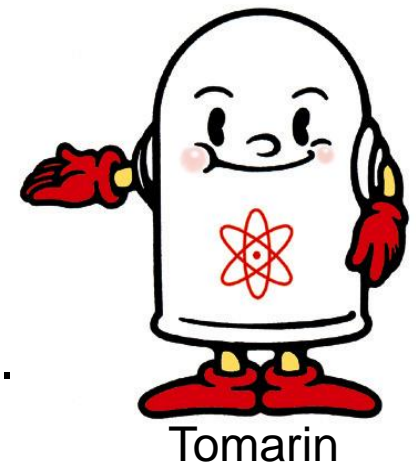
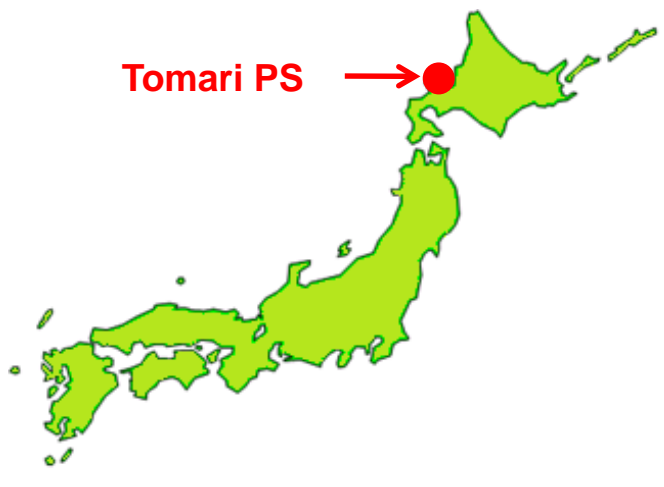


ALARA Activities in Tomari Power Station

October 2018
Hokkaido Electric Power Co., Inc.



1. Overview of Tomari Power Station



Summary of Tomari Power Station

Name	Tomari Power Station
Location	Ooaza Horikappu Mura, Tomari Mura, Furuu Gun, Hokkaido, Japan
Site area	Approx. 1,350,000 m ²

	Unit 1	Unit 2	Unit 3
Rated electric output	579MW	579MW	912MW
Reactor type	Pressurized light water reactor		
Fuel type	Slightly enriched uranium		
Cooling water flow rate	40 m ³ /sec/unit		66 m ³ /sec
Cooling water intake/outlet method	Surface layer intake/underwater discharge		
Date construction commenced	August 1984	August 1984	November 2003
Date commercial operation commenced	June 1989	April 1991	December 2009



2. Development of Radiation Dose Reduction Measures (Unit 1)

Tomari PS is a newer among the nuclear power plants in Japan and has actively adopted radiation exposure reduction measures which have been proved at other plants. The figure below shows the outline of the development of major radiation dose reduction measures which have been adopted at Unit 1 of Tomari PS.

Development of Radiation Dose Reduction Measures (Unit 1)

Item	Number of periodic inspections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Automation of work	▽Using reactor vessel stud tensioner															
	▽Using reactor vessel stud bolt rotating device															
	▽Using reactor vessel stud bolt holes brushing device															
	▽Adopting eddy-current inspection robot for steam generator heat-transfer pipes															
	▽Adopting pipe automatic UT device															
▽Adopting check valve seat automatic facing device																
Rationalization of work	▽Using improved thermocouple connector															
	▽Using reactor vessel sealing plate															
	▽Using primary coolant pump cartridge seal															
	▽Using DF probe for volumetric inspection work of steam generator heat-transfer pipes															
	▽Using steam generator manhole lid handling device															
	▽Installing a fan to prevent the suppression of dust while reactor vessel upper lid is open															
▽Adopting steam generator new type nozzle lids																
Reducing dose equivalent rate in work environment	▽Integration of control rod driving device cooling duct															
	▽Optimization of water quality control during shutdown															
	▽Adopting low-cobalt materials for reactor vessel, etc.															
	▽Shielding reactor vessel upper lid temporary placing space with lead screens and lead mats															
	▽Lead shielding of pipes on passageways in reactor containment vessel															
	▽Permanent shielding of main coolant pipes															
	▽Lead shielding of reactor vessel upper lids															
	▽Adopting primary coolant pump internal decontamination															
	Using lead shielding tools for the maintenance of steam generator primary manhole, etc.															
	▽Installing shielding lid on the primary coolant pump casing															
▽Optimization of pH control of primary coolant during operation																
Injecting Zn into primary coolant system while plant is in operation																
▽																

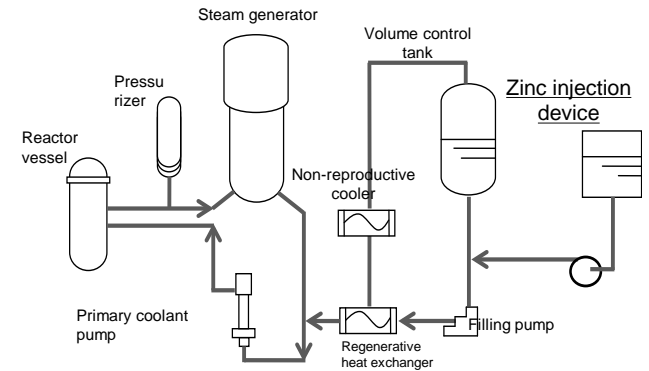
3. Injecting Zn into primary coolant system while plant is in operation

- While a plant is in operation, zinc is injected into the primary coolant system. The zinc substitutes for cobalt absorbed in oxide film and thereby prevents cobalt from being absorbed on the surface of piping. With this method, dose equivalent rate of the primary coolant system is reduced, and radiation exposure is reduced accordingly.
- In Unit 3 of Tomari PS, we have introduced the zinc injection into the primary coolant system since the hot functional test for the first time in the world to reduce radiation dose.

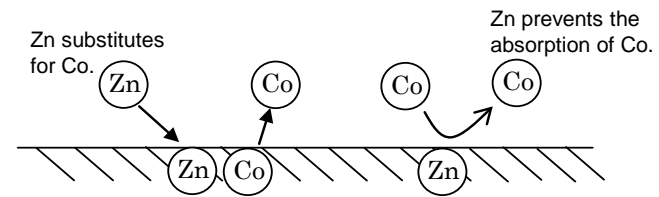
Effect of zinc injection to reduce dose equivalent rate (Unit: mSv/h)

	Unit 1				Unit 2					Unit 3	
	Before injection	After injection		Reduction effect (1-((2)/(1)))	Before injection	After injection			Reduction effect (1-((4)/(3)))	After injection	
	15th (1)	16th	17th (2)		13th (3)	14th	15th	16th (4)		1st	2nd
S/G water chamber (HOT)	24.00	19.00	13.00	Reduced by approx. 46%	22.00	13.00	13.00	14.00	Reduced by approx. 36%	15.00	7.00
S/G water chamber (COLD)	39.00	22.00	22.00	Reduced by approx. 44%	35.00	18.00	16.00	18.00	Reduced by approx. 48%	15.00	5.00
R/V upper lid	12.00	17.00	16.00	Increased by approx. 33%	18.00	16.00	6.00	12.00	Reduced by approx. 33%	14.00	10.00
Primary coolant pipe HOT	0.017	0.035	0.021	Increased by approx. 24%	0.046	0.031	0.020	0.014	Reduced by approx. 70%	0.020	0.012
Primary coolant pipe COLD	0.124	0.106	0.045	Reduced by approx. 63%	0.181	0.142	0.079	0.088	Reduced by approx. 51%	0.025	0.013
Primary coolant pipe CROSS	0.025	0.029	0.017	Reduced by approx. 32%	0.044	0.032	0.017	0.020	Reduced by approx. 55%	0.012	0.006

(Outline of the zinc injection system)



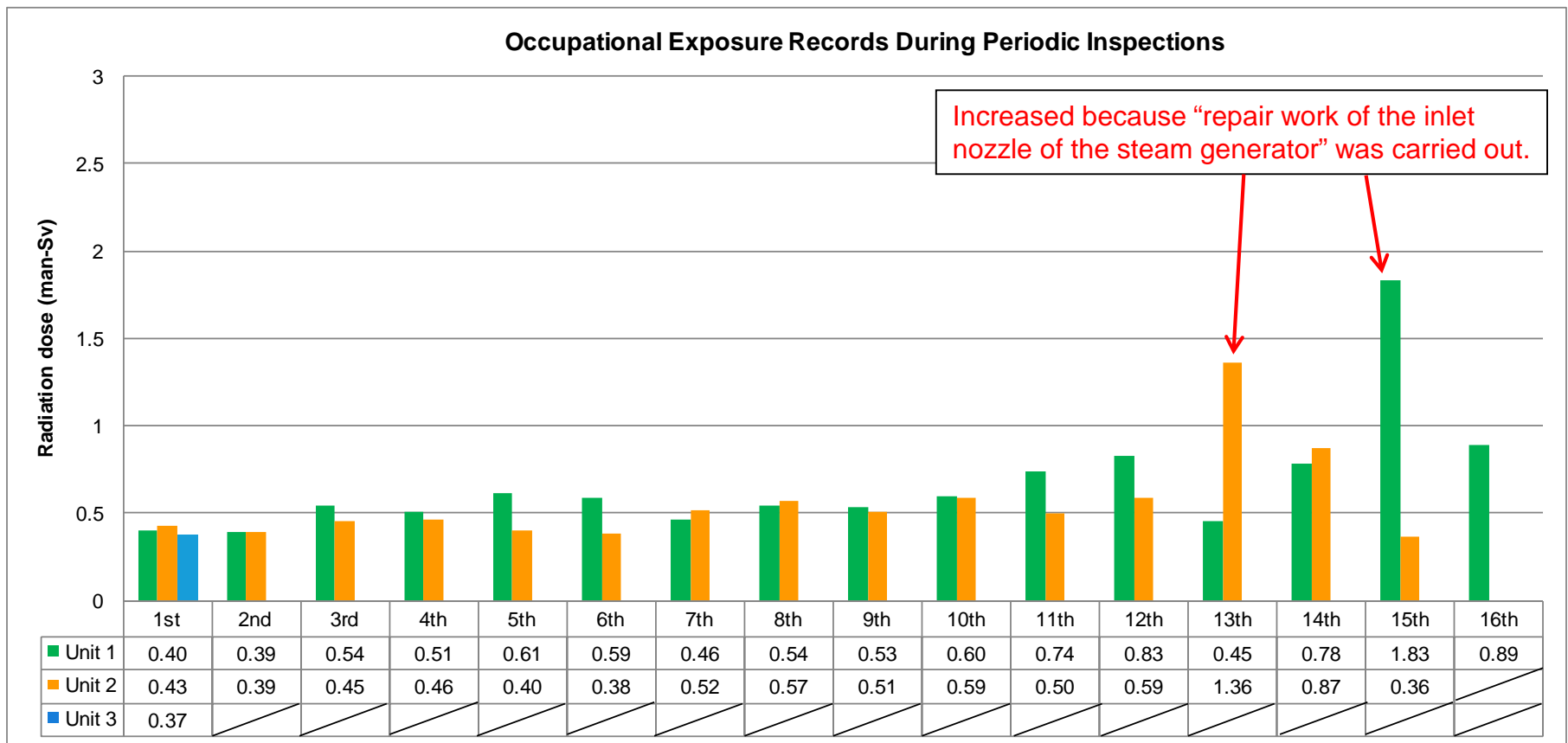
(Mechanism to reduce radiation exposure)



4. Occupational Exposure Records During Periodic Inspections

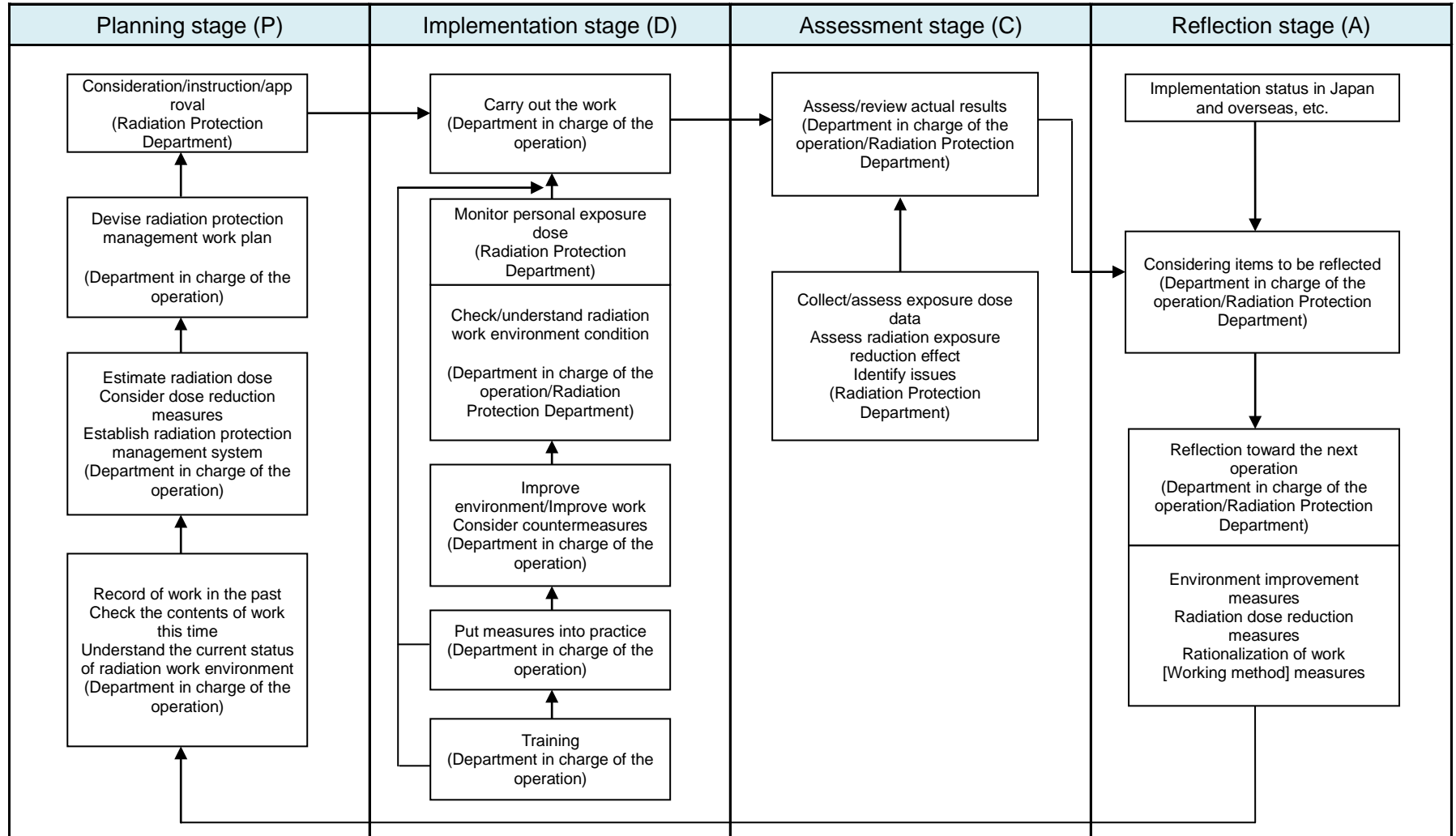
Occupational exposure records at Tomari PS have been hovering at around 0.5 man-Sv since the 1st periodic inspection.

That is probably because Tomari PS has actively adopted, through all stages from the designing stage, radiation exposure reduction measures which have been proved at other plants.



5. Radiation dose reduction management flow at Tomari PS

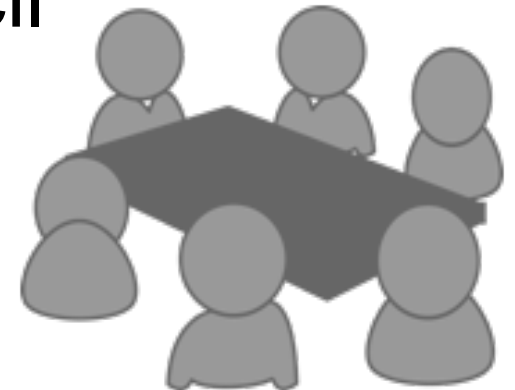
When working within a controlled area, workers and Radiation Protection Department apply PDCA (plan-do-check-act) cycle to share information and to improve working method.



The following four meetings are held at Tomari PS to reduce radiation exposure.

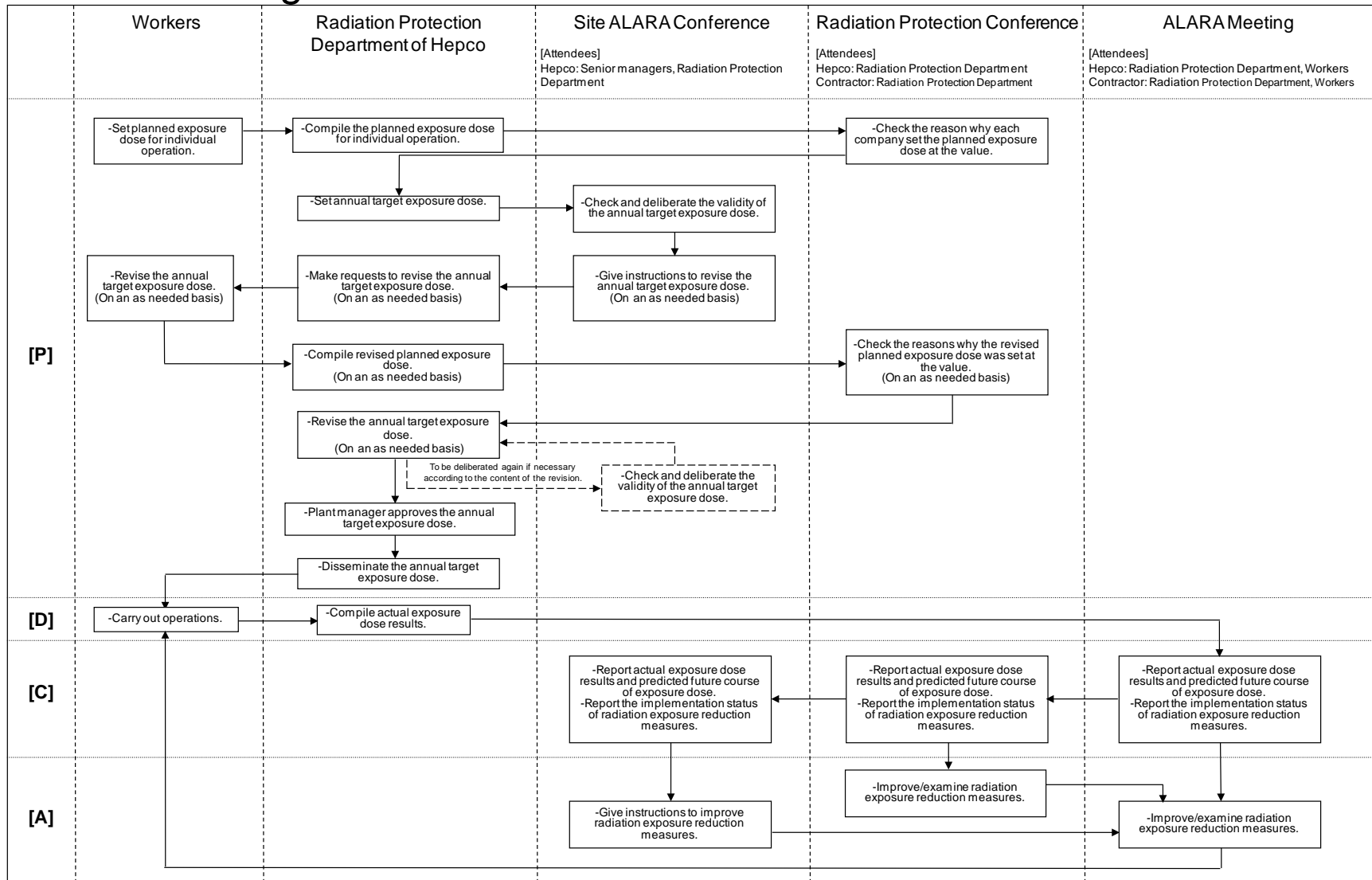
○ Meetings within the Power Station

- (1) Site ALARA Conference
- (2) Radiation Protection Conference
- (3) ALARA Meeting
- (4) Safety and Health Council



6. Meetings within the Power Station (2)

The following figure shows the PDCA flow applied through the meetings held within the Tomari PS.



6. Meetings within the Power Station (3)

(1) Site ALARA Conference

A meeting where senior managers of Tomari PS get together to deliberate radiation exposure to workers, radiation exposure reduction measures, and validity of planned total radiation exposure dose with the aim of reducing radiation exposure dose.

○ Contents of Site ALARA Conference (Frequency: 1 time each in the 1st Q and 4th Q/ whenever necessary)

- Check and deliberate the validity of the annual target radiation exposure dose.
- Check and deliberate the validity of the reviewed annual target radiation exposure dose.
- Check changes in actual result of radiation exposure dose and future prospect.
- Check the effect of radiation exposure reduction measures against work projects with higher planned radiation exposure dose.
- Make suggestions if improvement of facilities is required.
- Based on the status of radiation exposure reduction measures introduced at other plants in Japan and overseas, suggest measures suitable for Tomari PS.

(2) Radiation Protection Conference

A meeting where members of Radiation Protection Department of Tomari PS and persons of contractors responsible for radiation protection get together to verify radiation exposure reduction measures with the aim of reducing radiation exposure dose.

This conference is held periodically and whenever the need arises, such as when it becomes necessary to share information that is important to radiation protection.

○ Contents of Radiation Protection Conference (Frequency: 1 time/month principally, before periodic inspection, during periodic inspection, after periodic inspection, whenever the need arises)

- Share information about areas where access to which is restricted during periodic inspections.
- Check company-by-company tables explaining the outline of increases/decreases in radiation exposure dose during periodic inspections.
- Check the implementation status of radiation exposure reduction measures.
- Share information about changes in radiation protection management system.
- Requests from contractors.

6. Meetings within the Power Station (5)

(3) ALARA Meeting

A meeting where members of worker and Radiation Protection Department of Tomari and contractors get together to check radiation exposure reduction measures against work projects with high planned exposure dose with the aim of reducing radiation exposure dose.

○ Contents of ALARA Meeting (Frequency: 1 time/week in principle)

- Check changes in radiation exposure dose during work.
- Explain predicted changes in radiation exposure dose for the future.
- Explain what caused an increase or a decrease in radiation exposure dose in comparison with the planned radiation exposure dose.
- Check the implementation status of radiation exposure reduction measures.

6. Meetings within the Power Station (6)

(4) Safety and Health Council

A meeting where senior managers of Tomari PS and contractors get together to check occupational safety and radiation protection management status.

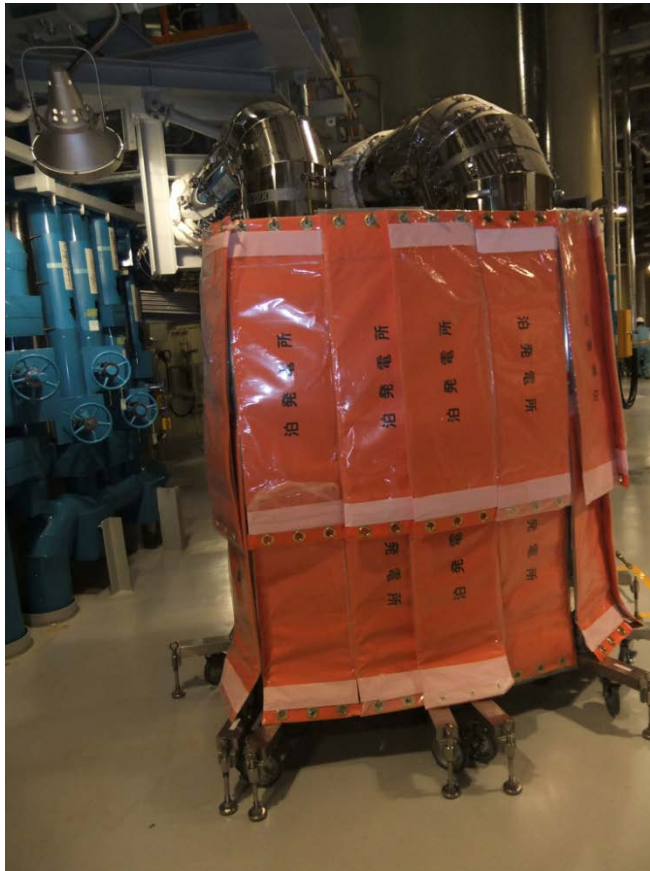
○ Contents of Safety and Health Council (Frequency: 1 time/month)

- Check changes in radiation exposure dose during periodic inspections.
- Check actual records of radiation exposure dose during individual work project.
- When radiation exposure dose exceeds the dose planned for a work project, check the factor which caused the excess.



7. Radiation Dose Reduction Measures Using Temporary Shield (1)

- Install temporary shield for common areas.
At Tomari PS, Radiation Protection Department installs shielding screens, as a radiation dose reduction measure, at common areas other than worksites where radiation exposure dose level gets high.



Temporary shield using screens
(Example)



Temporary shield using tungsten mats
(Example)

7. Radiation Dose Reduction Measures Using Temporary Shield (2)

At the time of the 3-2 periodic inspection, tungsten mats were installed at 15 locations in total (116 pieces of shielding material), such as main pipes, to reduce dose equivalent rates at common areas.

As a result, according to the total occupational dose at common areas, the radiation exposure dose reduction effect of tungsten mats was 3.84 man-mSv.

In the next periodic inspection, tungsten mats will be installed at more locations to further reduce radiation exposure dose.

Effect of shielding installed at the time of 3-2 periodic inspection (major common areas)

Installation location		Dose equivalent rate before shielding (mSv/h)	Dose equivalent rate after shielding (mSv/h)	Reduction rate in dose equivalent rate at the time of 3-2 periodic inspection (%)
C/V17.8m	A-C Loop Room 1F passageway RHR pipe	0.027	0.020	25.9
C/V17.8m	A Loop Room 1F RHR pipe	0.025	0.020	20.0
C/V24.2m	A Loop Room 3F SI pipe	0.096	0.080	16.7
C/V24.2m	C Loop Room3F SI pipe	0.102	0.070	31.4
C/V26.6m	A Loop Room 4F SI pipe	0.078	0.050	35.9
C/V26.6m	B Loop Room 4F SI pipe	0.060	0.040	33.3
C/V26.6m	C Loop Room4F SI pipe	0.075	0.050	33.3

- We have adopted radiation exposure reduction measures verified at other plants and improved working methods in cooperation with workers. As a result, radiation exposure dose has been hovering at around 0.5 man-Sv since the initial periodic inspection.
- By displaying signs to show dose equivalent rate and promoting the installation of temporary shielding, we are reducing radiation exposure of radiation workers.
- As the plants of Tomari PS ages, large scale repairing construction works may become necessary. Even so, by taking radiation exposure dose reduction measures suitable to each construction works, we will reduce radiation exposure.
- We continuously collect information actively on radiation exposure reduction measures which have been actually applied in Japan and overseas, and put into practice radiation exposure reduction measures which are optimal to Tomari PS.

END

