

Profile SFR-63

BFS-1

RUSSIA

GENERAL INFORMATION

NAME OF THE FACILITY	Fast critical facility «BFS-1».
SHORT NAME	The «BFS-1» facility.
SIMULATED COOLANT	Na, Pb, Pb-Bi, water, gas.
LOCATION	FSUE «State Scientific Centre of the Russian Federation – Institute for Physics and Power Engineering named after A.I. Leypunsky» (FSUE «SSC RF - IPPE»), Obninsk, Kaluga region 249033, Russian Federation
OPERATOR	Rosatom State Atomic Energy Corporation
CONTACTPERSON (name, address, position, telephone, email):	Igor P. Matveenko, 1, Bondarenko Sq., Obninsk, Kaluga region, 249033, Russia Scientific Advisor to the Director of the Institute of Nuclear Reactors and Thermal Physics, PhD, tel.: +7 484 39 9 82 13, matveenko@ippe.ru

STATUS OF THE FACILITY	In operation; upgrading is being done simultaneously with the operation; the upgrading completion date is 2016.
Start of operation (date):	February 20, 1962. Upgrading work is to be done in 2014-2016.

MAIN RESEARCH FIELD(S)	<input checked="" type="checkbox"/> Zero-power critical assemblies <input checked="" type="checkbox"/> Design basis and beyond the design basis accidents <input type="checkbox"/> Thermal hydraulics <input type="checkbox"/> Coolant chemistry <input type="checkbox"/> Materials <input type="checkbox"/> Systems and components <input type="checkbox"/> Equipment for scientific research
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TECHNICAL DESCRIPTION

Description of the facility

The «BFS-1» facility is designed to study full-scale mock-ups of research and power fast reactors (thermal power up to 1000 MW) with different types of fuel, fertile material and coolant (Na, Pb, Pb-Bi, water, gas), various core and blanket layouts; and to conduct research into neutronic characteristics of critical assemblies with a simple composition (benchmarks). The «BFS-1» facility is also used for experimental studies carried out to justify nuclear safety

of fuel cycle technologies and fuel cycle facilities. The «BFS-1» facility achieved its first criticality on June 30, 1961.

The «BFS-1» facility has a critical assembly that allows simulating fast reactors cooled by sodium or heavy metals, VVER-type reactors (where water is simulated by polyethylene disks), with different types of nuclear fuel.

The vessel of the «BFS-1» facility is a vertical steel tank which is 2 m in diameter and 2.2 m in height. The core volume is $\sim 6\text{m}^3$. At the base of the vessel there is a spacer grid, which is a steel plate 100 mm thick. It has openings which are 35 mm in diameter and arranged in a triangular lattice with a pitch of 51 mm. The vessel is filled up with steel or aluminum tubes (~ 1500 in number) 50×1 mm in diameter, whose shanks enter the openings of the spacer grid. The tubes are refilled with disks of fuel, fertile, structural materials and coolant, their number, proportion and order being the same as in the cores, fertile blankets and reflectors of simulated reactors. The key technical parameters of the «BFS-1» facility are given in table 1.

Table 1. Key technical parameters of the «BFS-1» facility

Power	0,2 kW
Moderator for simulated light-water reactors	Distillate, boric acid solution, polyethylene, graphite
Simulated coolant	Na, Pb, Pb-Bi, water, gas
Reflector	U, UO ₂ , Pb, Pb-Bi, steel, etc.
Fast neutron flux density, max.	$10^{10}\text{cm}^{-2}\cdot\text{s}^{-1}$
Core cooling	Natural convection or forced air cooling

Some of the tubes placed in the central part of the vessel have pulley drives and act as safety, shim or control rods in the core.

The «BFS-1» facility allows using two or three safety rods (SR), which drop out of the core by gravity on an emergency signal, one to three shim rods (SHR) and one or two automatic control rods (ACR). Each SR or SHR occupies two tubes of the critical assembly and each ACR occupies one. On an emergency signal, shim rods and automatic control rods are withdrawn from the critical assembly at a maximum speed.

Composition of the safety, shim and automatic control rods is the same as that of the fuel rods. The only difference is that CR tubes are longer, with disks or tubes containing neutron absorber (boron carbide, boron carbide and polyethylene, europium dioxide) placed above the upper axial shield.

Nuclear fuel is simulated by a combination of disks containing plutonium metal and/or uranium, and/or uranium dioxide (enrichment to 36 and/or 90% ^{235}U) and disks containing fertile or raw materials – thorium metal, uranium and/or depleted uranium dioxide.

Metal, oxide, monocarbide and nitride fuel can be simulated at the «BFS-1» facility. The quantity of fissile materials is sufficient for assembling full-scale mock-ups of low- and medium-power fast reactor cores and blankets.

A significant amount of neptunium dioxide and thorium metal makes it possible to do research on fast reactor cores designed for burning (transmutation) minor actinides or producing U-233.

Critical assemblies are studied by using small-size fission chambers moved along the height of the critical assembly with the help of a measuring device. In these measurements small-size fission chambers are placed in the inter tube gaps of the core and blankets. When activation measurements are taken, irradiated indicators are put in the fuel rods between the disks of materials composing the critical assembly core.

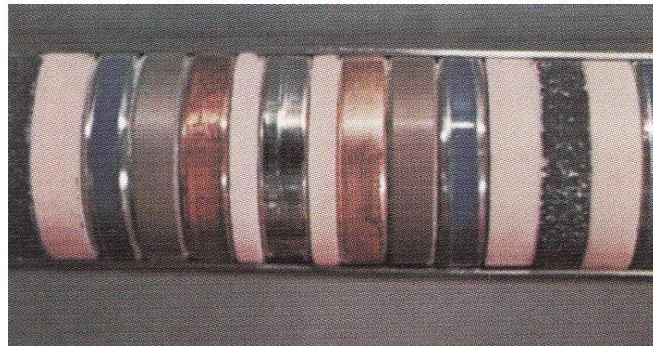


FIG. 1. A sample of a fuel cell at the «BFS-1» facility

By means of an electric cyclotron (pulsed neutron source), neutron spectral distribution can be studied by the time-of-flight method (the path length is 50 metres).

Scheme/diagram

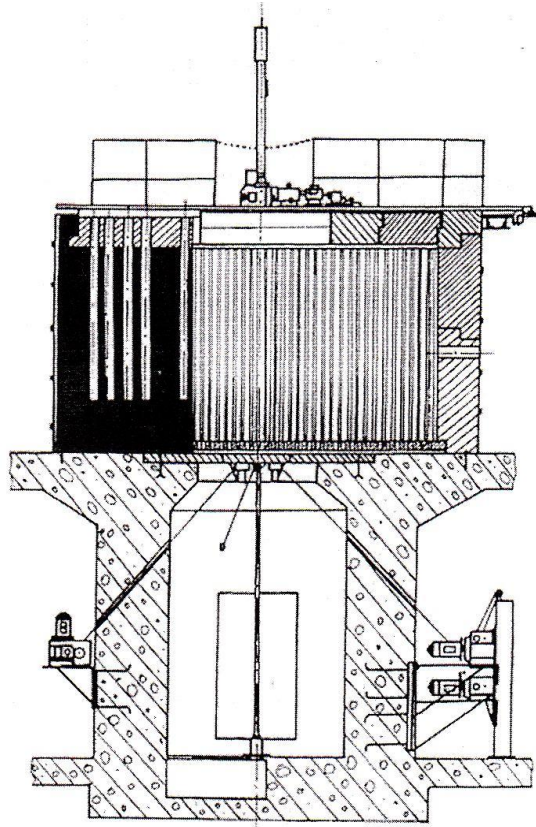


FIG. 2 The «BFS-1» facility, vertical cut

3D drawing/photo



FIG. 3. Upper part of the «BFS-1» facility with the measuring device



FIG. 4 Loading platform of the «BFS-1» facility

Parameters table

Simulated coolant	Na, Pb, Pb-Bi, distillate, boric acid solution, gas.
Power	0,2 kW.
Power of the simulated reactor facilities	Up to 1000 MW (th.).
Test sections	
	<u>Characteristic dimensions</u> outside diameter → 2000 mm, overall height → 2700 mm.
	<u>Static/dynamic experiment</u> Static and dynamic.
	<u>Temperature range in the test section</u> 20 – 70°C
	<u>Operating pressure</u> no
	<u>Flow range (mass flow, velocity, etc.)</u> –
Coolant chemistry, measured and controlled coolant parameters	–
Instrumentation	<ul style="list-style-type: none"> – When studies are made in to critical assemblies, measurement so neutron flux distribution with in the critical assembly are performed by means of small-size fission chambers which are placed in the inter tube gaps of the core and blankets and moved with the help of a measuring device (designer and manufacturer → SSC RF-IPPE); – Measurements of the neutron spectra in the cores and accelerator-driven system models are made with the help of the electron accelerator MI-30 by using the time-of-flight method (designer and manu-

	facturer→SSC RF-IPPE) – Neutron detectors for the activity measurement. – A wide variety of activation detectors.
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COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

The «BFS-1» facility was commissioned in 1961. Its size didn't allow large-size simulation of power reactor cores to be fully implemented. However, by using an electron accelerator – the MI-30 electric cyclotron, one-of-a-kind research on neutron spectral distributions was carried out by the time-of-flight method.

Mock-up so fast reactors such as IBR-2, BOR-60 and BN-350, MBIR, SVBR as well as foreign reactor mock-ups were studied at the «BFS-1» facility.

The «BFS-1» facility was also used to:

- Conduct studies in justification of reactor safety (for sodium or lead cooled fast reactors and VVER-type reactors);
- Develop and introduce new techniques for specifying neutronics characteristics of fast and VVER-type reactors;
- Perform experiments for verification of techniques, specification of neutron data and computer codes for neutronics characteristics of fast and VVER-type reactors;
- Perform experiments on safety justification of the fuel cycle and geological disposal.

PLANNED EXPERIMENTS (including time schedule)

The Federal Target Programme «Next-Generation Nuclear Energy Technologies for the period from 2010 to 2015 further extended to 2020» provides for upgrading and retrofitting the «BFS-1» fast critical facility. The «BFS-1» facility is to be used for experimental studies to justify Russian fast reactor designs of a new generation, as well as for international cooperation in science and technology. In this connection it's been decided to keep using the «BFS-1» facility until 2030 .

TRAINING ACTIVITIES

Activities relating to training experimentalist specialist at the «BFS-1» facility have to be agreed with Rosatom State Atomic Energy Corporation.

REFERENCES (*specification of availability and language*)

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