1.4. APPLIED STUDIES

Nuclear data for nuclear energetics. Within the program for creating a new generation of power reactors, measurements were performed at the IBR-30 booster of the total transmission and self-indication functions in the fission cross sections for ^{232}Th, ^{238}U, and ^{239}Pu nuclei within a wide range of neutron energies up to 200 keV. An analysis has been completed of the results of measurements with the ^{238}U isotope in the range of energies from 0.465 to 200 keV. The resonance self-screening factors in cross sections were found which are used in practical calculations of nuclear reactors and of radiation shielding. The coincidence, within standard deviations, of the total and partial transmissions at energies above 20 keV points to the absence of resonance self-screening in the radiative capture cross section. The non-exponential behavior of the total transmission points to resonance blocking of the total cross section throughout the entire energy range. The results of the measurements were used for estimating the average resonance parameters: scattering radii and neutron force functions.

Modernization of the DIN-1 installation located at IBR-30 beam N 7 was carried out for measuring thermal cross sections of reactor materials. Implementation of the program of measurements has started.

Activation analysis. The preceding report announced the development of devices such as "AZOT" for express analysis of the nitrogen content in food grains, combined fodder and nitrogen-containing organic compounds. During the period covered by the report, modification and correction of the techniques and schematic solutions on the basis of industrial tests were performed. The final documentation has been given to the Institute of Technical Physics (Chelyabinsk-70) for serial production of instruments. Technical support was also given in adjusting the devices. The technical facilities of the instruments, obtained in the course of multi-year tests, were reported at a scientific conference held in the USA.

Methodological work has been completed on the utilization of moss and of pine-tree needles for biomonitoring atmospheric deposition with the aid of instrumental neutron activation analysis (INAA). Utilization of the record-breaking flux of resonance neutrons from the IBR-2 reactor made it possible to extend the number of identified elements up to 40 (for comparison, in Norway 20 elements were identified). Metals from vanadium to uranium, including REE, are reliably identified, as are a number of non-metal elements. During the years covered by the report this technique was applied in studies of the distribution of atmospheric deposition at a series of sites in Norway and at 20 points on the Kola peninsula. In the latter case, the depositions, including those of nickel, were traced from nickel factories to distances of up to 300-500 km. The work was carried out jointly with the University of Tronheim and the RAS Institute of Ecology of the North.

Complex studies of pollution by heavy metals and REE of the basins of the Upper Volga and Oka have been carried out in collaboration with the RAS Institute of the Lithosphere of the Earth. Water, residues, etc., were used for monitoring. A number of anomalies in the pollution were revealed. For example, one of the tributaries of the Oka river is strongly polluted with zirconium.

Neutron radiography. Studies were carried out of the transportation of gadolinium ions along micro cracks in concrete. The results permitted the conclusion that the technique of dynamic radiography can be used at neutron beam N11 of the IBR-2 reactor for studying the transportation of ions of gadolinium and cadmium, of analogs of calcium, potassium and sodium, and of chlorine also.

Experiments have revealed that, unlike H_2O, ions and their complexes are transported deep into concrete not in the course of diffusion through the main matrix of the material, but only along micro cracks with dimensions from 30 to 1000 μm. Knowledge of such non-stationary transport processes is extremely important for studies of the aging of concrete, especially of concrete under stress in a water medium with admixtures of heavy metal ions and organic compounds. This work was carried out jointly with the Institute of Non-Destructive Methods of Control (Saarbrucken). The project of a device for dynamic radiography is scheduled to be prepared jointly in 1994.

Radiation studies. In accordance with the proposal of physicists from LSHE JINR, CERN and FRG, studies have been initiated at the IBR-2 reactor of the radiation resistance of various detectors and electronic devices developed for experiments at the new powerful hadron colliders. A series of studies of the radiation resistance of Si-detectors in beams of fast neutrons has been carried out. For the first time have data been obtained on the possibility of using the chosen type of detector in the case of fast neutron fluences up to 10^{14} n/cm^2. The results of studies have shown that such detectors can be applied both in experiments at accelerator complexes and in constructing rapid mosaics for detecting thermal neutrons from pulsed neutron sources.

Irradiation of electronic equipment based on GaAs comprising 20 low-noise preamplifiers and shapers has revealed that the parameters of the equipment start changing when a fluence of 10^{14} n/cm^2 is accumulated, and that the equipment becomes totally inoperative after receiving a fluence of 10^{15} n/cm^2.

Neutron doping of silicon. The possibility of neutron doping of silicon was studied in 1992 at beam N 3 of the IBR-2 reactor. A monocrystal silicon ingot 61 mm in diameter and 242 mm long was irradiated using an experimental setup. Measurement of the electric parameters of the doped ingot showed that its average specific resistance of 61 Ohm·cm was in accordance with the requirements of the customer, within a spread not exceeding 3%.

The design, construction and assembly of a setup for commercial production (up to 1500 kg) of neutron doped silicon monocrystals (with maximum dimensions of ϕ127 mm x 370 mm) were completed in 1993. Work has started to put it in operation and for adjustment. Test runs have been carried out for irradiation of silicon samples at a reactor power of 100 kW with the aim of determining the operational parameters of the setup.