ANALYSIS OF OCCUPATIONAL RADIATION EXPOSURE IN REPROCESSING PLANT OF PNC, TOKAI

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INTRODUCTION

Reprocessing plant of PNC in Tokai-mura (Tokai-plant) began the operation in 1980, however the operation was suspended in 1983, because of the failure of acid recovery evaporator and the pinholes appeared at dissolvers.

While repairing the dissolvers with remote welding method and the acid recovery evaporator with direct maintenance by workers under high radiation exposure in cell, PNC decided to install the third dissolver to ensure the stable operation of the plant.

After the installation work of the third dissolver performed in 1984, the plant operation was started again in 1985. The cumulative amount of spent fuel reprocessed reached to 347 tons as of May 1987.

The averaged number of radiation workers engaged in operation and maintenance work is around 2,000 persons/year and the averaged annual collective dose is around 0.8 man·Sv.

In this paper, the authors give an empirical formula for the annual individual dose distribution of Tokai-plant, which was acquired through the analysis of past annual individual dose distributions.

RADIATION CONTROL

The radiation control of the plant has two major aspects. The one is the routine radiation control for the routine radiation works associated with regular plant operation. The other is the non-routine radiation control for the non-routine radiation works such as maintenance works and reform of process equipments.

Non-routine radiation work is further divided into two categories, namely special radiation work (SRW) and second grade

radiation work. The non-routine radiation works in which the pre-operational estimated dose for whole body, extremities or skin could exceed respectively 3 mSv, 15 mSv or 6 mSv per week are to be classified as SRW to be put under more strict radiation control.

Non-routine radiation works other than SRW are classified as second grade radiation work. Safety regulation of the plant prescribes some radiation protection criteria to keep individual dose as low as reasonably achievable. Table 1 shows a part of the dose limitation system for whole body.

Table 1 Dose limitation System at Reprocessing plant of PNC, Tokai for whole body

Investigation level	Action level	Dose limit
3 mSv/3 months	13 mSv/3 months	30 mSv/3 months

ANNUAL INDIVIDUAL DOSE DISTRIBUTION

The individual dose distribution of the year in which the plant was operated relatively smooth (Operation-year), namely 1981, 1982, 1985 and 1986, form Long-normal distribution, as is seen in Fig. 1. Year denotes fiscal year and this is the same hereafter.

On the other hand, the individual dose distribution of the year in which large scale SRW's auch as maintenance of the acid recovery evaporator (E30-Work) and installation of the third dissolver (R12-Work) were performed (LSRW-year), namely 1983, 1984, has sharp increase in higher dose region, therefore the individual dose distribution dose not form Long-normal distribution. This is shown as curved distribution in Fig. 2. Radiological data of E30-Work and R12-Work are presented in Table 2 to help realize the magnitude of these radiation works.

Table 2 Radiological data of E30-Work and R12-Work

	Period [Day]	Workers [person]	Average dose [mSv]	Collective dose [man•Sv]
E30-Work	190	320	4	1.2
R12-Work	150	340	4	1.3

ANALYSIS OF INDIVIDUAL DOSE DISTRIBUTION

Individual dose distributions of E30-Work and R12-Work were precisely examined.

As a result, it was found in each case that there is a group of workers with higher individual dose. And that the individual

dose of the group forms *Normal* distribution as is shown in Fig. 3. Substracting this group from the whole workers who received higher dose than detection limit (curved distribution in Fig. 2), we had the same Log-normal distribution (dotted distribution in Fig. 2) as in Fig. 1.

This leads us to conclude that the distribution of LSRW-year has two components, namely Log-normal distribution and Normal distribution. The latter is specific to LSRW-year.

CONCLUSION

The empirical formula for the annual individual dose distribution of Tokai-plant (F) is given as follows:

$$F(x) = \frac{\beta N}{\sqrt{2\pi}} \int_0^X \left[\frac{(1-\lambda)}{\sigma_f X} \mathrm{Exp}\left\{ - \frac{(\ln X - \mu_f)^2}{2\sigma_f{}^2} \right\} + \frac{\lambda}{\sigma_g} \mathrm{Exp}\left\{ - \frac{(X-\mu_g)^2}{2\sigma_g{}^2} \right\} \right] dx$$

Table 3 Parameters for the annual individual dose distribution function

x	Individual dose	- [mSv]
N	Total radiation workers in a year	1,500∿2,900 [person]
β	Ratio of workers with measurable dose to N	0.31 ∿ 0.46
σ_f	Standard deviation of Log-normal distribution	1.0 [mSv]
μ_f	Mean of Log-normal distribution	0.6 [mSv]
σ_g	Standard deviation of Normal distribution	2.7 [mSv]
μ_g	Mean of Normal distribution	10.0 [mSv]
λ	Ratio of workers with Normal distribution to βN	Operation-year : 0 LSRW-year : 0.1

REMARKS

As for the specific radiation work that could give rise to higher individual dose, it is one of the conceivable choices to increase the number of workers to be employed in the work in order to reduce the number of workers who would receive higher dose.

However this could possibly cause the increase of collective dose as a whole.

This is the subject left to be discussed from the view point of the Optimization of Radiation Protection.

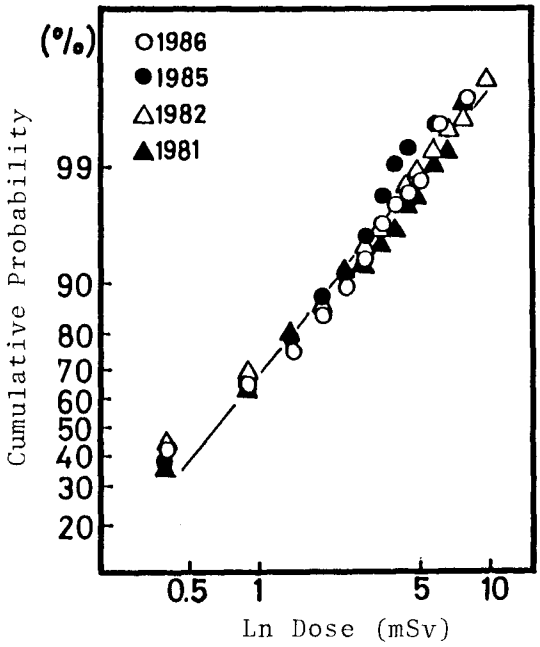

Fig. 1 Annual individual dose distribution of Operation-year*.

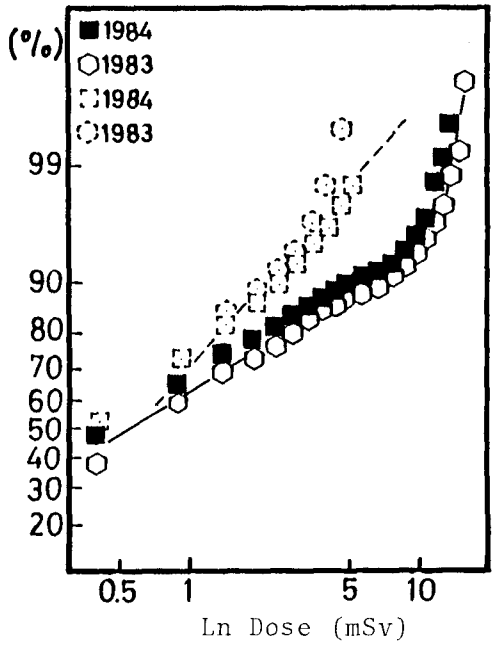

Fig. 2 Annual individual dose distribution of LSRW-year* (Curved) and modified distribution (Dotted).

* Definition is give in the text.

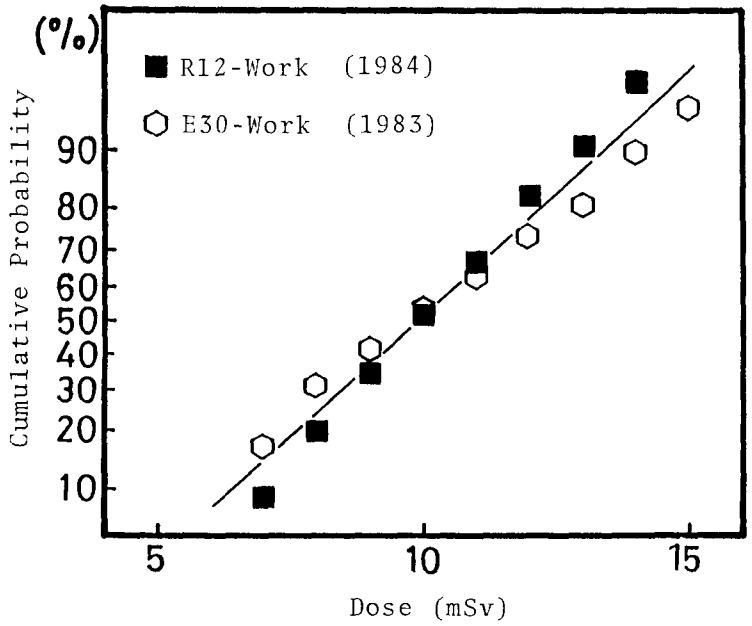

Fig. 3 Annual individual dose distribution of workers who received higher dose than other workers in R12-Work and E30-Work.