

Progress report on the neutron metrology and dosimetry at CMI for the period March 2009 –March 2011

Czech Metrology Institute (CMI)
Inspectorate for Ionising Radiation
Prague, Czech Republic

Prepared by: Miloslav KRALIK (mkralik@cmi.cz)

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 metrology / dosimetry.
5. Comparisons and demonstrations of equivalence.
6. 14 MeV neutron source.

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

The CMI is equipped with manganese bath for measurement of emission rate and instruments for measurement of anisotropy of emission. Spectral emission (neutron energy spectrum) of the radionuclide source can be measured by means of a Bonner spectrometer (BSS) only. The equipment was not changed during the reported period.

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 and Pu-Be sources are available for tests of neutron area and personal dosimeters. At present the highest emission is $2 \cdot 10^7 \text{ s}^{-1}$ for Am-Be, $1.6 \cdot 10^8 \text{ s}^{-1}$ (March 2011) for ^{252}Cf , and $5 \cdot 10^7 \text{ s}^{-1}$ for Pu-Be sources (not ISO 8529-1 field). The evaluation of the contribution of scattered neutrons is done mainly by distance variation methods.

During the reported period a problem was encountered with calibration/verification of electronic personal dosimeters. An electronic dosimeter, DMC 2000 GN produced by Mirion has a range from $10 \mu\text{Sv/h}$ up to 10 Sv/h , i.e. 6 orders. It would be interesting if any metrological institute is equipped with sources which placed 75 cm from the ISO water phantom can cover this range satisfactorily.

3. Low resolution neutron spectrometry at working places.

Although the CMI is equipped with two sets of Bonner spheres for the characterization of neutron fields at working places and around different sources of neutrons a set supplied by CENTRONIC was used in the reported period only. This set was used with different detectors of thermal neutrons:

A) Active: proportional counter SP9 filled with ^3He .

In 2010 measurement was realized in a new storage for spent nuclear fuel equipped with modified casks Castor 440/84M. These casks have more moderating material, so the neutron spectrum is softer and ambient dose equivalent between casks lower [1].

B) Passive (used mainly in pulsed neutron fields):

a) Track detectors (sandwich of CR39 with ^{10}B radiator)

b) Pairs of TLD ^6LiF and ^7LiF

These detectors were successfully used for measurement of neutrons generated in (D,D) reaction in Plasma focus device (Z-pinch) [2,3].

c) Mn foils used as an activation detector

An attempt to measure spectrum of neutrons produced by high energy photons produced by microtron (≈ 20 MeV) in a reaction $\text{Pb}(\gamma, n)$ using track detectors and TLDs failed. Track detectors are too sensitive and TLDs cannot be used due to very high photon background. The experiments Mn foils are continuing and results will be available in the midst of 2011.

4. Numerical metrology / dosimetry.

The MCNP5 and MCNPX 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.

5. Comparisons and demonstrations of equivalence.

In the above mentioned period the CMI was not involved in any comparison.

6. 14 MeV neutron source.

An absolute measurement of 14 MeV neutron yield by means of an associated particle counting has not been finished yet due to shortage of a man power.

References

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Applications of a Bonner sphere spectrometer for determination of the energy spectra of neutrons generated by ≈ 1 MJ plasma focus