Workshop on Radiation Exposure Control
at TEPCO's Fukushima Daiichi Nuclear Power Plant, etc.

Activities Concerning Radiation Control for the Treatment of Accumulated Water at the Fukushima Daiichi Nuclear Power Plant

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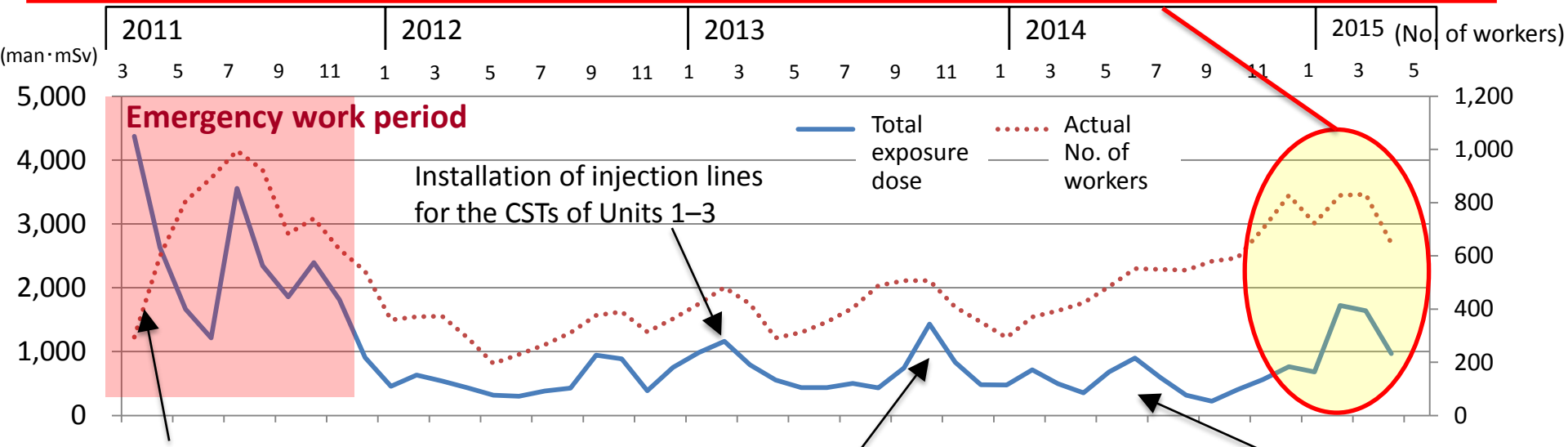
Radiation exposure and major works at 1F

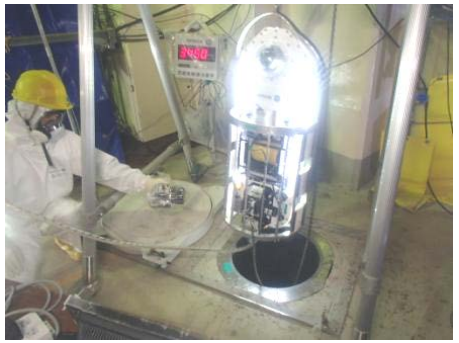
CST: Condensate Storage Tank
SFP: Spent Fuel Pool

The treatment of the accumulated radionuclide-contaminated water, the largest yet since the start of the emergency works, has been conducted.



Installation of power cables

Removal of debris in Unit 4 SFP



Investigation of torus rooms in Units 1 & 2

From the website of TEPCO

The Development Program for the Foundations of Technologies Related to Countermeasures against Accidents in Power Reactors, etc. – Fiscal Year 2012 (Technology Development of Swimming Survey Robots toward Advancement of the Foundations for Remote Technologies)

Treatment of Accumulated Water: Installation of a pumping system for accumulated radionuclide-contaminated water.

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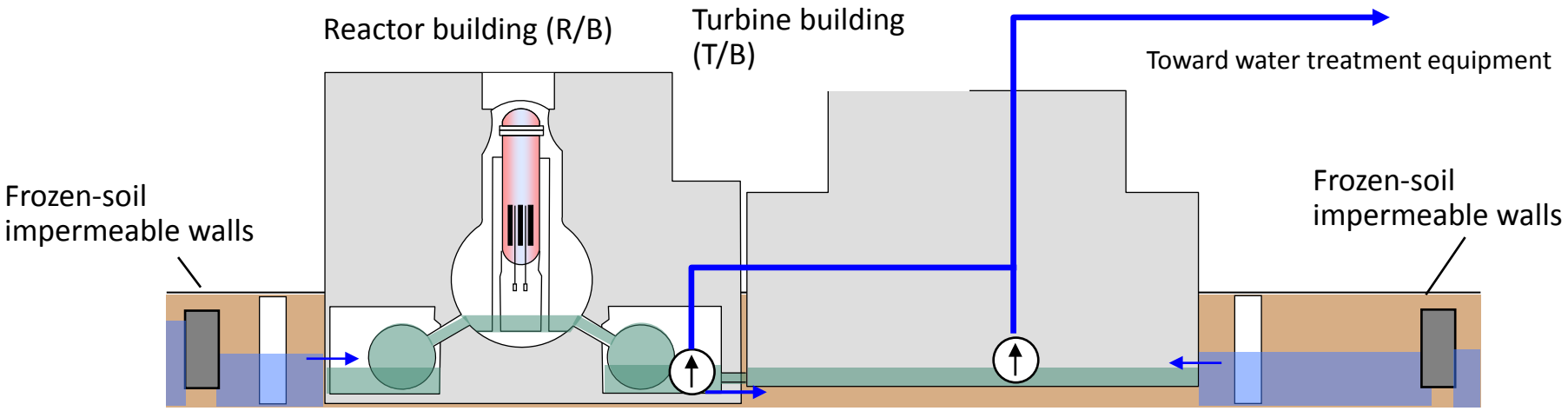
Overview ① Objective and details of the works

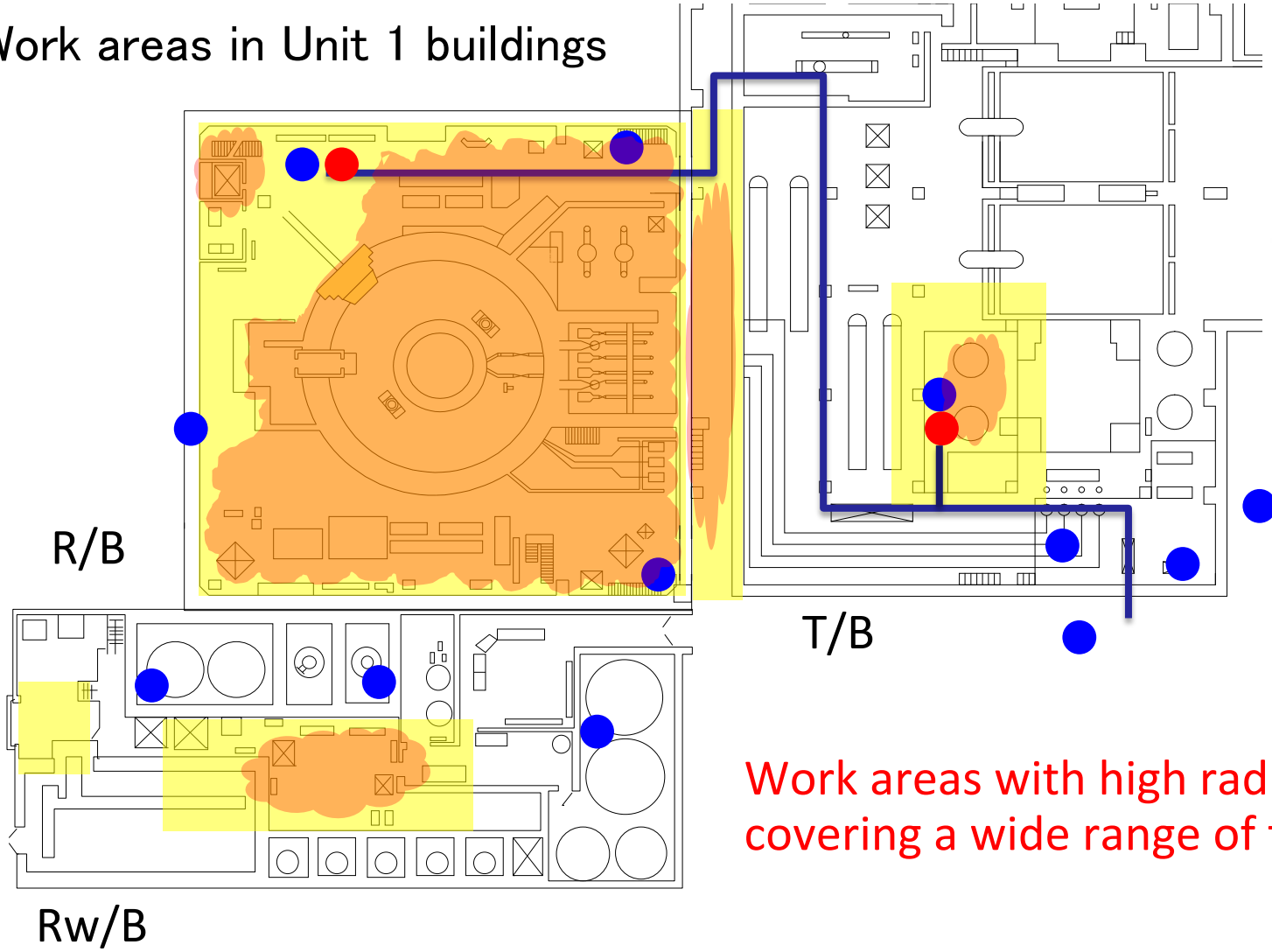
Objective	Prevent leakage of the accumulated water from the building, by controlling the water level of accumulated water in the building, against the decline in the groundwater level due to installation of the frozen-soil impermeable walls.
Details of the works	Installation of pumps and water level gauges in the reactor buildings as well as the relevant installation of pipes and cables, and drilling the floor.
Working period	Required to complete before the establishment of the frozen-soil impermeable walls. Initial schedule: from the end of October 2014 to the end of March 2015 (subject to change)



Hitachi GE is responsible for the works in Units 1 & 4

Overview ② Work areas and dose rate

Work areas in Unit 1 buildings



Work areas with high radiation and covering a wide range of the site.

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Issues and challenges

Works conducted in a large-scale setting and in areas of high radiation, requiring responses to the following two challenges.

1) There is a concern that the key persons who have already received a large cumulative exposure dose may not be able to continue engaging in the works at 1F during and after the treatment period as they will have reached the exposure dose control limit.

Measures are required to reduce the exposure dose of key persons at 1F.

2) There is a concern that problems related to radiation control may occur for workers newly engaging in the treatment, among whom there would be many without any previous work experience at 1F or other nuclear facilities.

Measures are required to prevent problems related to radiation control.

4. Exposure dose reduction measures for key persons

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Key persons

Those workers are exceptional who have thorough knowledge about specific situation at the site of 1F such as “environment”, “operation”, “equipment”, and “layout”, etc. among those engaging in works before and after the earthquake.

Essential as key persons at 1F for future works as well

Many of them have had a large cumulative exposure dose after the earthquake

The exposure dose would be large especially for supervisors and group leaders in the treatment of accumulated water.

Reduction is required of exposure dose for supervisors and group leaders.

4. Exposure dose reduction measures for key persons

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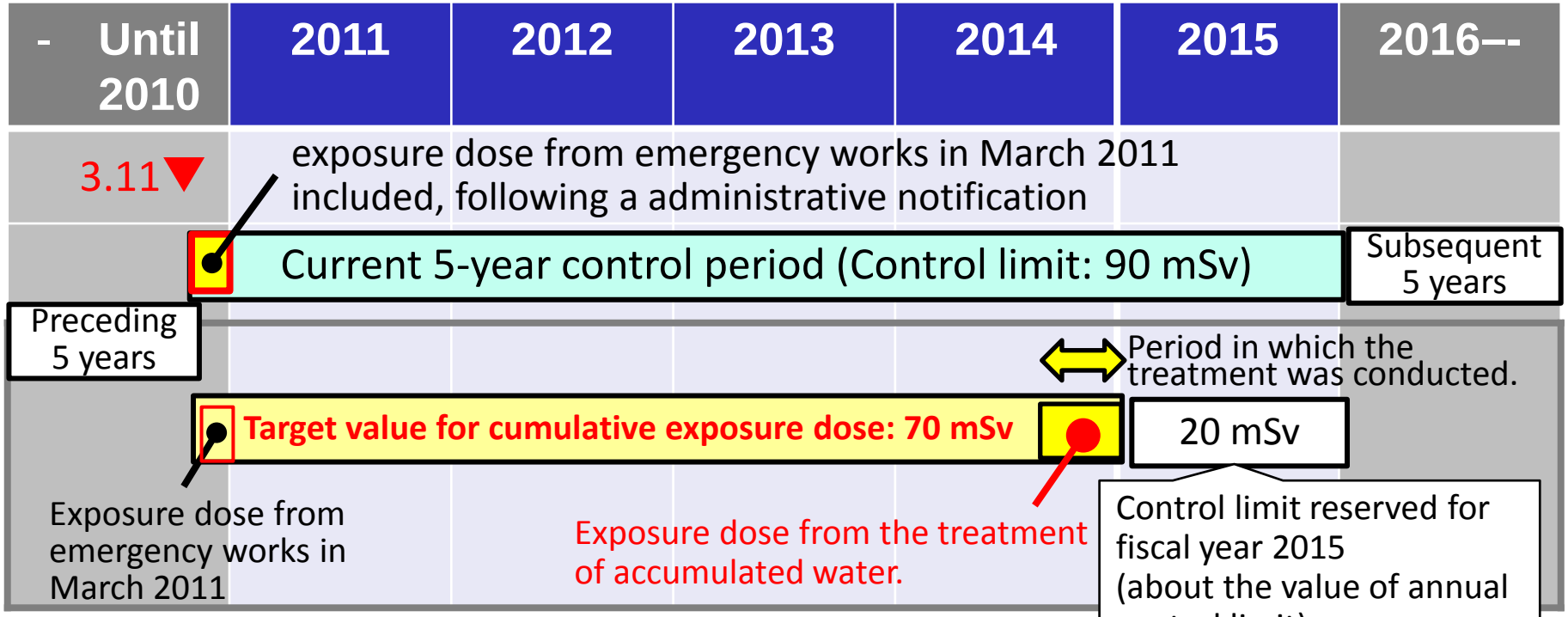
Control limit for individual dose (mSv)

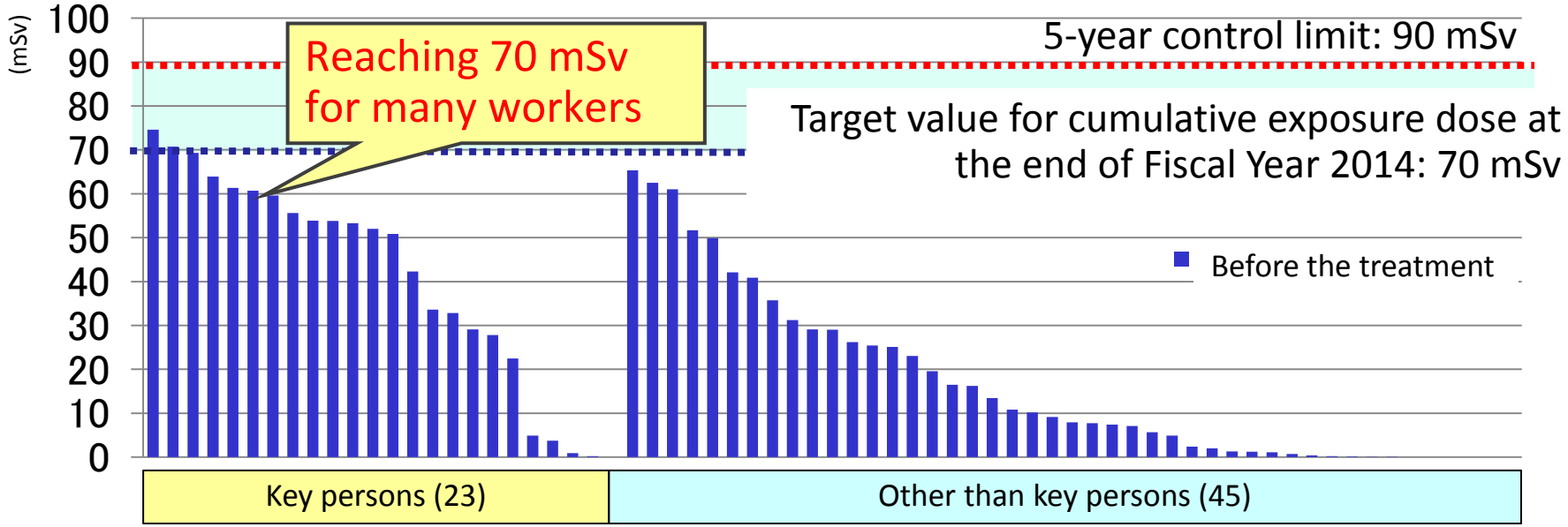
Period (Fiscal year)	Dose limit (Ionizing Radiation Ordinance)	Control limit set by Hitachi-GE	
		1F	Other plants
5-year *	100	90	
1-year	50	45	20

5-year control limit and the control target value for the treatment (Fiscal year)



Cumulative exposure dose by workers: before the treatment (for supervisors)

Before the treatment, cumulative exposure dose since Fiscal Year 2011
(as of the end of Sep. 2014)



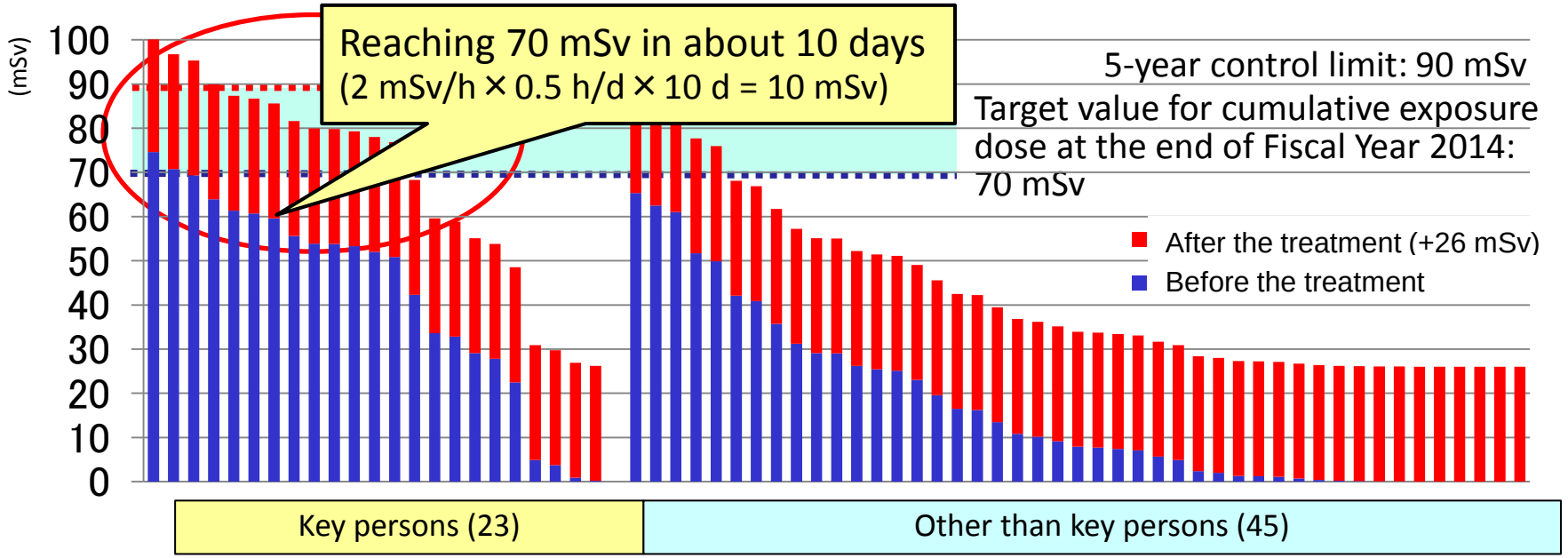
	Key persons	Other than key persons
No. of workers	23	45
> 90 mSv	0	0
> 70 mSv	2	0

Cumulative exposure dose, exceeding or reaching 70 mSv for key persons

4. Exposure dose reduction measures for key persons

Cumulative exposure dose by workers: after the treatment (expected for supervisors)

Assuming that all workers receive uniform doses from the treatment (+26 mSv/worker)



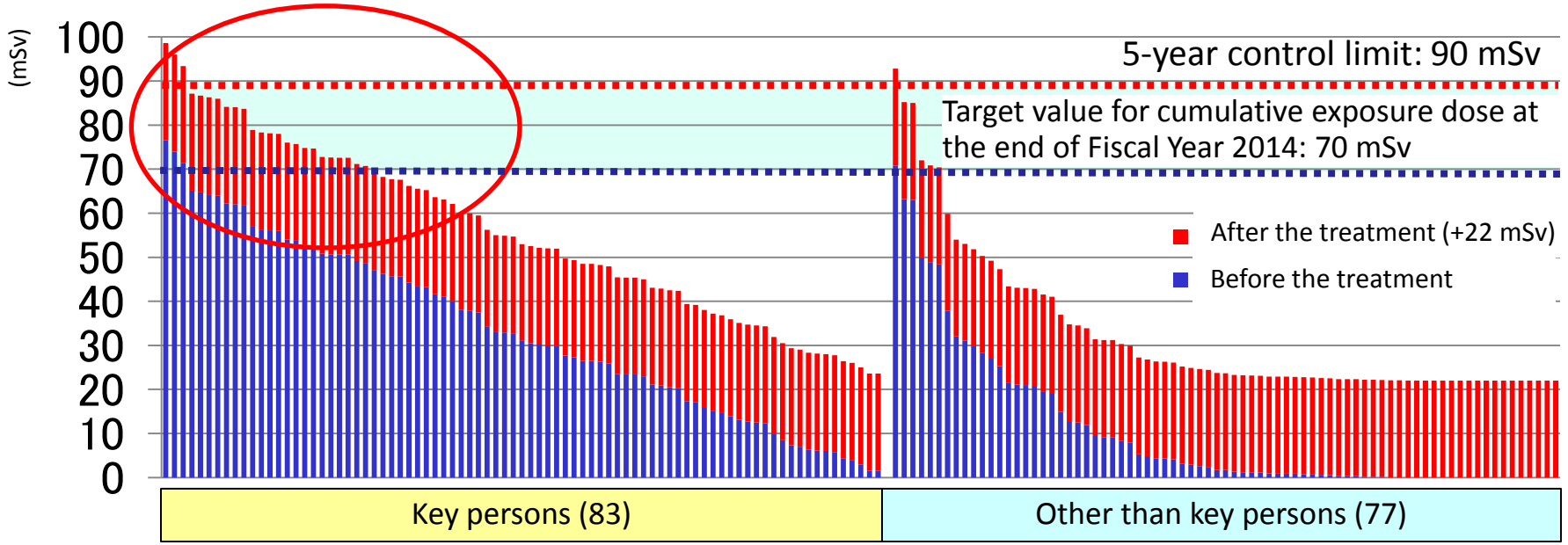
	Key persons	Other than key persons
No. of workers	23	45
> 90 mSv	3	1
> 70 mSv	13	5

Cumulative exposure dose, exceeding 70 mSv at the end of FY 2014 for more than half of key persons.
This would have an impact on works both during the treatment and for the fiscal year 2015.

4. Exposure dose reduction measures for key persons

Cumulative exposure dose by workers: after the treatment (expected for group leaders)

Assuming that all workers receive uniform doses from the treatment (+22 mSv/worker)



	Key persons	Other than key persons
No. of workers	83	77
> 90 mSv	3	1
> 70 mSv	24	6

Cumulative exposure dose, exceeding 70 mSv for many group leaders as well.

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Measures against challenges

Cumulative exposure dose would exceed 70 mSv for many key persons among supervisors and group leaders.

This would have an impact on works both during the treatment and for the fiscal year 2015.

↓

Reduction of exposure dose is required for key persons.

↓

Dose reduction by dose control

↓

Individual dose control focusing on key persons

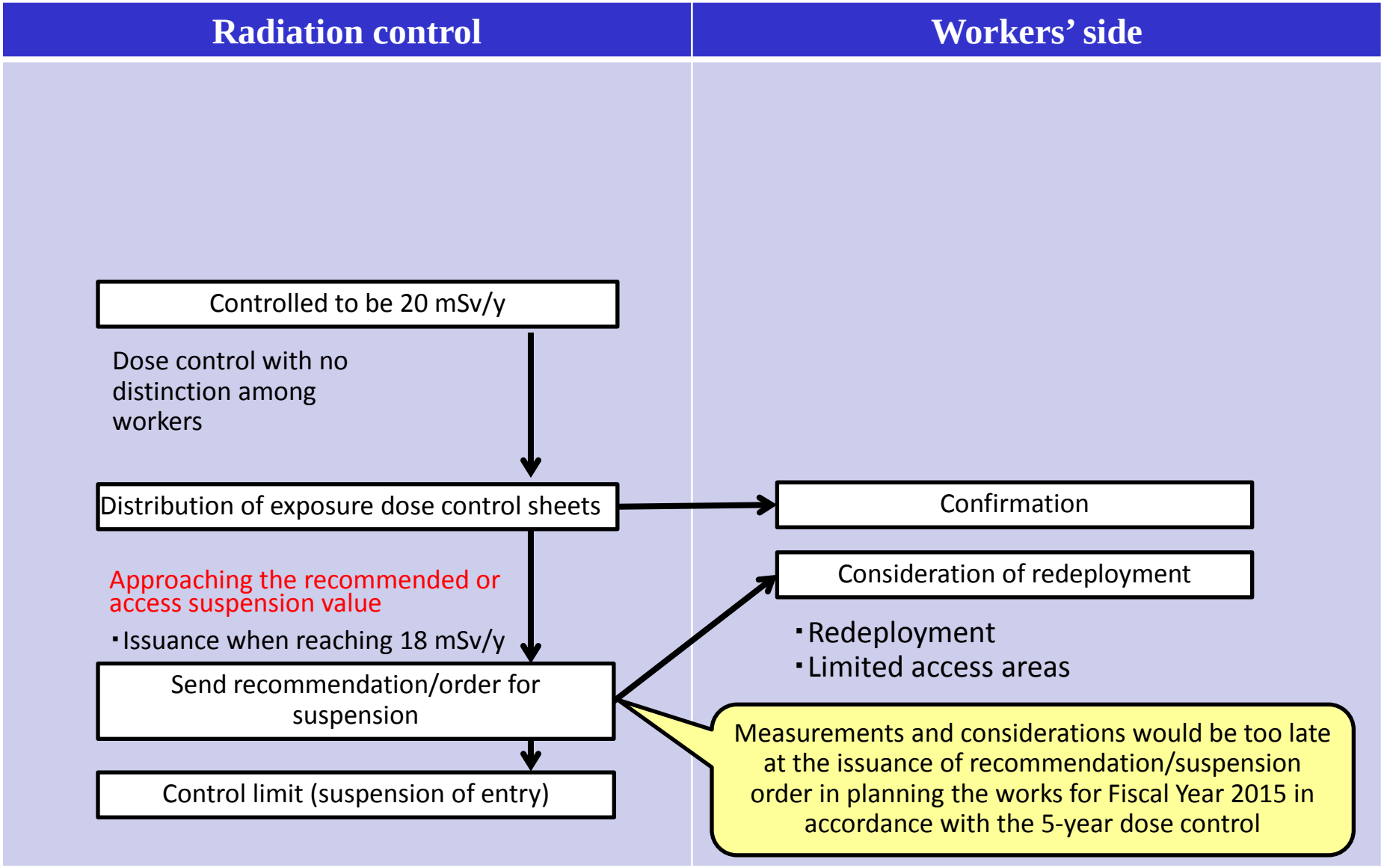
↓

Dose reduction with respect to the environment

↓

Consideration and implementation of exposure dose reduction measures

Control method (previous)



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Control method (previous)

Radiation control	Workers' side

Target value needs to be set at an early stage for individual dose control, taking into account the cumulative exposure dose already received and the (planned) future works.

Controlled to be 20 mSv/y

Dose control with no distinction among workers

Distribution of exposure dose control sheets

Confirmation

Approaching the recommended or access suspension value

・Issuance when reaching 18 mSv/y

Consideration of redeployment

・Redeployment
・Limited access areas

Send recommendation/order for suspension

Measurements and considerations would be too late at the issuance of recommendation/suspension order in planning the works for Fiscal Year 2015 in accordance with the 5-year dose control.

Control limit (suspension of entry)

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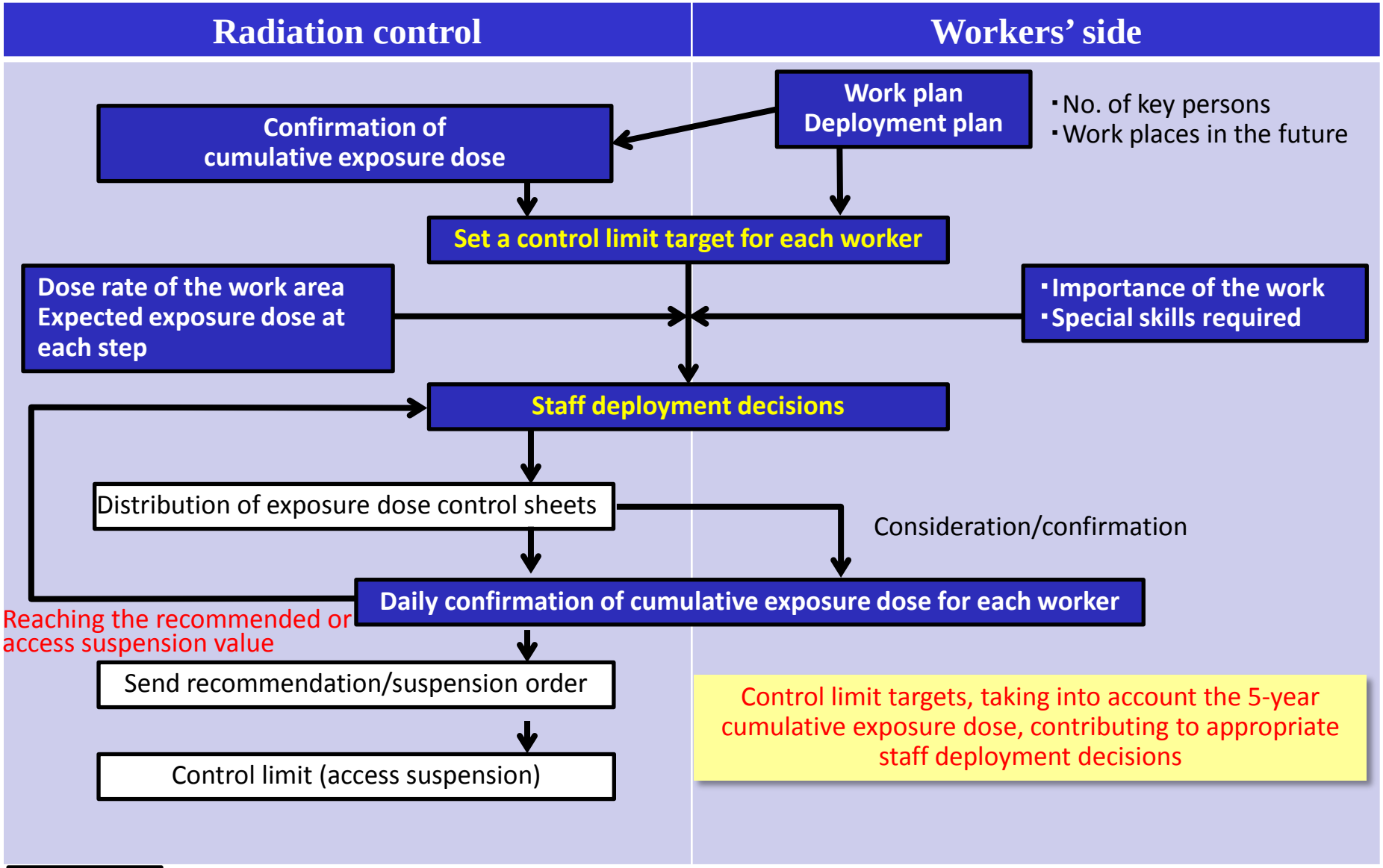
Control method (in this treatment)



4.1 Individual exposure dose control

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Control method (implemented)

Daily confirmation of cumulative exposure dose for each worker

Managed not only with a system but also by each subcontractor

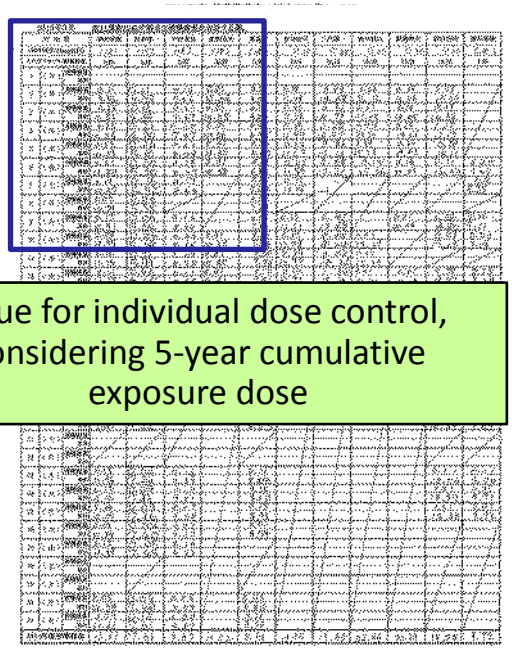
March 2015

Worker			Ichiro Hitachi	Jiro Hitachi	Saburo Hitachi
Annual control limit			**18**	**10**	**30**
Cumulative exposure dose received by 28 Feb.			9.45	4.42	22.28
1	(Sun.)	Exposure dose			
		Cumulative			
2	(Mon.)	Exposure dose	0.36	0.40	1.11
		Cumulative	**9.81**	**4.82**	**23.39**
3	(Tues	Exposure dose	0.25	0.20	0.94
		Cumulative	**10.06**	**5.02**	**24.33**
4	(Wed.	exposure dose	0.23	0.21	0.89
		Cumulative	**10.29**	**5.23**	**25.22**

Cumulative exposure dose of the year received by the end of the previous month

Exposure dose of the day

Value for individual dose control, considering 5-year cumulative exposure dose



(Prepared by each subcontractors)

Cumulative expsosure dose of the year

Daily confirmation of the cumulative exposure dose

Daily coordination of staff deployment

Dose control of 70 mSv, achieved at the end of Fiscal Year 2014 by frequent confirmation and instruction

4.2 Measures for exposure dose reduction

Exposure dose reduction measures are required with respect to the environment to reduce the exposure dose for key persons

↓

Drastic measures are also required especially in areas of high dose rate

↓

Measures related to specification and methods of construction, in addition to decontamination and shielding

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① Implementation of exposure reduction measures (reduction by design modification)

Change of piping routes at the Matsuno-roka (corridor) in T/B of Unit 1

Initial plan

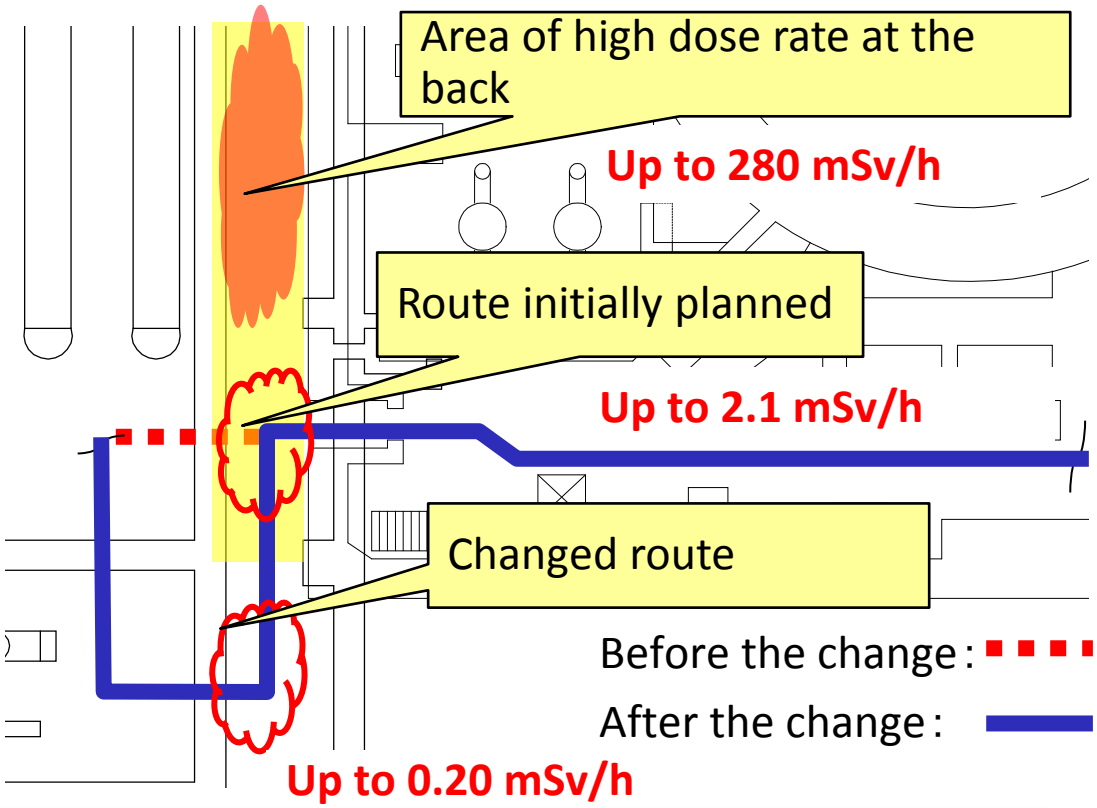
Penetration works at areas of high dose rate

Expected exposure from the whole works:

1020 man·mSv

Large exposure dose especially when removing interfering objects

Expected exposure from the removal of interfering objects : 760 man·mSv



Possibility of significant exposure reduction from the removal of interfering objects by making a detour for the piping route to pass areas of low dose rate

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① Implementation of exposure reduction measures (reduction by design modification)

Change of piping routes at the Matsuno-roka (corridor) in T/B of Unit 1

Study on the effect of changing the route

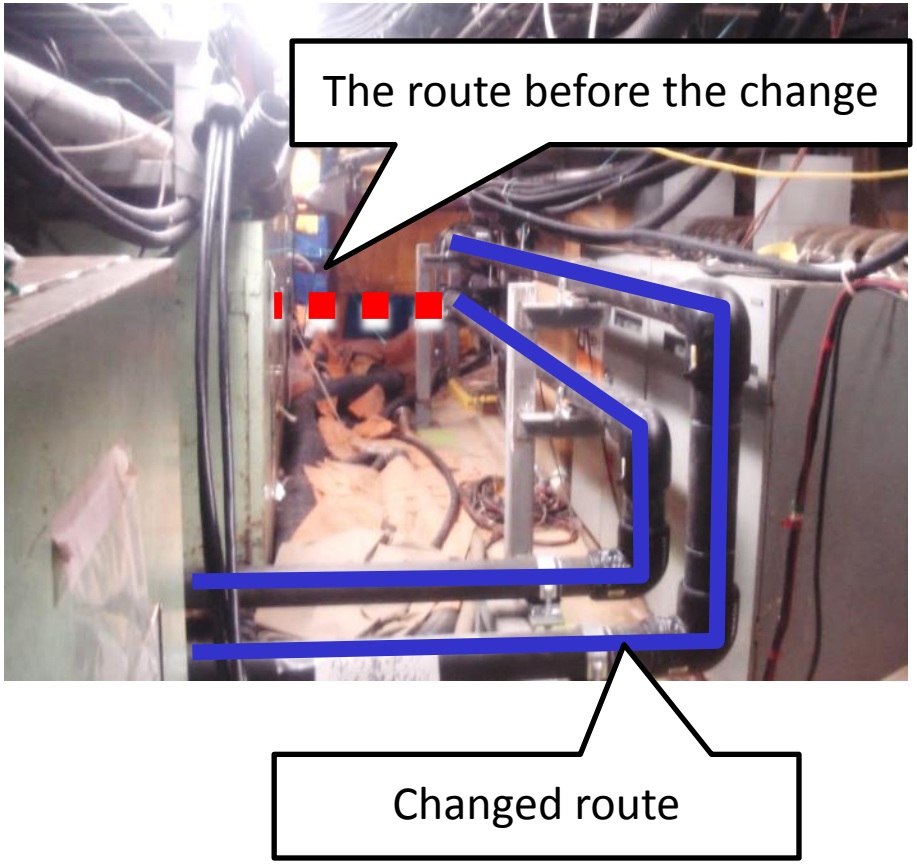
↓ Exposure dose reduction, expected to be 400 man-mSv or more

↓ Effects expected to be large

Changing the route, consideration of design change

↓ Design change feasible

Implementation



Significant exposure dose reduction. Reduced by about 510 man·mSv.

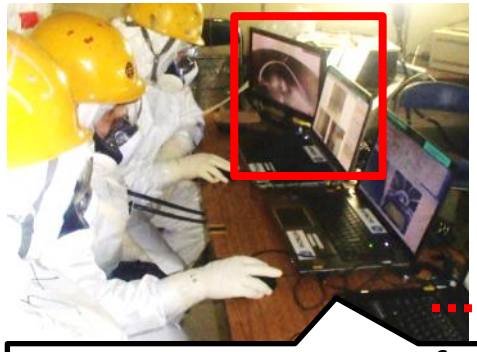
② Implementation of exposure reduction measures (reduction by improving methods)

Remote monitoring of NW area of R/B in Unit 1

Up to 1.3 mSv/h

Installation of a monitoring camera in the work area

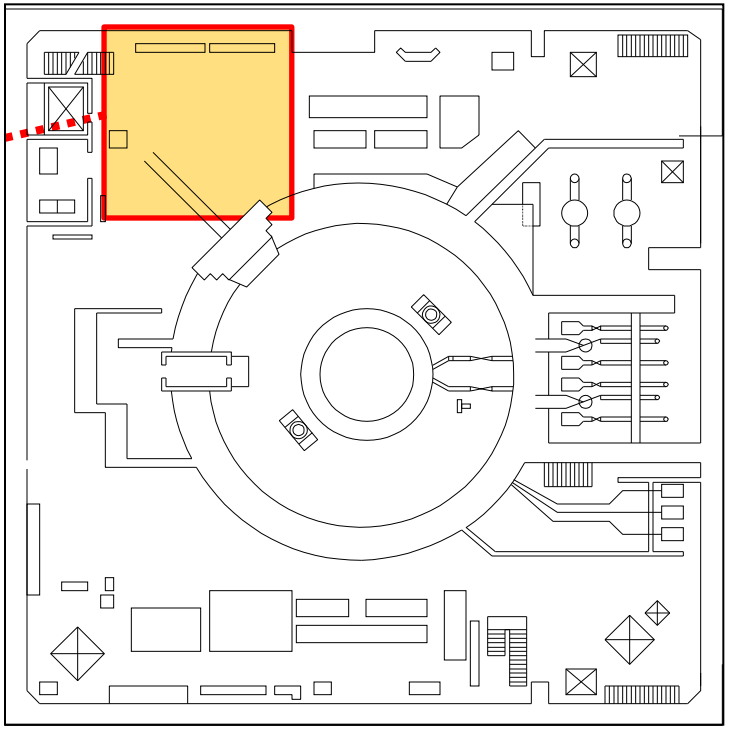
Monitoring area



Monitoring areas of low dose rate

Monitoring area

Up to 0.10 mSv/h



Exposure dose reduction measure, required for supervisors → Consideration of introducing remote monitoring → Consideration of the effect on reduction → Implementation

Reduced by about 90 man·mSv: significant reduction of exposure for supervisors

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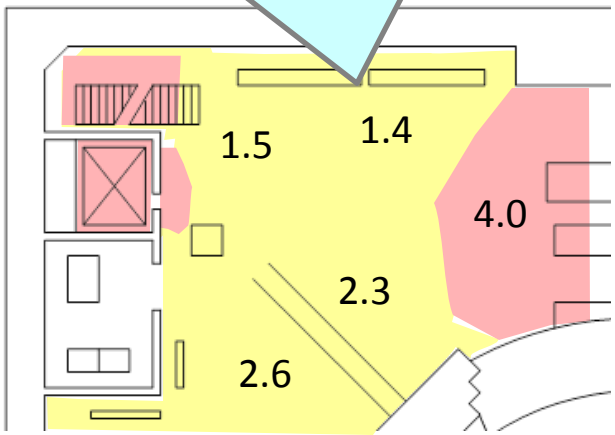
③ Implementation of exposure reduction measures (reduction of dose rate by shielding, etc.)

Decontamination/shielding at the NW area of the R/B in Unit 1

Expected that the radiation exposure is the highest for the works conducted in this area among all works



(mSv/h)

Initial exposure dose rate: **Ave. 2.2 mSv/h**

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③ Implementation of exposure reduction measures (reduction of dose rate by shielding, etc.)

Decontamination/shielding at the NW area of the R/B of Unit 1

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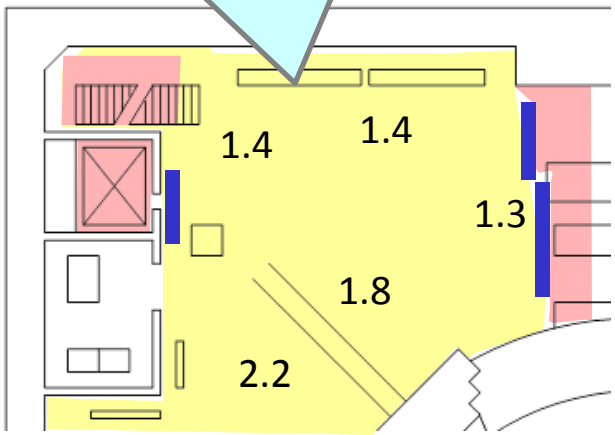

(mSv/h)

: Shielding (2- to 4-fold lead with 3 mm thickness)

Initial exposure dose rate: **Ave. 2.2 mSv/h**

After decontamination/shielding: **Ave. 1.6 mSv/h**

HITACHI

③ Implementation of exposure reduction measures (reduction of dose rate by shielding, etc.)

Decontamination/shielding at the NW area of the R/B of Unit 1

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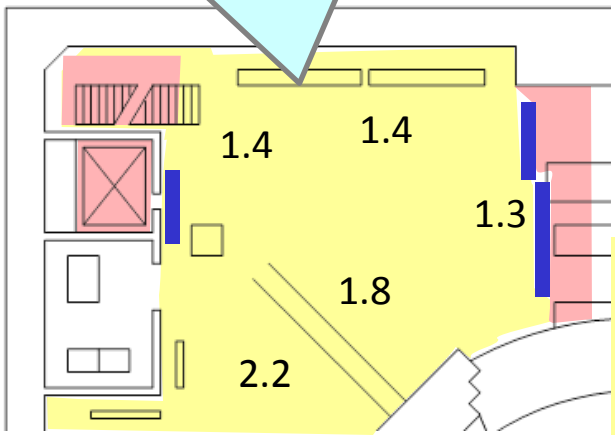

(mSv/h)

: Shielding (2- to 4-fold lead with 3 mm thickness)

Initial exposure dose rate: **Ave. 2.2 mSv/h**

After decontamination/shielding: **Ave. 1.6 mSv/h**

Further reduction measures considered

(Target: 1 hour of work, aiming at individual dose to be 1 mSv or lower per one day)

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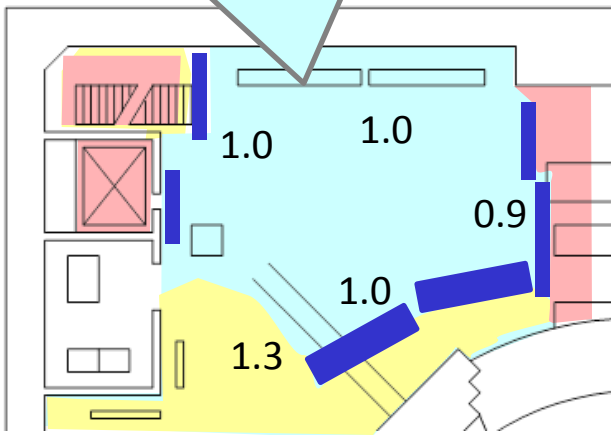
③ Implementation of exposure reduction measures (reduction of dose rate by shielding, etc.)

Decontamination/shielding at the NW area of the R/B of Unit 1

Expected that the radiation exposure is the highest for the works conducted in this area among all works



(mSv/h)

Initial exposure dose rate: **Ave. 2.2 mSv/h**

After decontamination/shielding: **Ave. 1.6 mSv/h**

Further reduction considered
(Target: 1 hour of work, aiming at individual dose to be 1 mSv or lower per one day)

After additional shielding: **Ave. 1.0 mSv/h**

: Shielding (2- to 4-fold lead with 3 mm thickness)

Significant reduction of the exposure dose rate inthe area

Reduction rate: about 1,800 man·mSv

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③ Implementation of exposure reduction measures (reduction of dose rate by shielding, etc.)

Decontamination of the NW area
(before and after decontamination)

Before decontamination

After decontamination

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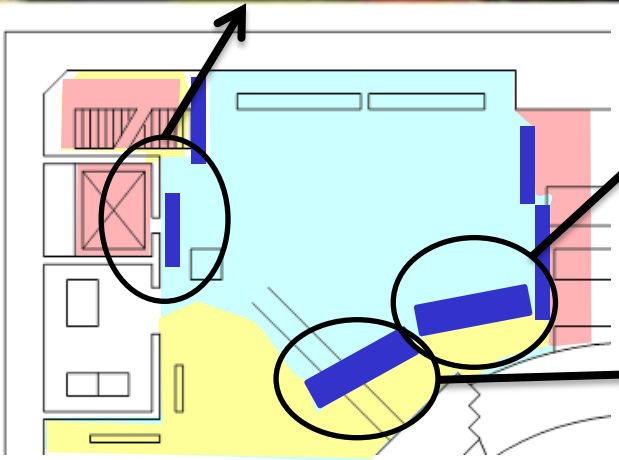
③ Implementation of exposure reduction measures (reduction of dose rate by shielding, etc.)

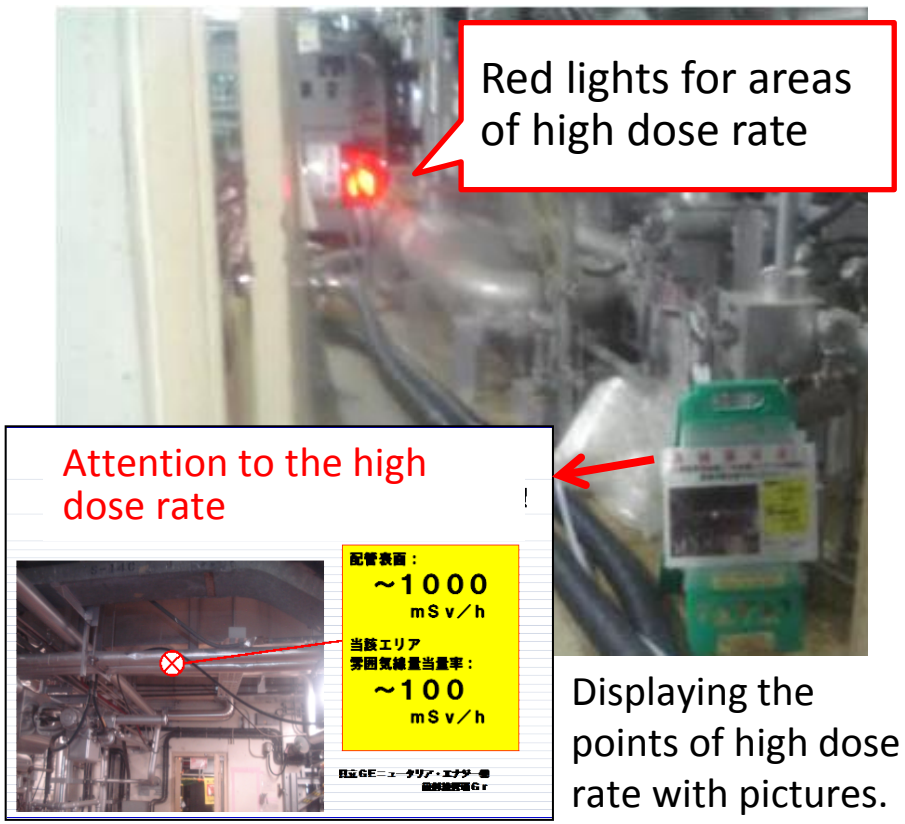
Shielding of the NW area in the R/B



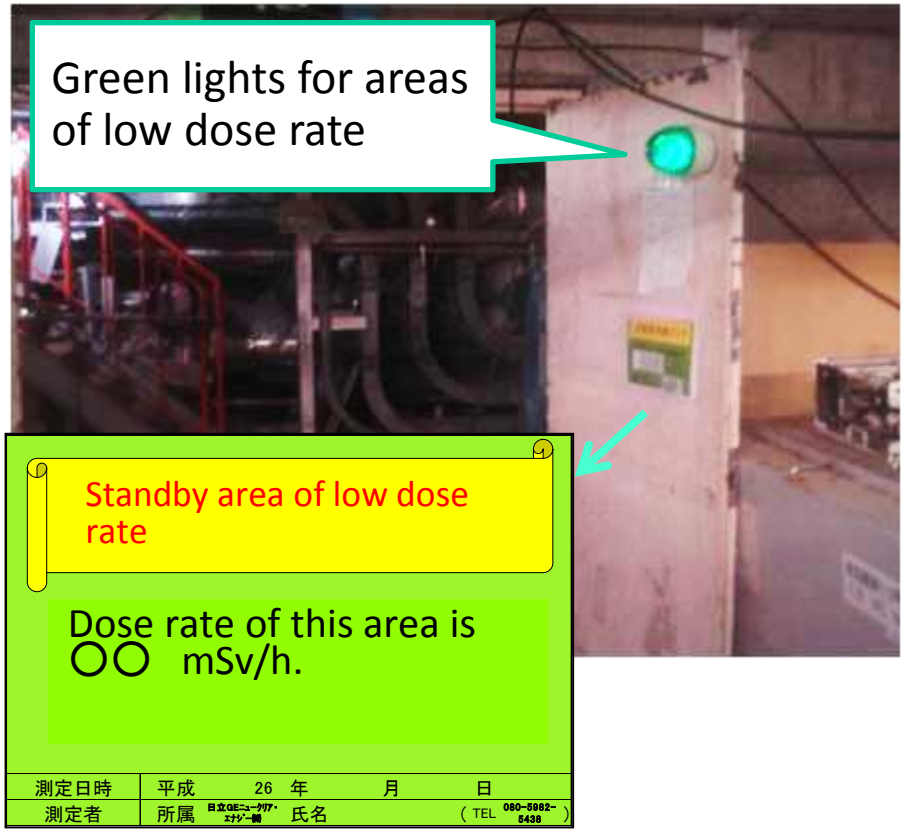
④ Exposure reduction measures (reduction by other measures)

Visualization of radiation environment (by indication with rotating beacon lights)

Reflection of a request by workers.



Displaying the points of high dose rate with pictures.



Significantly effective in preventing excess exposure in addition to exposure reduction.

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Results of exposure reduction measures

Reduction achieved by the major measures

Major exposure reduction measures	Man·mSv
① Change of the piping route at corridor in T/B of Unit 1	510
② Remote monitoring of NW area in R/B of Unit 1	90
③ Shielding and decontamination of NW area in R/B of Unit 1	1,800
Other measures (shielding, improvement of methods, etc.)	1,600
Reduction by implementation of measures (sub-total)	4,000
Reduction by modification of construction specifications, etc.	3,600
Total	7,600

Achievement of 4,800 man·mSv (as of 31 May) compared with the initial expectation of 12,400 man·mSv.

Significant reduction achieved for the exposure dose.

Individual exposure dose reduced for key persons as well.

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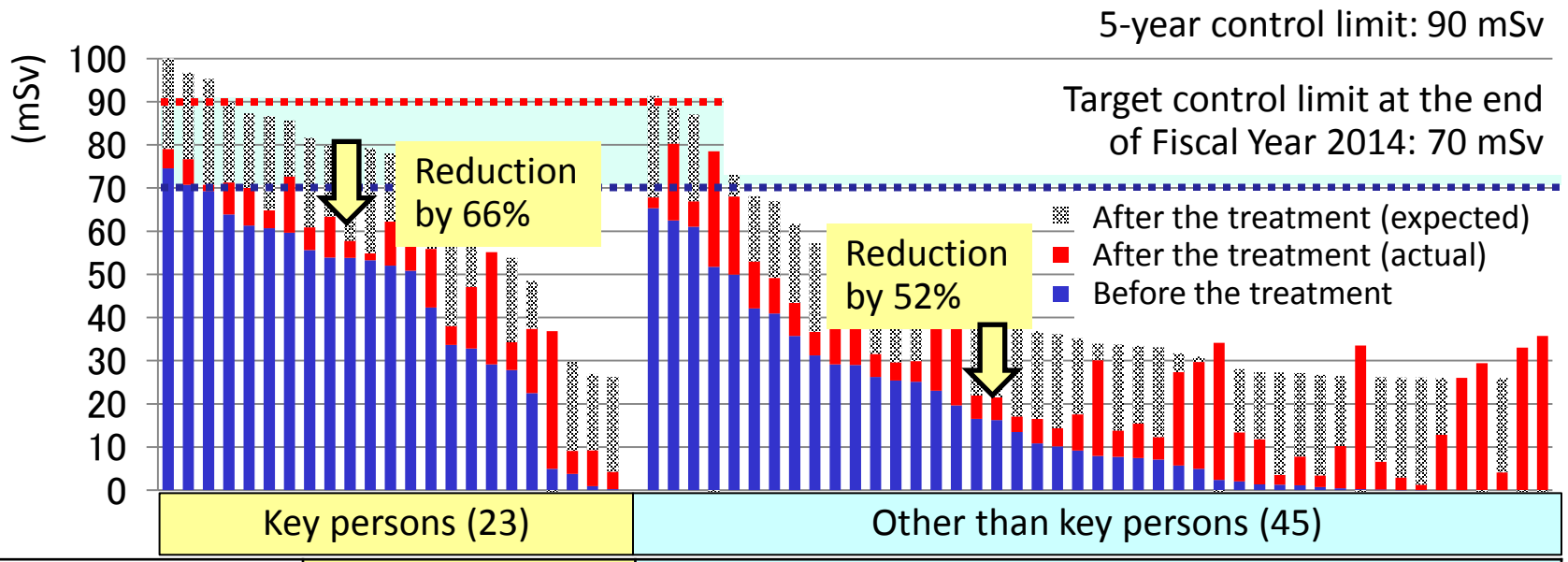
Achievement after the treatment (for supervisors)

After the treatment. Cumulative exposure dose since Fiscal Year 2011 (as of the end of Fiscal Year 2014)

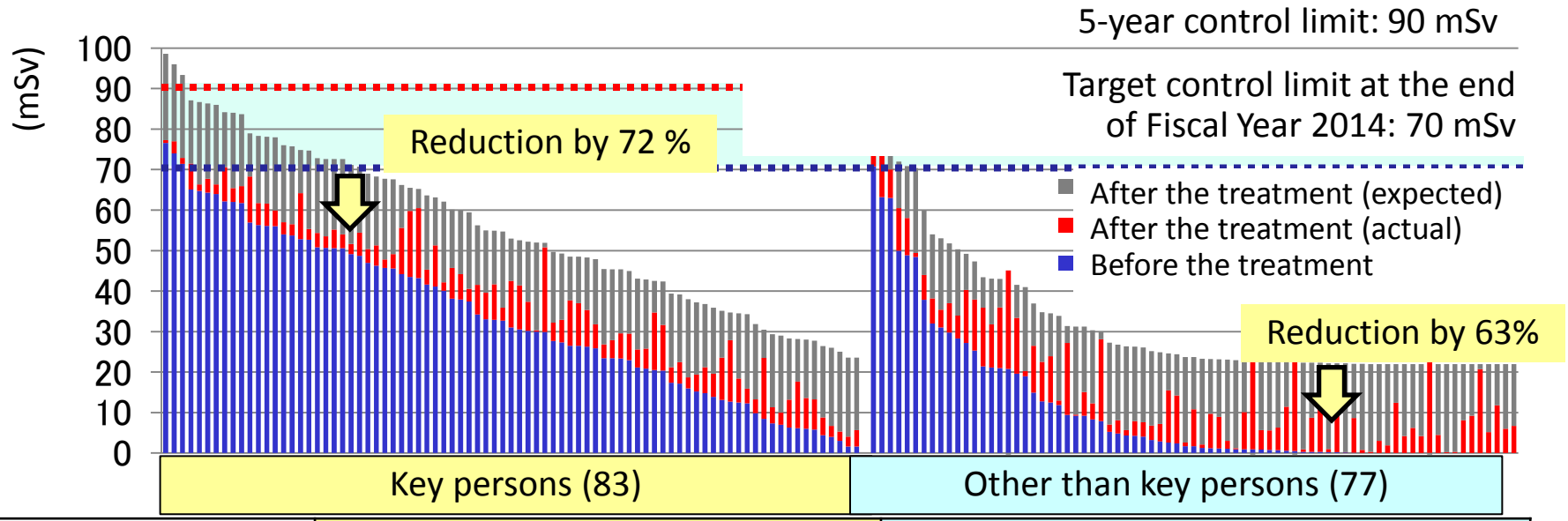


	Key persons	Other than key persons
No. of workers	23	45
> 90 mSv	0	0
> 70 mSv	6	2

The allowable exposure dose for works in Fiscal Year 2015 has been reserved for key persons in accordance with the 5-year control limit owing to the results achieved by the individual dose control and the exposure reduction measures.

Achievement after the treatment (for group leaders)

After the treatment. Cumulative exposure dose since Fiscal Year 2011 (as of the end of Fiscal Year 2014)



	Key persons	Other than key persons
No. of workers	83	77
> 90 mSv	0	0
> 70 mSv	5	3

Similarly, the allowable exposure dose for works in Fiscal Year 2015 has been reserved for key persons among the group leaders.

5. Measures to prevent problems related to radiation control

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Workers with or without previous work experience at 1F or other nuclear facilities

- Severe radiation environments at 1F
- Expected that there would be many workers without previous work experience at 1F or other nuclear facilities

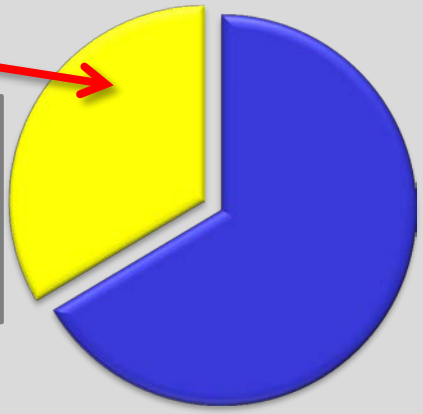
} There is a concern that problems related to radiation control may occur

[Actually…]

No work experience at 1F: 34%

Among them:
With work experience at nuclear facilities: 23%
No work experience at nuclear facilities: 77%
(25% of all workers)

Many workers without previous work experience at nuclear facilities, as expected.



Preventive measures, required against problems related to radiation control → Provision of a new education program considered

Physical experience education →

The hands-on “experience education of radiation control related to dangers” was developed.

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The “experience education of radiation control related to dangers” - 1

Experience of body contamination

Recognizing contamination with fluorescent paints representing contamination, by irradiating with black light.
Experiencing surface contamination when assistance is or is not available in wearing and removing the protective clothing.

Experience of APD alarm sound

Experiencing the APD alarm sound, which is unusual in daily life, using an APD demonstration device.

Experiencing how the alarm sound is heard in the presence or absence of noise.

APD: Alarmed Pocket Dosimeter

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The “experience education of radiation control related to dangers” - 2

Experience of exposure dose reduction

Use of natural a radiation source

- Dose reduction with respect to distance from the source
- Dose reduction by shielding

Experience of checking for full-face mask leaks

Use of a mask and the fit checker

- Check for fitness of the mask
- Experiencing leaks when fitting of the mask

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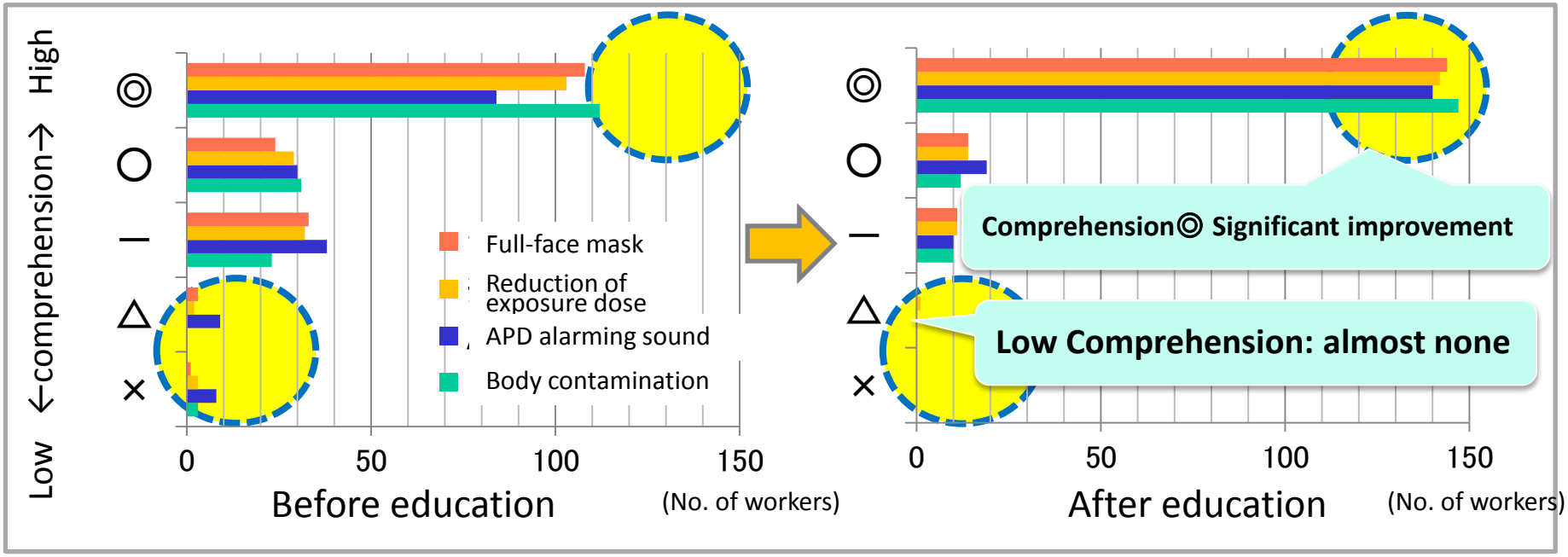
Effects and results of the “experience education of radiation control related to dangers”

Provided a total of 5 times to 184 workers.

Workers’ improved comprehension, confirmed by questionnaire results after the education experience



No (“zero”) problem has occurred related to radiation control owing to “experience education of radiation control related to dangers” and other activities to prevent problems.

6. Summary

1) By administrative measures including the setting of a target value of the dose control for each of the workers taking into consideration of their 5-year cumulative exposure dose as well as staff deployment coordination, etc. and

measures with respect to the environment including decontamination, shielding, and specification and methods of construction,

the key persons may be able to continue engaging in both the current works and those for the Fiscal Year 2015 at 1F while controlling their exposure dose at 1F.

2) By providing the “experience education of radiation control related to dangers”,

no (“zero”) problem has occurred related to radiation control.

7. Challenges for the future

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1) Keeping and training of key persons

It is an important challenge to keep and train personnel to be key persons at the site in the long-run 1F decommissioning works.

2) Preventing problems related to radiation control

Continued preventive measures are required through provision of education to newly engaging workers as well as further improvement in comprehension of radiation control.

8. Conclusion

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・Steady progress has been made in the works related to the treatment of contaminated water owing to the progress in the treatment of accumulated water and the operation of the Advanced Liquid Processing System, etc.

・Works toward the 1F decommissioning are being implemented, such as the understanding of the situation by use of robots in investigating inside PCV of Unit 1.

・Toward the 1F decommissioning, the works are planned from now on to be conducted in high dose rate areas.

The radiation control activities, such as individual dose control and measures for exposure dose reduction, will become even more important.

The Hitachi group is committed to the works for the decommissioning of Fukushima Daiichi Nuclear Power Plant.


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