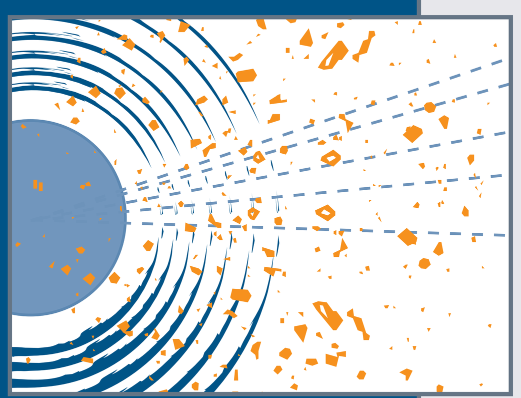
Neutron beam characterization at workplaces and neutron personal dosimeter performance assessment in the Chinon NPP



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1. EDF
2. SPRA
3. LANDAUER EUROPE

INTRODUCTION

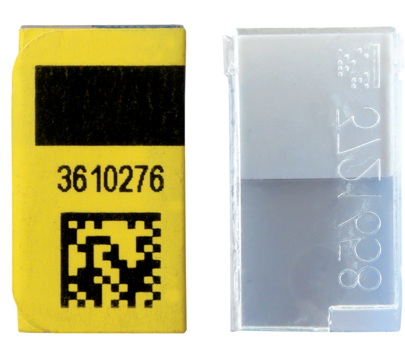
The results reported by the neutron dosimetry can show large dose assessment discrepancy depending on the type of dosimeter device and on the neutron field.

That is why it seems necessary to investigate neutron fields characterization at workplaces. It will help understand whether the neutron dosimeter device matches the needs of worker monitoring.

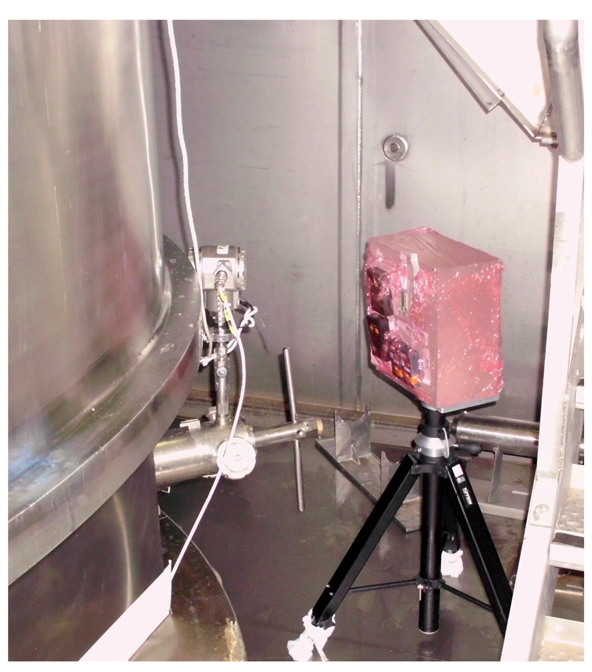
EDF and LANDAUER EUROPE, with support from the SPRA, decided in 2011 to carry out a measurement campaign in the Chinon NPP, using a ROSPEC™ spectrometer and Neutrak T (CR-39) dosimeters. The purpose of the measurement was to characterize the neutron spectrum and the CR-39 response during fuel evacuation.

EXPERIMENTAL SET-UP

ROSPEC™ is a rotating neutron spectrometer manufactured by BTI

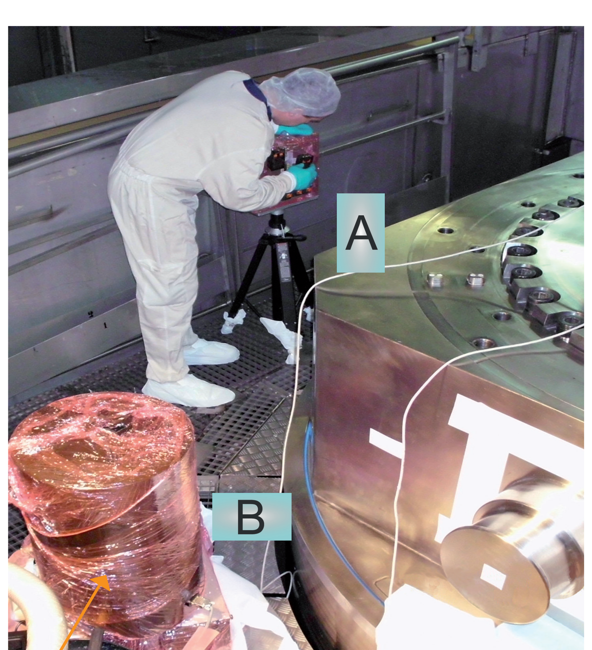


Neutrak® T (CR-39), passive dosimeter with fast neutron and thermal neutron detectors (LANDAUER Product)

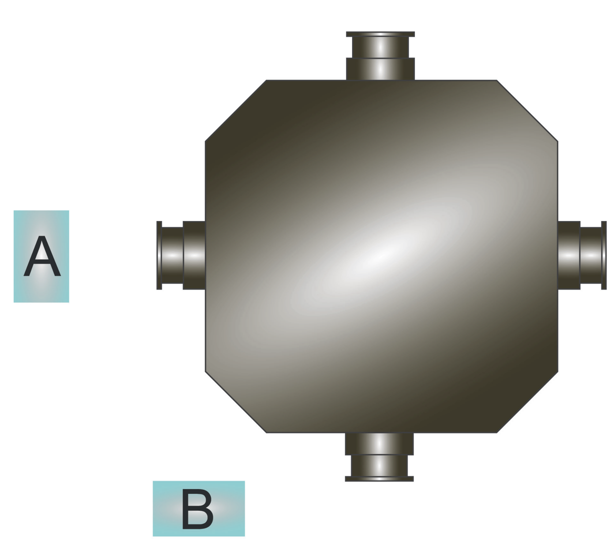


Slab phantom with EPD and CR-39

Positioning of the dosimeters on the slab phantom



ROSPEC™

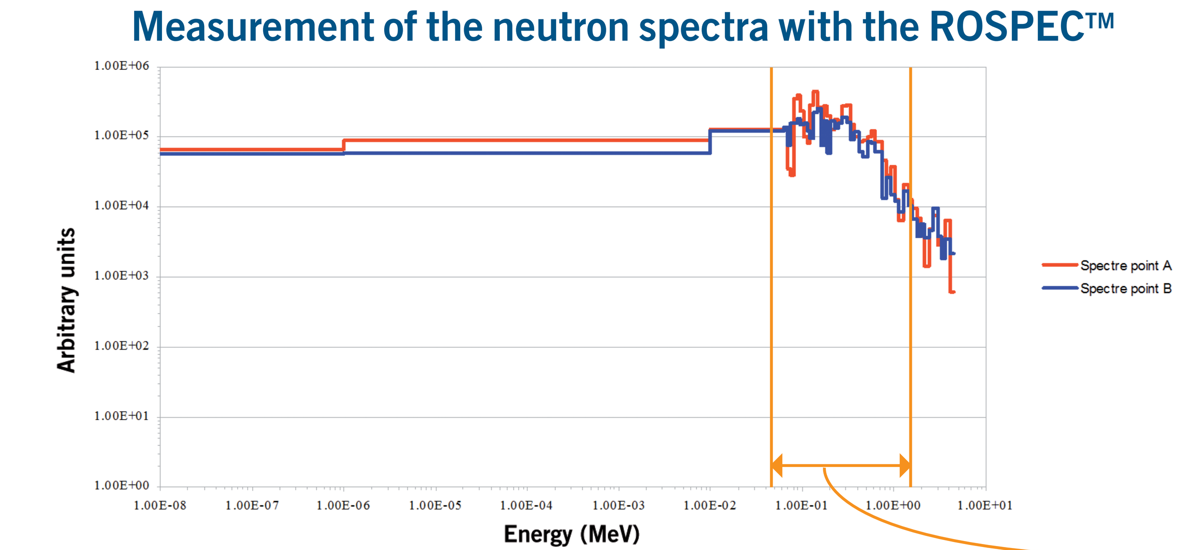


Schematic of the fuel tank (top view)

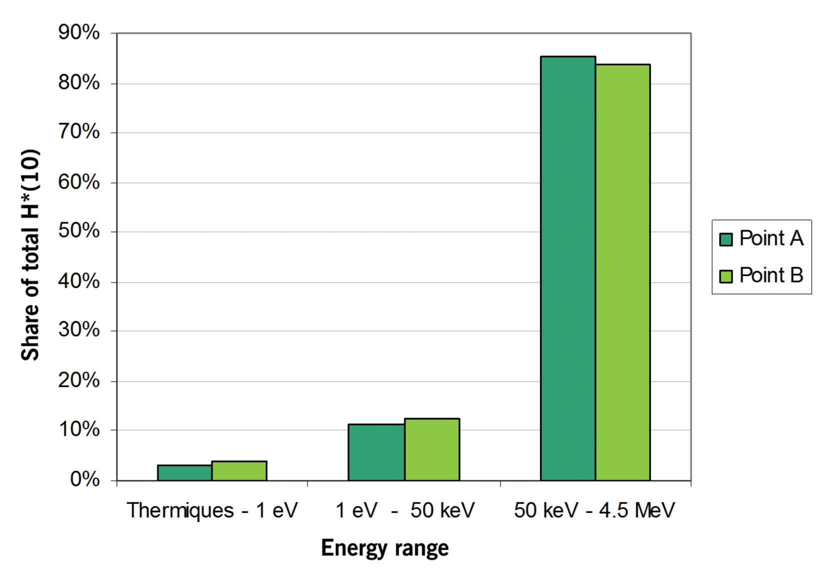
ROSPEC™ and Slab phantom have been switched between points A and B to be able to compare the measurement at the same position

RESULTS

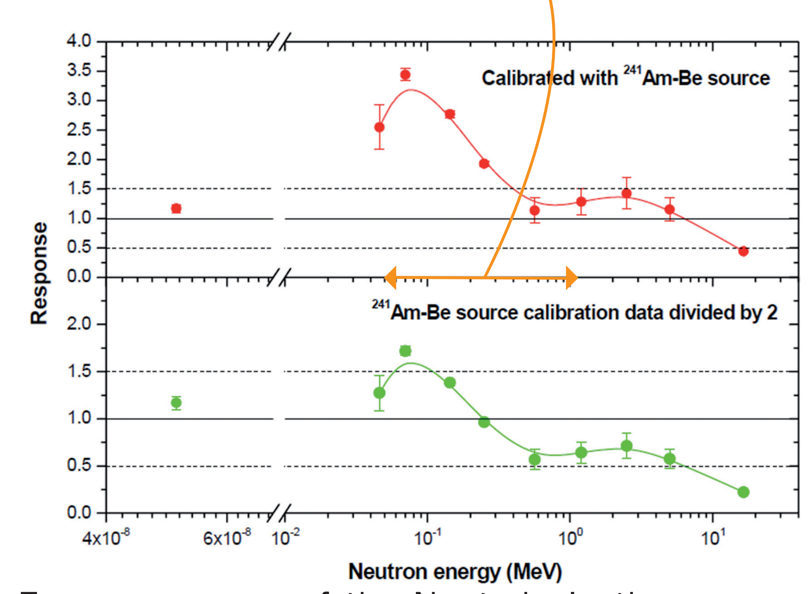
Measurement of the neutron spectra with the ROSPEC™



Given the discrepancy between the spectrum at points A and B, the two neutron spectrum could be considered as identical.



The major dose component is due to the neutron in the range of 50 keV to 1 MeV (~ 85 %).



Energy response of the Neutrak. In the range of 50 keV to 1 MeV, the energy response of the Neutrak meets the ISO 21909 standard requirements. Therefore, the Neutrak dosimeter is appropriate to use in the Chinon NPP.

	Point A	Point B	
Time	107 min	120 min	
DMC Hp(10) [µSv]	241	311	
ROSPEC H*(10) [µSv]	178	145	
Berthold [µSv]	143	160	
NEUTRAK T (10 dosimeters per batch)	Batch 5	Batch 1	Batch 2
Mean dose [µSv] NEUTRAK T	170	190	180
Coefficient of variation for the Neutrak measurement (%)	17	21	18
Neutrak / ROSPEC	0.95	1.31	1.24

ROSPEC™ measurements were done in terms of H*(10) and Neutrak T measurements in terms of Hp(10).

Due to the fact that it was a front irradiation, H*(10) from the ROSPEC™ was considered to be the reference dose.

The measurement performed with the Neutrak dosimeters were consistent with those of the ROPSEC™ (with a bias in the range of 5% to 31%).

Even if the measurements were performed at low dose level, the coefficient of variation on 10 samples is acceptable for individual monitoring.

Berthold equipment is also in line with ROSPEC™ and Neutrak, however DMC tends to over-estimate the dose by a factor 1.5 to 2.

CONCLUSION

The tests were done to investigate the performance of the dosimeters worn by NPP employees when working in the vicinity of the fuel tank, a specific workstation where the neutron fluence is expected to be high.

The neutron fluency has been measured at two different points around the fuel tank, and both measured spectra show no sizeable discrepancy.

The major part of the dose is due to neutrons in the energy range of 50 keV to 1 MeV, which corresponds to the range for which the Neutrak is designed.

The results show a good agreement between the Neutrak detector and the ROSPEC™ spectrometer that is taken as reference. The observed bias is in the range of 5 % to 31 %.

However the results show that there may be a bias between EPD and passive dosimeter of the order of 50% This discrepancy had already been identified by other experiments.

All these points show that the Neutrak is well suited for individual monitoring in NPP (Nuclear Power Plant).

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