AbstractID: 7699 Title: A Linear Programming Model and Solution for Radiation Shielding Design of Radiotherapy Treatment Vaults

Purpose: To optimize shielding material combinations and thicknesses for megavoltage radiotherapy accelerator vaults for any photon energy using linear programming by minimizing the costs of shielding materials while satisfying the constraints pertaining to regulatory doses and available space.

Methods: Radiotherapy accelerator vault construction usually requires an experienced physicist to design the appropriate thicknesses of concrete, steel or lead to satisfy the regulatory limiting doses, available thicknesses for shielding and the budget allocated for the project. We have developed a model and solution using linear programming that minimizes the costs of the shielding materials while satisfying regulatory dose limits and space available for the project. The model considers primary, leakage and scatter x-ray radiation and neutron contamination using calculation techniques as in NCRP 151. The optimization routine will insert the required tenth value layers (TVLs) of steel or lead depending on the demands and the cost of these materials. The optimization considers neutron contamination as well. We discuss a parameterized version of the model that is never infeasible and which allows the user to weight the space versus cost according user preference.

Results: The results of the linear program can be easily checked for correctness using standard calculation techniques. If there is abundant space for the wall thickness, concrete only is the result of the optimization since it has the lowest cost. If the allowed wall thickness is too small for concrete only, the optimization will return combinations of concrete, steel or lead such that all constraints are satisfied and costs are minimized. Existing thicknesses of concrete, for example, are easily incorporated into the model as are special requirements for IMRT.

Conclusion: The linear program returns reliable, viable and optimized shielding thicknesses of concrete, steel and lead for primary barriers as well as for leakage and scatter radiation barriers.