CALIBRATION

OF SOURCES AND EQUIPMENT

II

Calibration of Brachytherapy Sources

Brachytherapy uses encapsulated radioactive sources to deliver a high dose to tissues near the source.

An important part of a general QA programme for brachytherapy dosimetry is the source calibration.

For some calibrations sources, ventors assign large uncertainties to their stated calibration values (up to 10%).

End-user calibration is necessary to ensure traceability to international accepted standards.

"Each institution planning to provide brachytherapy should have the ability to independently verify the source strength provided by the manufacturer"

AAPM (TG 40)

Characterization of Brachytherapy Sources

Gamma ray sources

The recommended quantity for the specification of gamma sources is the reference air kerma rate defined as the air kerma to air, in air, at a reference distance of one meter, corrected for air attenuation and scattering.

For needles and other rigid sources the direction from the source centre to the reference point shall be at right angles to the long axis of the source.

Units: μGy/h LDR brachytherapy sources
μGy/s HDR brachytherapy sources

Characterization of Brachytherapy Sources

Betta ray sources

The recommended quantity for the specification of betta ray sources is the reference absorbed dose rate in water at a reference distance from the source.

The reference distance differs from one type of source to another.

- For planar type sources is 1mm from the centre of the source.
- For seeds and line sources is 2mm in a transverse direction from source's longitudinal axis.
- For balloon and stent sources is 0.5 mm measured from the surface of the source.

Primary Standards

Cs-137, Co-60, Ir-192 (LDR): measurements with graphite cavity ionization chambers that serve as primary standards of exposure.

NIST: sources of Cs-137 and Co-60 are calibrated in air at distances less than 1 m and corrections for air attenuation, build –up and room scatter are applied (working standards for the calibration of unknown sources of the same type).

LDR Ir-192 seeds: same procedure with large number of sources.

HDR Ir-192 sources: no primary standards are available. Calibration of the suitable ionization chamber in reference fields for X-radiation, Cs-137 and Co-60. The calibration factor is then derived for the Ir-192 energy.

Primary Standards

The extrapolation chamber is a primary standard for the determination of absorbed of absorbed dose rate of beta ray sources.

extrapolation chamber: air-filled plane parallel chamber where the distance between the high voltage and collecting electrodes can be varied. The values as a function of air gap are fitted to determined the slope at the limit of zero air gap.

Traceability in calibrations at SSDLs

The recommended detector for the calibration of all brachytherapy photon sources and intravascular beta sources is an appropriately calibrated well type-chamber.

For SSDLs the prefered method for traceability in the source calibrations is to have a well type calibrated chamber against the PSDL.

The calibration should be carried out for each radionuclide and source type to be used.

Traceability in calibrations at Hospitals

The recommended detector for the calibration of all brachytherapy photon sources and intravascular beta sources is an appropriately calibrated well type-chamber.

For traceability from the hospital to SSDL, the well type chamber should calibrated at the SSDL

Maintenance of standards

Photon and Intravascular Sources

Recalibration of the well-type chamber regularly (if not possible for all radionuclides with long lived sources and additional constancy checks at lower energies)

Maintenance of standards

Ir-192 quality

The complicated energy spectrum of Ir-192 HDR includes 40 energies (from 50 keV-700 keV) with an average energy of 397 keV.

Checks of the well-type chambers response at the "end" energies should be performed (use of Am-241, 60 keV, and Cs-137, 661 keV).

Maintenance of standards

Betta planar sources

A standard may be established by the calibration of a long-lived planar source (Sr-90)at the PSDL level.

This source serves as a local standard for the calibration of other devices.