



General Overview and History on Inter-comparisons for neutron dosimetry - Description of the IC2012n Action

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- **EURADOS 1999 – Performance Test**

17 participants from 10 EU Member States

(Rad. Prot. Dosim. Vol.89 N.1-2, pp.107-154 (2000))

- **IAEA 2004-2005 Intercomparison on measurements of the quantity personal dose equivalent $H_p(d)$ in mixed (neutron-gamma) fields**

32 Participants from Countries all over the world

(Rad. Prot. Dosim. Vol.125 N.1-4, pp.61-68 (2007))

- **EURADOS 2012 Intercomparison for Whole Body neutron dosimeters (IC2012n)**

31 participants with 34 dosimetry systems mainly from EU+ Japan and USA (full results for 32 systems)

EURADOS 1999 – Performance Test



- Task within EURADOS Action Group harmonization and dosimetric Quality Assurance in Individual Monitoring for External Radiation
- No fee – voluntary base – participants ‘selected’ by the Action Group
- 17 Participants from 10 European Member States
- *Irradiation conditions at different dose values (allowed “correction” according to the radiation field information):*
 - Bare ^{252}Cf at 0° , 30° , 60°
 - Realistic spectra simulating workplace fields: *SIGMA* facility and *Canel+* assembly at IRSN
 - Variation of angle of incidence by turning the phantom about a vertical axis
- 4 categories of dosimeters
 - NA -Albedo dosimeters (NA)
 - NH -High energy neutron dosimeters (PADC or NTA based)
 - NS - Multi-element dosimeters with one detector type (PADC or TLD based)
 - NM – Multi-element dosimeters with at least 2 detectors
- **Results:** no IMSs had all results within the factor 1.5 (+50%, -33%), 3 of them narrowly outside it, 7 within a factor of 2 (+100%, -50%) whilst one very bad results => factor 1.5 does not fit with neutrons

IAEA 2003-2005 Intercomparison on measurements of the quantity personal dose equivalent $H_p(d)$ in mixed (n- γ) fields

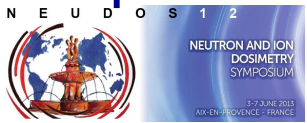


- No fee – voluntary base
- 32 Participants from Countries all over the world
- *2-phased procedure:*
 - Part 1 – Type Test intercomparison:* irradiation in selected calibration fields (neutrons, photons and mixed): ^{252}Cf ($0^\circ, 45^\circ, 60^\circ$), Am-Be, X ray (W250), ^{60}Co , $^{252}\text{Cf}+^{60}\text{Co}$, 565 keV n+ ^{60}Co
 - Part 2 – Simulated workplace fields:* CANEL assembly at IRSN, $^{252}\text{Cf}(\text{D}_2\text{O})$, ^{252}Cf behind shadow cone variation of angle of incidence by turning the phantom about a vertical axis
- *Info provided to participants:* «The neutron irradiations are all typical for mixed neutron-photon workplace fields at nuclear reactors, i.e. neutron spectra with significant contributions from slow and intermediate energy neutrons »
- *Results:* 50% good results, 20% very poor results
performance influenced by IMS than type of dosimeter

EURADOS self-sustained programme of inter-comparisons for Individual Monitoring Services (IMS)



- Participation fee – voluntary base
- Regularly performed
- IMS from Countries all over the world, mainly from Europe
- Routinely used dosimeters, i.e. no prototype under development
- Irradiation plan by the Organization Group based on a combination of standard calibration radiation fields or simulated workplace fields at different dose values
- Irradiation performed at Accredited Laboratories
- Results provided in “Certificate of Participation” with certificates provided by the Irradiation Labs as annex
- Participants meeting to report and discuss the results
- Results reported and published in anonymous form in a specific EURADOS Report + papers into the open literature



- ✓ **Test performance** of neutron dosimeters intended to measure $H_p(10)$ as provided by IMSs
- ✓ **Passive or active dosimeters *routinely*** used in individual monitoring of exposed workers.
- ✓ **Only neutron fields** (no additional photon irradiations over and above the photons associated with the neutron-production mechanism)
- ✓ Radiation fields (**standard and simulated workplace fields**) with energy range from thermal to several MeV with different dose values and angles

⇒ **allow IMSs to test their performance and**

⇒ **at the same time to provide reference calibration traceable to Accredited Laboratories**

EURADOS IC2012n time schedule (application and execution phase)



15 April 2012	Announcement - Call for participants
10 June 2012	Deadline for IMS sending Application Forms with information on their dosimeters
30 June 2012	Confirmation of participation by OG coordinator and instructions to provide dosimeters
3 August 2012	Deadline for IMS sending dosimeters to OG coordinator
October–November 2012	Irradiations at NPL and PTB and irradiation data to the OG coordinator
20 December 2012	Instructions to IMSs to provide results with general information on radiation fields
20-24 December 2012	Dosimeters sent back to IMSs for readout
31 January 2013	Deadline for IMS to send 1st step results
28 February 2013	OG coordinator sent radiation field information to provide the 2 nd step-final results
10 March 2013	Deadline for IMS to send 2st step results
24 April 2013	Final and reference results from OG coordinator to the participants
3 May 2013	Deadline to confirm the results by IMS
4th June 2013	Participant's meeting
Within 15 June 2013	Certificate of Participation to all IMSs

IC2012n results: 2-step procedure



As some (few) IMSs using albedo dosimeters needed information on the radiation field prior to the evaluation procedure;
as we need to keep the procedure fair to every IMS participating though allow of course all IMS to provide results according to their routine procedure,

⇒ **the participants were asked to provide the results in 2 steps:**

- **1st step:** with no information on the radiation fields provided by the OG
- **2nd step:** with information on the radiation fields though it was up to the IMS to choose the proper calibration factor to be applied.
- Participants were allowed to change their results between the first and the second step only according to their routine procedure which has to be described and justified

IC2012n: information on radiation fields provided to the participants



➤ For 1st step results:

"Dosemeters were irradiated in groups with different neutron spectra: radionuclide source, mono-energetic fields or workplace fields.

Some of the fields contained significant contributions from slow and intermediate energy neutrons.

No additional gamma component was added to the field over and above that associated with the neutron production.

No information on dose, radiation quality, or the angle of the incident radiation will be given at this stage"

➤ For 2nd step results:

Irradiation conditions	Information provided to participants
Bare Cf-252 source at 0° , 45°	Bare radionuclide source
250 keV mono-energetic neutrons at 0°	250 keV mono-energetic neutrons at 0°
Cf-252 (D2O moderated) at 0°	Radionuclide source with significant moderated neutron fluence component
Bare Cf-252 shielded with shadow cone	Radionuclide source with significant moderated neutron fluence component

No "internationally agreed" criterion for the performance of individual monitoring

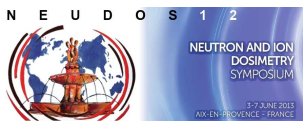


No criterion for overall uncertainty of neutron dosimetry measurements (for photons ISO14146 and more publications and results) => no "outliers" for specific requirements => no "standardised" judgement

ICRP §251 states that in workplace fields, where the energy spectrum and orientation of the radiation fields are usually not known, estimation of effective dose can vary within a factor of 1.5 in either directions for photons and may be substantially greater for neutrons of uncertain energy.

Greater uncertainties at low level of effective dose for qualities of radiation.

=> The OG of the EURADOS IC2012n used a factor of 2 to analyse the EURADOS IC2012n results



Results: Certificate of Participation



- ✓ EURADOS itself is not accredited for the evaluation of IMS
- ✓ The results issued by EURADOS itself cannot be regarded as an « official test report »
- ✓ Results to the Individual participants in the form of *Certificate of Participation*, with the irradiation reports provided by the Accredited Irradiation Laboratories as an annex together with signed dose reports provided by the Participant for each step
- ✓ No « judgement » or compliance statements or number of outliers
- ✓ The IMS can use the *Certificate of Participation* to show compliance with the stated performance to its customers and/or with technical standards requirements
- ✓ Irradiation reports provided by the irradiation Labs can be used as calibration or confirmation of calibration

- First neutron dosimetry inter-comparison since almost 10 years
- Acceptable number of participants (how many more IMSs provide personal dosimeters in EU and worldwide?)
- Results are generally good though for few participants results are quite bad
- Factor of 2: reasonable and achievable (though it should not prevent from improving the actual dosimeters and from further developments in neutron dosimetry techniques)
- Need for improvement in EURADOS IC procedure?

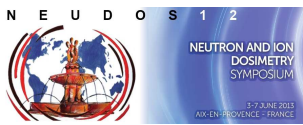
We ask for your feedback!



If you have any suggestion or claim...

Please email to:

IC2012n@eurados.org



EURADOS IC2012n Participant Meeting – 4th June 2013

