

PROSPECTS OF DEVELOPMENT OF SCIENTIFIC INVESTIGATIONS IN INP NNC OF RK

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The further growth of energy production, based on organic fuel utilization, faces a number of hardly solvable economical, ecological and transportation problems caused by growth of volumes and fuel transportation costs, depletion of exploitation fields, emission of harmful and radioactive substances, environmental pollution.

Presently, in many countries a lot of activity on elaboration and perfection of existing reactors, designing projects of entirely new reactors is carried out. The main tendency in the development of power reactors is in the assurance of their safe operation, maximal safety of population, in decreasing their influence on environment along the tendency to make nuclear power plants (NPP) economically competitive with alternative energy sources and especially with thermoelectric power stations operating with organic fuel. All of these are based on extensive and effective application of our experience in atomic energy, achievements in advanced technologies and techniques. Nowadays, coordination and cooperation of countries for safety assurance of operating NPP and design of new power reactors (France, Germany) is planned. No country can avoid studying world experience and collaboration with other countries when developing their nuclear energy industry.

Nuclear reactors at normal operation are one of the most ecologically pure sources of energy, which can compete with thermoelectric power stations with organic fuel. The important quality of new NPPs is the high level of safety, which is reached by using modern technologies, realized in projects of nuclear plants of new generation. Some developed countries such as France, Sweden, Japan, Belgium and others produce between 40 and 70% of their electric power at NPPs. In spite of the general decrease in NPP building rates, the high growth rates of NPP operating power take place in such countries of South-Eastern Asia as Japan, South Korea, Taiwan and in number of other states of this region and also in China and India.

The distinctive feature of conditions, which promote of the beginning of nuclear power development in Kazakhstan, is that it will start to develop practically from zero point: Kazakhstan have no NPP except one energy installation with a reactor on fast neutrons BN-350. Kazakhstan in contrast to Russia and Ukraine is free from building beginnings, construction trammels and traditions of modern NPP. That's why Kazakhstan can choose its own optimal for conditions of Kazakhstan way for the nuclear power development at the beginning, not designing NPP, which does not meet the highest international safety requirements. Kazakhstan from the very beginning must direct its attention on the building of the safest NPP, which will meet the highest international requirements of XXI century.

The expediency of creation and development of national nuclear power in Kazakhstan is caused by the following presuppositions:

- Deficit of thermal and electrical energy production in some regions of the country poor in organic fuel
- Necessity to solve ecological problems
- Necessity to breakthrough in the field of new technologies
- Availability of nuclear raw materials and production base of nuclear fuel cycle
- Presence of scientific, production and organizational structures, capable to carry out the

scientific and research works in the field of ecology and radiation safety, nuclear physics and radiation material science related to nuclear power, and to realize functions of scientific management, supervision and control.

A important condition of nuclear power development is the existence of the necessary basis of its fuel cycle. Nuclear fuel cycle of Kazakhstan was created as a part of nuclear-industrial complex of the USSR. The metal mining plants, uranium concentrate and fuel tablets factories for power reactors compose the foundation of nuclear fuel cycle in Kazakhstan.

The perspectives of nuclear power development in Kazakhstan are connected with realization of the following principles and security measures. The building of NPP is considered as one of variants for the power industry development. In particular, for building of NPP in Balkhash (on the site of the South-Kazakhstan RWPP) the new projects of reactors can be chosen, designed using technologies of increased safety. The passive systems, based on using of natural physical processes, are applied along with active systems of safety assurance an reactor facilities of a new generation. That is why, in particular, the investigations on assurance of the reactor power facilities safe operation are conducted at the existing research reactors.

The development of nuclear power and industry must ensure a high ecological safety. Radiation protection of a power plant unit may include a series of physical barriers preventing output of radioactivity to ensure the level of external gamma-radiation outside the industrial site to be within the natural background not more than 15-18 uR/h in case of normal exploitation.

Under the Low of RK "About environmental protection" the elaboration and realization of a power station project is to be realized in the case of obligatory agreement of construction works with community and local authorities. According to professional estimations, operation of Balkhash NPP would cut the coal consumption on 14-16 million of tons a year, oxygen on 24-26 mln. tons a year and correspondingly greenhouse gas exhaust on 30-34 mln a year.

For processing and long-time storage of radioactive waste and spent reactor fuel, the modern technologies will be used; it is planned to build a depository, assuring population safety and ensuring minimal man-caused influence on the environment in accordance with the adopted international standards.

From our point of view, small sized NPPs are one of perspective directions of nuclear power development in Kazakhstan. Kazakhstan has a large territory and also a large quantity of consumers which are far from power networks and demand autonomous power and heat supply. In these conditions the nuclear power development using nuclear energy installations of small capacity is enough actual for Kazakhstan. With the help of small sized NPP it is possible to demonstrate NPP safety, their ecological attraction, prepare staff for NPP exploitation.

Power reactors of small capacity (from 10 MW up to 350 MW) are more technologically studied and meet the modern requirements on safety and ecological purity. Such reactors, unit-type as a rule, can be build on common plants and delivered in large-block construction to the site with further removal after decommissioning. This ensures economy of small NPP. The reliability and safety of NPP is ensured owing to internal self-defense of reactor, realization of heat removal by natural circulation of heat carrier, integration of equipment module layout, absence of operatively worked armature, small power-strength of active zone, usage of self-control principles and passive systems of emergency safety and heat removal. The effectiveness of small NPPs can be reached by reduction of primary capital investments during the construction of NPP from blocks and, also, by such factors as relative constructive simplicity, wide capabilities of plant production, large-block delivery to the place of using with the further removal after operation.

Scientific-technical requirements for nuclear power development is supported by scientific establishments in the Republic involved in nuclear power investigations with highly skilled scientific and engineering.

The scientists and specialists of NNC RK and other scientific and design organizations of the Republic take part in the development of materials for NPP (their construction is possible both in

Kazakhstan and in other countries) in works on the projects ITER and the Kazakhstani material science TOKAMAK facilities.

There are organizations for training of qualified specialists for nuclear power at the following: East-Kazakhstan State University (specialists training in the field of nuclear industry oriented on exploitation of productions of joint-stock company "Ulbinsk Metallurgic Plant", uranium-mining and processing enterprises of the republic); the Institute of Energy and Communication in Almaty and State University "Semei" (in the field of nuclear power, including major "Nuclear reactors and power facilities"). At the Institute of NNC RK the field study of students and carrying out degree works on nuclear research complexes is ensured. To increase the quality of training close collaboration with the leading institutes of higher education in Kazakhstan is undertaken by inviting scientists and professors for giving lectures.

Existing scientific-technical potential of the Institute of nuclear physics of NNC RK and the presence of unique nuclear facilities (reactor WWR-K, isochronous cyclotron U-150M, electrostatic accelerator of heavy ions UKP-2-1) and acknowledged scientists involved in basic and applied research in the field of nuclear physics, solid state physics and applied nuclear physics make possible to develop science, nuclear power and industry in the Republic of Kazakhstan.

Objectives in the field of nuclear physics

- Investigation of the mechanism of nuclear reactions and structure of light and heavy nuclei of low and moderate energies using isochronous cyclotron U-150M
- Investigation of experimental sections of nuclear reactions at ultra low energies using the accelerator of heavy ions UKP-2-1 for astrophysical and thermonuclear applications
- Investigation of power allocation of fission fragments of ultra heavy nucleus
- Investigation of physical bases of processes in hybrid nuclear installations ("subcritical reactor+accelerator")
- Investigation of mechanisms of (n,n')-reaction and qualities of excited states of deformed nuclei using WWR-K reactor
- Experimental investigation of light charged particles interaction with atomic nuclei introduced in crystal pinholes
- Very cool neutrons in investigations of nuclear-physical and neutron-optical effects, structures of condensed matters.

Objectives in the field of solid state radiation physics

- Material studies in conditions simulated for accidents at "fast" reactor
- Material studies at Kazakhstani TOKAMAK
- Development of physical technology bases for multifunctional multilayer metallic materials
- Development of new electron and ion technologies and devices for determination of minute concentrations of man-caused elements (^3H , ^{36}Cl)
- Development of theory and practical realization of energy-mass-spectrometers with absolute spatial and time-of-flight focusing
- Structure and interaction of radiation defects.

Objectives in the field of applied nuclear physics

- The program "Radio-ecological problems of oil and gas industry of the Republic of Kazakhstan"
- The system of radio-ecological environmental monitoring at the sites of nuclear explosions and waste storage facilities of uranium-mining industry

- Industrial production of radioactive isotopes for medical and industrial purposes for the republic of Kazakhstan and neighboring states of Central Asia
- Cadastre of industrial waste from plants of mining and metallurgy industry of the Republic of Kazakhstan
- Monitoring of air basin conditions of the largest cities of Kazakhstan (for example, Almaty and Almaty region)
- Investigations of geochemical behavior of artificial radionuclides, including transuranium elements in habitat (on the base of Semipalatinsk test site)
- Total examination of Kazakhstani population nearby places of nuclear explosions for estimation of retrospectively absorbed doses by the method of EPR-dosimeter, study physical-chemical properties of radiation signal of EPR in soil of SNTS.

Creation of branch networks for development of fundamental and applied research in other regions of Kazakhstan is, from our point of view, **the objective** of the Institute of Nuclear Physics of NNC RK.

The branches of the Institute of Nuclear Physics of NMC RK are created and will be equipped with the modern facilities for carrying out full-scale investigations: Astana branch at Eurasian State University named after Gumilev (Astana), Aksai branch (Aksai, West-Kazakhstan oblast), Kurchatov laboratory (Kurchatov, East-Kazakhstan oblast), Azguir expedition (Atyrau oblast).

The results of longstanding mutually beneficial collaboration of Kazakhstani scientific and educational organizations with Joint Institute of Nuclear Investigations (JINI, Dubna, Russia), having status of international intergovernmental organization, can be used for the creation of interdisciplinary laboratory complex for investigating fundamental physical and chemical tasks and broad advanced technologies at the Eurasian State University (ESU) named after Gumilev and branch of the Institute of Nuclear Physics of NNC RK.

The unique accelerator complex, designed by JINI, can become the main element of this laboratory complex taking into account perspectives of science and technology development and stepwise amalgamation of science and higher education. JINI is recognized internationally in the field of electro-physical apparatus and, particularly, accelerating techniques development.

Taking into account the interests of Kazakhstan the accelerator complex will be created to carry out fundamental and applied research. The scientific activities for the development of this unique complex will be carried out with the help of specialists in the field of accelerator techniques of the INP of NNC RK (school of academician L.M. Nemenov from KazSSR AS).

The technologies of food, biological and chemical profiles using nuclear membranes (with the help of accelerator complexes is the important application on nuclear technologies) can represent nowadays more possibilities for the complex education of students and carrying out of interdisciplinary works in ESU named after Gumilev.

The organization of Aksai branch is related with monitoring and radio-ecological tasks; investigations on LIRA facilities and territory of Karachaganak oil and gas condensate field. In the future, it is proposed its orientation on ecological problems related to industrial development of West Kazakhstan and broadening of hydrocarbon mining.

Kurchatov laboratory is created for radio-ecological investigations on the territory of Semipalatinsk Nuclear Test Site.

Azgir radio-ecological expedition fulfill works on radiation monitoring of the territory of GALIT facility.

The modern highly technological power of the Country will become, from our point of view, an economical basis for stable economical development of the Country assuring development of nuclear power as one of the primary elements in combination with developed uranium industry.