Purpose:

Helical Tomotherapy is an emerging form of radiation therapy treatment which is finding its way into existing and new facilities. The predominant source of radiation to consider for shielding design is from head leakage because of the presence of a beam block. The definition of the head leakage factor in NCRP reports is irrelevant for this machine and there is no accepted way to determine it by measurement. With the increased use in monitor units for treatment typical of IMRT, a more accurate determination of the factor for rotating radiation sources is advantageous in radiation shielding design.

Method and Materials:

The scatter field of the accelerator head is modeled with a function which approximates a Gaussian and convoluted with a point distance function to obtain a parametric expression for the radiation field as a function of distance and angle. Radiation measurements obtained from Tomotherapy were used to determine fit parameters for the parametric expression. Head leakage factors are evaluated at a large a distance from the accelerator to obtain a limiting value appropriate for radiation shielding calculations. An example of the use of the factors is applied to the design of JBCC facilities.

Results:

Head leakage factors were determined for the AP and lateral directions. The factors are $\varepsilon_{0°}=1/8,300$ and is $\varepsilon_{100°}=1/2,600$. The shielding of the Tomotherapy facility at the JBCC with concrete required 0.74m for the control area in front of the accelerator and 0.92m for the corridor on the side. With areas interchanged, the shielding for the control area is 1.18m and the corridor is 0.80m.

Conclusion:

A new method of determining the head leakage factor was presented. Due to the radiation anisotropy of the Tomotherapy accelerator, its orientation to protected areas may be an important factor in the consideration of radiation shielding of a new facility.