THE CALIBRATION OF GERMANIUM DETECTORS USED FOR LUNG COUNTING

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EXTENDED ABSTRACT

Lung counting arrays are often calibrated using an anthropomorphic torso phantom, usually the one developed by Lawrence Livermore National Laboratory (LLNL) and now manufactured by Radiology Support Devices. The lung sets for this phantom contain radioactivity that is homogeneously distributed. Work carried out in the Human Monitoring Laboratory, and presented at the last Bioassay Conference, suggests that this is not the most appropriate calibration geometry. The data clearly showed that germanium detectors only "see" low-energy photon emitters that are directly beneath. As a result, germanium detectors that are calibrated using lung sets that have the activity homogeneously distributed through the tissue equivalent material will be using pseudo-effcienceies that can introduce large errors in the final estimate.

A recent collaboration with Battelle has resulted in a new lung phantom that will help quantify these errors. This phantom can be used to simulate regional deposition in the lung. It is essentially an LLNL lung but it has been sliced into eight sections. Two sets have been made: a blank and an active set. These sets can be combined to simulate one of 600,000,000 depositions.

The HML has also acquired a second torso phantom (JAERI). The JAERI phantom is more anthropomorphic and will provide the calibration base for female workers in the Canadian nuclear industry and also be used to validate facilities that count from both front and rear. Some of differences between it and the LLNL are shown below:

Phantom	Height (cm)	Depth (cm)	Total Volume (cm^3)
JAERI	27	15	3585
LLNL	22	22	3900
ICRP (m)	30	20	3846
ICRP (f)	23	18	3076

Monte Carlo Code calculations have also proved very useful in wide range energy calibrations. The code MCNP has been used to predict the position of the knee of the efficiency versus energy curve. For example, Fig 1 shows the experimentally determined efficiency curve for one of the germanium detectors. The position of the knee is not clear from this curve. The HML has found that the

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performance of its lung counting software's analysis section is sensitive to the knee position. Therefore, the position has been calculated using MCNP, a Monte Carlo code for neutron and photon transport. Fig 2 shows the theoretical efficiency calculated for the HML's germanium detector measuring a lung with a muscle chest wall. Fig. 2 has been used to define the knee in the HML's software.

Figure 1

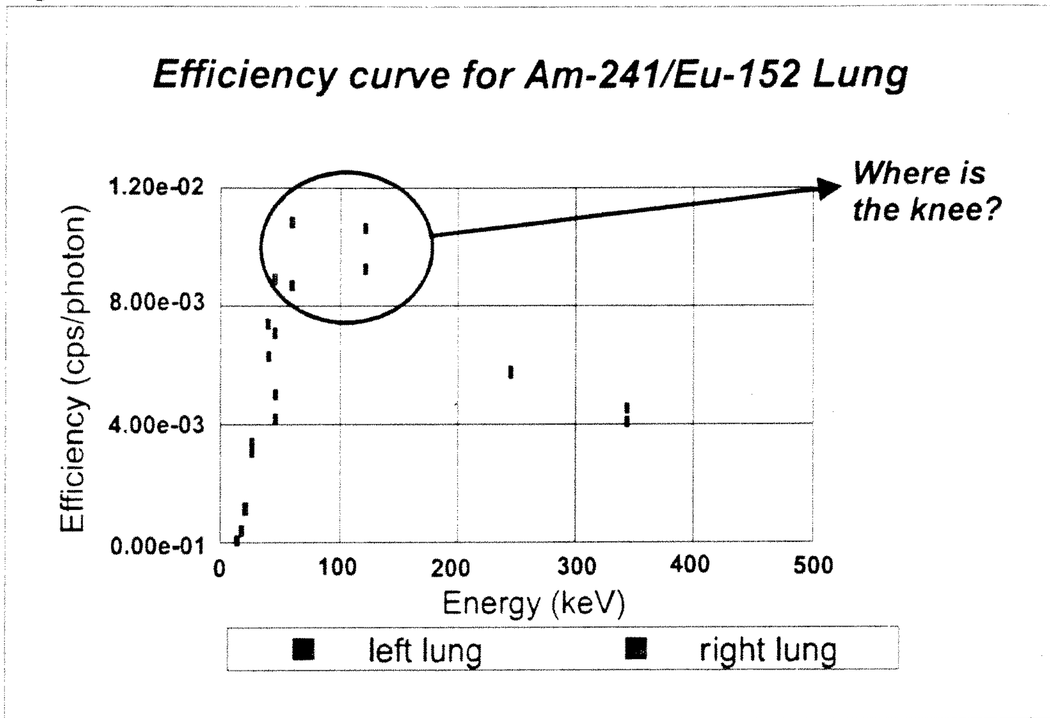

Figure 2