Profile SFR-64

BFS-2

RUSSIA

GENERAL INFORMATION

NAME OF THE FACILITY	**A full-scale physical model of a high-power BN-type reactor– the «BFS-2» critical facility.**
SHORT NAME	BFS-2.
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, BondarenkoSq., 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):	September 30, 1969. Upgrading work is to be done in 2014-2016.

MAIN RESEARCH FIELD(S)

- ☒ Zero-power critical assemblies
- ☒ Design basis and beyond the design basis accidents
- ☐ Thermal hydraulics
- ☐ Coolant chemistry
- ☐ Materials
- ☐ Systems and components
- ☐ Equipment for scientific research

TECHNICAL DESCRIPTION

Description of the facility

At present, the «BFS-2» facility is the largest operating critical test facility in the world; its size allows full-scale simulation of up to 3000 MWe fast reactor cores, blankets, in-vessel shielding and in-vessel storages with different types of fuel, fertile material, coolant (Na, Pb, Pb-Bi) and with various core and blanket layouts.

The «BFS-2» facility is structurally identical to «BFS-1», but it is of a larger size, which makes it possible to simulate high-power fast reactor mock-ups. The vessel is 5 m in diameter and 3,3 m in height, the number of tubes (fuel rods) in the vessel is about 10000. The tubes have the same diameter as those at the «BFS-1» critical facility and they are filled with the same (as at «BFS-1») disks containing reactor materials. The key technical parameters of the «BFS-2» facility are given in table 1.

Table 1.Key technical parameters of the «BFS-2» facility

Power	1 kW
Moderatorfor 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.	10^9 $cm^{-2}\cdot s^{-1}$
Core cooling	Natural convection or forced air cooling

The «BFS-2» facility allows using 8 safety rods (SR) consisting of 4 tubes each, 9 shim rods (SHR) consisting of 6 tubes each, two automatic control rods (ACR) containing 2 tubes each and one automatic control rod (ACR) containing 1 tube.

The «BFS-2» facility is equipped with several experimental loading machines that help facilitate experimental studies, namely with a coordinate manipulator used for shuffling the fuel rods in the critical assembly vessel, rearranging samples and detectors within the critical assembly in the automatic control mode, operating in the oscillation mode.

Reactor mock-ups are assembled with disks containing reactor materials. The disks are loaded into steel tubes 50×1 mm in diameter;the latter are installed in a hexagonal grid with a pitch of 51 mm, in a vessel 5 m in diameter.

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

3D drawing/photo

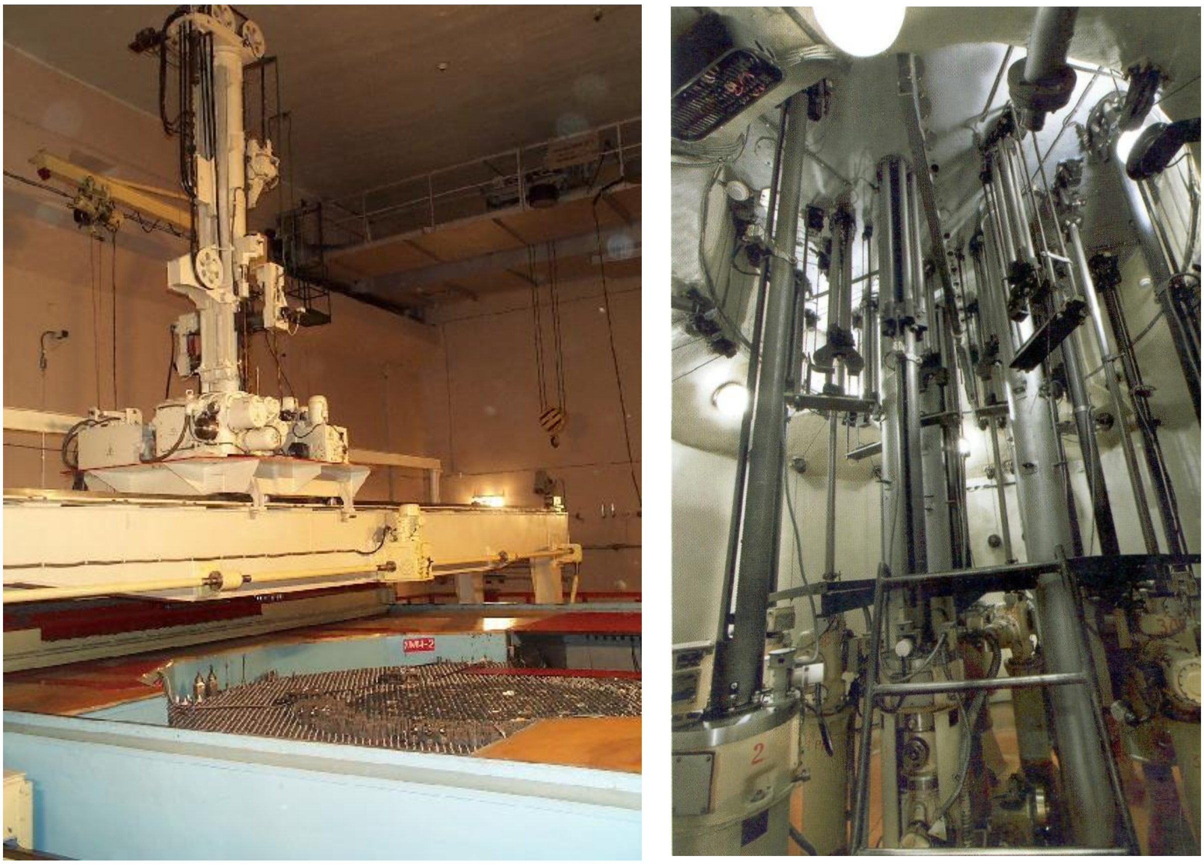

FIG. 1. Pieces of the « BFS-2» equipment

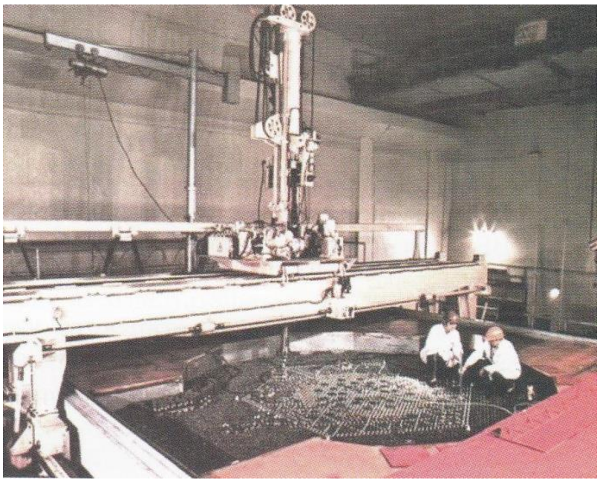

FIG. 2. Reactor box of the «BFS-2» facility

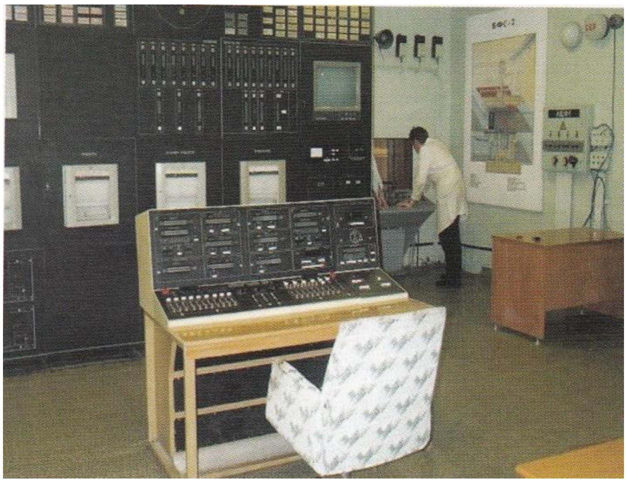

FIG. 3. Control room of the «BFS-2» facility

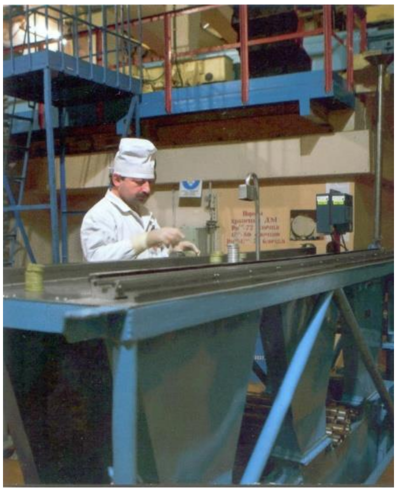

FIG.4. Test section for experimental preparation at the «BFS-2» facility (left) and experimental results being processed at the «BFS-2» facility (right)

Parameters table

Simulated coolant	Na, Pb, Pb-Bi,etc.
Power	1 kW.
Power of the simulated reactor facilities	Up to 3000 MW (e).
Test sections	
	Characteristic dimensions Outside diameter 5000 mm, Overall height 3200 mm.
	Static/dynamic experiment Static and dynamic.
	Temperature range in the test section 20 – 70 ^{o}C
	Operating pressure -
	Flow range (mass, velocity, etc.) –
Coolant chemistry, measured and controlled coolant parameters	–
Instrumentation	– When studies are made into critical assemblies, measurements of neutron flux distribution within 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); – A set of activation detectors; – A set of neutron detectors for the reactivity meter.

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

Over the 50 years of the BFS operation wide experience has been gained by the scientists of the SSC RF-IPPE in operating the critical facilities and carrying out experiments. The activity factor of the fast critical facilities is approximately 0,80.

One of the research lines is to study characteristics of reactor sat the design stage. Full-scale core and blanket mock-ups of operating reactors (BOR-60, BN-350, BN-600), the China experimental fast reactor (CEFR) and advanced reactors of a new generation (BN-800 and SVBR-100) have been simulated. Both homogeneous and heterogeneous core compositions with uranium, plutonium and MOX fuel were studied. This work has made it possible to justify the key characteristics of the reactors being designed – critical parameters, reactivity margin, CR worth, CR interference effects, sodium void reactivity effect.

Another research line is to perform special purpose experiment sat the facility, using the simplest geometric models and minimum set of materials (the so-called integral experiments). That kind of research, when real fuel assemblies of different compositions were used, was important for finding uncertainties of the simulations. Commissioning operations and scheduled shut downs were studied for power reactors.

Different techniques have been developed and mastered- miniature double fission chambers, a hydrogen detector and a scintillation spectrometer providing suppression of signals from gamma radiation; time-of-flight method, a number of techniques for measuring reactivity effects, include in gin versed kinetics solution equation to eliminate spatial effects. Also, much work has been done to create algorithms for experimental data evaluation (consideration of heterogeneous effects, extrapolation of reactivity effects to zero size of samples, introduction of contamination corrections, etc.).

The BFS complex was used for experimental studies under commissioning agreements with the USA (experimental studies into simulated geological disposals of highly-enriched uranium and plutonium as regards their resistance against water penetration), China (experimental studies into the simulated CEFR reactor with uranium oxide fuel), Korea (experimental studies into the simulated KALIMER reactor with uranium oxide fuel and uranium-plutonium metal fuel), France (comparison of measurement techniques, experimental studies into minor transactinides burn up in fast reactors), Japan (experimental studies into the simulated BN-800 type fast reactors), India and other countries. A coordinated experimental programme was implemented at the BFS, MASURCA, FCA critical facilities.

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 fast critical facilities to simulate next generation fast reactors (BN-1200, BREST-OD-300, SVBR-100, MBIR and other advanced reactors for NPPs).Research work is to be conducted at the «BFS-2» facility under the contracts with France and Repubic of Korea.

In this connection it’s been decided to keep using the «BFS-1» facility until 2035.

TRAININGACTIVITIES

Activities relating to training experimentalist specialist sat the «BFS-2» facility have to be agreed with Rosatom State Atomic Energy Corporation.

REFERENCES (*specification of availability and language*)

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