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# First Argentinean Intercomparison of Neutron Detectors

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## ABSTRACT

An intercomparison exercise on neutron detection for radiation protection purposes was organized during 2011 by ARN Neutron Laboratory in order to verify the present status of instrumentation applied in this field by different nuclear facilities in Argentina, such as research reactors, nuclear power plants, particle accelerators, and a bureau of safety. In the exercise, the ARN laboratory acted as reference laboratory. Neutron Irradiator N40-BG-M-2 (Hopewell Designs Inc.) and the sources ISO Cf-252, Cf-252 + D2O and AmBe were used. An assessment of measurement variables affecting the uncertainty was carried out.

## 1. INTRODUCTION

Private and public laboratories were invited with the only condition of one detector per participant. Results showed that 75% of detectors are acceptable within the dose rate range of the ARN neutron laboratory.



Figure 1. ARN Neutron Laboratory

## 2. DELIVERED DOSE TRACEABILITY

Staff from Los Alamos National Laboratory (LANL) characterized the neutron field in the course of two visits (2006, 2008). Neutron spectral measurements and dose equivalent measurements were performed. In addition, extensive Monte Carlo simulations were performed to determine neutron spectra, dose rates, room return, source anisotropy and fluence-weighted dose conversion coefficients. Such details were calculated by MCNP, dose rate measured with SWENDI and spectrometry carried out with the ROSPECT complemented with the Simple Scintillation Spectrometer, both of them from BTI; a transfer instrument regarded by the ISO earlier calibrated at NIST and at the PTB.



Figure 2. Detectors on calibration bank in the same positions as they were irradiated.

## 3. IRRADIATION PROTOCOL

The irradiations were performed on a platform located 2 meters above the ground, at the same height of the source and the detector at two pre-set distances: 70 cm and 300 cm from the source centre to the reference point. 30 seconds prior to register each reading (independency) 30 seconds delay between reading (transient up to reach stability) Detectors with multiple response times were tested on extreme irradiation scenarios (usually 6 seconds and 24 seconds). Detectors with automatic selection had no option but to work in their fixed response time.

## 4. ACCEPTANCE CRITERIA

Acceptance criteria for this exercise were adapted from IAEA RS-G-1.3 Safety Guide. Despite that RS-G-1.3 sets acceptance criteria for Personal Dose Equivalent Hp(10), however, in this exercise, it was performed considering Ambient Dose Equivalent H\*(10). This criterion was based on that Hp(10) and H\*(10) quantities are both good estimators of the Effective Doses received by an individual in a radiation field. That being said, in order to consider a measurement acceptable, the average readings must fall within the interval defined by -33% to 50% around the RVL.

In symbols:

$$0.66 < \bar{X} / RVL < 1.50$$

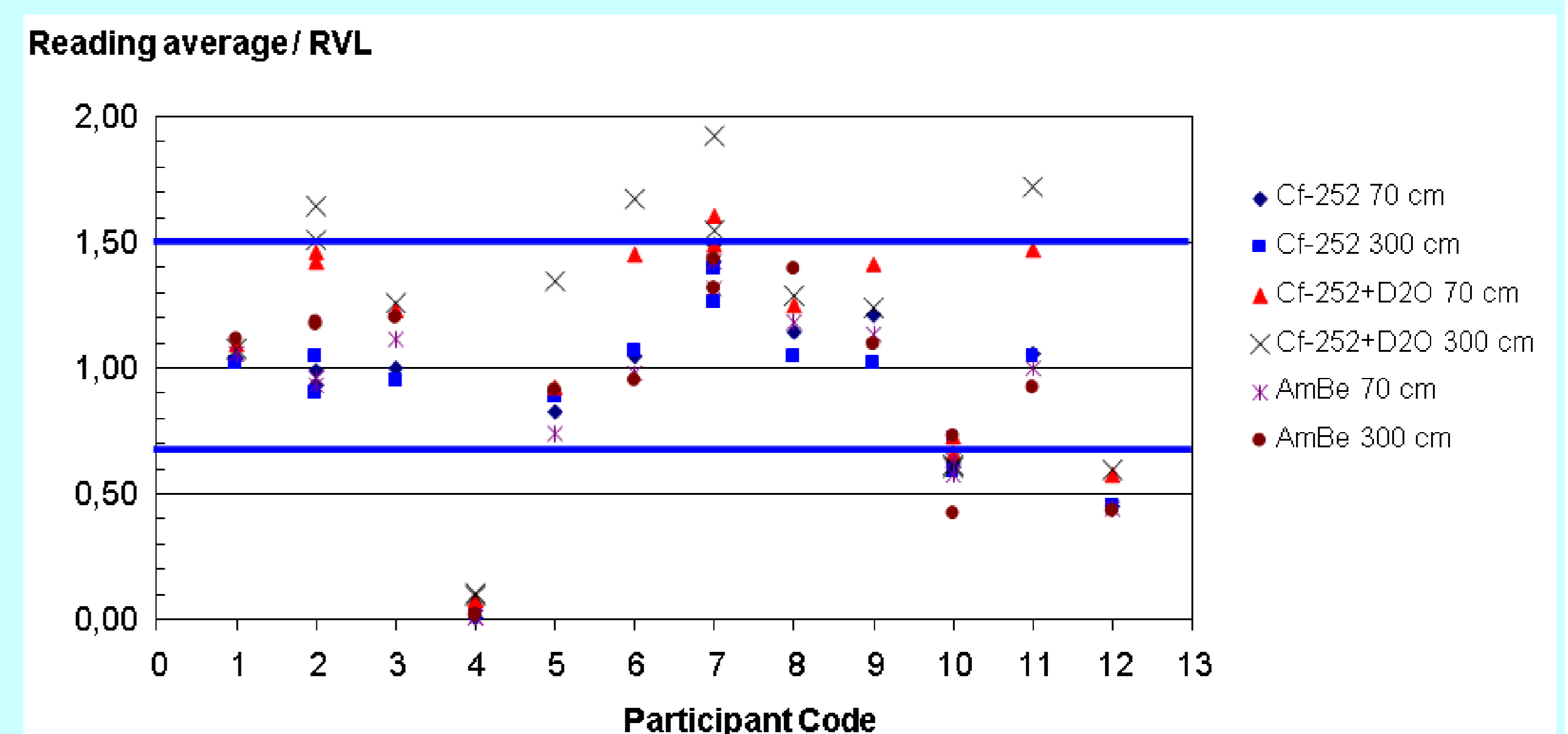
## 5. RESULTS

It is considered as result the response, defined as the average of ten readings divided by RVL.

$$\text{response} = \bar{X} / RVL$$

The RVL and the indication of the detector quantity is the Ambient Dose Equivalent rate. The uncertainty assigned come from the measurement of the repeatability, the resolution of the display in the range of the value of the quantity and the uncertainty in the positioning (1 cm). The uncertainty is expressed as the percentage of the response. Figure shows responses for each participant, depending on the quality of radiation, the dose rate at which it was exposed (to 70 cm or 300 cm), and the response time.

A significant percentage of detectors do not respond properly in neutron fields produced by the low dose rate Cf-252 + D2O source. This is due to inherent conditions in the detector design and the source selected for calibration. Taking into account the previous condition, a detector response was considered acceptable if it had got a successful performance at least 5 of 6 tests.



Participants' responses in all fields. Codes 2, 4, 7 and 10 were irradiated for two response times. No uncertainties were added for clarity.

## 6. CONCLUSIONS

The intercomparison exercise on Neutron Detection for Radiation Protection Purposes during 2011 was successfully performed. The status of tested detectors is acceptable. In summary: 42% of detectors response is acceptable in 6 fields, 33% in 5, 8% in 3 and 17% of detectors response is not suitable in any field.