

2. NEUTRON SOURCES

2.1. The IBR-2 Pulsed Reactor

In the 2002 the IBR-2 reactor operated in accordance with the approved working schedule. It operated 8 cycles (2133 hr) at W=1,5 MW for physical experiments with 3 cases of emergency shutdowns by the automatic emergency system (AES). The details of the IBR-2 operation are summarized in Tables 1 and 2.

Table 1

**The operation parameters of the IBR-2 reactor in the period
from January 1, 2002 to January 1, 2003**

Cycle №	1	2	3	4	5	6	7	8	TOTAL:
<i>Time of cycle</i>	14.01 - 25.01	11.02 - 22.02	11.03 - 22.03	08.04 - 19.04	13.05 - 24.05	21.10 - 01.11	11.11 - 22.11	02.12 - 13.12	
Operation for physical experiment, hr	265	264	263	260	262	267	267	265	2113
Operation of movable reflector, hr	274	275	276	272	274	276	276	276	2199
Generated power, MW·hr	400	378	397	394	397	403	403	400	3172
Number of emergency shutdowns (AES)	–	–	1	1	1	–	–	–	3
Due to:									
▪ Voltage drops	–	–	1	1	1	–	–	–	3
▪ Instrumental malfunction or failure	–	–	–	–	–	–	–	–	0
▪ Electronic equipment failure	–	–	–	–	–	–	–	–	0
▪ Personnel error	–	–	–	–	–	–	–	–	0

Table 2

The IBR-2 parameters as of 01.01.2003

№	Parameter (counted from the start of reactor operation)	Actual	Rated
1	Total operation time for physical experiment, hr	42746	
2	Total generated power, MW·hr	77690	85000
3	Mechanical operation time of the movable reflector MR-2P, hr Radiation generation by MR-2P, MW·hr (with the flux density over the center of the blade $5 \cdot 10^{13} \text{ n/cm}^2 \cdot \text{MW}$ for neutrons with $E > 0,1 \text{ MeV}$)	18268 30462	19000 36000
4	Maximum fluence on the reactor jacket in the center of active zone (10^{22} n/cm^2): • for $E_n > 0,1 \text{ MeV}$ • for $E_n > 0,8 \text{ MeV}$	3,36 1,45	3,72
5	Maximum fuel burn, (%): • for pellet TVELs • for spigot TVELs	5,8 6,3	6,5 8,2
6	Reactivity resource, (%)	0,47	
7	Total number of emergency shutdowns	441	550

Main results of the IBR-2 modernization in 2002:

1) MR-3 – chief task of the year

1.1. JINR EW :

- Manufacturing of the MR-3 parts is completed in the main.
- Test assembling of the manufactured parts (carriage, platform, technological frame, dismountable shielding) and elimination of faults are under way.
- Working assembling of the reduction gearbox is carried out.

1.2. NIKIET

- Main reactivity modulator was manufactured and handed over to FLNP.
- Auxiliary reactivity modulator is planned to be completed by 30.12.2002.
- Manufacturing of the jacket is delayed due to the technological problems, which arose during its welding.

2) New fuel assembly

2.1. Manufacturing of PuO₂ pellets is in progress at the Industrial Enterprise «Maiak» (~ 50 %).

Date of TVEL completion was corrected – 2nd quarter of 2003.

2.2. Manufacturing of the fuel assembly parts was started.

2.3. Investigation of two used fuel assemblies from IBR-2 was completed in NIKIET.

3) Working documentation

3.1. Working design of a new jacket for the IBR-2M reactor was completed, working drawings were handed over for manufacturing.

3.2. Detail designing of stationary reflectors, rolling shieldings, etc. was started.

3.3. Project of works to disassembly the existing jacket of IBR-2 was completed, project of works to assembly a new jacket of IBR-2M was started.

4) CSS

4.1. A full-scale test-bench was created in FLNP to study the automatic emergency system motor drive of the IBR-2M, first investigations proved the efficiency of the technical project solutions in the speed of response of the automatic emergency system (AES).

4.2. Search for cheaper variants to create electronic equipment was continued.

5) Helium facility

5.1. Engineering design of a special helium facility for the cold moderator was completed.

5.2. Detail designing is in progress.

To provide the above-mentioned works a sum of about 553 k\$ was spent in 2002, according to the plan 700 k\$, including JINR – 130 k\$ (according to the plan 250 k\$), MAE – 423 k\$ (according to the plan 450 k\$).

Plan for the modernization of IBR-2 in 2003

1. MR-3 (chief task):

- test assembling of MR-3 and bench tests;
- moving of MR-3 to bldg. 117, its assembling and tests at a regular place.

2. Fuel assembly of IBR-2M:

- completion of manufacturing of TVELs,
- manufacturing of the fuel assembly parts.

3. *Development of design documentation:*

- working documentation for the IBR-2M reactor equipment,
- project of works to assembly the new jacket of IBR-2M.

4. *Manufacturing of the IBR-2M reactor jacket.*

5. *Development of the design of CSS electronic equipment.*

6. *CHF:*

- completion of the working design;
- manufacturing of CHF.

2.2. The IREN Project

The plans of activity for 2002 included three main items:

1. Preparation for full decommissioning of the IBR-30 reactor.
2. Completion of the approved part of the IREN working project and creation of the design documentation for manufacturing the multiplying target.
3. Manufacturing of elements of the LUE-200 accelerator and start-up of its dismantling in bldg. 43 of FLNP.

The detailed time-tables for realization of this program were prepared in FLNP and LPP together with external partners involved in the implementation of the project. These documents were presented to the JINR Directorate together with the request for necessary funding in the amount of 570K\$. After consideration of financial possibilities of JINR, a special grant of the Directorate at the rate of 380 K\$ was allocated for realization of the project. In the first half of the year the work schedule and financial plan were executed with a delay of no more than one quarter, and by July 15 about 180 K\$ was invested, which made it possible to cover debts for 2001 and to pay for necessary materials and works under contracts. But in the following period payments became irregular and insufficient to purchase equipment and to ensure the continuation of activity both in the Laboratories of JINR and in external organizations.

In spite of lack of financing many items of the plan of IBR-30 decommissioning were fulfilled. In particular, the construction of building 117/6 for storing activated elements of IBR-30 was practically completed by the end of 2002. However, because of the delay in purchase of the dosimetric equipment and creation of the physical protection system of the building, its official commissioning, including licensing, is shifted to the second quarter of 2003. The most part of the equipment necessary for dismantling the active zone of IBR-30 was designed and manufactured in the JINR Experimental Workshop. Two test-benches intended for training the personnel who should perform the most important and “dirty” operations in the course of the reactor dismantling were equipped and officially accepted for operation. In October, 2002, a special commission of Gosatomnadzor inspected the state of affairs and compliance with the terms of the license for decommissioning of IBR-30 and approved the realized part of the program. However, in the inspection report the delay in the fulfillment of the work schedule for at least four months was noted. Nevertheless, works to dismantle the reactor can be started in July, 2003, providing the allocation of necessary funds.

The contracts concluded with NIKIET, Moscow, in the first quarter of 2002 to work out the design documentation for manufacturing of the IREN multiplying target and to create a technical project of the control system for the facility were actively executed, in spite of lack of financing. The technical specification for the control system was prepared in close cooperation of experts from JINR and NIKIET and agreed with all involved services of JINR. More difficult situation was with the completion of the working project of the IREN facility developed by GSPI, Moscow. After a number of shifts the agreement was achieved that the approved part of the working project should be completed in May, 2002. However, the preliminary version of this document was submitted for approval to JINR only in October.

Even in conditions of irregular and deficient financing the work schedule to create systems for the linac LUE-200 was fulfilled only in the part implemented by the JINR Laboratories. A very difficult problem of advanced development of the design documentation necessary for manufacturing of elements of the LUE-200 accelerator was solved by the LPP and FLNP design offices. Design engineering of all elements of the linac located in the accelerating halls of bldg. 43 of FLNP was completed. We managed to complete the manufacturing of the form for the accelerator, and also of some elements of the magnetic focusing system. However, works to manufacture the power supply system of the solenoid and some elements of the HF systems executed in BINP, Novosibirsk, are carried out with a considerable delay for lack of financing.

More favorable situation was with the tests of the HF system on a full-scale test-bench. The ten-day session of continuous operation of the modulator with a klystron at HF power level of no less than 70 % of the design value was successfully conducted. All elements of the HF feeder were tested and certified. A part that had no necessary parameters was given to the manufacturers for reconstruction. The electron source was assembled on the test-bench and will be tested in January, 2003. The designing of the control system of the accelerator was completed. A part of the equipment necessary for creation of this system was purchased and tested in the structure of the control system of the HF full-scale test-bench. A considerable part of quadrupole lenses was produced in the workshop of LHE. First two modules of the solenoid were manufactured in LPP for testing and certification on the test-benches of precise magnetic measurements in LPP and DLNP. The majority of elements of the linac vacuum system were tested and prepared for installation in bldg. 43.

It should be noted that the works conducted in the JINR Laboratories were remunerated from a special bonus fund allocated by the JINR Directorate. Without this support it would be impossible to perform design works, to dismantle auxiliary systems of the IBR-30 reactor, to start repairing the accelerating halls in bldg. 43 and to realize the most part of works on creation of the elements of LUE-200.

The total investments volume in the project by the end of 2002 was 312 K\$, including payment to EW JINR for works that will be completed in 2003.

Summing up the fulfillment of the IREN project in 2002, it should be noted that the work schedule was only partially executed. The backlog is two quarters, on the average. So, the start-up of the linac is possible in 2004 and the completion and start-up of the first stage of the IREN project is shifted for 2005. The specified dates can be met providing the availability of necessary funds within the next three years.