



STATUS OF AIR KERMA AND ABSORBED DOSE STANDARDS IN INDIA

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The Radiation Safety Systems Division of Bhabha Atomic Research Centre, India maintains Primary and Secondary Standards of various parameters of radiation measurements and provides calibration services to various users of radiation in the country. This is an apex laboratory in India and plays a pivotal role in ensuring accurate radiological measurements. The laboratory coordinates national intercomparisons of radiation measurements to maintain their uniformity and traceability and is linked through various programmes with the other International organizations such as Bureau Internationale des Poids et Mesures (BIPM) Paris, International Atomic Energy Agency (IAEA) Vienna, Asia Pacific Metrology Programme (APMP) Taiwan. It is the recognized Regional Secondary Standards Dosimetry Laboratory (SSDL) of IAEA/WHO (World Health Organisation). This paper brings out the status of various primary and secondary standards for radiological measurements maintained at BARC.

- 1. Primary Exposure / Air-kerma standard at Co-60 energy (therapy level):** The primary standard for exposure/ air-kerma measurements maintained at BARC is a graphite cavity chamber of volume 4.362 cc with an internal diameter of 1.8 cm, internal height of 1.78 cm and wall thickness of 704.3mg/cm². Correction factors for the difference between electron stopping powers, photon mass energy absorption coefficients of air and graphite wall, correction for recombination, radiation field non-uniformity, stem scatter and polarity effect are applied and the maximum overall uncertainty in the realisation of exposure / air-kerma is around $\pm 1\%$. This standard has been intercompared with IAEA and BIPM through transfer standard and the agreement in the results are better than $\pm 1\%$. An intercomparison under the APMP programme is to be held during May, 2002.
- 2. Primary Exposure / Air-kerma standard at protection and brachytherapy level:** A set of three spherical graphite-walled cavity chambers of different air-volumes are maintained as primary standards for protection level and brachytherapy measurements of Ir-192, Cs -137 and Co-60 sources. These chambers are made of high purity reactor-grade graphite of density 1700 kg/m³. The three chambers have different wall thickness, the external diameters of all the chambers being equal. A reference standard in the form of a re-entrant chamber developed at BARC, calibrated against this primary standard was intercompared with a reference standard from M.D Anderson Centre, Houston, U.S.A and the results showed a good agreement. Recently one of the chambers was used for the Cs-137 intercomparison with IAEA and showed an agreement of better than $\pm 1\%$.
- 3. Primary Standard for X-rays – the free air chamber (FAC):** This facility is utilized in conjunction with a Philips RT-250 X-ray machine for calibrating secondary standard dosimeters at different X-ray qualities in the 75 to 250 kV range. The total uncertainty in the realization of air kerma is around $\pm 1\%$ using the free air chamber. Accuracy of calibration of the secondary standards is estimated to be better than $\pm 2\%$. The FAC has been intercompared via transferable transfer standards with FACs at BIPM (1971), BNM (France) RCL (Canada) and Kriss (Korea), which showed good agreement within $\pm 1\%$ after necessary correction for the spectral differences in X-ray beams. BARC is just now taking part in intercomparisons of X-ray air kerma calibration factors organised by Institute of Nuclear Energy Research (INER), Taiwan under Asia Pacific Metrology Programme.

In addition to the above-mentioned primary standards, the SSDL is also maintaining the following secondary standards. For air kerma measurements at Co-60 gamma energy, ionisation chambers of Exradin A3, NE2571, NE2577 and Victoreen 415 types are calibrated and maintained. For Co-60 radiation dose to water measurements, NE 2571 and NE 2577 chambers calibrated at BIPM in terms of $N_{D,w}$ are maintained. For air kerma at medium energy x-rays, chambers of the type Exradin A2, NE 2571, NE2577, Victoreen 415 B, Victoreen 415, Exradin A3 and NE 2581 are maintained. These chambers have been calibrated against the primary standards and have been used in the international intercomparison experiments.

The future programme of development of standards include i) Development of graphite / water calorimeters as absorbed dose standards, ii) Establishment of extrapolation chamber as primary standard for absorbed dose for beta and soft x-ray beams and iii) Development of energy-independent plastic scintillators as reference standard for low energy low activity brachytherapy sources.