

Verification of Uniformity of Cell Shielding in SFA Disassembling Division of Annex to SNF Storage Facility at Kurskaya NPP

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Introduction

Experts of Sosny R&D Company and the Kurskaya NPP verified the conformity of the shielding of the SFA disassembling division of the annex to the SNF storage facility, i.e. the walls, ceiling, doors, slide gates, inspection windows and holes of the shielded cell, with the project requirements. The work was aimed at revealing and eliminating all possible defects before the cell commissioning in order to reduce external exposure to the personnel.

The shielded cell of the annex to the SNF storage facility is intended for disassembling the RBMK-1000 spent fuel assemblies (SFAs) into two fuel rod bundles and loading these bundles into ampoules and casks for further storage.

Primary radiation tests of the shielding were performed from February 24, 2013 to April 27, 2013 every day from 6 p.m. till 6 a.m. in accordance with the working program approved by the chief engineer for the Kurskaya NPP. The test results proved conformity of the shielding to the project requirements. Also, the input data required for development of an additional shielding in the poorly protected premises were prepared.

Basing on the input data provided, the Volgograd Design Office of Atomenergoproekt and the Central Design Bureau for Machine Building developed the additional shielding that was manufactured and mounted by Energoteks.

The radiation tests of the shielding were repeated on May 20-22, 2013 in compliance with a test program. During the tests of the shielding, no other activities were being performed in the annex to SNF storage facility.

Before getting work permits, the personnel were instructed on their actions in case of the equipment failure and deviations of process parameters, as well as labor and radiation safety. The target training was recorded in the Training Logbook. The tests were conducted with adherence to the basic rules and regulations for radiation safety, namely:

- Radiation Safety Norms (NRB-99/2009) [1];
- Main Sanitary Regulations for Radiation Safety (OSPORB-99/2010) [2];
- Sanitary Rules for Design and Operation of Nuclear Power Plants (SP AS-03) [3], and

Instruction "Radiation Safety During Operation and Repair of Equipment at Kurskaya NPP".

Scope of Work

Compliance of the cell shielding with design requirements was verified with a GIK-7-4 radionuclide source containing ^{60}Co radionuclide with an activity of 1700 Ci [4].

The verification principle consisted in comparison of design and measured EDR on the external surface of the shielding induced by gamma emission.

The source activity for the radiation tests was pre-substantiated with account taken for the design wall thickness, i.e. the cell shielding (1000 – 1100 mm of concrete with a density of 2.4 g/cm^3) and doors (300 mm of steel). The activity of the source ensured the EDR on the external surface of the shielding that could be registered with an admissible error and the minimum exposure of the personnel involved in the radiation tests.

Master-slave and boom-mounted manipulators were used to reload the source from the KTIB-250-12 shielded cask [5] into a special canister.

During the shield testing, the source-containing canister was moved all over the shielded cell that had been divided into squares 1 m on side in accordance with a specially developed diagram (Fig.1). Each square was numerated (1–132, Fig.1). Coordinates x , y and z of the source locations were set during preliminary calibration of the boom-mounted manipulators.

The external surface of the shielding walls adjacent to the shielded cell was squared in the same way and all squares were given the same numbers as those in the shielded cell (see the diagram in Fig.2). The distant walls were divided into squares 1 m on side and numbered, too.

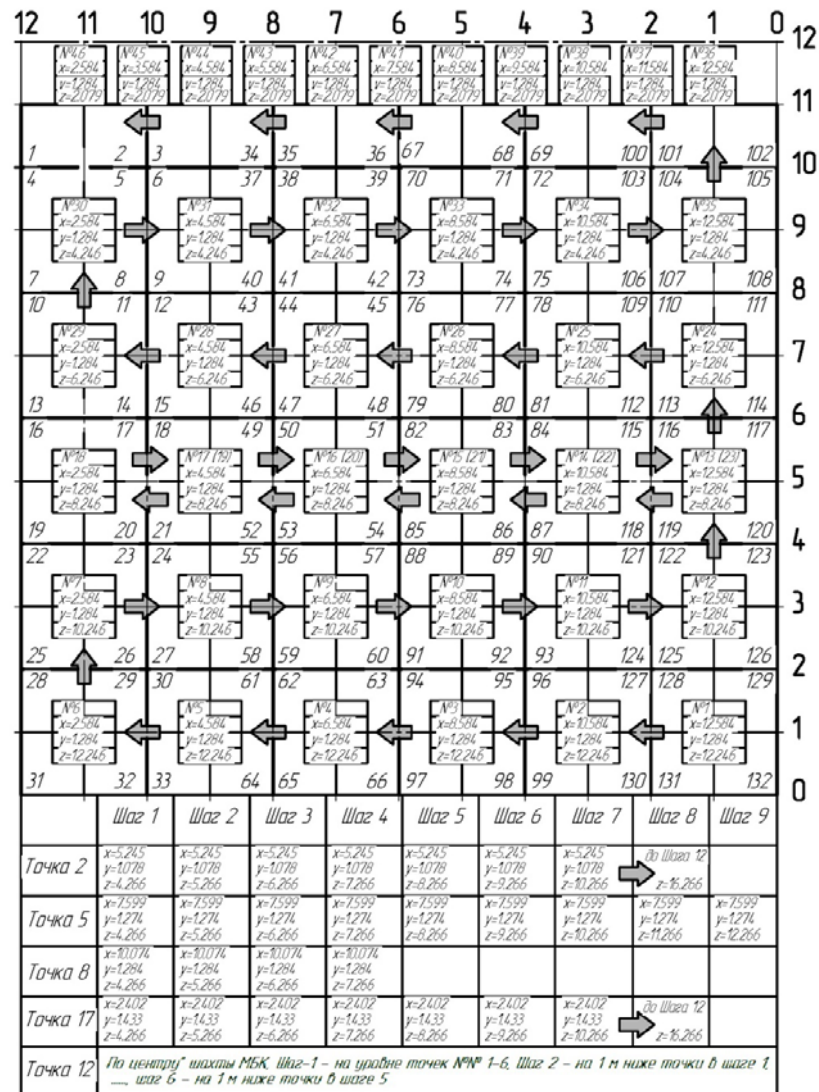


Fig. 1. Diagram of locations of canister containing the GIK-7-4 source in the shielded cell during the radiation tests of the shielding at elevations from +12.050 to +32.040

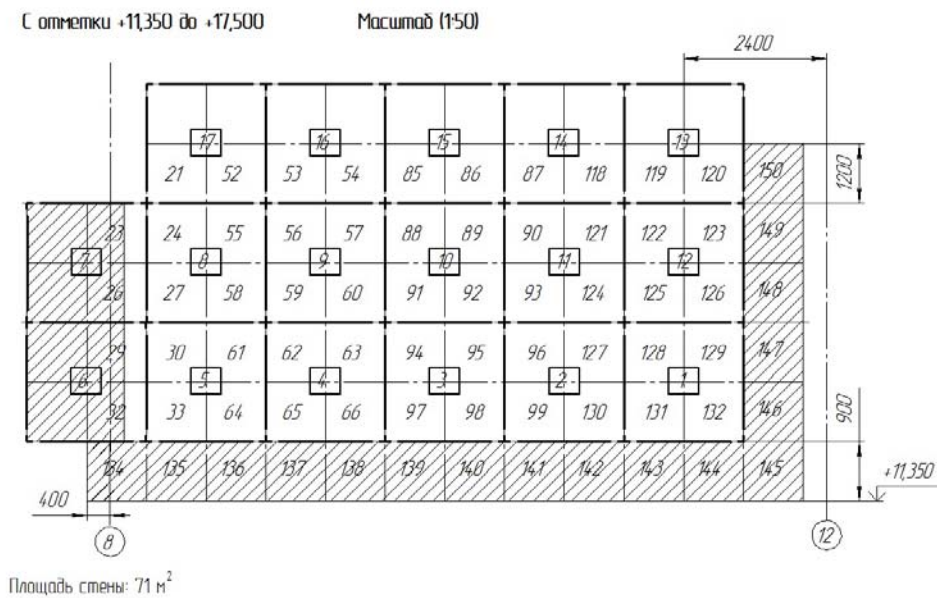


Fig.2. Diagram of Room 432 - Control Room 1 (9-12 – axis E, Д-Е – axis 9)

Thus, the distance to the points on the external surface of the shielding in the square intersections in compliance with the mapping and preliminary calculated committed EDR of gamma radiation were known for any location of the in the shielded cell. The gamma EDR was calculated using the Microshield 8.02 software.

The radiation tests of the shielding of the shielded cell of SFA disassembling division in the annex to the SNF storage facility were performed in 28 rooms. For the primary tests of the shielding at elevations from +12.050 to +32.040, the source-containing canister was placed in the plane of the cell axis in points 1–46 (Fig. 1). For the primary tests of the shielding at elevations from 0.000 to +12.050, the source-containing canister was lowered into channels upright (points 2, 5, 8, 12 and 17, Fig. 3). Position STEP 1 of the source was similar to its location at a height of 1 m above the cell floor over points 2, 5, 8, 12 and 17 (Fig. 3). The source-containing canister was moved from STEP 1 position to STEP 2, STEP 3 ... STEP 9 positions at an interval of 1 m.

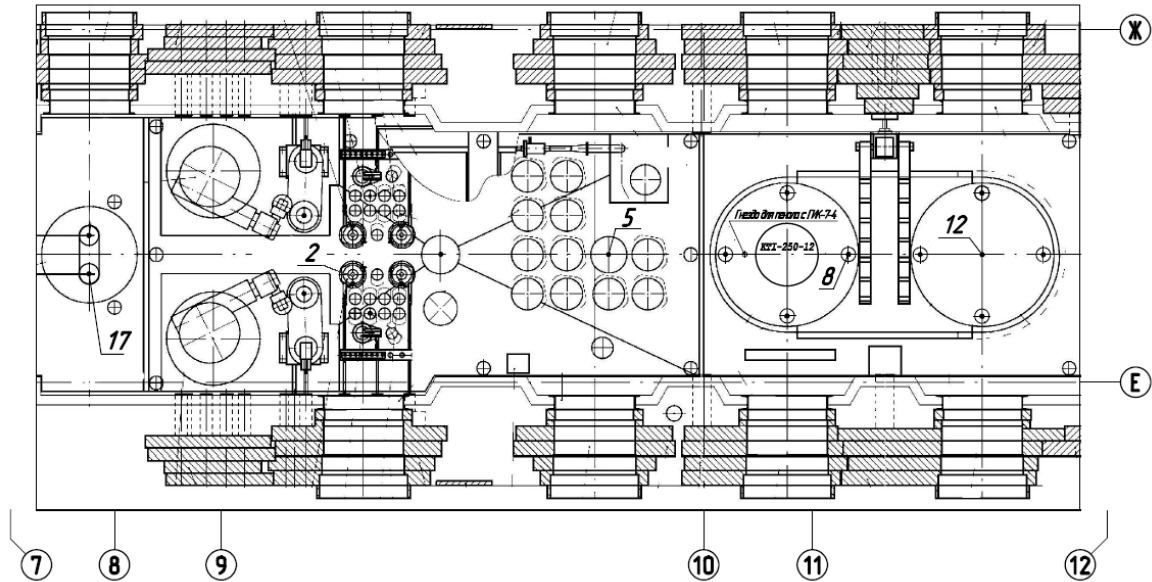


Fig. 3. Channels for moving the canister containing the GIK-7-4 source during the primary radiation tests of the shielding from the elevation of ± 0.000 to +12.050 (control points 17, 2, 5, 8 and 12)

The gamma EDR (a measurement range from 0.1 $\mu\text{Sv/h}$ to 10 Sv/h) was measured with MKS KP-AD-6 dosimeters with sensors on a telescopic rod with the maximum length of 4.25 m. All measurements were performed on the external surface of the shielding, in particular, symmetrically about the source location, in the corners of the squares on the walls of the adjacent rooms (each square is 1 m on side) and, in some cases, in the center of specified squares.

Three radiation-measuring teams participated the radiation tests. The communication between the management, radiation-measuring teams and operators who moved the source in the shielded casks was arranged through walkie-talkies.

Results of radiation tests of shielding

According to the results of the radiation tests of the cell shielding in the annex to the SNF storage facility at the Kursk NPP, the design and measured EDR values are almost the same and verify compliance of the shielding with the project requirements.

The measured EDR were revealed to exceed the design one in some regions of the surface in the main hall of the SNF storage facility (Room 319), maintenance room (Room 343), transfer cell (Room 344), control room 3 (Room 347), control rooms 1 and 2 (in the niches for the drive of the mechanism for removing/installing the filter cover and near the holes for the slave manipulators).

The results obtained for Rooms 319, 343 and 347 and control rooms 1 and 2 were submitted to the Volgograd Design Office of Atomenergoproekt for the development of additional shielding. The results of the radiation tests for Room 344 were submitted to the Central Design Bureau for Machine Building, Saint-Petersburg.

After the additional shielding was fabricated and installed and the radiation tests were repeated, it was recommended to start the pilot operation of the SFA disassembling division of the annex to the SNF storage facility without any additional radiation tests with encapsulated gamma sources. A necessity to thickening the shielding in Room 319 and Room 347 was noted.

The radiation measurements made during cutting of the first SFA in the shielded cell on July 21-22, 2013 demonstrated that the gamma EDR in the rooms adjacent to the shielded cell complied with the design values. Thus, the radiation tests and subsequent remedial measures are qualitative.

The individual personnel doses received during the primary and repeated radiation tests of the cell shielding of the annex to the SNF storage facility at the Kurskaya NPP do not exceed 20 μ Sv.

References

1 Radiation Safety Norms (NRB-99/2009). SanPin 2.6.1.2523-09. – To replace NRB-99: approved by the Ministry of Health of the RF on July 7, 2009. enforced on September 1, 2009 - M., 2009 – 61 pages.

2 Main Sanitary Regulations for Radiation Safety (OSPORB-99-2010). SP 2.6.1.2612-10: approved by the Chief Sanitary Doctor of the RF. – M., 2010.

3 Sanitary Rules for Design and Operation of Nuclear Power Plants (SP AS-03), Sanitary Rules and Hygienic Standards, Sanpin 2.6.1.24-03.

4 Sealed Gamma Radiation Source with Radionuclide Cobalt – 60 of GIK type. Passport PS 45.T.GIK-7/SE./ Mayak Production Association.

5 Transport packaging YKTIB-250-12. Operating Manual 45.T.YKTIB-250-12 PЭ with modification 1./ Mayak Production Association.