JSC “Afrikantov OKBM”

SERVING THE NUCLEAR MACHINE BUILDING INDUSTRY SINCE 1945

JSC “Afrikantov OKBM”
Burnakovsky proezd, 15, Nizhny Novgorod, 603074 Russia
Tel.: +7 (831) 275-40-76, 275-26-40
Fax: +7 (831) 241-87-72

okbm@okbm.nnov.ru
www.okbm.nnov.ru

FAST NEUTRON REACTOR PLANTS

Joint Stock Company “Afrikantov OKB Mechanical Engineering”

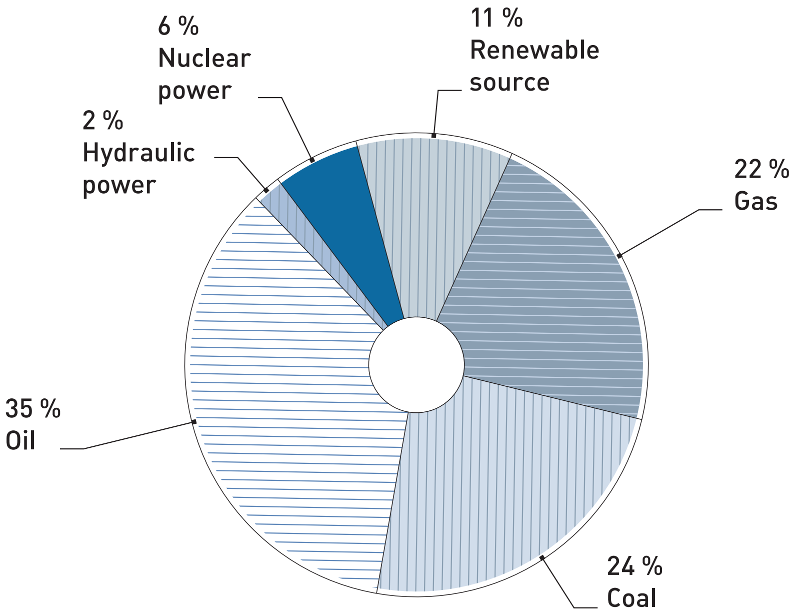
Fast Neutron Reactor Plants

From Experience to Prospects

TABLE OF CONTENTS

INTRODUCTION

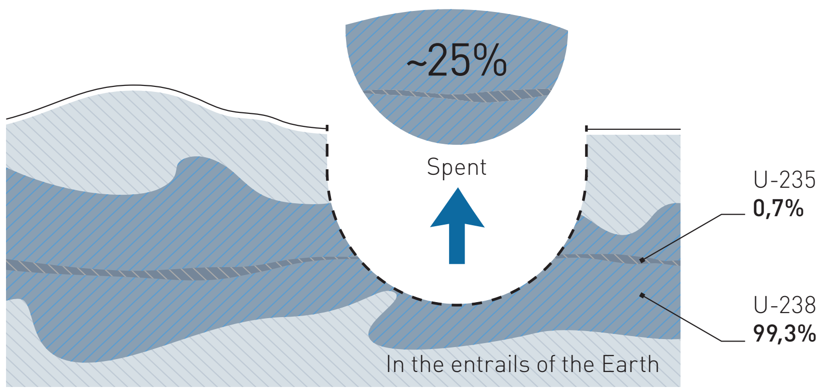
The objective reality not only in Russia but in the entire world society is a steady increase in power consumption at a decrease in the organic fuel stores. Currently, nearly 80% of human needs for power are satisfied by organic fueled plants. The share of nuclear power in the structure of total power supply is insignificant, not more than 6%, and that in the electricity generation ~16%.



World's power structure. Share in power consumption

On the one side, objective processes of reduction in organic fuel resources, reduction in availability of organic fuel resources, an increase in the cost of these resources and, respectively, the cost of power produced, as well as the requirement for reducing the impact on the environment and population form the basis for predictions concerning an increase in nuclear power.

Currently, the basis for the world's nuclear power is the thermal reactor technology. In Russia, it is mainly the VVER technology that reached the high level of safety and commercialization. Thermal reactors use U235 as the fuel. This isotope in any unit mass of planetary uranium is 0.7% and the remaining 99.3% is U238 which is not a nuclear fuel for thermal reactors as it is practically non-fissionable in the thermal neutron spectrum. In total, the entrails of the Earth contain 10–14 millions of tons of uranium, of which nearly 4 millions have already been developed.



Stores of planetary uranium

According to the expert opinion, if only thermal reactors operate the stores of planetary U235 will be depleted by the end of this century. Therefore, nuclear power based on these reactors only has the same crucial disadvantage as the conventional organic fuel power industry does. Nevertheless, there is a nuclear process that makes it possible to use the dominating portion of natural U238; at neutron capture, U238 transforms to Pu239 which is also fissionable as U235. At irradiation, Pu239 not only undergoes fission but also captures neutrons; therefore, other isotopes such as Pu240, Pu241 and Pu242 are generated. Such transformation most effectively takes place in fast reactors. Of principal importance is that during this process plutonium can be produced in the quantity that exceeds the needs of the reactor itself (breeder reactor). Due to this, plutonium is produced not only to support operating fast reactors but also to gradually accumulate it for other reactors. In this connection, it is obvious that introduction of fast breeder reactors is a necessary condition for developing a large scale nuclear power.

During operation of fast reactors, an important task of creating a closed nuclear fuel cycle shall be solved. The closed nuclear fuel cycle is characterized by repeated cycles of processing the spent nuclear fuel and manufacturing new fuel based on the produced plutonium. Solution of this task will make it possible to:

- arrange extended reproduction of uranium plutonium fuel with utilization of plutonium accumulated in thermal reactors, as well as weapon grade plutonium by increasing efficiency of using natural uranium by ~100 times;
- separate radioactive waste from thermal and fast reactors that generates in nuclear reactions;
- ensure in prospect burning of most hazardous radioactive waste, i.e. transuranium elements (isotopes of neptunium, americium and curium with the long high-life).

Sodium-cooled fast reactors are the main reactor type for implementing the closed fuel cycle.

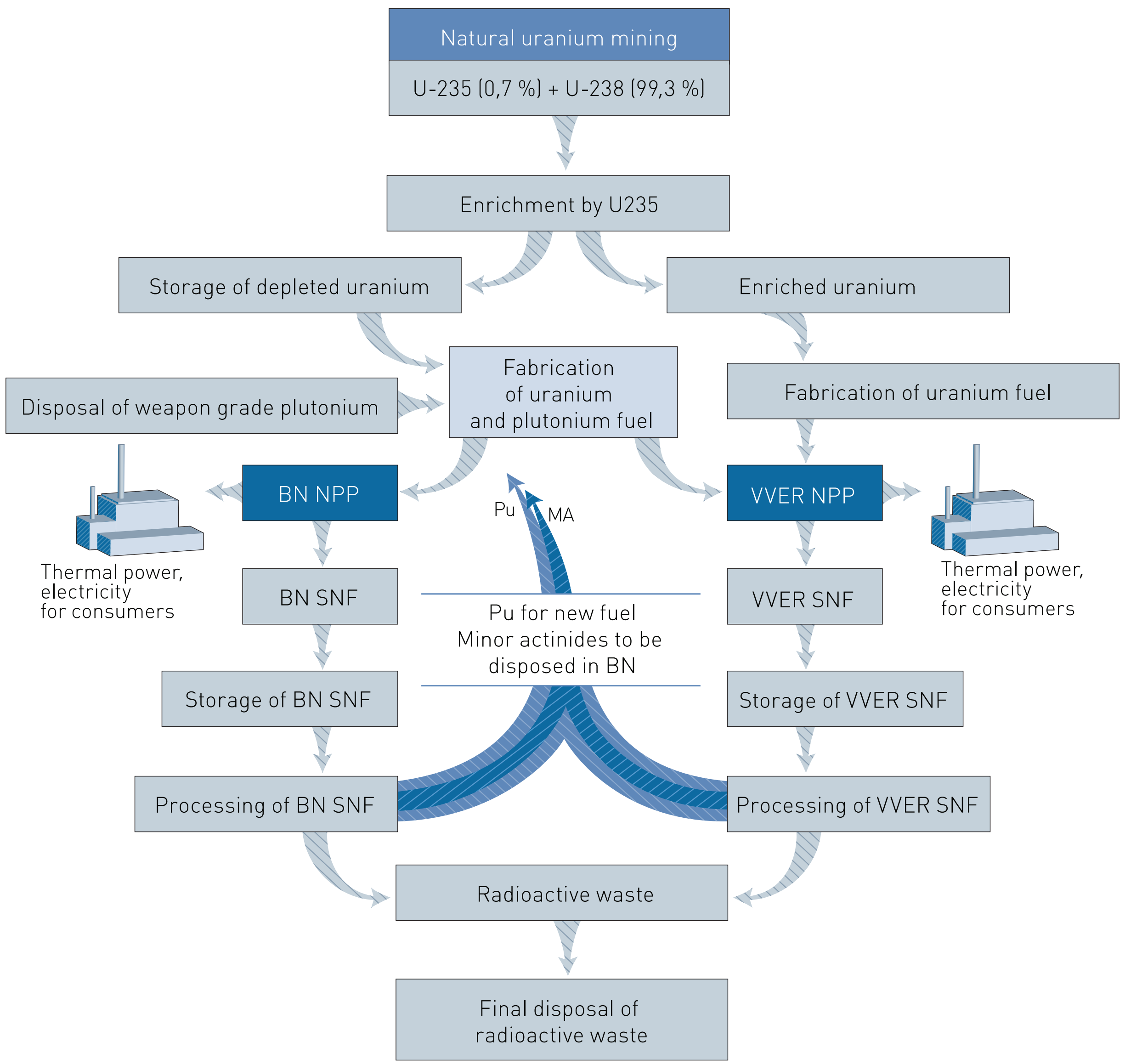


Diagram of the closed fuel cycle for VVER and BN reactors

STEPS IN ASSIMILATION OF THE FAST SODIUM REACTORS

Activities on fast reactors were initiated in State Scientific Center "Institute of Physics and Power Engineering" (SSC IPPE) from creating the research base, i.e. 5 MW research reactor (BR-5, 1958) which was enlarged afterwards to 10 MW (BR-10, 1973). This reactor was the first to use scientific and technical ideas and solutions which were used later on to create more powerful fast reactors. Such solutions included sodium coolant to remove heat from the nuclear reactor, ceramic fuel in the form of the uranium and plutonium dioxide mixture and stainless steel as the main material for structures that contact with sodium.

The BOR-60 reactor — design of this reactor was developed by JSC "OKB "GIDROPRESS" — was the next step in assimilating the fast sodium technology and was developed providing wider possibilities of performing various studies. The reactor was commissioned in 1969 and is up to now the main experimental base for sodium reactors.

Experience gained in the course of development, construction and operation of BR5/10 and BOR-60 made it possible to start in the early 60s in the last century designing and creating the BN-350 experimental and production reactor. The reactor has been operated since 1973.

Experience in operation of the BN-350 reactor plant and further development and commissioning of larger power sodium reactor designs (BN-600 and BN-800) made it possible to commercially assimilate this technology. The Chief Designer of the reactor plant is I. I. Afrikantov OKB Mechanical Engineering, the Research Adviser of projects is SSC IPPE and the General Designer of the NPP is Saint Petersburg Research and Design Institute ATOMENERGOPROEKT (JSC SPbAEP).

In February 2010, resolution of the Government of the Russian Federation approved the Federal Target-oriented Program entitled The New Generation Nuclear Power Technologies for 2010–2015 Period and with Outlook to 2020 which provided for research and development activities on the BN-1200 next generation project. A responsibility center was established to more effectively coordinate activities under this project. Development of the BN-1200 project and experimental validation of solutions adopted will make it possible to create at the horizon of 2022–2025 a commercial power unit that will operate with the closed fuel cycle, of which technical and economic indicators will be comparable with those of state-of-the-art VVER units.

International Cooperation on Fast Reactors

JSC "Afrikantov OKBM" is the main contractor to develop and manufacture main equipment for the Chinese experimental fast reactor (CEFR).

Geography of fast reactor location

Main Technical Characteristics of BN Reactors

	BN-350	BN-600	BN-800	BN-1200
Layout	loop	integral	integral	integral
Fuel	Uranium dioxide (UO_2)	Uranium dioxide (UO_2)	Plutonium and uranium dioxide ($UPuO_2$)	Plutonium and uranium dioxide/ Uranium and plutonium nitride ($UPuO_2$/UPuN)
Breeding ratio	0,93 (plutonium factor)	0,85 (plutonium factor)	1,0	1,2–1,4
Nominal thermal power, MW	750	1470	2100	2800
Gross electrical power, MW	up to 150*	600	880	1220
Primary coolant temperature at the IHX inlet/outlet, °C	440/280	535/368	547/354	550/410
Secondary coolant temperature at the SG inlet/outlet, °C	420/270	505/318	505/309	527/355
Parameters of the tertiary circuit:				
– live steam temperature, °C	410	505	490	510
– live steam pressure, MPa	4,9	14	14	17
– feedwater temperature, °C	160	240	210	275

* In addition to electricity generation, the BN-350 plant ensured desalination of the sea water

More than 50 years of experience in development of fast sodium reactors.

EXPERIENCE IN DEVELOPMENT AND OPERATION OF THE BN-350 RP

The experimental and production BN-350 NPP equipped with the fast neutron sodium cooled reactor was built on the Mangyshlak Peninsula near the city of Shevchenko (currently, the city of Aktau, the Republic of Kazakhstan) and was intended to generate electricity and to desalinate the sea water for the needs of industrial enterprises and the city itself. At the time when the BN-350 NPP started its operation, it was the only in the world nuclear desalination plant.

Main steps of the BN-350 lifecycle:

- commencement of activities under the project in 1960;
- start of construction in 1964;
- power startup in 1973;
- decommissioning in 1998.

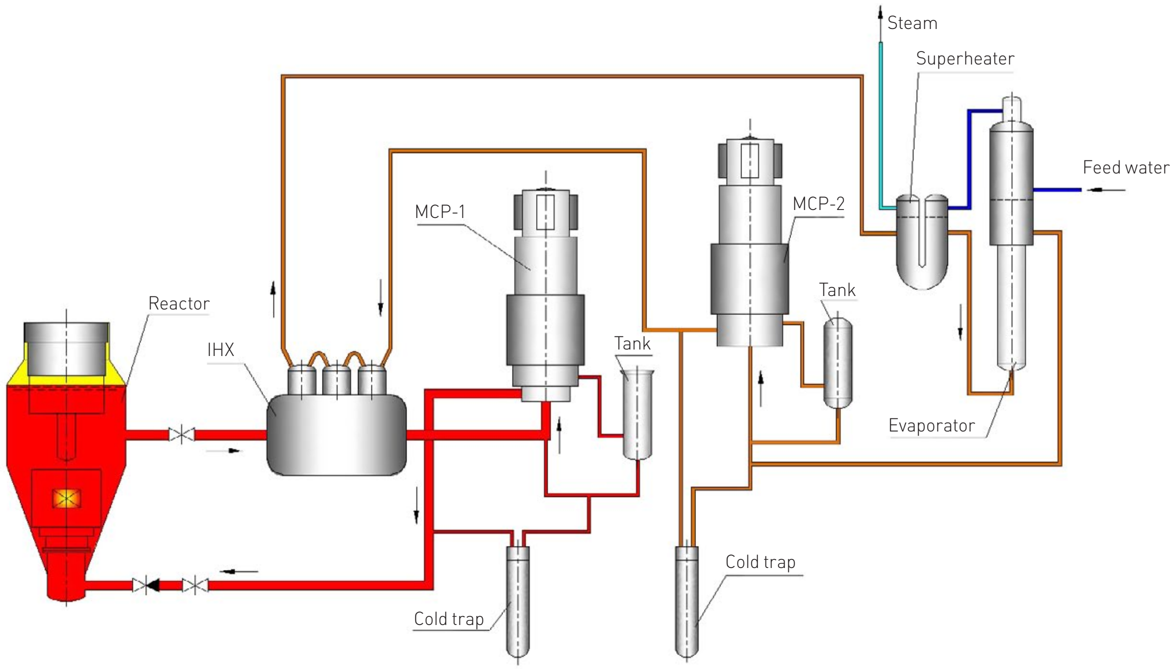
It was the first in the world experimental and commercial fast power reactor.

BN-350 RP power unit

JSC “Afrikantov OKBM” is the Chief Designer of BN-350.

The specific characteristic of fast reactor plants is an intermediate circuit with non-radioactive sodium that transfers heat from the reactor to the steam water circuit connected to the turbine.

BN-350 had a loop layout with primary pumps and heat exchangers located outside the reactor vessel. This makes it easier to maintain and replace pumps and heat exchangers, and the secondary circuit is not radioactive as it is not affected by the neutron flux from the core. The main disadvantage of the loop layout is large diameter hot pipelines that operate under high temperature and sharp thermal cycling, heavy integral flows at the vessel and a large quantity of primary pipes with highly radioactive sodium. In such layout, it is more difficult to isolate and prevent radioactive leaks. In case of power uprating, these disadvantages are more serious. Therefore, taking into account advantages and disadvantages of the loop layout, it can be concluded that such layout can be preferably implemented in experimental reactors, as well as in small power reactors.



Schematic diagram of the BN-350 reactor plant

BN-350 operation confirmed that power units fitted with sodium-cooled fast reactors are reliable, safe and easy to operate. Thanks to operation of BN-350, a lot of information was obtained that made it possible to create a reliable basis for development of subsequent reactor plants.

EXPERIENCE IN DEVELOPMENT AND OPERATION OF THE BN-600 RP

BN-600 located at Beloyarsk NPP, Unit 3 is the key plant that demonstrates results obtained and possibilities for further upgrade of fast reactors. It is the only reactor in the world that has been successfully commercially operating for more than 35 years at the production scale of power.

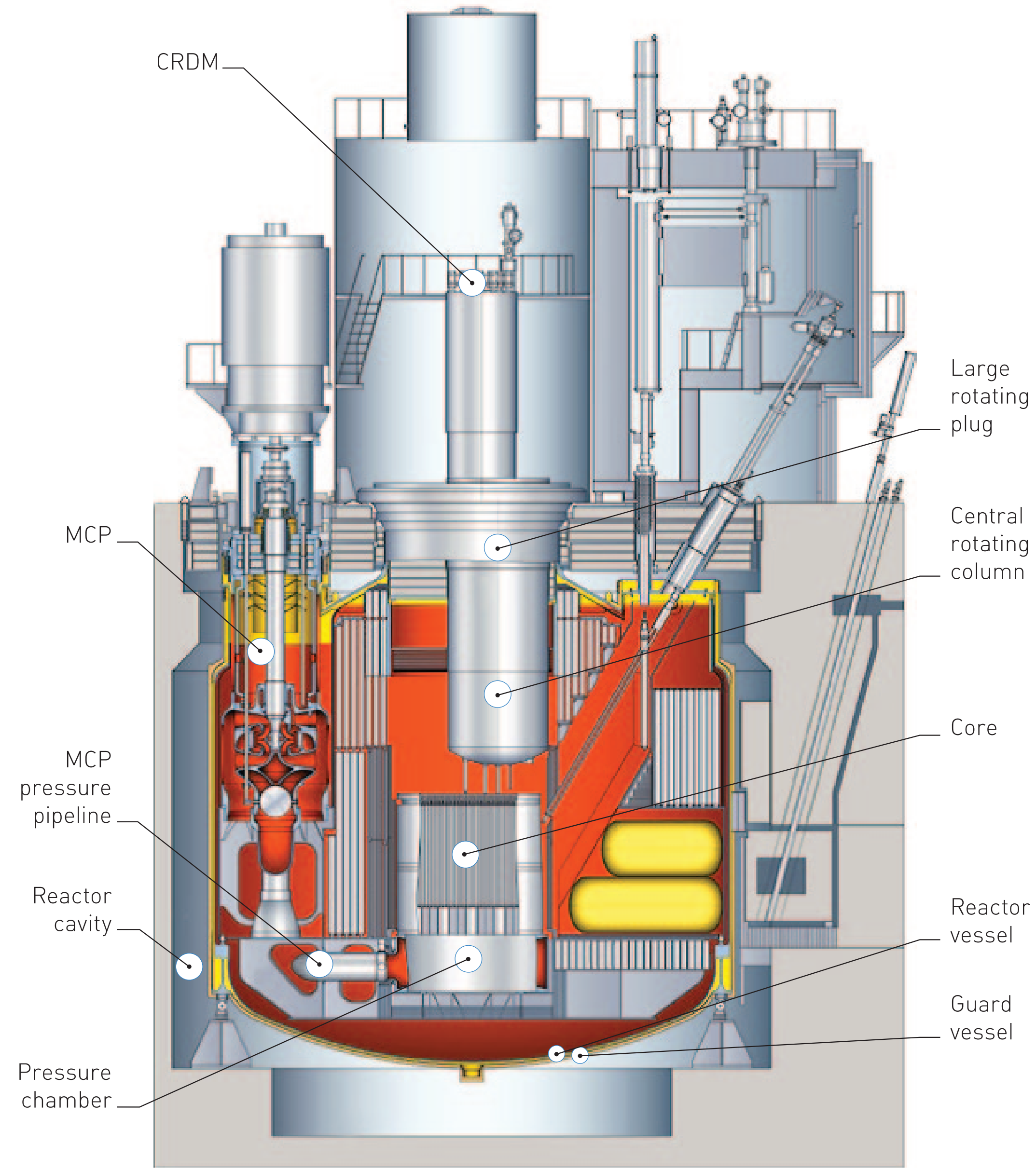
Main steps of the BN-600 lifecycle:

- start of construction in 1969;
- power startup in 1980;
- extension of the design operation life in 2010: license for extension up to 2020.

> BN-600 has been operating for more than 35 years without failures.

Beloyarsk NPP

> JSC "Afrikantov OKBM" is the Chief Designer of BN-600.



BN-600 main primary equipment

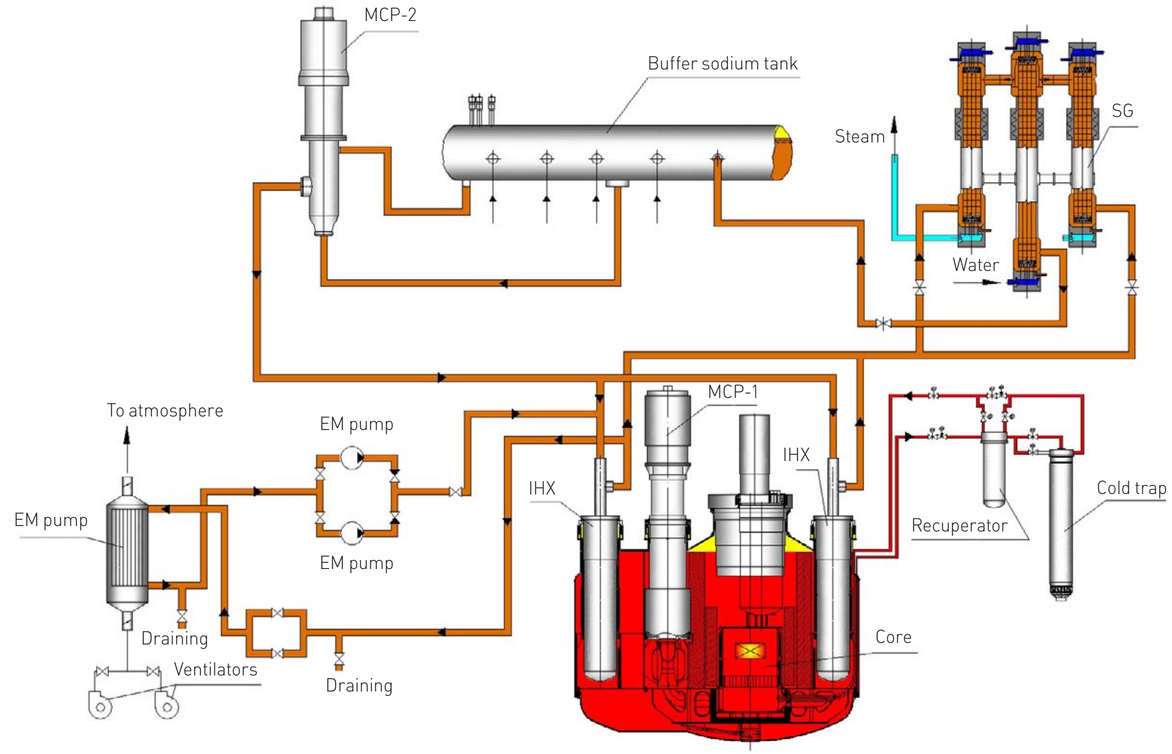
Many technical solutions implemented in the BN-600 design are successive to those which were proven in the BN-350 reactor.

The BN-600 reactor plant has the following distinctive features:

- integral primary circuit with the reactor that houses not only the core, but also main circulation pumps and intermediate sodium-sodium heat exchanger;
- straight-tube section-module steam generator that provides power unit operation at the nominal power without one or even two sections;
- larger power and better thermodynamic parameters as compared with the BN-350 reactor plant;
- better natural circulation conditions for the primary and secondary coolant;
- guard vessel of the same strength as the main one.

In the course of operation, BN-600 demonstrated high indicators and thus solved the assigned task aimed at validating the reliability and safety of sodium-cooled fast reactors as a whole and of sodium coolant in particular. BN-600 was recognized three times as the best power unit in Russia concerning reliability and safety indicators.

BN-600 reactor hall



Schematic diagram of the BN-600 reactor plant

Safety of BN-600 is based on:

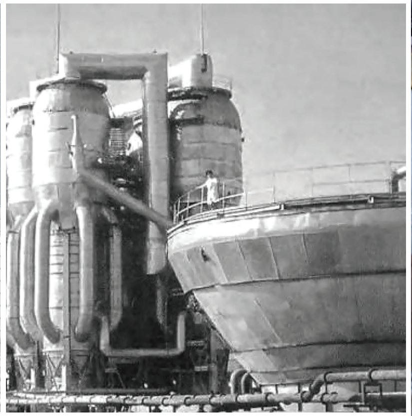
- inherent safety due to intrinsic physical properties;
- three-circuit thermal arrangement that excludes a contact of primary radioactive sodium with the tertiary pure water;
- liquid-metal sodium coolant of the high thermal inertia and large thermal margin in the primary and secondary circuits;
- negative effect of reactivity in all operating modes;
- low pressure reactor vessel with no water and water steam.

In April 2010, the reactor has completely worked out its design service life of 30 years. The construction of the reactor plant retained sufficient operability that made it possible to obtain a license for extension of the operating life by 10 years. It is possible to additionally extend the BN-600 operating life.

JSC "Afrikantov OKBM" supervises operation of BN-600 at Beloyarsk NPP, Unit 3 by solving together with Beloyarsk NPP specialists issues related to ensuring reliable and safe operation of this reactor through the entire service life.

BN-350 check assembly

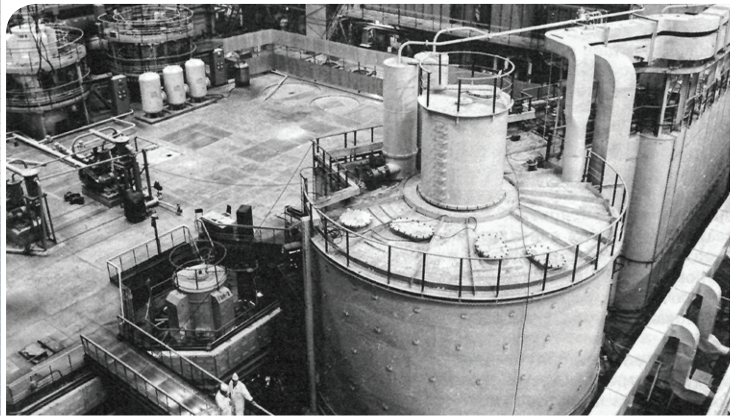
Installation of BN-350

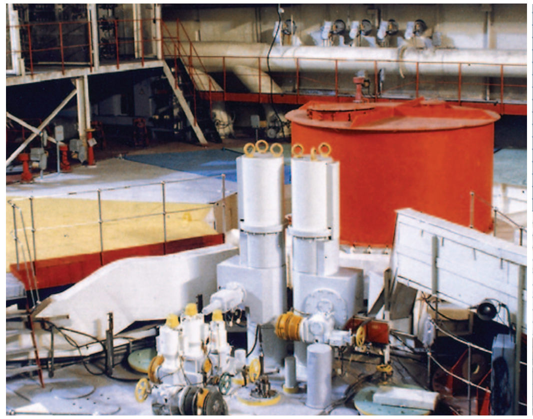


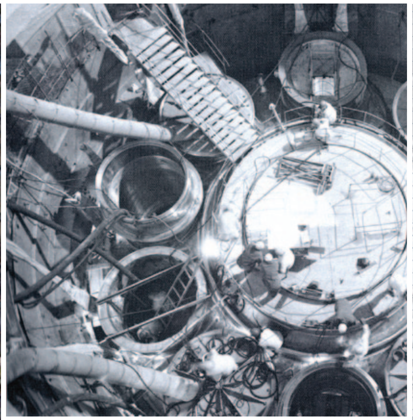
BN-350 desalination plant

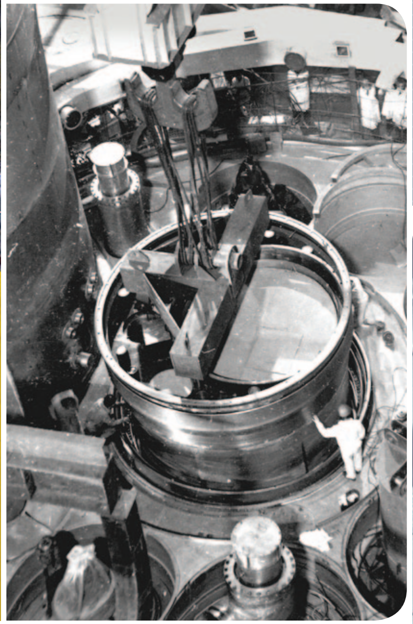
BN-600 reactor hall

BN-350 reactor hall



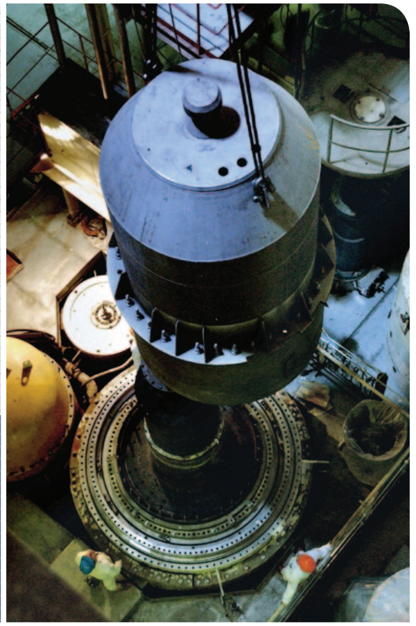






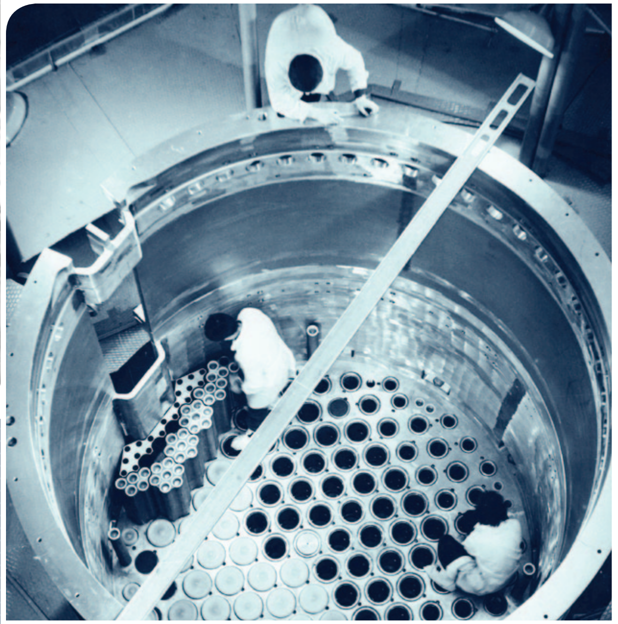
Installation of the BN-600 vessel

Installation of the BN-600 IHX



Installation of the BN-600 large rotating plug

BN-600 reactor hall



Installation of BN-600 headers

BN-800 REACTOR PLANT

The most powerful in the world the BN-800 sodium-cooled fast reactor developed by JSC "Afrikantov OKBM" was commissioned in 2015 at Beloyarsk NPP, Unit 4.

Main steps of the BN-800 lifecycle:

- start of construction in 1985;
- restart of power unit construction in 1997;
- fist criticality in 2014;
- power startup in 2015.

BN-800 is the most powerful operating fast power reactor.

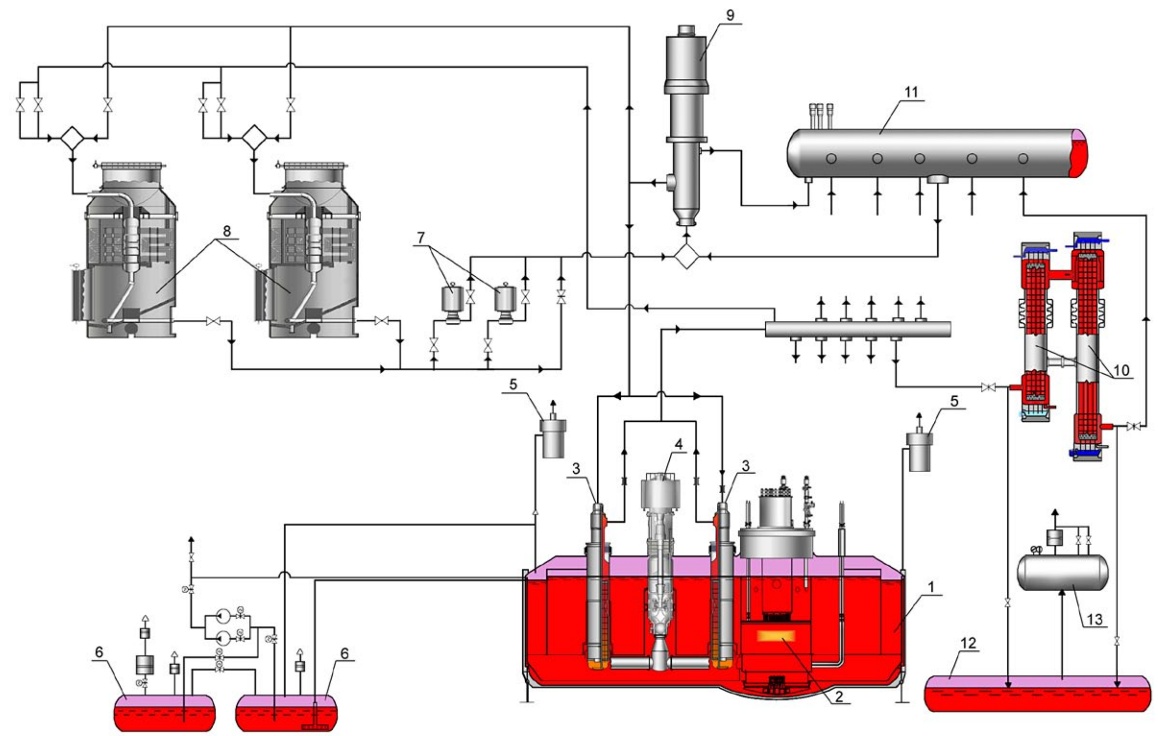
Beloyarsk NPP, Unit 4

Thanks to the experience gained and production facilities built, JSC "Afrikantov OKBM" developed the BN-800 reactor plant and ensured supply of all equipment for the reactor plant that was mainly fabricated at OKBM.

BN-350 and BN-600 used enriched fuel. They were aimed mainly to refine the design of equipment for fast sodium power reactors. BN-800 uses mixed uranium and plutonium fuel and is aimed to refine components of the closed nuclear fuel cycle for transition to the new technological platform.

State-of-the-art technologies used for BN-800 are mainly based on technical solutions of which efficiency has been proven by experience of BN-600 successful operation for more than 35 years. The following has been implemented:

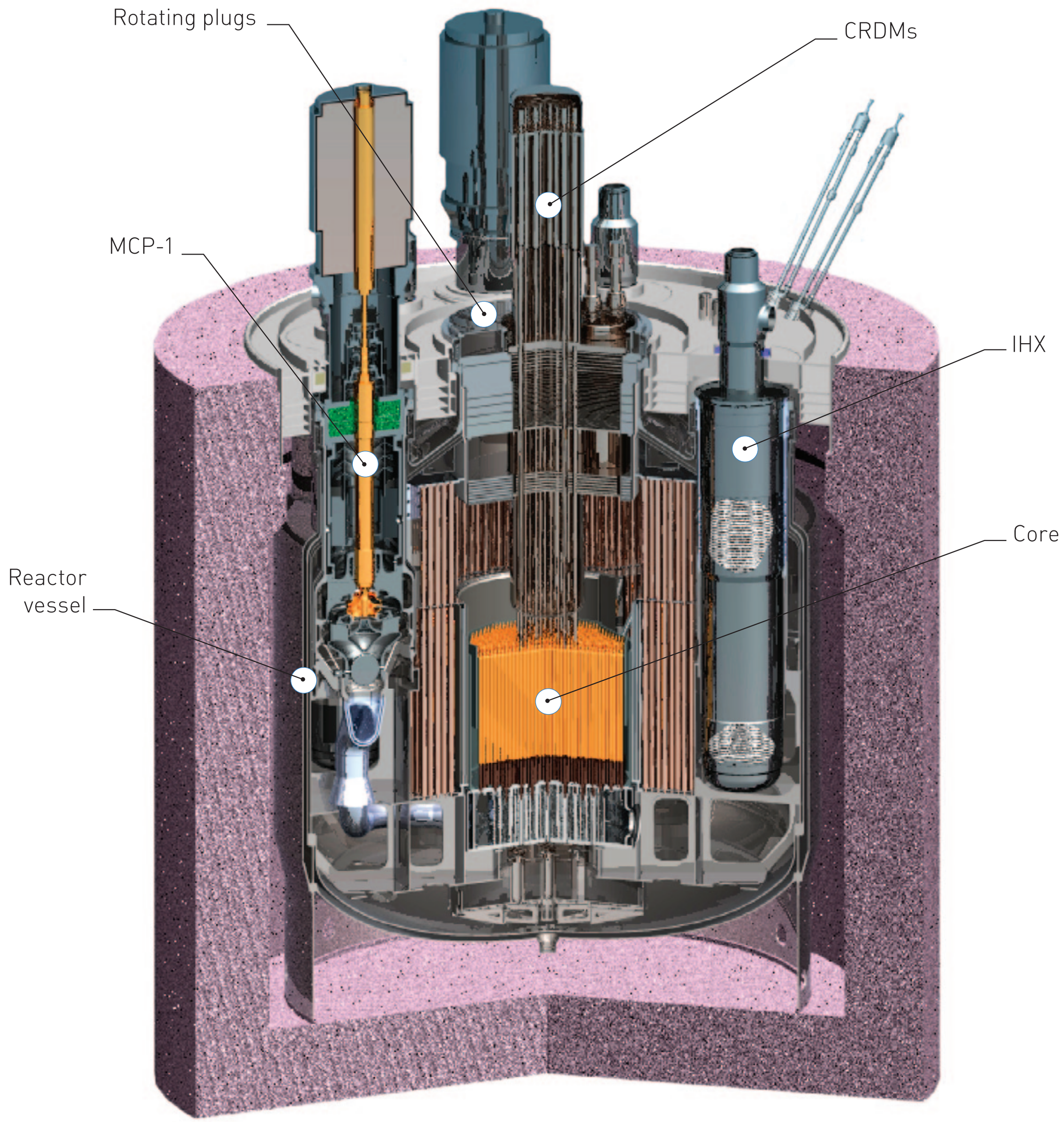
- integral reactor with the vessel supported from below;
- rotating plugs that were made leak-tight using tin and bismuth alloyed gates;
- special design of main and refueling equipment.



Schematic diagram of the BN-800 reactor plant

1 — reactor
2 — core
3 — intermediate heat exchanger
4 — MCP-1
5 — hydraulic lock
6 — compensating tank
7 — electromagnetic pump
8 — air heat exchanger
9 — MCP-2
10 — SG section
11 — buffer tank
12 — secondary draining tank
13 — emergency discharge tank

JSC "Afrikantov OKBM" is the Chief Designer and Complete Supplier of equipment for the BN-800 project.



BN-800 main primary equipment

Reactor Vessel

The reactor vessel accommodates internals, primary sodium and argon.

It is a cylindrical vessel with the cone head and elliptical bottom with the support ring.

The main vessel is enclosed in the guard vessel of which geometry repeats the geometry of the main vessel. The outer surfaces of the main and guard vessels are thermally insulated.

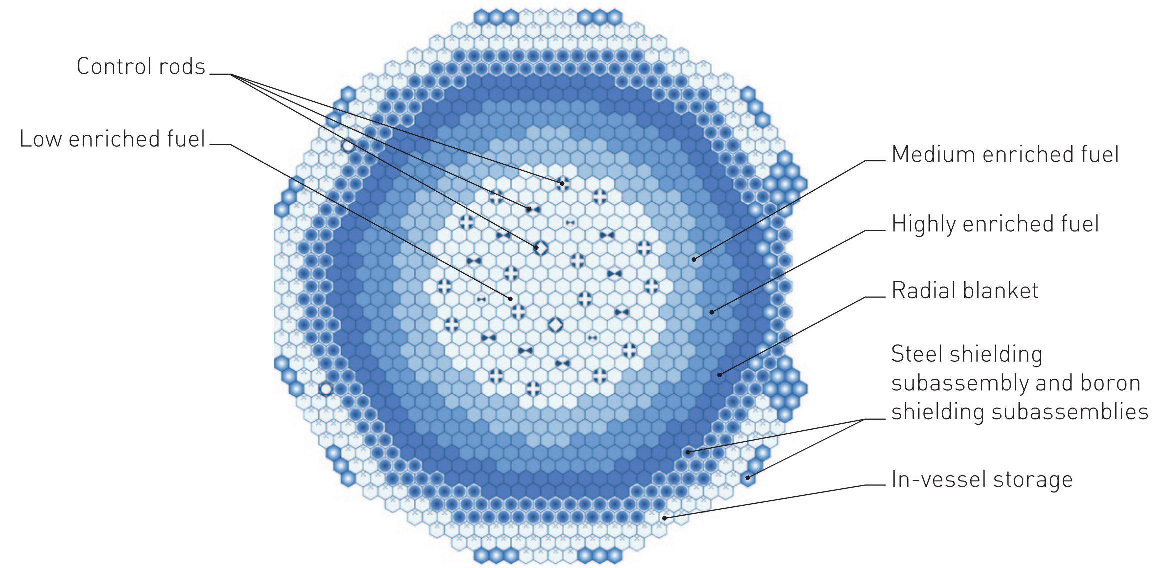
The main vessel accommodated the following:

- skirt that supports all internals and in-vessel equipment;
- distributing header with core assemblies;
- in-vessel protection that ensures minimum activation of primary sodium.

Reactor Core

The reactor core is made up of fuel assemblies, radial blanket, absorber rods, steel shielding assemblies, boron shielding assemblies and spent fuel assemblies in the in-vessel storage.

Radially, the core has three fuel zones with different plutonium mass in the uranium and plutonium mixture. They are zones of low, medium and high enrichment. Fuel in the core is encircled by the radial blanket with the depleted uranium.



BN-800 core map

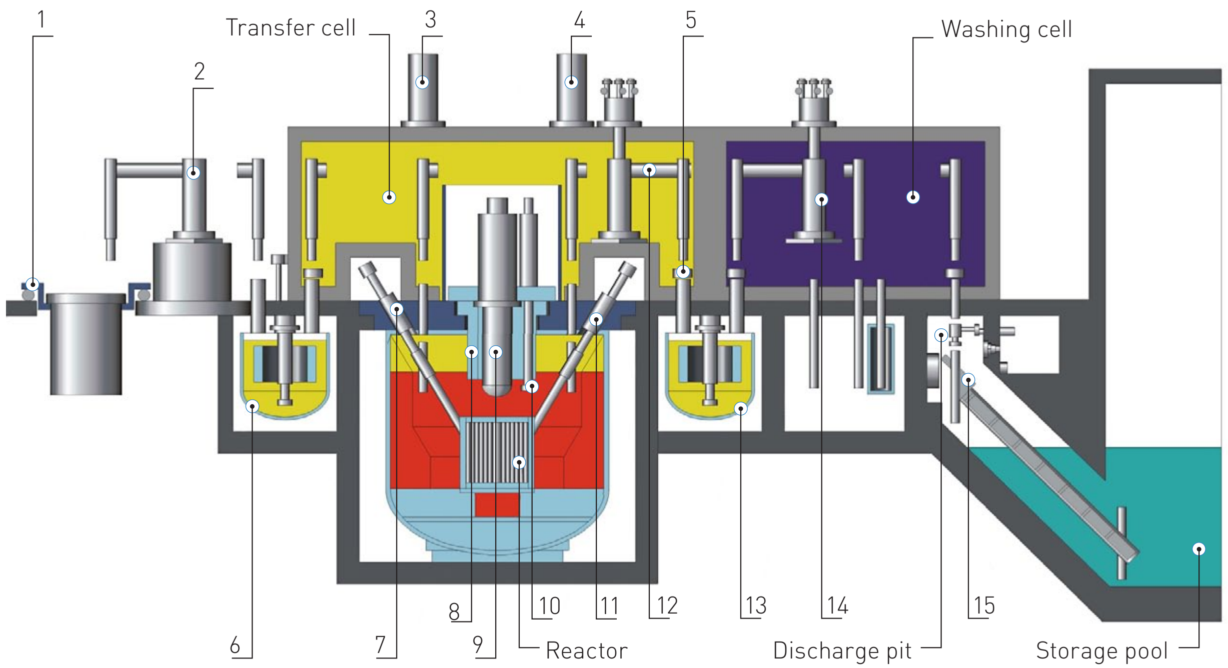
Refueling System

A set of refueling mechanisms moves core subassemblies along the refueling path and includes an in-vessel and ex-vessel portions. All mechanisms and equipment of this system operate during refueling and are in a standby position in between.

In-vessel refueling equipment performs the following.

1. Rotating plugs and central rotating column:

- accommodate refueling mechanisms and other equipment, guide the refueling mechanism towards the core cells and interface CRDMs with control rods;
- provide biological shielding and thermal protection for the operating personnel;
- seal the reactor primary circuit with respect to the environment in all operating modes of the plant;



BN-800 refueling scheme

1 — Rotating seat
2 — Fresh subassembly transfer mechanism
3 — Loading elevator plug lifting mechanism
4 — Unloading elevator plug lifting mechanism
5 — Gas gate valve
6 — Fresh subassembly drum
7 — Loading elevator
8 — Rotating plug
9 — Central rotating column
10 — Refueling mechanism
11 — Unloading elevator
12 — Fuel transfer cell mechanism
13 — Spent fuel drum
14 — Fuel washing cell transfer mechanism
15 — Inclined elevator of the fuel discharge pit

2. Refueling mechanism:

- withdraws, turns and installs subassemblies in the reactor core and elevator sleeves, as well as samples gas in the course of subassembly leak tests.

3. Elevator:

- moves core subassemblies from the reactor core to the reactor fuel handling cells and back.

The ex-vessel refueling system performs the following:

- takes fresh subassemblies to the fresh subassembly drum, heats them in the fresh subassembly drum before loading to the reactor and loads them into the reactor;
- unloads spent fuel assemblies from the reactor, places and temporarily keeps them in the spent fuel subassembly drum to remove residual heat;
- transfers spent fuel subassemblies from the fresh fuel subassembly drum to the washing cells and transfers them after washing to the inclined elevator of the fuel discharge pit;
- seals reactor fuel handling ducts and ducts of the fresh fuel drum and spent fuel drum;
- provides biological shielding for the operating personnel.

Spent fuel is transported along the external fuel handling duct in isolated gas volume in the inert medium.

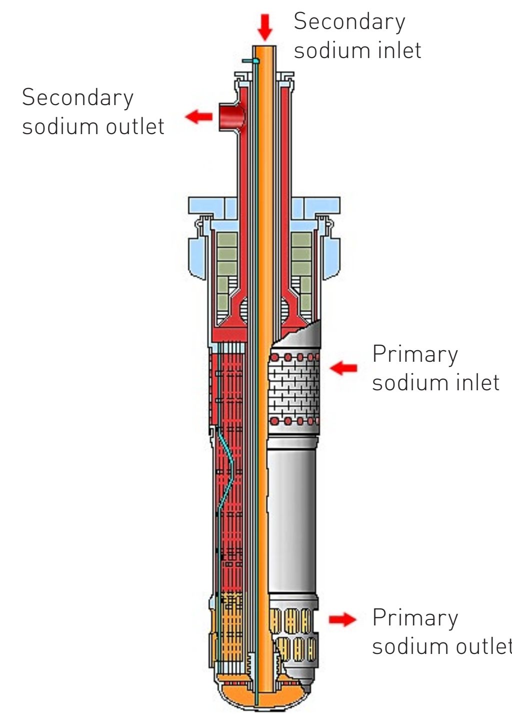
Intermediate Heat Exchanger

Intermediate heat exchangers transfer heat from the primary coolant that circulates on the shell side to the secondary sodium coolant that circulates in tubes. Six intermediate heat exchangers are used.

A vertical shell-and-tube counter flow heat exchanger with coaxial supply and removal of the secondary coolant is used. It has a tube system, pressure chamber and drainage chamber, central tube, protection tube unit, guard vessel and fasteners.

Main Characteristics

Thermal power, MW	350
Heat exchange surface, m^2	1657
IHX height, mm	13500
Mass, t	56
Assigned service life, years	45



BN-800 intermediate heat exchanger

Main Circulation Pump

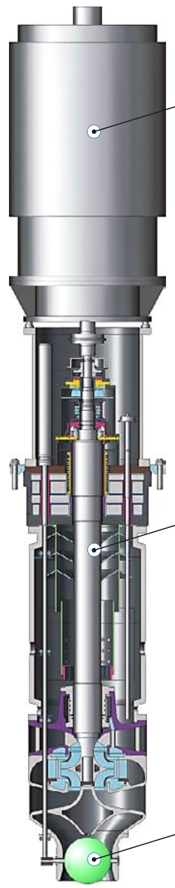
MCP-1 circulates sodium in the primary circuit of the reactor plant.

Centrifugal, vertical, immersible, one-step pumps, pumps with double-suction impellors, a lower hydrostatic bearing and mechanical gas shaft seal are used. Three MCP-1 are utilized.

The pump has such main parts as a pull-out part, electric drive, connection coupling, motor frame, check valve drive, level meter, flow meter, and auxiliary systems (oil, water, and gas systems).

Main Characteristics

Output flow, m^3/h	12300
Head, m	101
Pump height, mm	13500
Assigned service life (body components), year	45



BN-800 MCP-1

Steam Generator

An once-through, high pressure, section and modular steam generator is used. The steam generator in every loop has 10 sections, a buffer tank and connecting pipelines in the secondary and tertiary circuits; each section has two modules. The module is a vertical shell-and-tube straight tube heat exchanger. These modules are an evaporator and a superheater. The steam generator generates high pressure superheated steam. In all design modes of the reactor plant, during which feedwater is supplied, the steam generator cools the reactor.

Main Characteristics

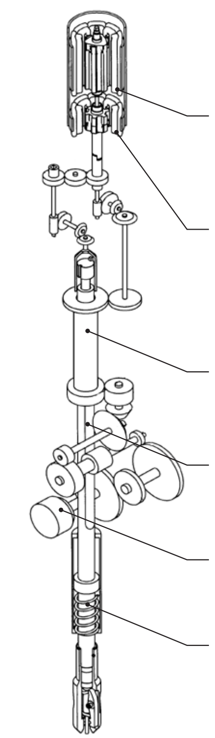
Thermal power, MW	700
Steam capacity, kg/s	292
Assigned service life, year	45

Control Rod Drive Mechanisms

CRDMs ensure assigned movements of control rods.

According to the functional purpose, control rods are divided into the following groups:

- 12 shim rods to compensate for the reactor reactivity margin — including thermal and power effect of reactivity — and to change this margin in the course of reactor operation; to compensate for the change in the reactivity margin with fuel burnup only shim rods in the outer ring are used;
- 2 control rods to control and maintain reactor power in the course of reactor operation;
- 9 scram rods to sharply reduce power and transfer the reactor to the subcritical state in abnormal operation and emergency situations;
- 3 passive control rods to shut down the reactor in beyond-design basis accidents at failure of scram rods, shim rods, and control rods. Passive control rods are suspended by the sodium flow through the sleeves of the passive emergency protection and are automatically inserted into the core at a decrease in the sodium flow rate to 50% of the nominal value, including in case of scheduled reactor shutdown and in design modes accompanied with emergency protection actuation.



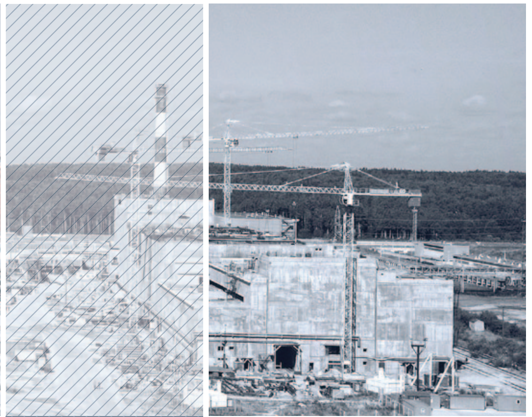
Kinematic diagram of a dummy shim rod

Safety of the BN-800 Reactor Plant

The BN-800 design is based on progressive solutions to enhance safety:

- emergency cooling down system with the air heat exchanger connected to the secondary circuit;
- core with the sodium void effect of reactivity close to zero;
- passively hydraulically suspended control rods;
- tray under the pressure chamber to catch corium at core melting in case of a severe accident.

With implemented improvements, the BN-800 design satisfies requirements set for prospective nuclear power units with respect to the safety level.



Construction stage, March 2010

Construction stage, July 2014

Construction stage, July 2011

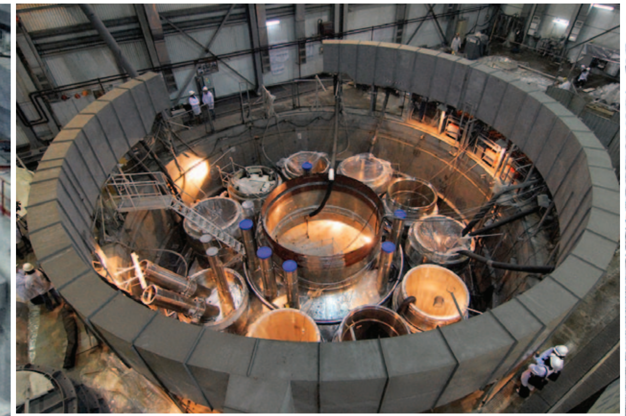
Installation of the on-site transportation package set in the reactor hall

Installation of the reactor head

Construction stage, June 2009

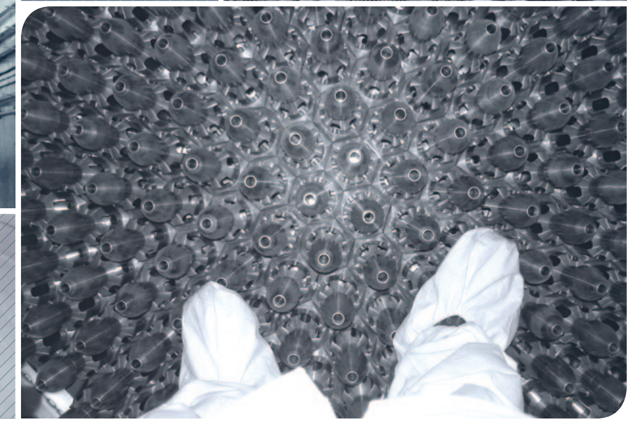
BN-800 reactor hall

Installation activities, February 2014



Construction stage, July 2011

Installation of the pump



PROSPECTS OF THE FAST REACTOR TECHNOLOGY — BN-1200 PROJECT

Development and implementation of the BN-350, BN-600 and BN-800 projects made it possible to set up an effective design, production and operation infrastructure as a base for further development of the fast reactor technology.

Objectives of construction:

- make a reliable design of the next generation reactor plant for the serial commercial power unit equipped with the fast reactor intended to fulfill top-priority tasks of transition to the closed fuel cycle in nuclear power;
- raise technical and economic indicators of the power unit equipped with the fast reactor to the those of the state-of-the-art VVER of the same power;
- enhance safety to satisfy requirements set for Gen IV reactor plants.

The BN-1200 design has used the main technical solutions proved for the BN-600 and BN-800 designs.

To enhance safety and raise cost efficiency, several new circuit and layout solutions have been used:

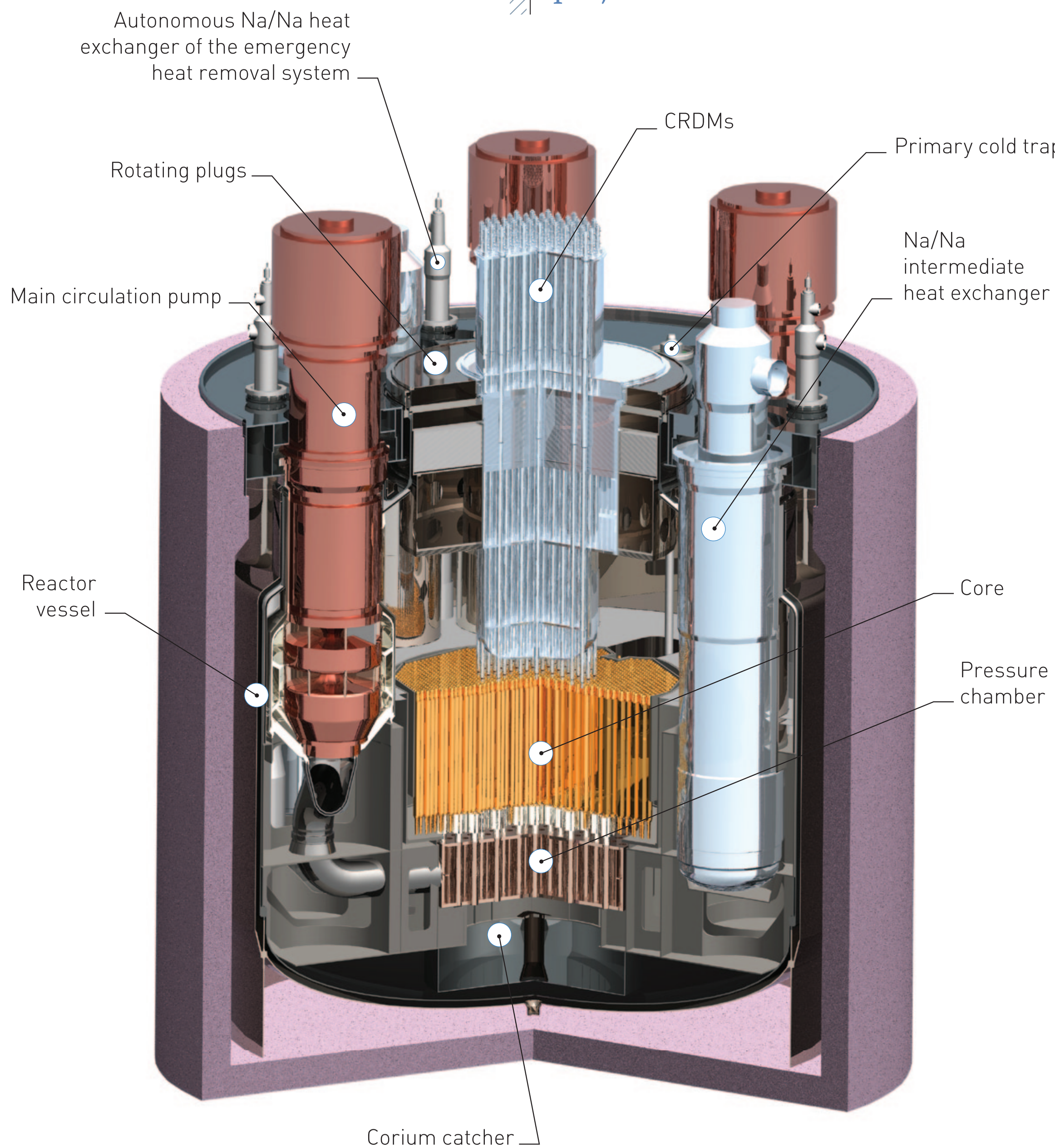
- integral primary circuit with all sodium systems — including cold traps, neutronic and chemical monitoring systems — in the reactor tank;
- transfer from section modular steam generators to integral generators based on large capacity straight tube modules that significantly reduces material consumption;
- long-term hold of fuel assemblies in the in-vessel storage that made it possible to exclude the sodium drum in the refueling system;
- long fuel life due to enlarged fuel assemblies that will reduce costs for fuel.

Power of the serial power unit has been selected based on the following requirements:

- the same electric power as that of NPP-2006 to ensure coordinated selection of NPP sites and to unify the turbogenerator and other electric equipment of the electricity output system;
- portability of large-sized equipment by rail (reactor vessel and large rotating plug are assembled at the site).

JSC "Afrikantov OKBM" is the Chief Designer of the BN-1200 reactor plant and coordinates required research and development, including defining optimal design solutions for the power unit.

JSC "Afrikantov OKBM" hosts the Responsibility Center for the BN-1200 project.



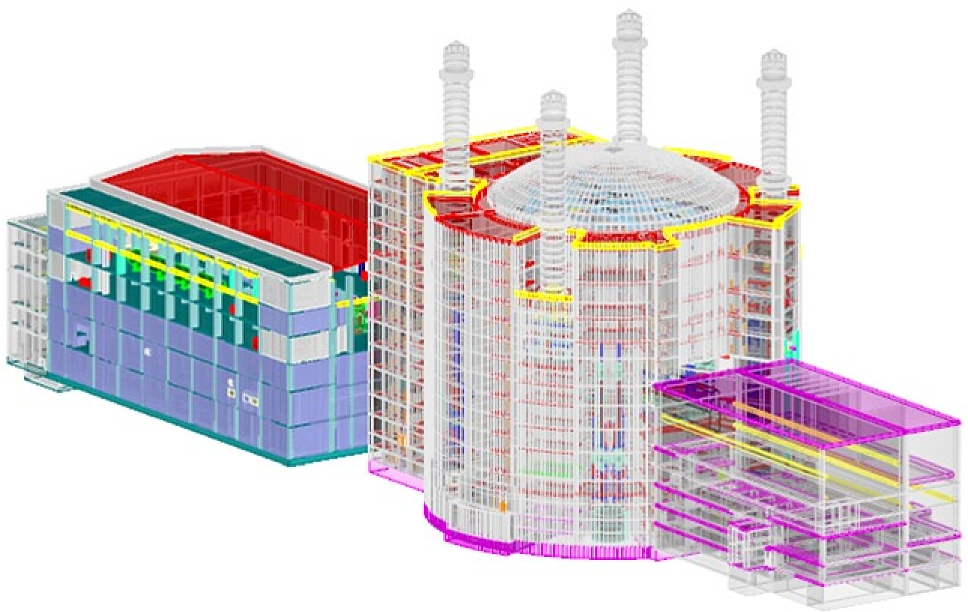
BN-1200 main primary equipment

Safety of the BN-1200 Reactor Plant

The BN-1200 reactor plant design uses several new technical solutions for enhancing safety:

- Sodium systems and primary equipment are fully integrated in the reactor tank with the system for sodium purification from oxides also located in the reactor tank to exclude radioactive sodium leaks and sodium interaction with air that is the severest design basis accident in fast reactors.
- The improved emergency heat removal system is used with autonomous heat exchangers built in the reactor vessel that ensures natural sodium circulation immediately through the core fuel assemblies due to the passive check valve in the autonomous heat exchanger to increase the quantity of removed power at the admissible temperature state of the core.
- In addition to the PAZ-G passive shutdown system based on hydraulically suspended rods, which was well proven in BN-800, the PAZ-T system of rods that respond to the change in the sodium temperature at the core outlet is implemented. These devices are sensitive to the increase in the coolant temperature in all accidents with the imbalance between power and flowrate and therefore they ensure additional enhancement of reactor plant safety.
- A compartment above the reactor is leak-tight to isolate radioactive products in case of severe beyond-design basis accidents.

The BN-1200 design implemented in the head power unit and next series of the power unit will make it possible to retain the scientific and production potential and strengthen the leading position of Russia in the world with respect to the fast sodium reactor technology.



BN-1200 power unit planned for Beloyarsk NPP, Unit 5

EVOLUTION OF TECHNICAL SOLUTIONS FOR SAFETY ENHANCEMENT OF FAST REACTOR DESIGNS

	BN-600	BN-800	BN-1200
1. Solutions for sodium circuits:			
– sodium-sodium intermediate circuit	+	+	+
– jacketing of vessels with radioactive sodium	+	+	+
– jacketing of pipelines with radioactive sodium	+	+	Pipelines with radioactive sodium have been excluded
– jacketing of secondary pipelines	-/+ (partially)	-/+ (partially)	+
2. Emergency protection:			
– active	+	+	+
– passive based on hydraulically suspended rods	-	+	+
– passive based on the temperature principle	-	-	+
3. Emergency heat removal system:			
– within the tertiary circuit	+		
– air heat exchangers are connected to the secondary circuit	-	+	
– air heat exchangers are connected to the primary circuit	-	-	+
4. Core melt retaining system	-	+	+
5. Emergency discharge isolation system	-	-	+

Solutions adopted for the design of reactor plants, use of passive safety systems and inherent safety properties of the sodium coolant make it possible to ensure the safety level that excludes necessity of population evacuation in case of any technically possible accidents.

CONCLUSION

Russia has gained a significant experience in development and fabrication of sodium-cooled fast reactors. This experience demonstrates that this reactor technology is well mastered and reliable thus making it possible to achieve a high level of safety and competitiveness in prospective fast reactor designs. Development and implementation of BN-350, BN-600, and BN-800 reactor plants has made it possible for OKBM to make an effective design and production infrastructure which is a basis for further development of the fast reactor technology.

Operation of the BN-800 reactor plant will make it possible to check efficiency of new technical solutions and ensure transition to development of the serial BN-1200 reactor plant and a production infrastructure for the closed nuclear fuel cycle.

The BN-1200 concept is based on a large positive experience in development and operation of sodium-cooled fast reactors and maximum possible use of achievements of this technology thus making it possible to develop in the nearest term a reliable head power unit followed by serial construction.

Technical and economic indicators of the BN-1200 power unit developed for serial construction are comparable with ones of next generation pressurized water reactors.

Implementation of the fast reactor technology will make it possible to:

- develop competitive NPPs with the high safety level;
- make the structure of the closed fuel cycle at the production scale to solve the issue of fuel supply for the nuclear power in the long prospect;
- reduce the scope of radioactive waste by processing the VVER spent nuclear fuel and by using plutonium and minor actinides extracted from it.

ABBREVIATIONS

BN	Sodium-cooled Fast Reactor
CRDM	Control Rod Drive Mechanism
EM	Electromagnetic
IHX	Intermediate Heat Exchanger
JSC	Joint Stock Company
MCP-1	Primary Circulation Pump
NPP	Nuclear Power Plant
RP	Reactor Plant
SG	Steam Generator
SNF	Spent Nuclear Fuel
VVER	Pressurized Water Reactor