

Measuring neutron radiation in Gorleben

At the request of the Ministry of the Environment, Energy and Climate Protection of Lower Saxony, measurements were carried out in the centre of the town of Gorleben. Data from measurement hut No. 5, which is located approx. 2 km from the transport cask storage facility, have shown that exclusively neutrons from cosmic radiation contribute to the ambient dose equivalent.

The Ministry of the Environment, Energy and Climate Protection of Lower Saxony entrusted the Physikalisch-Technische Bundesanstalt with neutron radiation measurements in the centre of the town of Gorleben. The neutron ambient equivalent dose was determined at "Reference measurement hut" No. 5 (MH5), which is located approx. 2 km from the transport cask storage facility (TBL). In addition, it was checked whether – and if so, to what extent – dose contributions occur at MH5 which are not due to cosmic radiation. This was achieved by comparing the data with measurements carried out at roughly the same time on PTB's site. Ultimately, also the attenuation factor of the measurement hut was determined for the neutron radiation occurring there.



Fig. 1: Measurement set-up at MH5. MH5 can be seen at the back, on the right-hand-side.

The measurements were carried out with a part of the neutron spectrometer NEMUS. The multisphere spectrometer (Bonner-sphere spectrometer) NEMUS is PTB's secondary standard for the dissemination of the unit for the ambient equivalent dose for neutron radiation in unknown radiation fields such as, e.g., at workplaces and in the environment.

The essential criterion for the selection of the spheres resulted from the task consisting in determining the relation of measurement values at different places (PTB in Braunschweig and MH5 in Gorleben) to be able to thereby detect a possible contribution of neutrons of artificial origin and to determine the influence of the "measurement hut" on the display of an ambient neutron monitor. It was not necessary to use the complete NEMUS spectrometer.

Accordingly, three moderating spheres of the spectrometer were chosen for the measurements.

- The core component for the investigations was the 12" sphere (diameter: 30.48 cm). Of all spheres of this spectrometer, it has the dose response with the lowest energy dependence. Furthermore, this dependence corresponds best to that of the neutron monitor of type LB6411 and to the 30 cm PE sphere of the NLWKN – which are both used for the monitoring of the environment at the transport cask storage facility. Thus, the 12" sphere was used for the measurement of the ambient dose equivalent on PTB's site as well as outside and inside MH5.
- The 5" sphere (diameter: 12.70 cm) has a fluence response that exhibits a maximum in the presence of low-energy neutrons. It was used as an indicator for possible changes in the neutron spectrum. It was also used on PTB's site as well as outside and inside MH5.
- The 8" sphere (diameter: 20.32 cm) was used outside MH5 in Gorleben as a monitor, unchanged during the total measurement time in order to be able to detect possible temporal variations of the radiation intensity.

In all measurements, the influences of the intrinsic background of the detectors used, of the ambient pressure prevailing during the measurements, and of the intensity of the cosmic neutron radiation were taken into account.

The measurements covered a period extending from 16 October 2012 to 9 November 2012. They were divided into four consecutive measurement phases without any interruption between the phases.

- PTB1: Measurements on PTB's premises in Braunschweig
- GOR1: Measurements in the direct vicinity of MH5 in Gorleben
- GOR2: Measurements inside MH5
- PTB2: Measurements on PTB's premises in Braunschweig

The essential measurement results are compiled in Fig. 2. The dose rate near MH5, 1 m above the ground, is in agreement with the value measured on PTB's premises. This results from the observation that the ratio of the values measured by the 12" sphere in Gorleben and at PTB are in agreement within the measurement uncertainties. Thus, no contributions to the neutron ambient dose equivalent can be seen at MH5 which do not stem from cosmic radiation.

The ratios of the measurement results in the case of the smaller spheres seem to suggest that the different environmental conditions have a slight impact on the share of low-energy neutrons in the neutron spectrum. This, however, has no influence on the ambient dose equivalent.

When comparing the measurements carried out inside with those undertaken outside the measurement hut, it turns out that no influence of the measurement hut on the neutron ambient dose equivalent of the neutron radiation occurring there can be detected.

These results are an important contribution to the concept of dose measurements at the fence of the TBL. They show that measuring instruments can be used inside MH5 to be able to determine the contribution of cosmic neutron radiation for the measurement values at the fence of the TBL.

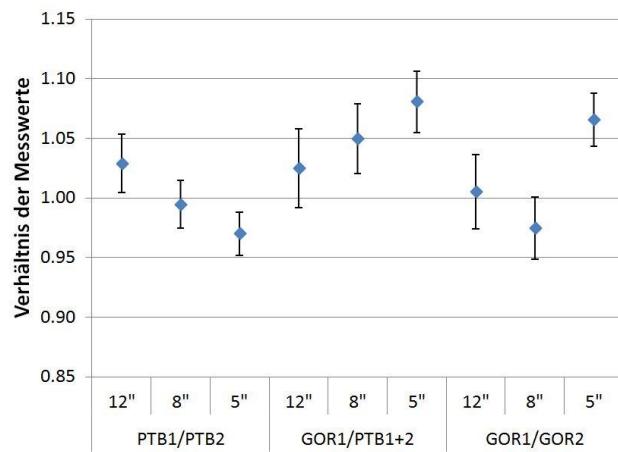


Fig. 2: Ratio of values measured with different moderating spheres (the designation is indicated in inches) and under different measurement conditions.

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