Effect of Corner Reflection on the Critical Mass of Plutonium

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INTRODUCTION

One common way to handle incidental reflection in Criticality Safety Evaluations is to bound it with a certain thickness of tight fitting, 4π water reflection. From there, comparisons to other tight-fitting, 4π reflectors are reasonably intuitive as they follow density and scattering cross section. However, if the actual process conditions do not have 4π reflection, comparisons can become more difficult, particularly if the increased leakage is competing against a more effective reflector than water. One common example would be an object sitting in a corner.

The current work looks at not only comparing corner reflectors of varying thicknesses to 4π water reflection, but also comparing the effects of 4π reflection and corner reflection of the same materials.

DESCRIPTION OF WORK

MCNP6.1 is being used to model a sphere of Pu metal at theoretical density sitting in a corner of reflector material (Figure 1). The sphere mass is varied to maintain criticality as the thickness of the reflector is varied over a range of thicknesses representative of the situations found in processing conditions.

Reflector materials include high density polyethylene, graphite, beryllium oxide, beryllium, lead, granite, stainless steel, nickel, iron, Inconel, carbon steel, several concretes, vermiculite, and water for comparison.

These calculations are run on the High Performance Computing system at Los Alamos National Lab, using ENDF/B-VII.1 cross sections.

Once the critical mass for each reflector thickness for each material is found (k_{eff} = 1), a graph is created that shows the critical mass value as a function of thickness of the reflector (Figure 2). This data will then be compared to previous internal work for 4π reflectors.

Fig. 1. Sphere of Plutonium inside Reflector Prism

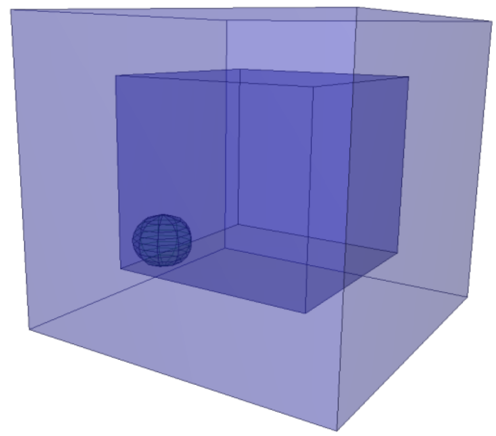
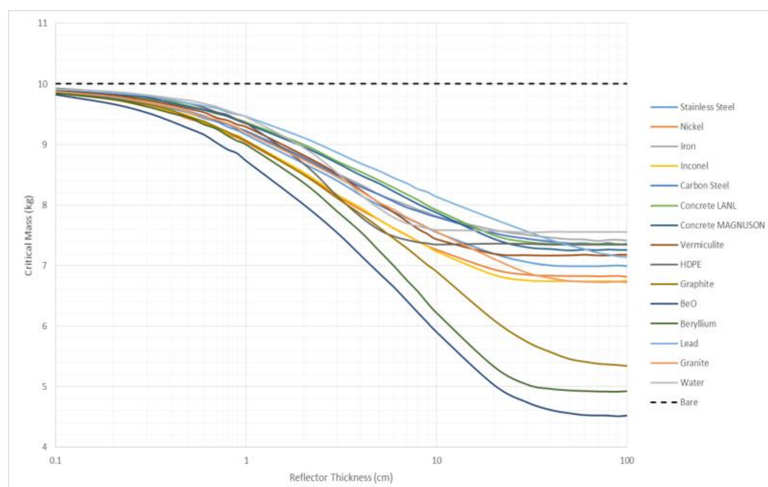


Fig. 2. Comparison of Corner Reflection for Different Materials

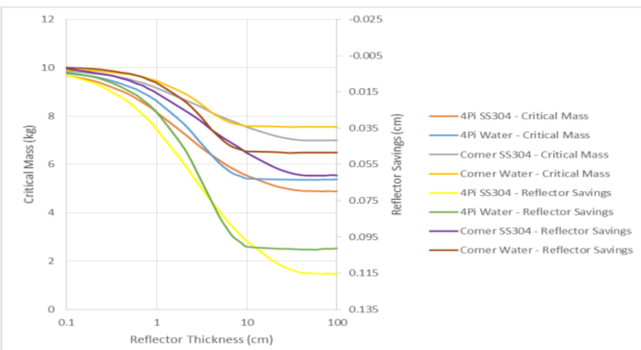


RESULTS

Graphs such as Figure 2 allows the user to determine what thickness of a given reflector can be bound by the thickness of water that they have generalized in their models. Such generalizations can be extremely useful, for example, in situations where a variety of temporary shielding may be employed.

However, comparisons such as Figure 3 are the ultimate goal of this analysis as they give hard numbers to back the use of 4π water reflection to bound corner reflection of more effective reflector materials. In the example shown in Figure 3, 1 inch of 4π water reflection shows the same reduction in critical mass as ~9 cm of SS304 corner reflection. The 4π data from the previous analysis only provided justification for ~1.5 cm of SS304 without invoking engineering judgement or qualitative arguments.

Fig. 3 Comparison of 4Pi Reflection to Corner Reflection



REFERENCES

1. Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U, H. C. Paxton & N. L. Pruvost, July 1987