AbstractID: 4842 Title: Liquid helium calorimeter for brachytherapy source strength measurement

Purpose: To construct and demonstrate the utility of a new liquid helium calorimeter for the determination of contained and emitted power of low dose rate (LDR) and beta emitting brachytherapy sources

Method and Materials: A liquid helium adaptation of the UWMRRC Stump calorimeter (Rev. Sci. Instrum., 76, 2005) was constructed for use with LDR and beta emitting encapsulated brachytherapy sources. Silver absorber construction provides 4π measurement geometry for contained power measurements, eliminating the need for geometric or solid-angle corrections and removing uncertainty stemming from source anisotropy. Temperature of the absorbers as well as the detector housing is actively controlled, and an electrical substitution measurement technique is used. This technique does not require corrections for thermal coefficients that change with temperature, thus eliminating the uncertainty of the absorber mass from the measurement uncertainty. Temperature is monitored using germanium resistance thermometers, and overall system temperature stability is improved by placing the liquid helium reservoir inside a vacuum chamber that is in turn surrounded by liquid nitrogen.

Results: The decreased noise floor of the liquid helium calorimeter will permit more accurate measurements of low activity sources than was possible with the Stump calorimeter. Preliminary MCNP5 Monte Carlo modeling indicates that the contained power collectors will be 99.99% efficient for the LDR sources for which the calorimeter was designed, and that for the $^{90}Sr/^{90}Y$ beta emitting source, the efficiency decreases to 98.13% as a result of the more energetic bremsstrahlung photons.

Conclusion: Knowledge of the contained and emitted power for brachytherapy sources can yield a direct source strength value for use as a benchmark in Monte Carlo statistical models. The emitted fraction, which is the quotient of the emitted power and the total contained power, can also be utilized in determining the validity of geometric and atomic source composition used in statistical models.