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Correction for LLNL Phantom Torsos to Account for Smaller-Sized Human Lungs

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The Livermore phantom torso[1,2] is somewhat barrel-chested; the depth of the chest is more than 24 cm at the Xiphoid Process, without overlays. This is usually greater than that in a human subject with a similar chest-wall thickness (1.9 cm), which results in the lungs of the phantom being larger (deeper) than those of the subject for which the phantom is being calibrated. Therefore, when counting human subjects, it is necessary at times to adjust the calibration factor appropriately for smaller-size individuals, especially when higher-energy emitters are involved, such as the 60-keV gamma ray from ^{241}Am.

We have done preliminary work to determine the degree of correction necessary for ^{241}Am *in vivo*. To simulate two smaller sizes of human lung, we made up two sets of ^{241}Am-loaded lungs with cross-sectional depths that were 4 cm and 6 cm less than the depth of the phantom lungs. (The active material was concentrated in the frontal portions of the lungs, and the posterior portions—4 cm and 6 cm thick—were made of background lung material.) They were counted in the phantom using the LLNL Dual Phoswich Detector, with the detectors placed high on the chest and tangent to the clavicle and sternum.

The observed increase in detection efficiency versus the difference in depth between the normal phantom chest and the subject's chest (assuming equal chest-wall thicknesses and a smaller lung depth for the subject) is plotted in Fig. 1. Figure 2 is a plot used to calculate the correction factor for people of different chest depths. It is based on physical measurements of the phantom with and without its four chest overlays. The equivalent depth of the phantom subject is plotted versus chest-wall thickness.

The step-by-step process used to determine the overall correction factors is as follows:

(1) Estimate the subject's chest-wall thickness.

(2) Measure the subject's chest depth while he is lying down, either at the Xiphoid Process or at the center of the 5-1/4-in. detector circle (the latter is preferred).

(3) Using Fig. 2, determine the phantom depth equivalent to the subject's chest-wall thickness.

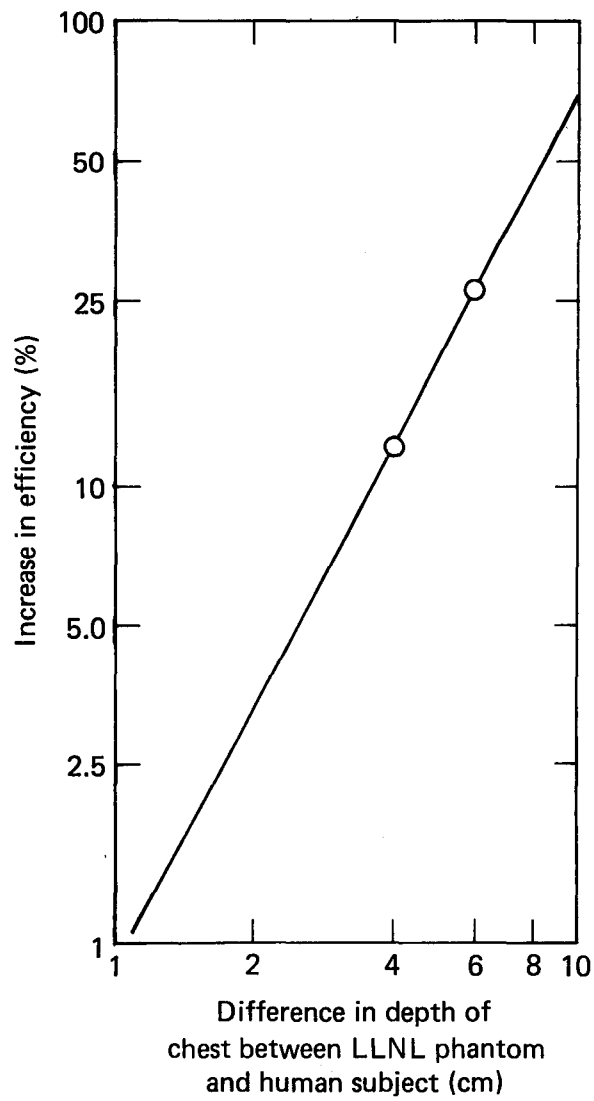

FIG. 1. Increase in detection efficiency for ^{241}Am when subject's chest depth is less than the phantom's.

(4) Subtract the value obtained in step 2 from the value obtained in step 3 to obtain the difference in lung size between the phantom and the subject.

(5) Use Fig. 1 to determine the increase in detection efficiency.

We also plan to determine the correction necessary for ^{238}Pu and ^{239}Pu.

References

1. P. N. Dean, R. V. Griffith, and A. L. Anderson, "Design Criteria for Phantoms for Calibration of External Detectors for the *In-Vivo* Assay of Plutonium," *IAEA International Symposium on Diagnosis and Treatment of Incorporated Radionuclides* (December 1975, Vienna), p. 265.
2. R. V. Griffith, P. N. Dean, A. L. Anderson, and J. C. Fisher, "Fabrication of a Tissue-Equivalent Torso Phantom for Intercalibration of *In Vivo* Transuranic Nuclide Counting Facilities," *IAEA International Symposium on Advances in Radiation Protection Monitoring* (1979, Vienna), IAEA-SM-229/56, p. 493.

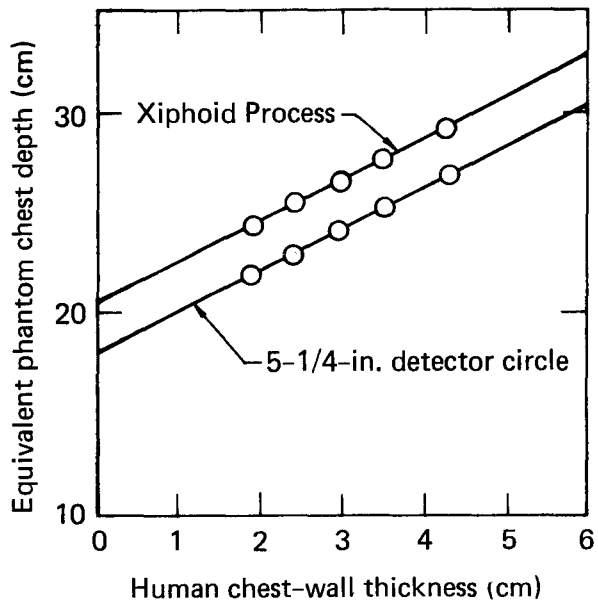

FIG. 2. Phantom chest depths equivalent to human chest-wall thicknesses.