Commissioned by the Ministry of Health, Labour and Welfare
Project to Enhance the Radiation Exposure Dose Reduction Measures for Works Relating to the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Plant

Good Practices in Radiation Exposure Dose Reduction Measures

Issued in February 2024

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translator's note:

[1] '1F' means 'TEPCO's Fukushima Daiichi Nuclear Power Plant'.

[2] Strainer replacement work accompanied by alpha ray exposure prevention measures during water flow testing of equipment that transfers stagnant water in reactor buildings that containshigh concentrations of alpha nucleus.

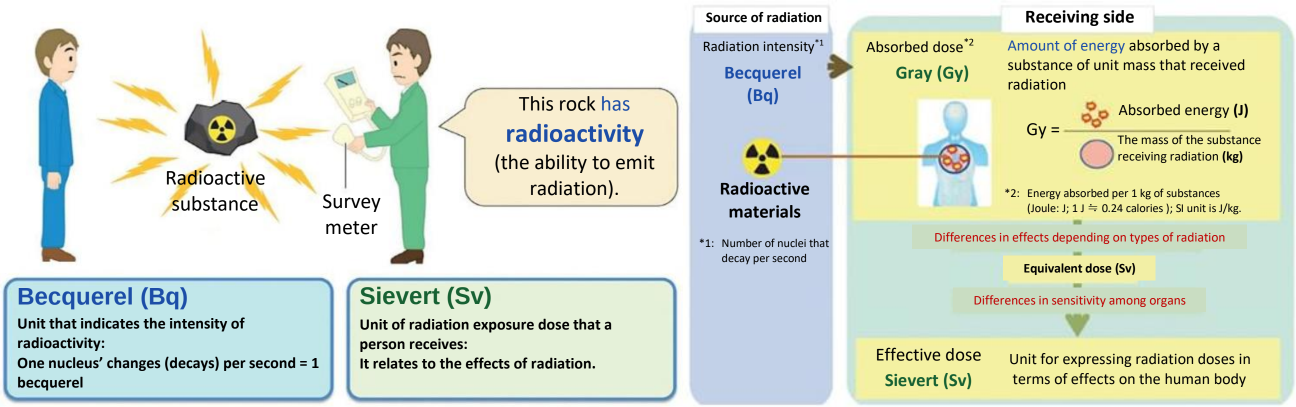
[3] Dust containing alpha nucleus.

1

Knowledge of measurement and assessment of the radiation environment of the workplace

(1) Units of radiation

The unit of radioactivity is the becquerel (Bq). As illustrated in the figure below, it represents the ability of a radionuclide to undergo nuclear transformation into other nuclei (referred to as decay or disintegration) per second. A comparable term is radioactive material. Radioactivity, a capacity, is used in the following manner: The radioactivity of 2 kg of radioactive material is 100 becquerels (Bq) and its concentration is 50 Bq/kg. A statement such as, “It was contaminated with radioactivity” or “Radioactivity was released” does not make good sense. The correct representation is that “Radioactive substances were released. The radioactivity of the released substances is 100 Bq.”



Material provided by the Ministry of the Environment of Japan; “BOOKLET to Provide Basic Information Regarding Health Effects of Radiation (2023)”.

Radioactive substances emit radiation to the surroundings. Radiation includes alpha (α) rays, beta (β) rays, gamma (γ) rays, and others. Gamma rays have strong penetrating power and are the primary cause of external exposure.

The table below summarizes the units of radiation exposure. These units are broadly classified into absorbed dose, which represents the energy absorbed by a material when exposed to radiation, and equivalent dose and effective dose, which represent the effect of radiation on the human body. Absorbed dose is a physical quantity used for both humans and objects. Effective dose is a unit for expressing stochastic effects, such as human cancer and genetic effects.

		Unit	Definition
Unit of radioactivity		Becquerel Bq	The number of radioactive decays per second (number/second)
Unit for measuring radiation exposure	Absorbed dose	Gray Gy	The amount of radiation energy absorbed in matter. A dose of 1 Gy corresponds to 1 joule (J) of energy absorbed by 1 kilogram (kg) of matter.
	Equivalent dose	Sievert Sv	The dose for each tissue or organ, measured in order to evaluate the effects of radiation exposure on the tissue or organ. Equivalent dose = absorbed dose × radiation weighting factor
	Effective dose	Sievert Sv	The value obtained by multiplying the equivalent dose of an organ or tissue by the tissue weighting coefficient (due to differences between organs and tissues). Dose for evaluating the stochastic effect of cancer or other diseases on the entire human body: Effective dose = Σ (equivalent dose × tissue weighting factor)

(2) Principles for radiation exposure protection

Reducing external exposure

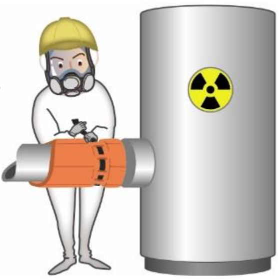
To reduce external exposure, it is important to understand the following four principles of radiation exposure protection.

Principle 1 Remove radioactive materials

Move radioactive materials or wash them out (flush them) from the inside of piping.

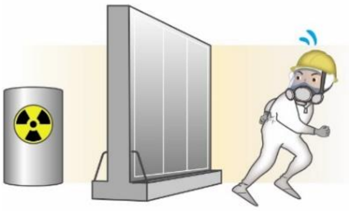
Principle 3 Install shielding

Cover radioactive equipment, piping and other items, with shielding materials such as leadwool or lead plates.



Principle 2 Maintain sufficient distance from radiation

If possible, move away from the radiation source. Do not go any closer to it than required. (Also remember where the waiting areas are.)



Principle 4 Reduce working time

Make sufficient preparations before conducting work, such as discussing the procedures involved or inspecting tools, so that work proceeds smoothly.

Preventing internal exposure

To reduce internal exposure, it is important to understand the following three principles of radiation exposure protection.

Principle 1 Contain the source of contamination

1. Install a pre-clean room, isolation doors, etc.
   Maintain the isolation functions (boundary) and manage the negative pressure.

2. Response to contaminants
   Pack contaminated materials and seal them in containers.

Pre-clean room

Taking off protective clothing

Taking off gloves and Tyvek

Principle3 Do not take contaminants into the body

1. Wear protective equipment
   Wear the required personal protective equipment. Fit the respiratory protective equipment properly, so that there are no leaks.

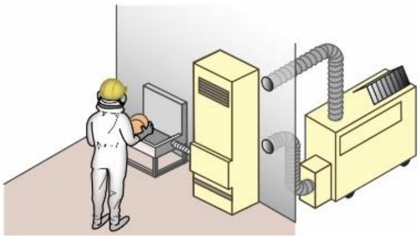
2. Prevention of physical contamination
   Ensure that protective equipment (masks, protective clothing, gloves, etc.) be removed or attached in such a way that it does not adhere to the body or underwear.

3. Move to safety
   In the event of injury, move to an uncontaminated area immediately.

Principle2 Do not allow contamination to spread

1. Identify contamination zones
   Clearly mark off contamination zones and regulate the access of workers and goods.

2. Use equipment and materials
   For work in areas where there is a risk of dust being blown around, use temporary shelters or exhaust fans with filters. At the boundary of the contamination zone, inspect for contamination on the body or underwear using a body surface monitor, etc.



2

Knowledge of setting up a travel flow line from the rest area to the work area

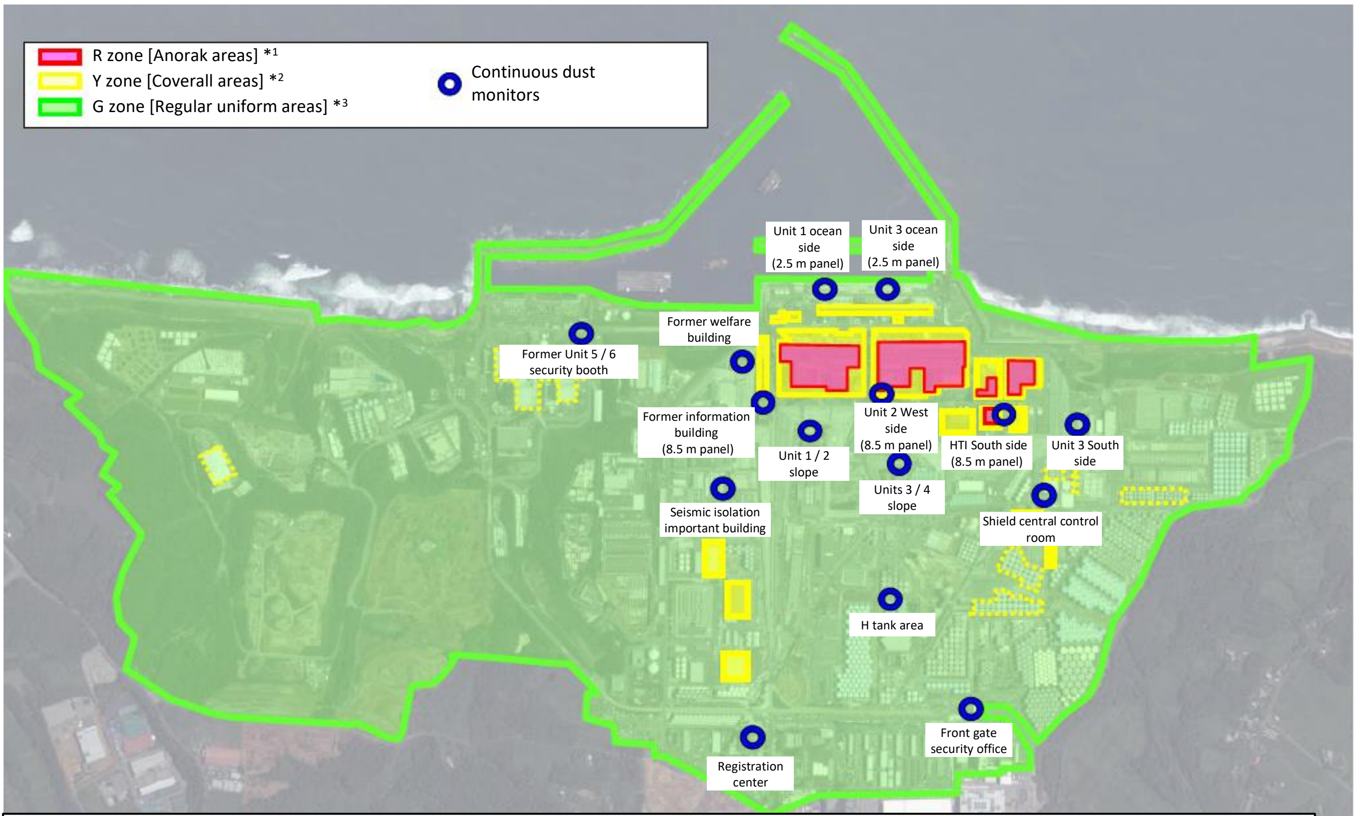
(1)1F site operation zone status

Zone		Protective Equipment
Red αZone **(Anorak areas)**	Work areas where the surface contamination density of alpha nuclides exceeds or is likely to exceed one-tenth of the surface concentration limit specified by law	・Full-face mask ・Coverall in one layer and Anorak ・Work boots (for R zone) ・Helmet (for R zone) ・Cotton gloves + rubber gloves ・Socks
Red Zone **(Anorak areas)**	・Inside the reactor buildings, the Units 1 to 3 ・Refers to areas such as the basement of the reactor building and turbine building that hold retained water (retained water stored in the water level stabilization area and retained water stored in the buildings), areas for decontamination of retained water, and areas where contaminated water is handled directly.	・Full-face mask ・Coverall in one layer and Anorak ・Work boots (for R zone) ・Helmet (for R zone) ・Cotton gloves + rubber gloves ・Socks
Yellow βZone **(Coverall areas)**	・Inside the buildings including water treatment facilities*1 ・Work in tanks containing concentrated brine/strontium-treated water and in tank transfer lines*2 ・Areas where the 70 µm dose equivalent rate (γ+β)/1 cm dose equivalent rate (γ) is 4 times or more	・Full-face mask ・Coverall single and Anorak ・Work boots (for Y zone) ・Helmet (for Y zone) ・Cotton gloves + rubber gloves ・socks
Yellow Zone **(Coverall areas)**	・Inside and around the buildings around the Units 1 to 4 ・Areas where highly concentrated dusty work or work involving the handling of contaminated water is conducted ・Areas to be set up as needed depending on the work environment	・Half-face mask ・Coverall ・Work boots (for Y zone) ・Helmet (for Y zone) ・Cotton gloves + rubber gloves ・Socks
Green Zone **(Regular uniform areas)**	・Areas where the concentration of radioactive materials in the air is not likely to exceed the mask-wearing standards with the exception of the White Zone, Yellow Zone, Yellow β Zone, Red Zone, and Red α Zone.	・DS2 mask ・regular work clothing ・Work boots (for G zone) ・Helmet (for G zone) ・Cotton gloves + rubber gloves, or work gloves ・Socks
White Zone	・Permanent rest areas, seismically isolated important buildings, and the main office building (Entrance/Exit Control Stations of the Units 1 to 4). ・Inside the filter unit of the temporary storage tank of the groundwater bypass ・Each temporary rest area	

*1: Excluding tank patrolling, field surveys during work planning, observation visits and work that does not involve the handling of concentrated salt water, etc.

*2: Certain light work (such as patrolling, monitoring, and transportation of items brought in from outside the premises)

(Taken from the website of Tokyo Electric Power Company Holdings, Incorporated.)



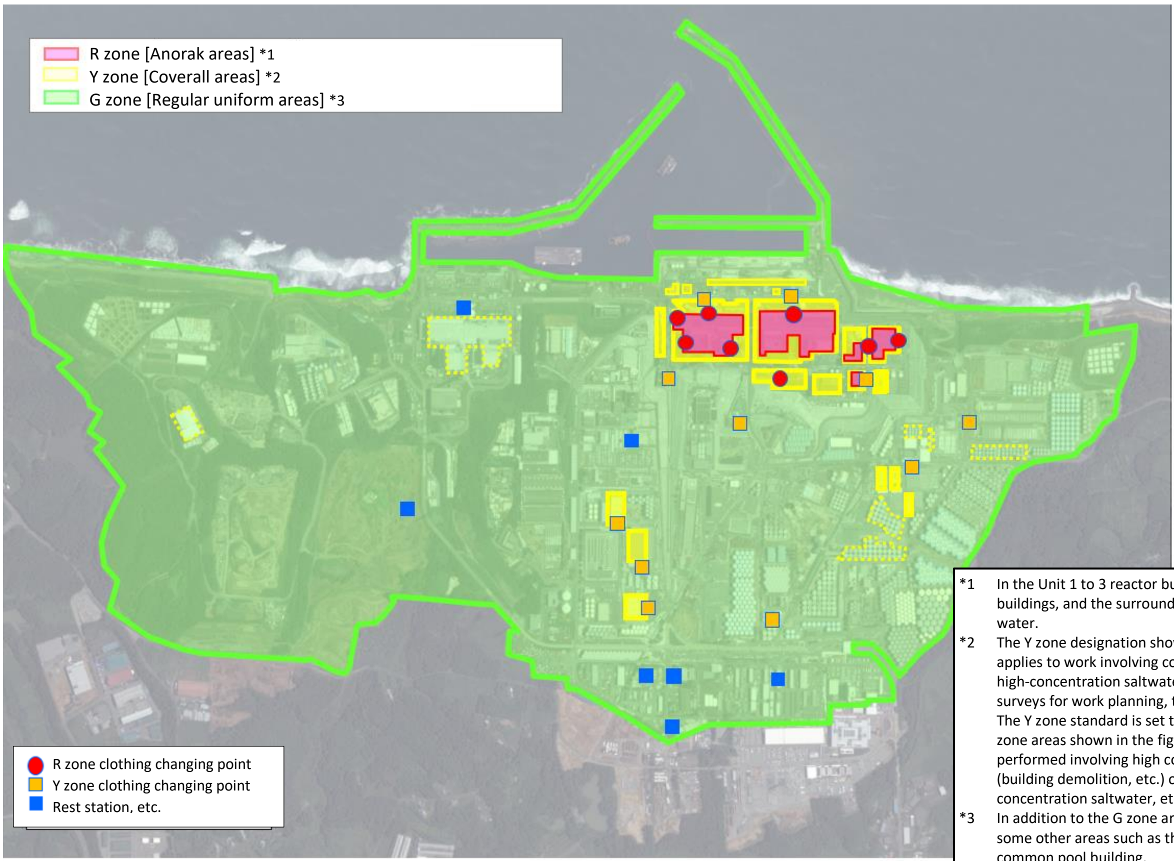
*1 In the Unit 1 to 3 reactor buildings, the Unit 1 to 4 turbine buildings, and the surrounding buildings, areas with retained water.

*2 The Y zone designation shown by the yellow dotted lines applies to work involving contamination, such as handling of high-concentration saltwater. For work such as patrols or site surveys for work planning, the G zone standard applies.
The Y zone standard is set temporarily even outside the Y zone areas shown in the figure, in G zone areas, when work is performed involving high concentration particulate matter (building demolition, etc.) or on tank transfer lines for high concentration saltwater, etc.

*3 In addition to the G zone areas shown in the figure, covers some other areas such as the second and third floors of the common pool building.

Provided by: JAPAN SPACE IMAGING CORPORATION, (C)DigitalGlobe

(2) Locations of each area, and of clothing changing points



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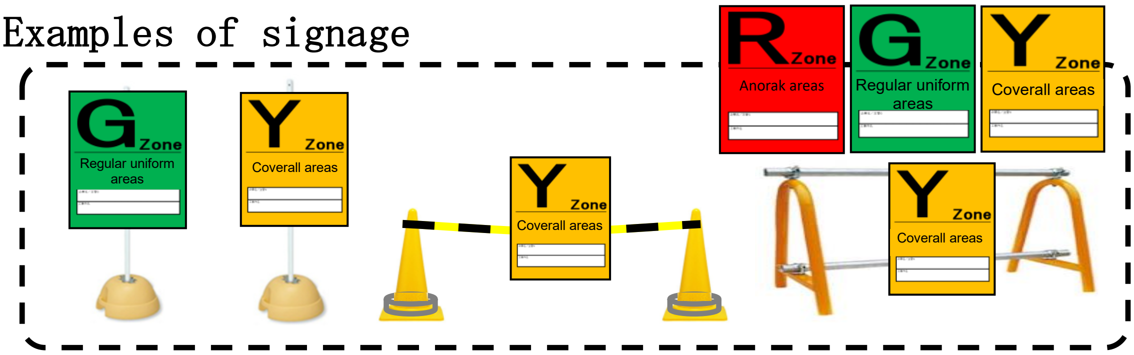
（Material provided by Tokyo Electric Power Company Holdings, Inc.）

(3)Basic items of operation zone management

🟥 **R Zone (Anorak areas)**	Work areas where the surface contamination density of alpha nuclides exceeds or is likely to exceed one-tenth of the surface concentration limit specified by law
	・Inside the reactor buildings, the Units 1 to 3 ・Refers to areas such as the basement of the reactor building and turbine building that hold retained water (retained water stored in the water level stabilization area and retained water stored in the buildings), areas for decontamination of retained water, and areas where contaminated water is handled directly.
🟨 **Y Zone (Coverall areas)**	・Inside the buildings including water treatment facilities*1 ・Work in tanks containing concentrated brine/strontium-treated water and in tank transfer lines*2 ・Areas where the 70 μm dose equivalent rate ($\gamma+\beta$)/1 cm dose equivalent rate (γ) is 4 times or more
	・Inside and around the buildings around the Units 1 to 4 ・Areas where highly concentrated dusty work or work involving the handling of contaminated water is conducted ・Areas to be set up as needed depending on the work environment
🟩 **G Zone (Regular uniform areas)**	・Areas where the concentration of radioactive materials in the air is not likely to exceed the mask-wearing standards with the exception of the White Zone, Yellow Zone, Yellow β Zone, Red Zone, and Red α Zone.

For easy identification of different zones, such as Yellow and Green zones, any of the signs shown on the below will be displayed.

Examples of signage



(4)Protective equipment for each area

R Zone Anorak areas	Y Zone Coverall areas	G Zone Regular uniform areas
Full-face mask 	Full-face mask or Half-face mask *1 *2  	DS2 mask 
Coverall and Anorak 	Coverall 	regular work clothing 

*1 For work at water treatment facilities including Advanced Liquid Processing System (ALPS), etc., a full-face mask is required. This does not apply to inspection work.

*2 A full-face mask must be work during all work in tank areas containing concentrated salt water or treated Sr water (with the exception of work not involving concentrated salt water, patrols, site surveys, and inspections during work planning) and during work related to transfer lines.

（Material provided by Tokyo Electric Power Company Holdings, Inc.）

3

Good Practices

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<tr><th colspan="3">Location</th><th colspan="3">Category</th><th colspan="2" rowspan="6">Good Practices in Radiation Exposure Dose Reduction Measures</th></tr>
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<tr><td>Inside turbine building</td><td>T B</td><td>2</td><td>Distance</td></tr>
<tr><td>R　ZONE</td><td>R</td><td>3</td><td>Shielding</td></tr>
<tr><td>Y　ZONE</td><td>Y</td><td>4</td><td>Removing radiation source</td></tr>
<tr><td>G　ZONE</td><td>G</td><td>5</td><td>Remote-control, robot operation</td></tr>
<tr><td rowspan="2">Other ( )</td><td rowspan="2">Z</td><td>6</td><td>Preventing spread of contamination</td><td rowspan="2">No.</td><td rowspan="2"></td></tr>
<tr><td>7</td><td>Other</td></tr>
</table>

<table>
<tr><th>Title</th><td colspan="4">Mock-up verification of cable laying work inside the Unit 2 reactor building</td></tr>
<tr><th>Work location</th><td colspan="4">Inside the reactor building, the Unit 2</td></tr>
<tr><th>Overview</th><td colspan="4">Verification of radiation exposure reduction during cable installation work inside the Unit 2 reactor building using a full-scale mock-up</td></tr>
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<tr><td>Population radiation exposure dose (person-mSv)</td><td>529 (Projected)</td><td>384 (Projected)</td></tr>
<tr><td>Person time (person-day)</td><td>---</td><td>---</td></tr>
<tr><th>Good Practice Description</th><td colspan="4"></td></tr>
</table>

- The work is scheduled to lay approximately 300 cables and hoses inside and outside the Unit 2 reactor building to the arm-type equipment and related apparatus to be used to investigate the inside of the primary containment vessel (PCV).
- Of these, approximately 180 cables and hoses must be safely installed in the reactor building under high radiation doses without damaging the cables and hoses within a limited working time.　Before actually starting the work, we conducted a thorough desk study with our business partners on the plan for "radiation dose reduction" and optimized the work process from the following perspectives. Subsequently, in August 2023, the feasibility of this optimized plan was confirmed at the Naraha Remote Control Technology Development Center of the Japan Atomic Energy Agency (JAEA) using a full-scale mock-up of the area around the cable laying. Confirmation using this mock-up showed that the plan had a significant effect on reducing exposure doses (from 529 person-mSv to 384 person-mSv)

  [Proposed exposure reduction]

  (1) Reduction of the number of cable-laying crews by utilizing alternative fixtures
  (2) Optimization of the grouping of approximately 180 cables and hoses and the laying order of each bundle
  (3) Streamlining of cable-laying work by improving the cable-laying route
  (4) Optimization of separation and alignment of cables

- We will feed back the results of the verification of the radiation exposure reduction plan using this mock-up into our training plan. Then, the workers will be trained prior to the on-site construction to ensure their proficiency.

* This project is conducted as part of the work of the International Research Institute for Nuclear Decommissioning (IRID).

Edited by Mitsubishi Heavy Industries, Ltd.

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<tr><td>Inside reactor building</td><td>R B</td><td rowspan="7">Y , G</td><td rowspan="7">1 , 3 , 6</td><td>[✓ 1]</td><td>Time</td></tr>
<tr><td>Inside turbine building</td><td>T B</td><td>2</td><td>Distance</td></tr>
<tr><td>R ZONE</td><td>R</td><td>[✓ 3]</td><td>Shielding</td></tr>
<tr><td>Y ZONE</td><td>[✓ Y]</td><td>4</td><td>Removing radiation source</td></tr>
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<tr><td>7</td><td>Other</td></tr>
</table>

Title	Measures for radiation exposure dose reduction and contamination prevention during boring investigation
Work location	The entire premises of the Fukushima Daiichi Nuclear Power Plant(FNDPP), with a particular focus on the sea side of the Units 2 and 3 and the vicinity of the former contaminated water tank group
Overview	To reduce radiation exposure during drilling surveys, we have established and are operating dose monitoring, hand protection, and evacuation systems. Furthermore, measures are implemented to prevent the contamination of uncontaminated geological layers with borings.

			Before Implementation	After Implementation
Assessment (Qualitative / quantitative)	Effects	Population radiation exposure dose (person-mSv)	-	-
		Person time (person-days)	-	-
Good Practice Description				

○ Description

- On the grounds of the Fukushima Daiichi Nuclear Power Plant, there are places where the soil and groundwater are contaminated, such as on the seaward side of the Unit 2 to 3, and near tanks where contaminated water has leaked in the past. Elsewhere, contamination of the original topsoil layer under the embankment (former topsoil) has been found during construction in the past.
- Due to the machine structure and the characteristics of work involved in boring investigations, workers may come into close contact with soil and groundwater (muddy water) during exploratory drilling and excavation (mud circulation, sample collection, etc.). Thus, the implementation of dose monitoring and hand protection is employed to reduce the exposure of drilling engineers from the potential contamination of the former topsoil, ground, and groundwater. Furthermore, an evacuation system has been established in the event of an emergency.


Dosimetry of former ground surface


Dosimetry of obtained samples


Wearing thick rubber gloves


Contamination prevention measures

- Contamination prevention measures are implemented to ensure that radioactive materials on the ground surface and in contaminated soil and groundwater are not transferred to lower, uncontaminated ground layers.

○ Effectiveness of countermeasures

- In the past, there have been several instances where high-dose ground was encountered. However, by implementing thorough measures to reduce radiation exposure, no drilling engineers have been overexposed.
- No contamination resulting from boring investigation has been identified in the ground layers.

Edited by Oyo Corp.

Location			Category			
Inside reactor building	[✓ RB]	RB R Y	1 3 5 7	[✓ 1]	Time	Good Practices in Radiation Exposure Dose Reduction Measures
Inside turbine building	TB			2	Distance	
R ZONE	[✓ R]			[✓ 3]	Shielding	
Y ZONE	[✓ Y]			4	Removing radiation source	
G ZONE	G			[✓ 5]	Remote-control, robot operation	
Other ( )	Z			6	Preventing spread of contamination	No.
				[✓ 7]	Other	

Title	Dose reduction initiatives in RCW system dose reduction measures
Work location	Fukushima Daiichi Nuclear Power Plant the Unit 1 Reactor Building (1FL,3FL)
Overview	To reduce the radiation exposure to and burden on workers when sampling residual water in RCW-Hx, which has been confirmed to have a high radiation dose, remote operation, remote monitoring, shielding, and training were conducted.

			Before Implementation	After Implementation
Assessment (Qualitative / [✓ quantitative])	Effects	Population radiation exposure dose (person-mSv)	3,240	1,020
		Person time (person-day)	3,000	2,150

Good Practice Description	

- Purpose of operation

As measures to reduce the radiation dose in the RCW heat exchanger, which has been confirmed to have a high radiation dose, sampling of the residual water in the exchanger will be conducted to obtain the information necessary to formulate a drainage plan before draining the highly contaminated residual water.

○ Air dose rate around RCW heat exchanger: > 1,000 mSv/h
○ Air dose rate in the work area: approx. 3.0 mSv/h
○ Remote control/monitoring area: approx. 0.01 mSv/h

- Measures for radiation exposure dose reduction

[Utilization of remote monitoring system and low-dose areas]

Reduce entry into high-dose areas by remotely confirming work progress and providing instructions

[Utilization of remote control and low-dose areas]

The remote operation of equipment allows for the reduction of workers entering high-dose areas.

[Shielding]

Partition shields are placed in the work area to prevent dose contributions from the surrounding environment.

[Time reduction (route optimization)]

The best access route is selected according to the air dose rate and work content to reduce staying time.

[Mock-up training]

By optimizing the personal allocation and improving work proficiency, the time spent working in high-dose areas is reduced.

- Effects of the implementation of the measures to radiation exposure dose reduction

Before implementing reduction measures[*1]: Approx. 3,240 person-mSv

After implementing reduction measures[*2]: Approx. 1,020 person-mSv

Reduction effect: Approx. 2,220 person-mSv

*1: Evaluated value excluding additional work

*2: Actual results excluding additional work

Remote monitoring and operation area and work status

Utilization of partition shields

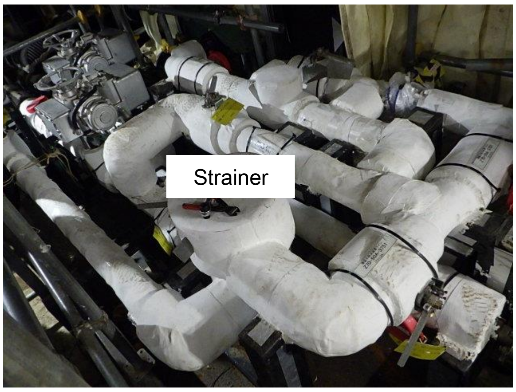
Pre-work training situation

Edited by GE Hitachi Nuclear Energy

Location			Category			
Inside reactor building	R B	Y	1、6	[✓ 1]	Time	Good Practices in Radiation Exposure Dose Reduction Measures
Inside turbine building	T B			2	Distance	
R ZONE	R			3	Shielding	
Y ZONE	[✓ Y]			4	Removing radiation source	
G ZONE	G			5	Remote-control, robot operation	
Other ( )	Z			[✓ 6]	Preventing spread of contamination	No.
				7	Other	

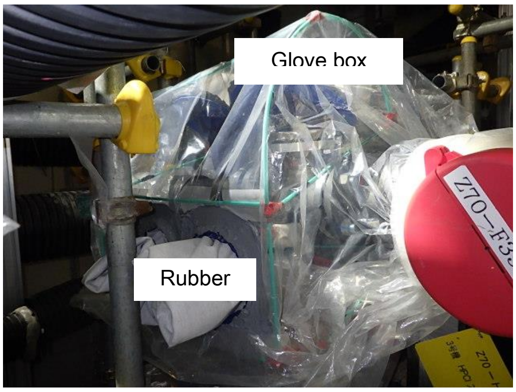
Title	Reducing radiation exposure in flow tests of alpha countermeasures for the strainer on the retained water transfer equipment [1]			
Work location	The Unit 3: Waste basement storage building (FSTR), 1st floor			
Overview	We tried to reduce radiation exposure by making a glove box for the replacement of the strainer of the retained water transfer equipment.			
Assessment (Qualitative / [✓ quantitative])	Effects		Before Implementation	After Implementation
		Population radiation exposure dose (person-mSv)	95.6	54.4
		Person time (person-day)	-	-
Good Practice Description				

The replacement of strainers and other components installed in the retained water transfer equipment was carried out in the glove box. This shortens the work time for covering the work area and prevents contamination from spreading to the work area, thereby reducing radiation exposure.



Retained water transfer equipment

(Working environment: to 0.35 mSv/h)



Installation of a glove box to strainers, etc.

Edited by GE Hitachi Nuclear Energy

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[1] translator's note: Strainer replacement work accompanied by alpha ray exposure prevention measures during water flow testing of equipment that transfers stagnant water in reactor buildings that contains high concentrations of alpha nucleus.

Location			Category			
Inside reactor building	R B	R,Z	5,6	1	Time	Good Practices in Radiation Exposure Dose Reduction Measures
Inside turbine building	T B			2	Distance	
R ZONE	[✓ R]			3	Shielding	
Y ZONE	Y			4	Removing radiation source	
G ZONE	G			[✓ 5]	Remote-control, robot operation	
Other (PCV 内)	[✓ Z]			[✓ 6]	Preventing spread of contamination	No.
				7	Other	

Title	"In-situ" measuring of alpha dust[*1] in severe environments
Work location	All locations in the PCV and inside the building where there is a possibility of alpha dust leakage
Overview	In anticipation of future full-scale fuel debris retrieval operations, we have developed a prototype device to measure "in-situ" real-time alpha dust concentration during debris-cutting operations in severe environments (high humidity and high radiation dose) in the Primary Containment Vessel(PCV). The developed machine is designed to operate in a 100% humidity and Sv/h environment and is capable of measuring high-concentration alpha dust, more than 30 times higher than the expected concentration in the PCV. We successfully demonstrated six months of maintenance-free continuous operation at the demolition work site of JAEA's MOX fuel handling facility. This is a work site where alpha dust is scattered and workers must wear an air-line suit.

			Before Implementation	After Implementation
Assessment ([✓ Qualitative] / quantitative)	Effects	Population radiation exposure dose (person-mSv)		
		Person time (person-day)		

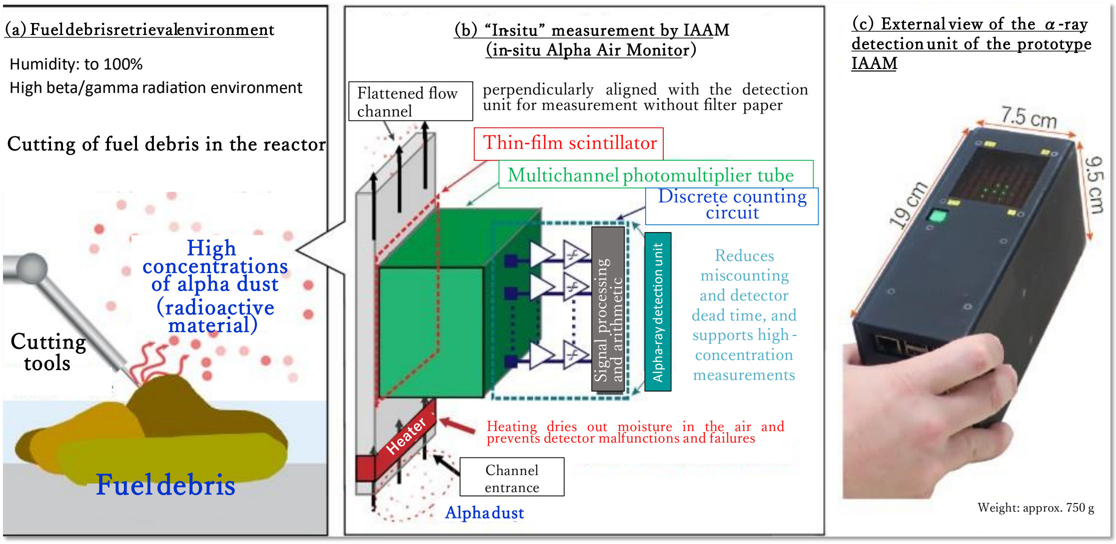
Good Practice Description	

[Objective] To ensure safe execution of decommissioning work, it is recommended to perform measurements near the source of alpha dust, as internal exposure at this location has a significant impact.

Conventional dust monitors are susceptible to malfunction or failure in severe environments and have difficulty with real-time measurement. In light of these challenges, we have developed a prototype device to perform real-time measurement under severe environments.

[Results and development progress] Stable operation in a high-humidity environment was achieved by heating and drying the air. The high-dose operation (>1 Sv/h) was achieved by optimizing the detection mechanism. The filter paper-free measurement demonstrated a significant improvement in real-time response and 6-month maintenance-free operation at the glove box dismantling site. Our objective is to enhance the applicability, durability, and usability of the measurement through future testing in actual environments of FDNPP (under high humidity, high radiation dose, and high alpha dust concentration).

[*1] translator's note: Dust containing alpha nucleus



Edited by Japan Atomic Energy Agency

Good Practices in Radiation Exposure Dose Reduction Measures

Location			Category		
Inside reactor building	[✓ R B]	R B	3，4，5，6	1	Time
Inside turbine building	T B			2	Distance
R ZONE	R			[✓ 3]	Shielding
Y ZONE	Y			[✓ 4]	Removing radiation source
G ZONE	G			[✓ 5]	Remote-control, robot operation
Other ( )	Z			[✓ 6]	Preventing spread of contamination
				7	Other

No.

Title	Measures for radiation exposure dose reduction during opening work at the X-6 Penetration among detailed investigation inside the 1F-2PCV
Work location	The Unit 2 reactor building, 1st floor, northwest area
Overview	In preparation for the retrieval of fuel debris on a small scale, an isolation room was established in the northwest area on the first floor of the Unit 2 reactor building, and the X-6 hatch was opened.

Assessment (Qualitative / [✓ quantitative])			
		Before Implementation	After Implementation
Effects	Population radiation exposure dose (person-mSv)	1224.10	655.40
	Person time (person-day)	-	-

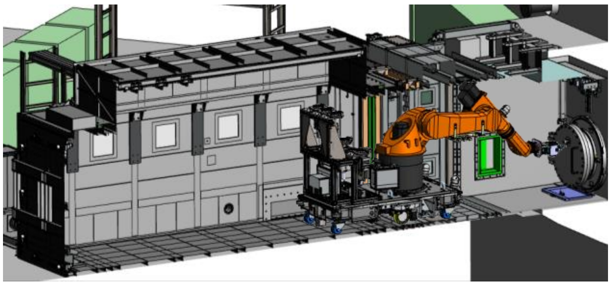
Good Practice Description: The following items were implemented as measures for radiation exposure dose reduction.

Engineering measures

	Item	Overview
1	Automation, remote work, process improvement	The polishing of X-6 penetration, the opening and closing of the airtight doors, and the opening of the hatches were conducted remotely.
2	Shielding	Mobile temporary shielding, pallets with shielding, shielding in isolation rooms, and shielding with airtight doors are used.
3	Removing radiation source	The sediments that fell when the X-6 hatch was opened were collected in the greatest possible quantity and stored in a shielded collection box.
4	Mock-up	Mock-up training was conducted in factories and other locations to enhance work proficiency and reduce cycle times.

Administrative measures

	Item	Overview
1	Utilization of low-dose areas	The on-site headquarters was established in a low-dose-rate area in the west yard of the reactor building.
2	Proper allocation of workers	Shielding was utilized to optimize the number and placement of workers.
3	Labor-saving monitoring	The air dose rate and personal dose were monitored continuously via the wireless dosimeter (P-WARM) and remote monitoring system (RMS).



Source：Tokyo Electric Power Company Holdings, Inc.

Edited by Toshiba Energy Systems & Solutions Corporation

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<tr><th colspan="3">Location</th><th colspan="3">Category</th><th colspan="2" rowspan="6">Good Practices in Radiation Exposure Dose Reduction Measures</th></tr>
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<tr><td colspan="2">Title</td><td colspan="6">Measures to reduce radiation exposure of the crystalline lens of the eye during installation of a large cover for fuel retrieval at Fukushima Daiichi Nuclear Power Plant the Unit 1</td></tr>
<tr><td colspan="2">Work location</td><td colspan="6">Upper part of the wall of the Unit 1 reactor building</td></tr>
<tr><td colspan="2">Overview</td><td colspan="6">A series of tests were conducted to assess the effectiveness of shielding using Bi resin-containing faceplates in reducing the radiation exposure dose to the crystalline lens of the eye during operation in the upper part of the wall of the Unit 1 reactor building.</td></tr>
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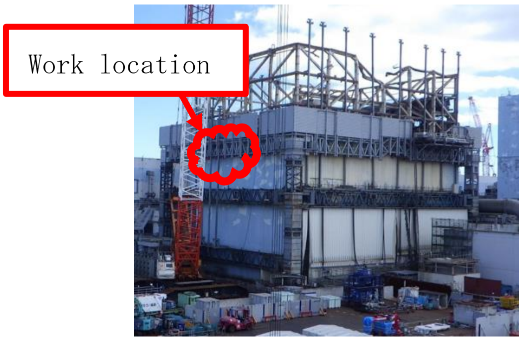
- Purpose

At the Fukushima Daiichi Nuclear Power Plant, work is underway to install large covers on the reactor building for the purpose of controlling dust dispersion during debris retrieval from the reactor building, building a work environment, and controlling rainwater inflow in order to retrieve fuel from the Unit 1 spent fuel storage pool.

In this work, the air dose rate is high on the operating floor in the upper portion of the reactor building, and the air dose rate increases as one approaches the operating floor. The lens equivalent dose is higher than the effective dose among the exposure doses of workers engaged in this work. One of the key issues to be addressed is reducing the crystalline lens equivalent dose. To reduce exposure doses, especially those due to scattered radiation, we investigated the applicability of a Bi resin-containing faceplate with a thickness of 2.55 mm (hereinafter referred to as the “faceplate”). This faceplate is currently under development by Chiyoda Technol Corporation and Tokuyama Corporation.



Unit 1 reactor building

Bi resin-containing faceplate

●Investigation method

In order to select a location for the investigation, measurements were conducted around the outer wall of the upper part of the Unit 1 reactor building to determine the γ-ray spectrum using a zinc cadmium telluride (CZT) semiconductor detector.

Full-face masks with and without Bi resin-containing faceplates were prepared at the selected locations, and passive personal dosimeters for crystalline lens measurement of 3 mm dose equivalents were attached to the inside and outside of each. Following a period of approximately 24 hours of installation, passive personal dosimeters were collected and subjected to measurement. A comparison was then made between the results of the internal and external measurements in order to ascertain the effectiveness of the shielding.

●Investigation results

The results of the tests conducted in this study indicate that the full-face mask, when used alone, is effective in reducing the radiation dose by approximately 5% relative to the 3 mm dose equivalent in the work environment around the Unit 1. Furthermore, it was demonstrated that the 2.55 mm thick Bi-resin-containing faceplate exhibited an additional dose reduction effect of 2.7%.

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Good Practices

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