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SUMMARY
OF
RESEARCH REPORT

EXPERIMENTAL DETERMINATION OF THE WALL-SCATTERED
RADIATION FUNCTION $G_s(\omega)$

December, 1963

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Summary Prepared
by James L. Jones
Tech/Ops Research
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Burlington, Massachusetts

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SUMMARY

BACKGROUND

A significant portion of the dose rate in a structure exposed to a field of radioactivity can be due to radiation scattered by the walls into the sensitive volume. In the analysis of structures based on the methods of the Engineering Manual, the radiation scattered from the wall is represented by a function $G_s(\omega)$, where ω is the solid angle fraction subtended by the structure at the detector. The function $G_s(\omega)$ was derived from Spencer's data for air-scattered radiation and was assumed dependent only on ω ; i. e. , walls subtending equal solid angles would scatter equal dose rate to the detector, regardless of their respective positions with respect to the source plane.

These two assumptions required direct testing under experimental circumstances that would give unambiguous answers. These answers could then be compared directly with those given by the Engineering Manual method.

EXPERIMENTAL ARRANGEMENT

To minimize complications, steel cylinders were used in a simulated circular field. Dose rates were measured on the axis various distances below ground to eliminate direct radiation and were expressed as functions of the solid angle.

The variation of dose rate with solid angle was found in steel cylinders, 1/2, 1, 1-1/2, and 2 in. thick, and in a rectangular structure, 1 in. thick. The cylinders were 5 ft high, and readings could be taken down to 48 in. below the surface.

RESULTS

The formula used in the Engineering Manual to calculate dose rate below ground due to wall-scattered radiation was

$$\frac{D_s}{D_0} = S_w B_w E \left[G_s(\omega_u) - G_s(\omega_{u'}) \right], \tag{1}$$

ω_u and $\omega_{u'}$, defining the upper and lower boundaries of the cylinder, respectively. The function $G_s(\omega)$ was adopted directly from the data in Spencer's monograph, using the relation

$$G_s(\omega) = 0.5 \left[1 - S_a(\omega) \right]. \quad (2)$$

Expressing (1) in terms of S_a and including skyshine, we obtained

$$\frac{D_s^\infty}{D_0} = 0.5 S_w B_w E \left[S_a(\omega_{u'}) - S_a(\omega_u) \right] + 0.088 (1 - S_w) B_w \left[S_a(\omega_{u'}) - S_a(\omega_u) \right] \quad (3)$$

as the predicted value of the ratio of the dose rate in the cylinder to that 3 ft above an infinite plane source.

Direct comparison of this with the experimental dose rate gave agreement within 20%, except for the highest and lowest positions, in the thin-walled structure and in the lowest position in the thicker cylinders. However, the theoretical shape of $S_a(\omega)$ indicated that the modifying mass and shape functions S_w , B_w , and E may be wrong. If this is accepted, the calculated curves are modified to approach the experimental value at $\omega = 1$, perforce diverging more at small values of ω . This would imply that the dose rate is a function of the position of the wall with respect to the source plane as well as its solid angle.

An experimental curve of $S_a(\omega)$ was also derived. A trend toward the calculated value was found with increasing wall thickness, indicating that the assumption is better when a greater scattering path length is involved, as would be expected. These results are plotted in Figure 1.

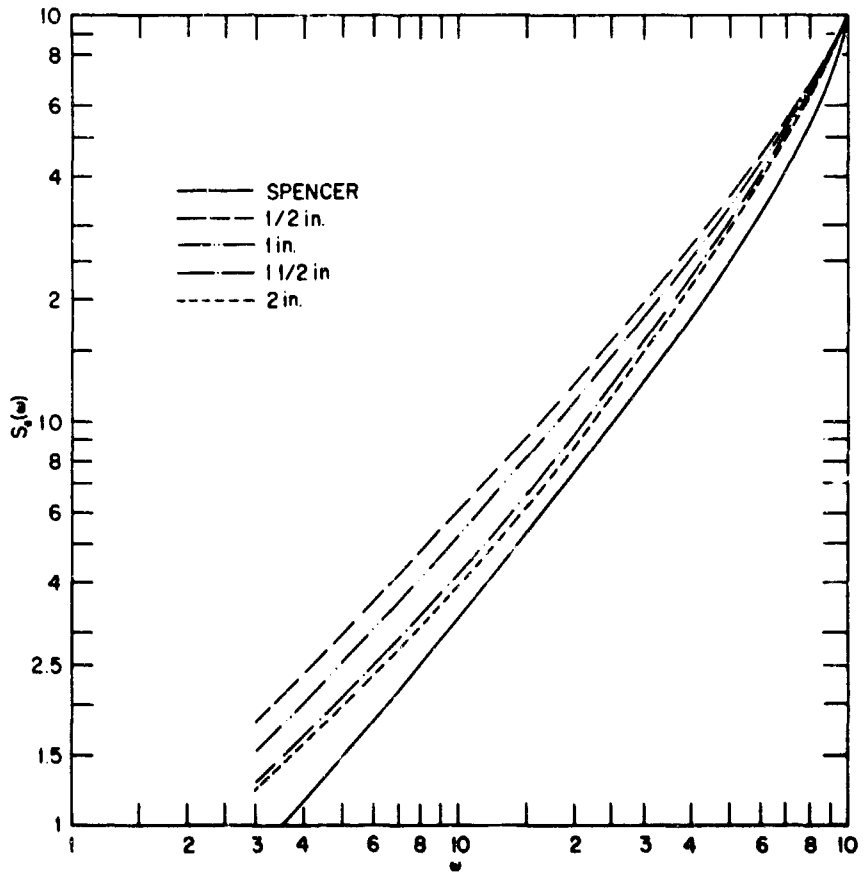


Figure 1. $S_g(\omega)$