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Ratchet Door Shielding Design Calculations

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Introduction

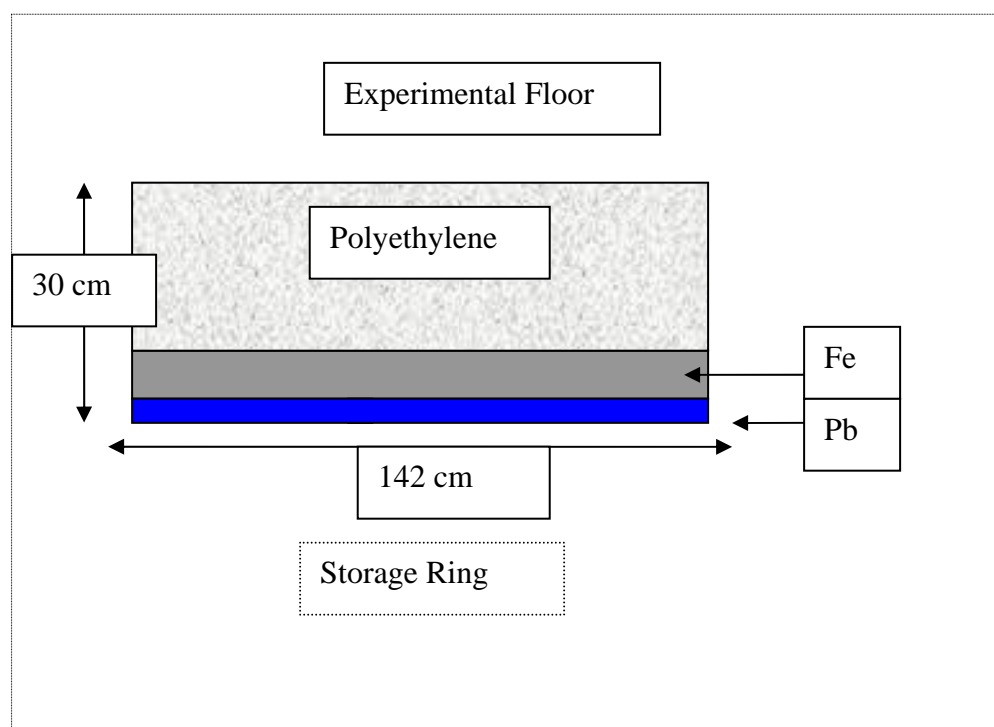
The ratchet wall at the experimental floor side will have sliding doors to provide access to beamline front ends during installation and maintenance. The thickness and design of these sliding doors should provide shielding equivalence of the concrete thickness of the ratchet wall. Each of the sliding doors will be a composite to provide effective shielding from neutron and gamma radiation, emanating from beam losses inside the storage ring.

Two sets of design calculations were carried out for the ratchet door configuration. A beam loss of 1.1 nC/min, at a location closest to the ratchet door, is assumed. The closest distance of ratchet door from beam center line is taken as 3.5 m. The thickness of the door is set at 30 cm, space available for the ratchet door thickness, and the width is set at ratchet wall opening + 20 cm overlap on either side. The height of the door should provide 20 cm of overlap at the top and bottom beyond the concrete edge of the wall opening.

The two door configurations considered for the ratchet door are the following;

Case 1: Thickness of 5.0 cm Pb, 5.0 cm Fe and 20 cm Polyethylene

Case 2: Thickness of 5.0 cm Pb 10 cm Fe and 15 cm Polyethylene



Attenuation Lengths used for the calculations

Material	Density (g/cm ³)	Gamma Attenuation Length (g/cm ²)	Neutron Attenuation Length (g/cm ²)
Lead	11.35	25	161
Iron	7.80	37	100
Polyethylene	1.00	70	6.3

Dose Rate Calculations

The dose rate on external contact for the given beam loss scenario was calculated by the equation 1

$$H = \sum_i \frac{F_i W}{R^2} e^{-t_1/\lambda_{1i}} \cdot e^{-t_2/\lambda_{2i}} \cdot e^{-t_3/\lambda_{3i}} \quad \text{eq.1}$$

Where

H = Dose equivalent rate on external contact with the door, summed over all components

F_i = Dose equivalent factor for the ith radiation component

W = Electron energy dissipation rate

R = Distance of the dose point from source

t = Thickness of the shielding materials

λ_i = Attenuation length of the ith radiation component

Dose equivalent rate Calculation for Case 1: (5 cm Pb, 5 cm Fe and 20 cm Polyethylene)

Dose Equivalent Rates on contact;

Gamma = 0.612 mrad/h

Neutrons = 0.10 mrem/h

Total Dose Equivalent Rate on contact = 0.712 mrem/h

Dose equivalent rate Calculations for Case 2: (5 cm Pb, 10 cm Fe and 15 cm Polyethylene)

Dose Equivalent Rates on contact;

Gamma = 0.229 mrad/h

Neutrons = 0.15 mrem/h

Total Dose Equivalent Rate on contact = 0.379 mrem/h

Conclusion

Case 2 (thickness of 5 cm Pb, 10 cm Fe and 15 cm Polyethylene), lead towards the storage ring side, is recommended for the ratchet door configuration to reduce the dose rate to < 0.5 mrem/h on contact. The door structure should be encased inside a steel frame.