5-10 Toward Safe Decommissioning of Nuclear Facilities

—Development of Safety Assessment Code for Decommissioning Activities—

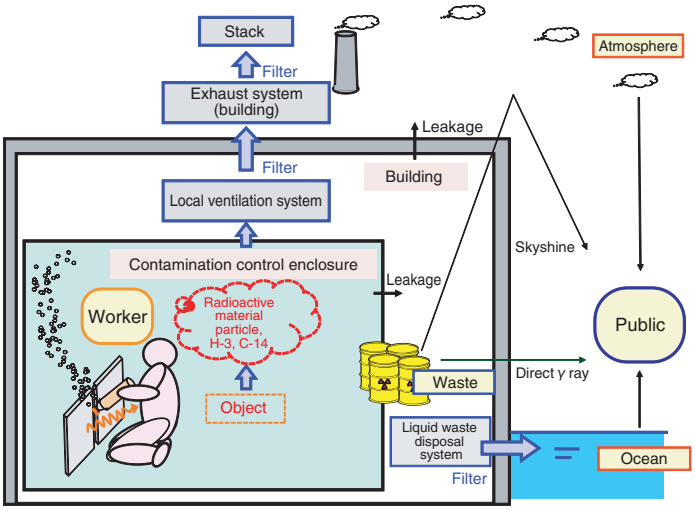

Fig.5-19 Pathways of radioactive materials to the environment for estimation of the public dose
Radioactive aerosols and vapors are dispersed into the work space through dismantling activities, and are then released or leaked to the atmosphere through filters and buildings, or released to the ocean through filters in the disposal system. The public exposure dose is evaluated considering various pathways, for example, the internal dose by inhalation of radionuclides in the air, the external dose from radionuclides on the ground surface, and the internal dose from the ingestion of food.

Table 5-2 Calculated results of collective dose to workers compared with actual dose
The calculated external dose agreed well with the actual dose using the actual working time and dose-rate distribution in the area. The dose from the removal of equipment in the reactor and turbine buildings showed a higher value than the actual one because all the contaminated equipment was assumed to be located near workers, for evaluation of the worst-case scenario.

(in person-mSv)

Object	External dose		Internal dose	
	Estimate	Actual	Estimate	Actual
Reactor internals	52.0	73.1	0	0
Reactor pressure vessel	103.9	82.7	0	0
RPV connected piping	95.8	63.2	0	0
Shielding concrete	31.9	27.3	0	0
Equipment (R. B.)	231.8	35.6	15.0	0
Equipment (T. B.)	5.7	0.6	4.3	0

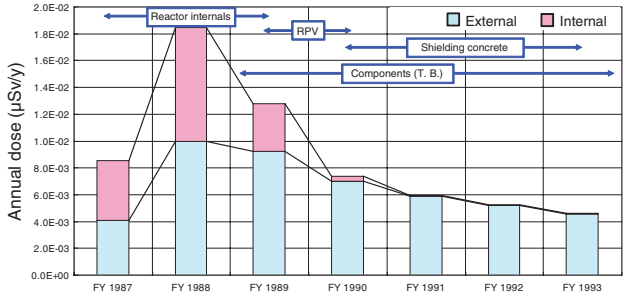

Fig.5-20 Calculation results for annual public dose during JPDR decommissioning project
The annual public dose is found to be negligibly low. After identifying several important pathways, the dose during the period of dismantling of the reactor internals is found to be dominant.

Aging or damaged nuclear facilities (e.g., Fukushima Daiichi NPS) should be decommissioned so as to ensure both engineering and radiological safety. Prior to the decommissioning process, a decommissioning plan, including a safety assessment for the public and the workers, is sent to the regulatory body for approval. The safety assessment requires the estimation of public and worker doses by considering various exposure pathways in normal and accidental situations during decommissioning, where the amounts of radioactive aerosols and vapors dispersed into the atmosphere and the ocean are calculated on the basis of the radioactive inventory, dismantling procedures, and schedule. A computer code system was developed for this safety assessment. A schematic illustration of the radionuclide pathway model used for normal situations is shown in Fig.5-19.

One of the most important parameters in the model is the radionuclide dispersion ratio to the air during the cutting of radioactive materials such as contaminated pipes. So far, the dispersion ratio has been obtained by experiments using non-radioactive pipes. To assess the existing data, we carried out cutting experiments using contaminated pipes, and confirmed that the existing data gave reliable and conservative estimates.

The dismantling activities of the Japan Power Demonstration Reactor (JPDR) have yielded information available for dose assessment. We applied the safety assessment code to the dismantling of JPDR, and compared the calculated results with the actual data. Table 5-2 shows the external dose to workers. It is found that the calculated results agree well with the actual data. Fig.5-20 shows the calculated results of the annual public dose. The results show that the public dose is negligibly low, that the dose during the period of dismantling of the reactor internals is dominant, and also that most internal and external doses are attributed to the exposure of radionuclides released to the ocean or the ingestion of sea food. The internal dose of carbon-14 is due to the ingestion of agricultural crops.

The code will be continually applied to forthcoming decommissioning activities of nuclear facilities.

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Reference

Shimada, T., Sukegawa, T. et al., Development of Safety Assessment Code for Decommissioning of Nuclear Facilities (DecDose), Journal of Power and Energy Systems, vol.4, no.1, 2010, p.40-53.