USE OF RESEARCH REACTORS IN SOVIET ATOMIC CENTRES

The manner of controlling and directing research reactors in the USSR was described in October at the IAEA seminar for atomic energy administrators by Dr. U.V. Archangelski, Department Chief, State Committee for Utilization of Atomic Energy, USSR. He also enumerated the research reactors in operation. In addition to the portions of the paper which are quoted below, he gave details of the scientific work being carried out in these reactors.

Dr. Archangelski described how the establishment of Soviet atomic centres is proceeding in two ways: centres using standard reactors intended principally for training technical staff and for instructing experts from other fields in the applications of atomic energy; and highly specialized centres equipped with specialized reactors for use in specific sectors of science and technology. The current programme of research reactor building was adopted in 1956-57, and will be completed by 1965.

The installations which have been found technically and economically most suitable are water-moderated, water-cooled reactors with a beryllium or graphite reflector, and operating on medium- to highly-enriched uranium. This type is superior to all others in its ability to produce fairly high neutron fluxes of varying energies using relatively low power, in the simplicity of its heat exchange, control, and shielding systems, the low capital outlay and the moderate expenditure on fuel and operating costs. These qualities, together with safety, have led to the use of these reactors on a wide scale, and most of the research reactors already built or being built in the Soviet Union are of this type. Their power varies from 5 to 50 000 kW, and they provide neutron fluxes ranging from 10^{11} to 2×10^{15} n/cm^2/sec.

Research reactors are constructed by institutes and laboratories under the control of the authorities listed below, and also by organizations and institutes operated by various State Committees on particular branches of science and technology. Both the immediate operators and outside organizations are enabled to use the reactors in their research.

1. USSR State Committee on the Utilization of Atomic Energy:

Type of Reactor	Date of Start-up	Purpose	Operator
IRT-2000	1957	nuclear physics, molecular physics, radiation chemistry, radiobiology, isotopes	Atomic Energy Institute, Moscow
TVR	1948	nuclear physics, technical research	Theoretical and Experimental Physics Institute
VVR-2	1957 (after reconstruction)	nuclear physics, molecular physics, radiation chemistry, radiobiology, isotopes	Atomic Energy Institute, Moscow
RFT	1958 (after reconstruction)	materials testing, physics and technical research	Atomic Energy Institute, Moscow
SM-2	1961	materials testing, research on transuranic elements, nuclear physics	Atomic Reactor Institute, Ulyanov Oblast

2. Academies of Sciences in the Union Republics:

VVR-M	1959	nuclear physics, solid-state physics, isotope production, technical research	Physics and Technical Institute, USSR Academy of Sciences, Leningrad
VVR-M	1960	"	Physics Institute, Ukrainian Academy of Sciences, Kiev
VVR-S	1960	nuclear physics, isotope production, training	Nuclear Physics Institute, Uzbek Academy of Sciences, Tashkent
VVR-K	1964	nuclear physics, radiation chemistry	Nuclear Physics Institute, Kazakh Academy of Sciences, Alma Ata (under construction)
IRT-2000	1959	solid-state physics, radiation chemistry	Physics Institute, Georgian Academy of Sciences, Tbilisi

IRT-2000	1962	nuclear physics, instrument manufacture	Physics Institute, Latvian Academy of Sciences, Riga
IRT-2000	1962	technical research, isotope production, radiobiological research	Institute of Heat and Mass Transfer Studies, Byelorussian Academy of Sciences, Minsk
VVR-Ts	1963	radiation chemistry	Branch Physics and Chemistry Institute, State Committee on Chemistry, Obninsk (under construction)

3. USSR Ministry of Higher and Secondary Specialized Education:

IRT-1000	1963	training and research	Tomsk Polytechnical Institute (under construction)
IRT-1000	1964	training and research	Engineering and Physics Institute, Moscow (under construction)
IRT-1000	1965	training and research, physics of metals	Urals Polytechnical Institute, USSR Academy of Sciences, Physics of Metals Institute, Sverdlovsk (under construction)

Usually, the planning and design of a research reactor begins with a technical discussion, attended by the interested parties, on the specifications for the facility as a whole. Generally, the technical specifications define the purpose of the reactor, the approximate programme of research, and the technical and physical characteristics and experimental facilities implied by that programme.

It is the usual practice to decide on the thermal power of the reactor and the approximate volume and working area of the installations and laboratories within the reactor building, and to agree on a rough estimate of the maximum cost of construction.

Since it is generally the design and construction organizations of the State Committee on the Utilization of Atomic Energy which design the reactor and its basic equipment, the technical specifications approved by the body ordering the reactor are also reviewed and approved by the State Committee's Research Reactor Department. Designing is done in two or three stages, depending on the degree of complexity and the novel features of the reactor. Two-stage designing consists of drafting the working plan and the working drawings of the reactor. Three-stage designing is supplemented by production of a rough scheme, mainly for the purpose of more detailed and thorough testing to determine whether the specified technical requirements can be fulfilled.

For purposes of testing the various technical solutions adopted, experimental construction work and investigations are included in the working plan. The nature and extent of these are agreed upon at the rough scheme stage, and the results are incorporated into the working plan in the form of appropriate scientific and technical reports.

Generally, experimental construction work on a new reactor includes investigation of the reactor core on a critical assembly, the development and testing of fuel elements, and mock-up studies and experimental testing of the non-standard assemblies and mechanisms of the reactor. The rough and working designs are approved by the customer, and are examined and passed by the Scientific and Technical Board of the State Committee.

The buildings and installations for housing a reactor together with its equipment and laboratories are usually planned in two stages - a rough scheme and working drawings. Usually the State Committee only approves the rough scheme and the estimate of construction costs, the quantity and quality of the working drawings being checked by the customer. The customer also carries out the subsequent construction work independently, placing building contracts, ordering equipment from industrial undertakings, and training operating staff.

The completed and assembled reactor may, regardless of which authority it belongs to, be started up only with the permission of the State Committee. This rule is laid down to avoid any possibility of an accident, the risk of which is at its greatest, as experience has shown, at the time of first start-up and achievement of criticality.

Safety testing of the reactor and the conformity of its operating regulations with nuclear and radiation safety requirements is one of the most important responsibilities of the Research Reactor Department. Authorization of start-up and operation is granted only after thorough examination of the reactor's technical condition and after appropriate instructions have been issued and the personnel has been given theoretical and practical training.

Examination is usually carried out by an independent group of experts invested with the proper authority by the State Committee and the management of the research centre. All recommendations by the group must be complied with, and the decision to grant permission for start-up and operation depends on the group's report. Subsequent operation of the reactor is carried out under the supervision of the technical management of the research centre, and only in exceptional cases or upon the request of the

owners of the reactor may a commission be appointed to investigate its condition.

Nuclear fuel in the form of finished fuel elements is delivered to customers by the State Committee's supply organization against payment at government-fixed prices. Orders for fuel must be placed not less than six months before the date when they are required. The reason for this is that fuel elements for research reactors are ordered in small consignments, which complicates the production process.

Planning of the utilization of a reactor is mainly the responsibility of the management of the research centre where it is situated. However, for the purpose of co-ordination of activities and exchange of experience and data concerning research in progress, annual conferences on the co-ordination of research reactor utilization are organized jointly by the State Committee and the Atomic Energy Department of the Academy of Sciences.

The decisions taken by these conferences are in the form of recommendations regarding the main lines of research to be carried out at a given reactor and are based on an analysis of work already performed and of its quality and practical value. These recommendations are aimed at eliminating unjustified duplication of assignments and at enhancing the scientific and practical worth of research work.

Reactors which do not belong to State Committee organizations also perform pure and applied research under assignments set and financed by the Committee. In such cases the programme, scope and schedules of the work are agreed with the authority conducting the research and are supervised by the staff of the Committee's research centres.

Research reactors forming part of the State Committee system submit technical and scientific reports on a quarterly basis. The technical reports comprise data on the work of the reactor proper and of its auxiliary facilities, on thermal energy output or consumption of nuclear fuel, on repairs to equipment, on emergency shutdowns and radiation conditions, on staff matters, and so on. Special mention is made of improvements to the reactor's facilities.

Scientific reporting consists of data on the use of the reactor's experimental facilities, and brief notes on research completed or being carried out and on assignments for the next accounting period. Other organizations owning reactors submit similar reports but on an annual basis, usually in January or February of the following year.

The organizational questions which constantly arise in the design, building and utilization of reactors are generally dealt with by staff of the Research Reactor Department. In complex cases, administrative and technical conferences are held, attended by the individuals and organizations concerned.