

New radiological control of areas in Fukushima Daiichi NPS

*Tokyo Electric Power Company Holdings ,Inc,
Fukushima Daiichi NPS*

Radiation Protection Department

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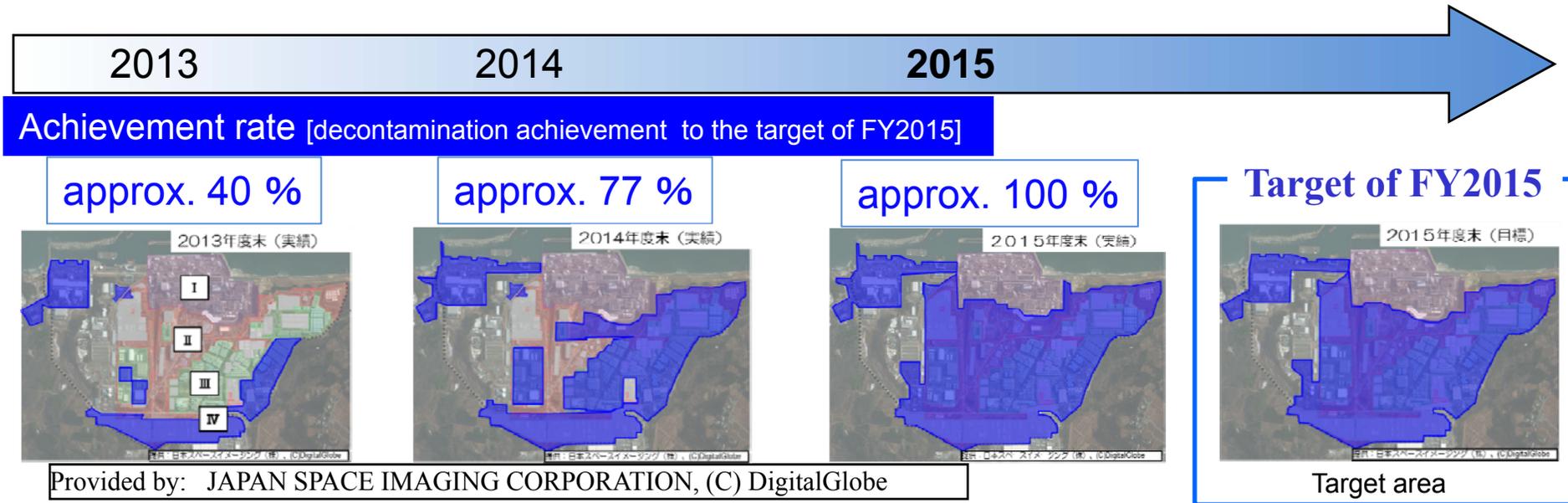
1. Objectives and Overview

Fukushima Daiichi Nuclear Power Station (1F) was hit by the big earthquake and tsunami, which caused the station black out and subsequent loss of cooling functions for reactor and spent fuel pools (SFPs). Consequently the fuels were damaged, hydrogen explosion blew off top of the reactor buildings and radioactive materials were released to the atmosphere and the ocean. It caused soil contamination at 1F site areas, so we had to wear coveralls and full-face masks when leaving the seismic isolated building to engage in work.

We have decontaminated the 1F site areas through asphalt paving, surface soil stripping, soil flipping, etc.

In order to keep the decontaminated area of 1F site clean and reduce the protective gear burden on workers (coveralls → normal work clothes), the spreading of contamination from highly contaminated areas, such as inside the Unit 1-4 buildings and the tank dismantling area must be prevented.

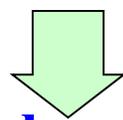
2. History of dose reduction (Decontamination)



- Area I Areas in the vicinity of Units 1-4 where radiation dose equivalent rates are particularly high
 - Area II Planting areas and areas with remaining woods
 - Area III Areas where facilities are installed or are to be installed in the future
 - Area IV Already paved areas, such as streets and parking lots
- Scope of the implementation policy for reducing on-site dose

* Areas with about 5 $\mu\text{Sv/h}$ are marked with

The target dose rate is set to **average of 5 $\mu\text{Sv/h}$** , and the dose rate is **evaluated at chest position**.
Evaluation of dose rates at ground surface level using collimator **is used concurrently** for **locations that are affected by direct rays** from the plant.



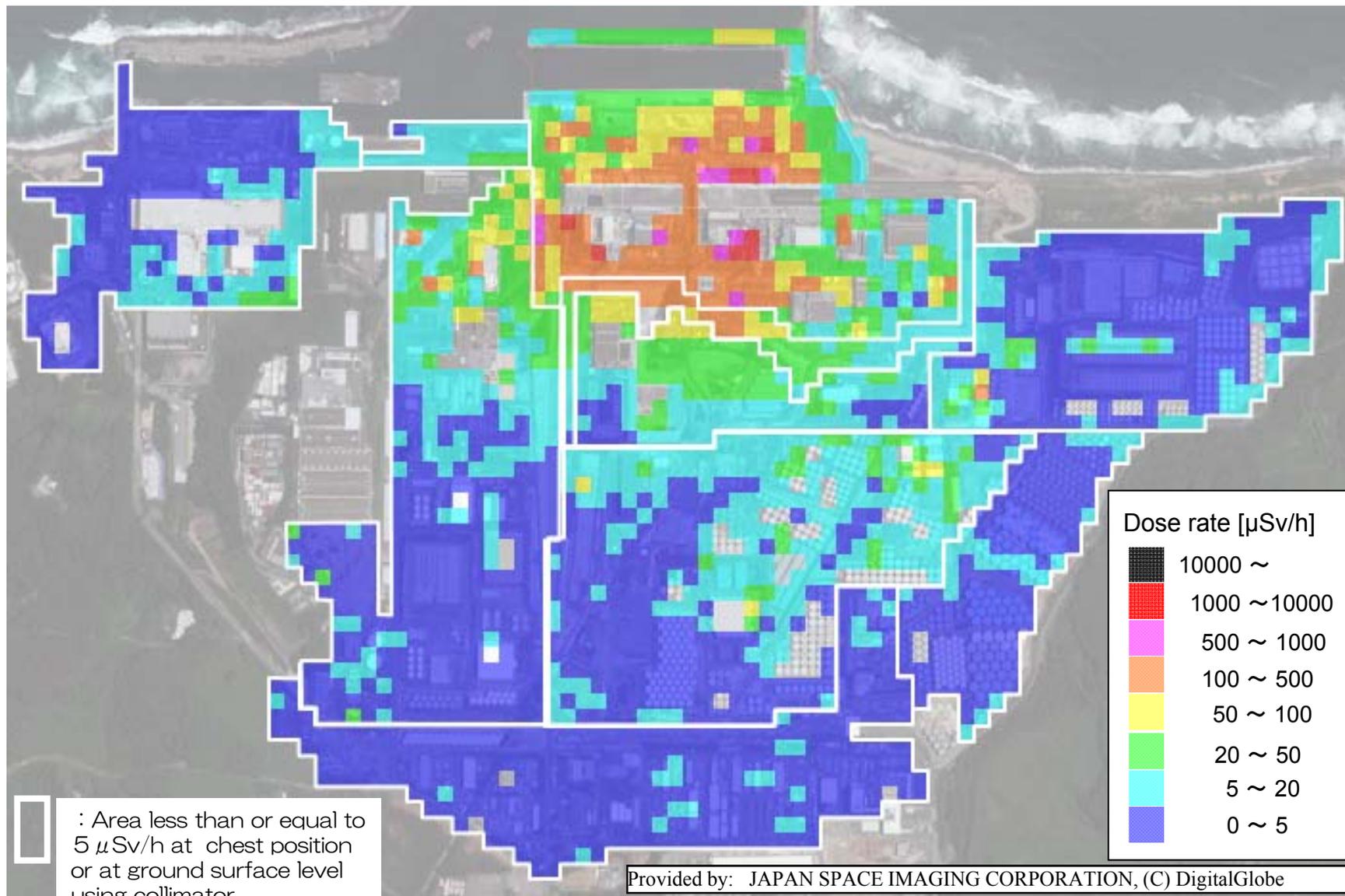
Target has been achieved.



Target areas are the areas II, III, IV.

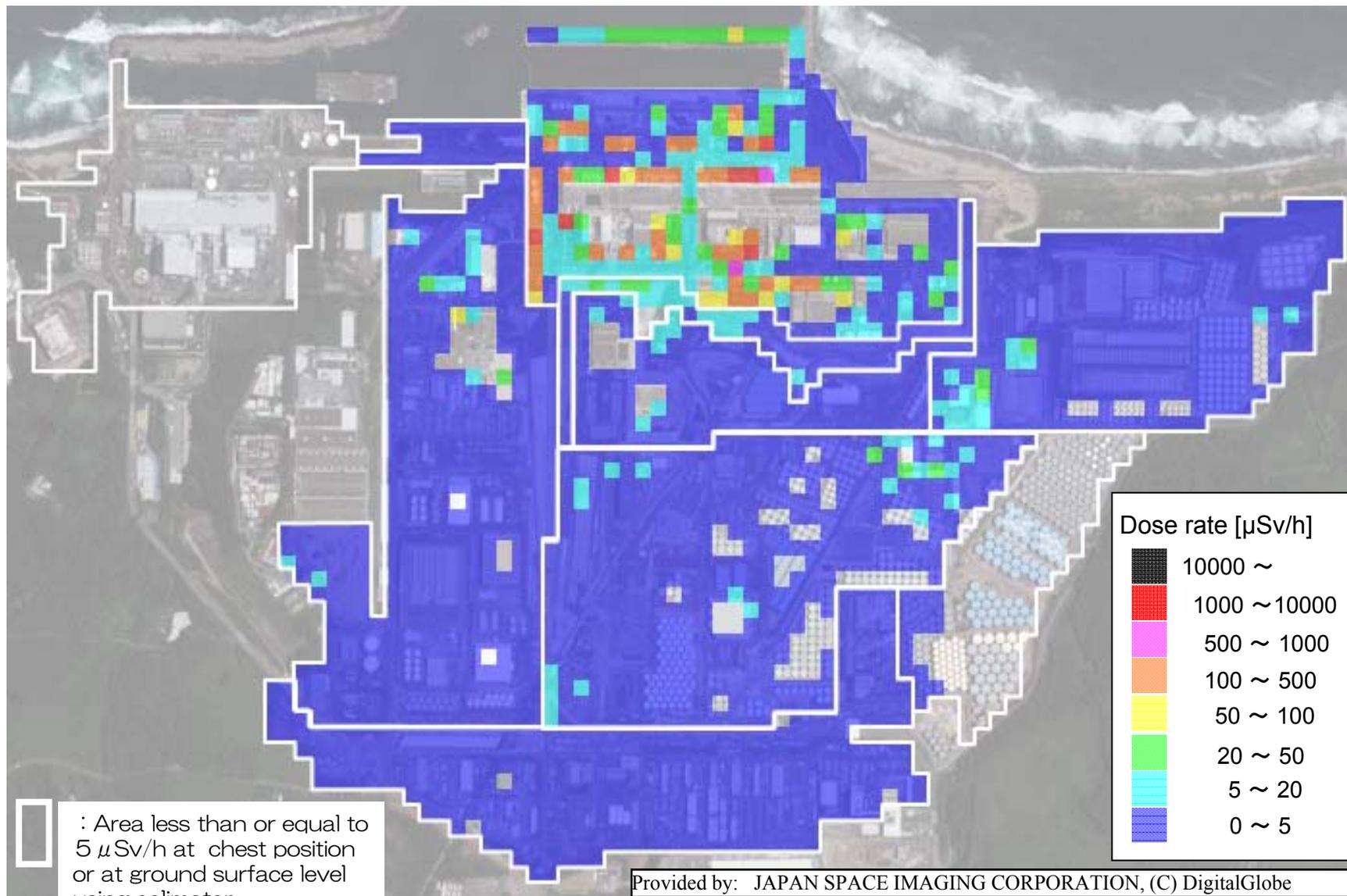
3-1. Detailed Dose Map (evaluated at chest position)

- measurement period: 2014. 10 ~ 2016. 4 -



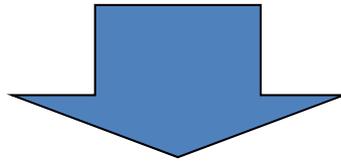
3-2. Detailed Dose Map (Evaluated at ground surface level using collimator)

– measurement period: 2014. 10 ~ 2016. 4 –



4. Need for finer zoning

- The coveralls may be excess protective clothing in the low contaminated areas such as the decontaminated areas.
- The rule to prevent the contamination from spreading when workers transfer from higher contaminated areas to other areas had been less stringent than that as before the accident.



In order to keep the decontaminated area of 1F site clean and reduce the protective gear burden on workers (coveralls → normal work clothes), the controlled area must be divided to some zones according to contamination levels, and the spreading of contamination from highly contaminated areas, such as inside the Unit 1~4 buildings and the tank dismantling area must be prevented.

5. Changes to Zoning -Finer zoning of “Controlled Area- Divide Contaminated Controlled Area to three zones according to contamination levels

Before		New zoning		Personal Protective Equipment	
Controlled Area	Areas requiring full-/half-face masks	Heavily Contaminated Areas	Anorak Areas (Red zone) <ul style="list-style-type: none"> Inside Reactor buildings of Unit 1 to 3 the area including contaminated water inside building of unit 1 to 4 and others 		<ul style="list-style-type: none"> Full-face mask Double layers of coveralls or anorak Working shoes (to be worn in R zone only) Hard hat (to be worn in R zone only)
		β-ray Areas (areas to consider β-ray exposure)	Coveralls Areas (Yellow zone)	<ul style="list-style-type: none"> Inside buildings housing water treatment systems (RO/ALPS,etc) ※1 Inside dikes for tanks holding the treated water containing Sr,Cs※2 	<ul style="list-style-type: none"> Full-face mask Coverall Working shoes (to be worn in Y zone only) Hard hat (to be worn in Y zone only)
		Other areas		<ul style="list-style-type: none"> Inside buildings of Unit 1 to 3 except for heavily contaminated area Outside buildings in the vicinity of Units 1 to 4 and others(4m/10m elevations) 	<ul style="list-style-type: none"> Half-face mask Coverall Working shoes (to be worn in Y zone only) Hard hat (to be worn in Y zone only)
	Areas not requiring full-/half-face masks	Normal Work Clothing Areas (Green zone) Areas other than the ones mentioned above		<ul style="list-style-type: none"> DS2 mask Site-only working clothing, normal working clothing ※3 Working shoes (to be worn in Y zone only) Hard hat (to be worn in Y zone only) 	
	Controlled area without risks of contamination	Inside break rooms and a part of the Essential Seismic Isolation Building			

※1 Except for observation, inspection

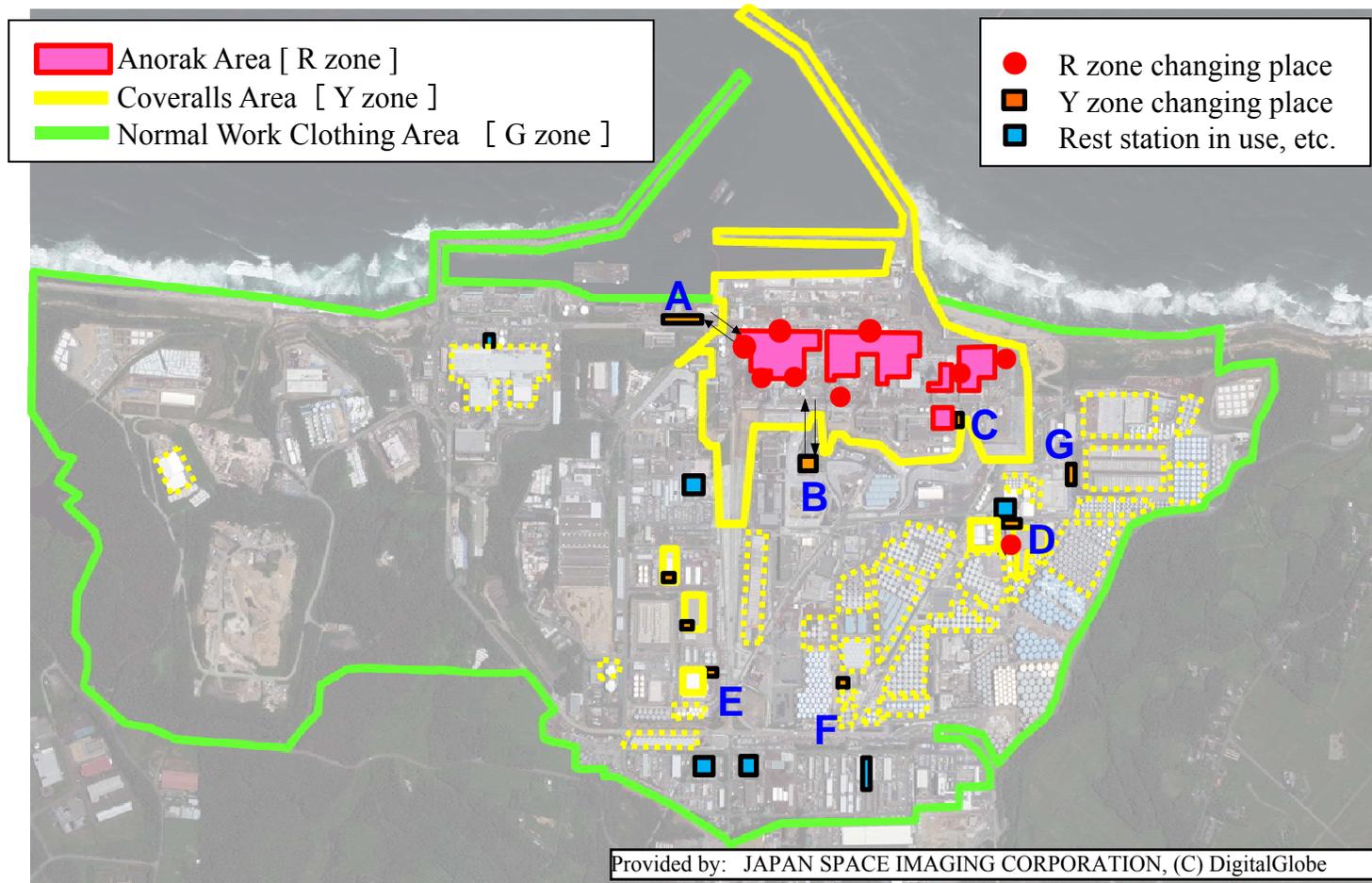
※2 Except for work without use of contaminated water (Sr treated water ,etc) ,patrol, survey before working, observation, inspection

※3 Designated light work such as patrol, monitoring, transporting items from outside of 1F site, is applied.

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6. Map after finer zoning



- ※ For works in environments with high dust concentration and handling contaminated water in G zone, the site of work as such shall be temporarily designated as Y zone.
- ※ In  area, for works in environments with handling contaminated water, the workers must equip Y zone equipment, but if the work is patrol, survey before working, etc., the workers may equip G zone equipment.

7. Zoning Control Basics

Zoning is implemented according to the basic policies below. However, taking the work efficiency and the burden into consideration, the control will be optimized and expanded gradually.

Item	Basic Policies
Zoning/Marking	<ul style="list-style-type: none"> ➤ R zone and Y zone shall <u>be clearly marked</u> with posting or zoning signs to prevent trespassing of workers. ➤ <u>For works in environments with high dust concentration and handling contaminated water in G zone, the site of work as such shall be temporally designated as Y zone.</u>
Contamination Control	<ul style="list-style-type: none"> ➤ <u>Perform contamination control so as not to spread contamination to a lower-contamination area.</u> <p>【Personnel】 : <u>Protective clothing and equipment shall be used exclusively in the designated zone.</u> When leaving one zone, one shall take off the protective clothing and equipment at the changing place.</p> <p>【Objects】 : <u>In principle, an object shall be used exclusively in the designated zone.</u> If this is not viable due to the size, shape, or volume of the object or for any other reason, a decision needs to be made on a case-by-case basis.</p> <p>【Vehicles】 : <u>In principle, a vehicle shall be used exclusively in the designated zone.</u> Maintain the contamination level inside the vehicle low.</p>

8. PPE

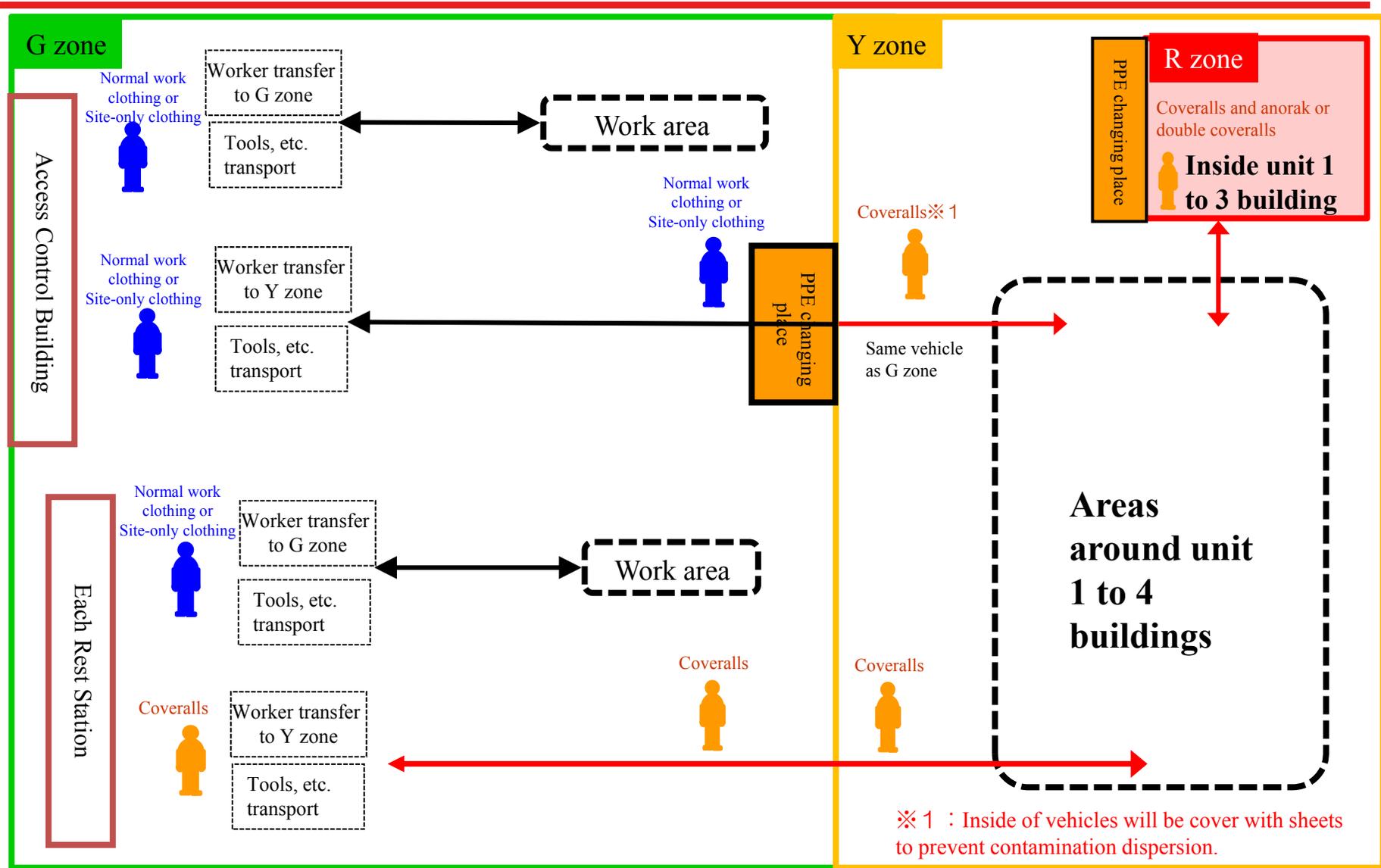
	During work		On-site transportation (Access Control Building ⇔ Rest Station)	
Before	Heavily Contaminated Area Double layers of coveralls or Anorak over coverall 	Coverall Light works in the vicinity of Access Control Building, etc. Normal work clothing	Ride a work vehicle Blue coverall	Ride a normal clothing vehicle Normal work clothing +surgical mask +cotton gloves +shoe cover
	R zone Double layers of coveralls or Anorak over coverall	Y zone Coverall 	G zone Normal work clothing (for works of Safety Patrol and monitoring, transporting from outside of 1F site) or Site-only Clothing  	Ride a work vehicle Site-only Clothing (coverall for on-site transportation is available)
New	Hard hat and shoes shall be used exclusively in the designated zone.			

9. The major opinions from main contractors

Before finer zoning, opinions were invited from main contractors. The major opinions and approaches for them are as indicated below.

Opinion	solution
There are a lot of workers moving from the vicinity of U1-4 (Y zone) to other areas. Because of the crowded PPE changing place A,B and C, dose may be increased and the workers may suffer heatstroke.	Only the workers who move immediately from access control building to the vicinity of U1-4 may use the PPE changing place A,B and C.
Since the available space is limited in nearby areas of the changing area in the vicinity of Units 1 to 4, sufficient parking slots can not be secured close to the changing area. It is difficult that vehicles shall be used exclusively in the designated zone.	Until the sufficient parking slots is available, vehicles are not used exclusively in the designated zone.

10. Traffic Line (areas around unit 1 to 4 and inside buildings)



※If contamination is detected on site-only clothing, the vehicle will be decontaminated and covered with sheets. If that is not possible, worker will wear coveralls when using the vehicle.

11. Issues to be solved

Taking the following issues into consideration, proper steps will be taken gradually.

Issues		Contents for discussion (approaches toward solving the issues)	Target deadline
Resolving the Shortage of the changing places And Improving the environment in the changing place	So that all the Y zone workers may go through changing places, the number of changing place must be increased.	<ul style="list-style-type: none"> Increasing the number of changing place 	
		Taking the size and location of changing places into consideration, proper steps will be taken.	Proper steps from FY2016
		Taking a installation of the sufficient parking slots and stocking places of items (tools ,etc.) into consideration, large-scale and gathered facility for changing place will be installed.	FY2018
	Resting area shall be set in the changing place so that workers may take a short rest to avoid suffering heatstroke in summer.	<ul style="list-style-type: none"> Installing the air-conditioners and toilets 	FY2016
vehicles shall be used exclusively in the designated zone.	Securing available spaces for sufficient parking slots.	<ul style="list-style-type: none"> With increasing the number of changing place, securing available spaces for sufficient parking slots shall be taken into consideration, 	FY2018
Tools, protective gears shall be used exclusively in the designated zone.	Securing available spaces for sufficient stocking area in the vicinity of units 1-4 (Y zone)	<ul style="list-style-type: none"> With increasing the number of changing place, securing available spaces for sufficient stocking area shall be taken into consideration, 	FY2018