

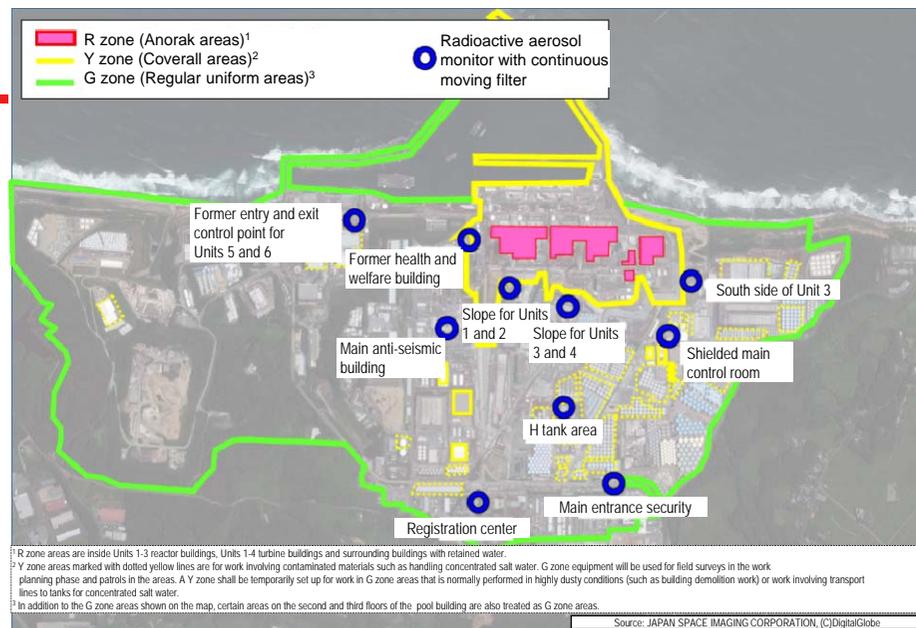
Efforts to Improve Working Environment and Reduce Radiation Exposure at Fukushima Daiichi Nuclear Power Station

**14 November 2016
Tokyo Electric Power Company Holdings, Inc.**

1-1 Overview of Zoning

Based on the progress of measures to reduce environmental radiation dose, the Fukushima Daiichi Nuclear Power Station site has been divided into three zones according to contamination levels from March 8, 2016, and workers are provided with appropriate protective equipment for each zone.

The success of these operations has been confirmed by changes in the necessary protection level provided by the masks and on-site uniforms worn.



R zone (Anorak areas)	Y zone (Coveralls areas)	G zone Regular uniform areas	
Full-face mask 	Full-face mask or half-face mask^{1, 2}  	Disposable dust mask 	
Anorak over coveralls 	Coveralls 	Regular uniform³ 	On-site uniform 
or coverall over coverall			

¹ For work performed inside buildings of Units 1-4 and surrounding buildings, including water treatment facilities such as multi-nuclide removal facilities (excluding observation visits), full-face masks are to be worn.
² For work performed around tanks containing contaminated water, for example, concentrated salt water or strontium treated water (excluding work that does not involve the handling of concentrated salt water, field surveys in the work planning phase, patrolling, observation visits, etc.), and work that involves the handling of transport lines to tanks, full-face masks are to be worn.
³ Certain light work (such as patrolling, monitoring and transportation of items brought in from outside the premises)

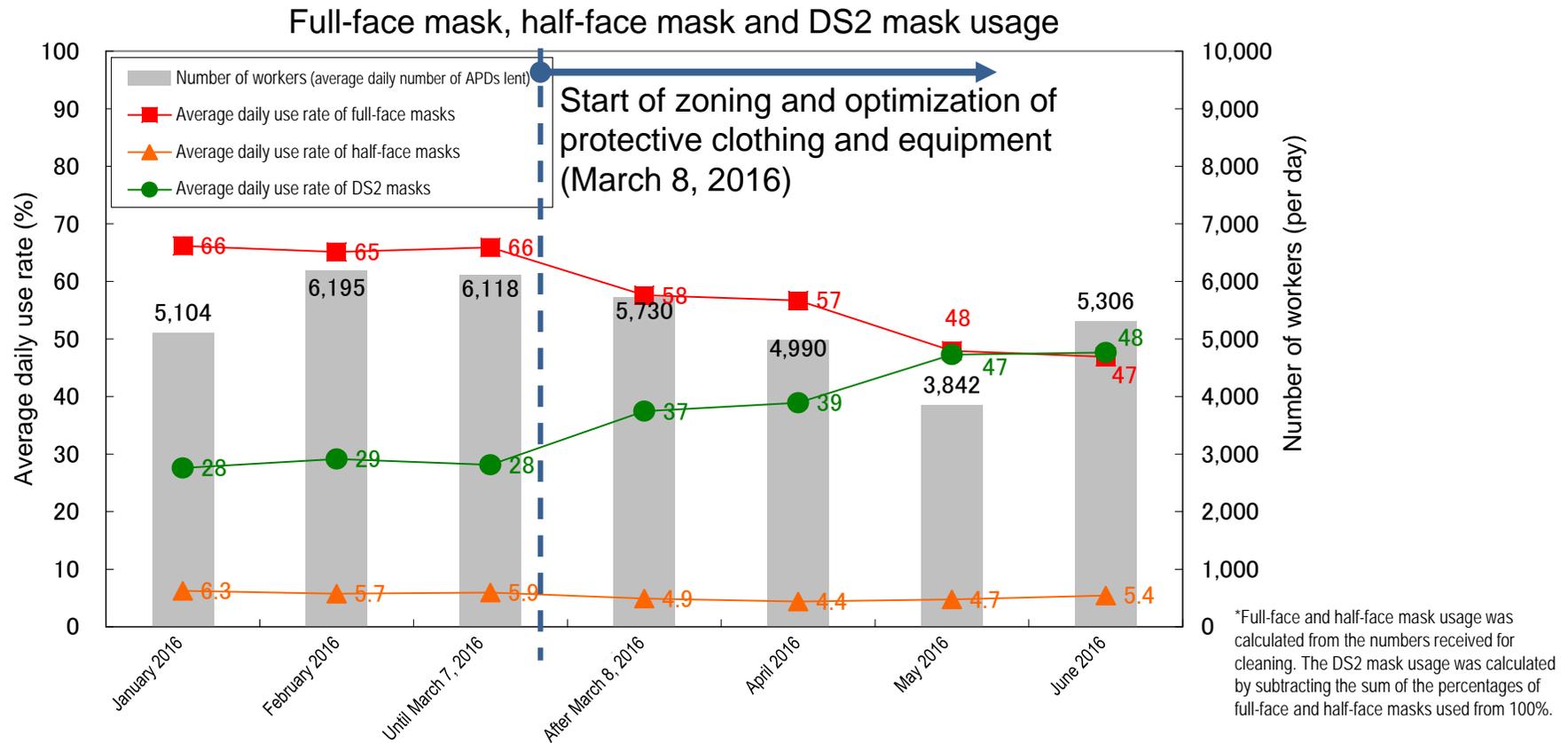
1-2 Basic Rules for Zoning Area Control

The basic rules to implement zoning are as follows:

Item	Basic rules
Partitioning/ marking	<ul style="list-style-type: none"> ➤ The R zone and Y zone areas will be marked by signs and partitions so that workers will not carelessly enter these areas. ➤ <u>For work performed in highly dusty conditions (such as building demolition work) or work involving contaminated materials such as concentrated salt water in G zone areas, Y zone areas are to be set up.</u>
Contamination control	<ul style="list-style-type: none"> ➤ <u>To prevent contamination from spreading into lower-level contaminated zones, the following rules will be applied:</u> Workers: <u>Different protective clothing and equipment shall be properly used depending on each zone.</u> Workers exiting higher-level contaminated zones and moving to lower-level contaminated zones must remove their protective clothing and equipment in changing rooms. Materials (tools, machines): <u>In principle, different materials shall be used exclusively in each zone.</u> If it is difficult to do so because of the size, shape, quantity, etc.; therefore, decisions will be made on a case-by-case basis. Vehicles: <u>In principle, different vehicles shall be used exclusively in each zone.</u> Contamination levels in the vehicles must be kept low.

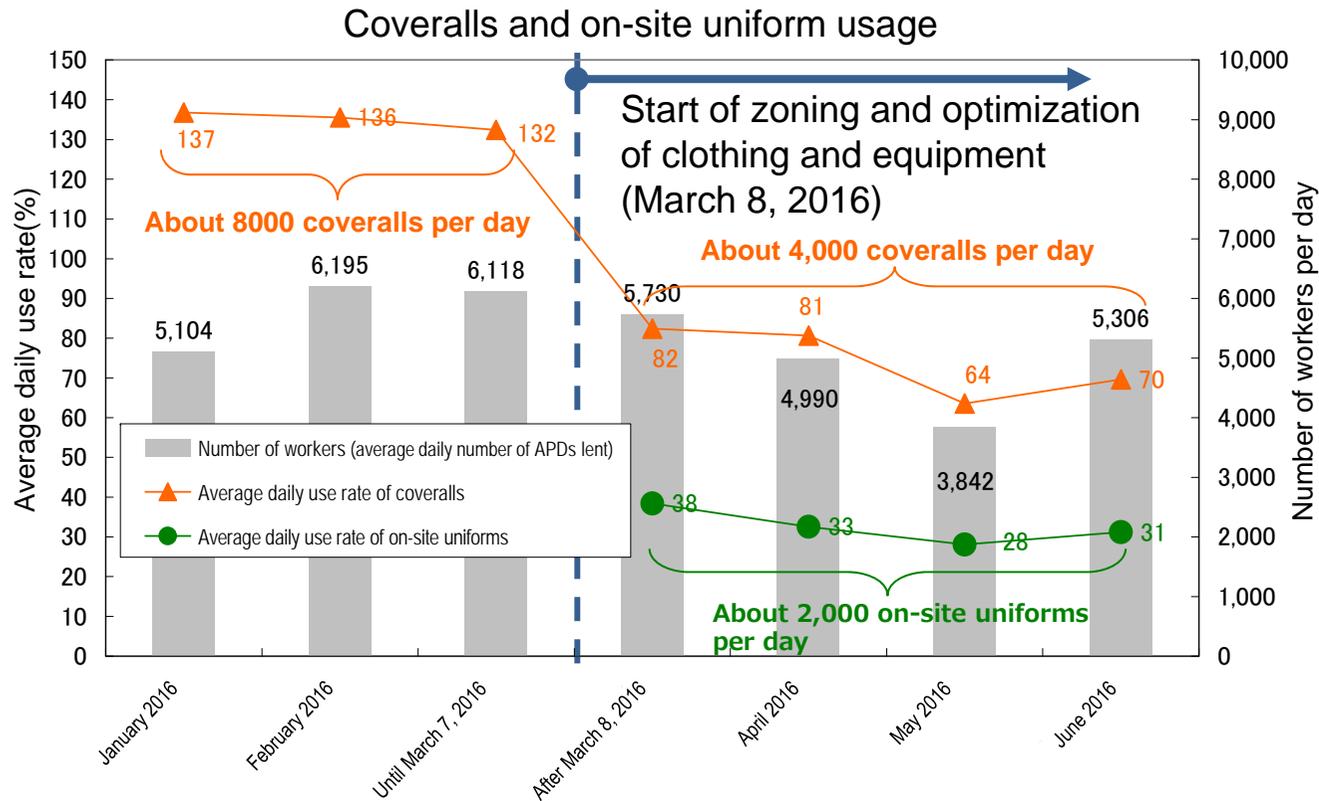
1-3 Changes in Mask Usage

- After the new zoning application, the average daily use rate of full-face masks has decreased from about 66% to about 47% and the average daily use rate of disposable dust masks (DS2) has increased from about 28% to about 48%.
- These changes indicate **reductions in protection level that equipment must provide from full-face masks to DS2 masks.**



1-4 Changes in Coveralls and On-site Uniform Usage

- Since the new zoning application, coveralls usage has decreased from about 8,000 coveralls per day to about 4,000 coveralls per day.
The usage of on-site uniforms has remained at around 2,000 uniforms per day.
- These changes indicate reductions in protection level of clothing from coveralls to normal on-site uniforms.
- There has been no significant increase in the number of contaminated regular uniforms and on-site uniforms in post-work contamination tests. (The number has remained on average at about two cases per day.)



*Coveralls and on-site uniform usage was calculated from the number of coveralls and on-site uniforms that had been provided to workers. Coveralls usage exceeds 100% because there have been cases where workers used more than 1 set of coveralls on a single day for such reasons as the need to remove the coveralls before a break and wear a new one to continue work after the break.

1-5 Improvements after the New Zoning Application

- Due to application of the new zoning, about 2,000 G zone workers use on-site uniforms per day.
- Full-face mask usage has been decreasing, and there has been a shift from the previous combination of coveralls and full-face mask to a combination of the disposable dust mask (DS2) and on-site uniform, which means that a marked reduction can be seen in the use of excessive protective equipment.
- After the new zoning was put into effect, the following improvements have been made systematically based on requests and opinions from contract companies:

(1) Introduction of on-site summer uniforms (from May 30)

- On-site uniforms for the summer, made of a thinner and more breathable fabric (weighing only 200g as opposed to 450g for winter) were introduced on May 30.
- On-site uniforms with even higher breathability were introduced in early August for extremely hot midsummer days.

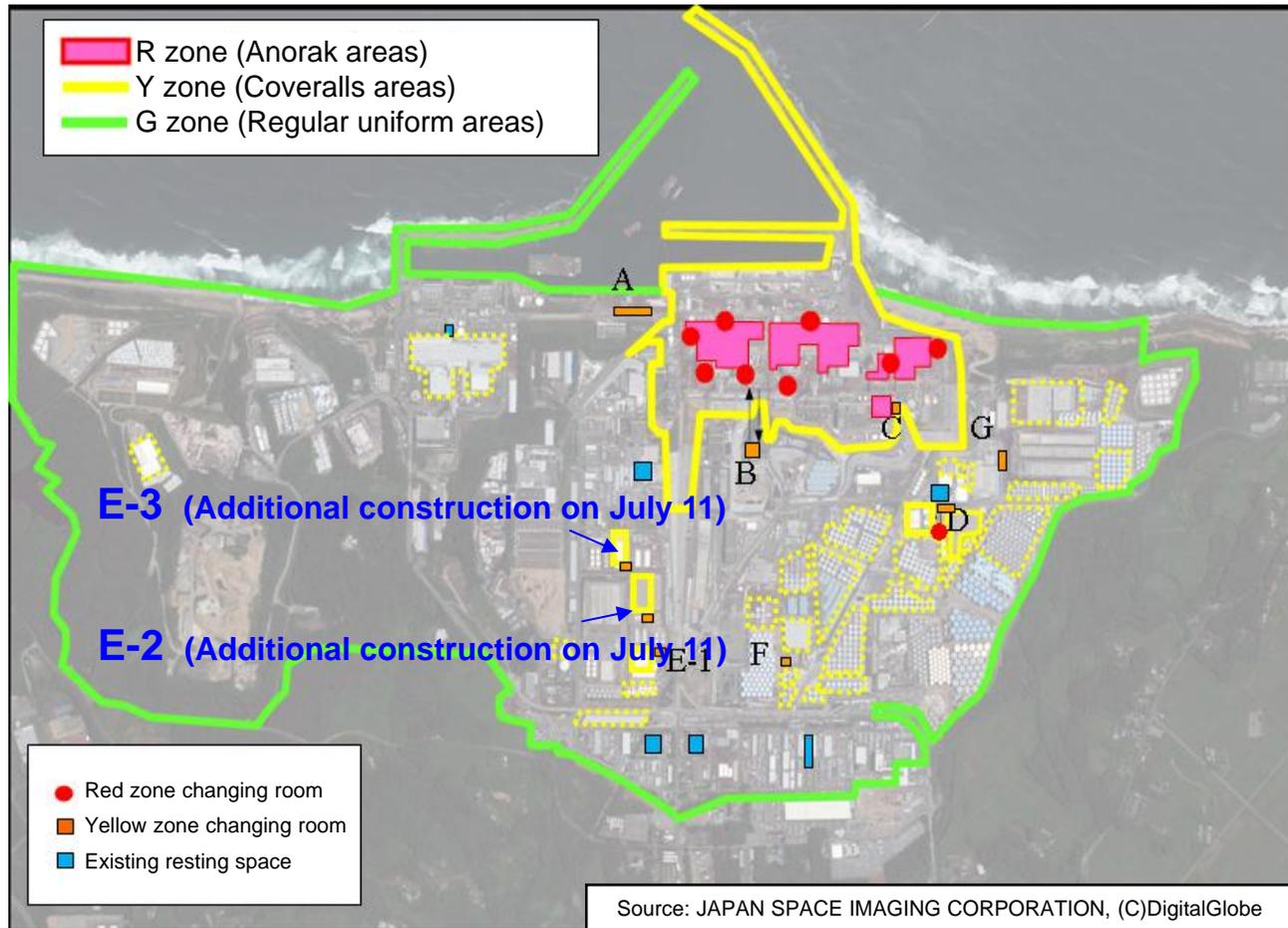
(2) Start of lighting and air conditioning for changing rooms (from June 1)

Power cables were installed for lighting and air conditioning in the changing rooms where workers put on and remove protective equipment for Y zone work.

(3) Construction of additional changing rooms (from July 11)

Because changing rooms near the multi-nuclide removal facilities were used heavily and always congested, two additional rooms were constructed to resolve the congestion and enhance the convenience for workers.

For Reference: Zoning Areas and Changing Room Locations



Changing Room	Capacity (Number of people)
A	300
B	500
C	200
D	500
E-1	100
[Additional construction] E-2	200
[Additional construction] E-3	200
F	100
G	150

*A Y zone will be temporarily set up for work in G zone areas that is normally performed in highly dusty conditions (such as building demolition work) or handles concentrated salt water.

*Y zone areas marked with dotted yellow lines are for work involving contaminated materials such as handling concentrated salt water and dealing with transport lines to tanks. G zone equipment will be used for patrols and field surveys in the work planning phase.

For Reference: Results of Interviewing Partner Companies

● The main opinions voiced by partner companies in interviews are in the bottom table. We are open to requests and opinions from partner companies to optimize the conditions for contamination controls.

Item	Major opinions	(Plan) response actions
Changing rooms	<ul style="list-style-type: none"> ➤ The changing rooms are <u>hot, humid and too small.</u> 	<ul style="list-style-type: none"> ➤ <u>Air conditioning equipment was installed in the changing rooms.</u> → Operation was started on June 1. ➤ <u>New changing rooms were constructed near the heavily congested ones.</u> → Operation was started on July 11.
Vehicles	<ul style="list-style-type: none"> ➤ It is <u>difficult to decontaminate the vehicles used on the premises. There is a concern that the contamination inside them may spread to workers, clothing through human sweat</u> in the summer . ➤ Strictly separating vehicles used for each zone causes <u>an increase in the number of vehicles and a shortage of parking spaces.</u> 	<ul style="list-style-type: none"> ➤ <u>Covering the seats of vehicles is recommended to prevent contamination from spreading.</u> ➤ Securing parking spaces for designated vehicles in each zone is a task to be addressed in the future.
Operations	<ul style="list-style-type: none"> ➤ It is <u>difficult to recognize the boundaries between G zone and Y zone areas.</u> ➤ <u>Depending on the type of work,</u> it would be better to permit workers to <u>work in Y zone areas wearing protective equipment for G zone areas</u> rather than designating all areas around Units 1 to 4 as Y zone areas. ➤ Because contaminated tools are stored in Y zone areas, <u>workers have to enter Y zone areas just to pick up tools.</u> 	<ul style="list-style-type: none"> ➤ <u>Signs in a standardized format were made and installed sequentially.</u> ➤ Reducing the Y zone areas around Units 1-4 will be considered as soon as the necessary preparations are completed, such as monitoring radioactive aerosols with continuous moving filters and partitioning. ➤ Securing tool storage spaces for designated tools in each zone is a task to be addressed in the future.

2-1 Start of ALARA Symposium: Background and Concept

(1) Background

Decommissioning the Fukushima Daiichi Nuclear Power Station is a type of work that has never been done before. The entire site was contaminated with radioactive materials from the accident and radiation dose levels were not low.

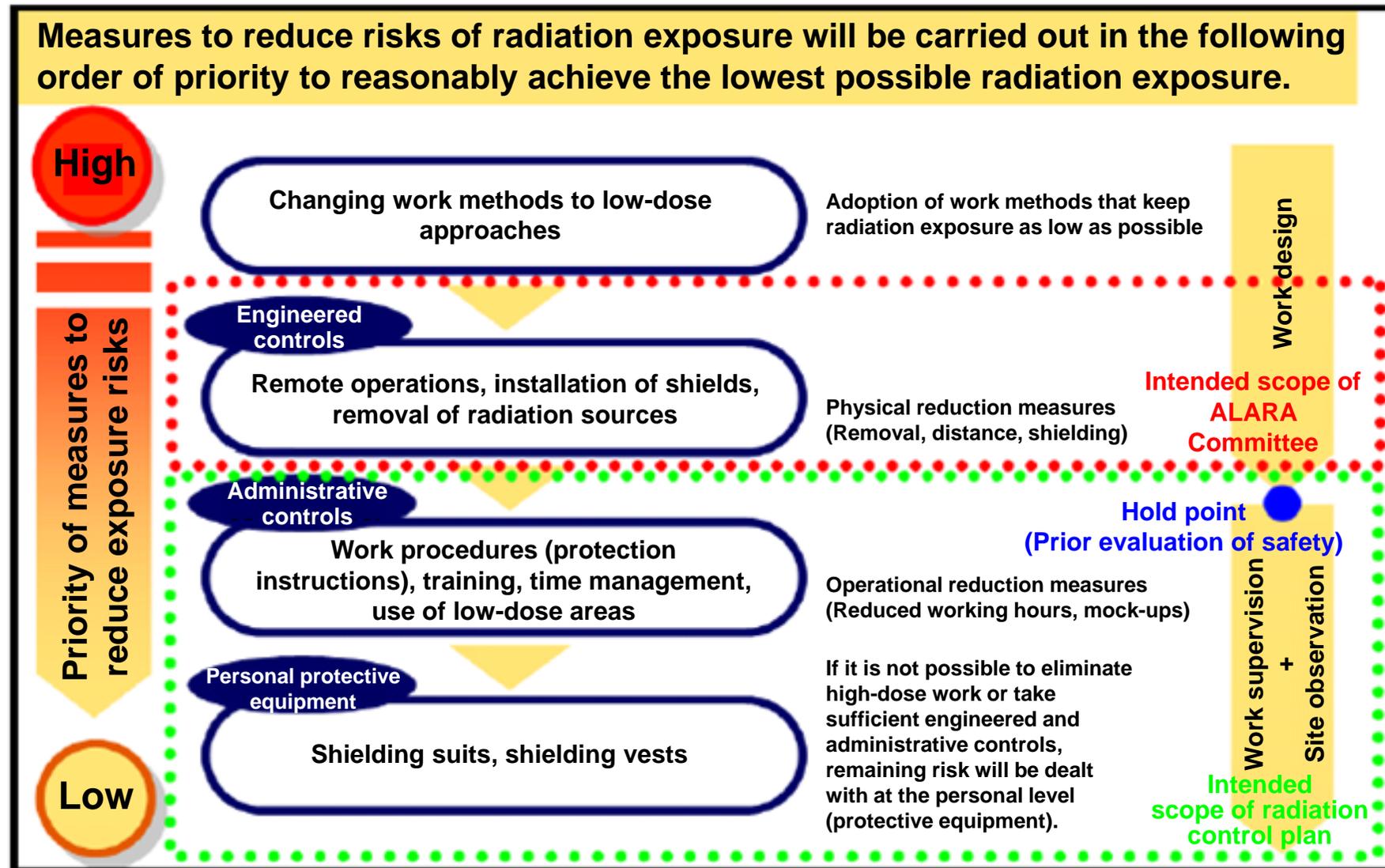
In this environment, various measures to reduce radiation exposure have been put into effect for each type of work, but the total exposure dose has been at a high level of 100 persons-Sv (FY2016). Going forward, there is a possibility that it will rise to even higher levels as the mid- and long-term roadmap progresses and we enter the inside of the buildings.

(2) Concept

When radiation exposure is considered a risk, it is important to implement engineering controls (physical measures) such as remote operations, removal of radiation sources, and installation of shields as well as change work methods to low-dose approaches.

In addition, operational measures such as work procedures, training (mock-ups) and time management will also be implemented as administrative controls. If those measures are still insufficient, radiation dose limits may also be enforced by having workers wear personal protective equipment such as shielding suits.

2-2 Prioritizing Reducing Exposure Risk Measures



2-3 Purposes and Scope of ALARA Committee

(1) Purposes and review items for ALARA Committee

Implementation of engineered controls has a great effect in reducing radiation exposure but it **also has a major impact on costs and the work schedule, so it is difficult to make changes or additions immediately before starting work.**

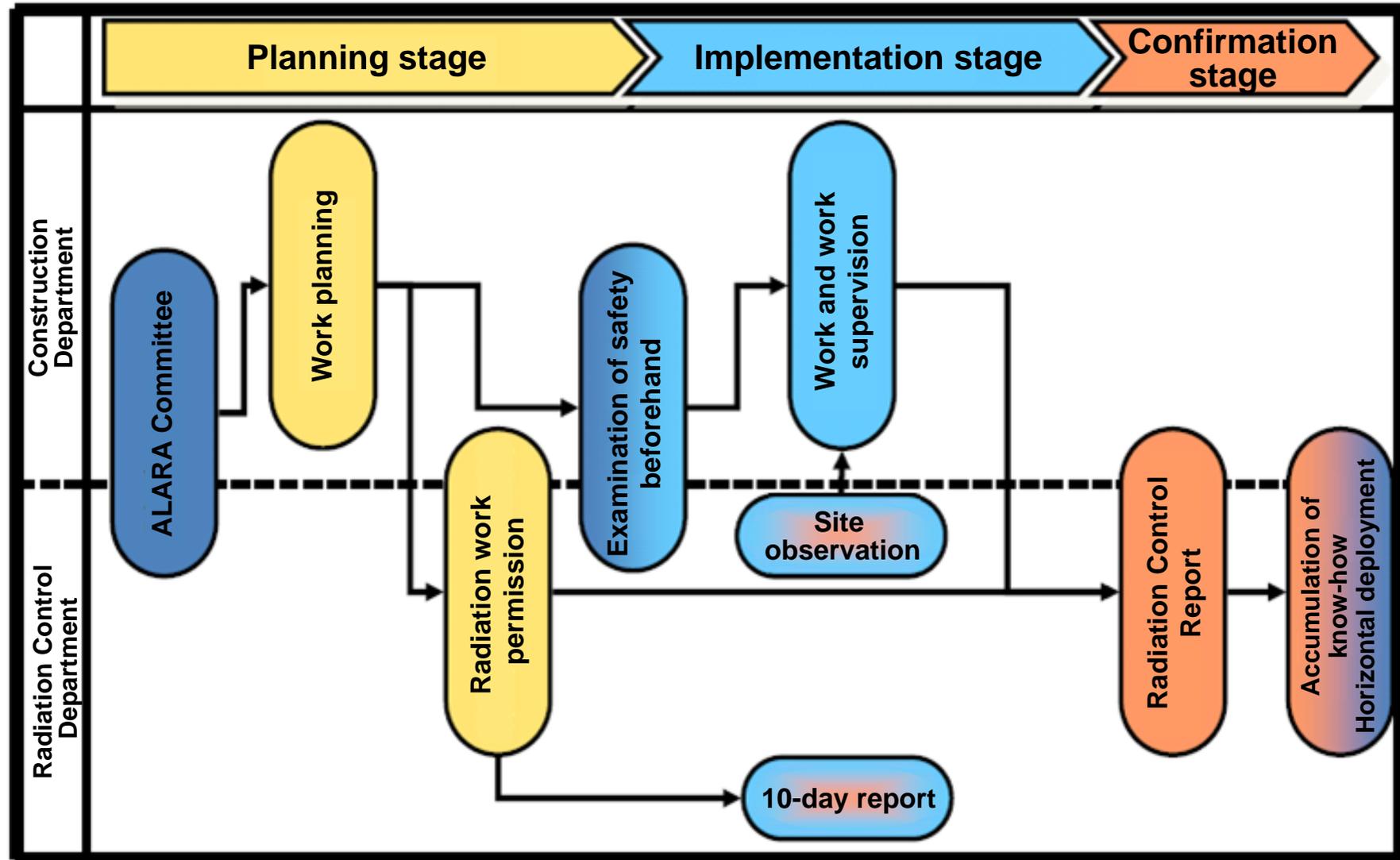
Therefore, it is crucial to examine measures to reduce radiation exposure in the early stages. It is also meaningful to discuss the implementation in the ALARA Committee based on the three rules of radiation protection (justification, optimization and dose limits) and in the spirit of ALARA (As Low As Reasonably Achievable) when optimizing radiation exposure. Because administrative controls and personal protective equipment can even be implemented immediately before work with established operational processes, they have been confirmed through examination of safety beforehand and with a radiation management plan (RWA).

(2) Scope of ALARA Committee

From the second half of FY2014, validity of the exposure reduction measures, which are applied to the work exceeding 1 person-SV at the planning stage, are being confirmed.

General project managers (assistant site managers), contractors, TEPCO's Construction Department, and Radiation Control Department attend the ALARA Committee and confirm that effective measures are taken against the main radiation sources and that exposure reduction measures can be obtained from the results.

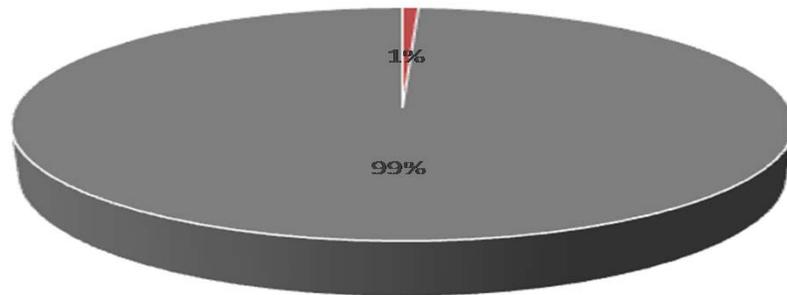
2-4 Overview of Exposure Reduction Measures for Individual Tasks



For Reference: Percentage of Work Cases Subject to ALARA Committee

(1) Percentage of work cases
(Percentage of work cases subject to ALARA Committee among all work cases)

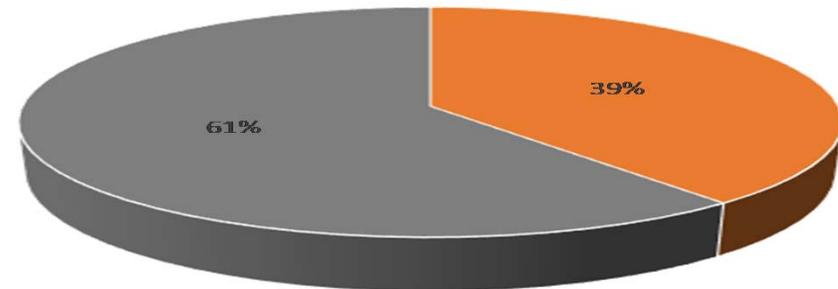
Number of work cases
(actual records in 2015)



■ Subject to ALARA Committee
■ Others

(2) Percentage of radiation dose
(Work dose subject to ALARA Committee as a percentage of total dose)

Radiation dose
(actual records in 2015)



■ Subject to ALARA Committee
■ Others

Although about 60% of the total radiation was subject to ALARA Committee in the FY2015 planning phase, the actual results have decreased to about 40% from changes in the work schedule, re-examination of planned radiation exposure and implementation of dose reduction measures.

Work cases exceeding 1 person-Sv, which is over half of the planned radiation dose, are subject to ALARA Committee and work cases with less than 1 person-Sv have been confirmed through examination of safety beforehand and with the radiation management plan. However, lowering of the ALARA Committee standards is being considered because the percentage of work dose subject to ALARA Committee actually decreased to about 40%.