Purpose: To investigate the feasibility of developing a “standard reference material” for tissue density variations obtained in CT scans.

Methods: The Hounsfield unit (HU) is used universally in CT scanners to describe the radiodensity of tissues. The deceptively simple definition of the HU, the linear attenuation coefficient of a material relative to that of water, is made complicated by interactions of materials with the polychromatic beam, and by measurement geometry and detector response. The variations over time and across scanners can be addressed with a “reference standard” that is scanner-independent. We began the development of one set of such standards by characterizing them in a NIST traceable standard beam quality, whose spectrum has been measured with a Ge detector; the spectrum compared well with IPEM report 78 for the given filtrations. Transmission through polyurethane foams of 4 different densities (nominally from 0.065 g/cm3 to 0.3 g/cm3) were measured in the M80 (80 kVp) beam using a CMOS x-ray camera, recording the value of ln(I0/I) = mu*x, where x is the thickness of the foam in the range of 1.9 cm to 10 cm. A mu_eff is defined by (ln2)/h where h is the half value layer that can be experimentally measured.

Results: For each density, the transmission was performed at 6 different thicknesses with an average statistical uncertainty of about 4%. With 4 densities, mu_eff can be determined to < 1%. A calculation has been performed by folding in the measured spectrum with mu(E) based on XCOM output for polyurethane. The experimentally determined slope of mu_eff vs density is found to be 2.2% lower than the expected value, possibly due to a scattering contribution.

Conclusion: Characterizing a material in a beam of known quality enables a direct assessment of the linear attenuation coefficient, which can serve as a scanner-independent reference.

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None.