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A Technical Basis for Glovebox Shielding Removal

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Introduction

Necessary for various operations within Los Alamos National Laboratory's (LANL) plutonium facility, glovebox shielding is an obvious radiological protection measure. Unfortunately, however, the type and thickness of shielding required for a specific glovebox is not so obvious. While the shielding is dependent on many factors, such as material type (MT) present and operation being performed, its determination is a complicated effort.

The technical basis behind the methodology used to determine such glovebox shielding is important. Regarding several aqueous process gloveboxes currently under study, the existing shielding configuration lacks a technical basis and appears to be inconsistent. For example, some gloveboxes within the process have external hydrogenous shielding while others have stainless steel tanks filled with water. Based on the operations performed in each glovebox, such shielding may or may not be necessary. Personnel may be inhibited by the material and face ergonomic difficulties (e.g. the shielding may effectively shorten the glovebox worker's arm length). Indeed, if the shielding prohibits personnel from easily performing a task, the dose received may increase due to longer stay times! If, however, the shielding is truly unnecessary, reconfiguration of any glovebox must be justified by maintaining the utility and function of the glovebox line while also keeping personnel doses As Low As Reasonably Achievable (ALARA). In addition, other facility management or regulatory requirements must also be incorporated into any reconfigured shielding design. This paper documents the technical basis behind the recommendation to remove the external hydrogenous shield on an ion exchange glovebox.

Methodology

The ion exchange glovebox contained an aqueous portion of the process sequence that was assumed to take place in four ion exchange columns. For the source description of MT-42, the specific material type within the columns, the following isotopic composition was assumed: 0.72% ^{238}Pu, 1.26% ^{239}Pu, 6.4% ^{240}Pu, 1.86% ^{241}Pu, and 89.77% ^{242}Pu.[1] Neutron spectra were generated via the SOURCES-3A computer code[2] while the photon spectra were generated with ORIGEN-S.[3] Photons resulting from neutron capture were inherent to the transport calculation. Detailed information regarding the radiation source term can be found in previous work by Shores.[4]

The Monte Carlo code MCNP[5] was used to determine dose in the form of effective dose equivalent (EDE) rates by transporting the radiation through the model geometry (Figure 1). Neutron fluence was tallied over several planar surfaces within the geometry and converted to an EDE by scaling according to the neutron emission rate and multiplying by appropriate fluence-to-dose conversion factors (frontal AP exposure geometry).[6] Photon EDE rates were similarly calculated.

Results and Conclusions

A shielding analysis for a glovebox housing an ion exchange process was performed with MCNP-4B. The glovebox was modeled with and without the existing shielding in place. With a source term driven by photons, the hydrogenous shielding of the glovebox was ineffective and determined unnecessary. The absence of shielding decreased the photon EDE as capture photon production was minimized. From a practical perspective, removal of the shielding should result in lower dose rates because of the enhanced ergonomic geometry and subsequently shorter stay times. Simple removal of the external shielding, an artifact of history lacking a technical basis, would certainly support the spirit of ALARA.

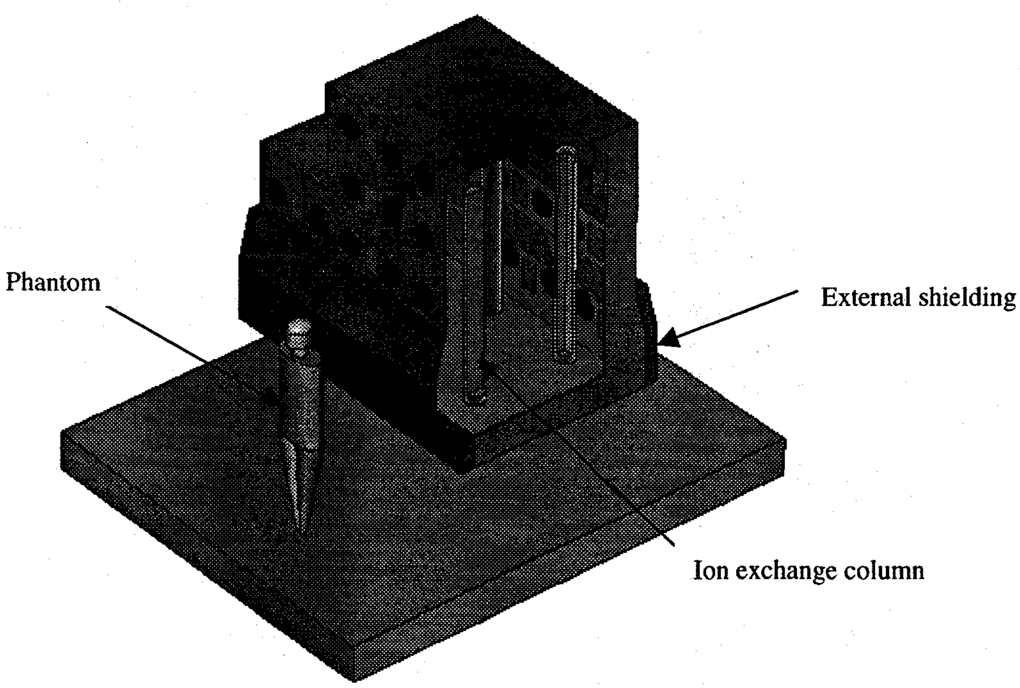

Figure 1. Cut away view of ion exchange glovebox

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