ESTIMATION OF DOSES TO WORKERS AND THE PUBLIC IN THE JPDR DECOMMISSIONING

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INTRODUCTION

Japan Power Demonstration Reactor (JPDR, BWR, 90MWt) went into power operation in 1963 and finally shut down in 1976. It had played an important part as a pilot of Japanese nuclear power plants till the end of service. The dismantlement of the JPDR started on December in 1986 and will take about 7 years to complete. The purposes of the dismantlement are to demonstrate the complete dismantlement of JPDR using the developed techniques and to accumulate practical data which will be beneficial to dismantling of commercial power plants in the future. This paper describes the estimated results of the collective dose to workers and the maximum individual dose to the public, [1],[2] including the calculation method based on the dose rates in the working area and the environment, man power and the dismantling methods.

ESTIMATION OF COLLECTIVE DOSE TO WORKERS

The dismantlement of reactor internals, reactor pressure vessel(RPV) and radiation shielding concrete will be very noticeable works from the view point of the radiation control. The dose rates were calculated to be maximum 3.6 R/h around the RPV (with water), 0.2 R/h inside the radiation shielding concrete (after removal of the RPV) and 1 R/h around the primary cooling pipes. In the JPDR decommissioning, " remote underwater cutting "," disk cutter " and " controlled blasting " will be adopted in order to reduce the dose to workers and the released amount of radioactivity to the environment. The local exhaust devices with HEPA filters and/or temporary containment rooms will be prepared in the places where air contamination might occur. The radioactivity inventory data of activated components such as the reactor internals and the others were taken from the calculated results [3] and the measured values, respectively.

Collective external dose

Collective doses in each working area were estimated by multiplying the average dose rate in the area by man power (man•day). The average dose rates in the working areas were calculated for the dismantling of the RPV and the radiation shielding concrete by QAD-CG code. The collective dose obtained is shown in Table 1. In the dismantling of the reactor internals about one half of the collective dose (0.17 man•Sv) results from decontamination and transport of waste packages. And in the RPV dismantling about one half of it (0.26 man•Sv) also results from preparation of the RPV cutting.

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Table 1. Collective Dose to workers

Building	Dismantled component or structure	Manpower (man•day)	Collective dose (man•Sv)		
			External	Internal	Total
Reactor Building	Reactor Internals	9,200	1.7×10^{-1}	2.3×10^{-4}	1.7×10^{-1}
	RPV	4,100	2.6×10^{-1}	2.5×10^{-4}	2.6×10^{-1}
	Radiation Shielding Concrete	4,500	7.9×10^{-2}	1.3×10^{-4}	7.9×10^{-2}
	Others	17,700	1.5×10^{-1}	3.7×10^{-4}	1.5×10^{-1}
	Total	35,500	6.6×10^{-1}	9.8×10^{-4}	6.6×10^{-1}
Others	Whole installations	37,500	3.6×10^{-1}	5.4×10^{-4}	3.6×10^{-1}
Total		73,000	1.0×10^{0}	1.5×10^{-3}	1.0×10^{0}

Collective internal dose

The dispersed amounts of radioactivity in each dismantling work were calculated using the radioactivity inventory data, the R&D data and so on [4],[5]. The parameters used for safety analysis are shown in Table 2. The collective internal dose was estimated by multiplying average internal dose rate by man power. For the estimation of average internal dose rate the airborne radioactivity concentration was determined mainly based on the DAC of ICRP publication 30 and the above parameters. Then it was assumed that a worker wore a half-mask during operation. The results are also shown in Table 1. The collective internal dose will be 1.5×10^{-3} man•Sv through the JPDR decommissioning, and it will be reduced to a negligible level by the above air contamination protections compared with the collective external dose.

ESTIMATION OF INDIVIDUAL DOSE TO THE PUBLIC

The doses to the public during dismantling are classified as follows.

- internal dose by inhalation and external dose by radioactive plume arisen from gaseous effluent

- internal dose by intake of seafoods grown in ocean where liquid effluent was discharged.

Dose due to gaseous effluent

The released radioactivity from the stuck would be estimated to be 1×10^{6} Bq(3×10^{6}MeV• Bq) through the JPDR decommissioning by using parameters shown in Table 2. The maximum individual dose to the public was estimated at a point where the maximum dose was expected, assuming that total activity was released into environment at a constant rate through a year. The individual dose obtained is shown in Table 3.

Table 2. Parameters used for safety analysis.

Item of parameter		Value
Dispersion factors for radiation shilding concrete cutting with	abrasive water jet	0.4g/min
	diamond saw	0.06g/min
	controlled bluster	0.03g/kg
Dispersion factor for reactor internals cutting with underwater plasma arc torch		0.05~5g/m
Dispersion factor for RPV cutting with underwater arc saw		$0.2kg/m^3$
Dispersion factor for equipment & piping cutting with gas torch		$3cm^2/kg$
Dispersion factor for decontamination of tanks with water jet		$0.01g/m^3$
Dispersion factor for decontamination of contaminated concrete with planner		$0.08g/m^2$
Resuspension factor for decontamination of floor		$5\times10^{-6}cm^{-1}$
Leakage of half mask		0.1
Leakage of temporary containment room		0.1
Penetration of HEPA filter for exhaust attached to temporary containment room		5×10^{-4}
Penetration of HEPA filter for exhaust attached to facilities		1×10^{-2}

(1) Internal dose by inhalation

The annual average air concentrations were calculated with all the 16 direction sectors and the maximum value of them was used for dose calculation. If a release rate of 2×10^2Bq/h continues for a year, the maximum value of annual average radioactivity concentration in the air would be $2\times10^{-8}Bq/m^3$in the residential district. Deriving from these values, the internal individual dose to the public at the site boundary would be estimated to be 2×10^{-13}Sv by inhalation.

(2) External dose by radioactive plume

If a release rate of 4×10^2MeV•Bq/h continues for a year, the maximum annual dose would be estimated to be below 7×10^{-14}Sv in the residential district outside the site boundary.

Table 3. Individual doses to the public

Effluent	Pathway	Radioactivity	Dose
Gaseous	Inhalation	1×10^{6}Bq (2×10^{2}Bq/h)	2×10^{-13}Sv
	External	3×10^{6}MeV•Bq (4×10^{2}MeV•Bq/h)	7×10^{-14}Sv
Liquid	Intake of seafood	1×10^{9}Bq (1×10^{5}Bq/h)	7×10^{-8} Sv
Total			7×10^{-8} Sv

<u>Internal dose due to liquid effluent</u>

Total radioactivity discharged into ocean would be 1×10^{9}Bq through the JPDR decommissioning project. If a discharge rate of 1×10^{5} Bq/h continues the internal dose by intake of seafoods (seaweed, fish, non-vertebrate animal) would be estimated to be 7×10^{-8}Sv.

CONCLUSION

In the JPDR decommissioning project, the collective dose to workers and the maximum individual dose to the public would be 1man•Sv and 7×10^{-8} Sv, respectively. From the dose estimation, we believe the JPDR decommissioning will be performed with radiological safety.

References

[1]Japan Atomic Energy Commission, Guide for Methods of Evaluating Compliance with the Dose Objectives around a Site of Light-Water-Cooled Nuclear Power Reactors, (1976)

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