

AbstractID: 2946 Title: The Effects of Pre-Irradiation on Ionization Chambers Used in Radiation Therapy

Purpose: To investigate the effects of pre-irradiation on settling (stabilizing) behaviour of a variety of ion chambers, and relate this behaviour to chamber design. Chambers without pre-irradiation can produce errors of up to 1.5%.

Method and Materials: Data was collected for a large number of common ion chambers, which were induced to display maximum settling behaviour. The chamber regions generating this behaviour were identified through the use of lead shields. Responses to six radiation qualities were measured. Radiographs of the chambers provided insight into some of the physical sources of settling behaviour.

Results: Ion chambers require exposure to radiation for settling to occur. Maintaining bias on the instrument is not sufficient. Different models display different settling characteristics, but chambers of the same model can also display a variety of responses for both the difference between initial and equilibrium readings and for total settling time. The internal structure of the stem was the source of much of the observed settling behaviour. This is a temporary, reversible effect and is not related to permanent radiation-induced damage in electronic devices. Radiographs provided insight into physical sources of settling behaviour, particularly the extent of ion chamber guarding and the proximity of insulating material to the active air volume. Most models of Baldwin-Farmer ion chambers show time-dependent settling behaviour independent of beam quality, but exposure-dependent behaviour was observed for one model.

Conclusion: Settling behaviour varies significantly from model to model, and even chamber to chamber. Ratios of initial reading to settled reading can vary by up to 1.5% over 30 minutes, although differences of 0.5% over 20 minutes are more typical. Settling behaviour for individual chambers is similar in either air or water, and quality independent. Pre-irradiation of an ion chamber is essential to avoid the introduction of significant error into photon beam measurements.