Optimization of protection for KOMAC

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1. Introduction

ICRP declared the Commission's three fundamental principles of radiological protection is used for an evaluation scale for radiation safety these days. Each means, (1) JUSTIFICATION : Radiation works should not be carried out if there are not any net benefits from the works, (2) OPTIMIZATION : it is intended for application to the works that have been deemed to be justified, and maintains exposure as low as reasonably achievable considering economic and social factors, (3) the application of DOSE LIMIT : even if the justification and optimization is satisfied, it should not be exceed the individual dose limit.

Optimization is a major part of practical radiation protection, and how to apply it to KOMAC is discussed more detail in this paper.

2. Methods and Results

The best option of optimization is that maintain exposure as low as reasonable achievable considering various properties and conditions.

The situation of KOMAC is classified with three categories (radiation source, the characteristic of exposure and the social perspective) introduce the safety systems, and management procedures for optimization of radiation protection. Furthermore, this mentions limitation and proposes improvement to the current protection systems.

2.1 Radiation source

The perspective of radiation source is that the kind of the source, the number of the source, and capacity. KOMAC operates 100 MeV 20mA proton accelerator, five different types of accelerators, and other radiation generators.

Just focus on the 100 MeV proton accelerator which capacity is maximum in KOMAC, the types of radiation generated are as follows. Representative radiation during accelerator on include: proton, neutron, gamma ray. In addition, interaction proton beam and target generates radio-nuclides and they emit gamma rays while decay.

During on the proton irradiation, it is necessary to control not to remain in target rooms and use shielding doors to minimize external exposure. Also, PSIS (Personal Safety Interlock System) could control entrance to high radiation field such as target rooms, and open and close shielding doors by five modes include emergency mode. The ultimate purpose of emergency mode of PSIS is for minimize exposure in unexpected and abnormal situation. If the situation that not to proper to operate accelerator is happened, the interlock is activated to control operation of the device and protect workers from the source.

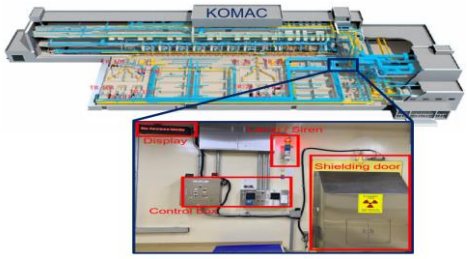

Fig. 1. The picture of PSIS system

Now, not only PSIS but other safety systems in KOMAC are already got permissions including evaluation of the effects for the exposure from Korea regulators. With radiation protective level, the systems should be maintained and operated at least.

2.2 Characteristic of exposure

The meaning of the characteristic of exposure is that the radiation workers, exposure time, the numerical statistics of exposure and latent exposure.

As the demand for the number of experiment by using proton accelerator and ion beam devices is increased, the number of workers from other organization is also increased. The trend is shown in the figure below.

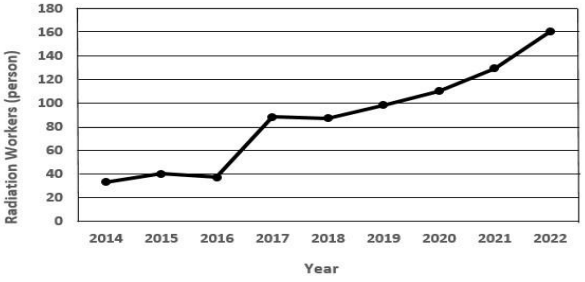

Fig. 2. Development of the number of radiation workers.

For manage the workers directly, KOMAC operates the entrance control system at the front of the radiation controlled area and controls that permitted people only could enter the field with EPD (Electronic personal dosimeter) and TLD (Thermoluminesence dosimeter). For entering the controlled area, radiation workers have to submit a plan for the work to the radiation safety team previously, and can start after approval.

By this system, it is easy to apprehend about radiation work times, places, entering times, cumulative dose and collective dose. Based on these data, radiation safety team can manage the exposure to individuals and total workers, and control the source. In addition, it can be identified the facility or radiation work type where doses are measured high. We can focus where needs to attention more carefully for protect radiation.

Table I : Access statistics by facility (Jan.2021 ~Jun.2023)

FACILITY	Work time (hr)	collective dose (uSv)
RG facility 1	12413.5	3075.33
RG facility 2	1695.6	121.56
RG facility 3	12085	1217.06
RI product facility	756	458.69

Based on the above data and suppose that workers work for 2000 hours in a year, then we can calculate collective dose for 160 workers. The result is approximately 361.6 uSv/yr, the value falls much short of the legally effective dose limit. Additionally, all dose rates in every facilities is not exceed our criteria 12.5 uSv/hr.

The facility which is the relatively highest collective dose compared to work time is RI product facility, and the main reason why exposure occur is affected by the decay radiation from the artificial radioactive isotope. Since this isotope is not sealed, it has possibility to contaminate, then workers should be measured themselves for protection like using whole-body counter after work.

2.3 Social perspective

For the social perspective, it includes the purpose of work which occur radiation exposure, the safety awareness of workers, administrative capacity and so on.

Fig.3 shows the work performed by the radiation safety team and it is divided into four main categories: (1) Operation on safety system, (2) Management of radiation workers, (3) Management of radiation works, (4) License for Nuclear facility's use.

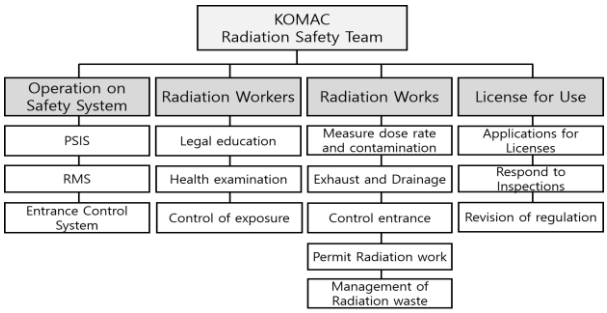

Fig.3. KOMAC Radiation management diagram

Among them, (3) Management of radiation works is most relevant with social perspective. First, KOMAC measures radiation level, surface and air contamination periodically to prevent deterministic effect and confirms that shield is within the regulation limit. Second, as mentioned earlier in 2.2 characteristic of exposure, all of workers should get permit about the plan before work. By the advance work plan, radiation safety team can recognize and recommend that the work should be prepared protection action before works so as not to intrude justification.

3. Conclusions

Each safety systems is properly maintained for radiation protection, and it can be proved by exposure dose report. However, the safety system has been operated since 2015 with proton accelerator completion, so some of equipment are aged and replacement parts are limited. So a major improvement of safety system will be needed. And there are limit that the manager cannot be present at all time at all radiation workplace, so workers have to work according to the rules to minimize unexpected exposure.

Radiation safety team conducted own workplace education for radiation workers this year, and it can remind the importance of radiation safety and regulation. One way to improve safety awareness is to take education about safety regular.

But the perception of workers is more important than the passive environment like the safety systems and education. It means that perfect safety system and structure for radiation protection is already prepared in KOMAC. However, the best optimization of protection method is that workers change their perception of safety through personal inspections.

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