Comparison of occupational dose during outage between foreign countries' and Japanese Nuclear Power Plants

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1.Introduction

At Japanese Nuclear power plants, various measurements have been applied positively for dose reduction, such as shielding, improvement of work method, and the application of optimum water chemistry and remote control device in high dose rate area. So the doses during outages have been reduced year by year, but in recent years those remain higher level than that of other countries.

The dose during outage depends mainly on the dose rate of the workplace and the amount of work.

According to individual dose, Mr. R.H. Clerk, Chairman of ICRP proposed the idea of the new recommendation for the radiation protection system, which suggested that worker constraint be 20mSv/year in the next recommendation of ICRP, and when the next recommendation is applied to the statute of Japan (100mSv/5years and 50mSv/year is now applied in the statute of Japan based on ICRP 1990 recommendation), severer management than before will be required.

Now we investigated about the dose in a periodical inspection comparing Japan with foreign countries in the viewpoint of the dose equivalent rate of the workplace, duration and interval for periodical inspection, and the number of workers.

And we considered the subject which should be carried out for the radiation control for periodical inspection from now on, and we considered the way to set the new goal of dose reduction.

In addition, we investigated the trend of individual dose limit regulation of foreign countries which considered the next recommendation of ICRP, and the actual result of the trend of the number of workers who are exposed over 20 mSv/year. And we considered the subject which should be carried out for the radiation control for personnel from now on.

2. Analysis and investigation

(1) Occupational dose during outage

When it compares with foreign countries about collective dose per BWR plant in 2001, the dose of periodical inspection in Japan (1.78 person-Sv) is much higher than that in foreign countries(about 0.6 person-Sv).(Fig.1) Moreover, even if it removes the dose in modification works the dose of Japan is still higher. The main factors of the difference between Japan and foreign countries are the difference in the dose equivalent rate of the workplaces, and the difference in the amount of work. So we investigated the factors of the differences between Japan and US which succeeded in the reduction of the occupational dose during periodical inspections comparing of the dose equivalent rate of the surface of PLR piping, duration and interval for periodical inspection, and the number of workers.

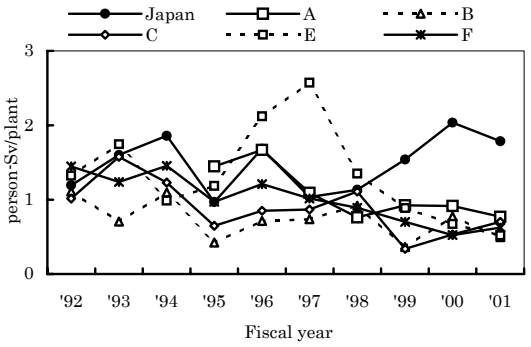


Fig.1 Trends in occupational outage dose per BWR plant in leading countries

(2) Individual dose

Some countries in Europe have already preoccupied the idea of the new recommendation of ICRP in the statute of their own countries, and they set their dose limit of occupational exposure to 20 mSv/year (Table.1)

And we investigated the worker who exceeded 20 mSv/year in some countries in the world, comparing France, US, UK with Japan using ISOE Data Base. (Fig.2), they have succeeded in drastic reduction in France from 1996.

On the other hand, the number of workers who are exposed over 20mSv/year in Japan still remain almost the same level.

So we investigated the method of reduction in France, and we had the analysis of the difference from Japan in work method, and the system of work etc.

And we analyze the actual condition of workers who are exposed over 15mSv/year (relatively high

exposed) in Japan, and considered how to reduce workers who are exposed over 20mSv/year from now on.

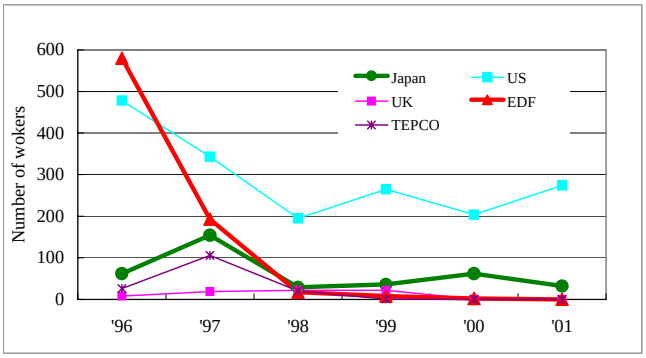


Fig.2 Trends in Number of workers who are exposed over 20mSv/year

Table.1 Regulation in some countries

Country	Dose limit	
	Public (mSv)	Worker (mSv)
Japan	1/year	100/5years & 50/year
Belgium	1/year	20/year
Denmark	1/year	20/year
Finland	1/year	100/5years & 50/year
France	1/year	20/year*
German	1/year	20/year and 100/5years & 400/work period in life
Sweden	1/year	100/5years and 50/year & 700/work period in life
UK	1/year	20/year (If impossible,100/5years & 50/year)
US	1/year	50/year
Norway	1/year	20/year
Switzland	1/year	20/year (Important work : 100/5years & 50/year)
Korea	1/year	100/5years & 50/year

(reference) CEPN,European ALARA Newsletter

3. Result of analysis / investigation

(1) Occupational dose during outage

a. Dose equivalent rate of the surface of Primary piping

Dose equivalent rate of the surface of Primary piping, of the reactor which contributes most to the dose equivalent rate in PCV and has a great influence on collective dose during periodical inspection is kept lower level in Japan, so it can be said that the dose rate of the workplace in Japan's NPP is well controlled comparing other countries.(Fig.3)

b. Duration for periodical inspection

When we compare Japan with 5 countries in Europe and US about the days of outage per reactor, the outage in Japan is much longer than other countries.

In 2001, the outage days per reactor in Japan is as about twice as those in US. The result says that we spend more time for periodical inspection in Japan than in US fundamentally although we have many amounts of maintenance work in Japan in recent years. (Fig.4)

But it turns out that on line maintenance is performed in foreign country and the period and collective dose of periodical inspection are low seemingly. (Fig.5)

On line maintenance only makes the period and the collective dose of the periodical inspection small

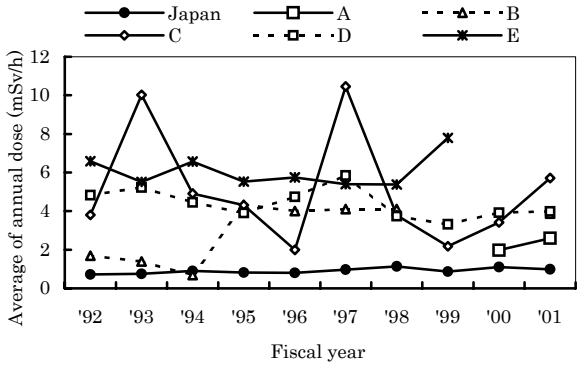


Fig.3 Trends in the dose rate on the surface of the recirculation pipes in countries using BWR

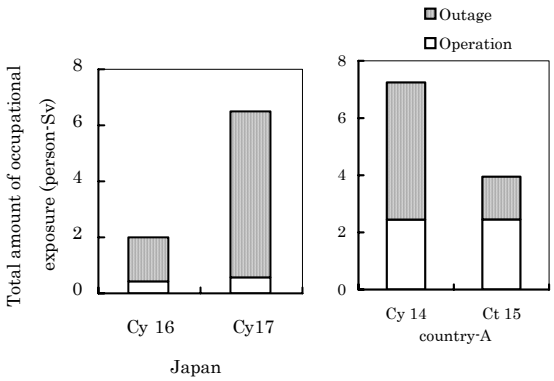


Fig.5 Breakdown of dose in Japanese and country-A's operating cycles

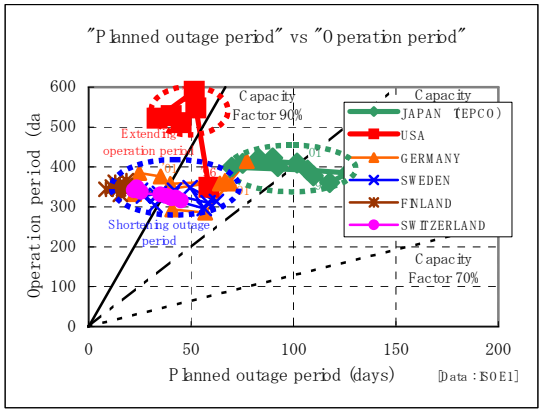


Fig.4 Correlation between days of outage and intervalbetween outages (comparison with BWR plants in other countries)

seemingly and does not succeeded in substantial dose reduction, but it is considered that there are secondary effects, such as equalization of an employment opportunity.

c. Interval for periodical inspection

Fig.4 shows that the outage days of Japan is longer than that of US, and the interval for periodical inspection is shorter than that of US.

Operation period in US is about 18.2 months (since latter half of the 90s) and as 1.4 times as long as that in Japan (about 13 months)

In US, an operation period is protracted by the deregulation and electric power liberalization in the latter half of the 90s, and operation for over 500days is available, and that is the reason of operation period protraction .

If we are able to perform operation for over 500days like US in Japan, collective dose during periodical inspection is considered that dose of normal inspection in Japan can be reduced by about 2/3 in every year.

The longer the interval for periodical inspection becomes, the higher the operating efficiency is, so the higher operating efficiency leads to lower opportunity of occupational exposure. We should perform protraction of interval for periodical inspection as much as possible on the assumption that safe reservation from now on.

d. The number of workers

Compared to some countries, the number of workers when the amount of work is the maximum in Japan(TEPCO) in 2001 is 1.5 to 2 times as large as that in other countries. (Fig. 6) This is considered to be the reason that we have larger work volume in Japan, and occupational dose during outage in Japan becomes high compared with a foreign countries.

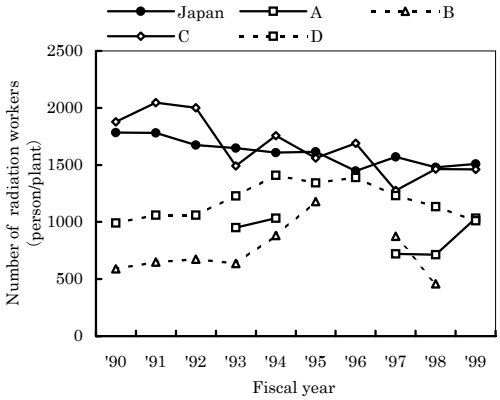


Fig.6 Number of workers involved in radioactive work in countries using BWR

e. Method of setting the new goal of occupational dose reduction(trial)

We tried to set the new goal (future goal) of dose reduction with relatively analysis using collective doses at past plant outages, which categorize by generating capacity classes of reactors (MWe). We have four generating capacity classes of reactors (460MWe,784MWe,1100MWe -BWRs and 1350MWe-ABWR) . Steps of establishing the new dose reduction goals we tried are follows .

(a) Classify collective doses (person-Sv of normal inspection and maintenance work) of plant outage to each capacity classes.

(b) Found the value of person-Sv per day of outage (person-Sv / day) which calculated with statistical method using data of recent outages (about past 10 outages which are lower levels after mainly dose reduction measures has performed) .

(c) New goal = [person-Sv per day of outage](standardized) X [days of outage](each)

(2)Individual dose

The following things became clear when investigating the reason of the reduction of over 20 mSv/year person in France, and the overseas situation.

a. Reducing the volume of maintenance operations

In EDF, they succeeded in reducing the volume of maintenance operations such as Simple Refuel Shutdowns and the optimization of preventive maintenance.

b. The extension of the fuel cycle

They succeeded in the extension of the fuel cycle (going from a refueling of 1/4 of a core every 10-12 months to a refueling of 1/3 of a core every 18-20 months) on the 1300MWe energy rated leves and that contributes in reducing the shutdown periods and consequently in reducing the collective and individual dose.

c. Equalization of exposure (deviation reduction of exposure to a specific individual)

(a) The number of workers is increased and the individual dose is decentralized.
(b) From 2001, EDF has severer individual dose management value, (local alarm level is 16mSv/year, and national alarm level is 18mSv/year) .

On the other hand, the result which investigated the situation of individual dose in Japan (TEPCO) by 15 mSv/year excess person is as follows.

d. The number of workers of over 15mSv/year in TEPCO in 2002 is 321 persons of 24,373 persons.（Fig.7）
e. About 40% of total dose of over 15mSv/year workers is caused in maintenance work, and that is greatly dependent on the amount of maintenance work. (Fig.8)
f. When we investigated the occupation of workers who excess 15mSv/year at Fukushima-Daiichi NPS (TEPCO), the supervisor and group leader who are a skillful technician occupied two thirds of the whole. Therefore, simple increase in an injection of normal worker, cannot make decentralization of an individual dose effectively. It is thought that increase in a skillful technician can make decentralization of an effective individual dose.

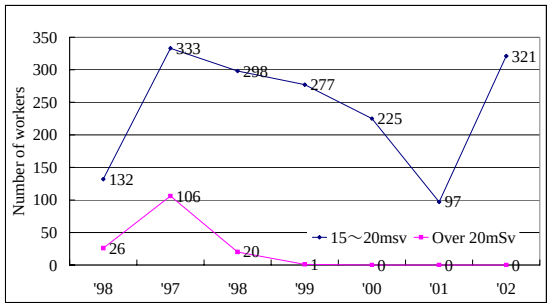
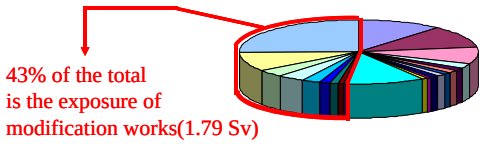


Fig.7 Number of workers range from 15mSv to 20mSv and over 20mSv



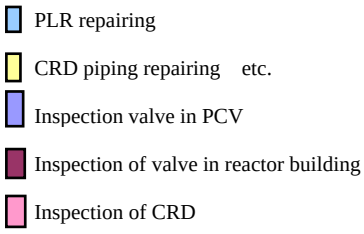


Fig.8 Total exposure of over 15mSv/year (4.15 person-Sv) in 2002

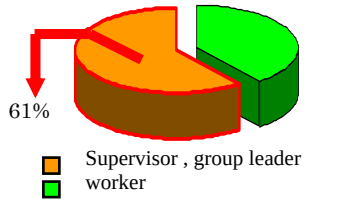


Fig.9 Occupation ratio of workers who are exposed over 15mSv/year at Fukushima Daiichi NPS

4.Conclusion

(1) Occupational dose during outage

In the BWR plant in Japan, the dose equivalent rate at workplace is reduced greatly, and it is thought that work environment in Japanese NPP is excellent in every country in the world. However, the inspection systems itself, such as the interval for periodical inspection, required work item, the amount of required work, is much stricter than other countries. This is the reason of the difference in occupational dose.

From now on, on the assumption that safe reservation, we should perform rationalization and the optimization of the contents of work and interval of periodical inspection, which also took in the viewpoint of optimization of radiation control.

This is the subject which should be examined for a mid- or long-term from now on with the regulation government of Japan.

Moreover, we should set the reasonable goal of the collective dose reduction in consideration of the type of reactor, contents and volume of work etc. from now on.

And we have to plan reasonable measurements for dose reduction so that we maintain a level about what has attained the target, and perform the preferential measure for reduction about what has not reached a target.

(2) Individual dose

In order to cut down the number of workers who are exposed relatively high in Japan, we performed the measurement of dose reduction with emphasis on workers who are exposed relatively high as a short-term subject.

And It is thought that it is necessary to perform rationalization and the optimization of the contents and frequency of work with the high-dose exposure as a mid- or long-term subject, and the measurement for equalization (training of a skillful worker).

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And we considered the way to set the new goal of dose reduction.
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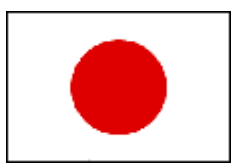
TEPCO TOKYO ELECTRIC POWER COMPANY



Japan