3.17. OJSC "MACHINE-BUILDING PLANT"

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The Open Joint Stock Company "Machine-Building Plant" (OJSC "MSZ") is one of the country's largest industrial enterprises. It belongs to the Fuel Company "TVEL" of the OJSC "Atomenergoprom" within the State Corporation "Rosatom" and is one of the world's leading companies which produce and supply nuclear fuel to nuclear power plants. Another business it pursues is production of fuel for research reactors and reactor facilities of Naval craft.

O.L. SEDELNIKOV
General Director of OJSC "MSZ"

I.V. PETROV
Technical Director of OJSC "MSZ"

OJSC "Machine-Building Plant" site

The administrative building

The nuclear fuel produced by the OJSC "MSZ" for NPPs was and is in use not only in Russia, but also in Armenia, Hungary, Germany, the Netherlands, Lithuania, India, China, Slovakia, Ukraine, Finland, Czechia, Switzerland, Sweden, the UK. At present, 58 commercial reactors – one in eight reactors of the world – run on fuel of the company's making.

The OJSC "MSZ" won its stable position in the home and foreign markets by virtue of its more than 50-year experience in producing fuel elements and fuel assemblies for power reactors as well as by pursuing the firm's quality and environmental policies.

The OJSC "MSZ" has a research complex on its site with critical facilities owned by the State. OJSC "TVEL" is an organization eligible for using the nuclear facilities on the MSZ site as their Operator.

Nuclear research facilities of MSZ

Type	Name	Thermal power, kW	First criticality year	Status	Operation time, years*
CF	Rig 4	0.03	1967	In operation	45
CF	Rig 5	0.03	1967	In operation	45

* *As of 2012*

URANIUM-GRAPHITE RIGS 4 AND 5

Rigs 4 and 5 are structurally identical. Each of them is a complex of a critical assembly and the equipment essential for physical tests, control of the critical assembly and management of nuclear, radiation and general industrial safety. The rigs were brought into service on April 20, 1967.

The critical rigs are uranium-graphite reactor prototypes. They are shaped as hexagonal prisms made of graphite blocks measuring 200×200×600 mm and 200×200×400 mm. The critical assemblies are installed in a canyon 4100 mm wide and 7800 mm long. The core has a height of 3000 mm, average diameter of 1400 mm, while the thickness of the side and end reflectors is 500 mm.

Main areas of research at Rigs 4 and 5

In accordance with the license and certificate the critical rigs are designed for physical tests (experiments) to determine the following characteristics:

– physical identitity of the control and protection system (CPS) rods, burnable absorber rods (BAR), working and startup neutron sources (WNS, SNS);

– worth of CPS rods, BARs, WNSs, SNSs, experimental absorbers;

– boron mass in displacers and test absorbers, with the highest permissible error of 0.02 g;

– physical index of graphite rods.

Besides, experiments are performed to determine the characteristics of the critical rigs, such as:

– position of CPS members in the core;

– worth of CPS members;

– critical position of CPS members;

– differential characteristics of the manual rod actuator;

– integral efficiency of the manual rod actuator; as well as:

– to install (remove) neutron flux sensors (KNK-56 chambers and SNM-11 counters);

Main performance of Rig 4 (Rig 5)

Power	0.03 kW
Reactivity margin	0.6 (0.8) β_{eff}
Moderator	Graphite
Moderator temperature, max	30 °C
Coolant	–
Reflector	Graphite
Graphite level	500 mm above the core
Maximum thermal neutron flux	$1 \cdot 10^6$ cm$^{-2} \cdot$s^{-1}
Number of reflection sides	10
Emergency protection rod material	Boron carbide
Number of EP rods	4
Type of CPS drive	Servodrive

– to measure power density distribution in the critical assembly.

Nuclear fuel – BM-2 slugs of uranium metal with 2 % enrichment, 37.0 mm in diameter and 103.7 mm long – is placed in metallic shells with the inner diameter of 39 mm and wall thickness of 1.5 mm. The uranium-235 charge is 27.7 kg.

Channels are arranged in the graphite stack with a pitch of 200 mm. The stack accommodates 138 process channels, including:

– 26 working channels loaded with 29 BM-2 slugs;

– 1 working channel loaded with 20 BM-2 slugs;

– 7 working channels without nuclear material;

– 5 experimental channels;

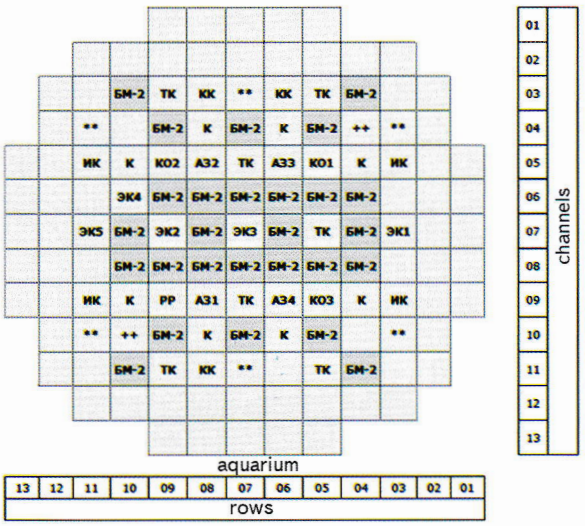
– 6 channels for neutron sources;

– 11 channels for shim rods;

– 1 channel for a manual control rod;

– 4 channels for EP rods;

– 2 channels for neutron counters;



"Rig 4 map" (mirror image of Rig 5):

ИК – Ionization chambers KNK-56
БМ-2 – Channels with BM-2 fuel
ЭК – Experimental channels
АЗ – Channels with EP rods
К – Channels for shim rods
++ – Channels for counters
КК – Channels for KNK-56
ТК – Process channels
*** – Channels for sources*
КО – Channels with shim rods
РР – Channels with manual rods

– 7 channels for ionization chambers;

– 1 channel of the startup source;

– 67 channels with graphite rods.

The EP rods 28 mm in diameter, shim rods and the manual control rod with the diameter of 12 mm are made as pivotally connected sections of boron carbide.

The experimental channel is a duralumin tube measuring 100×2.5 mm in diameter and 4295 mm in height.

Rigs 4 and 5 are provided with a device for remotely controlled operations, which allows inserting (withdrawing) items into (from) the critical assembly automatically or manually.

Main activities

Rig operation may be arranged in two shifts.

Rig operation schedule: 7.2 hours a day, 5 days a week, 51 weeks a year.

The average time utilization factor is 0.71.

In the next 10 years, Rigs 4 and 5 will be operated without restrictions.

History

In the middle 1950s, the Machine-Building Plant was ordered to organize lot production of goods for the defense industry. It was necessary to establish mature processes for manufacture and control of intricate products containing fissile materials, with nuclear safety assured at all production stages.

The expanding range of products and the scope of research and development efforts dictated the need for critical facilities. Over the whole time of its activities, the plant had seven rigs in operation.

The basic concept for provision of critical facilities on the site was devised by Chief Engineer Dmitri Sokolov, who also managed the actual work.

In mid-1960, Physics Laboratory No. 2 was set up for the main purposes of determining the neutronic characteristics of products in general and of their most important components in particular.

The laboratory had close contacts with the leading research and engineering centers of the country, such as: Kurchatov Institute, NIKIET, OKBM, etc. In a few years, the tight-knit staff of Laboratory 2 learned to deal with important and sophisticated jobs. The first critical facility was brought to first criticality in 1960.

Critical facilities of the first stage were put into operation in the 1960s – Rig 1 (1966), Rigs 2 and 3 (1967) – and set the stage for testing products of the 2nd generation, including hot tests at Rig 2.

With Rigs 4 and 5 commissioned in 1968, it became possible to determine the physical characteristics of the most important components produced to various orders.

The next stage in development and improvement of power reactors (VVER) saw construction and commissioning of Rig 7 in 1979. This facility was designed for experimental assessment of the starting physical characteristics of VVER-1000 fuel assembly sets. It was at this rig that a full-scale VVER-1000 core was brought to first criticality (for the first time in the USSR) after fuel for Novo-Voronezh 5 was loaded into it. Later on, Rig 7 was employed for making-up of fuel sets and full-scale neutronic experiments to determine the characteristics required for

safe fueling, startup and operation of power reactors for Novo-Voronezh (1980), South-Ukraine (1983), and Kalinin (1983) NPPs. In 1984, Rig 7 was upgraded for making-up of FA sets and physical tests of full sets of AST-500 fuel assemblies for nuclear district heating plants. The same year, the first interdepartmental operations were carried out to test the first-of-the-kind set of AST-500 assemblies for Gorki District Heating Plant Unit 1, followed by the same effort for Unit 2 a year later (in 1986). Along with the principal tests, experimental work was carried out to study the effect of manufacturing tolerances on the physical parameters of fuel assemblies as well as to investigate the nuclear safety issues of nuclear district heating plants; those activities were continued in 1989–1990 with the set of fuel assemblies for Voronezh-1 under the scientific guidance of the Kurchatov Institute and the OKBM.

In 1998, the control and protection systems of all the rigs were retrofitted in accordance with the design produced by the GSPI, with the hardware manufactured and installed by OJSC "MSZ". The equipment service life was extended to December 31, 2013 in conformity to the requirements of NP-024-2000.

During the period of 2001-2011, Rigs 1, 2, 3, 6 and 7 were decommissioned and taken off the books of Rostekhnadzor; Rigs 4 and 5 are in operation at present.

Personalities

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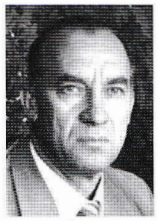

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