

**THE FIRST STAGE OF LIQUIDATION OF TEMPORARY RADWASTE REPOSITORIES AND
REHABILITATION OF THE RADWASTE DISPOSAL SITE
AT THE RUSSIAN RESEARCH CENTER "KURCHATOV INSTITUTE"**

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ABSTRACT

The paper presents basic results of the first stage of implementing the "Rehabilitation" Project at the Russian Research Center "Kurchatov Institute" (RRC KI) located in the city of Moscow. This Project was developed with the aim of conducting activities on cleaning-up contaminated areas and liquidation of old radwaste repositories found at the RRC KI Site. These old radwaste repositories were built at the RRC KI Site in 1943-1974 when the Institute was closely involved in research and other efforts under programs on development of nuclear weapons and formation of nuclear power in the former USSR. The old radwaste repositories were for the most part filled with low- and intermediate-level waste, however, high level waste was also placed in these repositories in minor amounts. At the first stage of the "Rehabilitation" Project implementation in 2002-2003, there were fulfilled tasks pertaining to organization and assurance of radiation and environmental safety when conducting the rehabilitation activities. This stage also included activities on comprehensive survey of the old repositories, which allowed refining geometric boundaries of their locations, their design features and characteristics of radwaste contained therein. The same stage involved development of technical solutions on liquidation of those of the old repositories from which radwaste can be easily withdrawn, and commencement of the work on liquidation of these repositories. The work performed resulted in significant reduction in the amount of old radwaste found at the RRC KI Site. A number of old repositories that had been in service for over thirty years and thus presented a potential hazard to the environment were liquidated. Currently the work is underway on liquidation of "accessible" old repositories, preparations are being made for liquidation of "not easily accessible" repositories, efficient technologies for cleaning-up contaminated soil and technologies for reducing the radwaste volume are being sought and developed. In view of this, RRC KI is interested in establishment of mutually beneficial cooperation with foreign partners for solution of the problems mentioned above.

INTRODUCTION

Russian Research Center "Kurchatov Institute" (former Kurchatov Institute of Atomic Energy) was established in 1943 for implementation of research theoretical and experimental investigations and designing under the Atomic Project of the former Soviet Union. Initially, Kurchatov Institute gave its exclusive attention to the solution of the nuclear weapon problems. But in 50-th, fundamental and applied investigations aimed on development of nuclear power units of various types and on ensuring their safety were started.

Result of the above activities is storing of radwaste on the Kurchatov Institute Site. At that time the problems of handling radwaste were partially solved with creation of temporary repositories built at a special radwaste disposal site (RWDS) of the Kurchatov Institute territory. Generally, the unconditioned waste with various activity levels had been placed in these temporary repositories.

Due to the Moscow City growth the Kurchatov Institute Site has been surrounded by dwelling zones. The buffer zone of the Kurchatov Institute is limited by the perimeter of its territory, and apartment buildings are actually situated within tens of meters of its boundary including the old repositories of radwaste. This led to the fact that now these old radwaste repositories constitute a potential danger for people and environment.

At the end of 2000 the decision on liquidation of the old radwaste repositories and rehabilitation of the contaminated areas of the Kurchatov Institute territory was made to improve environment conditions and increase level of radiological safety. With this purpose, the "Rehabilitation" Project was developed [1-2]. The paper presents basic results of the work performed in 2002-2003 at the early stage of implementing the "Rehabilitation" Project and describes problems encountered at this stage of the Project implementation.

MAIN PROJECT TASKS AND THE ORDER OF THEIR FULFILLMENT

The "Rehabilitation" Project provides for fulfillment of the following main tasks listed in the projected order of their performance:

- opening of old repositories easily accessible for withdrawal of radwaste, radwaste withdrawal, sorting and packing in accordance with current regulations, dismantling of repository structures, sorting and decontamination of contaminated structures;
- opening of old repositories not easily accessible for withdrawal of radwaste and performance of similar work on radwaste withdrawal, sorting and packing, dismantling of repository structures with due regard to peculiarities of these repositories, sorting and decontamination of contaminated structures;
- collection and cleaning-up of contaminated soil at the RWDS and other contaminated areas within the overall Kurchatov Institute Site;
- rehabilitation of the RWDS territory and other contaminated areas within the overall Kurchatov Institute Site;
- assurance of radiation safety and environment protection when conducting activities under the tasks listed above.

The hardware needed to solve the mentioned tasks along with the process and design solutions were determined in the Project. According to the agreement with Moscow Government and MosNPO "Radon" enterprise management, all the radwaste must be transported to the specialized grounds of the "Radon" enterprise where they shall be conditioned and disposed.

BRIEF DESCRIPTION OF THE KURCHATOV INSTITUTE LOCATION AND OBJECTS FOR REHABILITATION

In 1943 the site in the north-west city suburb near the Cschukino village (Schukino city district now) was situated to build the Kurchatov Institute. Now, the Kurchatov Institute Site includes two areas (the main site of 100 hectares and the secondary one of 4 hectares). The other object of the Kurchatov Institute, so-called “Gas Plant”, is located on the secondary site that is about 1.5-2 km far from the main site and is located on the bank of the Moscow river.

The radwaste disposal site is located in the north-west part of the main Kurchatov Institute Site and adjoins the Institute guarded perimeter dividing the Institute and apartment buildings. Disposition of the old repositories on the RWDS is shown in Fig. 1.

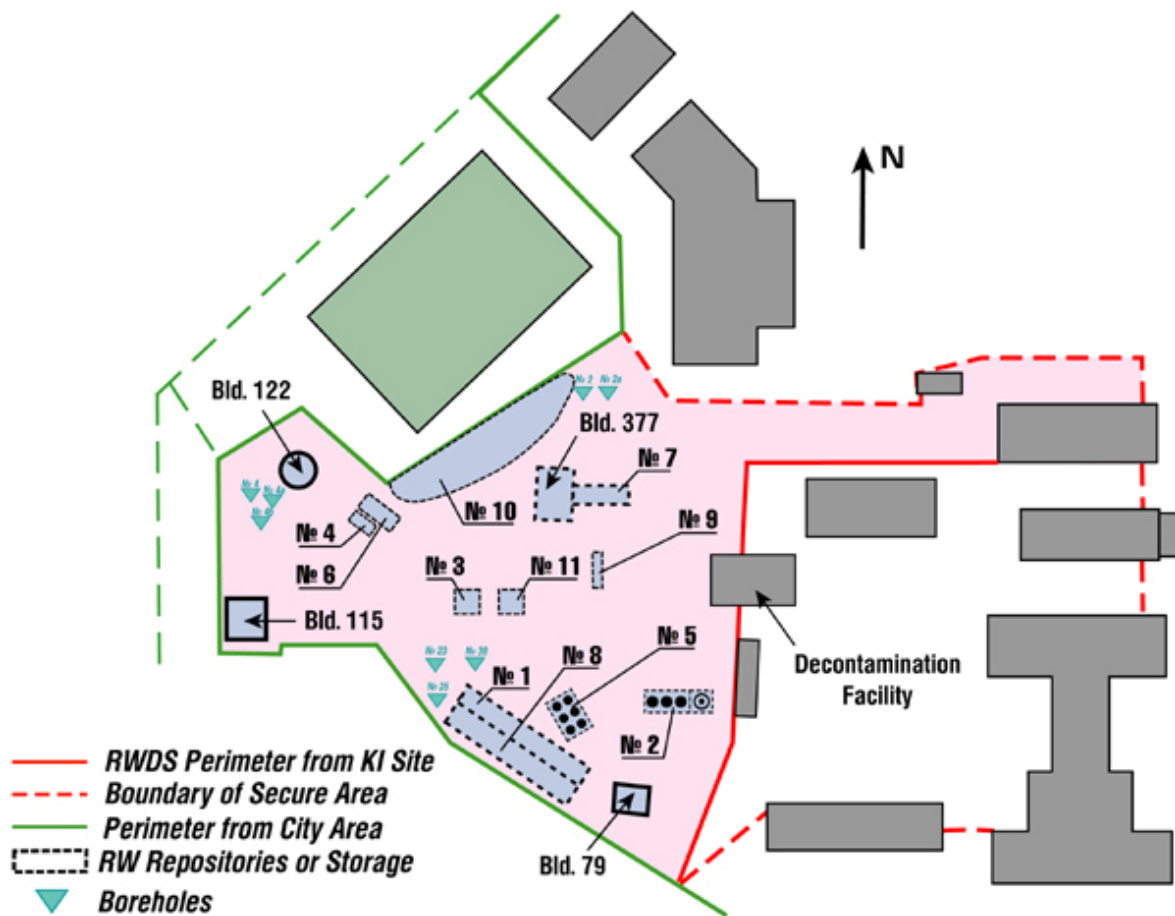


Fig. 1 Arrangement of old repositories at the Kurchatov Institute radwaste disposal site

The main characteristics of the old radwaste repositories and other objects of the Kurchatov Institute being under the “Rehabilitation” Project are given in Table I.

Table I The List and Main Characteristics of Objects under the "Rehabilitation" Project

Object	Characteristic of the Object	RW Rep. Vol. / RW Vol., m ³	RW Activity, kBq
1. Objects at the Radwaste Disposal Site Intended for Rehabilitation:			
RW Rep. #1	The repository consists of two rows of concrete wells with the diameter of 1.5 m and depth of 1.2 m. The number of wells is about 30	160 / 30	1.5×10 ⁸
RW Rep. #2	The repository consists of a steel tank with the diameter of 1.5 m and height 4 m and 3 concrete wells with the outer diameter of 1.1 m and height of about 5.5 m. The tank and wells are buried for their full heights	7.1 / 6.2 (tank) 10.5 / 7 (wells)	2.0×10 ¹⁰
RW Rep. #3	A ground-based concrete repository. The area is 6x6 m and height is 3 m. It has the concrete cover with 5 metal hatches	110 / 80	7.4×10 ¹⁰
RW Rep. #4	The concrete repository buried in the ground. Dimensions of the repository are 18×7×4.5 m. It is divided into three compartments with common concrete ceiling with three hatches	650 / 625	2.2×10 ¹²
RW Rep. #5	The repository consists of six underground concrete wells enclosed with concrete mass; the well diameter is 1.5 m and depth is 4 m	60 / 50	2.0×10 ¹⁰
RW Rep. #6	A trench with trapezium cross section. The cross section dimensions are: 18 m upper base, 7 m bottom base. The depth is 4 m. The walls are made of concrete and bricks. It adjoins repository #4	900 / 600	1.5×10 ¹²
RW Rep. #8	The underground repository with the dimensions of 60×10 m and height of 1.8m. It covered with concrete slabs	1100 / 300	2.0×10 ⁸
RW Rep. #9	Concrete well	24 / 0.5	
RW Rep. #10	Of a trench type (the natural ravine was used as a trench), the depth of radwaste occurrence is 5-6 m	2500 / 300 (radwaste) + 2000 (soil)	
Bld. #122	Inoperative pumping unit located on the RWDS. The well with the diameter of 8 m and depth up to 10 m	520 / 200	
2. Other Objects at the Kurchatov Institute Site Intended for Rehabilitation:			
Sewerage system	Drains and wells		
RW Rep. in Bld. #30	A trench with the dimensions of 2.35×0.9 m and depth of 1.2 m. It is covered with the lead cover with the thickness of 0.1 m	2.5 / 0.8	1.4×10 ³
Outdoor RW Rep. of Bld. #30	A concrete canyon with the dimensions of 5.0×2.0 m and depth of 1.8 m with metal cover	18 / 14.5	2.4×10 ¹
RW Rep. in Bld. #209	Three stainless steel tanks, dimensions of each are 2.9 ×2.0 ×4.95 m, covered with concrete covers.	50 / 20	3.1×10 ⁹
Rw Rep. in Bld. #116	Partially earth chamber with the dimensions of 9.0 ×2.3 ×3.0 m with concrete walls of 1.2 m in thickness and concrete ceiling of 0.8 m.	62 / 31	2.4×10 ⁸
Contaminated soil	The territory of the RWDS and yards of Bld. #30 and Bld. #209		

The exact compositions of radwaste in the old repositories are not known, but according to the archive data and results of radiation survey, such gamma and beta active nuclides as ^{137}Cs , ^{60}Co , and ^{90}Sr are the main contaminating radionuclides.

It can be noted that last summer during performance operations on liquidation of old radwaste repository #3 another radwaste repository was found at the distance of 5 m eastward. No archive data concerning this radwaste repository was found, therefore, its structure and waste composition will be determined by its investigation.

PECULIARITIES OF DEVELOPMENT AND REALIZATION OF THE REABILITATION PROJECT

The choice of technological decisions, methods and means of rehabilitation and handling with radwaste during disposition of old repositories was largely determined by the following peculiarities of the RWDS:

- Location in vicinity to apartment buildings;
- Close vicinity of old repositories to other Kurchatov Institute operating facilities unrelated to the "Rehabilitation" Project;
- Presence of utilities and communications including the city ones and other Kurchatov Institute auxiliary buildings being out of "Rehabilitation" Project.

The mentioned factors required unique engineering decision, using of special means restricting leakage of radioactive aerosol in the atmosphere and limiting gamma doze along the outer boundary of the RWDS during the works. According to the Project the following engineering and technological decisions were specified:

- Performance of old repository opening and radwaste removal under light temporary shelters;
- Using of dust-suppressing compounds and equipment for their application;
- Continuous monitoring of aerosols in the air during the works;
- Continuous monitoring of the gamma-doze in the working zones and along the outer perimeter of the RWDS.

In the development of the earthwork technologies the special attention was given to detection of underground nets and communications available on the RWDS and determination of their lines. Excavation of trenches above 6 m in depth is accentuated by a need to ensure integrity of underground lines.

The works on rehabilitation of the old radwaste repositories were performed under the following technological schedule: radiation survey + exploring drilling + gamma logging of the boreholes⇒ opening of the repository⇒ measuring of radiation conditions⇒ estimation of the radwaste volume activity⇒ determination of the withdrawal method and container type⇒ withdrawal of radwaste + measuring of radwaste volume activity⇒ radwaste withdrawal + dust suppression + measuring of radiation conditions⇒ loading and packing of radwaste⇒ measuring

of radiation characteristics of containers with radwaste and container shipment⇒ liquidation of repository structures⇒ final radiation examination and acceptance of the repository area by the Commission.

A decontamination facility was built at the RWDS for decontamination of vehicles, mechanisms, and dismantled old repository structures. The radiation monitoring included measurement of exposure rate and concentrations of radioactive aerosols at working areas, monitoring of ground water activity at the RWDS and around. During trench filling by soil, the soil was separated by its gamma activity measured in the power shovel bucket.

IMPLEMENTATION STATUS OF THE REABILITATION PROJECT

In 2002 and first half of 2003 the works on exploring drilling and old repository inspections were performed.

The works on exploring drilling and inspections were implemented for old repositories #1, #3, #4, #5, #6, and #10. These works were performed in two stages. At the first stage, the exploring drilling and inspections were performed in boundary zones of the old repositories. The inspections included analyses of earth physical and radiation conditions in these zones. On the basis of the obtained data the positions of old repositories and their geometrical dimensions were determined (or refined). The lithology of enclosing soil, radiation and groundwater conditions, and other characteristics of the repositories and places of their locations were determined too. At the second stage, the boreholes were drilled right within the boundaries of the old repositories with the purpose of investigation of the physical and radiation condition of waste masses in the repositories.

The structure and location of the exploring boreholes were determined by the repository parameters and its radwaste mass. The distances between the boreholes were determined by the lengths of detected anomalies and necessity of detailed exploration of repositories.

Two methods of drilling of exploring boreholes were used. They are auger drilling and core drilling. The auger method was the main and it was used for drilling through fill-up, undisturbed, and soft grounds. The core drilling method was used to drill through hard materials, firstly through the concrete plates. Extraction of core for examination was performed with special device, using of which allows getting of chunk sample.

The exploring drilling procedures accompanied with the set of primary investigations including documenting of the cores, tests of cores, primary gamma logging of the boreholes, measurement of the ground water level, and water sampling. Analyses of the sampled core materials were carried out with gamma-spectrometry and radiochemical methods developed in the Kurchatov Institute.

Such new devices as current and spectrometric collimated detectors for gamma-logging of boreholes by specific activity of radionuclides, exploring video system for examination of closed cavities, combined detector for evaluation of total activity of radwaste were developed and used for investigation of old repositories. During investigation of some old repositories, new

modifications of gamma-locator and gamma-viewer for remote monitoring of gamma-radiation field as well as georadiolocation equipment were also tested.

The works on opening and radiation examination of repository #3 were also implemented to evaluate state and activity of the radwaste mass. The basic outcomes of the works on exploring drilling and investigation of the specified old repositories are:

Repository #1

The repository was constructed as a 50.0×3.0 m trench ranging along repository #8 and adjoining north-west boundary (wall) of this repository. Two parallel rows of the concrete wells 1.2 m in diameter are erected in the trench.

Radwaste are in the wells. The radwaste contained in the space of this repository are classified as low and intermediate-activity waste. The radwaste are represented by unconditioned and partly decomposed materials as wood, fabric, rubber, concrete and brick debris, rubbish, etc. According to the results of the performed gamma logging, the exposure rate is 1-27 $\mu\text{Sv/h}$. In terms of groundwater conditions the area is not filled up with water. In the investigated samples of cores the following radionuclides are detected: ^{90}Sr , ^{137}Cs , ^{60}Co , ^{241}Am , and traces of plutonium isotopes.

Repository #3

The total activity of the waste mass in repository #3 was revised. Inspection of this repository was performed through the hatches of the repository compartments with especially developed and standard radiometric and spectrometric instruments. The performed measurements demonstrated that the main radionuclides contained in the waste are ^{137}Cs and ^{60}Co , and their activities are 73 Ci and 13.5 Ci respectively. The measurements showed up considerable non-uniformity of activity over the repository.

Repository #4 and Repository #6

Disposition and geometrical dimensions of these repositories mainly agree with data contained in the archival documents. Repositories #4 and #6 adjoin each other. The radwaste in repository #4 are contained in the cement matrix. The top of the repository is covered with concrete slabs and cement topping with the total thickness of about 1 m. Over a lifetime of repository #4, the cement matrix was partly damaged that was pointed by cavities disclosed in the process of exploring drilling. The highest values of ^{90}Sr and ^{137}Cs concentrations are observed in the core samples taken in the depth range from 2.5 to 3.6 m. Small metal pieces containing ^{60}Co were observed in the samples taken at the depth of 3.6 m too. The enclosing soil of the boundary zones of repositories #4 and #4 is the loose fill sand with debris, and some parts of the enclosing soil are contaminated.

Repository #5

Five boreholes were drilled within the works on exploring drilling at repository #5. The enclosing soil in the boundary zone of the repository is the loose fill sand with debris. In terms of

underwater conditions the enclosing soil is not filled up with water. All the boreholes passed through the cement mass including radwaste filling internal spaces of repository wells. The depth of the repository wells is about 4 m. The radwaste masses in repository wells consist of such unconditioned waste as metal, wood, fabric, glass, rubber, and other inclusions. Over repository period, there were partial decomposition of the organic component of the waste and partial failure of cement matrix. Performed gamma logging of the boreholes showed that the main radionuclides contained in the waste are: ^{137}Cs , ^{60}Co , and ^{90}Sr . The values of exposure rate are varied in the range from 0.3-1.0 to 600-700 $\mu\text{Sv/h}$.

Repository #10

The exploring boreholes were in the range lines. Eight range lines of the boreholes were drilled. The distances between the boreholes were from 2 to 3-4 m. The exploring boreholes were drilled up to the depth of 7.0 m. Three boreholes were drilled in the trench broaching contaminated soil up to the depth of 3 m from repository surface. The exploring drilling, gamma logging and analysis of the sampled specimens demonstrated that repository enclosing soil is mainly the loose fill sand with debris and industrial and household waste. Soil in the investigated zone is not filled with water up to the depth of 6.0 m and contaminated in the upper layer up to the depth of 1.0 m. In the repository boundary zone the areas with anomalous values of exposure rates were shown up. Cesium-137 is the isotope determining soil contamination. The highest level of soil contamination and its deepest location was fixed in the areas of several boreholes. The depth of contaminated soil is up to 4.0 m and the exposure rate is from 5-10 to 200 $\mu\text{Sv/h}$.

The works on partial withdrawal, sorting, and decontamination of contaminated soil and waste from shown up contaminated places were being implemented when exploring drilling was performed. Soil was excavated with power shovel to the average depth of 0.75-1.0 m. Sorting of the soil in terms of exposure rate was being carried out when excavation was performed. Soil was sorted into 5 groups under the following criteria listed in Table II.

Table II The Criteria of Contaminated Soil Sorting

Groups	Classification	Expose Rate
#1	Clean soil	Less or equal to 3 $\mu\text{Sv/h}$
#2	Contaminated soil	More than 3 $\mu\text{Sv/h}$
#3	Clean soil with concrete inclusions	
#4	Contaminated soil with large amount of inclusions that demands performance works on their picking and removal	
#5	Metal waste including contaminated cables	Equal to or greater than 0.2 $\mu\text{Sv/h}$

The area where the works on soil excavation and decontamination were performed was about 1300 m². The measurements of residual radioactivity of the surface at the decontaminated area demonstrated that it did not exceed the safe level.

RADWASTE WITHDRAWAL AND LIQUIDATION OF OLD REPOSITORIES

In 2002 and 2003 the works on radwaste removal from the “accessible” old repositories were also performed. The sequence of radwaste withdrawal and liquidation of “accessible” old repositories was the following: #9, #8, #1, #5, and #2.

In the process of works on radwaste removal and liquidation of these repositories, the efficiency of used environment protection means, and means ensuring personal safety were examined. Dust-suppressing compounds preventing formation and spread of radioactive aerosols and dust, continuous monitoring of air volume activity, continuous monitoring of radiation conditions, using of additional jacketing of cabs with lead sheets and glass to shield operator in the radwaste reloading procedures were used for these purposes. In addition, radiation conditions over the entire radwaste disposal site were monitored when conducting these works using a gamma-locator (Fig. 2).

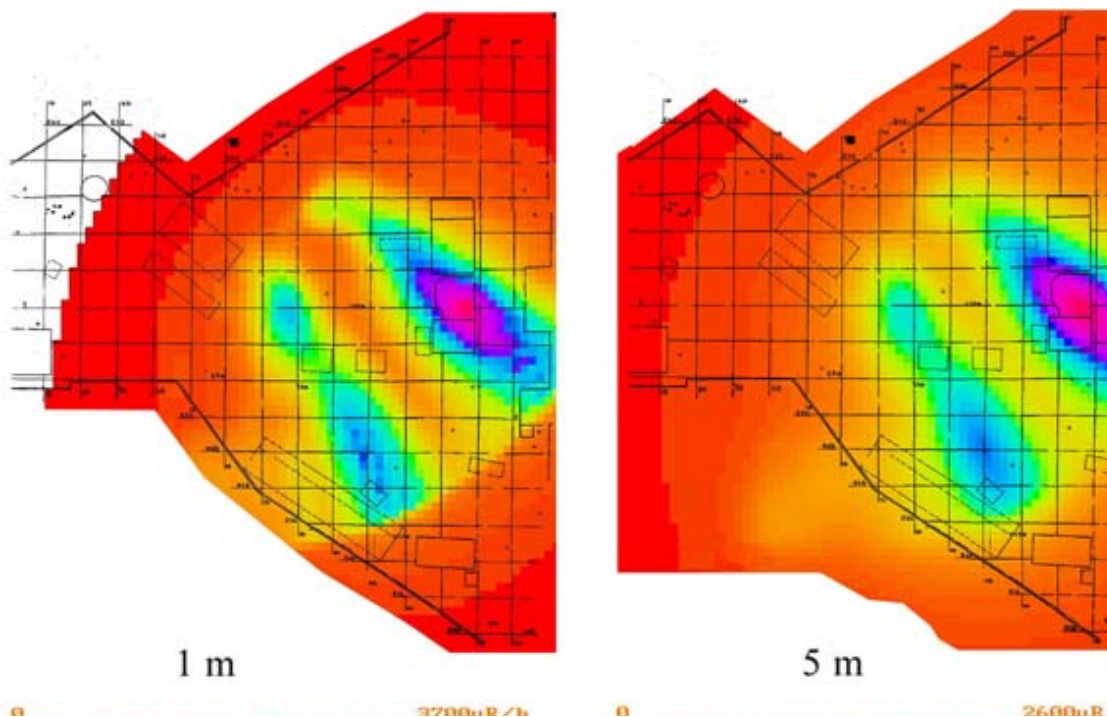


Fig. 2. Distribution of gamma dose rate at an elevation of 1 m and 5 m above the radwaste disposal site obtained with the gamma-locator

The works were conducted using for the most part conventional construction machinery provided with additional means necessitated by specific character of the work being performed. Power shovels equipped with a grab bucket or a back digger were used for radwaste withdrawal (Fig. 3).



Fig. 3. Radwaste withdrawal by construction machinery

The same power shovels but equipped with a hydraulic hammer were used to crush concrete structures. Truck cranes and manual handling devices were also used to withdraw the radwaste. Robotics available at the RF Ministry of Emergency – “Brokk-110” and “Brokk-330” robots produced in Sweden - were tried out when withdrawing high level waste and liquidating one of the old repositories (Fig. 4).



Fig. 4. Radwaste withdrawal by the Sweden robot “Brokk 330”

After radwaste removing the structures of the old repositories were dismantled and the repositories were liquidated. The basic outcomes of these works are:

Liquidation of Repository #9

The steel cylindrical vessel with radwaste of 0.3 m³ in volume was removed from the repository and shipped to the specialized yard of MosNPO "Radon" enterprise. After that the repository structures were dismantled and removed to the special storage area of the RWDS.

Liquidation of Repository #8

The works on radwaste withdrawal from the repository were implemented in two stages – in autumn of 2002 and in spring of 2003. Radwaste withdrawal and their loading in the containers were performed with power shovel. The loaded containers were temporary stored at the especially prepared area of the RWDS. During loading of the waste in the containers they were sorted by the gamma-radiation exposure rate. In the sorting procedure, metal waste with the surface exposure rate of 0.2 μSv/h and above were separated. These radwaste were transported by truck loader to the special area intended for storage of clean scrap. The volume of radwaste removed from the storage was 305 m³. These radwaste were packed in 95 containers (10 containers of 5 m³ in volume and 85 containers of 3 m³ in volume). The manual decontamination of the repository structures was performed after radwaste removal. After the decontamination, the final radiation examination of the repository was carried. It was observed that gamma-radiation exposure rate did not exceed the standard of 3.0 μSv/h approved for the RWDS.

Liquidation of Repository #1

30 concrete wells were opened and cleaned within the works on radwaste removal. The radwaste stored in the wells were packed in 100 liter metal casks containing metal chips, metal tubes, other small-size metal structures, working clothes, and footwear. And then, some of the casks were placed in the repository out of the well concrete rings. To withdraw the radwaste, the concrete rings, where radwaste were placed, were lifted by truck crane one by one and then moved to the RWDS area prepared for temporary storing. The waste that were left on the repository bottom were loaded in the containers by power shovel. The total volume of radwaste removed from the repository and loaded in 48 containers was above 145 m³. The manual decontamination of the repository structures and final radiation examination of the repository were performed. It was observed that gamma-radiation exposure rate does not exceed the standard approved for the RWDS mentioned above.

Liquidation of Repository #5

The works on radwaste removal and liquidation include opening of repository concrete mass, its destroying, crushing of concrete matrix in wells, waste withdrawal from the wells, crushing of concrete rings of which the wells were made, sorting, and removal of concrete debris. The works on soil excavation in the repository opening procedure were performed by the power shovel with grab bucket or back digger. The same power shovel equipped with hydraulic hammer was used to crush concrete. The withdrawal of unconditioned radwaste from the wells was performed with the same power shovel too. It was equipped with grab bucket for this purpose. The radwaste packed in the stainless steel cases were withdrawn with truck crane. All the radwaste were packed in the certified containers. The total volume of radwaste removed from the repository

was above 80 m³. After radwaste withdrawal and removal of concrete debris, the manual cleaning of the repository bottom and final radiation examination of the repository were performed. The radiation examination demonstrated that gamma-radiation exposure rate does not exceed the RWDS approved standard.

Liquidation of Repository #2

In elimination of the repository, the in-situ concrete block of the upper well shielding were crushed with electroblasting method and hydraulic hammer. Then, soil around the wells was removed up to the depth of 5.5 m with the help of power shovel. The radwaste were withdrawn from the wells with the manual manipulator and crane. The concrete rings of which the wells were made, were removed to the RWDS area prepared for temporary debris storing with the truck crane and loader.

The removed radwaste were loaded in the containers or casks of 200-liter volume. The total volume of radwaste removed from the repository wells was about 20 m³ and 5 containers and 5 casks were needed to pack the waste. The earthworks on ramp preparation were implemented near the wells to install the equipment. The needed equipment and tools were prepared to pump liquid radwaste from the metal tank containing liquid and solid radwaste. With the help of this equipment liquid radwaste were pumped from the tank. The volume of liquid radwaste was about 2 m³. Liquid radwaste composition was water-oil emulsion where oil content increased in pumping. The tank with remaining liquid radwaste and solid radwaste was withdrawn and moved to the RWDS area prepared for their temporary storage with specially made equipment and tools. The final radiation examination of the repository demonstrated that gamma-radiation exposure rate does not exceed the RWDS approved standard.

CONCLUSION

Within the described starting stage of the "Rehabilitation" Project the tasks oriented to exploring drilling, radiation examination of boundary zones and radwaste masses of the old repositories along with the opening of "accessible" old repositories, radwaste withdrawal, and their liquidation were solved.

During development and realization of the mentioned Project the insufficiency and uncertainty of source information and archive data about old repository structures, amount and type of radwaste, and their activities took place. The insufficient and defective initial data caused corrections and changes of the technical and technological decisions in the process of realization of Project works. Solutions of the above problems were attained by implementation of large volume of works on exploring drilling, investigation of sampled core materials, and using of such unconventional exploration means and methods. Some new detectors and special equipment were developed, tested and used during investigation of old repositories. That ensures obtainment of reliable information about location of the old repositories, their boundaries, volumes, composition and radwaste activities, along with the information about existence of local areas of contaminated soil.

It should be noted that the volume of works on rehabilitation of the contaminated objects and areas many times exceeded the volume of works on radwaste handling during current operation of the Kurchatov Institute experimental facilities. So, this circumstance forbade realization of the "Rehabilitation" Project with Kurchatov Institute service and science divisions only. Thereby, the independent division – "Rehabilitation" Scientific and Technical Division was created. Successful realization of works in 2002-2003 years proved the rightness of decision about creation of this specialized Division.

Another problem is lack of domestic industrial tested techniques of old repository opening, withdrawal of radwaste, and liquidation of the radwaste repository structures. Manual manipulators, remotely controlled machines and mechanisms operating in gamma fields, and machines controlled directly by operator and having shielding to protect operator against ionizing radiation, and other specialized tools are virtually absent.

The experience of these works demonstrated the expedience of development of light, module, and easy constructed structures as temporary shelters over working areas for location of decontamination places intended for treatment of equipment and vehicles, along with the necessity of development of mobile units intended for mechanized soil decontamination.

It should be noted that a large volume of works was fulfilled with using of the Institute laboratory base. But field conditions of rehabilitation works demand creation of mobile laboratories ensuring performance of proximate spectrometric, radiometric, and radiochemical analyses of waste, soil, and ground water.

As a result of the implemented works the amount of "old" radwaste at the Kurchatov Institute territory was considerably decreased, six old radwaste repositories being in use for more than 30 years and so, constituting a potential danger, were liquidated. The volume of solid radwaste delivered and prepared for delivery to the yard of the MosNPO "Radon" enterprise was above 600 m³. The radwaste were loaded in the certified containers developed by the Kurchatov Institute, packed and processed in accordance with the up-to-date standards.

The standard levels of exposure rate and aerosol concentration at the outer perimeter of the RWDS were not exceeded during these works. The exposure dozes for personnel directly involved in the works with radwaste over all working period did not exceed the standard values, and were:

- in 2002 – average individual doze is 0.95 μSv , and collective dose is 0.050 $\text{man}\times\text{Sv}$;
- in the middle of 2003 – average individual doze is 2.0 μSv , and collective dose is 0.041 $\text{man}\times\text{Sv}$.

Currently the work is underway on liquidation of "accessible" old repositories, preparations are being made for liquidation of "not easily accessible" old repositories, efficient technologies for cleaning-up contaminated soil and technologies for reducing the radwaste volume are being sought and developed. In this connection there is the intention of the Kurchatov Institute to establish mutually beneficial cooperation with foreign partners for solution of the problems mentioned above.

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