Recent Activities in Neutron Metrology at the Czech Metrology Institute

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April 2005

The following neutron metrology areas are covered by the CMI:

1. Radionuclide source based fluence standards - specification of radionuclide neutron sources.
2. Calibrations and tests of neutron area and personal dosimeters in ISO 8529-1 neutron fields.
3. Low resolution neutron spectrometry at working places.
4. Numerical dosimetry.
5. Comparisons and demonstrations of equivalence.

1. Radionuclide source based fluence standards - specification of radionuclide neutron sources.

The radionuclide source is characterized by emission, anisotropy of emission and spectral emission (neutron energy spectrum). CMI is equipped with the manganese bath, which serve as a primary standard for the absolute determination of emission rate from radionuclide neutron sources, and with the device enabling measurement of emission anisotropy.

CMI cooperates with other national metrology institutes involved in the measurements of neutron emission rates by an absolute method, e.g. with KRISS [1].

2. Calibration and tests of neutron area and personal dosimeters in ISO 8529-1 neutron fields.

Neutron fields created by Am-Be, bare and moderated ^{252}Cf sources are available for tests of neutron area and personal dosimeters. At present the highest emission is $2 \cdot 10^7$ s^{-1} for Am-Be and $8 \cdot 10^8$ s^{-1} for ^{252}Cf sources. The evaluation of the contribution of scattered neutrons is done by the shadow cone and distance variation methods.

3. Low resolution neutron spectrometry at working places.

For the characterization of neutron fields at working places a Bonner spheres spectrometer (BSS) is used. It consists of 13 polyethylene spheres with nominal diameters in inches: 2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 10, 12, 15. As a central detector of thermal neutrons is utilized a cylindrical proportional counter of type 0.5 NH 1/1K made by the French company LMT. The

response matrix was calculated using the MCNP transport code and adjusted to the experimental calibration with mono-energetic neutrons at PTB Braunschweig, Germany.

Past years the BSS was used for the characterization of neutron fields at nuclear power plants around reactor shielding and at the interim storage around casks with spent nuclear fuel [2].

In pulsed neutron fields, where the measurements with the active detector (proportional counter) of thermal neutrons are impossible due to problems with overloading, the track detectors or pair of TLD such as ^{6}LiF and ^{7}LiF are applied. As an example of measurements with track detectors can serve measurement of spectra of photo-neutrons around radio-therapeutic linac [3] and with TLDs measurement of (d,d) neutrons near the plasma focus device [4]. These measurements are still ongoing.

4. Numerical dosimetry.

The MCNP and PENELOPE transport codes are in routine use at CMI. These codes are used as supplementary tools to experiments, e.g. for the determination of efficiencies, responses and different corrections. An influence of the position of the personal dosimeter on the face wall of the ISO phantom during calibrations in photon and neutron radionuclide sources fields was thoroughly studied [5, 6]. The ratios of indicated values of personal dose equivalent during calibrations on the phantom and in free-in-air geometry for different sources were also evaluated.

5. Comparisons and demonstrations of equivalence.

In 2003 CMI participated at the Inter-comparison on the usage of computational codes in radiation dosimetry, QUADOS, held on July 2003 in Bologna, Italy. CMI workers solved seven from eight problems and presented two contributions in the proceedings [7].

CMI is involved in “Neutron emission rate CCRI(III)-K9.AmBe comparison – which began in 1999 and still has not finished.

CMI is also engaged in EUROMET Project No. 608 – Key comparison for the calibration of ambient dose equivalent meters in ISO neutron reference fields, which began in 2003. CMI has finished its task [8] but due to troubles with one area dosimeter all participants have to start their measurements again in 2005.

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