Efforts to Reduce Radiation Exposure at the Takahama Power Station (Draft)

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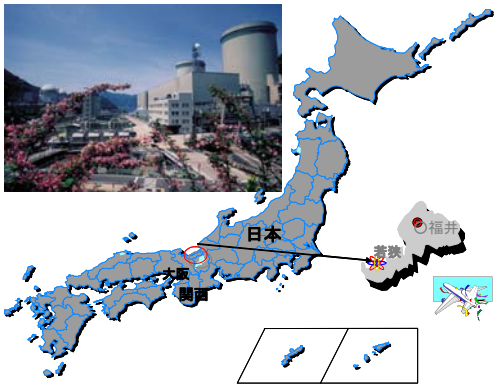
Prepared by Masashige Takagi
Radiation Management Department
Takahama Power Station
Kansai Electric Power Co.

Overview of Takahama PS

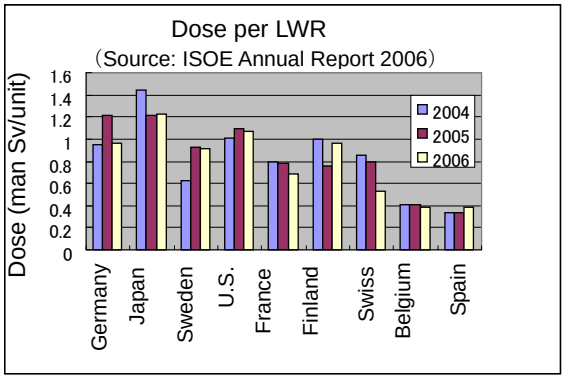


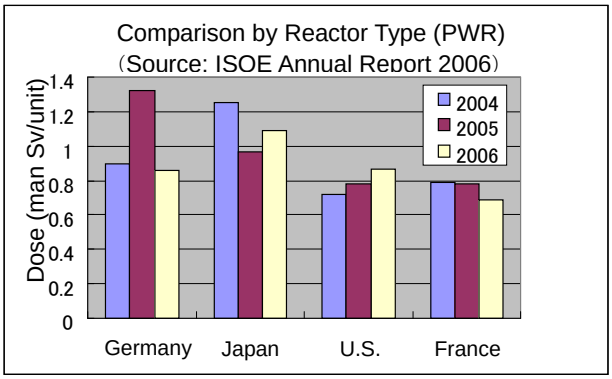
1. Overview of the Takahama Power Station

Kansai Electric Power Co. has a total of 11 pressurized water reactors at three nuclear power stations, all in the Wakasa Area. Of these 11, four are installed at the Takahama Power Station, with a total installed capacity of 3392MW (two 826MW units and two 870MW units).

2. Current levels of radiation exposure in Japan

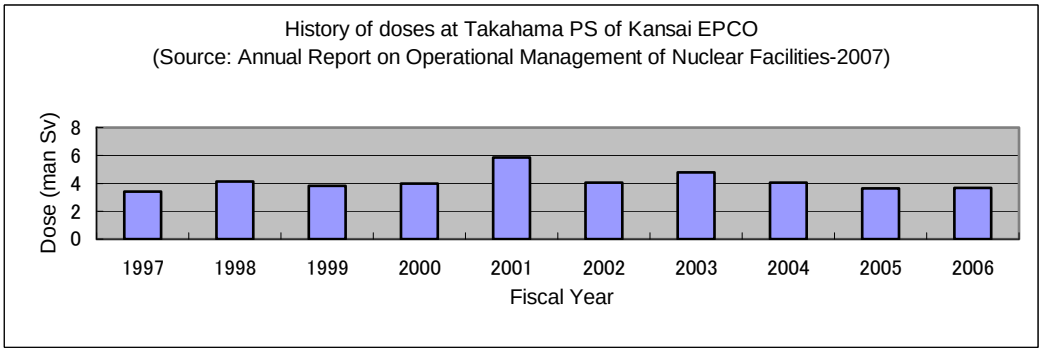
Radiation exposure in Japan is at higher levels than in other major countries of the world.





3. Radiation exposure at the Takahama Power Station

The graph below shows the history of doses at the Takahama Power Station in the last several years. They are almost leveling off, although there are some ups and downs depending on what jobs were involved in each refueling outage.

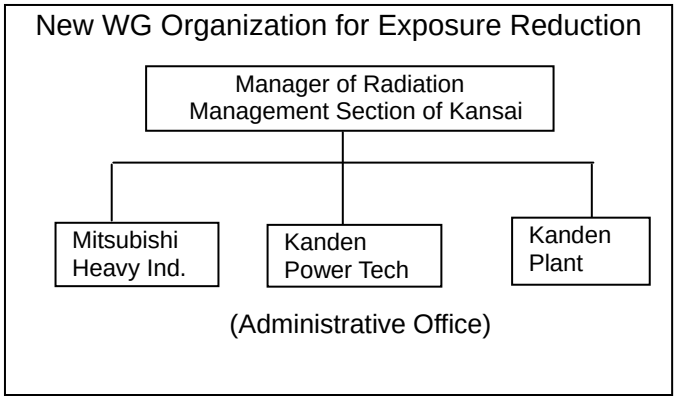


4. Formation of a working group to address radiation exposure

We have been steadily carrying out radiation exposure reduction activities at the Takahama Power Station since many years ago. Our efforts include, for example, improvement of water chemistry, automation of work, and work management with attention to details.

Furthermore, we have recently set up a working group (WG) for radiation exposure reduction aiming at starting dose reduction efforts from a different viewpoint from the unit4 18 th outage in 2008, apart from the traditional activities. The WG places particular emphasis on reducing doses transmitted/received between different work activities.

The figure on the right shows the organizational structure of the newly organized WG. As shown, contractors (three major vendors), which are directly involved in the performance of outage work, are included. This is to promote exposure reduction efforts in a more efficient and effective way in close cooperation with the organizations that are well-versed in outage work activities as well as work areas. This WG works under the supervision of the Manager of Radiation Management Section of the power station and leads exposure reduction activities on a station-wide basis.



5. Study of measures to reduce radiation exposure

The newly started exposure reduction activities can be divided into two major categories: “exposure reduction from the viewpoint of environment” and “exposure reduction from the viewpoint of outage work.” The latter is led by the WG.

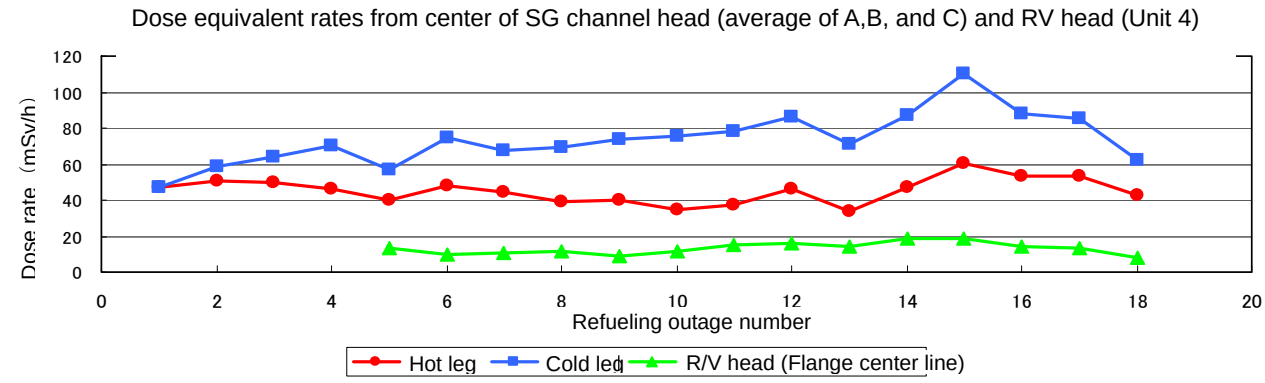
“Exposure reduction from the viewpoint of environment” includes zinc injection while the plant is in operation. This was first introduced in Unit 4, with preparations made during the last outage (the 2007 outage), and will be applied to the other units as well, with high expectations for successfully reducing total radiation exposure at Takahama.

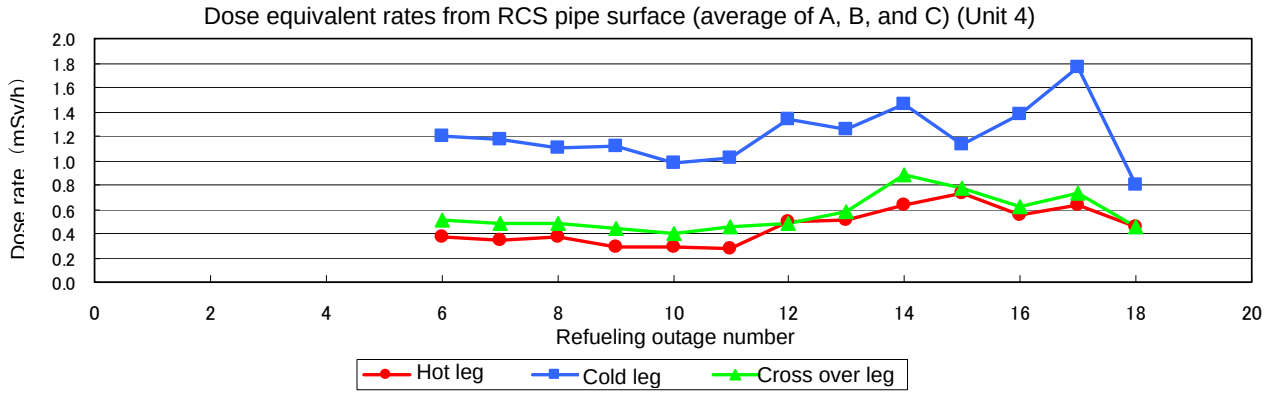
As for “exposure reduction from the viewpoint of outage work,” while efforts to reduce exposure from workers’ own tasks are continuing, a new concept of “reducing doses transmitted/received between different work activities” has been introduced and exposure reduction measures have been studied under this concept.

6. Examples of the newly introduced measures for radiation exposure reduction

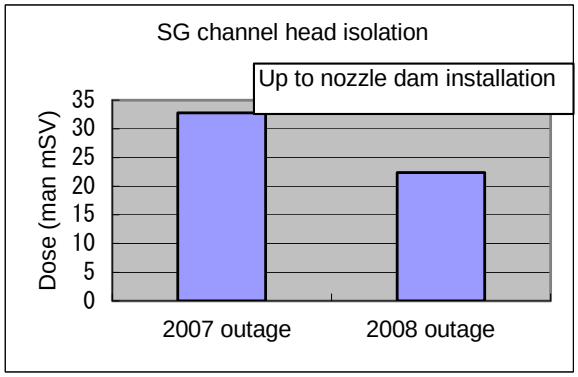
[Measure 1] Source term reduction by zinc injection during plant operation

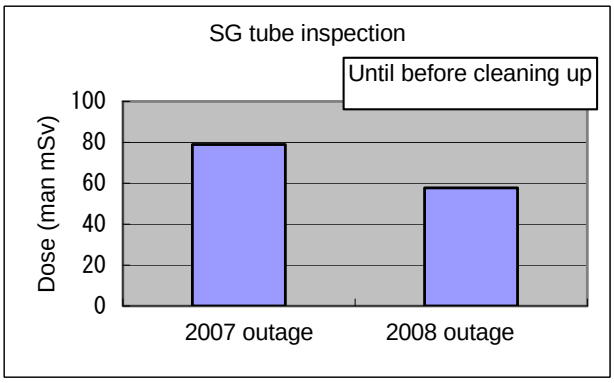
This is a source term reduction technology which utilizes depleted zinc solution injected into the reactor coolant system through the chemical volume control system during plant operation. The injected zinc solution replaces radioactive cobalt deposited on the inner surfaces of pipes and equipment with non-radioactive zinc. The zinc injecting equipment was installed in Unit 4 during the 2007 outage. The effects after one year of application are that dose equivalent rates from major components and pipes have decreased by about 20 to 40 % (compared with the values from the 2007 outage).





This reduction in dose rates is attributable to the decreased doses in the following jobs.



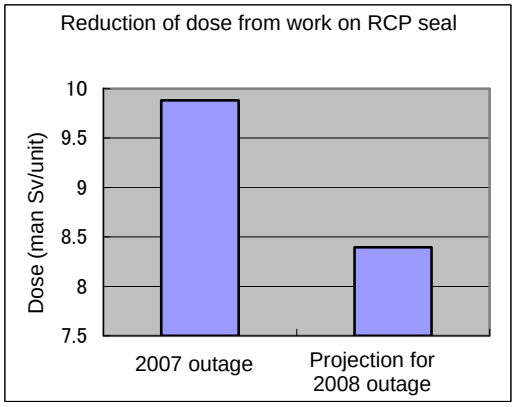


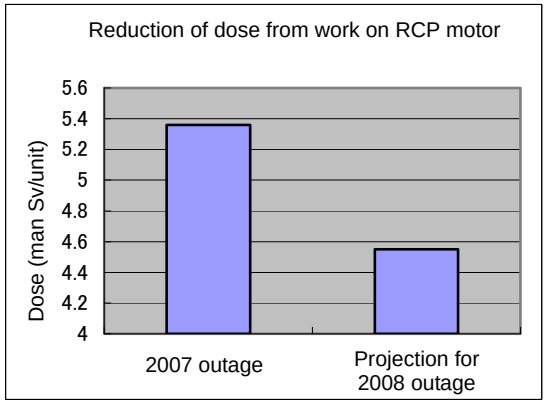
Dose reduction in SG channel head work - 31.7%
Dose reduction in SG tube inspection - 26.9%

[Measure 2]
Dose reduction by adjusting the schedule for draining secondary water from the steam generator (SG)

The steam generator is a significant radiation source. Radiation levels do not diminish very much with distance, exposing personnel in the loop room to radiation hazards. Meanwhile, this exposure can be reduced effectively by keeping secondary water in the SG. Thus, with a view to adjusting the outage schedule to minimize the duration in which the SG secondary water is drained, the newly organized working group has collected information about the jobs which require the removal of SG secondary water, and tried to minimize the durations of these jobs as well as to schedule the draining operation at a time when only a limited number of personnel are present in the loop room.

The work on the RCP is a typical example of a job taking place within the loop room. This has traditionally been performed partly during the period when the SG is drained of secondary water. With our recent efforts, reduction as shown in the figures below can be expected for Unit 4.





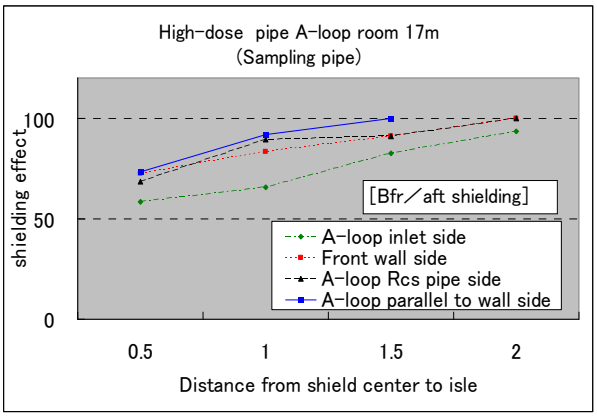
＊） Actual doses from the work in the 2007 outage performed with SG secondary water drained were corrected using the dose rates that would have been produced if the work had been done with secondary water in the SG.

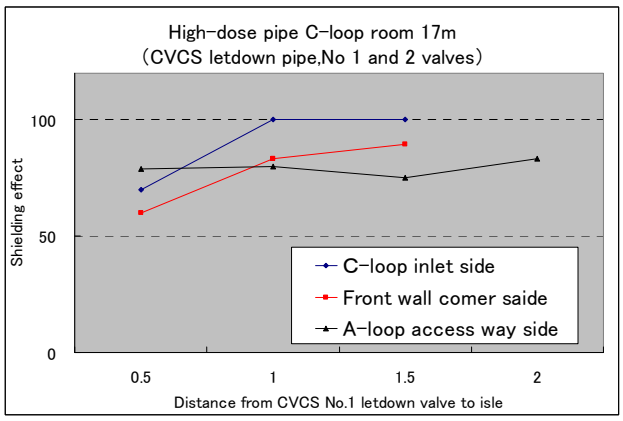
[Measure 3] Installation of temporary shielding

In the current refueling outage for Unit 4, temporary shielding has been installed in areas where there are high doses and a relatively large number of workers, to avoid radiation effects from equipment and piping. The shielding used is ALARA shielding, i.e., resilient shielding made of a stainless steel plate with 1-cm thick lead attached on both sides. This shielding is placed on a mount which is installed on piping or other component in a way that will not apply load on the equipment. The places where this was installed are shown below.

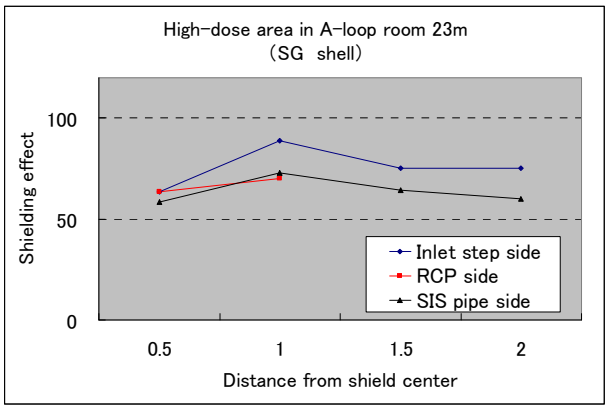
(1) At the middle between the steam generator shell and the RCP
(2) On the grated floor above the cold leg pipe
(3) Near the sampling pipe for high dose equivalent rate located at the bottom of the loop room
(4) Near the CVCS letdown point and RCS drain pipe and valves (for one loop only)

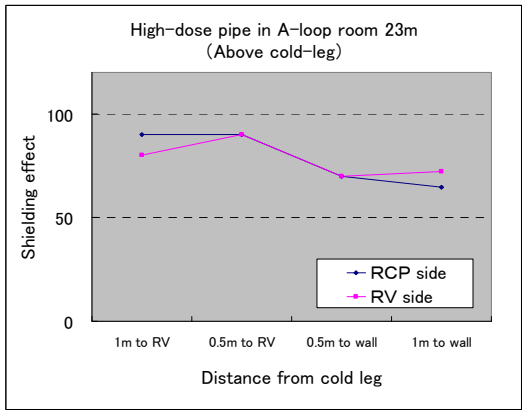
The following figures provide the dose equivalent rates in the environment after the temporary shield installation.





(EP = workers' entering point)





This temporary shielding is installed at places close to radiation sources. As a result, doses in large areas around the shielding will become low, effectively protecting workers who have to move around to perform their work.

However, installing temporary shielding will produce an additional dose (approx. 7man mSv) because a mount (fabricated with single pipe scaffoldings) has to be installed in a high dose area. This means that overall decrease in radiation exposure from one outage can only be expected if the shielding is installed in areas where a large number of outage workers will stay for long hours. The issue for the future is how to lower exposure from installing a mount.

[Measure4] Assessment of Radiation Effects ("Assessment of the Environment Surrounding the Work Area" and "Radiation Exposure Reduction Assessment" "

During a refueling outage, many different work activities take place in the same work area, resulting in workers receiving doses not only from their own work but from others'. To address this issue, the working group provided sections/groups scheduled to be involved in the current outage work with "Information about Radiation Exposure Reduction - Assessment of the Environment Surrounding the Work Area." This presents information about when and where dose rates are expected to increase during the outage, how much increase is expected in dose rates, and so on.

In addition, it was also decided that the working group would make "Radiation Exposure Reduction Assessment" referring to the "Information about Radiation Exposure Reduction - Assessment of the Environment Surrounding the Work Area" to discuss and implement measures for preventing radiation effects.

The fool-proof concept applied in human error prevention, i.e., "exclusion," "replacement," and "mitigation of effects" has been introduced into this "Radiation Exposure Reduction Assessment." Under this concept, the working group has, in advance, assessed effects of radiation transmitted/received between different work activities and studied measures to prevent these effects. For the current outage, the "Radiation Exposure Reduction Assessment" has been applied on a trial basis only to the major jobs performed by the three contractors included in the WG.

Additional doses from other activities taking place nearby one's work area have been traditionally incurred due to lack of appropriate information. The Assessment of Radiation Effects aims at reducing doses of this kind as much as possible by providing information in advance about radiation effects between different work activities and measures to prevent them.

[Measure 5]　Simplified, portable shielding

Effects of shielding on radiation exposure reduction can be enhanced by minimizing doses resulting from installation and removal of the shielding. Furthermore, to avoid exposure to radiation from large sources such as a steam generator, it is also necessary to increase geometric effects of shielding. With these points taken into consideration, a simplified portable shield was designed for protecting workers working in stationary positions.

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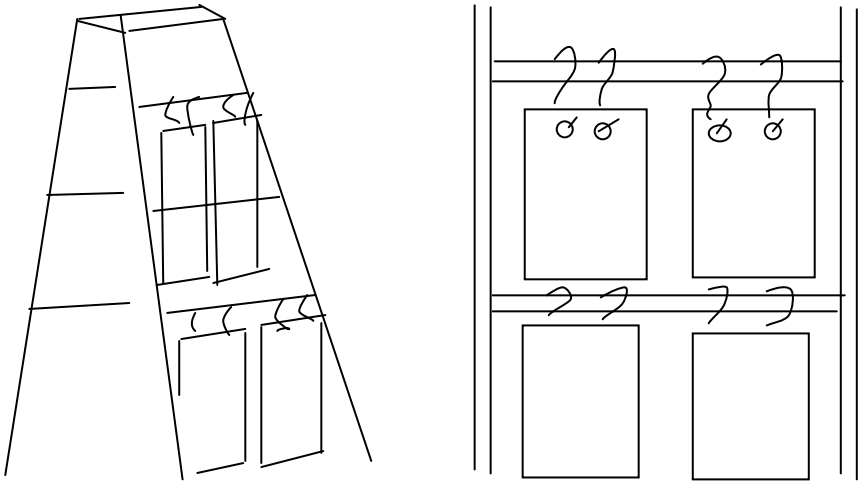
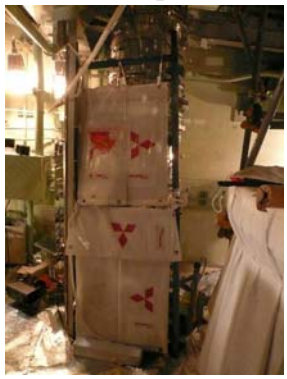
This shielding, made of lead, is hung using an S-shaped hook on a step ladder or on the frame of scaffolding carried into a work area, as shown in the figure below, and is placed near where workers work.

【Use of portable shielding】



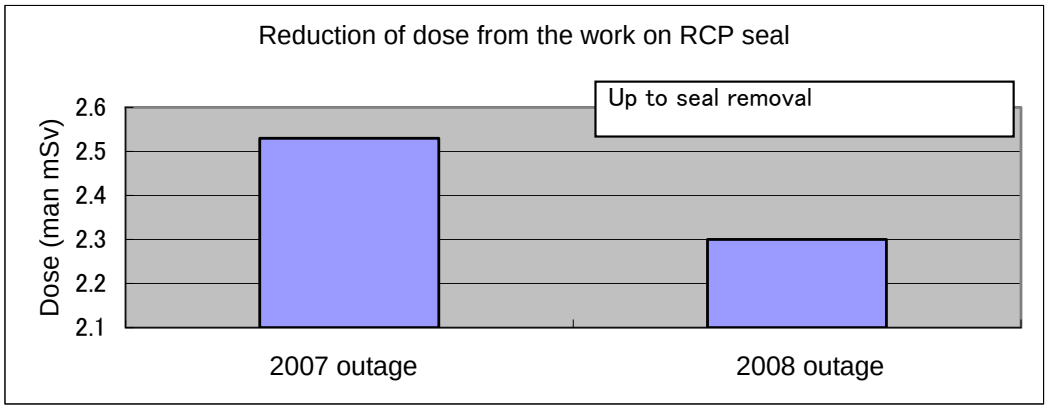
【Shielding material】

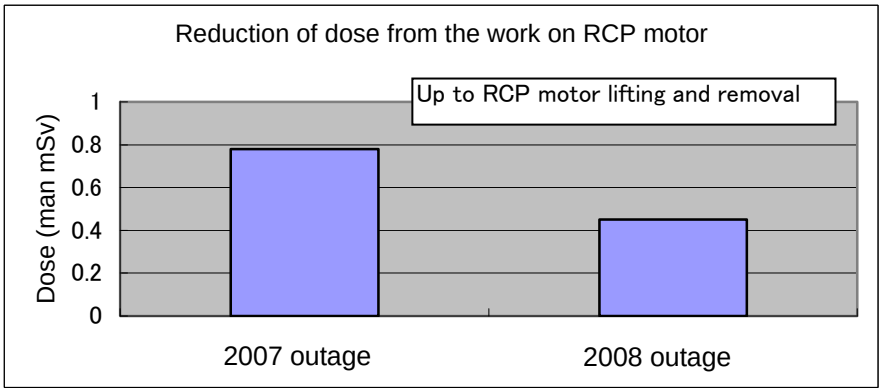
【Shields in a work area】



This simplified, portable shielding was used near the RCP motor during its inspection in the ongoing outage (the 2008 outage) for Unit 4. The result was that the dose under the environment where the dose rate is normally about 0.1mSv/hr was about 0.03mSv/hr.

The effects of using the temporary shielding and the simplified portable shielding on dose reduction are shown in the following figures.





7. Conclusion (Overall evaluation)

The recent efforts for radiation exposure reduction described above have been made in collaboration with the Radiation Management/Radiation Protection Departments of main contractors, under the supervision of the station top management. Each of the parties has provided insights from their own perspectives, feeling that “we are one.”

This has led to a station-wide awareness towards radiation exposure reduction, promoting discussions involving all parties concerned. Establishment of awareness like this seems to be a favorable side effect of the recent efforts.

With Unit 4 still in a refueling outage, the final evaluation is yet to be made on the effects of the temporary shielding and Radiation Exposure Reduction Assessment. In the meantime, we will check the outage schedule and progress in work activities, track the effects of the measures in place, and discuss and implement improvements for continuously promoting radiation exposure reduction efforts.