he University of Wisconsin Accredited Dosimetry Calibration Laboratory (ADCL) has developed a free-air chamber (FAC) to investigate the effect of spectral differences on the calibration of mammographic ionization chambers. The National Institute of Standards and Technology (NIST) traceable calibration point for mammography is based on a tungsten anode and aluminum filter x-ray beam at 30kVp with a first half value layer (HVL) of 0.36 mm Al. Clinical mammography uses a molybdenum anode and molybdenum filter combination at kVp’s ranging from 23kVp to 30kVp and HVL’s of 0.25 to 0.35 mm Al.

The FAC was designed by F.H. Attix. It has a variable length so that charge measurements are made for different plate separations and thus different volumes. This eliminates electric field distortion problems and allows a direct measurement of air attenuation. This FAC design and its characterization was recently published in Rev. Sci. Inst. 66: (3) 2574-2577 (1995). A direct comparison with the Ritz low energy free-air chamber at NIST shows agreement to ±0.24%, which is well within the uncertainty of the measurement.

A variety of mammographic chambers have been calibrated with the FAC on a constant potential tungsten anode and aluminum filter machine and a clinical molybdenum anode.
and filter machine. Figure 1 shows the energy response of two chambers for tungsten (W) and molybdenum (Mo) beams. One chamber is a standard mammographic chamber with a thin entrance window (thin window) and the other is widely used for mammography but is not designed for mammography (thick wall). Note the large energy dependence in the mammographic range for the thick wall chamber. This thick wall chamber needs to have more than one calibration point in the mammographic range to have less effect on the measurement of exposure and thus mean glandular dose. This energy dependence also affects the accuracy of half value layer measurement.

The mammographic ionization chambers that we have calibrated have factors on molybdenum beams that agree with those of the tungsten beams to within 5%. Although this is not clinically significant for diagnostic exposures, we can determine calibration factors within at least 2%. Thus, there is a needless 5% error in dose determinations unless a more accurate value is established. In addition, if the chamber has significant energy dependence, the measurement of HVL can be in error by up to 8%. The results of this research demonstrate the importance of an ADCL calibration with the proper beam modality. NIST in conjunction with CDRH and the UW-ADCL are in the process of establishing molybdenum calibration beams on a constant potential x-ray generator.

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