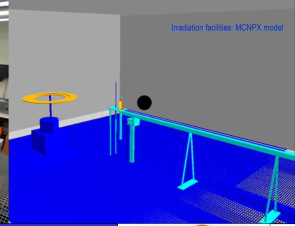
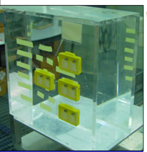


Calibration Laboratory



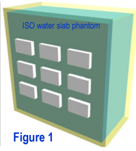
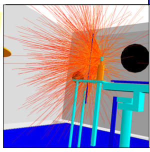


Figure 1

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The ISO water slab phantom in a neutron reference field

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At the accredited PSI calibration laboratory personal dosimeters for neutron radiation are irradiated in reference fields on the ISO water slab phantom. In this work the detailed MCNPX models of the irradiation facilities were used to determine the influence of the phantom on the neutron field of a ^{252}Cf source. In particular the dose build-up at the phantom surface due to backscattered neutrons, the homogeneity of the dose at the front surface and the modification of the energy spectrum were investigated. Furthermore, the influence of backscattered radiation from the room on these effects was quantified. In 100 cm distance from the source a dose build up of up to 10% in the room was obtained compared to a 16% build up without room backscatter. Measurements with MGP DMC 2000 GN active personal dosimeters (APDs) confirm the effect. In the same irradiation conditions the simulation indicates a variation of the dose rate by less than 2% within the 22 x 22 cm^2 center area of the phantom.

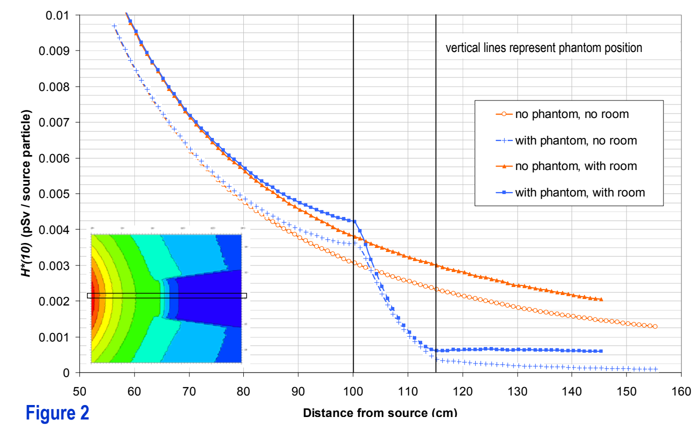

Figure 2

2) Dose build up at the phantom surface

The dose build up at the phantom front surface due to backscattered neutrons was evaluated along the central column of the mesh tally in Fig. 2 and 3. Fig. 2 shows the dose build up at the front surface of the phantom and the influence of the room backscatter on the effect. The relative dose build up decreases from 16% in a simulation without the room to 10% in the presence of room backscatter. Measurements of *Hp(10)* with APDs on the phantom and free in air show a build up of ~7% .

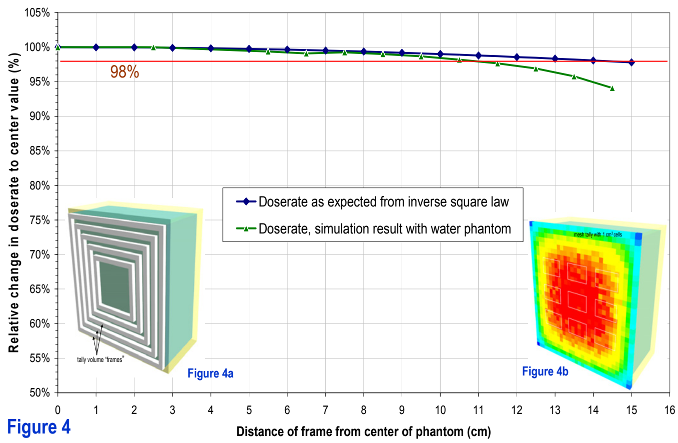

Figure 4

4) Homogeneity of dose across phantom surface

The homogeneity of d*H*(10)*/d*t* across the phantom surface is affected both by the 1/r^2 law (moving away from the center of the phantom front surface the distance to the source increases) and by a decrease in backscattered neutrons at the edge of the phantom. The overall effect was simulated for a distance of 100 cm from the ^{252}Cf source by means of the square frame tally volumes shown in Fig. 4a. In Fig. 4 the scored dose in these tallies is shown as a function of distance from the center of the front surface. The dose rate decreases by less than 2% up to a distance of 11 cm from the center. Approximately half of the decrease is due to the 1/r^2 law.

1) MCNPX Monte Carlo model

Simulation results are based on a detailed MCNPX model of the neutron irradiation facilities including the ISO water slab phantom (Fig. 1,3). For neutron scoring volume averaged fluence tallies were used in the form of the volumes and meshes shown in Figures 3, 4a, 4b, and 5a. Results were obtained in terms of ambient dose equivalent rate.

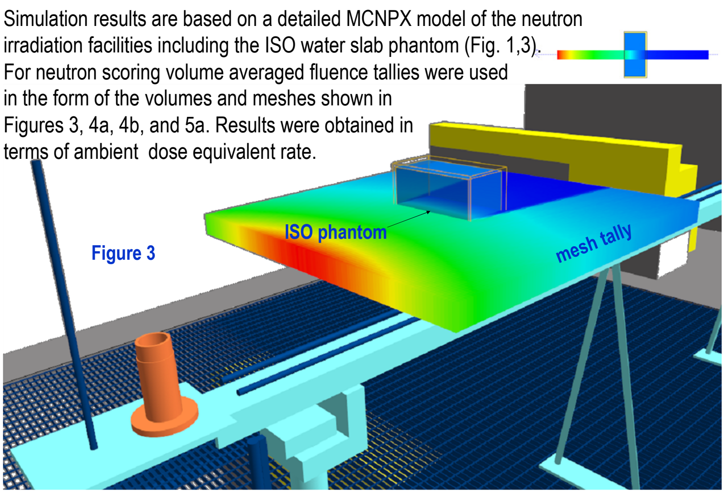

Figure 3

3) Energy spectrum at the phantom surface

The energy spectrum of the ambient dose equivalent changes at the phantom surface due to the lower energy of backscattered neutrons. To illustrate this effect, contributions to *H*(10)* per energy bin were obtained using the tally volume shown in Fig. 5a. The simulations were carried out with and without the presence of the water phantom. Fig. 5 contains the spectra for these two situations in comparison to the direct spectrum without room backscatter and without the phantom. It should be noted that the major dose contributions originate from the high energy part of the spectra. If the difference between the two spectra is taken, i.e. the spectrum of the dose build up due to the phantom, 87% of the build-up are found to be above 128 keV.

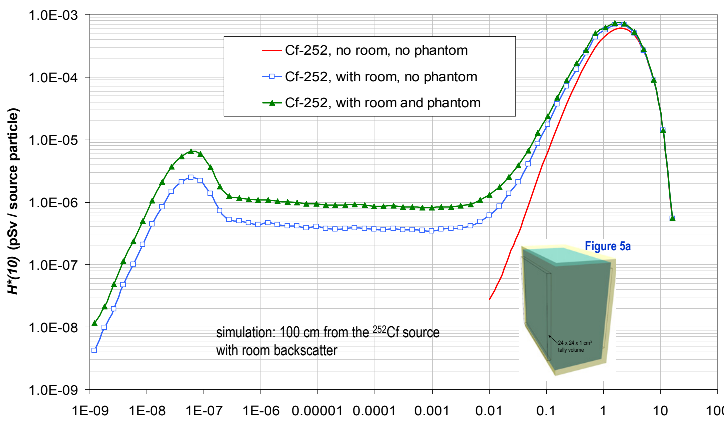

Figure 5