

LONG-TERM ^{14}C ACTIVITY MEASUREMENTS IN TREE RINGS NEAR IGNALINA NUCLEAR POWER PLANT: HOW IT HELPS TO INCREASE SAFETY OF OUR ENVIRONMENT

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Atmospheric ^{14}C is produced by natural process of cosmic radiation interaction with Earth atmosphere as well as by anthropogenic human activities [1]. Almost double concentration of the anthropogenic radiocarbon appeared in atmosphere as a result of intensive nuclear weapon testing back in 1960's. After moratorium of the tests, introduced since 1963, the ^{14}C activity in global atmosphere is declining. However, considerable amounts of ^{14}C in the nuclear reactors is generated by neutron radiation interaction with ^{17}O , ^{14}N and ^{13}C . It accumulates in reactor vessel components, coolant and cleaning systems, and is partly released into environment mainly in a form of $^{14}\text{CO}_2$ and $^{14}\text{CH}_4$. RBMK-1500 type graphite moderator reactors were exploited at Ignalina NPP (Lithuania): Unit 1 - 1983-2004; Unit 2 - 1987-2009. Over decades $^{14}\text{CO}_2$ gas releases from NPP accumulates in local biosphere by photosynthesis, while increasing overall radiation background.

In order to examine the temporal variations and dilution peculiarities of the released radiocarbon gaseous effluents from Ignalina NPP, there were extracted 9 pine tree cores around the INPP which were separated to 410 tree ring samples (time span 1980-2017) to determine the overall increase of radiocarbon concentration in NPP surroundings as compare to 3 tree cores from background rural area at Vaikšteniai. Paired tree core samples, taken at the unidirectional sampling sites (located to the south direction from INPP at the 1.8 and 5.1 km, to the west direction at the 2.6 and 4 km, and to the north-east direction at 1.9 and 6.6 km), were examined in details by considering meteorological data records from the Ignalina NPP local meteorological station (2004-2015) in order to trace atmospheric dilution effectiveness of ^{14}C released from the 150 m height INPP ventilation stacks.

Samples were physically and chemically (BABAB) prepared [2], graphitized with AGE-3 (IonPlus AG) coupled with elemental analyzer (Vario Isotope Select, Elementar, GmbH) [3] and measured at Vilnius Radiocarbon SSAMS (NEC, USA) facility [4].

The results showed pronounced increase of ^{14}C up to 17.8 pMC in the tree rings during INPP exploitation as well during decommission periods. Year-by-year tree rings ^{14}C concentration data analysis of unidirectional samples revealed high variation of the atmospheric dilution conditions, which resulted in average about 30% variation of dilution effectiveness peaking up to about 300% for some years. This database of local radiocarbon activity variations could be used to reconstruct a history of unknown events in Ignalina NPP.

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