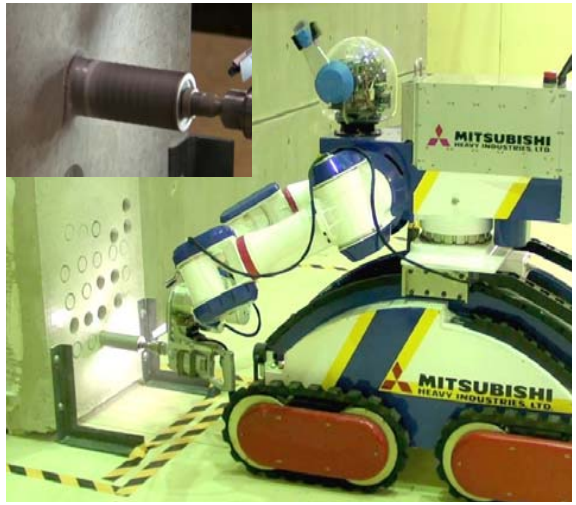


Figure 10. Boring core

- Vehicle size: Length1250mm, Width700mm, Height1300mm
- Weight：Approx. 550kg (Vehicle:480kg, Core boring device: 70kg)
- Automatic following-tracking independent 4 crawlers (for travelling on ground) enable the vehicle to travel on stairs or rough/uneven ground with ease.
  (However, the corridors inside the reactor building are too narrow for the vehicle to travel.)
- The vehicle automatically measures its center of gravity so that the upper equipments can be held at the right point. (Figure 9)
- The vehicle's two arms with seven axes enable the vehicle to do work such as core boring etc. (Figure 10)

National Project ‘Development for a remote controllable decontamination technique inside the reactor buildings’

Plan of an investigation into contamination status in the south on the first floor at Units 1, 2, and 3 reactor buildings

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1. Result of the site investigation in FY2012

- First floors at Units 1 to 3 reactor buildings (max. dose rate, up to 100Sv/h) were mainly investigated in a national project in FY2012. The result is as follows.
- Contribution rate for the dose rate at the height of 150cm from the floor ground from each contamination source (floor surface, wall, ceiling, hot spot, and others, mainly upper structure) was as follows:
    1. Contribution rate from the floor surface: 10 to 40%
    2. Contribution rate from the wall and ceiling: 5 to 15%
    3. Contribution rate from the hot spot: 10 to 40%
    4. Contribution rate from others mainly upper structure: 30 to 70%

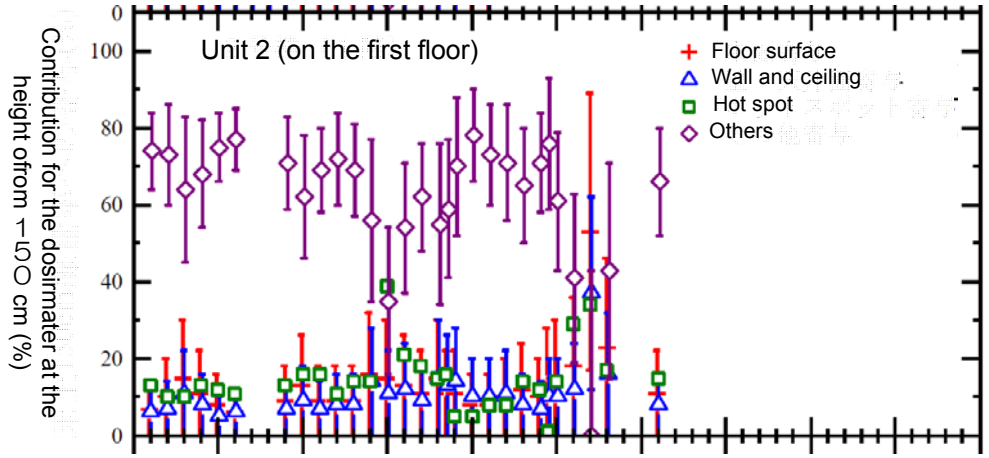


Figure 1. Contribution rate to the height of 150cm from the floor surface (on the first floor at Unit 2 reactor building

- Contaminating nuclides are Cs134 and Cs137, and the existing ratio is 2 to 3 (after adjusting to the accident period, 1 to 1). Both are estimated originated in the accident. No α nuclide was found.
- Contamination remains at minute damages on the epoxy-painted surface. There was no penetrating contamination.

2. Objectives and areas of the investigation

■Objectives

We aim to collect input data to accelerate the discussion on the dose reduction plan at the upper levels of the reactor buildings and the high dose area (the south side on the first floor of Unit 1 reactor building and the fifth floor of the Unit 2 reactor building) in cooperation with a national project ‘forming a general plan for lowering dose.’

■On-premise investigation area in FY2013

The second and third floor of Units 1 to 3 will be investigated. In addition, 1)the high dose areas on the first floor where the investigation was impossible in FY2012 and 2)the upper structures which are suspected to contribute to most of radiation dose (judging from the investigation results in FY2012) will be also investigated.

2. Objectives and areas of the investigation

Figure 1. Investigation area and item

Unit	Area and floor	Investigation item				Note
		Dose rate (Dosimeter)	Contamination distribution (γ imager)	Connative radiation source (Integral dosimeter)	Penetrating contamination (Core sampling)	
1	South side, 1st floor	○	○	—	○	- Warrior (i-Robot*1) and γ camera (NEDO) for investigation - MESITeR (Mitshubishi Heavy Industry*1) for coring
	Higher place, 1st floor	○	○	—	—	- Lifting apparatus and γ camera (NEDO) for investigation
	Whole area, 2nd floor	○	○	—	—	- Rosemary (CIT*1 *2) and N-Visage (γ imager made in UK) for investigation
	Whole area, 3rd floor	○	○	—	—	- Rosemary (CIT*1 *2) and N-Visage (γ imager made in UK) for investigation
2	Higher place, 1st floor	○	○	○	—	- Lifting apparatus and γ camera (NEDO) for investigation - Workers will attach the integral dosimeter (Quixel Badge) for connative radiation source investigation
	Whole area, 2nd floor	○	○	—	—	- Rosemary (CIT*1 *2) and N-Visage (γ imager made in UK) for investigation
	Whole area, 3rd floor	○	○	—	—	- Rosemary (CIT*1 *2) and N-Visage (γ imager made in UK) for investigation
	Whole area, 5th floor (operation floor)	○	○	—	○	- N-Visage (γ imager made in UK) for investigation - MESITeR (Mitshubishi Heavy Industry*1) for coring
3	Higher place, 1st floor	○	○	—	—	- Lifting apparatus and γ camera (NEDO) for investigation
	Whole area, 2nd floor	○	○	—	—	- Rosemary (CIT*1 *2) and N-Visage (γ imager made in UK) for investigation

*1 Remote operated vehicle *2 Chiba Institute of Technology

3. Schedule

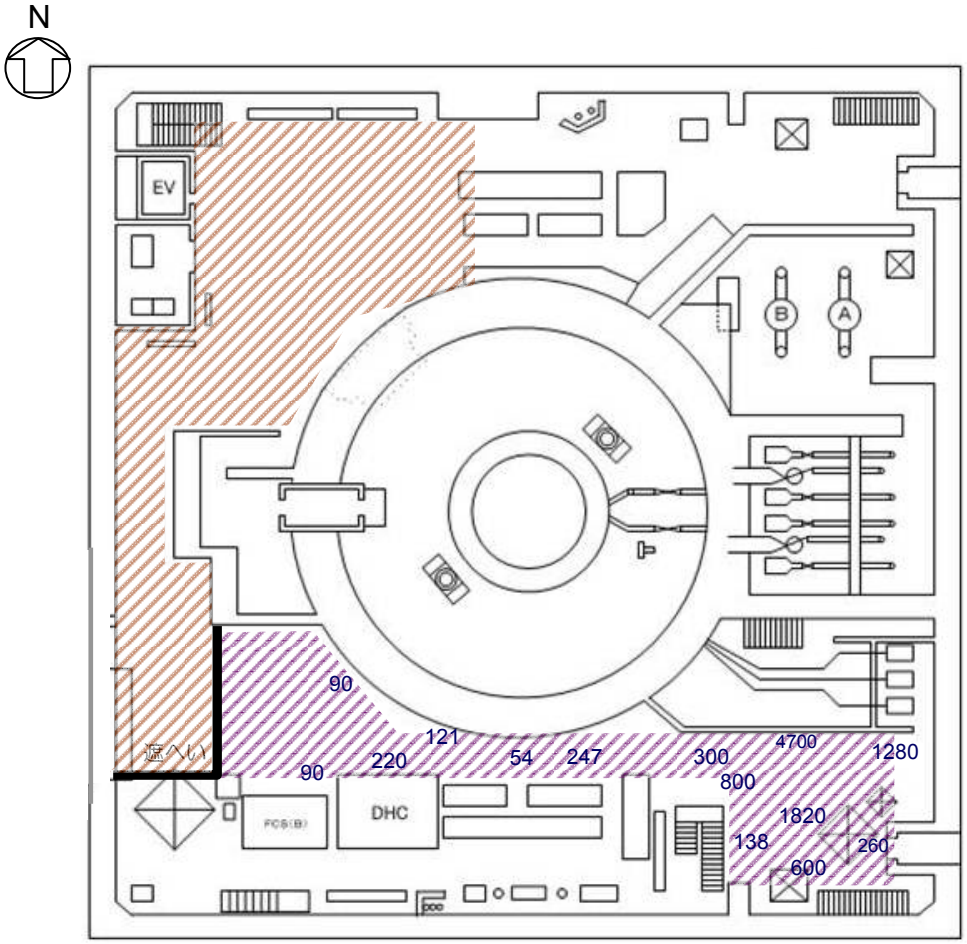
Table 2. Investigation schedule (plan)

Investigation area	Dec., 2013			Jan., 2014			Feb., 2014			Mar., 2014			Apr., 2014			How to make use of the results of dose lowering based on the investigation results
	Early	Mid.	End	Early	Mid.	End	Early	Mid.	End	Early	Mid.	End	Early	Mid.	End	
South side on the first floor at Unit 1	Dose measuring and photo shooting with γ camera (Hitachi)								Sampling cores (Mitsubishi)							Contributing to forming a decontamination plan starting in the second half of FY2014
Higher places on the first floor at Units 1, 2, and 3	Installing an integral dosimeter at upper structures (Toshiba)									Dose measuring at higher place and photo shooting with γ camera (Hitachi)						Contributing to 1)the decontamination work on the first floor at Unit 1 (from the second half of FY2014) and 2) forming a decontamination plan on the first floor at Unit 3
Second and third floors at the reactor build. at Unit 1	Dose measuring and photo shooting with γ camera (Hitachi)															Contributing to forming a decontamination plan at higher floors
Second and third floors at the reactor build. at Unit 2	Dose measuring and photo shooting with γ camera (Hitachi)															Contributing to forming a decontamination plan at higher floors
Second floor at the reactor build. at Unit 3	Dose measuring and photo shooting with γ camera (Hitachi)															Contributing to forming a decontamination plan at higher floors
Fifth floor (operation floor) at the reactor build. at Unit 2	Videotaping and dose distribution measurement (Toshiba), photo shooting with γ camera (Hitachi), core sampling (Mitsubishi)															Contributing to discussion and judgment on how to remove the fuel from Unit 2 planned in the first half of FY2014

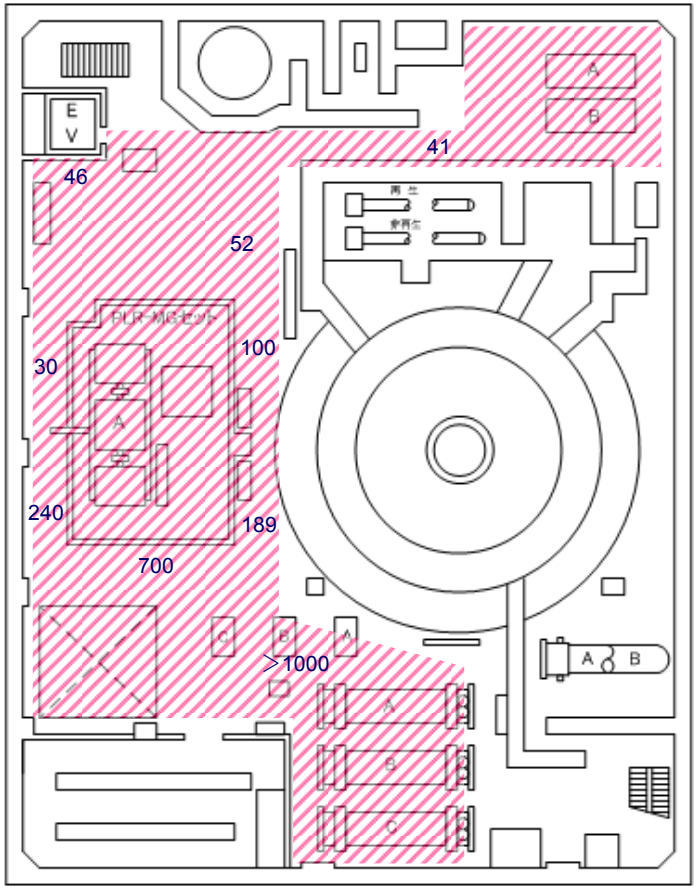
* The work schedule is subject to change due to the adjustment for the areas at the site.

■ Details of the structure of investigation apparatuses and investigation points will be reported separately before each work starts.

<Reference> Investigation area on the first and second floors at Unit 1



First floor at Unit 1



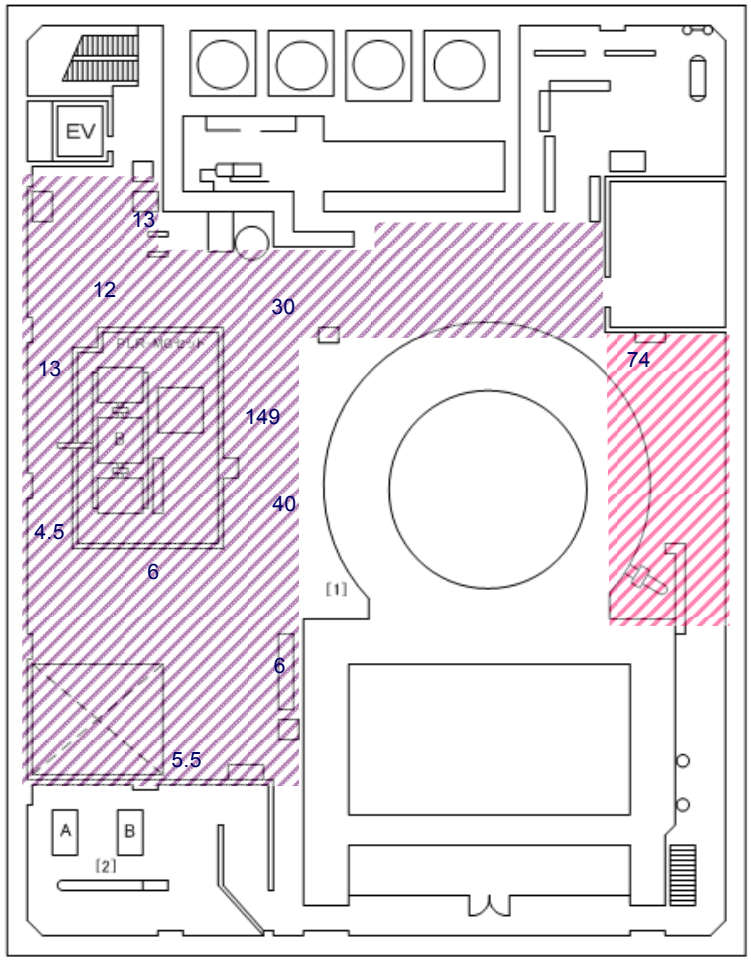
Second floor at Unit 1

：Investigation area in FY 2012 (already completed)

：Investigation area in FY2013 (excluding the investigation area for the higher place*1)

*1: Investigation area for the higher places on the first floor at Unit 1 will be confirmed based on the measurement data by 3D laser obtained after December, 2013.

<Reference> Investigation area on the third floor at Unit 1

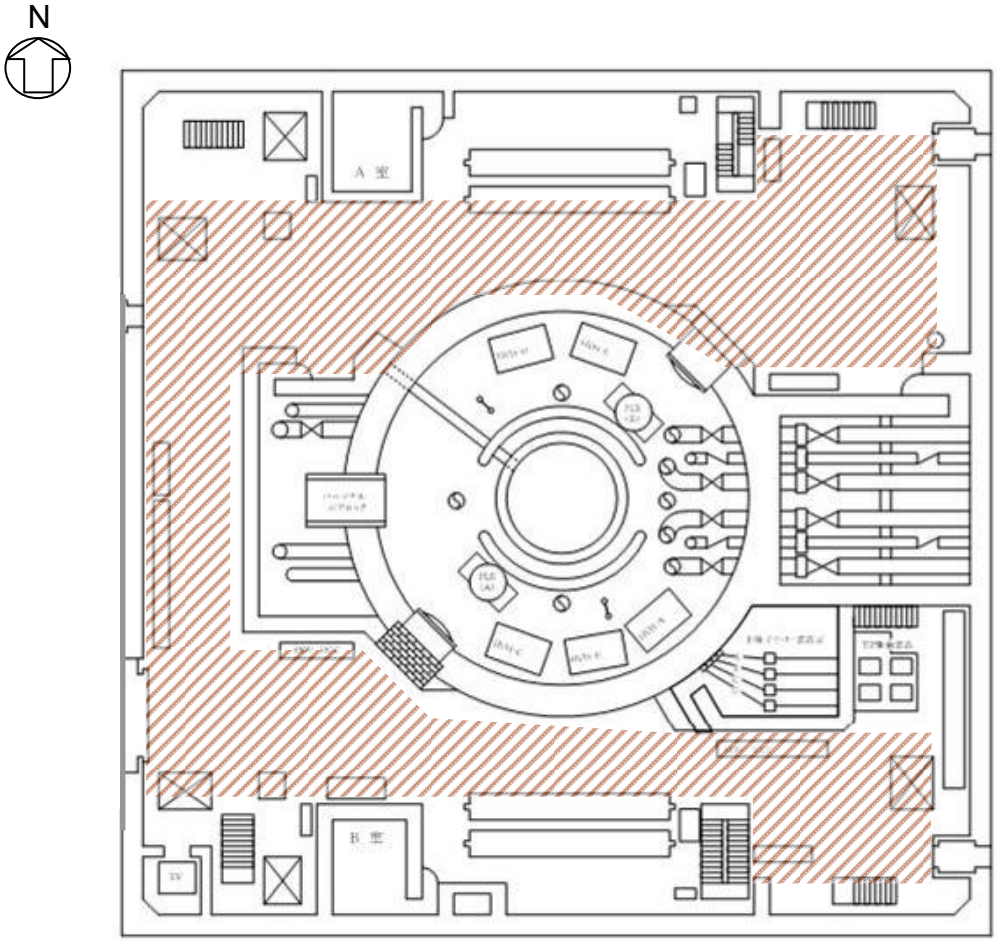


Third floor at Unit 1

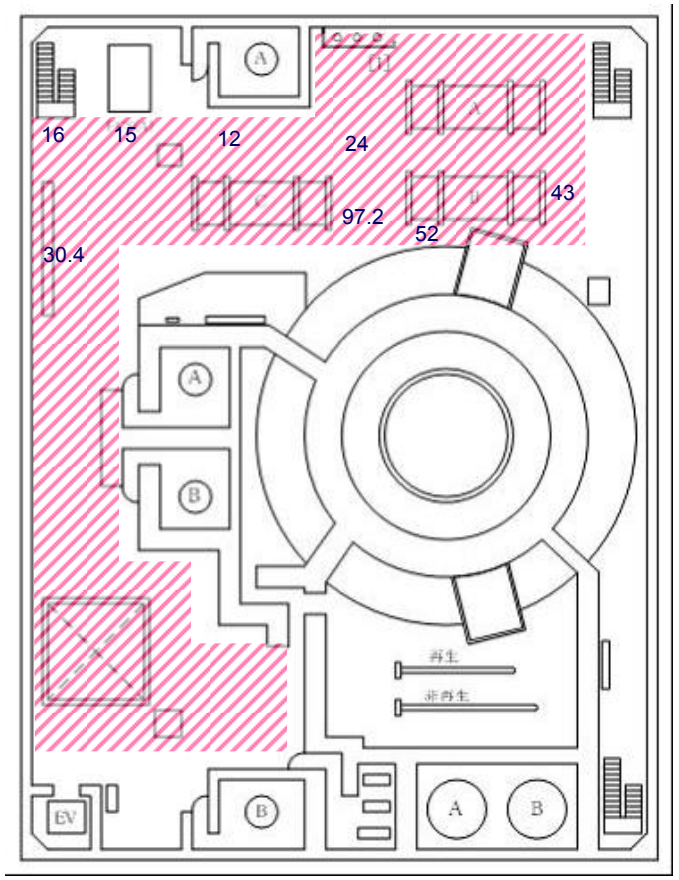
：Investigation area in FY 2012 (already completed)

：Investigation area in FY2013

<Reference> Investigation area on the first and second floors at Unit 2



First floor at Unit 2



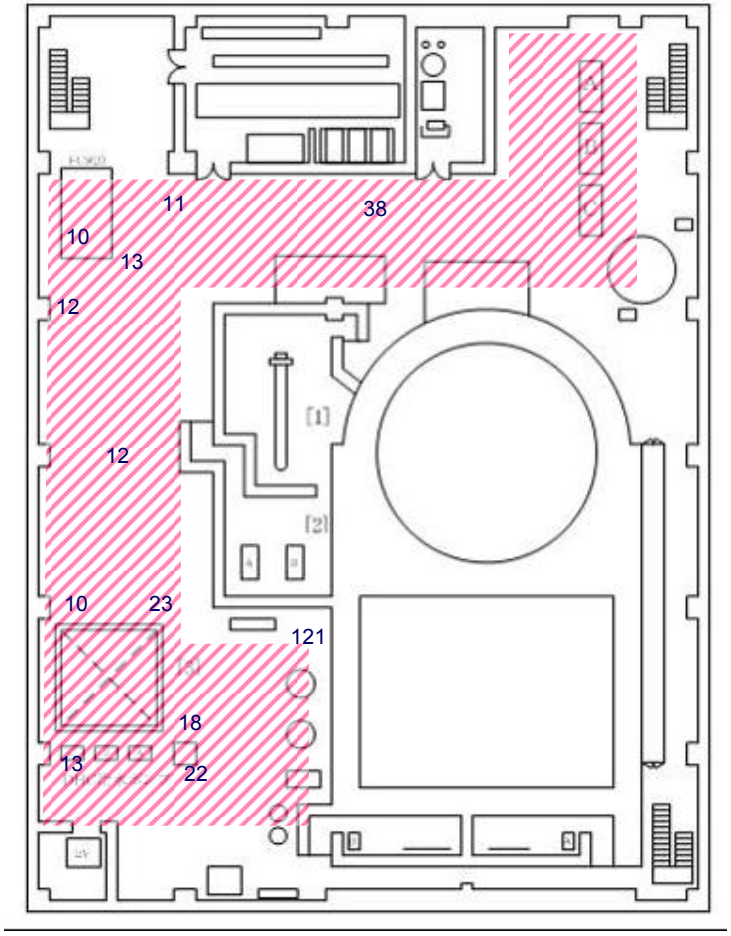
Second floor at Unit 2

：Investigation area in FY 2012 (already completed)

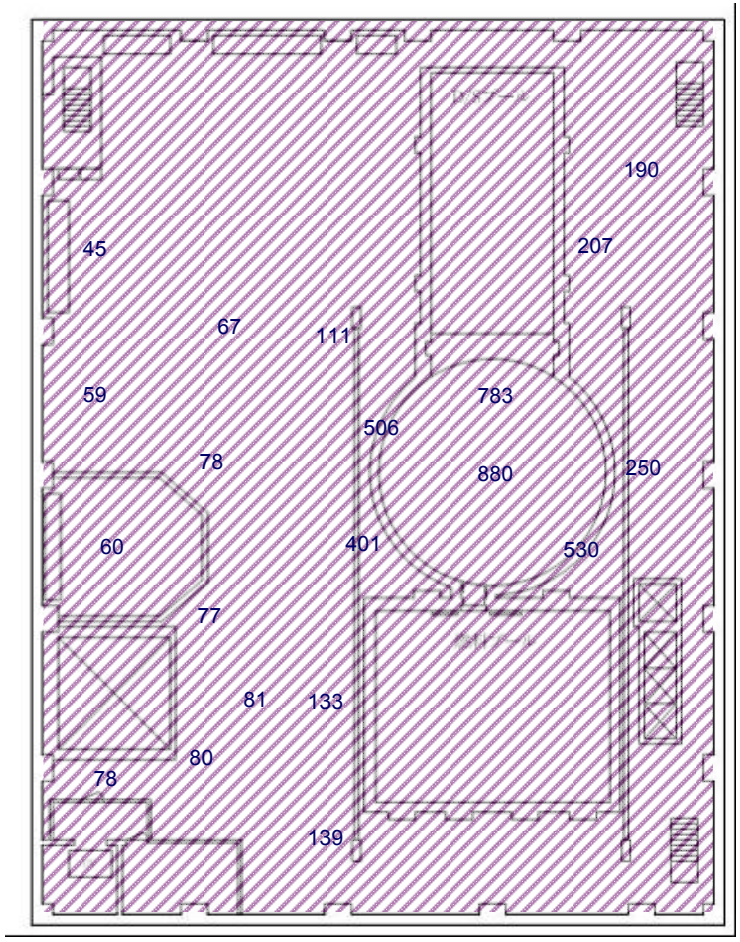
：Investigation area in FY2013 (excluding the investigation area for the higher place[*1])

*1: Investigation area for the higher places on the first floor at Unit 2 will be confirmed based on the measurement data by 3D laser obtained after December, 2013.

<Reference> Investigation area on the third and fifth floors at Unit 2



Third floor at Unit 2

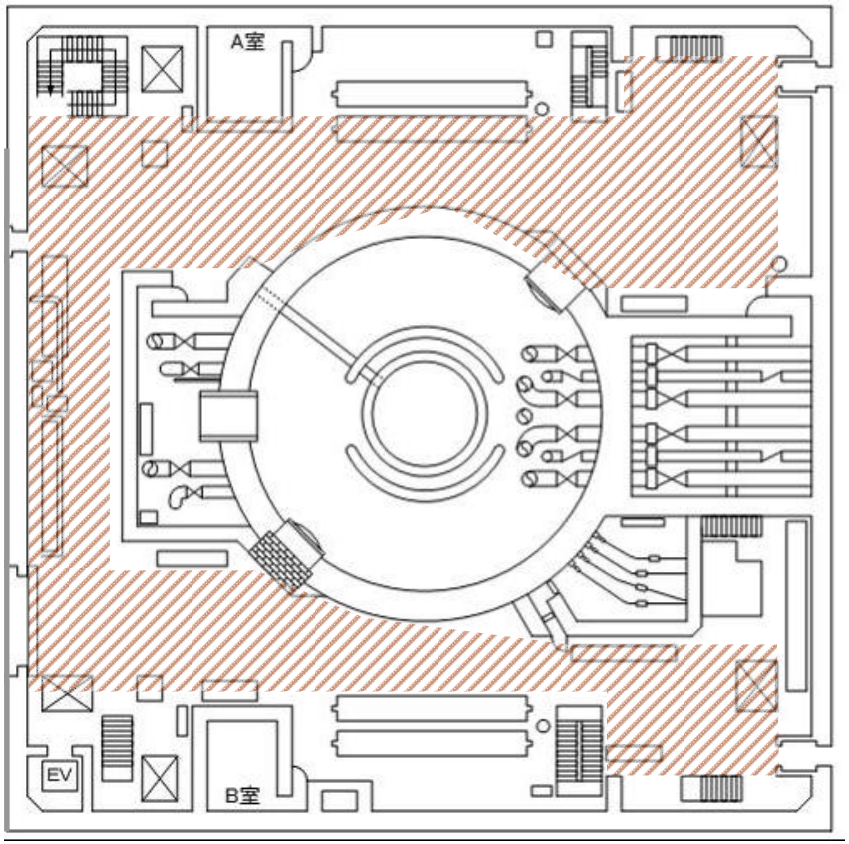


Fifth floor at Unit 2

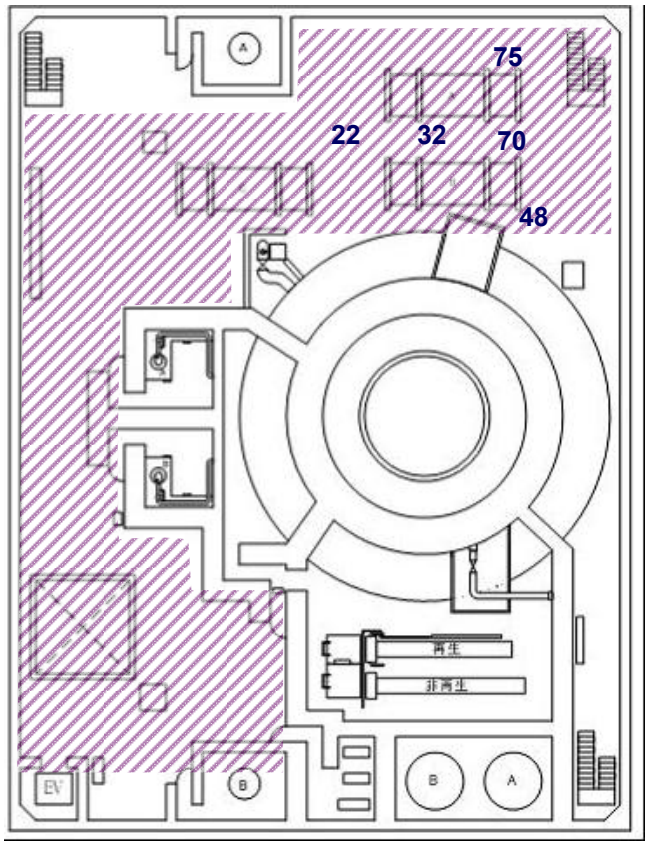
：Investigation area in FY 2012 (already completed)

：Investigation area in FY2013

<Reference> Investigation area on the second and third floors at Unit 3



First floor at Unit 3



Second floor at Unit 3

：Investigation area in FY2012 (already completed)

：Investigation area in FY2013 (excluding the investigation area for the higher place*1)

*1: Investigation area for the higher places at Unit 3 will be confirmed based on the measurement data by 3D laser obtained after February, 2014