G. KISELEV.

NEW CONCEPT OF A POWER ENERGY PROSPECTIVE DEVELOPMENT

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1. PRESENT STATUS' OF NUCLEAR POWER IN THE FORMER USSR

The present state of nuclear power in the country may be characterized as the crisis one due to:

1,1. Ecological, economic, social and political consequences of Chernobyl catastrophe.

1.2 The use of power reactors in the functioning NPP that don't fit modern safety requirements (inherent properties and passive safety systems).

1.3. Relatively poor quality of manufacturing basic technological equipment of NPP.

1.4. Relatively poor quality of construction and assembly work.

1.5. Relatively low trainiing level of NPP operators, low level of their wages, that does not fit their responsibility.

1.6. The absence of conditions, excluding negative influence of human factor to NPP safety.

1.7. The absence of the state guarantees and of social protection of the population in connection with NPP exploitation.

1.8. Unsatisfactory experimental basis for substantiation of technical solutions made.

1.9. Negative attitude of considerable part of the population towards NPP construction.

Only a complex solution of the problems available in nuclear power will help to get the society approval to further development of nuclear power in the USSR.

2. BASIC PROBLEMS OF NUCLEAR POWER DEVELOPMENT

Futrher existence of nuclear power depends on guarantees of NPP ecologic safety and that of nuclear fuel cycle (NFC) plants.

The guarantees may be provided by:

2.1. Commissioning new types of nuclear power facilities (NPF) with inherent safety properties and passive safety systems.

2.2. Development and introduction of wasteless technologies at NPP and NFC plants including nuclear fuel recycling and transmutation of long-lived radionuclides.

2.3. Improvement of existing and development of new methods of high quality equipment production for NPP and of its quality control.

2.4. Improvement of existing and development of new progressive methods and technologies of assembling Npp equipment.

2.5. Solving social problems of NPP personnel.

There is no doubt also that a comparative study is to be carried out for ecologic safety of nuclear power and NPP plants on the one hand, and of thermal power and of elecric power plants based on replenishable energy resources, on the other hand.

Besides the ecology, it is necessary to solve the problems of social protection for the population of the regions where NPP and NFC plants are situated.

The items of this part of the "Concept" concerning ecologic and social acceptability of nuclear power for the population must. be taken into account in studying NPP economic efficiency.

3. PRINCIPAL FEATURES OF NPF OF EXISTING TYPES

The following principal faults of NPF of existing types should be pointed at (power reactors of WER, RBMK, and BN types are meant here):

3.1. Nuclear fuel is used that is enriched with Uranium-235 in the form of uranium dioxide. Nuclear fuel with natural isotope content is not used in the power reactors,

3.2. For the excess reactivity compensation in the initial period of the campaign due to the use of enriched nuclear fuel, certain construction means are provided (burning out absorbers, additional sol id absorbers, introduction of Boron into the heat carrier, movable compensator rods).

3.3. In the course of NPF functioning, nuclear fuel burnout and change of reactivity take place, which demand appropriate control systems.

3.4. In the course of NPF functioning, Xenon production occurs in the nuclear fuel, its amount affects transition processes in the power reactor, which demands appropriate design and construction solutions.

3.5. To provide NPF nuclear safety, a fast-acting emergency protection has to be provided, with appropriate reserve and reliable power supply.

3.6. Low efficiency of nuclear fuel utilization in one irradiation cycle in NPF.

3.7. Absence of conditions for reducing partial incipiration of radionuclides in spent nuclear fuel (SNF) during one nuclear fuel cycle.

3.8. Presence of a number of NPF neutron parameter control systems in the course of its operation, which makes the NPF more complicated.

3.9. Absence of possibilities for SNF repeated use in NPF, of technologies and apparatus for handling radioactive fuel assemblies and targets for loading them into the NPF core.

3.10. Low thermal technical parameters of VVER- and RBMK-type NPF.

The above mentioned faults in NPF of existing types, affect their safety level considerably, they can't be done with within the framework of existing USSR scientific and technical programs for development of safe nuclear power. New approaches are needed, accounting for national and foreign experience in developing and running NPP, based on introduction of modern nuclear science and technology

4. ELECTRONUCLEAR REACTORS IN PERSPECTIVE NUCLEAR POWER

For solving the problem of nuclear power ecologic and social acceptability, we propose to use electronuclear reactors (ENR) in perspective development scheme of nuclear power after the year 2000, with provision for corresponding fundamental and applied research in the programs for 1991 - 2000. With the introduction of ENR, the nuclear power could have reliably solved the problems of nuclear safety, provided itself with fuel in the long run, and excluded long-time burying long-lived radionuclides.

Schematically, an electronuclear reactor consists of two main blocks namely, a linear accelerator of protons and a target complex. The proton linear accelerator (LA) has the following parameters: 1.5 GeV energy of protons, 0.3 A proton beam current, 900 MW(e) power of RF system, 900 m length, As a target material, lead, Pb-Bi or dump Uranium may be used. As a result of proton interaction with the target material, high-energy neutrons are produced, which are captured in the blanket surrounding the target. Per one absorbed neutron, up to 55 - 80 secondary neutrons can be produced which may be used both for energy production and for transmutation purposes. Electric power of an electronuclear reactor with a blanket containing transuranium elements and with effective breeding coefficient $K_f < 0.95$, may come to 1.3 GW(e) that allows to have the useful power about 0.9 GW(e).

Compared to NPF of existing types, ENR has the following advantages:

4.1. As the initial charge, dump Uranium and other actinides can be used.

4.2. ENR as an intense neutron source, can be used for nuclear transmutation of FP and of actinides for which no useful application can be found.

A subcritical breeding system combined with a proton accelerator, allows to use about 3.76 neutrons for energy production per single act of fission compared to that of 2.46 for Uranium-235 in fission reactors.

4.3. To provide for ENR normal functioning:

- no reactivity compensation system is needed in the initial period of the campaign and further on;

- power control can be provided through the accelerator current control;

- emergency protection system can be based on RF-power cutoff.

4.4. Principal possibility of full burnout of fissile isotopes, including burnoff of WER-1000 and RBMK spent nuclear fuel.

Thus, ENR possess new safety properties compared to NPF of existing types having the source in the use of a subcritical system excluding completely power boost due to protection cystem fault or to operator mistakes. Besides that, the possibility arises to use ENR for nuclear transmutation of long-lived radionuclides which is of principal importance for providing ecologic acceptability of nuclear power.

It shold be kept in mind that. the sums needed for ENR development and running, should be ascribed both to the cost of the energy produced and to the cost of nuclear transmutation process of long-lived radionuclides. This circumstance changes ENR economics considerably.

The proposed approach to perspective development of nuclear power in the former USSR is based on the existing experience of development and running the existing NPP and on the scientific and technical advance in accelerator technology both in the country and in the world.

The present status of scientific and technical developments in accelerating structures of the proton accelerator and of the target complex, indicate technical feasibility of building the ENR with required parameters.