DOI: 10.34854/ICPAF.52.2025.1.1.109

AUTOMATIC RADIATION MONITORING SYSTEM ON TOKAMAK T-15MD *)

Anashkin I.O., Kirneva N.A., Levin I.V., Ryzhakov D.V., Khvostenko A.P., Khripunov V.I.

RNC "Kurchatov Institute", Moscow, RF, nrcki@nrcki.ru

During the operation of the T-15MD thermonuclear installation with hydrogen plasma, two types of radiation are the most dangerous for personnel: gamma radiation and neutron radiation, which occur in the so-called acceleration regimes. Primary ("hard" up to 20 MeV) gamma radiation is generated in low-density plasma discharges during the formation, acceleration, and subsequent deceleration of a beam of accelerated electrons with an energy of ~ 12÷50 (up to 100) MeV in ~2 ms. Bremsstrahlung gamma radiation in (γ, n)-photosplitting reactions of the nuclei of materials included in the structural elements of installations generates the so-called photoneutrons with an energy of ~ 1.5÷2.5 MeV. As a result of the reactions of the subsequent radiation (n, γ) capture of photoneutrons by the nuclei of the elements that make up the structural materials of the installation, secondary capture gamma radiation occurs.

The radiation fields caused by these sources require a radiation monitoring system to determine the operating and maintenance conditions of the installation.

The Tokamak T-15MD installation is in a hall surrounded by biological protection made of heavy concrete with a density of $\rho = 3.6$ g/cm^3, 1.2 m thick and about 10 m high.

The Automatic Radiation Monitoring System (ASRK) measures the dose rate of gamma and neutron radiation at stationary points in the Tokamak T-15MD building. ASRK is based on scintillation sensors that are sensitive to a wide range of gamma (γ) and neutron (n) radiation. The T-15MD ASRK uses 22 BDKG-204 sensors that measure gamma radiation in the energy range of 20 keV to 10 MeV and 23 BDKN-02 sensors that measure neutron radiation in the energy range of 0.025 eV to 14 MeV. The sensors of the system are located both directly in the T-15MD installation hall and behind biological protection throughout the building (including on the roof). Information from the sensors is output to the workstation, which accumulates information from stationary control points with subsequent analysis to minimize radiation loads on personnel. Sound and light alarms are connected to the ASRK, which are triggered when the limit doses are exceeded.

During the experimental campaigns in 2023-2024, more than 3,000 pulses were recorded. In low-density plasma regimes, the formation and development of accelerated electron beams was accompanied by the generation of gamma and neutron radiation. The highest dose rates of gamma quanta were recorded directly in the installation hall in the shadow protection area, above the installation and on the biological protection wall separating the installation hall and gyrotrons hall. The level of gamma radiation doses recorded in the building in non-industrial premises did not exceed 40-60 nZv/hour or 0.13 mZv per year (the annual dose for group A personnel does not exceed 20 mZv). Estimation of the energy of the generated gamma quanta by the frequency of attenuation of radiation power during biological protection, using the universal Gusev tables [1], gave an energy value, as expected, of more than 10 MeV.

The work was carried out within the framework of the State assignment of the NRC "Kurchatov Institute".

References

[1]. N.G. Gusev, E.E. Kovalev, V.P. Mashkovich, A.P. Suvorov. Protection from ionizing radiation. Vol. 1. Energoatomizdat, 1980.

*) abstracts of this report in Russian