Gamma Shielding Attenuation Guide

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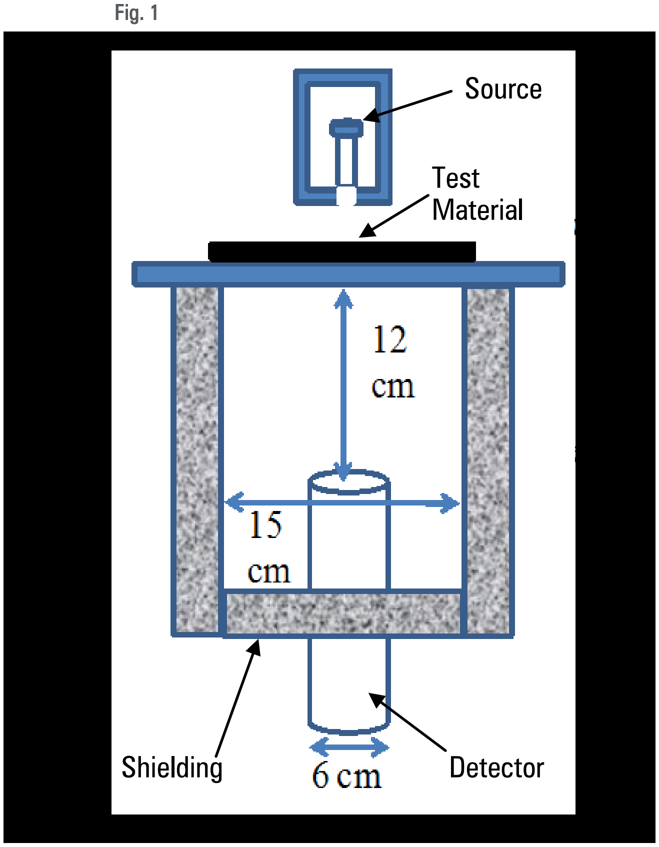
This definitive guide to the selection of shielding materials is based on their attenuating properties. The attenuation values are based on actual tested and calculated data for traditional and new shielding materials from "Gamma Ray Attenuation Properties of Common Shielding Materials" by Daniel R. McAlister, PhD., PG Research Foundation, Inc.

mass-in-the-path

Fig. 1. Attenuation test apparatus

Fig. 1



The ALARA professional's goal when selecting shielding materials is to place as much attenuating materials as practical as close to the radiation source as possible.

SYSTEM CERTIFICATION ISO 9001:2008 SGS

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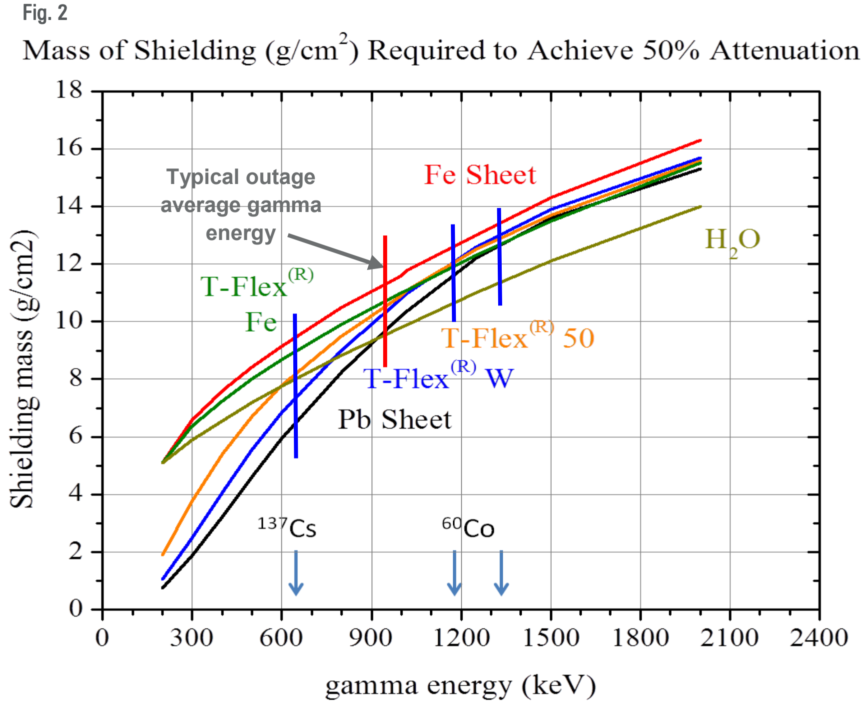
Gamma shielding attenuation comes down to the "mass in the path". The physics of attenuation for all currently available shielding materials is now well documented. The myth that some shielding materials can be "lighter in weight" than traditional shielding materials while providing similar gamma attenuation impact is *not correct*; this would necessitate reinventing physics.

goals

1. Maximize the dose reduction goals for the specific application while impacting the plant's overall goals.
    - Consider the shielding configuration/geometry.
    - Maximize the efficiency of the shielding by targeting the "hot spots" while minimizing the applied weight.
    - Consider the difficulty or ease of the installation (ALARA).
2. Select the shielding materials and configurations that will yield the desired results while being fiscally ($) prudent.
    - With the order-of-magnitude cost differences between available materials, consider the best "value" while not compromising your shielding goals.
    - Traditional shielding materials and configurations may still be the best approach.
3. Accurately predict the resulting attenuation and exceed the ALARA objectives.

Fig. 2. Note that for the gamma energy ranges from Cesium-137 through Cobalt-60, the mass-in-the-path needed to achieve a half-value (50%) attenuation impact, is very similar for all of the studied materials. The shielding thickness to achieve this attenuation impact, however, does vary by material, as can be seen in **Fig. 2** on page 3. The data presented in this document is based on actual tested results, which correlates closely with the theoretical calculations. The theoretical values are based on the XCOM database values available from National Institute for Standards and Technology (NIST).

Fig. 2



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Molded tungsten, shielding that targets the "hot spot"

Nozzle/piping, specialized lead panels supported by clamping ring & magnets

Traditional lead blankets providing shielding for multiple sources

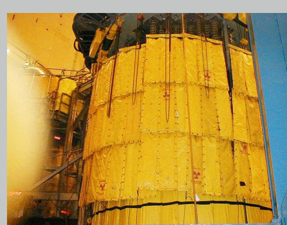

Fig. 3. Required thickness of a particular material to achieve a specific attenuation goal—in this case, 50% attenuation or one half value layer (hvl). Note that 1 cm. thickness of solid lead provides 50% attenuation for Cobalt-60 sources (see **Fig. 4** on page 4). The 100% tungsten/silicone material (NPO's product T-Flex® W) requires approximately 1.8cm thickness to achieve 50% attenuation.

Shielding design and material selection principles must include consideration of the physical conditions

The type of source(s) as well as the proximity and duration of work to these sources are important factors in optimizing the shielding configuration and material for a job. Utilizing a complement of shield panels to form a "wall", for example, may be best suited for attenuating gamma radiation from one large or multiple sources. Alternatively, shielding "hot spots" may be best accomplished by applying a molded or formed attenuating material as close to the source or "hot spot" as physically possible.

Fig. 3

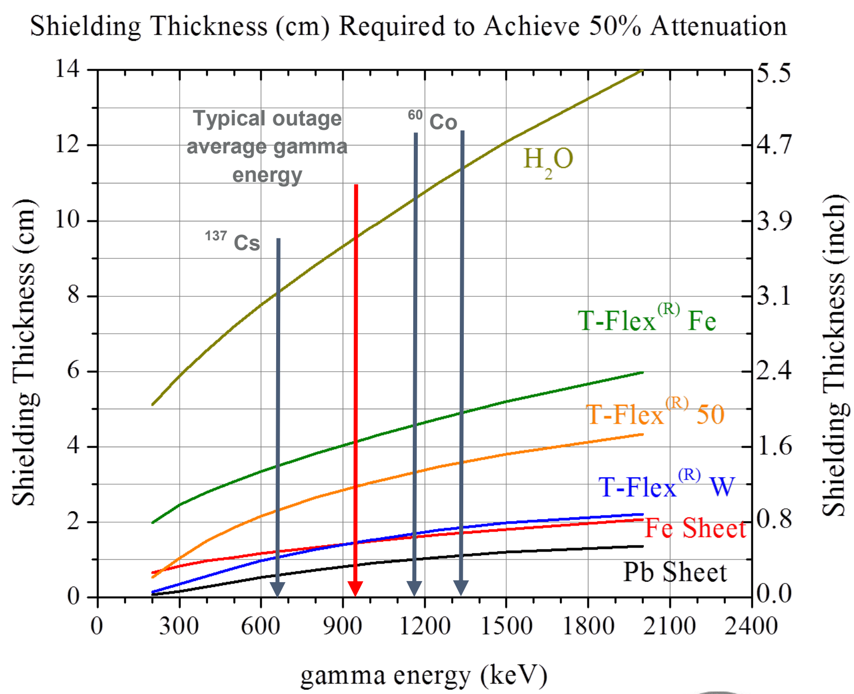

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Fig. 4. Composite materials molded with silicone provide similar attenuation as the equivalent mass-in-the-path of the same solid material. The data illustrates the hvl(s) thicknesses for Cs-137 and Co-60.

Fig. 5. This graph illustrates the gamma attenuating properties of conventional shielding materials for both Cs-137 and Co-60. For comparison, **Tables 1 & 2** show attenuation for standard and high density lead blankets. The curves provide the material thickness (mass-in-the-path) required to achieve the desired attenuation expressed both as a percent (%) and half value layers (hvl's).

Table 1

Percent Attenuation for High Density Lead Blankets*		
Number of Layers	Cs-137 (661 keV)	Co-60 (avg. 1250 keV)
1	53	34
2	78	56
3	89	71
*15 lbs/ft^2		

Table 2

Percent Attenuation for Low Density Lead Blankets*		
Number of Layers	Cs-137 (661 keV)	Co-60 (avg. 1250 keV)
1	40	24
2	64	43
3	78	56
*10 lbs/ft^2		

Fig. 4

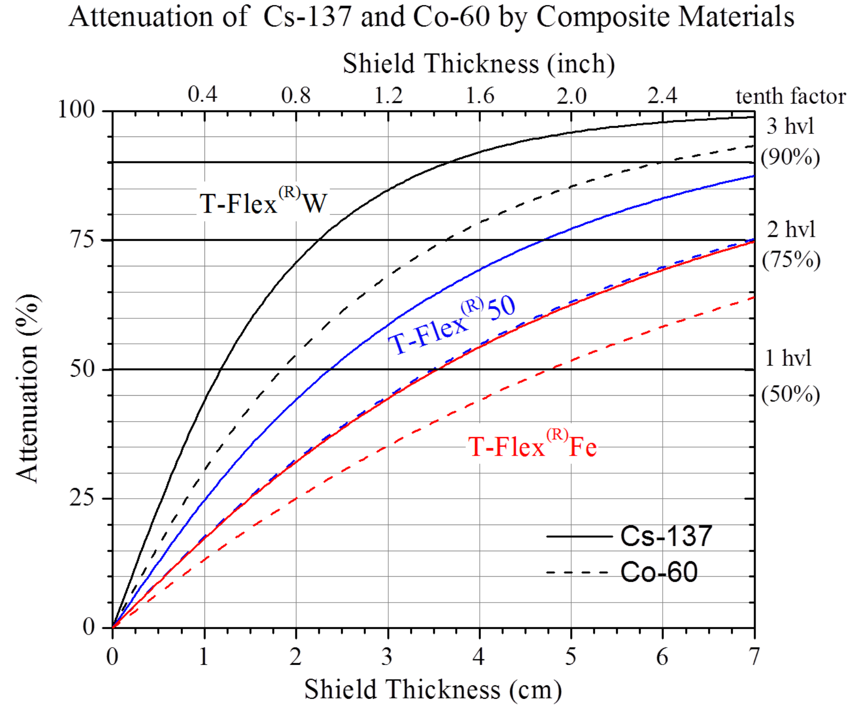
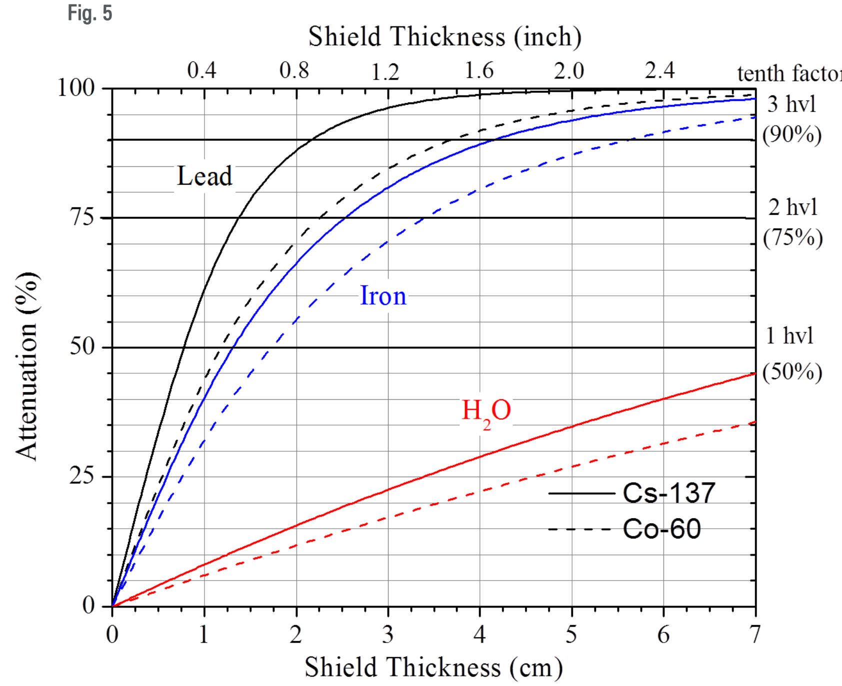


Fig. 5



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