Corrigenda to Design and Shielding of Radiotherapy Treatment Facilities
P W Horton and D J Eaton, eds. IOP Publishing (as of September 2017)

Chapter 5, p5-3

In concrete, the TVL and HVL will increase with increasing x-ray energy and the thickness will need to be increased to achieve a specific dose rate on the exterior of the shielding for a given incident dose rate.

IPEM (1997) tabulates TVLs for standard concrete (2350 kg m\(^{-3}\)) for x-ray endpoint energies ranging from 4 to 24 MV, and also has a graphical presentation of the TVL variation in concrete, steel and lead over the energy range 50kV–10 MV. However, these are average TVL values. In practice the mean energy of the x-ray beam will decrease as it penetrates the concrete due to the presence of lower energy Compton scattered photons which are not readily captured because of the low photo-electric cross-section in concrete. NCRP (2005) adopts this more scientific approach and gives values for the first TVL (TVL\(_1\)) and the subsequent equilibrium TVL (TVL\(_e\)). These are reproduced in table 5.1.

Chapter 5, p5-3, Table 5.1 (Co-60 row)

<table>
<thead>
<tr>
<th>Density (kg m(^{-3}))</th>
<th>Concrete</th>
<th>Steel</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TVL(_1) (mm)</td>
<td>TVL(_e) (mm)</td>
<td>TVL(_1) (mm)</td>
</tr>
<tr>
<td>2350</td>
<td>350</td>
<td>300</td>
<td>99</td>
</tr>
<tr>
<td>7870</td>
<td>370</td>
<td>330</td>
<td>100</td>
</tr>
<tr>
<td>11 350</td>
<td>410</td>
<td>370</td>
<td>110</td>
</tr>
<tr>
<td>410</td>
<td>440</td>
<td>410</td>
<td>110</td>
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<tr>
<td>450</td>
<td>450</td>
<td>430</td>
<td>110</td>
</tr>
<tr>
<td>460</td>
<td>490</td>
<td>460</td>
<td>110</td>
</tr>
<tr>
<td>510</td>
<td>510</td>
<td>490</td>
<td>110</td>
</tr>
</tbody>
</table>

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The end point energy of the leakage radiation will be degraded by the scatter interactions with components in the treatment head, and the mean energy of this radiation will be less than the primary radiation. Consequently the TVL values for leakage radiation will be lower than those for the primary beam and generally secondary shielding will be thinner than primary shielding. Again, IPEM (1997) tabulates secondary TVLs for standard concrete (2350 kg m\(^{-3}\)) for x-ray end point energies ranging from 4 to 24MV. These are average values, but the x-ray beam will undergo spectral changes as it penetrates concrete, as described in section 5.2.1. Again NCRP (2005) adopts a more scientific approach and gives values for the first TVL (TVL\(_1\)) and the subsequent equilibrium TVL (TVL\(_e\)) for leakage Co-60 radiation and x-radiation with end point energies in the range 4–30 MV. These are reproduced in table 5.2.
Figure 6.5. Left: A VISED plot of scattered photon tracks which ultimately reach the room door. Right: The MCNP mesh tally result for the same bunker geometry.

Figure 6.10. Left: A horizontal plane through the Birmingham neutron beam shaping assembly for BNCT and the Visible Human voxel model. Right: Dose rates (in Gy min$^{-1}$) experienced by a wide range of body organs during a typical treatment irradiation.