2. NEUTRON SOURCES

2.1. The IBR-2 Pulsed Reactor

In the year 2001 the IBR-2 reactor operated in accordance with the approved working schedule. It operated 8 cycles (~2066 hr) at W=1.5 MW for physical experiments with 8 cases of emergency shutdowns by the automatic emergency system (AES). The details of the IBR-2 operation are summarized in Tables 1 and 2 and Figures 1 and 2.

Table 1

The operation parameters of the IBR-2 reactor in the period from January 1, 2001 to January 1, 2002

Cycle №	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	***Total:***
Time of cycle	*15.01 – 26.01*	*19.02 - 02.03*	*12.03 – 23.03*	*9.04 - 25.04*	*14.05 - 25.05*	*22.10 - 3.11*	*12.11 - 23.11*	*03.12 - 14.12*	
Operation for physical experiment, hr	267	241	263	259	264	249	257	266	**2066**
Operation of movable reflector, hr	275	270	278	276	273	273	274	275	**2194**
Generated power, MW·hr	403	370	399	393	402	381	389	401	**3138**
Number of emergency shutdowns (AES)	–	3	1	2	–	1	1	–	**8**
Due to:									
▪ Voltage drops	–	1	–	–	–	1	1	–	**3**
▪ Instrumental malfunction or failure	–	1	–	1	–	–	–	–	**2**
▪ electronic equipment failure	–	–	–	–	–	–	–	–	**0**
▪ personnel error	–	1	1	1	–	–	–	–	**3**

Table 2

The IBR-2 parameters as of 01.01.2002

№	**Parameter (counted from the start of reactor operation)**	**actual**	**rated**
1	Total operation time for physical experiment, hr	40633	
2	Total generated power, MW·hr	74498	85000
3	Mechanical operation time of the movable reflector MR-2P, hr	16060	18000
	Radiation generation by MR-2P, MW·hr *(with the flux density over the center of the blade $5 \cdot 10^{13} n/cm^2$ for neutrons with E>0.1 MeV)*	27150	36000
4	Maximum fluence on the reactor jacket in the center of active zone (10^{22} n/cm^2):		
	• for En > 0.1 MeV	3.21	3.72
	• for En > 0.8 MeV	1.38	
5	Maximum fuel burn (%):		
	• for pellet TVELs	5.6	6.5
	• for spigot TVELs	6.0	8.2
6	Reactivity resource (%)	0.69	
7	Total number of emergency shutdowns	438	550

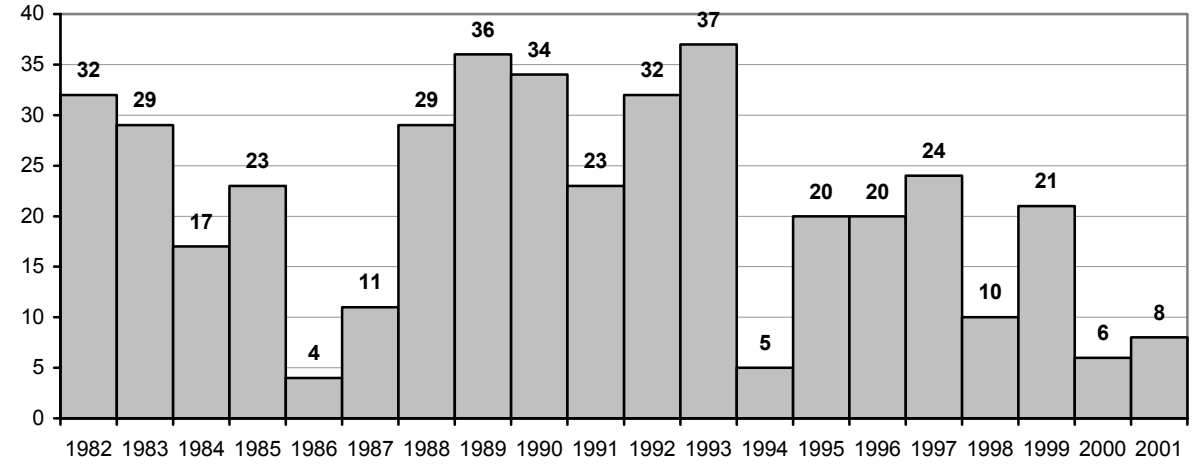

Fig. 1. *The number of unscheduled (AES-triggered) shutdowns per year*

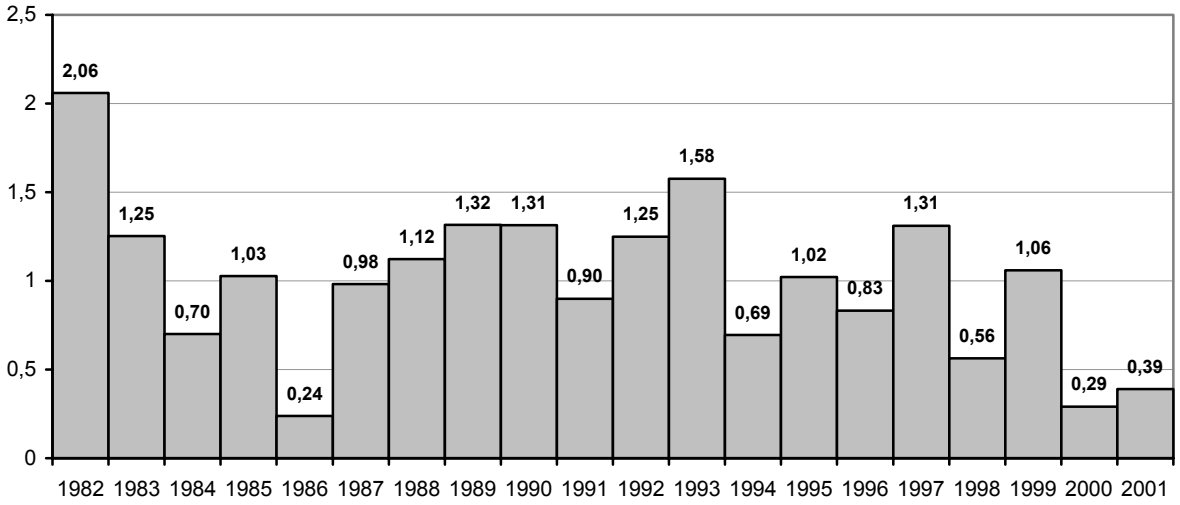

Fig. 2. *The number of unscheduled (AES-triggered) shutdowns per 100-hour operation time*

In the scheduled period (June-October) the preventive maintenance plan for 2001 (PMP-2001) was executed, including the removal of the used movable reflectors from the operative depository. The MR-2 taken out of operation in 1994 was removed providing a space for the MR-3 in the operative depository for the modernization period.

For safety reasons a diesel electric power station to be used in the event of failure of the IBR-2 regular power supply systems was put into operation in 2001.

In 2001, IBR-2 modernization works were conducted as planned:

1. MR-3 (chief task):

   The readiness of the parts is over 50%; an agreement with the "BRUEL&KJAER VIBRO A/S" for the delivery of vibration control equipment for MR-3 was signed; the method was developed and an ultrasonic test of forgings from nickel alloy to manufacture reactivity modulators was conducted. The working schedule on MR-3 project is presented in **Fig. 3.**

2. Manufacturing of TVELs:

   − The industrial enterpriseна "Maiak" completed works to reinforce the shielding of the facility "Packet" for the manufacturing of TVELs for IBR-2,

- The technology of the manufacture of pellets for TVELs is was developed,
- Investigations of 2 used fuel assemblies from IBR-2 with a maximum burn (5%) are set up in NIKIET.

3. The technological project for the modernization of IBR-2 is completed in the main. The technical solution that would allow the replacement of moderators without the dismantling of the executive mechanisms of the Control and Safety System (CSS) was found. General types of CSS motor drives and prototypes of the AES motor drive were developed.
4. Started the working drawings of the reactor jacket.
5. The technical project for the disassembly of the IBR-2 jacket was elaborated.
6. The "Geliimash" started the development of a special cryogenic helium facility for the cold moderator.

In 2001 the financing of works on IBR-2 modernization went in accordance with the plan (see Table 3).

Table 3

The financing of the project "IBR-2 Modernization" in 2001 (k$)

Working direction	JINR		MAE		Σ	
	Plan	Actual	Plan	Actual	Plan	Actual
MR-3	140	**189**	89	**89**	229	**278**
TVELs	68	**23**	154	**159**	222	**182**
Basic equipment	283	**21**	57	**53**	340	**74**
TOTAL:	491	**223**	300	**301**	791	**534**

Plan for the modernization of IBR-2 in 2002

1. MR-3:
   - Complete manufacturing in the 2nd quarter of 2002,
   - Test assembling (beginning) – 3rd quarter, 2002.
2. Development of design documentation:
   - Working documentation for the reactor equipment,
   - Project of works to disassembly the existing jacket.
3. Construction of a prototype of the AES CSC motor drive.
4. The reactor jacket (start manufacturing).
5. Fuel assembly for IBR-2M:
   - Manufacturing of TVELs,
   - Manufacturing of the fuel assembly parts.
6. CSS electronic equipment: development of the project.
7. CHF for CM: development of the project.