Progress report on the neutron metrology and dosimetry at CMI for the period May 2007 –March 2009

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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 instruments for measurement of principal characteristics of radionuclide neutron sources, i.e. emission rate and 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 $2 \cdot 10^{7}$ s^{-1} for Am-Be, $2.8 \cdot 10^{8}$ s^{-1} for ^{252}Cf, and $5 \cdot 10^{7}$ s^{-1} for Pu-Be 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.

CMI is now equipped with two Bonner spheres spectrometers (BSS) for the characterization of neutron fields at working places:

1) An older one 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.
2) A new one (PTB design) was supplied by the CENTRONIC. It consists of 10 polyethylene spheres with nominal diameters in inches: 3, 3.5, 4, 4.5, 5, 6, 7, 8, 10 and 12. SP 9

proportional counter filled with ^{3}He usually serves as a detector of thermal neutrons. Its response matrix was taken from PTB Braunschweig and adjusted in ^{252}Cf field [1].
Past years the BSS was used for the characterization of neutron fields at nuclear power plant at the interim storage around casks with spent nuclear fuel [2].
In 2008 BSS (CENTRONIC) was used for the specification of neutron fields produced by shielded Pu-Be source at the Bulgarian Institute of Metrology at Lovech and shielded Am-Be source at the Hungarian Nuclear Power Plant Paks.

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 ^{6}LiF and ^{7}LiF were applied. Track detectors were used for measurement of spectra of photo-neutrons around radio-therapeutic linac [3] and TLDs for measurement of (d,d) neutrons near the plasma focus device [4]. These measurements are still ongoing.

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 2007 measurements concerning the EUROMET project No. 608 – "Key comparison for the calibration of ambient dose equivalent meters in ISO neutron reference fields" were finished and results described in the CMI 9011-01/2007 Report. These results are included in the IRSN Cadarache Report DRPH/SDE/2008-03 as the IRSN was a pilot laboratory. This report describes results of half participants only because the comparison was interrupted due to non reparable circulating instrument.

CMI was involved in "Neutron emission rate CCRI(III)-K9.AmBe comparison – which began in 1999. Draft B of the final report was presented in 2007.

6. 14 MeV neutron source.

During 2007-2008 the French company IRELEC revitalized J15 machine – low voltage neutron generator which produces 14 MeV neutrons via T(d,n)^{4}He reaction. Highest possible voltage is 150 kV and maximal current of deuterium ions is 1 mA. A reliable monitoring system of 14 MeV neutron yield must be prepared.

References

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