Technical protocol of APMP comparison for the calibration of ambient dose equivalent meters in ISO neutron reference fields

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Contents

1. Introduction
2. Participants
3. Procedures
   3.1 Comparison methodology
   3.2 Neutron fields
   3.3 Transfer instruments
   3.4 Schedule
   3.5 Reports from the participants
   3.6 Evaluations and final report
4  Bibliography
5  Appendix
1. INTRODUCTION

The monitoring of neutron ambient dose equivalent is one of the most important tasks for the radiation protection in the nuclear power plant and other places. The reliability of the monitoring of the neutron ambient dose equivalent should depend on the capability and the reliability of the calibration of neutron ambient dose equivalent meter. Many of the national metrology institutes in APMP have listed the calibration of neutron ambient dose equivalent on their CMC table, but there is no international comparison supporting the CMC because of the difficulties and complexity to realize the comparison for the neutron ambient dose equivalent.

However, recently, EUROMET has carried out the comparison exercise for the calibration of neutron ambient dose equivalent meter using one spherical neutron survey meter, successfully. The same procedure for the comparison could be adopted for the APMP comparison.

So, we would like to suggest the international comparison for the calibration of neutron ambient dose equivalent meter. Two moderator-type neutron ambient dose meters will be used as transfer instruments and the calibration constants for two transfer instruments could be derived at the ISO neutron reference fields.[1]

2. PARTICIPANTS

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Note : see appendix

3. The comparison and measurements

3.1 pilot laboratory and evaluator

KRISS will be the pilot laboratory of this comparison and also take a role of evaluator.

3.2 Transfer Instruments

Two neutron survey meters used as transfer instruments are;
- a Neutron Rem Counter NSN2 (spherical device provided by Fuji Electric Systems, shown in Figure 1), produced by Fuji Electric Systems Co., Ltd. (Japan)
- a Neutron monitor 2222A (cylindrical device provided by KRISS, shown in Figure 2), produced by
3.3 Neutron fields

Measurements will be performed in the neutron fields of the following radionuclide sources: $^{241}$Am-Be, bare $^{252}$Cf and moderated ($^{252}$Cf+$D_2O$)/Cd which are calibrated in terms of emission rate and anisotropy.

The participating laboratory shall employ at least one of all those three sources.

3.3 Quantity to be compared

The quantity to be evaluated and compared will be the calibration constant of the survey meters, i.e. the ratio of the conventional true value and the reading of the survey meter.

$$N = \frac{H'(10)}{M}$$

where $H'(10)$ is the conventional true value of the ambient dose equivalent of the scatter-free neutron field at 10 mm of depth as defined by ICRU. Conversion coefficients for the operational quantities will be those adopted by the ICRP.[2]

$M$, the instrument reading corrected for the disturbance effects (e.g. room and air scattering, air attenuation, size effect, linearity etc)

$N$, calibration factor.

3.4 Calibrations

During the calibration, the instruments shall be irradiated perpendicular to their axis in order to clearly define the effective center of the device (Figure 1). The effective center is the intersection between the symmetric axis of the device and the perpendicular straight line which cross the mark on the instrument.

The measurement should be performed using one or more calibration methods defined in ISO 8529-2.[3]

The numerical values of fluence-to-dose-equivalent conversion coefficient, $h_f(10)$, given in ICRU 57 (or written in ISO 8529-3) should be used.[4,5]

The measurement should be performed in one or more neutron fields written in section 3.2.
The calibration factor $N$, $N = H'(10)/M$, can be determined from the ratio of $H'(10)$ and $M$ shown in section 3.3. For both transfer instruments for this comparison, $M$ can be obtained with two ways.

- $M$ could be read in “Sv/h” from the display of transfer instrument. In this case, $N$ becomes unit-less.

- $M$ could be read in “counts/s” with “counting device such as Ortec 776 module” using the pulse signal from the instrument. In this case, $N$ should be written in the unit of “Sv/count”.

Participants can evaluate the calibration factor with either both or one of two ways of readings depending on your situation.

The uncertainty budget should be evaluated according to the ISO standard GUM [6] and be given as one standard deviation, corresponding with a coverage factor $k=1$.

![Image](image.jpg)

**Figure 1** a Neutron Rem Counter NSN2 (spherical device provided by Fuji Electric Systems.)
Figure 2 a Neutron monitor 2222A (cylindrical device provided by KRISS).

4. Schedule

Measurement will start in 2011. Each participant must take two weeks for measurements. Including two weeks of transportation and consistency check in pilot lab, one month will be needed for each participating laboratory. The number of participants is 7 at present and in total 7 month will be necessary. Hopefully, the comparison will be completed in 2012.

5. Transportation

The pilot laboratory will measure the calibration constant of two transfer devices. The pilot laboratory is in charge of sending the two instruments to the participating laboratories. After each campaign of the measurement performed in the participating laboratory, the device will be returned to the pilot lab (KRISS). KRISS will check the device and will send to the next laboratory.

The participating laboratories must agree to cover the costs for insurance and the transportation of all instruments in both directions.

6. Report from the participant

The calibration measurements shall be documented in very detail. The participants should submit a detailed report, approved by their institutions, including all necessary details of:

- the sources employed (source strength, anisotropy, geometry, … )
- the irradiation facility (size of room, description of the irradiators, point of test, …)
- the calibration methods used (size and shape of shadow cones, fitting procedures, ...)
- the determination of uncertainty budget,
- any other necessary things to be commented.

The participants should submit their final report two months after finishing their measurements to the evaluator.

7. Evaluations and final report

The comparison reference value will be determined as the weighted mean of all values reported by participants. Independent calibration factors will be determined for the two transfer instruments circulated and the three difference sources possibly employed by more than one laboratory.

8. Bibliography


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