RADIOACTIVE WASTE MANAGEMENT DURING DECOMMISSIONING OF RESEARCH BUILDING "B" AT JSC "VNIINM" SITE

Kuznetsov A. Yu.[1], Belousov S. V.[2], Khlebnikov S. V.[2], Bocharov K. G.[3]

[1]ROSATOM SGIC, Moscow, Russia,

[2]JSC "VNIINM", Moscow, Russia,

[3]State Corporation "Rosatom", Moscow, Russia

Article received on December 4, 2019

The paper focuses on the radioactive waste management system that has been put in place to support the decommissioning of building "B". Based on the diversification of financial sources for decommissioning and their breakdown by contract implementation timeline, three organizational and engineering flowcharts suggested for radioactive waste transfer to a specialized organization were specified. The paper presents operational flowchart for the radioactive waste treatment unit located in the building "B", as well as the list of equipment involved in its operation. The basic equipment involved is as follows: equipment for RW compaction and decontamination, equipment of local gas cleaning systems, industrial vacuum cleaners, logistics support equipment (freight elevators, platforms, loaders), equipment for RW characterization CANBERRA Inspector-2000, as well as transport packages used to ship the waste to specialized organizations (Krad-3.0, KMZ, KMZ-RADON, PU-2EC-SH, PU-2EC-ST), soft packages of "big-bag" type. A total of 22,771.5 tons of waste were generated during decommissioning. Radioactive waste amounted only to some 3.4% of the total amount of waste. The costs associated with the transfer of radioactive waste to specialized organizations accounted for some 32% of the actual project budget. The cost of hull B decommissioning was reduced significantly due to a decrease both in the amount of radioactive waste and the cost associated with radioactive waste receipt by applying competitive procurement procedures. The paper argues that during decommissioning, waste contaminated with man-made radionuclides that cannot be categorized neither as radioactive waste nor as materials that can be used unrestrictedly are inevitably generated. The paper stresses that the safe management of such waste should be ensured. The decommissioning experience gained at the site of building "B" showed that the unconditional safety of operations and radioactive waste management, in particular, can be ensured by an active stance of the operating organization.

Keywords: *radioactive waste, decommissioning, radioactive contaminated equipment, decontamination, compaction, specific activity.*

Decommissioning of nuclear facilities (NF) is seen as an integral part of their life cycle. Under Federal Target Programs Nuclear and Radiation Safety in 2008—2015 (FTP NRS-1) and Nuclear and Radiation Safety in 2016—2030 (FTP NRS-2), considerable attention has been paid to addressing the challenges associated with the decommissioning of shutdown nuclear power plants and the management of resulting radioactive waste (RW) [1—3].

Some of NPPs that were shut down in the past are located at the territory of large settlements. For historical reasons, key nuclear research centers were also located in cities. One of the research clusters was established as early as in the late 1940s on the territory currently belonging to the Schukino municipality of the Moscow North-Western administrative district involving the Kurchatov Institute, VNIINM and the Institute of Biophysics. At present time, these sites are surrounded by dense residential areas. Organizations responsible for the operation of VNIINM and SIC Kurchatov Institute are implementing systematic efforts aimed at the elimination of the shutdown radioactively contaminated facilities [4—11].

VNIINM's research building B was one of such facilities. It was built in 1945 to perform experiments with nuclear materials and radioactive substances. As a result, part of its equipment, installations and engineering systems was contaminated by radioactive substances. The building was a standalone four-six-story structure having a footprint of 2,407 m^2 with a total floor space of 7,469 m^2 [9].

Figure 1. Research building B

The developed decommissioning designs provided for three decommissioning stages:

1) pre-decommissioning stage (implemented in 2013) — refurbishment of a sanitary inspection room, arrangement of units for radioactive and industrial waste management, installation of additional systems: radiation safety control; physical protection; fire alarm; ventilation system at each floor;

2) the main stage (implemented in 2013—2014) — removal of industrial waste, chemical reagents, decontamination and dismantlement of process equipment and pipelines, dismantlement of engineering systems, decontamination of building structures, experts' statement on the radiation state of building structures. The largest amounts of RW were supposed to be generated at this stage;

3) the final stage (implemented in 2015) — dismantlement of building structures and the foundation, remediation of site area. The largest inventory of industrial waste (building structures) and radioactive waste was generated at the final stage.

The following types of RW were expected to be generated during the decommissioning activities:

- contaminated process and other equipment;
- liquid and solid radioactive waste (LRW and SRW) stored in fume hoods and boxes;
- filtering elements of ventilation and gas purification systems;
- elements and fragments of communications (pipelines, ducts);
- fragments of contaminated building structures (metal, reinforced concrete);
- contaminated construction waste (bricks, plaster, glass, wood);
- contaminated soil;
- SRW resulting from the decontamination of equipment, vehicles and premises (rags, tools, etc.);
- overalls and personal protective equipment;
- polymeric materials used for SRW management purposes.

A total of 4,849.8 m^3 of RW was expected to be generated according to the decommissioning designs (Table 1). This estimate was based on the comprehensive engineering and radiation survey of the building (KIRO).

Table 1. Waste amounts categorized as RW

RW types	RW volume, m^3
Process equipment and utilities	931.7
Chemicals	90
Furniture	6.6
Building structures, including	
bricks	250
metal structures	3.1
reinforced concrete structures	150
concrete structures	100
wooden structures	300
sludge	380
sand	73.5
soil	500
cement screed	150
plaster	265
plastic compound	81
Total of construction RW	
In solid state	2,252.6
In loosen state	3,686.3
Rags, PPE, overalls, decontamination mats	101.4
LRW	30
Secondary LRW	3.8
LRW total amount	4,849.8

Radioactive waste management arrangements

Decommissioning of the research building B was indicated in the provisions of the Federal Target Program NRS-1; relevant operations were funded from two sources: the federal budget and the funds of special reserve Fund No. 3 (SRF No. 3) of the State

Corporation Rosatom. Such a breakdown proved to be effective, nevertheless, requiring the development of individual communication flowcharts between the customer (State Corporation Rosatom), state contractors (Kvant LLC, FSUE RADON) and the operating organization (JSC VNIINM).

The RW is owned by the operating organization (VNIINM). During the decommissioning, three communication flowcharts covering RW management issues were implemented. The first one under the execution of SRF No. 3 contracts with JSC VNIINM acting as a customer, a specialized organization acting as radioactive waste management contractor selected on a competitive basis. To enable radioactive waste shipments, bilateral RW acceptance and transfer certificates and passports were issued.

The second flowchart was implemented during the execution of a state contract between the State Atomic Energy Corporation Rosatom and LLC Kvant. To enable the transfer of the generated RW, a tripartite agreement was concluded with the following interested parties: JSC VNIINM (RW owner), State Corporation Rosatom (customer) and specialized organization LLC Kvant (contractor). A tripartite RW acceptance and transfer certificate and passports for RW packaging were issued.

The third flowchart was put in place during the execution of a state contract between the State Atomic Energy Corporation Rosatom and the Federal State Unitary Enterprise Radon. The RW resulted from LLC Kvant operations was handed over to JSC VNIINM. To enable RW transfer from JSC VNIINM to FSUE RADON, a bilateral RW acceptance and transfer certificate and a passport for RW packaging was issued in accordance with the approved procedure implemented to remove the waste from JSC VNIINM site and to ship it to the site of a specialized organization for temporary storage purposes.

The following documents have been developed to ensure RW accounting and control, as well as to measure its radiation characteristics:

- Guidelines on the Management of Radioactive Waste Generated from the Decommissioning of VNIINM Building B (OUK RAO-1-2013);
- Guidelines on Measuring Radiation Characteristics of Radioactive Waste Generated from the Decommissioning of VNIINM Building B (OUK RAO-2-2014).

Dismantlement of bulky equipment to enable the establishment of a RW management site

One of the tasks to be accomplished under the building B pre-decommissioning stage was the dismantlement and removal of bulky equipment located in the premises of a large radiochemical unit (LRU). A total of 26 units of equipment were dismantled, including two 8 m^3 containers and 4 units of long-length capacitive equipment of a column-type (equipment height 4.2—6.4 m) [12]. Bulky capacitive equipment was contaminated with long-lived α-emitting nuclides (^{235}U, ^{238}U, ^{239}Pu) [13]. The internal surfaces of the equipment were decontaminated with foamy solutions. This method enabled a significant reduction in the volume of decontamination LRW given a decontamination coefficient ranging from 25 to 70. These measures reduced RW activity (the waste was recategorized from the original RW Class 3 to RW Class 4) according to the content of transuranic radionuclides governing the waste activity.

Complete decontamination of the capacitive equipment, namely of its inner surfaces, could not be achieved under the work environment available inside the B building; therefore, to prevent secondary contamination, no in-situ equipment fragmentation was performed. Dismantled equipment was handed over to FSUE RosRAO. External surface of capacitive equipment was coated by a containment polymer composition during its removal followed by a dosimetric control. Only dismantled equipment containing no unfixed contaminants was accepted to be loaded into PU-2ETs-ST transportation container, which was transported along purpose-designed transport routes to the container (Figure 2).

A total of 17.5 m^3 of bulky equipment was fragmented by the specialized organization. These operations were performed at FSUE Radon site. The managerial and engineering solution implemented to manage large-sized capacitive equipment provided operational safety and enabled to reduce the costs.

Waste management unit for RW generated from B building decommissioning

A radioactive waste management unit was set up in the vacated LRU premises inside the B building. A specific feature of the unit provided for the use of process equipment enabling the decontamination of contaminated metal waste and RW compaction (fragmentation and compaction equipment). Decision on the use of such equipment by the designer was made due to the fact that it was considered practically impossible to demonstrate the safety of deep RW processing methods application at a site located within the boundaries of the Moscow city. The second reason suggested that it was economically unfeasible to provide additional in-situ processing of the generated waste volumes.

To set up a RW management unit, the developed designs provided for the arrangement of a few

Figure 2. Removal of bulky equipment from B building:
a — applying a containment coating, b — equipment transportation, c — external surfaces of the equipment subjected to control examination, d — equipment loading into a transport container

openings in the walls of the building, a transportation system (hoisting mechanisms) designed to move the waste from the upper floors of the building and equipment installation.

The RW management unit included the following sections:

- waste acceptance section for waste streams delivered from the upper floors by a lift and from the first floor — by freight trolleys;
- section for waste segregation, fragmentation, compaction, primary waste packaging;
- liquid decontamination section (ultrasonic bath);
- section for primary package (drums, packed briquettes, individual pieces of equipment, etc.) loading into KRAD 3.0 transport container;
- primary package and container certification section.

The RW management unit was fitted with the following main process equipment:

- waste compacting equipment:
  - press compactor into drums enabling effective compaction of waste into 200 l drums (Figure 3a);
  - scrap metal briquetting machine enabling significant reduction in metal waste volume (Figure 3b). The press was fitted inside a sealed chamber. These operations resulted in the production of (300 ÷ 500) × 600 × 240 mm briquettes;
- decontamination equipment featuring an ultrasonic bath fitted with a system enabling decontamination solution preparation and pumping equipment;
- logistics equipment:
  - freight elevators designed to mechanize the transfer of waste from the 2nd, 3rd, 4th floors of the building;
  - a mini-electric forklift designed to move packages around the RW management site inside the building (Figure 4);
  - cargo platform featuring a transfer trolley with a loading capacity of 10 tons, designed to mechanize the process of SRW container transportation to the certification zone and its further loading into purpose-designed vehicles (Figure 5);

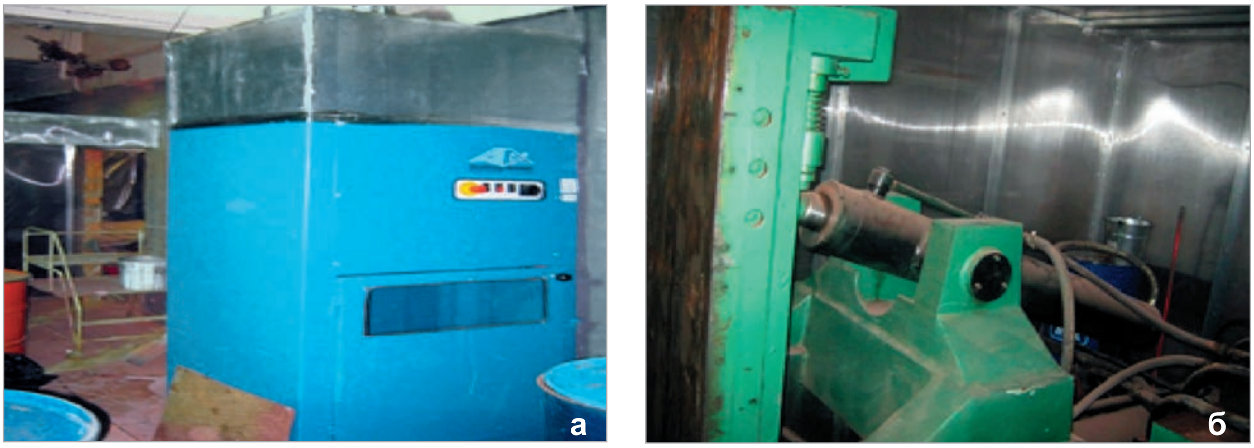

Figure 3. Compaction waste equipment: a — press compactor into drums; b — briquetting machine

Figure 4. RW drums moved by a mini-electric forklift

Figure 5. RW container on a transport trolley

  - a manual hydraulic trolley with a lifting capacity of 1.0 t designed to move waste packages along the areas where dismantlement operations were performed;
  - a forklift loader with a payload of 1.3 t designed to move drums and RW packages under indoor conditions assuming container loading with press briquettes;
  - 3.5 t forklift diesel loader designed to move empty and loaded RW containers outdoors;
- gas purification equipment. Designs of the gaseous effluent removal system fitted at the RW management site suggested that the aerosols before being released into the central ventilation and subsequently fed into gas purification systems were treated using high-performance industrial vacuum cleaners equipped with HEPA filters with a cleaning efficiency of 99.995 % and appropriate devices enabling safe unloading of the extracted waste into RW packages (Figure 6);
- equipment for RW characterization. To identify the radiation characteristics of the waste, a multichannel gamma spectrometer was used to measure x-ray and gamma radiation. The equipment also featured relevant software developed for gamma spectra processing.

The flow chart providing for the management of radioactively contaminated materials resulting from research building B decommissioning was described in detail within the decommissioning designs developed by JSC RAOPROEKT that passed all necessary examinations and approvals. Dismantled radioactively contaminated process equipment, engineering and process utilities, after being subject to in-situ decontamination, were fragmented so that the resulting overall dimensions of the fragments would not exceed 1000 × 750 mm. The fragments were wrapped into plastic film, the tails of which were fastened with tape. Then the items were loaded into container trolleys and manual lifting trucks and then moved from the premises along the corridor to the freight elevator enabling their transportation from the 2nd, 3rd and 4th floor to the 1st floor where the RW management unit was located.

Small radioactively contaminated elements of equipment, utilities, scraps, paper, wood, cleaning

Figure 6. Industrial vacuum cleaners

materials, construction waste, as well as the waste generated during the decontamination of premises, were segregated, wrapped with plastic film, packed into drums that were further transported by purpose-designed trolley carts from the premises to the RW management unit.

At the RW management unit, metal waste was handed over to the briquetting machine equipped with a lock chamber. SRW requiring pressing was sent to the vertical press compactor, where it was pressed into 200-liter metal barrels. Non-metallic waste in trolley containers considered as not suitable for pressing was packaged into similar drums.

Waste compaction equipment produced 200-liter drums containing pressed waste and briquettes produced by the baler.

Following the application of the fixing agent, the briquettes were wrapped in several layers of film, transported by a mini-electric forklift to the transfer table-platform, where they were further loaded into a transport container mounted by the second mini-electric forklift on a cargo platform. Similar transportation flow chart was followed in case of 200-liter drums.

Upon completing the container loading, its radiation monitoring and subsequent decontamination was performed, if necessary. Then, using a cargo platform on rails, SRW container was moved to another premise, where it was certified. After certification and relevant paperwork, the transport container installed on a cargo platform was sent to the outdoor platform, where it was further loaded into special vehicles using a truck crane.

KRAD-3.0, KMZ, KMZ-RADON, PU-2ETs-SKh, PU-2ETs-ST containers, "big-bag" type soft bags were used as packing kits enabling waste transportation to specialized organizations.

RW generated from research building B decommissioning

A total of 22,771.5 tons of waste were generated during research building B decommissioning. Table 2 presents the breakdown of the waste generated by categories.

Table 2. Breakdown of generated decommissioning waste by categories

Waste category	Amount	
	tons	%
RW	777.5	3.4
Waste materials with radionuclide contamination not assigned to RW category	127	0.6
Waste of Hazard Class I -IV (expired chemicals)	27.013	0.1
Construction waste (waste of Hazard Class V)	21,840	95.9

Most of the waste accounted for the construction waste being free from radioactive contamination mainly generated from the dismantlement of building structures. Radioactively contaminated waste accounted for approximately 4% from the total mass of all waste generated during the decommissioning.

A total of 1,603.2 m^3 of RW with a total activity of $7.76 \cdot 10^{10}$ Bq resulted from the research building B decommissioning, which is lower than the expected amounts predicted at the KIRO stage and stated under the decommissioning designs. The following measures enabled such an effective reduction of RW volumes:

- modern decontamination methods resulting in small amounts of secondary waste generation (dry decontamination methods);
- industrial vacuum cleaners widely used for dust removal purposes during building B decommissioning [14];
- careful segregation of the generated waste. This method has proved to be effective in terms of waste volume reduction only at certain labor costs. These costs were commonly not accounted for in relevant cost estimate documentation, nevertheless, identification of optimal segregation costs contributed to some financial benefits both for the decommissioning contractors and for the state customer, since proper segregation of waste offered a significant decrease in RW amounts;
- modern methods used to measure radiation characteristics of the waste. This task is considered as a quite challenging one with the possible ways of addressing it discussed in detail in [15]. Thus, thorough certification of the RW from building B and exclusion of some construction waste amounts from regulatory control became possible through the use of highly sensitive gamma spectrometers, collection of representative waste samples for laboratory research and measurement purposes, development and application of modern methods enabling the identification of difficult-to-detect radionuclides.

Such thorough measurements of radiation characteristics had its flip side as well, namely, resulting in the inevitable generation of waste contaminated with radionuclides, which could be attributed neither to radioactive waste nor to unrestricted-use waste, i. e. materials contaminated with man-made radionuclides. The management of such waste is currently regulated by provisions presented in section 3.11 of OSPORB 99/2010.

In 2015, some amounts of materials contaminated with man-made radionuclides (VLLW), not belonging to the RW category, were generated during B-building decommissioning. However, it was only in 2018, that the waste was shipped away from the VNIINM site with all necessary safety measures implemented.

Heated discussions are currently taking place around the management of such waste. The authors of [1] note obvious incompleteness of the legal framework in addressing this group of radioactively contaminated waste, seriously hindering its management. [3] emphasized on the need of allocating such waste into a separate class, establishing a particular disposal tariff and arranging for appropriate waste disposal facilities. The authors' statement [3] suggesting that the operating organizations should avoid VLLW generation seems to be unfeasible with respect to many cases, since from the financial perspective it's feasible to deactivate the waste only to a certain level often corresponding to the generation of materials contaminated with man-made radionuclides (VLLW). Accumulation of such waste at the sites and their safe storage would require some additional costs, nevertheless, providing only a temporary solution to the problem. Therefore, the challenge associated with VLLW storage and relevant disposal tariff setup is believed to be a most urgent one.

[16] discusses a possible way allowing to address this issue: the waste can be used during DF RW closure operations, as well as conservation of SRW storage facilities. Such an approach would require a very careful legislative study with some adjustments introduced to the storage facility's designs and provisions of licenses issued to operating organizations.

Another way proposed to address the challenge of VLLW management provides for their categorization as hazardous waste of the corresponding hazard class. Thus, FSUE RosRAO has identified and classified 12 types of waste assigned to the IV hazard class excluded from the regulation under provisions of Federal Law No. 190 On Radioactive Waste Management and relevant by-laws:

- 8 waste types contaminated with man-made radionuclides resulted from NPP decommissioning;
- 4 waste types contaminated with natural radionuclides resulted from equipment cleanup at nuclear fuel and power facilities.

Figure 7 presents the breakdown of radioactive waste resulted from decommissioning by years of its handover to specialized organizations.

As mentioned above, practical efforts on building B decommissioning were implemented by two organizations — JSC VNIINM and LLC Kvant. Figure 8 presents the resulted RW inventory.

Great amount of work on the decommissioning of research building B was performed by LLC Kvant. Its activities resulted in some 85 % of the total

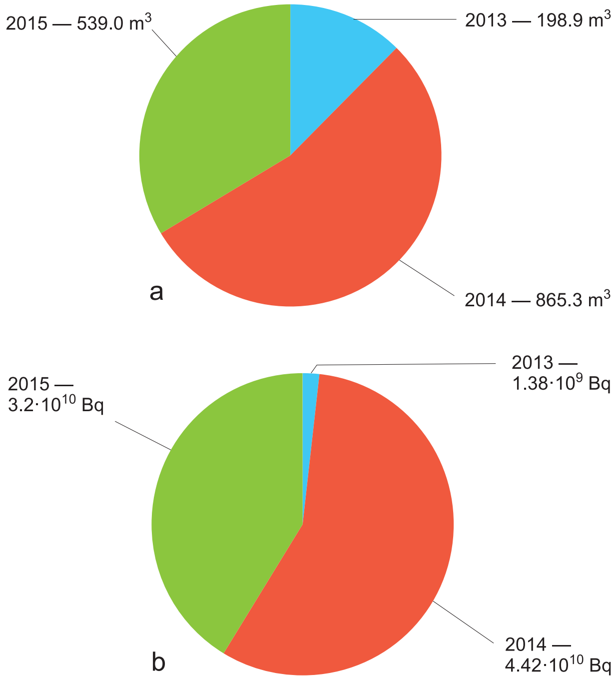

Figure 7. Waste shipments to specialized RW organization sites by years (a — by waste volume, b — by waste activity)

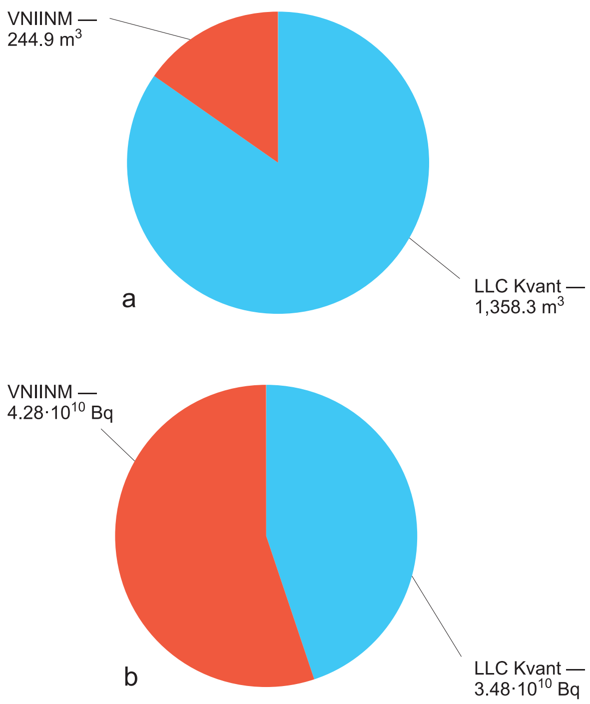

Figure 8. Radioactive waste generated by the executors of operations on building B decommissioning: (a — RW volumes, b — RW activity)

generated RW amounts. Owning to the availability of highly qualified units dealing with nuclear decommissioning and radioactive waste management within the VNIINM structure, the task of managing the most active RW inventory generated during building B decommissioning has been successfully addressed. Practical experience gained during these operations has shown that operating organizations involved in the decommissioning operations are able and should implement most hazardous operations in terms of the radiation risks involved, which provides an important contribution to safety.

Conclusion

Under the successfully completed project on the decommissioning of VNIINM's research building B, a set of managerial and engineering solutions enabling safe and effective RW management within the city limits was developed and practically tested.

The project lasted three years with relevant operations being performed under state contracts financed from the federal budget, as well as contracts financed from the Special Decommissioning Fund No. 3 of the State Atomic Energy Corporation Rosatom. The variety of funding sources has prompted the development of managerial and engineering flowcharts providing the interaction between different parties of the project engaged in the decommissioning and specialized organizations responsible for RW management. Each flowchart was implemented under the regulatory framework currently being in force.

Only 3.4 % of the total amount of waste resulted from building B decommissioning did accounted for RW. RW costs associated with its transfer to the sites of specialized organizations amounted to approximately 32 % of the actual project budget. Building B decommissioning costs were reduced significantly by reducing the RW inventory, as well as by reducing the cost associated with RW acceptance for storage, including the implementation of a competitive procurement process.

Summing up the experience gained during building B decommissioning, it was demonstrated that a decrease in nuclear decommissioning costs is impossible without modern technologies, such as waste compaction, decontamination methods (generating small amounts of secondary waste), modern spectrometric equipment and measurement techniques for quick and accurate waste characterization.

Building B decommissioning has shown that the top-priority task of providing the unconditional safety of RW management and decommissioning activities can be, in particular, ensured by an active stance of operating organizations during work execution providing for the safety of relevant operations.

References

1. Abalkina I. L., Linge I. I. Osobennosti obrashcheniya s RAO ot vyvoda iz ekspluatacii [Peculiarities of decommissioning waste management]. *Radioaktivnye othody — Radioactive Waste,* 2018, no. 3 (4), pp. 6—15.

2. Bocharov K. G., Mikheev S. V., Vedernikova M. V. Perspektivy rabot po nakoplennym RAO v organizaciyah Toplivnoj kompanii AO "TVEL" [Prospects of work on the accumulated RW in the organizations of the Fuel company JSC "TVEL"]. *Radioaktivnye othody — Radioactive Waste,* 2017, no. 1, pp. 87—94.

3. Abramov A. A., Dorofeev A. N., Deryabin S. A. Razvitie EGS RAO v ramkah rabot po federal'noj celevoj programme obespecheniya yadernoj i radiacionnoj bezopasnosti [Development of USS RW in the Framework of Federal Targeted Program of Nuclear and Radiation Safety Assurance]. *Radioaktivnye othody — Radioactive Waste,* 2019, no. 1 (6), pp. 8—24.

4. Ponomarev-Stepnoi N. N., Volkov V. G., Gorodetsky G. G., Zverkov Y. A., Ivanov O. P., Koltyshev S. M., Lemus A. V., Semenov S. G., Stepanov V. E., Chesnokov A. V., Shisha A. D. Izvlechenie radioaktivnyh othodov i likvidaciya staryh hranilishch v RNC "Kurchatovskij institute" [Extraction of radioactive wastes and liquidation of old repositories at the Russian Science Center Kurchatov Institute]. *Atomnaya energiya — Atomic Energy,* 2007, vol. 103, no. 2, pp. 647—652.

5. Velikhov E. P., Ponomarev-Stepnoi N. N., Volkov V. G., Gorodetskii G. G., Zverkov Yu. A., Ivanov O. P., Koltyshev S. M., Muzrukova V. D., Semenov S. G., Stepanov V. E., Chesnokov A. V., Shisha A. D. Reabilitaciya radioaktivno zagryaznennyh ob"ektov i territorii RNC "Kurchatovskij institute" [Rehabilitation of the radioactively contaminated objects and territory of the Russian Science Center Kurchatov Institute]. *Atomnaya energiya — Atomic Energy,* 2007, vol. 102, no. 5, pp. 375—381.

6. Volkov V. G., Zverkov Yu. A., Kolyadin V. I., Lemus A. V., Muzrukova V. D., Pavlenko V. I., Semenov S. G., Fadin S. Yu., Shisha A. D. Podgotovka k vyvodu iz ekspluatacii issledovatel'skogo reaktora MR v RNC "Kurchatovskij institute" [Preparations for decommissioning the MR research reactor at the Russian Science Center Kurchatov institute]. *Atomnaya energiya — Atomic Energy,* 2008, vol. 104, no. 5, pp. 335—341.

7. Danilovich A. S., Pavlenko V. I., Potapov V. N., Semenov S. G., Chesnokov A. V., Shisha A. D. Tekhnologii obrashcheniya s RAO pri vyvode iz ekspluatacii issledovatel'skih reaktorov MR i RFT [Technologies of radwaste management at a decommissioning of the MR and RFT research reactors]. *Radioaktivnye othody — Radioactive Waste,* 2018, no. 2 (3), pp. 63—72.

8. Evstigneev V. P., Gazin R. Kh., Semenov S. G., Chesnokov A. V., Shisha A. D. Obrashchenie s otrabotavshim yadernym toplivom issledovatel'skih reaktorov v NIC "Kurchatovskij institute" [Spent Fuel Management of Research Reactors in the NRC "Kurchatov Institute"]. *Atomnaya energiya — Atomic Energy,* 2019, vol. 126, no. 2, pp. 92—98.

9. Kuznetsov A. Yu., Belousov S. V., Savin S. K., Komarov E. A., Udalaya M. V., Sobko A. A. Osnovnye rezul'taty vyvoda iz ekspluatacii issledovatel'skogo korpusa B AO "VNIINM" [Main Results of the Decommissioning of the Research Building B of JSC "VNIINM"]. *Atomnaya energiya — Atomic Energy,* 2017, vol. 123, no. 4, pp. 210—216.

10. Kuznetsov A. Yu., Belousov S. V., Azovskov M. E., Efremov A. E., Khlebnikov S. V. Podgotovka k vyvodu iz ekspluatacii kompleksa zdanij ustanovki U-5 AO "VNIINM" [Decommissioning Complex of Buildings U-5 Research Facility JSC "VNIINM"]. *Atomnaya energiya — Atomic Energy,* 2018, vol. 125, no. 4, pp. 222—227.

11. Kuznetsov A. Yu., Antsiferova E. Yu., Belousov S. V., Vereshchagin I. I. Khlebnikov S. V. Reabilitaciya zdaniya 53 AO "VNIINM" [Rehabilitation of the building 53 JSC "VNIINM"]. *Atomnaya energiya — Atomic Energy,* 2019, vol. 126, no. 3, pp. 167—170.

12. Kuznetsov A. Yu., Azovskov M. E., Belousov S. V., Vereshchagin I. I., Efremov A. E., Khlebnikov S. V. Obrashchenie s krupnogabaritnymi radiacionno-zagryaznennymi emkostyami pri vyvode iz ekspluatacii issledovatel'skogo korpusa "B" AO "VNIINM" [Treatment with large Radiation Contaminated Tanks at the Decommissioning of the Research Building "B" VNIINM]. Izvestiya vuzov. *Yadernaya energetika — Nuclear Energy and Technology,* 2019, no. 1, pp. 107—118.

13. Kuznetsov A. Yu., Belousov S. V., Savin S. K., Azovskov M. E., Khlebnikov S. V., Efremov A. E., Vereshchagin I. I., Shirokov S. S. Issledovanie osadkov i otlozhenij v sistemah special'nyh kommunikacij korpusa B AO "VNIINM" [Investigation of Precipitates and Deposits in the Special Piping in Building B at the Bochvar All-Russia Research Institute for Inorganic Materials]. *Atomnaya energiya — Atomic Energy,* 2016, vol. 120, no. 3, pp. 209—213.

14. Kuznetsov A. Yu., Azovskov M. E., Belousov S. V., Vereshchagin I. I., Efremov A. E., Khlebnikov S. V. Primenenie dezaktivacii vakuumirovaniem pri provedenii rabot po podgotovke i vyvode iz ekspluatacii ob"ektov AO "VNIINM" [The Use of Decontamination with Evacuation During the Work on the Preparation and Decommissioning Objects of JSC "Vniinm"]. *Voprosy atomnoj nauki i tekhniki. Seriya:*

materialovedenie i novye materialy — Issues on Atomic Science and Technology. Series: Materials Science and New Materials, 2017, no. 3 (90), pp. 88—99.

15. Varlakov A. P., Germanov A. V., Sergeichev Y. V., Ivliev M. V. O razrabotke trebovanij k izmereniyam radiacionnyh harakteristik TRO, obrazuyushchihsya pri VE YAROO [On the Development of Requirements for Measurement of Radiation Characteristics of solid radioactive waste generated during decommissioning]. *Radioaktivnye othody — Radioactive Waste,* 2018, no. 4 (5), pp. 76—82.

16. Vedernikova M. V., Ivanov A. Yu., Linge I. I., Samoilov A. A. Optimizaciya obrashcheniya s zagryaznennymi materialami i RAO v predelah promyshlennyh ploshchadok [Optimization the Contaminated Materials and Radioactive Waste Management within Industrial Sites]. *Radioaktivnye othody — Radioactive Waste,* 2019, no. 2 (7), pp. 6—17.

Information about the authors

Kuznetsov Anrey Yuryevich, PhD, Head of information and analytical Department, “Rosatom SGIC” (26, 2, Staromonetny lane, Moscow, 119180, Russia), e-mail: A_Quznetsov@mail.ru, andyurkuznetsov@rosatom.ru.

Belousov Sergey Vyacheslavovich, Deputy Director, Department of decommissioning — head of Department of technology of decontamination, JSC “VNIINM” (5a, Rogova St., Moscow, 123060, Russia), e-mail: SVBelousov@bochvar.ru.

Khlebnikov Sergey Vladimirovich, Engineer-technologist of the 1-st category of decontamination technologies Department, JSC “VNIINM” (5a, Rogova St., Moscow, 123060, Russia), e-mail: SVKhlebnikov@bochvar.ru.

Bocharov Kirill Gennadyevich, Deputy inspector General, State Corporation “Rosatom” (24, Bolshaya Ordynka St., Moscow, 119017, Russia), e-mail: KGeBocharov@rosatom.ru.

Bibliographic description

Kuznetsov A. Yu, Belousov S. V., Khlebnikov S. V., Bocharov K. G. Radioactive Waste Management During Decommissioning of Research Building “B” at JSC “VNIINM” Site. *Radioactive Waste,* 2020, no. 1 (10), pp. 73—84. (In Russian). DOI: 10.25283/2587-9707-2020-1-73-84.