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Experience in Decommissioning RBT-10/1 and ARBUS Research Installations

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Decision-making and Implementation Steps



- Decommissioning concept (in agreement with ROSATOM);
- Decommissioning decision (ROSATOM's Order);
- Decommissioning Program (in agreement with ROSATOM);
- Preparations for the NRI decommissioning:
 - Nuclear fuel removal from the NRI site (operation organization);
 - In-depth engineering and radiation safety survey (operation organization);
 - NRI decommissioning program (NRI Chief Designer);
 - NRI decommissioning license (Rostekhnadzor).
- Decommissioning activities (operation organization or a third-party contractor);
- Final engineering and radiation safety survey (operation organization or a third-party contractor);
- NRI deregistration at the Federal Government authorities in the area of nuclear energy use (Rostekhnadzor, FMBA).

Decommissioning of the AST-1 nuclear research installation



AST-1 Nuclear Heat Plant

The AST-1 nuclear research installation with an organic coolant in the primary circuit was designed to justify scientific and technical solutions for creating NPPs and low-power nuclear heat plants for electricity and heat supply to industrial enterprises and residential settlements located in the Far North areas.

Commissioning – August 1963

Output:

as NPP - thermal	- 5 MW;
- electrical	-0.75 MW;
as AST - thermal	- 5 MW

Coolant-moderator – organic liquid - ditholilmethane (C₁₅H₁₆)

Operating pressure - 0.6 MPa

Coolant temperature - 240 °C

Shut down - May 1988

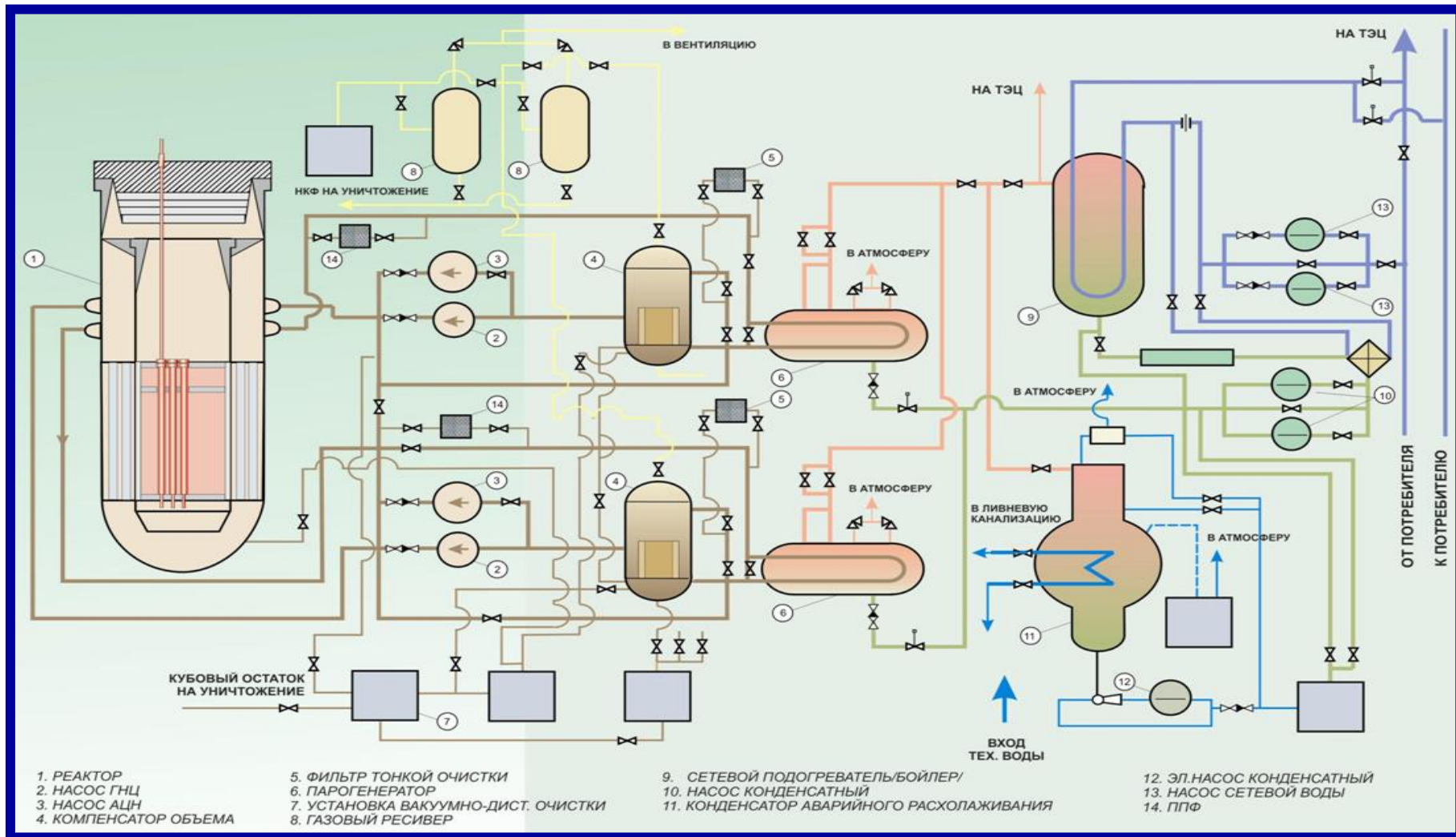
Work Objectives

- Decommissioning of the nuclear research installation as a source of ionizing radiation.
- Disposition of all AST-1 spent nuclear fuel after the 25-year operation (701 spent FAs) from the central storage facility to the MAYAK Production Association equipped with the long-term storage sites.
- Creating in the AST-1 cavity of a storage facility for high-level radioactive waste generated during the AST-1 operation and decommissioning.
- Conversion of the AST-1 building to a high toxic radioactive waste (HTRW) storage site.

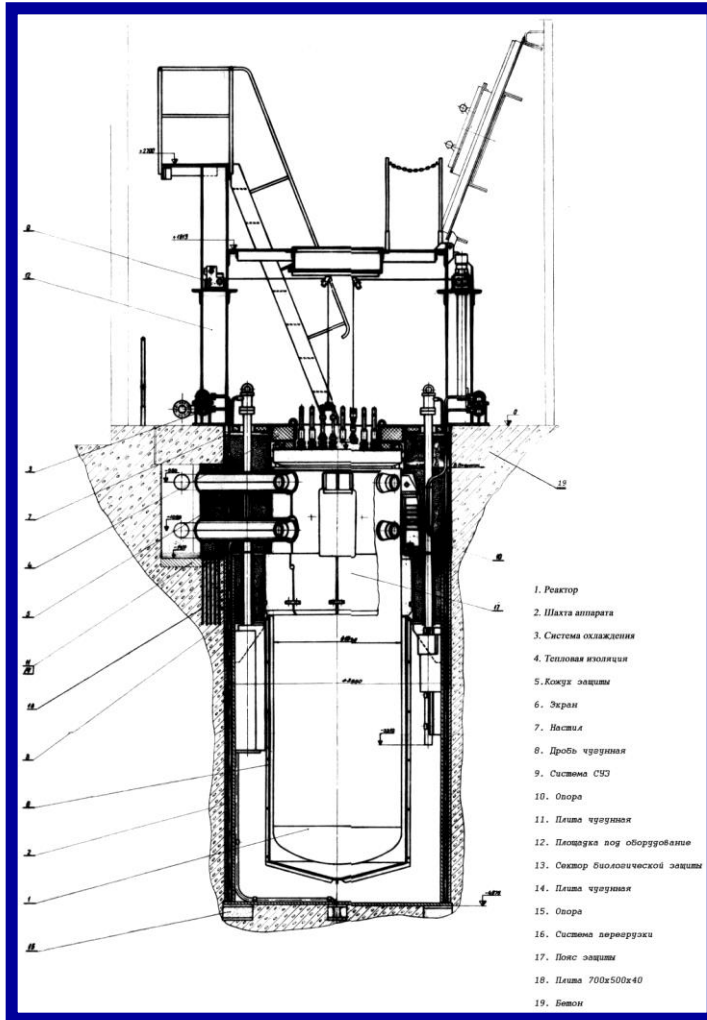
AST-1 Layout



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AST-1 Cavity



In accordance with the ROSATOM's concept on the use of buildings of decommissioned reactors as radioactive waste storages, a high toxic radioactive waste storage was created in the AST-1 cavity.

The HTRW storage design was developed by the design organization ATOMPROEKT (St. Petersburg).

The project was implemented in 2015 by the contracting entity KVANT LLC (Krasnoyarsk).

AST-1 Decommissioning Activities



The main goal of the AST-1 decommissioning is to fully decommission the nuclear facility as a source of radioactive contamination.

The key parameters to measure the progress in meeting the final goals are as follows:

- Complete dismantling and decontamination of the AST-1 equipment and pipelines. Dismantling of metal structures available from the equipment removal. Decontamination and disposal of the generated SRW and LRW.
- Creating in the AST-1 cavity of a storage facility for high-level radioactive waste generated during the AST-1 operation and decommissioning.
- Removal of the AST-1 fuel (701 spent FAs) from the RIAR's spent fuel storage for reprocessing.
- Decontamination and disposal of the primary organic coolant.

The decommissioning activities were started in 2000.

Work Results



As a result of the AST-1 decommissioning activities, the final state of the AST-1 was achieved as prescribed by the AST-1 Decommissioning Concept, the AST-1 Decommissioning Plan and the AST-1 Decommissioning Program:

- The license GN-07-303-3471 of December 27, 2017 was obtained for the radioactive waste management during their storage and processing; the license is valid till December 28, 2027.
- Spent nuclear fuel accumulated over the entire period of the AST-1 operation was shipped to the MAYAK Production Association.
- In-depth engineering and radiation safety survey was carried out at the end of work.
- A Statement for Termination of the Licensed Activity was sent to Rostekhnadzor with the set of documents justifying safe termination of such activities.
- After the inspection carried out by the RIAR's Nuclear and Radiation Safety Inspection Department, the head of Rostekhnadzor made a decision No. 3146/PK of August 15, 2018 on the termination of the AST-1 decommissioning license.
- On 12 October 2018, by the decision of the RIAR JSC Director "On assigning nuclear facilities to a separate category and determining their composition and boundaries", the facility category was changed from "Nuclear installation" to "Radioactive Waste Storage Facility".
- The Certificate of Recognition of the Organization fit for the operation of nuclear facilities and for activities in the field of the use of atomic energy of 21 November 2018, No. GK-S217, was reissued.

Current Status



- The AST-1 nuclear installation was completely decommissioned; its operation cannot be resumed.
- The work on the installation of the HTRW storage facility in building 131 was completed.
- The HTRW storage radiation dose on the employees, population and environment during normal and abnormal operation does not exceed radiation dose levels for personnel and population and complies with standards for emissions, discharges and content of radioactive substances in the environment.
- The area around building 131 was completely rehabilitated and there is no radioactive contamination with β - emitting radionuclides.
- The HTRW storage facilities were assigned to the Complex for Radioactive Waste Management for further operation.

Decommissioning Activities. Photo Report: Before and After



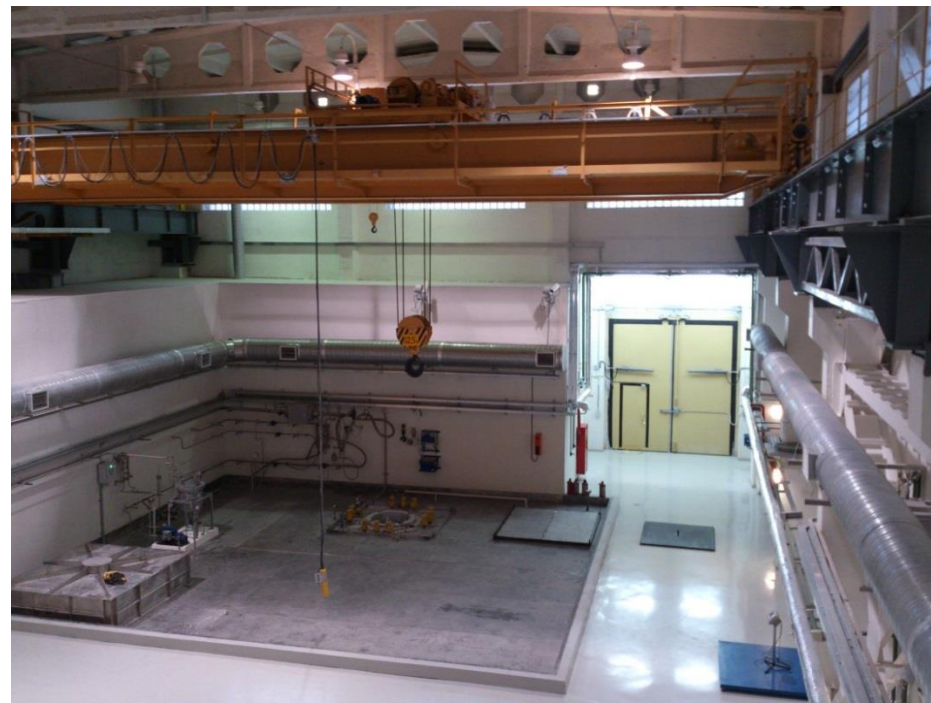
Decommissioning Activities. Photo Report: Before and After



Decommissioning Activities. Photo Report: Before and After



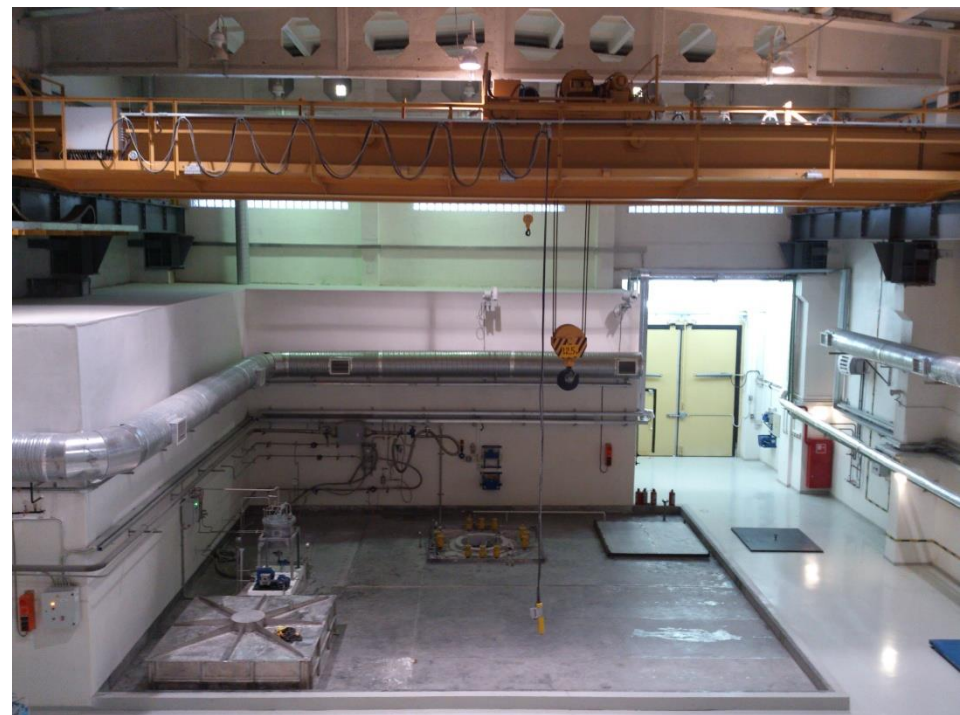
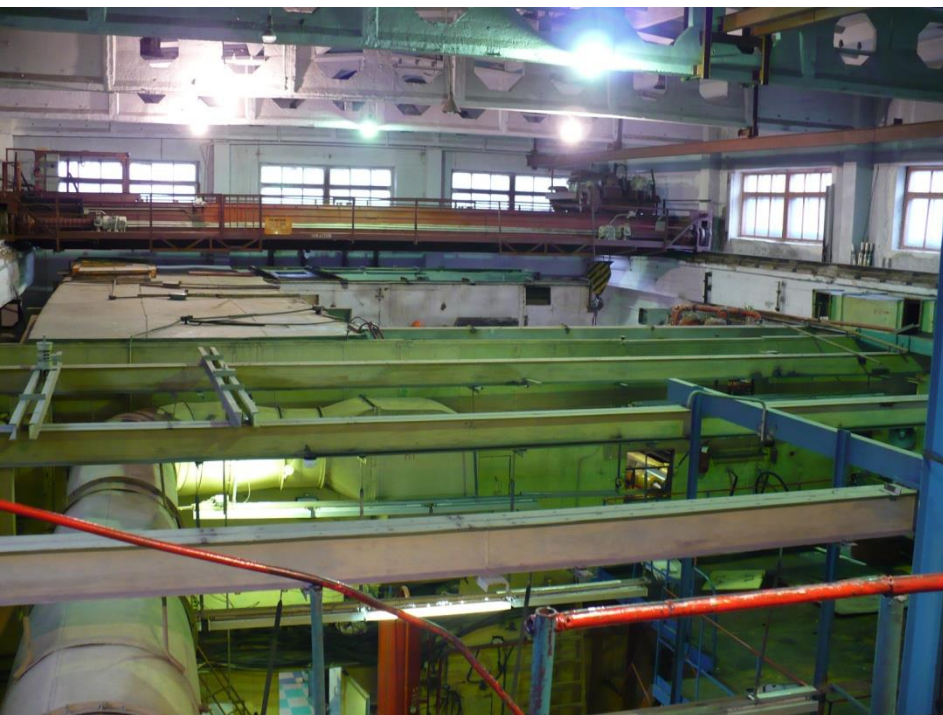
Decommissioning Activities. Photo Report: Before and After



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Decommissioning Activities. Photo Report: Before and After



Decommissioning Activities. Photo Report: Before and After



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Decommissioning Activities. Photo Report: Before and After



Decommissioning activities photo report: before and after



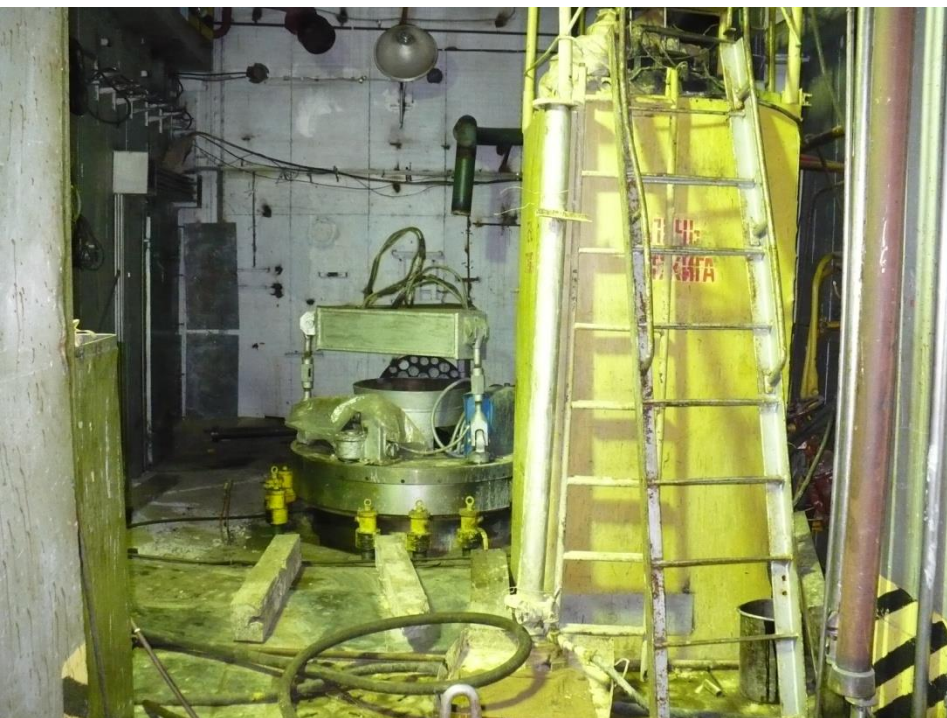
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Decommissioning activities photo report: before and after



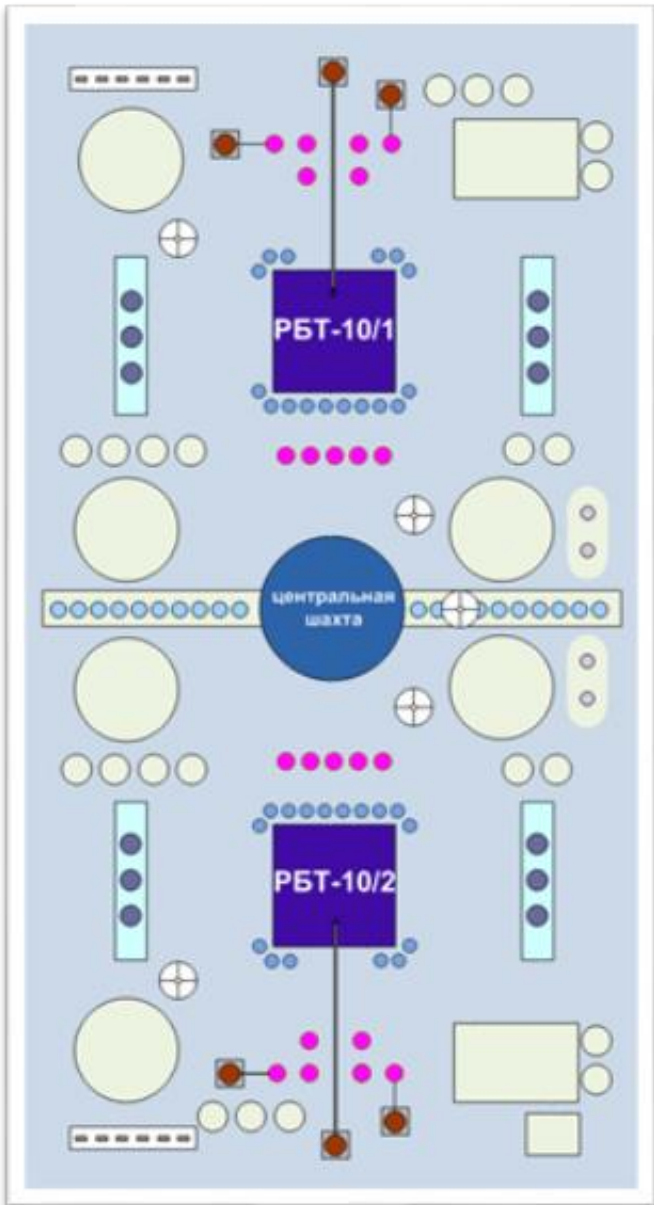
Decommissioning Activities. Photo Report: Before and After



Decommissioning of the RBT-10/1 Nuclear Research Installation



RBT-10 Reactor

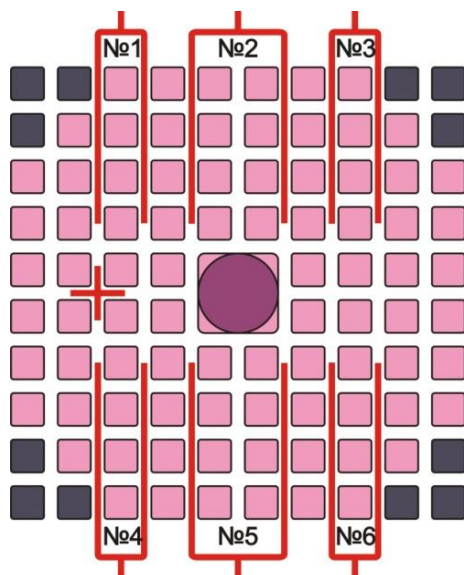


The RBT-10 research reactor complex consists of two thermal neutron pool-type water-cooled reactors similar in design, RBT-10/1 and RBT-10/2, which operate on spent fuel assemblies of the high-flux reactor SM-3.

The RBT-10/1 reactor was put into operation in 1984.

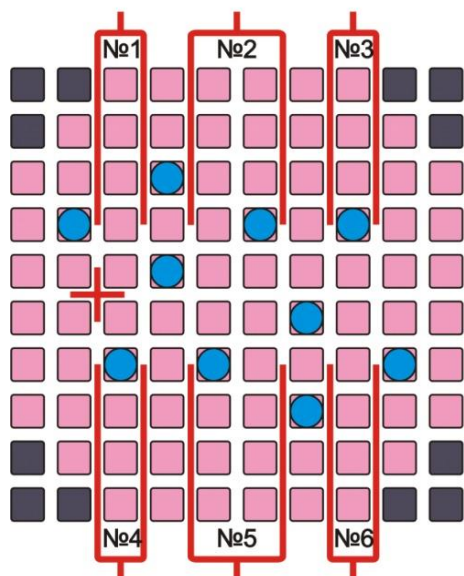
The RBT-10/2 reactor was put into operation in 1985.

RBT-10 Reactor



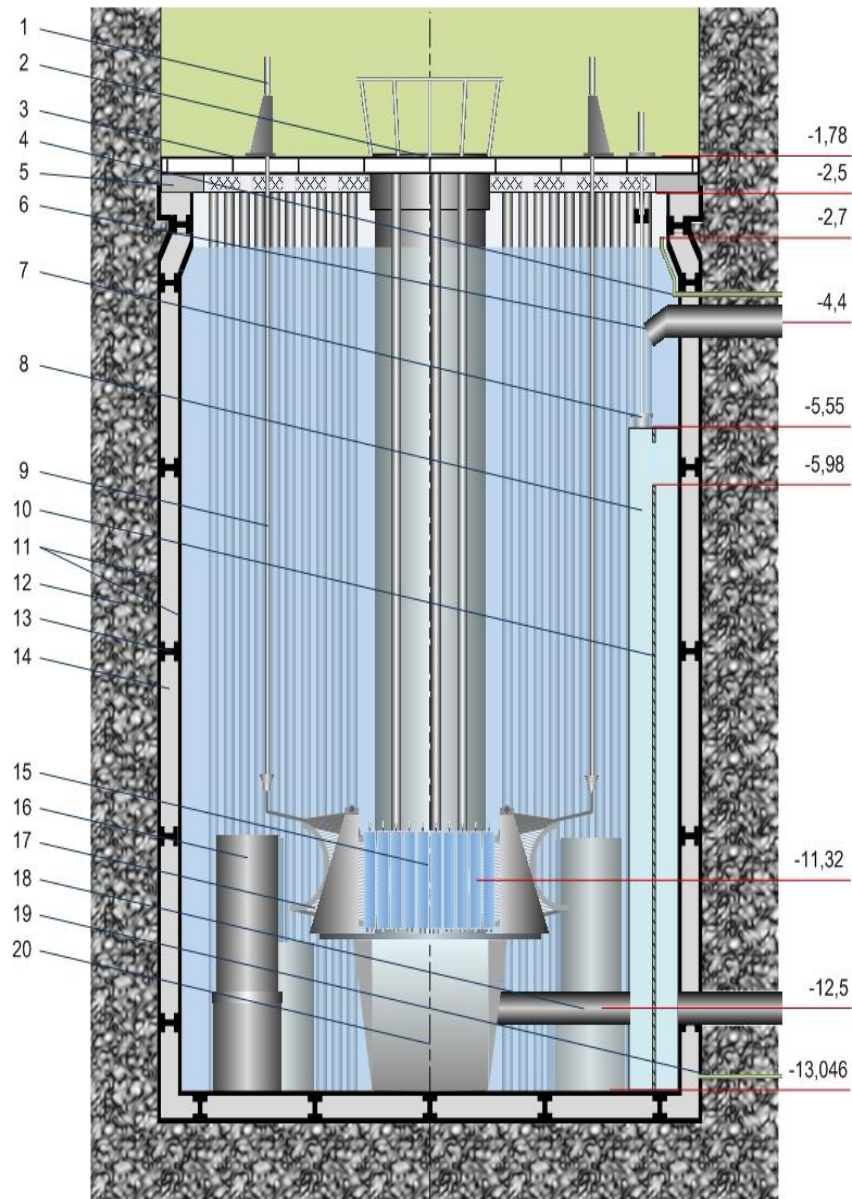
The reactor design provides for two options for using the RBT-10/1 reactor: the first option is with an experimental loop channel installed in to the core, the second one is with ampoule channels in the core.

The RBT-10/1 reactor was operated according to the first option from 1984 to 1988. Upon completion of the tests in February 1988, it was shut down to dismantle the loop facility and to rearrange the core according to the second option.



In 1989, after the core rearrangement, the reactor equipped with the new core achieved criticality after which the reactor was put into a long-term shutdown mode due to the lack of the RBT-10/1 Use Program.

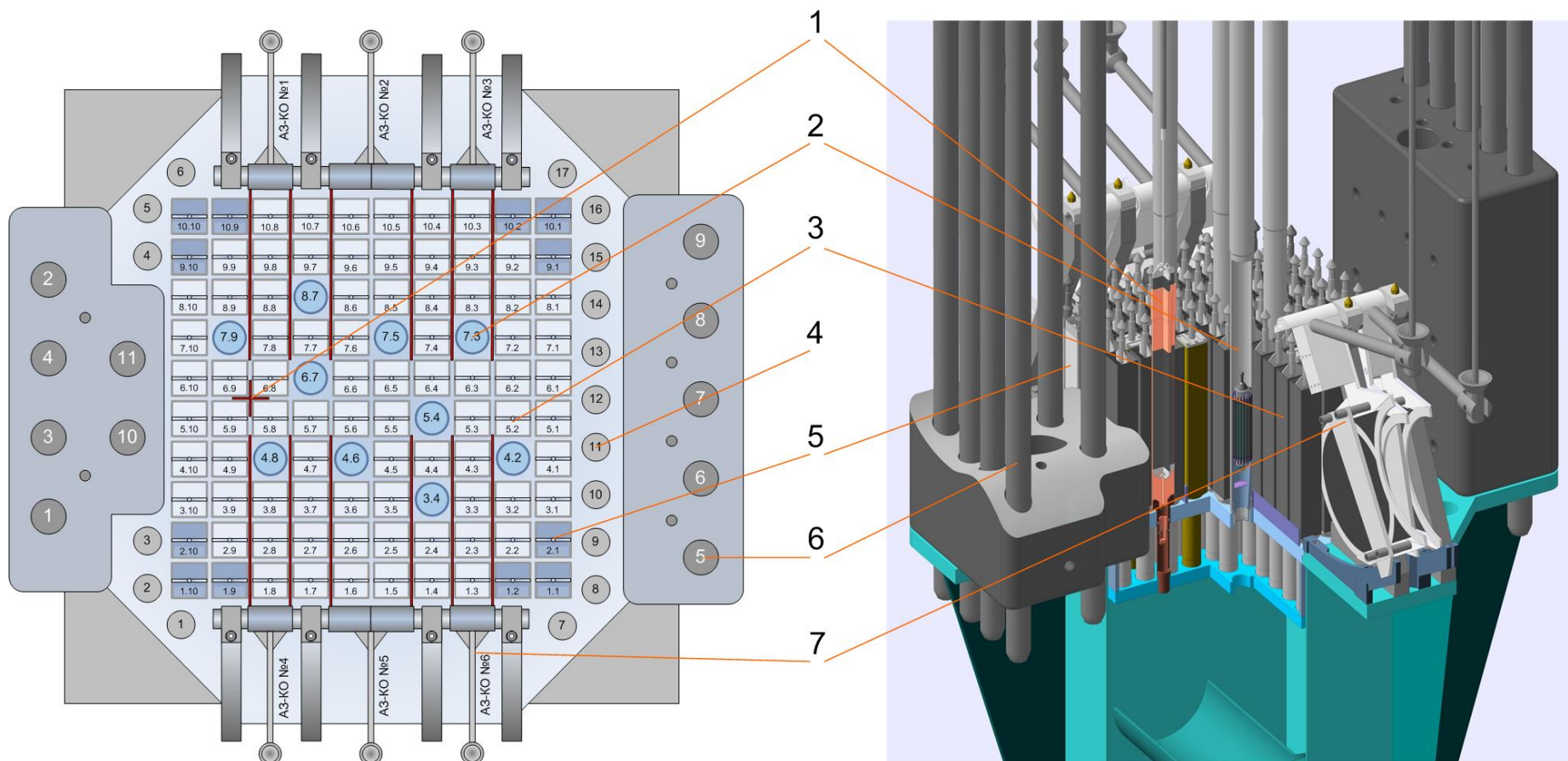
The RBT-10/2 Design and Purpose



The RBT-10/2 research reactor is widely used. It is intended for experiments to study material properties under irradiation in neutron flux up to 10^{14} n/cm²s, to produce radionuclide sources or materials with the required properties.

At present, the reactor is used to accumulate ¹³¹I for medical use, to color gemstones and to produce ⁹⁹Mo preparation.

RBT-10 Core



1. ER
2. Irradiation channel
3. FAs
4. Periphery irradiation channels

5. Angle reflectors
6. Ionization chamber
7. Safety & shim rods

The RBT-10/1 Decommissioning Concept



In April 2005, due to the lack of an Experimental Work Program and funding to ensure safe long-term shutdown conditions, the RBT-10/1 reactor was put to the final shutdown mode by Order of the Head of the Federal Atomic Energy Agency.

The decision was made and a concept of the RBT-10/1 decommissioning was developed.

Basic provisions of the Concept are as follows:

- partial dismantling of the equipment and repurposing;
- use of the premises in the building where the equipment of the RBT-10/1 reactor is located for the improvement of operational characteristics and experimental capabilities of the RBT-10/2 reactor.

On the basis of the adopted Concept, the following documents were developed in 2008:

- basic program for the RBT-10/1 decommissioning;
- RBT-10/1 decommissioning plan;
- a set of documents that passed ecological examination and on the basis of which a permit was issued for the right to perform activities in the field of nuclear energy use for the RBT-10/1 decommissioning.

RBT-10/1 Decommissioning Activities



Procedures were developed to:

- remove radioactive waste from the RBT-10/1 premises for the long-term storage;
- to remove radioactive working media from the equipment and technological systems of the RBT-10/1 reactor;
- decontaminate equipment, systems and building structures of the RBT-10/1 reactor.

The Structure, Regulation and Program of the Site Data System on the RBT-10/1 decommissioning were developed and implemented; the System being compatible with the industry system.

A digital radiation monitoring system for the MIR.M1-RBT-10 reactor complex was developed and implemented.

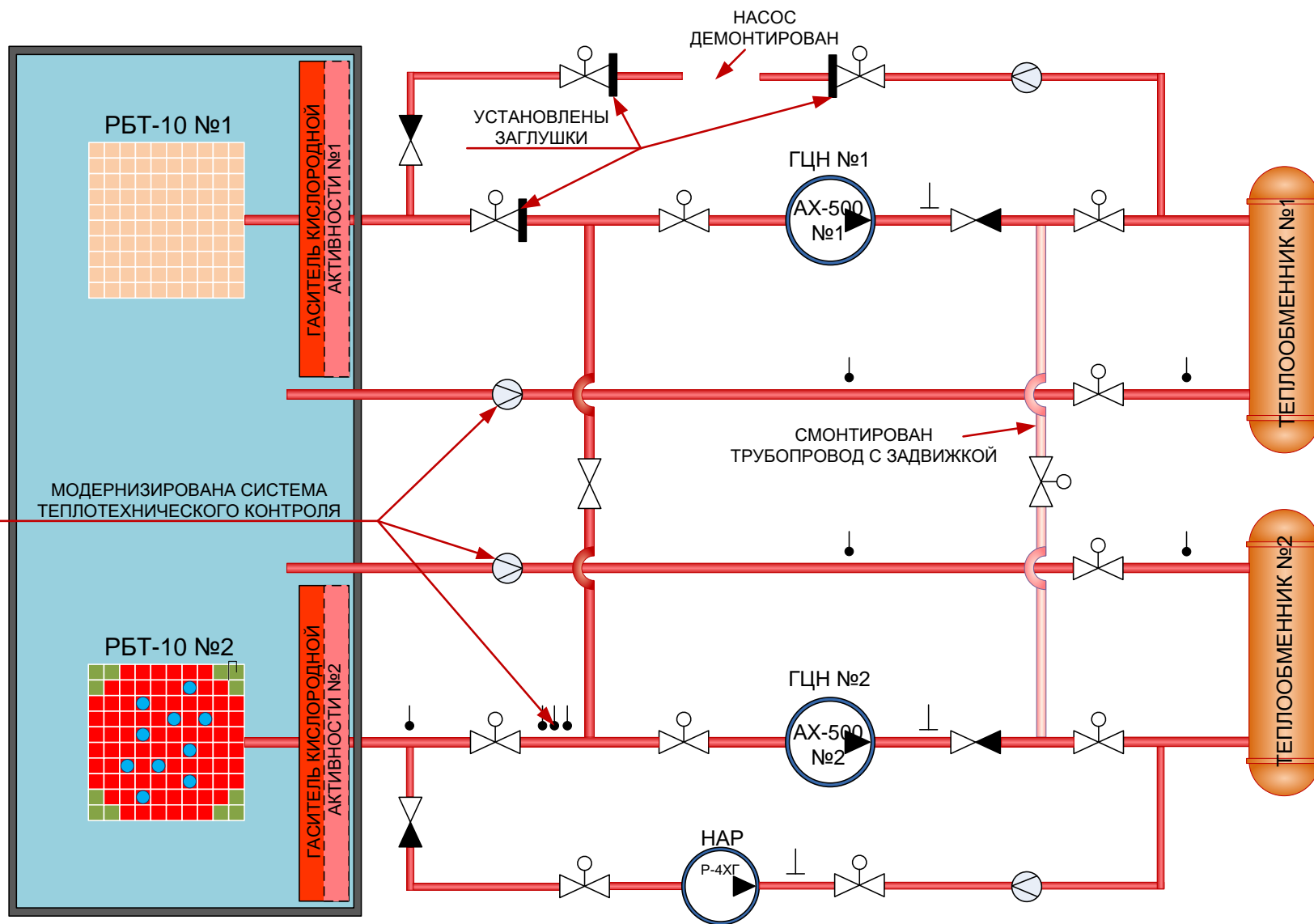
Safety of the RBT-10/2 operation with the upgraded cooling circuit of the reactor core was justified. The Program of the RBT-10/2 cooling system refurbishment was implemented.

The RBT-10/2 thermal control system was improved by placing third control channels and an backup reactor control board.

Refurbishment of the RBT-10/2 Cooling System



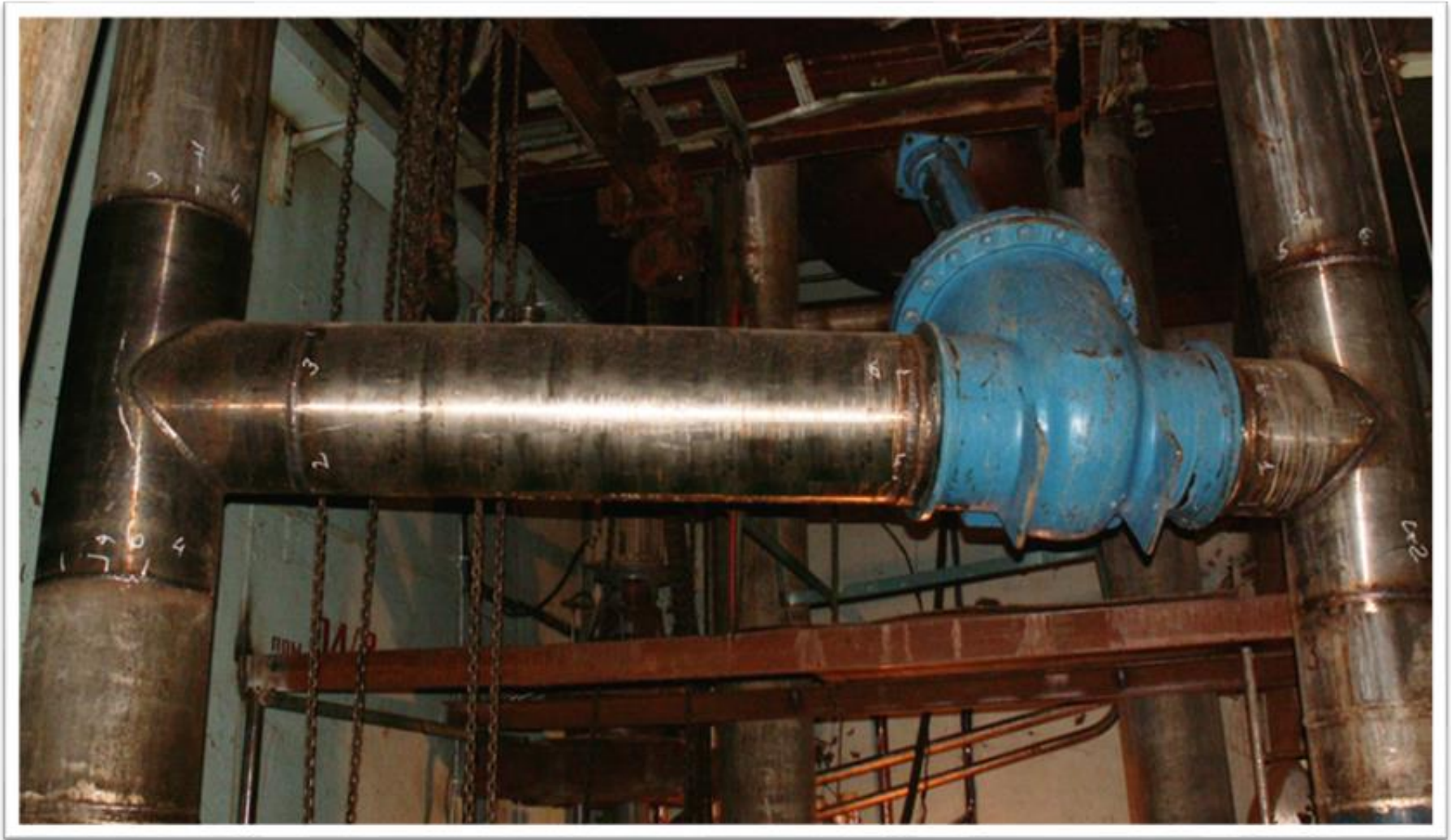
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Refurbishment of the RBT-10/2 Cooling System



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Upgrading of RBT 10/2 Thermal Parameters Control System



Upgraded system to control thermal parameters with absolutely new measurement equipment

1st control channel



2nd control channel



3rd control channel and backup control board



RBT-10/1 Decommissioning Activities



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Changes and amendments were introduced into the RBT 10/2 design documents after the upgrading of cooling and thermal control systems.

Reactor RBT-10/2 was brought to the designed power of 10MW.

Under-water video system was installed. The RBT-10/1 removable components were dismantled. Radwaste was removed from RBT-10/1 process rooms for long-term storage.

Spent RBT-10/1 fuel was sent for reprocessing.

Reactor control board, control channels, control rod and measurement boards were dismantled.

Rooms and equipment were decontaminated. The reactor building was reconditioned after the upgrade of RBT-10/2 cooling system and dismantling of equipment.

Final radiation and engineering survey of reactor building was performed.

Work Results



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**ФЕДЕРАЛЬНАЯ СЛУЖБА
ПО ЭКОЛОГИЧЕСКОМУ, ТЕХНОЛОГИЧЕСКОМУ
И АТОМНОМУ НАДЗОРУ**

**ВОЛЖСКОЕ МЕЖРЕГИОНАЛЬНОЕ ТЕРРИТОРИАЛЬНОЕ УПРАВЛЕНИЕ
ПО НАДЗОРУ ЗА ЯДЕРНОЙ И РАДИАЦИОННОЙ БЕЗОПАСНОСТЬЮ**

Отдел по надзору за ядерной и радиационной безопасностью в НИИАР
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УТВЕРЖДАЮ

И.о. руководителя Волжского МГУ
по надзору за ЯРБ Ростехнадзора
В.Е. Савинов
« 02 » 02 2014 г.

РЕШЕНИЕ

По результатам рассмотрения комплекта представленных документов:

- заявления ОАО «ГНЦ НИИАР» от 20.06.2014 №64-1000/5138 о прекращении действия лицензии Ростехнадзора от 31.12.2008 №ГН-04-108-1956;
- окончания срока действия лицензии Ростехнадзора на вывод из эксплуатации исследовательского ядерного реактора РБТ-10/1;
- акта инспекции от 14.03.2014 №АК-ДМ-09-14;
- письма и.о. начальника Управления по регулированию безопасности атомных станций и исследовательских ядерных установок В.А. Манакова от 18.07.2014 №05-05-01/1343

принимается решение о снятии с надзора и исключения из списка поднадзорных Федеральной службе по экологическому, технологическому и атомному надзору объектов использования атомной энергии исследовательского ядерного реактора РБТ-10/1 ОАО «ГНЦ НИИАР».

Начальник ОН за ЯРБ в НИИАР

Т.Н. Мишутина

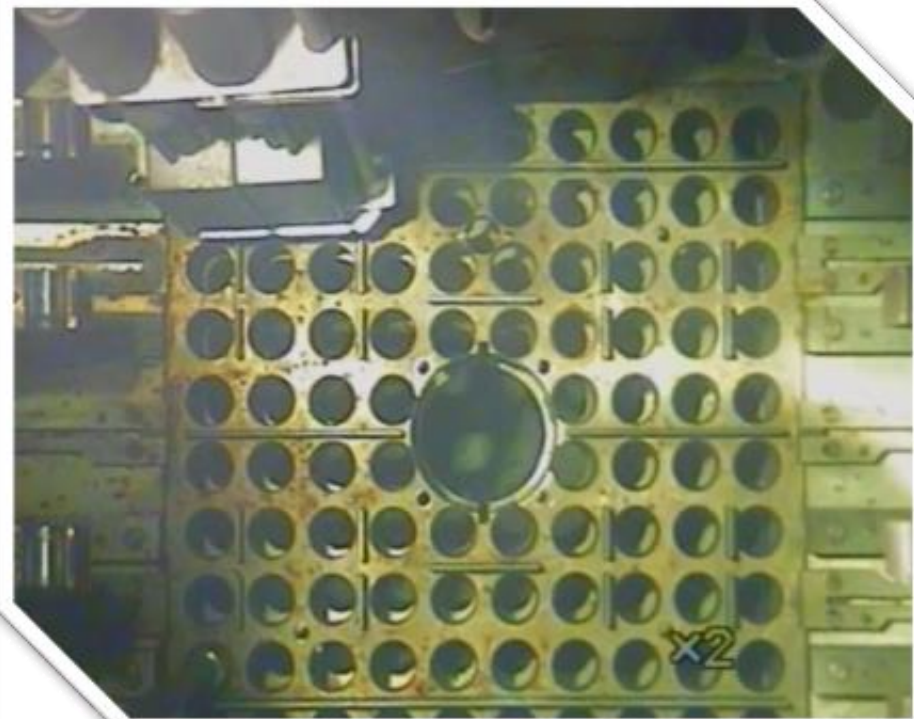
Reactor RBT-10/1 was decommissioned from Jan. 01.2009 till Dec. 19.2013. The decommissioning activities were performed in full volume.

Rostechнадzor made a decision to remove the RBT-10/1 from supervision and exclude it from the list of supervised objects.

Dismounting of Core Removable Components

Reactor core before dismounting

Reactor core after dismounting



Dismounting of Reactor Control Board



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Reactor control board before dismounting



Dismounting of Reactor Control Board



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Reactor control board after dismounting



Dismounting of Control Rods Racks



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Control rods room before dismounting



Dismounting of Control Rods Racks



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Dismounting in progress



Dismounting of Control Rods Racks



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Control rods room after dismounting



Practical Significance of the Work Performed



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Reactor fuel was sent for reprocessing, removable core components were dismantled, LRW and SRW were sent for long-term storage.

Dismounting of RBT-10/1 equipment and upgrading of RBT-10/2 cooling system resulted in:

- improved experimental capabilities of the reactor operated at 10MW;
- increased safety of reactor RBT-10/2 due to the implementation of majority logic according to the 2 of 3 scheme in the emergency protection of the reactor from thermal control devices;
- backup RBT-10/2 control board that meets all safety requirements;
- increased accuracy of measurements of heat engineering parameters and reduced operating costs for RBT-10/2 maintenance due to the introduction of state-of-the-art equipment.

Thank you for your attention!

**Research Institute of Nuclear Reactors, State Scientific Centre,
Joint-Stock Company (RIAR JSC)**

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