



EUROPEAN COMMISSION

Joint Research Centre - JRC
Directorate G - Nuclear Safety & Security
Unit G.2 - Standards for Nuclear Safety, Security and Safeguards
Retieseweg 111
B-2440 Geel/Belgium

Certificate for the ^{210}Pb massic activity in Bq/kg of a lead-disk from the company Nuclear Shields B.V., Netherlands

1. GENERAL INFORMATION

This certificate concern a special request from the company "Nuclear Shields B.V." (NS) to determine the massic activity of ^{210}Pb in a disk (provided by NS) made of pure lead according to NS. The RadioNuclide metrology Team (RN-Team) of the JRC performed gamma-ray spectrometry using an ultra low-background high purity germanium detector located in the underground laboratory HADES for the measurement. Note that the RN-Team did neither perform any chemical analysis of the disk nor did it investigate the provenance of the disk.

2. MATERIALS AND METHODS

2.1 Sample

One lead-disk was sent to JRC-Geel in June 2018. Its dimensions were measured at JRC-Geel and found to be 40.06 mm in diameter and 3.10 mm thick and a mass of 44.447 ± 0.010 g.

2.2. Detectors and measurements

The sample was measured using ultra low-level gamma-ray spectrometry (ULGS) (see Hult et al, 2006 and Hult, 2007) in the 225 m deep underground laboratory HADES. The detector Ge-2 was employed for the measurements. Detector Ge-2 is a semiplanar n-type detector, which has a relative efficiency of 8% and a sub-micron deadlayer at the top. The detector is highly suited for measurements of the 46.5 keV gamma-ray from ^{210}Pb . For the measurements, the disk was placed directly on the endcap of the detector. The sample was measured for 18 days starting June 8, 2018. During this time, 361.4 net counts in the 46.5 keV peak were recorded.

2.3. Efficiency calibration

The Full Energy Peak (FEP) efficiency was determined using a computer model of the detector that was set up by measuring point sources from PTB¹. In the simulation of the sample, the measured mass, diameter and height were fixed and the density adjusted (to 11.38 g/cm^3 , which accounts for small inhomogeneities in the relatively soft disk). The FEP efficiency was calculated using the EGSnrc Monte Carlo program (Kawrakow and Rogers, 2003). The simulations assume that the gamma-ray emissions are isotropic and uncorrelated. Furthermore, all calculations assume that the radionuclides are homogeneously distributed within the volume of the disk. The nuclear decay data was taken from the Decay Data Evaluation Project (DDEP) website http://www.nucleide.org/DDEP_WG/DDEPdata_by_Z.htm

¹ Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

3. RESULT

3.1 Massic activity

The massic activity result for ^{210}Pb is given in Table 1 with reference date of 08/06/2018. No other radionuclide was detected in the disk. The reported uncertainties are the combined standard uncertainties ($k=1$).

Table 1. Massic activity with combined standard uncertainties ($k=1$), at reference date 08/06/2018.

Material	Detector	Massic activity ($\text{Bq}\cdot\text{kg}^{-1}$)
		^{210}Pb
Lead (Pb) disk from Nuclear Shields B.V.	Ge-2 in HADES	19.7 ± 3.4

3.2. Uncertainty budget

All uncertainties contributing to the measurement result were joined to a combined standard uncertainties (coverage factor $k=1$) following the ISO Guide to the Expression of Uncertainty in Measurement (2008). For the analysed radionuclide (^{210}Pb) the dominating uncertainty components come from counting statistics (6%) and uncertainties of determination of FEP efficiencies (15%).

4. REFERENCES

1. Hult M, Preusse W., Gasparro J and Köhler M. "Underground Gamma-ray Spectrometry" Acta Chimica Slovenica 53 (2006) pp.1-7.
2. Hult M, "Low-level gamma-ray spectrometry using Ge-detectors" Metrologia 44, No.4, (2007) pp.S87-S94. Erratum at Metrologia 44, No. 5, p. 425.
3. Kawrakow and DWO Rogers. "PIRS-701: The EGSnrc Code System: Monte Carlo Simulation of Electron and Photon Transport" Ionizing Radiation Standards (NRC, Ottawa, Ontario,2003), 2003.

5. PERSONNEL

- Project Leader, QC and author of report/certificate: Mikael Hult
- Performing source preparation and measurements: Gerd Marissens
- EGSnrc efficiency calculations and data analysis: Guillaume Lutter

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Mikael Hult
Sector Head, Radionuclide Metrology