Design of Radiation Shielding for the RIKEN SSC

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Abstract.— A diagram useful in shield design was shown. Rough estimation of the skyshine of neutrons passing through the roof above the SSC facility was also carried out.

1. Introduction.-The RIKEN SSC will operate protons in the 200 MeV energy range, from deuterons to neon ions up to 135 MeV/A,and heavier ions in lower energy region. The maximum beam current will be 1μA. Spectra of neutrons which will be emitted are given elsewhere[1)2)3)]. Allowed radiation levels for the human health are also decided in Ref.3.

2. Design of the neutron shielding.

2-1. Ordinary concrete shielding.- On the basis of the calculated results of Alsmiller et al.[4)] and of Roussin et al.[5)], a diagram which gives the neutron dose as a function of depth in the shield was obtained. It is shown in Fig. 1. To see if there are any differences between the attenuation characteristics of parallel neutron beams incident on a slab and those of neutrons incident on a covering enclosing a point source or not, calculations with the ANISN code were carried out for the case of a spherical shell at which center a monoenergetic source was located. The spherical shell has 6 meter radius and 3 meter thickness. Results are shown in Fig.2. It seems that there is no pronounced difference between these two cases.

2-2. Iron-concrete shilding.- After Smith[1)], we made a rough dose-geometry contours for designing iron-concrete beam dump[3)]. These contours and calculated results of Ban[6)] show that the concrete shielding of 2 meter thickness attenuates the dose to the same level as the iron shielding of 0.8 meter thickness does for the given neutron source. Dose attenuation for monoenergetic neutrons in a concrete beam dump with 3 meter radius, in a double layer beam dump which consists of iron sphere with 0.8 meter radius inside and spherical concrete shell of 1 meter thickness outside, and in a large spherical concrete shell mentioned in paragraph 2-1 were calculated with the ANISN code. Results are shown in Fig.3. This shows that the concrete beam dump of 3 meter radius and the large spherical concrete shell attenuate the neutron dose to nearly the same level at 9 meter.

3. Skyshine.- Figure 4 plots the dose equivalent of skyshine as a function of distance. This was obtained by using the method of Alsmiller et al.[7)]. In this case, some corrections concerning to the effect of the location of a point source on the dose at a close range were made with the aid of the calculated results of Nakamura and Kosako[8)].

4. Concluding remarks.- Using Figs.1 and 4, the radiation levels at any places can be estimated easily. Shielding by the concrete wall of 3 meter thickness around the target area with the typical iron-concrete beam dump (combination of an iron sphere of 0.8 meter radius and a concrete spherical shell of thickness from 1 to 2 meter) proved to be adequate to reduce radiation beneath the allowable level. Assuming the operating time of SSC with full power to be 3000 hours per year, the radiation dose at the boundary of the campus can be suppressed to less than 5 mrem/year.

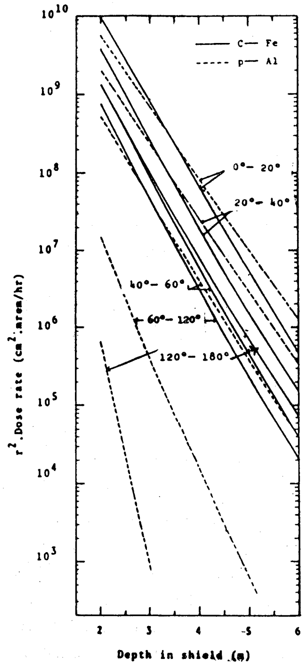
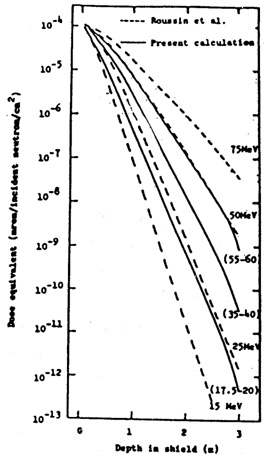


Fig.1. Dose rate multiplied by r^2 vs depth in concrete shield.

Fig.2. Dose equivalent vs depth in concrete shield.



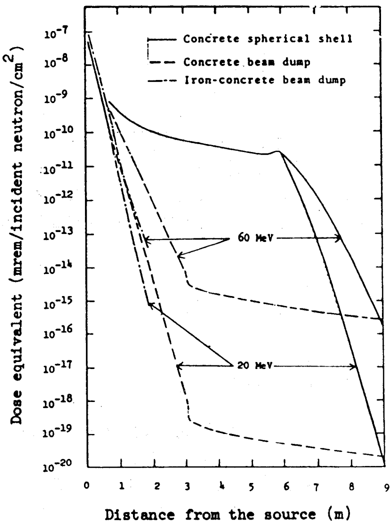
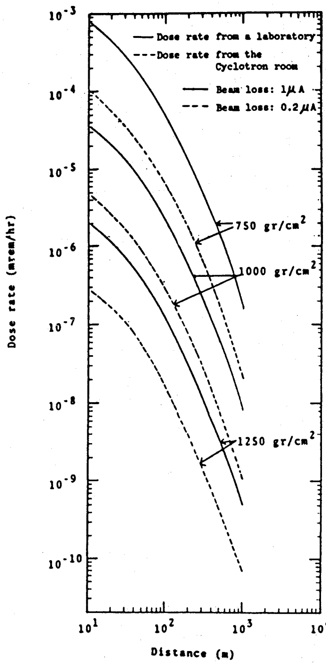


Fig.3. Dose equivalent vs depth in several shields.

Fig.4. Neutron dose rate for skyshine.



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