Nuclear Power Development in the USSR

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The Soviet Union belongs to those countries possessing abundant natural power resources. These resources of organic fuels as well as hydro power, in principle, allow us to respond to power demands for many, many decades ahead. However, we also observe in the USSR some discrepancies between the location of economical resources, and that of the power consumers. The main fuel and hydro resources are situated in the Eastern regions of the country, whereas the most industrially developed European part of the USSR and the Urals, with the highest density of population, begins to suffer from an ever-increasing deficiency of economical fuel. It is in this region that we are first of all considering the expediency of using atomic energy by constructing nuclear power plants.

Following the start-up of the first-in-the-world nuclear power plant in Obninsk in 1954, overall development of various nuclear reactor concepts was carried out in the Soviet Union: first, thermal nuclear reactors, then fast reactors. As a result of this effort, which included constructing and testing numerous reactor prototypes, two types of thermal reactors were chosen in the USSR for developing nuclear reactors of the so-called first stage. These reactors were WWER reactor (similar to PWR type) and RBMK-uranium-graphite channel-type reactor. (We observe no direct analogy here).

The decision to initiate a serial construction of nuclear power plants with WWER type reactors was preceded by the continued successful operation of the Novo Voronezh Nuclear Power Plant. As standard units utilizing that type of reactor we are constructing 880 MW nuclear power plants with two reactors of 440 MW each. Such nuclear power plants are being built in the central part of Russia, in the Kola Peninsula, the Caucasus, and the Ukraine. Similar plants are being built, or are to be built, in Bulgaria, the German Democratic Republic, Hungary, Poland, Rumania, Czechoslovakia, and in Finland.

The development of more powerful nuclear power plants with WWER type of reactors is being continued in the USSR to attain 1000 MW power a unit.

The second type of thermal nuclear reactors accepted for serial construction in the USSR is the RBMK reactor.

The history of developing power reactors of that type goes back to the time when the first nuclear power plant in Obninsk was put into operation. We shall celebrate the twenty years' anniversary of this nuclear power plant in 1974. Then the Siberian NPP (above 600 MW) was built in 1959, as well as the first unit (in 1964) and the second unit (in 1967) of the Kurchatov Beloyarsk NPP (total power of 300 MW).

The continuous and reliable operation of these reactors has proved that the choice was right. At the same time the feasibility of utilizing nuclear steam superheating in commercial nuclear power reactors was demonstrated.

The next step in developing reactors of that type was the development of the RBMK-1000 reactor of 1000 MW per unit. The main difference between the RBMK reactor and the Beloyarsk reactors is, in particular, the use of zirconium instead of stainless steel as material for the fuel element cladding and as the main structural material in the core, as well as utilizing fuel rods instead of annular fuel elements. Nowadays the RBMK-1000 reactor is accepted in our country as a serial one for several twin-reactor nuclear power plants under construction, each one of 2000 MW.

The first of these nuclear power plants – the Leningrad NPP – has reached the stage of installation of the equipment. Since this type of reactor is less known, I would like to stress the advantages which we consider as substantial in choosing this reactor for serial production. They are:

1. The absence of a multi-ton high-pressure vessel with a complicated manufacturing technology, and, therefore, the absence of the necessity in its control under operating conditions.

2. The reliability and vitality of the whole system due to the control over individual channels and the possibility of on-load refuelling.

3. The principal possibility of splitting the coolant circuit into smaller isolated groups of channels.

4. The possibility of increasing the power of a single reactor unit up to 2000, 3000 or even 4000 MWE.

5. The possibility of assembling a channel-type reactor with any number of separate sections.

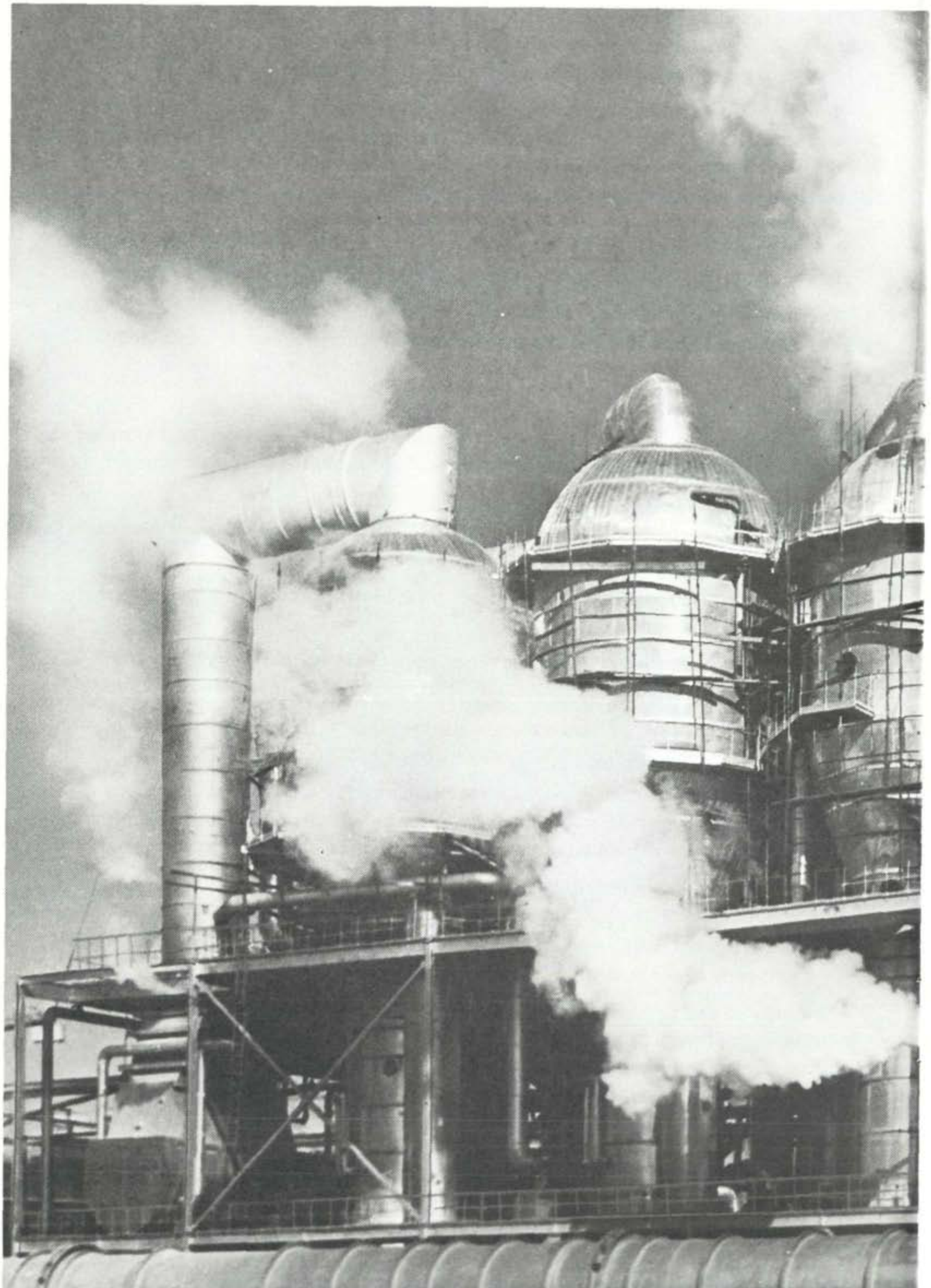
6. The possibility of manufacturing the sections of such a reactor under manufacturing plant conditions due to the use of standardized components and assemblies, and their mounting at the construction site of the nuclear power plant.

7. The possibility of utilizing the nuclear steam superheating.

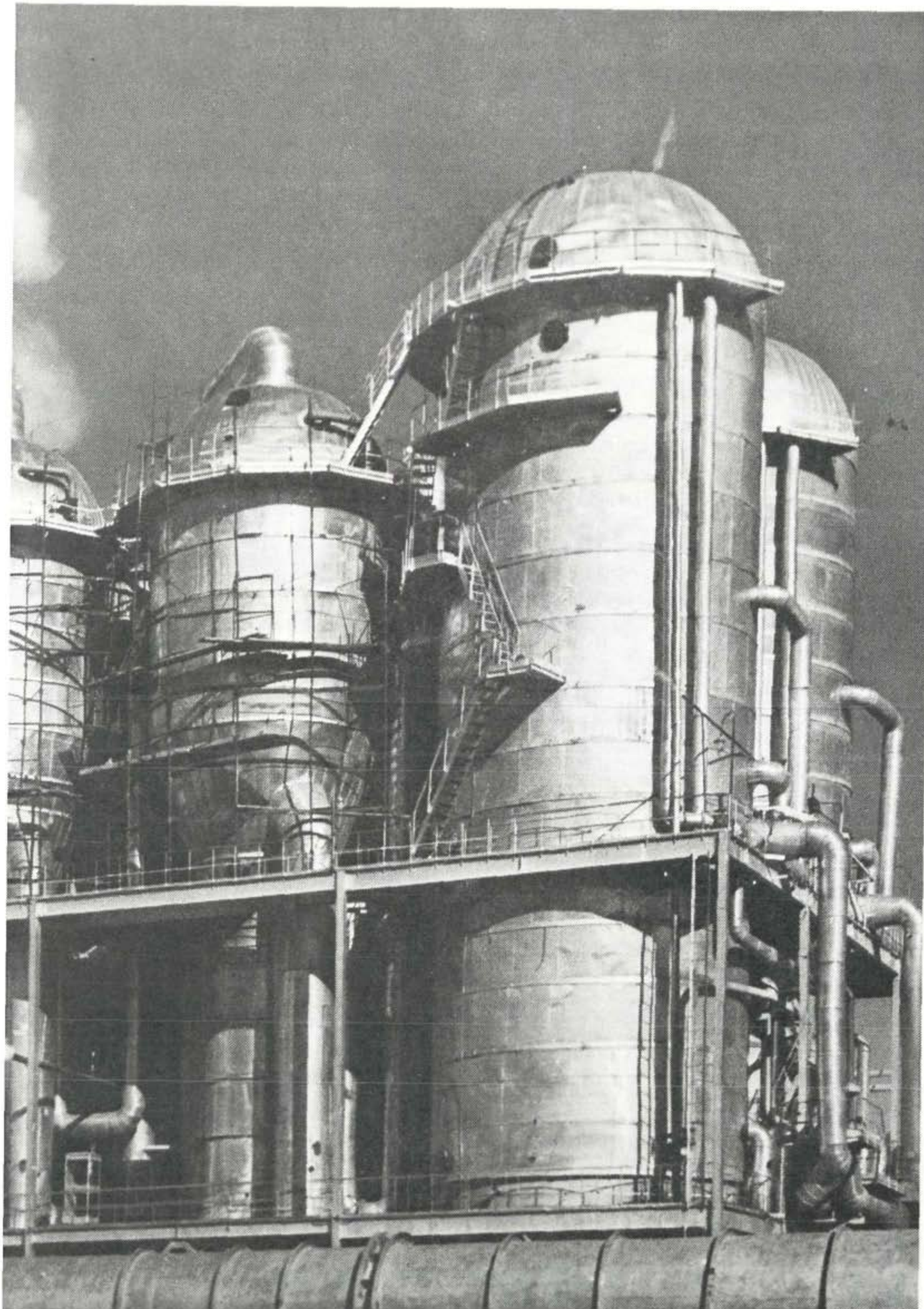
The advantages of such a reactor to a considerable extent overlap some disadvantages – complexity of the coolant circuit and, therefore, a high volume of construction work.

I would also like to stress, that a large-scale development of nuclear power insistently demands implementation of industrial methods for manufacturing and installation of reactors. The trend towards an increase of reactor power created the problem of developing a reactor design which would allow the construction of reactors of ever-growing capacity with minimum changes in design, and without a drastic change of production technology, i.e. of unified and standardized units and components fabricated at the manufacturing plants. We believe that the potentialities of channel-type uranium-graphite reactors will permit us to find ways of solving this problem.

It is on reactors of these types – WWER and RBMK – that we are mainly planning the development of nuclear power up to the end of the decade with about 30,000 MW of installed nuclear capacity in 1980.



This photo from the USSR State Committee on Utilization of Atomic Energy shows the distillation plant at the



Shevchenko Atomic Power Station.

The construction of thermal reactors of the first stage will evidently continue up to about 1985, with a gradual transition to nuclear power plants with reactors of the second stage fast-breeder reactors.

The development of reactors of that type already began in the USSR in the beginning of the 50's. Up to now substantial operational experience has been gained in the USSR with a number of experimental and test reactors. By the end of this year a physical start-up of the fast-breeder reactor at the 350 MW demonstration dual-purpose nuclear power plant in Shevchenko on the Caspian Sea will take place.

The first commercial 600 MW fast reactor is under construction in the Urals. We hope that the experience to be gained during the operation of this reactor will allow us to go over to a large-scale construction of sodium cooled fast reactors in the early part of the 1980's.

I would like to make a point here that I am telling you about the *main,* I stress the *main* directions in the USSR nuclear power development. This, however, does not mean that no research and development on a number of other promising designs is being conducted in our country. For instance, we have gained excellent operating experience with the 60 MW Fast Test Power Reactor BOR-60 which has been producing electricity since 1968.

Thus, for instance, in the USSR, as well as in the USA, certain studies are being carried out on fast gas-cooled reactors. If we are to speak of more, so to say, exotic projects, such as, for example, the molten salt reactor, then no less exotic work is underway in our country on using dissociating gas coolant in a single circuit design.

Much has been said and written on the role of fast reactors for the future nuclear power development. Evidence of the importance ascribed to the fast reactor development in our country are the resolutions of the XXIVth Congress of the Communist party of the USSR.

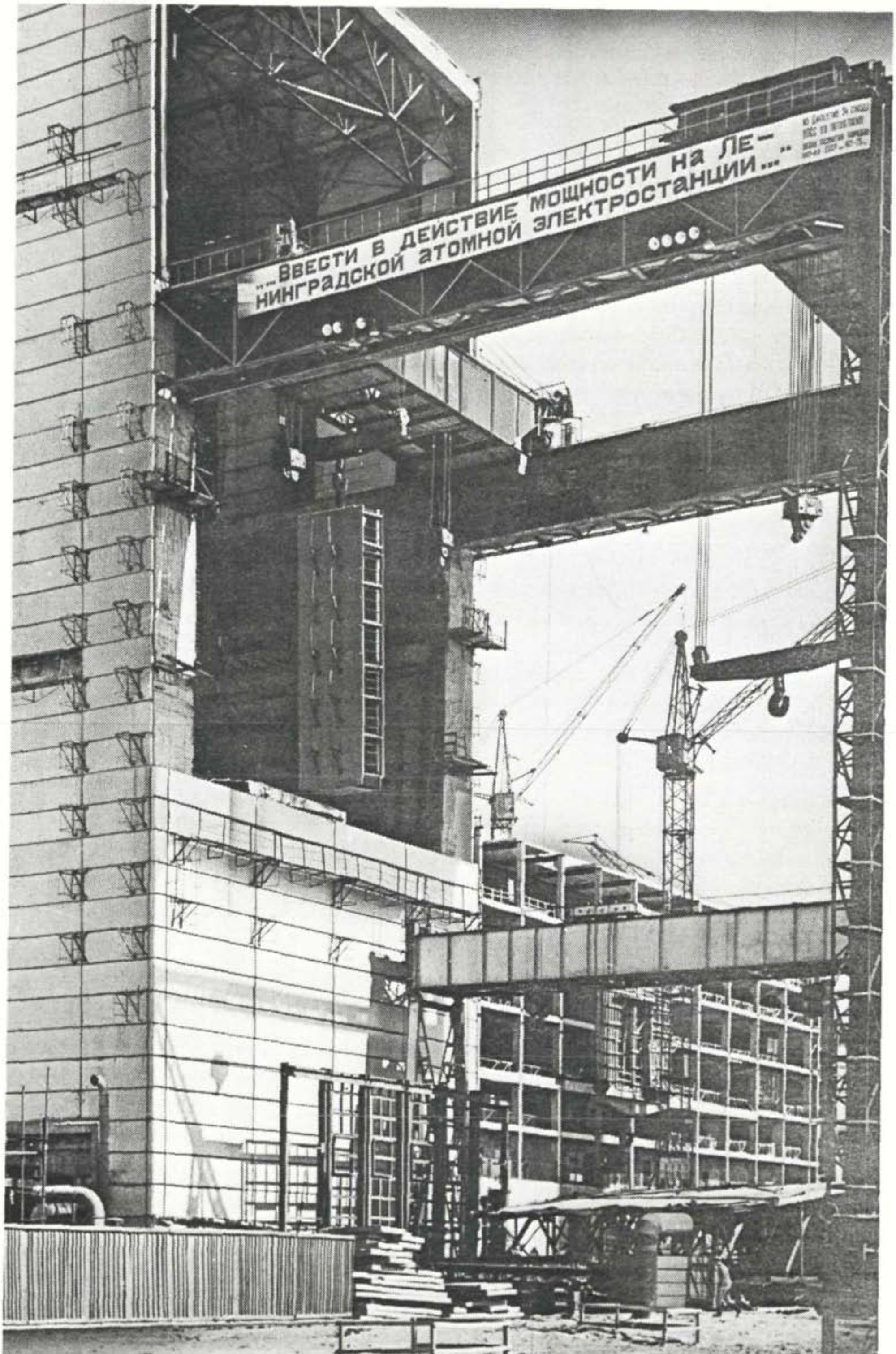
I would like to call your attention only to a single aspect of this large problem, namely, to the question of possible ways of increasing the capacity of the fast reactor power system to attain maximum integral economic benefit, as well as to the choice, in this connection, of fast reactor fuel characteristics.

Two approaches can be outlined in this aspect. One of them is based, as we see it, on short term considerations and presumes that first commercial fast reactors should be optimized on minimum power generation cost. This leads to the choice of plutonium breeders with rather modest breeding ratios.

However, there is another, (and I would say more long-term and more global) approach to the fast reactor system. In every general terms this approach is based on the following considerations:

It is generally accepted that fast breeder reactors, due to their low fuel cost component, promise to be the most economic reactor type. Furthermore, they are in fact the only reactor type in which cost of electricity generation does not practically depend on the cost of source material. In other words, the cost of electricity produced will not increase with the depletion of natural resources of "cheap" uranium.

The Scientific Research Institute of Atomic Reactors, Dimitrovgrad.


«...Ввести в действие мощности на Ле-
нинградской атомной электростанции...»

Therefore, the most economic solution of the problem might be intensive introduction (at the first stage) of the fast breeder reactors optimized to the maximum plutonium breeding, and even the introduction of fast U-235 converter reactors.

Such a strategy can provide for short doubling time of fast reactors and a speedy transformation of the nuclear power industry to the utilization of this reactor type. In this case we should carefully consider the merits of certain loss in fast breeder economics at the first stage, versus the possibility of accelerated introduction of fast reactors and their replacement of less economic thermal nuclear power plants.

I would also like to emphasize, that nuclear power development and the analysis of its future prospects show that overall introduction of nuclear power plants is not only profitable because of their competitiveness with organic fuelled power plants. Equally important is the opportunity of solving another crucial problem — the problem of preservation of human environment. In our country this is considered as the problem of the highest priority.

Recently, in September (1972), special legislation on the protection of the environment was approved by the Supreme Soviet of the USSR. We feel that the broad nuclear power development allows us to kill two rabbits with one shot. It gives abundant electricity to the population and decreases the pollution of the environment.

We consider the very attentive attitude of the public to the safety problems of nuclear power plants as essential. This and perhaps the strict attention of competing power industries resulted in the construction of nuclear power plants so carefully designed that there was not a single accident involving any dangerous consequences for the personnel or the environment. Obviously it is important to balance the necessary safety requirements of nuclear power plants and at the same time not to over-exaggerate them. We must keep within reasonable and justified limits.

I must add to this that many years of experience in operation of nuclear power plants convinced us of the advantage of nuclear power plants over fossil fuelled plants from the environmental point of view as well. Our calculations show that annual averaged concentration of radioactive substances in the air will not exceed 10^{-3} of the permitted level even with the total nuclear power capacity in the world equal to 5 million MW.

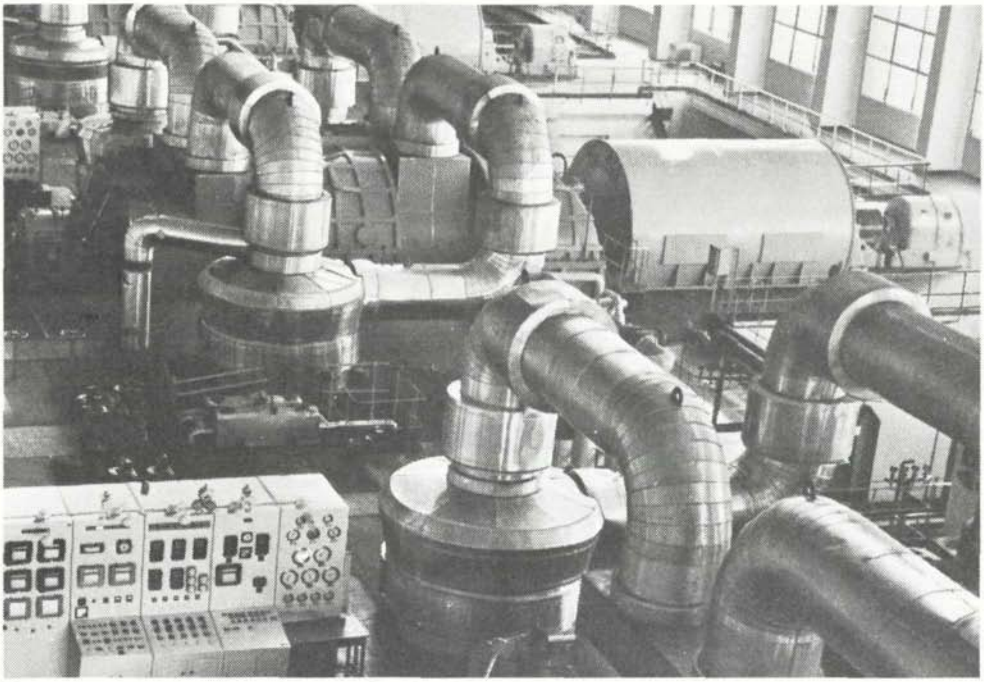
Our experience (and not only ours, but also worldwide) shows that the operation of nucleai power plants does not practically change the radioactivity level of environment in comparison with the natural background.

To mark the 30th anniversary of the first nuclear reactor start-up we may conclude with pride and satisfaction, that nuclear power has stepped up from the sphere of scientific research and development into the sphere of industrial application.

However, life and scientific and technical progress have made us "the nuclear people". I think in this respect of the audience which will mark the 50th anniversary of the first nuclear reactor start-up.

Who knows, maybe it will partly consist of the "thermonuclear people", who at the same time will be celebrating the anniversary of a first thermonuclear reactor start-up.

All of us know what wide opportunities for mankind will be opened as a result of harnessing thermonuclear fusion. The development of this problem of science and



The turbine hall of the Novo Voronezh Nuclear Power Plant.

technology (similar to the development of nuclear research) followed, as we remember, the pattern of sinusoidal successes.

The end of the 1950's was marked by the splash of (as we see it now) over-optimism. It was followed by years of relatively modest success, but years of very deep and important research.

Our outstanding specialist in this area, Academicius Artzimovich, estimates the rate of the progress in thermonuclear research as follows: "It is not so high as to create the sense of a great satisfaction, but it is not so low as to permit pessimism. The movement forward is continuing practically 'non-stop', though not so fast as we would like it".

We may state today, that work on the design of the first thermonuclear demonstration reactor has started in several countries, including the design on the basis of the closed magnetic "Tokomak" system developed by Soviet scientists. This system was highly appreciated by scientists in many countries. There is no doubt that in this field scientists still have a very big piece of work. Therefore the establishing of closer co-operation on an international basis for a solution of this problem, and in particular the organisation of co-operative research in this area between Soviet and American scientists, is of utmost importance and urgency. And we are working now with US AEC on this problem.

I would like to end by expressing my satisfaction and pride in appreciation of the benefits which peaceful nuclear science and technology have brought to mankind, and by expressing my sincere belief that even more will be achieved in this area in the future, especially under conditions of close international co-operation between scientists and other specialists of all countries.