Miniphantoms are becoming increasingly important for determining characteristics of photon beams (e.g. head-scatter, beam quality, transmission factors, and beam profiles). The relationship between the dose in a phantom and the ionization collected from a detector in a miniphantom is complex so these beam characteristics are usually described as relative measurements. The implicit assumption made is that the relative response of the detector in the miniphantom does not change during the sequence of measurements. Because of small changes in the photon energy spectrum, that assumption is not strictly valid. The questions addressed in this work are (1) how much does the change in the energy spectrum affect the final result and (2) is there a miniphantom design that minimizes the error. Monte Carlo techniques (BEAM98 and ITS) are used to simulate the photons and contaminating electrons exiting the accelerator. Then simulated experiments of head-scatter and narrow-beam attenuation are performed to determine the energy deposited in miniphantoms. The results for different miniphantom materials and dimensions are examined to isolate the effects of attenuation, lateral and longitudinal electron equilibrium, and phantom scatter in the miniphantom. These results are compared to experiments for 6 MV and 15 MV photon beams.