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USSR Report

ENERGY

(FOUO 9/82)

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ELECTRIC POWER

POWER MACHINEBUILDING MINISTER KROTOV REVIEWS PROGRESS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 1 Jan 82 pp 2 - 4

/Article by V. V. Krotov, USSR minister of power machinebuilding "Basic Reference Points"/

/Text/ The successful development of the Soviet Union's fuel and power complex, as noted at the 26th Party Congress and in Comrade L. I. Brezhnev's speech at the November (1981) Party Plenum, is one of the key tasks involving the entire national economy. In his report at the Party Congress, Brezhnev indicated that the problem of improving the structure of the fuel and power balance is becoming increasingly urgent; he also emphasized that "it is necessary to cut back on the amount of petroleum used as fuel and to substitute coal and natural gas for it and to more rapidly develop the atomic power industry, including the use of fast breeder reactors. And, of course, life requires that we continue to look for essentially new sources of energy, including the creation of the fundamentals of the thermonuclear power industry."

In his speech at the November (1981) Party Plenum, Brezhnev, referring to the future, reported that "the recently conducted review of the reserves of gas, petroleum and condensate in West Siberia has again demonstrated that nature has not neglected us. The resources available to the Soviet Union enable us to look into the future with confidence. We need only to be thrifty and to use them with intelligence. We cannot let up in our efforts to develop the fuel and power complex, including the development of new sources of energy. At the same time we must adopt energy saving equipment and technology as quickly as possible."

At the Sixth Session of the USSR Supreme Soviet of the Tenth Convocation in the report on the state plan for the economic and social development of the USSR for the years 1981 through 1985, it was noted that the 26th Party Congress, having confirmed the basic direction of the Party in the area of the economy for the primary development of the socialist industry, especially heavy industry, devoted particular attention to the further increase of the potential of the base sectors of industry, especially the fuel and power sectors. According to the plan in the 11th Five-Year Plan the output of electricity

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in 1985 is to reach 1,555 billion kilowatt-hours, an increase of 260 billion kilowatt-hours as compared with 1980.

Moreoever, the production of electric power at atomic and hydroelectric power stations will reach 450 billion kilowatt-hours, an increase of more than 1.7-fold.

The 11th Five-Year Plan calls for an increase in the extraction of petroleum and gas condensate to 630 million tons by the year 1985. Along with the introduction into industrial exploitation of new petroleum deposits it is planned to expand the use of intensive methods of influencing the petroleum-bearing strata in order to increase their yield. It is planned to continue the development of the gas industry at a rapid pace. In 1985 the amount of natural gas extraction must be 630 billion cubic meters, which exceeds the 1980 level by 45 percent.

To speed up delivery of the blue fuel to the customer in the 11th Five-Year Plan major gas pipelines must be built with a total length of 48,000 km, including from the fields in Tyumen' Oblast to regions of the Center and the Urengoy to Uzhgorod gas pipeline, which will satisfy export requirements.

The associations and enterprises of the USSR Ministry of Power Machine Building must work more diligently in the second year of the five-year plan than they did in the first. To meet the plans of the Party and government for outfitting facilities of the fuel and power complex with equipment, which became law at the next session of the USSR Supreme Soviet, the production of power units for atomic electric power stations will be increased by more than 2-fold; steam turbines by nearly 30 percent; hydraulic turbines by about 26 percent; boilers with a steam generating capacity of more than 10 tons per hour by 21.3 percent; the production of gas pumping units will be doubled; and the manufacture of consumer goods will be increased by 44 percent.

The tasks facing the sector require a great deal or organizational work at all levels of management and a lot of responsibility is put upon the shoulders of everyone participating in the solution. Meanwhile, the results of the production and economic work and the economic indicators of the Ministry's associations and plants for the first year of the 11th Five-Year Plan cannot be viewed as satisfactory. Every quarter the industrial organizations of the Ministry worked under a great deal of pressure; the targets for meeting assigned tasks were not always met, which led to additional difficulties. This is why in 1982 it is necessary to significantly activate efforts to meet the plans called for by the Party in the field of developing power machine building and primarily for implementing the decisions of the 26th Party Congress and the November (1981) Party Plenum.

"The Basic Directions for the Economic and Social Development of the USSR in the Period 1981 through 1985 and for the Period up to 1990", which were approved by the Party Congress, call for the power machine building industry to "significantly increase the production of equipment for atomic, hydro-, and thermal electric power stations, including atomic reactors with a rated capacity of 1 to 1.5 million kV and power units with a rated capacity of 500,000 to 800,000 kV for thermal electric power stations burning low-grade coal." At the same time it is planned to manufacture and deliver the first atomic reactor which will provide heat to large cities, to develop new designs of power units with fast neutron reactors with a rated capacity of 800,000 to 1,600,000 kV, and to create an experimental-industrial steam-gas turbine with a rated capacity of 250,000 kV (PGU-250) with the intercyclical gasification of solid fuel.

The associations and enterprises of the Ministry of Power Machine Building need to increase the production of equipment, which will make it possible to efficiently use secondary power resources in metallurgy and other sectors of industry, and also to organize the series production of gas pumping units and mainline gas pipelines at a pressure of 100 atmospheres.

The Ministry of Power Machine Building has developed a set of practical measures to accomplish the decisions of the 26th Party Congress and the decrees of the CPSU Central Committee and the USSR Council of Ministers. Thus, in the 11th Five-Year Plan it is planned along with with a growth in the amounts and pace of manufacturing the basic product to substantially improve other indicators of the production and economic activity as well. It is planned in 1985 to ensure the growth of the amounts of standard net product in an amount exceeding 42 percent, and for commodity output by not less than 42 percent. The average annual pace of increase of product output will be greater than 7 percent. Approximately 90 percent of the growth in product output (excluding the Atommash Production Association) is to be obtained by increasing labor productivity, which must be more than 134 percent for the five-year plan.

Along with this it is planned to conditionally cut back on the number of workers by several tens of thousands, including by substantially raising the technical level and improving the organization of production; to obtain a profit from reducing the cost of production in an amount of 10 million rubles; to attain a machine shift coefficient of 1.55; and to obtain economic savings on the order of 20 million rubles through mechanization and the maximum reduction in heavy and manual labor.

The basis for achieving these results is the significant speeding up of scientific-technical progress in the sector and the adoption into production of the creative achievements of scientists, inventors, rationalizers, the experience of leading production workers; the further expansion of the brigade form of organization and pay; raising the level of comprehensive mechanization and the automation of technological processes; the use of progressive methods of processing metal; the equipping of shops with modern control and measuring equipment; the adoption of rational procurements; the maximum reduction in the use of steel castings in equipment designs; the use in production and their control by computers; and the more efficient use of available and newly created capacities.

The ways and means for solving these important tasks have been thoroughly discussed in the labor collectives of the Ministry of Power Machine Building and in the Ministry's associations, enterprises and organizations.

Based upon these measures, recommended by the Ministry, each association, enterprise and organization, deriving from the established assignments, the specific nature of production and the nature of practical work, must come up with their own set of specific measures. The management of the associations and enterprises in concert with public organizations must constantly direct the labor collectives toward the efficient use of fixed assets, capital investments, the intensification of public labor; they must raise the responsibility of each worker for the task at hand.

In the power machine building sector we continue to take measures to further carry out the provisions of the CPSU Central Committee and USSR Council of Ministers decree "regarding the improvement of planning and strengthening the influence of the economic mechanism upon raising the efficiency of production and the quality of work"; the brigade forms for labor organization and pay, which now includes 67.5 percent of the sector's workers, are being developed.

At present it is necessary to further improve the organization of production and labor. Order No 221 of 13 July 1981 "concerning measures to increase the efficiency of production at sector enterprises in conditions of limited labor resources" the associations and enterprises were given the assignment of using the experience of the Production Association Kaluga Turbine Plant. Several enterprises have already started to do this. As it applies to the specific features of production brigades are being created, which are called upon to assimilate the experience of the Kaluga plant workers, and a system of needed measures is being developed. The departments of labor and wages and the departments for the scientific organization of labor are involved in this important undertaking. Measures are being taken to rework the technical documentation and to straighten out the technological paths. The managers of the associations and enterprises are now faced with the task of speeding up the process of assimilating the "Kaluga variant".

In his speech at the November (1981) Party Plenum, Comrade L. I. Brezhnev devoted quite a bit of attention to raising the efficiency of the national economy and its intensification. He emphasized, "It is necessary to work better. It is necessary to compile plans better and to do a better job of fulfilling them. It is necessary to better organize production and to produce better. In a word, it is necessary to work more efficiently. This, comrades, in the final analysis is basic and decisive."

At present in the associations and enterprises of the Ministry of Power Machine Building we are continuing to adopt the unified system for the operational production planning; and we are executing a set of measures to improve this work. Annual, integral schedules for the manufacture of orders from start to output according to an established plan are being developed, as well as for interministerial and intraministerial cooperation considering the stocks for the next period; network, cyclical schedules are being prepared for new articles and for articles that take a long time to produce. A system is being adopted which provides for the distribution of the annual plan depending upon the number of working days in a month; and control over the output of norm-hours by the shops of the enterprises is being tightened, etc.

Starting with the fourth quarter of 1981, the associations and enterprises of the power machine building industry are being assigned the task of improving the technical-economic indicators by making use of production reserves, which are discovered through the analysis of their production and economic activity. These assignments have become the basis for justifying counter plans made by the collectives of the enterprises. Along with this it has been deemed wise to use the functional-cost analysis method for making more efficient use of the reserves that are discovered for increasing labor productivity, reducing production cost, and raising profit. The functional-cost analysis is an efficient system for managing expenditures in conditions of scientific-technical progress, which promotes growth of output of high-quality product with a decrease in expenditures for its manufacture.

The managers of the associations and enterprises in order to improve the organization and intensification of production must speed up the realization of measures connected with the adoption of a system of operational production planning and increase their control over their full execution and for the use of the functional-cost analysis method.

In his speech at the November (1981) Party Plenum, L. I. Brezhnev noted that the 11th Five-Year Plan calls for a 1.5-fold increase in the rates of renovating equipment. Of course, this poses a large number of problems for the scientific-researach and design institutes. "Unfortunately," indicated L. I. Brezhnev, "far from all of them function as required by the present stage of scientific-technical progress. The proposed technical and technological solutions do not always respond to this level."

The scientific-technical and design organizations of the sector are making a considerable contribution to the improvement of the equipment that is being produced and to the creation of new power machinery, as evidenced by the hydroturbines being supplied for the Sayano-Shushenskaya GES. These turbines have a rated capacity of 640 MW. Additional proof of this claim are the 1,200 MW steam turbines for the Kostromskaya GRES and the 1,000 MW turbines for the Yuzhno-Ukrainskaya AES. The 16 and 25 MW gas pumping assemblies, which are now being tested at experimental-industrial compressor stations, are yet another example of the contribution of the institutes. In the associations and at the enterprises of the sector they are adopting progressive technological processes and expanding and improving metallurgical production; they are introducing capacities to obtain large ingots and forged pieces made of high-quality steel.

Nonetheless, our researchers and scientists are faced with the need to significantly speed up the solution of those pressing problems, which are directly linked with technical progress in the field of power machine building; and to increase the output of the means needed to expand the scientific-research and designing sectoral base; and to concentrate the creative energy of the designers, scientists, production specialists on solving specific, real long-term tasks for creating new equipment and improving production.

The State Plan for the economic and social development of the USSR in the years 1981 through 1985, which was accepted by the 6th Session of the USSR Supreme Soviet, 10th Convocation, called for a reduction of 30 billion rubles in allocations and material-technical resources for capital construction. The limits on money for these purposes in our sector were also affected. This is why it is so important that we do everything possible to assimilate the capital investments allocated to us in the five-year plan, especially in 1982, and why we must efficiently distribute and concentrate on the construction projects slated for completion in the near future and also the assimilation of newly introduced capacities. We must substantially speed up the installation of equipment presently awaiting installation at the enterprises and increase the turnover of funds in order to make use of the internal opportunities for further developing production.

The 26th Party Congress pronounced that the "economy must be economical". In June 1981 the CPSU Central Committee and the USSR Council of Ministers passed a decree "on strengthening work to conserve and make rational use of raw materials, fuel and power and other material resources." In the labor collectives of the power machine building industry this decree was perceived as a specific, real program for reducing production cost and raising the efficiency of all public production.

In executing this decree, the Ministry of Power Machine Building developed and delivered to the associations and enterprises a comprehensive program of measures for conserving material and fuel and power resources during the years 1981 through 1985. Most of the savings in the 11th Five-Year Plan is to be obtained through the production of progressive power machinery with a reduced relative expenditure of materials; by improving the structure of the equipment that is produced; the modernization and production of manufactured articles with an icreased service life, which will significantly reduce the demand for them.

A substantial contribution to the overall sector's conservation fund will be the replacement of outdated designs by progressive designs and the improvement of technological processes estimated to better, more wisely make use of equipment and metal in all stages of its processing and especially in the billet production, in order to conserve fuel, thermal and electric power. Finally, an important contribution to the conservation fund will be the more extensive use of new progressive materials and the use of experience gained in the sector in substituting other materials for metal.

The labor collectives of the power machine building industry, in participating in the all-union effort to conserve, are looking for ways to fulfill the established assignment to reduce the norms for expending metal, particularly rolled metal, fuel, thermal and electric power for the production of a unit of product.

The struggle to conserve material resources in the national economy is not a short-term capaign. This is one of the main directions of the Party's economic policy. For this reason the managers of the associations, enterprises and organizations of the sector along with the Party and public organizations must systematically study the organization of this important undertaking and monitor the progress in fulfilling the set measures aimed at the conservation and rational utilization of all material resources.

In these times the scope of socialist competition is expanding in all sectors of the national economy to overfulfill the assigned planned tasks, to increase the quality of manufactured articles, to reduce outlays for their production, and to increase labor productivity and the efficiency of all public production. The power machine building workers are actively participating in the all-union movement for highly-productive labor. Production leaders and innovators are being attracted to all initiatives to further improve the organization of labor. Socialist competition is being developed on the sound, proven principle of the "workers' relay race". In evaluating the labor contribution of each worker to the common good, the instruction of the Party regarding the fact that one cannot tolerate even isolated cases of wage equalization and the undeserved awarding of bonuses, which has a very harmful effect both on production indicators and on the morale of people. At the 26th Party Congress, L. I. Brezhnev said, "Conscientious workers must be encouraged and loafers and shoddy workers must not be given any loopholes for a good life when they are doing poor work. He who wants to live better must work more and harder." This principle must be persistently used in our labor collectives.

In the associations and enterprises of the power machine building industry a set of measures is being taken to reduce the turnover of labor, to strengthen labor and production discipline, and to provide for a regular pace of product output. In view of the demographic situation in the next five years, this important and very responsible task must be decisively activated, The managers of the enterprises along the Party, trade union and Komsomol organizations must achieve the maximum possible stability of labor collectives, using such an important factor as improving the social and daily living conditions of the workers toward this goal.

With each five-year plan the demand of the USSR national economy for reliable power machinery of various types and for different purposes increases. There are also a sizeable number of export orders. In order to meet all orders, it is necessary to work even harder and to continue to look and efficiently use internal reserves. In the final analysis, the well-being of the government and each man depends upon the conscientious labor of everyone.

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ELECTRIC POWER

MINISTER COMMENTS ON FUTURE DEVELOPMENT OF POWER INDUSTRY

Moscow ELEKTRICHESKIYE STANTSII in Russian No 12, Dec 81 pp 2-5

[Article by P. S. Neporozhiniy, USSR minister of power and electrification: "The Electric Power Industry in the 11th Five-Year Plan"]

[Excerpts] Work has begun on the utilization of nuclear power for the generation of heat. Nuclear heat-supply stations (AST's) with outputs of 860 Gcal/h each are being built.

Pumped-storage hydroelectric stations of 1,200 and 1,600-MW capacity are under construction.

The construction of new high-voltage and superhigh-voltage lines has made it possible to insure the further growth of the USSR Unified Power System.

The Siberian Integrated Power System was connected to the USSR Unified Power System during the five-year plan. The formation of various power systems into a Central Asian Integrated Power System was continued on the basis of the powerful Syrdar'inskaya GRES and the Nurekskaya and Toktogul'skaya GES's.

The on-site practical utilization of Ekibastuz coal has begun. Four power units of 500,000-kW capacity each are in operation at the Ekibastuz GRES-1, now under construction.

The technical and economic indicators of power-system operation have improved on the whole. The per-unit expenditure of fuel has been reduced from 340 to 328 g per kWh during the 10th Five-Year Plan. This has made it possible to insure a fuel savings of 36 million tons of conventional fuel over the 5 years.

Plans have been made to raise the production of electric power in the country to 1,555 billion kWh. In this case, the generation of electric power at nuclear and hydroelectric stations will amount to 450 billion kWh.

The increase in the production of electric power over the five-year plan will amount to more than 20 percent; that is, the high growth-rate of consumption will be maintained on the whole. At the same time, about 70 percent of the planned growth of electric-power production will fall to nuclear and hydroelectric power stations.

The percentage-share of newly introduced capacities (not requiring fossil fuels) will increase from 35 percent in the 10th Five-Year Plan to 53 percent in the 11th. Due to this, about 75 million tons of fossil fuel will be freed in 1985 as compared to 1980.

The installed capacity of electric-power stations should reach 334 million kW, taking into consideration the decommissioning of equipment which has reached the end of its service life (6-7 million kW).

In the near future, the development of electric-power and heat supply will be accomplished according to the following guidelines:

A nuclear-power system will be created in the country's European sector which will cover the growth of consumption in this region of electric and, to some degree, thermal energy.

The introduction of 23 to 24 million kW of new AES capacities is planned for 1981-1985. This trend is based on a considerable intensification of nuclear-power equipment construction, the development of the construction industry as well as the production of nuclear fuel.

Plans have been made to commission 17 power units of 1 million-kW capacity each as well as several 1.5 million-kW units at nuclear electric-power stations.

Construction will continue on hydroelectric power stations, mainly in the country's eastern regions, as well as in Central Asia with integrated utilization of reservoirs. These will include the Sayano-Shushenskaya, Bureyskaya, Boguchanskaya, Rogunskaya, Kurpsayskaya and Baypazinskaya GES's, as well as others.

In the European sector, construction will be completed on the two latest hydroelectric stations in the Volga-Kama cascade--the Nizhne-Kamskaya and Cheboksarskaya GES's. Construction will continue on hydroelectric stations in the Northern and Transcaucasus, and construction work will commence on pumped-storage hydroelectric stations [GAES's]--the Zagorskaya, Dnestrovskaya and Kayshyadorskaya GAES's.

Plans have been made to commission a total of 12 million kW of new capacities at GES's in the 11th Five-Year Plan.

We must mention certain system requirements for the operational utilization of hydroelectric stations.

In connection with the massive construction of base-load nuclear condensing power stations, there has arisen an acute need for peak and semipeak capacities in the European sector of the USSR.

The research and design studies which have been carried out attest to the fact that it is expedient to have 200 and 500-MW steam-turbine units operating at subcritical steam parameters as maneuverable semipeak capacities. A combination of GAES's and gas-turbine installations is the most economical for a peak source.

The guarantee of reliable AES operation in the base-load regime with the most efficient utilization of fuel is possible only with the introduction of a sufficient number of GAES's and gas-turbine installations which will smooth out operating conditions for base-load electric-power stations, covering the peak portion of the load and raising the load to AES's during nighttime hours. For this reason, the construction of GAES's and gas-turbine installations must be considered an indispensable part of the program for the development of the nuclear-power industry. By 1990 it will be necessary to commission maneuverable units with an output of more than 16 million kW, including 8 million kW at GAES's.

Unfortunately, the equipment to be used for such purposes, particularly the gas turbines, is being manufactured in limited quantity, and this delays the solution to the problem.

Plans have been made to commission 32 million kW of new capacities at thermal electric-power stations in the 11th Five-Year Plan.

The introduction of power units possessing high per-unit capacities will increase considerably. Provisions have been made to commission 7 power units of 800,000-kW capacity each, 9 units of 500,000-kW capacity, 26 units of 210,000 to 300,000-kW capacity and other equipment.

The most important tasks in the area of thermal-power engineering are the following:

the further improvement of the Ekibastuz fuel and power-production complex. Now under construction within this complex are two power stations with an output of 4 million kW each from 500,000-kW generating units;

the creation of the Kansko-Achinsk fuel and power-production complex, made up of the largest open-pit coal mines and thermal electric-power stations. The reserves of Kansko-Achinsk lignite are huge and amount to hundreds of billions of tons, of which about 130 billion tons are suitable for open-pit mining. The first 800,000-kW power units at the Berezovskaya GRES in this complex are slated for introduction in the 11th Five-Year Plan. In the future, 10 electric-power stations of 6.4 million-kW capacity each will be built here;

the further development of the Western Siberian fuel and power-production complex through the construction of a group of powerful electric-power stations utilizing local casing-head gas. In order to provide electric power to the rapidly growing gas and oil industrial region here, plans have been made to construct a number of electric-power stations with 800,000-kW power units.

The role of centralized heat sources, particularly heat-and-electric power stations and large-scale boiler plants, will be increased in the economy's heat supply in the 11th Five-Year Plan.

The total heat output from centralized sources in our country will amount to about 2,700 million Gcal, half of which will be due to TETs's.

Considerable attention will be devoted to involving new sources of power in the fuel-and-power balance. The coming years will be the years in which we master the first magnetohydrodynamic installations, as well as solar and geothermal power-production installations.

An experimental 5-MW solar electric-power station will be commissioned during this five-year period, while a 50-MW unit is planned for the future. It has been decided to build geothermal electric-power stations in Dagestan and on Kamchatka.

As a result of the realization of th;se trends, the utilization structure of fuel and power resources has changed considerably, and the consumption of petroleum products has been significantly reduced. The scale of fossil-fuel consumption, however, remains substantial. The great volume of consumption and the increase in the cost of extraction and transportation require a more economical expenditure of fuel and all types of energy.

In electric-power engineering, we must reduce the per-unit expenditure of fuel to 319-320 g/kWh.

An active energy-conservation policy must become the primary direction for the development of the entire fuel and power-production complex. There is a potential for saving in all sectors of the economy and it must be mobilized.

One of the most important conditions for improving the efficiency and reliability of electric-power production is the further growth and formation of the USSR Unified Power System. Plans have been made to insure the connection of the Central Asian integrated grid to the USSR Unified Power System in the 11th Five-Year Plan.

The primary electric network of the Unified Power System should provide for the distribution of power from newly constructed electric power stations and cover the overcurrents associated with the realization of an intersystem effect from the combined operation of the integrated power system and associated with the efficient utilization of power resources.

The establishment of system-forming networks will be accomplished through the construction of networks of higher voltage.

The rise in unit outputs of thermal and nuclear power stations to 4-6 million kW and the increase in the magnitude and range of overcurrents generate great requirements for a further improvement in the reliability of system-forming communications.

In the western and southern regions of the country, plans have been made to construct 750-kV electric transmission lines, while provisions have been made to make the transition to a new class of 1,150-kV lines in the Siberia-Urals region. The length of 500 to 1,150-kV lines commissioned in the 11th Five-Year Plan will amount to more than 17,000 km.

Plans have been made to construct a 1,500-kV direct-current line to transport electric power from the Ekibastuz complex to the European sector of the country.

Thus, the development of the power industry in the 11th Five-Year Plan is an important plan for the introduction and mastery of new equipment and new developments, as well as the realization of the resolutions of the 26th CPSU Congress and a power program directed at the further improvement of the welfare of our country's people. To insure the implementation of these tasks is the most important duty of the power engineers.

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ELECTRIC POWER

DEVELOPMENT OF NUCLEAR POWER IN USSR

Moscow TEPLOENERGETIKA in Russian No 1, Jan 82 pp 2-7

/Article by I. Ya. Yemel'yanov, corresponding member of the USSR Academy of Sciences, and V. A. Chernyayev, candidate for the degree of doctor of technical sciences: "Implementing the Decisions of the 26th Party Congress: Development of Nuclear Power in the USSR"/

/Excerpts/ The basic economic, engineering and scientific-technical tasks for the further development of the nuclear power industry over the next ten years and beyond are:

expanding the scale of adopting nuclear power into the national economy by the continued mass construction of industrial atomic electric power stations (AES) with standardized reactors using thermal neutrons;

raising the efficiency of nuclear power sources based upon thermal neutron reactors;

the development and assimilation of full-scale nuclear fast breeder reactors for the expanded reproduction of nuclear fuel in converter and breeder modes within the industrial AES's;

the assimilation of the controlled reaction of thermonuclear synthesis, and also the development and assimillation of the technical means which provide for the efficient use of the energy of thermonuclear synthesis for energy purposes;

and the development of a general strategy for the long-term development of the nuclear power industry.

The scale of AES construction in the USSR in the 11th Five-Year Plan was specified in the decisions of the 26th Party Congress. (7) During the period from 1981 through 1985 it is planned to introduce 24 to 25 million kilowatts of new capacities at atomic electric power stations, bringing the generation of electricity at AES's in 1985 to 220-225 billion kilowatt-hours.

In the 1980's the USSR will continue to cooperate with the socialist nations in the field of nuclear power within the framework of target programs approved by the 32nd Session of CEMA.

By the end of the 1980's the overall scale of nuclear power development in the USSR and the CEMA nations will grow considerably as compared with the end of the 1970's.

In proportion to the increase in the amount of electric and thermal energy produced by AES's, ATETs's and AST's, the practical importance of nuclear power will increase. To increase the efficiency of nuclear power sources based upon thermal neutron reactors it is expedient to do work in two directions.

1. Increasing the efficiency of nuclear thermal neutron reactors (RBMK and VVER) for the production of electricity at the base AES's. This can be accomplished by enlarging the per-unit capacity of the nuclear power units and increasing the initial parameters (efficiency) of the AES's power cycle, and also by increasing the efficiency of using nuclear fuel as the result of increasing the depth of its burn-up and recycling at an AES regenerator of the spent fuel.

2. Expanding the range of the use of nuclear thermal neutron reactors, which can be done in several ways.

First - the use of an AES to participate in meeting the alternating zone of the electric power load schedule.

Second - the extensive use of nuclear power sources for municipal heating and industrial central heating systems.

Third - the use of nuclear reactors to provide energy to high-temperature and energy-intensive industrial technological processes.

The channel uranium graphite reactors of the RBMK type possess the possibilities to enlarge the per-unit capacity and to increase the initial parameters (including the efficiency). Available scientific-technical experience in the production in a nuclear reactor of steam at a pressure of 10 to 13 MPa and superheating it to 500 - 550 degrees C (the first and second units of the Beloyarskaya AES) attests to the possibility of increasing the initial parameters and efficiency of an AES's power cycle with channel reactors.

Increasing the per-unit capacity of an AES's power units with channel reactors and raising their efficiency can provide significant national economic savings, which will be manifest in the economy of expenditures for a unit of useful capacity, metal, cosntruction materials, and labor resources. Moreover it is possible to reduce the number of construction and AES operating personnel and workers engaged in the extraction of nuclear fuel and the manufacture and processing of fuel elements /tvel/ for AES's.

There are also reserves for increasing the efficiency of the use of nuclear fuel in RBMK-type reactors. Experience in the operation of eight power units with RBMK-1000 reactors led to the discovery of reserves for the linear loads on the fuel elements and the maximum

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(according to crisis conditions of the heat exchange) capacities of the channels. This makes it possible to rely upon the stable and reliable operation of the tvels and the TVS at higher enrichments of the oxide fuel. (8)

Another method for improving the fuel cycle of RBMK reactors is to reduce the average fuel enrichment in the core during the first loadings of these reactors. Reducing the expenditure of uranium can be achieved by cutting back or completely eliminating the parasitic seizure of neutrons in the additional absorbents (DP) during the initial period of a reactor's operation.

Estimates show that during the first loading of a reactor the fuel (according to the conditions of the criticality) can have an enrichment of approximately 1.3 percent. The loading can be from a TVS containing uranium of one or two enrichments - stationary and reduced. A TVS with natural or depleted uranium can be used for the reduced enrichments.

The savings from reducing the enrichment of the fuel during the first loadings must be evaluated for the entire system forming the RBMK with consideration given to the rates of its development.

A significant increase in the depth of fuel burn-up can also be anticipated by substituting the steel spacer grids with zirconium grids, which corresponds to a reduction in the expenditure of uranium for feeding the reactor by approximately 5 percent.

The axial profiling with the use of a fuel of two enrichments will make it possible to increase the depth of burn-up and to reduce the expenditure of uranium for feeding the reactors by 3 to 5 percent. Rotating the TVS in order to eqaulize the fuel burn-up results in a similar savings.

There are plans to modernize the VVER-1000 reactors, which is to be accomplished in two stages. (9)

The first stage in modernization is to be accomplished on the power units now being built at the Yuzhno-Ukrainskaya and Kalininskaya AES's, and also on the third power unit of the Rovenskaya AES; moreover, they are making substantial changes in the design of the reactor. Essentially these changes call for the switchover to the uncovered design for a fuel assembly. As the result of this change the core can hold 163 fuel assemblies rather than 151 while retaining the internal diameter of the housing and the step of the tvel placement. The number of control organs can be reduced to 61 and the number of absorption elements in a cluster can be increased from 12 to 18.

The second stage in the modernization program is to be accomplished by using improved equipment, simplifying the overall layout of the AES, optimizizing the thermotechnical parameters and reloading modes, and adopting systems for monitoring the durability and serviceability of the equipment.

For the VVER-1000 reactor a specific improvement of the fuel cycle is possible in optimizing the reloading modes, improving the design of the fuel assemblies, and improving the operational control over the operation of the core, etc. In particular, they are planning to switch to two fuel reloadings per year with a reduction in the fuel cost for electric power of 8 to 9 percent.

VVER-type reactors have a high content of fissionable isotopes in the unloaded fuel; for this reason it is important to obtain a uranium regenerate from the spent fuel and its recycling in a closed fuel cycle. In connection with this it is important to reduce the amount of time that the reprocessed nuclear fuel is held in the external fuel cycle. With a three to four year delay and longer the expenditure of natural uranium in the VVER reactors, which operate in a closed fuel cycle, remains at the level (or somewhat higher) as its expenditure in RBMK reactors without the processing of fuel during the adoption of the measures we have discussed for improving the fuel cycle.

In using an AES for alternating loads one of the most important problems is to ensure the hermetic seal of the tvel casings in connection with the repeated changes in their load. For this reason it is advisable to take measures to develop and assimilate materials and a technology for manufacturing tvel casings with an oxide fuel that is resistant to large deviations in temperature; fuel compositions with an increased thermal conductivity and on their basis tvels for the maneuvering AES's; and equipment for the nuclear power units of the maneuvering AES's.

When using nuclear thermal neutron reactors for a central heating system and industrial heating supply systems it is advisable to increase attention to the following research:

that which provides the possibility of rigging central heating turbines (type T and TK) of the planned or under construction power units of the AES, the sites of which are found from 50 to 60 kilometers from the large users of heat with a concentration of thermal load at a level of 4,000 to 6,000 Gj/hour and higher;

that which is directed at the creation of an AST and also specialized ATETs based upon channel reactors with increased initial parameters of the central heating power cycle;

that which promotes the creation of atomic industrial heating supply plants (ASPT), which in contrast to the AST can generate steam at a pressure of 1.5 to 2.5 MP, and possibly as much as 4.0 MP for industrial needs.

The savings from the adoption of the results of this research will be seen both in the replacment of the scarce fuel oil by nuclear fuel and in the increased efficiency of the production of electricity using nuclear sources as the result of the combined generation of electricity based upon thermal consumption.

To ensure the opportunity to bring nuclear thermal neutron reactors into the supplying of energy for high-temperature and energy intensive industrial technological processes it is necessary to conduct research in these areas:

the creation of high-temperature nuclear reactors capable of operating reliably at a cooling agent temperature at core outlet of up to 900 to 1,300 degrees C;

the creation of technical means for transferring high-temperature heat from the core of a nuclear reactor to the technological flows, while providing the required level of radiation shielding of the final industrial product, technological equipment and operating personnel.

At present work is underway to develop an experimental industrial high-temperature nuclear reactor, the VG-400, with a thermal capacity of 1,000 MW, which is cooled by a gas cooling agent - helium.

For the conditions of the USSR the most pressing problem has to do with using high-temperature nuclear reactors for the chemical industry, in particular for the production of ammonia and methanol. This is caused by the following three factors:

the chemical industry is already an established and intensively developing consumer of natural gas;

the chemical industry has already assimilated the materials and structures of high-temperature equipment, which have an operating resource of up to 100,000 hours at a temperature of 850 degrees C;

it is based upon the high-temperature and power intensive process for the conversion of methane.

Later on it is possible to adopt nuclear fuel resources in such sectors of industry as petrochemicals, ferrous metallurgy, coal gasification, the production of hydrogen, and so forth. We are also thinking about the possibility for long-distance transporting of heat in a chemically connected state, based upon the storage of the heat from the nuclear reactor during the methane conversion process and upon its transport as a cold converted gas and separation at the place where the heat is used through the accomplishment of a reverse reaction - methanization. It is economically advisable to use the ATETs and AST on the basis of assimilated reactors for servicing the consumers of heat at a capacity of 4,000 Gj/hour and higher, and the atomic-chemical sources of heating can serve the smaller consumers of heat, the percentage of which is approximately 40 percent of the total consumption of heat.

Also of substantial interest is the matter of constructing aluminum and alumina complexes in regions near the sources of the raw materials for aluminum. These complexes would use the thermal and electric power from AES's, which does away with the need to spend large amounts of money for transporting fuel and raw materials, for the construction of high-voltage power transmission lines and transformer substations for the three-stage transformation of voltage.

In the 1980's work will continue on the creation and assimilation of power units using fast breeder reactors such as the BN with an electrical capacity of 800 and 1,600 million kilowatts. The effort to simplify the technological layout of an AES (at an AES using sodium fast breeder reactors the layout consists of three circuits) and to increase the operating time of the nuclear fuel was the reason for conducting research and development work on the creation of fast breeder reactors with a gas cooling agent (helium) - the BGR. Reactors of this type may become a good augmentation to the fast breeder sodium reactors and promote the more efficient solution of the fuel problems of the nuclear power industry.

At the same time at present fast breeder reactors (BN-350 and BN-600) are operating in a convertor mode, i.e., in the consumption of natural uranium. For this reason the most important scientific-technical task in the area of fast breeder reactors is the creation of fast reactors - breeders, which use in their core a secondary nuclear fuel - plutonium.

In summarizing all that has been said, we can with complete justification assert that the nuclear power industry in the USSR is even now becoming the basis for the growth in the production of electricity. It possesses great promise and significant possibilities for further improving. At the same time its development is giving birth to new questions no less complicated than those already solved. But this is the natural process of development.

The decisions of the 26th Party Congress spell out the foremost practical tasks and basic directions for scientific research in the field of nuclear power. There is every reason for confidence that Soviet scientists, engineers, designers, workers, builders, and all atomic industry workers will be able to handle the tasks assigned by the 26th Party Congress and to ensure the successful development of the nuclear power industry in the USSR. This also pertains to such an important field of the future development of the atomic power industry as the thermonuclear industry, the problems of creating of which require a separate examination.

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ELECTRIC POWER

POWER DEVELOPMENTS IN 1981, PLANS FOR 1982

Moscow TEPLOENERGETIKA in Russian No 2, Feb 82 pp 2-3

/Article by Ye. I. Borisov, first deputy minister of the USSR Ministry of Power and Electrification: "Implementing the Decisions of the 26th Party Congress: Results of Power Industry Development in 1981 and the Tasks for 1982"/

/Text/ The first year of the 11th Five-Year Plan has been noteworthy as a year in the struggle to fulfill the historic decisions of the 26th Party Congress, which defined the strategy and tactics for the social and economic development of the Soviet Union at a new stage in the building of communism.

A great deal of attention was devoted to the problems of the power industry in the CPSU Central Committee's report to the Party Congress, which was presented by General Secretary of the CPSU Central Committee and Chairman of the USSR Supreme Soviet, Comrade L. I. Brezhnev, and in the Basic Directions for the economic and social development of the USSR for the years 1981 through 1985 and for the period up to 1990.

The importance of the tasks facing the power industry workers was emphasized strongly at the November (1981) Party Plenum. The approved program for the further development of this branch of industry calls for an increase in the generation of electricity in the USSR in 1985 amounting to 1,555 billion kilowatt-hours, total. During the five-year plan it is planned to introduce equipment with a rated capacity of 69 million KW. The planned increase in the production of electricity in the European section of the USSR will come from atomic electric power stations.

Powerful thermal electric power stations will be built at a rapid pace; these stations will burn coal from deposits in the Ekibastuz and Kansk-Achinsk basins, the natural gas of Western Siberia, and casing head gas from oil drilling. Large hydroelectric power stations are to be built on the rivers of Siberia, the Far East and Central Asia, taking into consideration the comprehensive use of hydroresources. The extensive development of water storage power stations in the European section of the USSR will be reflected in the construction program.

The scale of centralized heating for domestic and industrial consumers will grow significantly. The generation of heat for consumers in 1985 will reach 2,670 million Gcal.

It is planned to put direct current power transmission lines into operation at a voltage of 1,500 KV between Ekibastuz and the Center and alternating current lines at a voltage of 1,150 KV between Ekibastuz and the Urals.

In the 11th Five-Year Plan the Central Asian unified power system will be joined with the National Electric Power Grid; and in the 12th Five-Year Plan the Far Eastern system will also be tied in with the national grid. Thus, by 1990 the formation of the National Electric Power Grid will almost be complete.

Work is planned for the practical adoption into the national economy of experimental units using renewable sources of energy, as well as the experimental-industrial units for the comprehensive power-technological reprocessing of solid fuels.

In fulfilling the decisions of the 26th Party Congress and the assignments of the national economic plan, the Soviet power industry workers completed a significant amount of work in 1981 to supply the national economy with electric and thermal power. Electric power output in the power stations of the Soviet Union amounted to 1,325 billion kilowatt-hours, of which nearly 80 percent was produced at thermal electric power stations. The output of thermal energy from the thermal electric power stations of the USSR Ministry of Power and Electrification amounted to nearly 900 million Gcal.

During the past year at Soviet electric power stations equipment rated at 10.5 million KV was put into operation. The increase in power capacities was accomplished largely by putting large units into operation. The following power units were introduced: 800 MW at the Ryazanskaya GRES; 500 MW at the Ekibastuzskaya GRES-1; 300 MW of capacity at the Stavropol'skaya, Azerbajdzhanskaya, snd Syrdar'inskaya GRES and the Navoiyskaya GRES and others. Large central heating units with a rated capacity of 250 MW each at an initial steam pressure of 24 MPa were put into operation at TETs-25 of Mosenergo and the Southern TETs of Lenenergo.

In 1981 work continued in introducing hydrounits at the under-construction Sayano-Shushenskaya GES (unit No 6 with a rated capacity of 640 MW), the Nizhnekamskaya (No 6-78 MW), the Cheboksarskaya (No 2 - 78 MW), the Gazalkentskaya (No 2 - 40 MW). The first hydrounits with a rated capacity of 200 MW were put into operation at the Kurpsayskaya GES. And the first two hydrounits with a rated capacity of 100 MW each were put into operation at the Dnestrovskaya GES.

Last year to further develop the Unified National Power System more than 11,000 kilometers of high-voltage 220 KW power transmission lines were completed, including 750 KV lines: the Smolenskaya AES to the substation at Novobryanskaya and the Chernobyl'skaya AES to the Vinnitsa; 500 KV voltage: Kostromskaya GRES to Vologda, the Ryazanskaya GRES to Tambov, Chusovaya to Severnaya, the Surgutskaya GRES to Tarko-Sala to Urengoy, the Ust'-Balyk to Dem'yanskaya, and others.

As before a great deal of attention was given to the development of distribution electric networks at a voltage of .4 to 20 KV, particularly those connected with the further electrification of agriculture. Altogether during the year more than 140,000 kilometers of such power transmission lines were completed.

To raise the degree of electrification of agriculture in the nonchernozem zone of the RSFSR in 1981 the USSR Ministry of Power and Electrification put into operation 1,600 kilometers of 35 KV and higher power transmission lines and 23,000 kilometers of .4 to 20 KV power lines.

In the first year of the 11th Five-Year Plan further work was done to raise the efficiency of fuel usage. The relative expenditure of fuel for the electric power produced was reduced by .9 g/per kilowatt-hour and amounted to 327.1 g/ per kilowatt-hour. The conservation of fuel as compared with 1980 was .9 million tons of conventional fuel.

In 1981 the relative expenditure of fuel for a group of power units at 800 MW was 328.6, at 500 MW - 343.2, at 300 MW - 335.5, 200 MW - 356.8 and 150 MW - 367.4 g/ per kilowatt-hour.

The least relative expenditures of fuel were as follows: the 800 MW power units at the Zaprozhskaya GRES - 319.9, the Uglegorskaya GRES - 321..2 g/ per kilowatt-hour, the 500 MW power units at the Reftinskaya GRES (the fuel was Ekibastuz coal) - 330.5, the 300 MW power units at the Sredne-Ural'skaya GRES - 315.6, the Kostromskaya GRES - 317.0, the Iriklinskaya GRES - 318.0, the Kirishskaya GRES - 324.7, the Lukoml'skaya GRES - 320.2, the 200 MW power units at the Belovskaya GRES - 336.5 and the Surgutskaya GRES - 334.0 g/ per kilowatt hour.

At the same time the collectives of several electric power stations operated below their capabilities and overexpended fuel as compared with established norms: the Ekibastuzskaya GRES-1 (a 500 MW power unit), the Yermakovskaya, Ladyzhinskaya, Pridenprovskaya, and Troitskaya GRES's (300 MW power units), the Voroshilovgradskaya, Starobeshevskaya, Berezovskaya, and Smolenskaya GRES's (200 MW power units), and the Noviyskaya, Yajvinskaya GRES's and the Severnaya GRES (150 MW power units).

The collectives of these power stations need to take all steps to ensure the economical operation of the equipment.

The generation of electricity by the central heating cycle at the USSR Ministry of Power and Electrification's heat and electric power plants (TES) increased last year by .1 percent, reaching 22.3 percent. At the TETs equipped with live steam at a pressure of 13 MPa, the relative expenditure of fuel was at a level of 260 g/(kilowatt-hour). At the Yefremovskaya, Kachkanarskay TETs's, Mosenergo's GES-1, the Ufimskaya TETs-1 and the Chelyabinskaya GRES in conditions of operating equipment on the central heating cycle, the relative expenditure of fuel was 150 to 160 g/(kilowatt-hour).

In the CPSU Central Committee and USSR Council of Ministers' decree "concerning increasing efforts to conserve and make rational use of raw materials, fuel and power and other material resources" special emphasis was given to the need to accomplish a set of measures to significantly increase the efficiency of utilizing all types of fuel and power resources in industry and agriculture, in transport, in construction, and in housing and municipal services.

To realize these important instructions in 1981 a plan of "basic measures of the USSR Ministry of Power and Electrification for the rational use and conservation of fuel and energy, material and labor resources and for increasing the efficiency of the operation of power systems in the years 1981 through 1985" was developed and implemented.

In the plan are more than 200 key measures for the modernization and rebuilding of equipment, improving the modes of its operation, and for bringing the technical-economic indicators of the existing equipment up to the designed values.

Thus, on 129 turbines of 150 MW and above power units a set of measures must be taken to prevent the contamination of condensors. On 149 boilers it is necessary to bring the air infiltrations into the combustion chambers and gas conduits up to the normative values, which will make it possible to conserve nearly three million tons of conventional fuel during the five-year plan.

One hundred sixty-three turbines and 133 boilers require modernization and rebuilding, which will raise their reliability and provide a fuel savings of nearly 1.3 million tons of conventional fuel. More than 9 billion kilowatt-hours of electricity will be additionally produced by reducing equipment stand-downs in repair and by raising the quality of the repair work.

Many of the planned measures have already been initiated and have yielded a positive effect at individual enterprises of the sector. The distribution and adoption of the experience of leading electric power stations alone will make it possible to conserve more than one million tons of conventional fuel.

In all collectives of the ministry's enterprises and subelements it is necessary to take steps to fulfill the assignments called for in this plan of action.

In 1981 construction work continued at the Berezovskaya GRES-1 - the first of the electric power stations within the Kansh-Achinsk Fuel and Power Complex. The first power unit of the station with a rated capacity of 800 MW is to be put into operation in 1984. Altogether at the Berezovskaya GRES-1 they will install eight such power units. This will be the most powerful thermal electric power station operating on coal.

The Kazakh SSR Ministry of Power and Electrification must do a great deal of work to speed up the assimilation of available capacities at the Ekibastuzskaya GRES-1, where four 500 MW power units have already been put into operation; but this power station is still operating poorly due to problems with equipment and in the construction and installation, the poor organization of the power station operation, and personnel shortages.

The hydroelectric power industry has been subjected to further development. The percentage of hydroelectric power within the Soviet Union's power balance is nearly 20 percent by capacity and nearly 15 percent by generation of electricity. The basis of the USSR's hydroelectric power industry is comprised by 65 large and medium-sized hydroelectric power stations with a rated capacity greater than 100 MW, representing 93 percent of all installed capacity at hydroelectric power stations. There are 14 hydroelectric power stations having a rated capacity of more than one million KW now in operation.

The construction of the Zagorskaya water storage electric power station near Moscow marked the beginning of carrying out the 26th Party Congress' program for using large GAES /water storage electric power station/ to raise the economy and reliability of power systems in conditions of the rapid growth of atomic electric power stations, operating in a base mode. The creation of water storage stations will make it possible during the off-hours to use atomic power units to a small extent. At the same time it is necessary to speed up the creation of special, very maneuverable equipment of the thermal electric power stations (GTU /gas turbines/, PGU /gas-steam turbine/, and semi-peak steam power units), and to work on improving the maneuvering characteristics and determining the reliability and service life of existing power units, including s.k.d. units during their operation in the semi-peak portion of the load schedule.

In recent years a lot of attention has been devoted to the introduction and assimilation of new capacities at atomic electric power stations. To fulfill the tasks decreed by the 26th Party Congress it is necessary to do a great deal of work to strengthen the pace of AES construction, for the production and assimilation of equipment, the creation of bases for the construction of housing and cultural and services facilities, and for the training of skilled personnel. The rapid development of the atomic power industry poses new, serious tasks for the operating personnel to ensure the reliable and safe operation of the atomic power stations.

At present the installed capacity of all atomic electric power stations has reached 15 million KW. This significantly exceeds the entire amount of electric capacities for the Soviet Union in the year 1940. At nine existing atomic electric power stations (Armyanskaya, Beloyarskaya, Bilibinskaya, Kol'skaya, Kurskaya, Leningradskaya, Novovoronezhskaya, Rovenskaya and Chernobyl'skaya) 25 power units with various types of reactors are in operation. In 1981 the Leningradskaya AES, the largest in Europe, reached full capacity (4 million KW). The Chernobyl'skaya (3 million KW), Novovoronezhskaya (2.5 million KW), and the Kurskaya (2 million KW) atomic electric power stations are functioning smoothly.

In the first year of the 11th Five-Year Plan new AES capacities were introduced, including power unit No 4 at the Leningradskaya AES, unit No 3 at the Chernobyl'skaya AES, unit No 3 at the Kol'skaya AES , and unit No 2 at the Rovenskaya AES.

The pace of construction work has been picked up at the Zaporozhskaya, Balakovskaya, Khmel'nitskaya and other atomic electric power stations, where power units are to be put into operation during the 11th Five-Year Plan. During the past year atomic electric power stations generated 85.6 billion kilowatt-hours of electricity; in 1982 the output is to reach 107 billion kilowatt-hours. This represents a 3-fold increase in the production of electricity as compared with the amount generated by all Soviet electric power stations in the year 1940.

A special feature of the development of the atomic power industry in the 11th Five-Year Plan will be the extensive adoption of large per-unit power units of one million KW each and the use of atomic energy for providing central heating to large cities from atomic heating and power plants (ATETs) and atomic heating plants (AST). Work has already gotten underway on the Odesskaya ATETs and the Novovoronezhskaya and Gor'kovskaya AST's.

Soviet power industry workers are faced with important tasks in 1982. The production of electricity for the USSR must reach 1,365 billion kilowatt-hours and the generation of heat from the TETs of the USSR Ministry of Power and Electrification to 925 million Gcal. The relative expenditure of fuel must be reduced to 324.5 g/(kilowatt-hour).

The Ministry has outlined specific measures to successfully fulfill these assignments.

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ELECTRIC POWER

CONSTRUCTION AT ZAPOROZHSKAYA AES

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 1, Jan 82 pp 5-9

/Article by A. V. Kocherga, L. N. Rukhmanov, A. P. Andriyevskiy, and I. V. Zhartovskaya, engineers: "Construction and Installation Work at the Zaporozhskaya AES"/

/Text/ From the editors: In the periodical ENERGETICHESKOYE STROITEL'STVO No 7 for 1981 there was a collection of articles dealing with the design, lay-out and structural decisions on the Zaporozhskaya AES.

In this issue we acquaint the readers with problems having to do with the engineering work that is done to prepare for the installation of equipment. We also commence the publication of materials regarding the experience of organizing and executing construction work at the Zaporozhskaya AES.

The decision to build the Zaporozhskaya AES was made in 1977; in 1979 by order of the USSR Ministry of Power and Electrification this atomic electric power station was declared the leading experimental, showcase project in a series of atomic electric power stations being built in accordance with a standardized design. In building the Zaporozhskaya AES it is proposed to develop structures called for in the design of atomic electric power stations with the modular lay-out of the main housing and also the technology for executing construction and installation work in order to disseminate the experience gained during the construction of subsequent atomic power stations in this series.

The technical design work for the Zaporozhskaya AES was developed by the Teploelektroproyekt Institute in cooperation with the designing, construction and installation, and installation-technological organizations. This has undoubtedly had a positive influence upon the selection the configuration and structures of the buildings of the power station, which made it possible to ensure the optimal conditions for organizing the construction.

In developing the technical design the stages in the construction of the basic production facilities were specified; these stages ensured the introduction of the power units within one to two years. Problems having to do with the construction of the reactor room were examined in particular detail: the physical volumes of construction work; the distribution of material, financial, and labor resources for each yeat of the construction for both the first power unit and all later units.

During the development of the technical design the Donetsk branch of the Atomenergostroyproyekt Institute prepared and coordinated the structural and technological assemblies of the AES production facilities and the design-estimate equipment sets with the general contracter; this made it possible to later regulate the working design work and the pace of the construction.

The first power unit of the Zaporozhskaya AES was planned for introduction in 1983 with later units to be put into operation in one-year intervals.

The All-Union Association Soyuzatomenergostroy's Administration for the Construction of the Zaporozhskaya AES is building the electric power station. This organization is using its own resources to build the AES's main housing and to do the excavation and concrete work on all facilities; it is also doing the roofing and waterproofing work on the industrial construction facilities. In addition it is doing the construction work at construction industry enterprises (AESK /AES construction combine/, DSK /house building combine/, the KVO plant and the NSO), the construction-installation, finishing and sanitary engineering work at housing, cultural and social facilities; it is also in charge of the planning and provision of public services and amenities for the housing settlement.

Specialized organizations have been called in to work on the AES, including:

the installation administration of the Yuzhenergomontazh Trust is installing the preassembled reinforced concrete and metal structures for the reactor rooms, the machine rooms, the unified auxiliary housing, the administration building and others; in addition, in its own on-site yards it is manufacturing preassembled reinforced concrete structures and reinforced concrete form units for the reactor room;

the installation sector of the administration of the Donbassenergomontazh is installing the preassembled reinforced concrete and metal structures of the special housing, the reserve diesel-generator plants and other facilities and, in addition, in its own on-site yards it is manufacturing the preassembled reinforced concrete structures and reinforced concrete form units for these facilities;

the installation administration of the Yuzhteploenergomontazh Trust is installing the thermal mechanical equipment of the reactor rooms, the special housing and the diesel-generator plants. It is also installing the stainless steel facings for the construction structures;

the installation sector of the Teploenergomontazh Trust is installing the thermal mechanical equipment in the machine room, the shore pumping station and the unified auxiliary housing;

the administration of the Soyuzenergozashchita Association is working on the protective special coatings for the construction structures, the equipment and thermal insulation for the equipment and pipelines;

the installation sector of theElektroyuzhmontazh Trust is in charge of installing the electrical, dosimetric and control and measuring systems and automation systems;

the administration of the Soyuzenergomontazhventilyatsiya Association is installing the special ventilation system in all facilities of the atomic electric power station and is doing the sanitary engineering work at the industrial site and the plants of the construction industry;

a sector of the Gidromekhanizatsiya Administration is working on the hydrotechnical facilities.

The subcontractor organizations are also participating in the expansion of the construction base and the construction of housing.

Preparatory work at the Zaporozhskaya AES began in 1978. In connection with the proximity (2.5 km) of the site of the Zaporozhskaya AES to the existing Zaporozhskaya GRES, which was put into operation in 1977, favorable conditions for the construction of the AES had been created. Thus, following comparatively inexpensive work to modernize and expand it, the GRES's construction and installation base was used to meet the needs of the AES now under construction. The existing transportation systems (a waterway with freight handling moorings, railroad lines and highways) are also being used. In addition, upon the completion of the Zaporozhskaya GRES, construction was undertaken to build a house building combine and an atomic electric power station construction combine (DSK and AESK) near the location of the industrial site. Work was also started on a boiler-auxiliary and nonstandard equipment plant (KVO and NSO), which made it possible to keep the construction and installation workers at the construction site so that later they can be transferred to working on the facilities of the AES (the house building combine was handed over for operation in 1980 and the atomic electric power station construction combine is to be completed in 1982, i.e., during the period when the greatest amount of work is to be done on the AES).

All of this made it possible to reduce the amount of time required for the preparation work by nearly one and a half years.

During the preparation period the existing concrete plant, the asphalt and bitumen facility, the roads to the river mooring, and a new road to the industrial site of the AES were modernized and expanded. The construction of new and the expansion of existing temporary buildings and facilities for the subcontracting organizations were also completed.

In view of the compressed time periods for the construction of the AES as early as 1979 they proceeded to work undertakings of the basic period, starting with the zero cycle /ground clearing/ of the main housing.

According to data of geological surveys near the main housing of power unit No 1 the ground water level is between 5 to 6 meters. For this reason according to the PPR /plan for execution of work/ issued by the Donetsk Branch of the Atomenergostroyproyekt Institute, the foundation pit beneath the main housing was dug in two layers: to the two meter level with the installation on organized berms of water draw-down wells every 25 to 30 meters and APVM-35 deep pumps; and to the 7 meter mark after lowering the level of ground water. The porous earth that was detected was replaced by a pillow of earth and crushed rock 1.5 to 3 meters thick.

After completing the earthmoving work on the main housing of power unit No 1 they began preparing the foundation at the 2.8 meter mark for the special housing. The excavation of earth was done for the entire depth of the foundation pit in one layer; the porous earth was replaced for the entire construction site at a depth of 1.5 meters.

Then the workers began to prepare the foundation pit beneath the pipelines of the responsible consumers near the the basic transport lines. In order to preserve the approaches to the power unit No 1 that was under construction, work was started from the direction of power unit No 4 (near the 30th axis of the special housing) and was performed in a single layer to the full planned depth (from the marks -5+ - 5.5 meters). The plan for the execution of work called for work to be done in two stages: from the 30th axis of the special housing to the deflection angle on the sprinkling basins (behind the first axis of the special housing) and from the deflection angle to the sprinkling basins to the diesel-generator plant No 1 along the reactor room of power unit No 1.

It was proposed to dig the foundation pit beneath the underground communications between the reactor room of power unit No 1 and the diesel-generator plants No 1 and 2 after completing the underground portion of these facilities. However, in connection with the need to install the basic construction cranes during the construction of the underground portion of the reactor room of power unit No 1 it was decided to carry out the second stage of the earthmoving work in two substages: first to dig the foundation pits beneath the diesel-generator plants No 1 and 2 and the pipelines between them and the reactor room of the power unit No 1, and then the foundation pit from axis 1 of the special housing to the deflection to the communications between diesel-generator plant No 1 and the reactor room of power unit No 1.

After completing the first substage of the earthmoving work the underground portions of the diesel-generator plants No 1 and 2 were built. Also, the retaining walls of the reactor room of power unit No 1 to the zero mark, the underground communications between these facilities, the backfilling, and the crane suspension tracks were completed. At the same time SKR-2600 and SKR-3500 cranes were installed on temporary tracks, coaxial with the main tracks (from the direction of the reactor room).

The second substage of work was performed after transferring the cranes to the main tracks and the disassembly of the temporary tracks.

Excavators equipped with a drag-line bucket with a capacity of one cubic meter and bulldozers on an S-100 tractor base were used to work the earth in the foundation pits of the main housing, the special housing and the communications corridor and the diesel-generator plants.

The amounts of earth removed at the facilities in thousands of cubic meters were as follows: 184 for the main housing, 48 for the special housing, 147 for the communications corridor (first and second stages), and 94 for the diesel generator plants.

The time periods for working the earth by facility were as follows: September 1979 through March 1980 for the main housing; and March through June 1980 for the special housing; the communications corridor, first stage - June through September 1980; second stage - January 1980 through March 1981 and October through November 1981; the diesel-generator plants - January 1980 through March 1981.

In March 1980 work was started on the concrete pouring in the machine room beneath the foundation of the turbounit and the framework of the building.

In accordance with the planned annual introduction of power units and the accepted pace of work equal to one year, by the end of 1980 work was underway on power unit No 2. Thus, the pouring of the monolithic concrete into the slab of the reactor room of power unit No 2 was started on 1 April 1981 (exactly one year after the start of this work on power unit No 1).

The amounts of work completed at the Zaporozhskaya AES as of 1 September 1981 are characterized by the indicators cited below:

	Start-up complex (according to design)	Completed
Est. Cost, mill. R	354,429	59,540
Incl const./instal work	169,987	49,479

The status of work on the basic facilities for the period is as follows:

for the reactor room of power unit No 1 - the foundation portion to the 10.81 meter mark is being completed and the reinforced assemblies for the overlap are partially installed to the 13.2 meter mark;

for the machine room with the deaerator stack of power unit No 1 - work is coming to an end on the underground portion to the zero mark; work has been started on the installation of the framework; and the reinforcement of the upper plate of the foundation for the turbounit is being completed;

for the reactor room of power unit No 2 - construction structures are being installed to the zero mark;

for the machine room with a deaerator stack of power unit No 2 - concrete has been poured beneath the foundations of the framework and the turbounit; and the lower slab of the turbounit's foundation is now being reinforced;

for the special housing - in the assembly of the workshops the installation of the framework to the 13.2 meter mark is being completed; and for the sanitation and services assembly the installation of the construction structures to the 9.6 meter mark is being completed; and for the special water cleaning assembly the foundation portion is complete and installation of the construction structures has been started;

for the diesel-generator plants No 1 and 2 - the construction of the underground portions has been completed;

for the remaining facilities - the installation of the underground lines near the main transport lines is being completed and the back-filling is underway; the underground lines near the main housing of the power unit No 1 are in place; the crane tracks are installed; work is in progress on the cooling pond, the ORU /open distribution device/ 750 kV, the administration and engineering and laboratory buildings; and the construction of the temporary facilities is being completed.

The flow-line construction of the AES requires an essentially new approach to the organization of work: each type of work must be executed in a way that permits work to get underway on the next kind of work as quickly as possible ; and what is more the pace for all types of work must be the same.

In the construction of the Zaporozhskaya AES two types of flow-line work are used:

for facilities to be used primarily for production purposes of all power units - the reactor rooms, the machine rooms and the deaerator rooms, the diesel-generator plants, the shore pumping stations (facilities common to all AES power units are not included in the flow-line approach);

for structural-technological assemblies of each facility to be used primarily for production purposes.

The greatest interest is in the organization of the second type of work flows, particularly for the reactor room, because there is no experience as yet in constructing atomic power stations with a modular layout of the main housing.

In developing the technical design for the Zaporozhskaya AES the Atomenergostroyproyekt /atomic electric power station construction and designing/ Institute and the Teploelektroproyekt /thermal electric power station designing/ Institute in concert with the Administration of Construction have come up with a breakdown of the construction portion of a reactor room into structural-technological assemblies, in accordance with which the following work flows are defined:

earthmoving (working and displacement of earth, the preparation of the foundation, backfilling);

the foundation slab to the 4.2 meter mark;

the foundation portion to the 10.8 meter mark;

the hermetic slab to the 13.2 meter mark;

the internal structures of the reactor room to the reactor support;

the internal structures of the reactor room to the floor mark of the central room;

the cylindrical portion of the hermetic casing;

the dome of the hermetic casing;

the cornice with a system of preliminary stressing of the casing;

the building of the reactor room.

For the machine room with a deaerator stack the following flows are stipulated:

earthmoving work;

concrete preparation beneath the foundations of the turbounit and the framework of the building;

the lower slab of the turbounit's foundation;

the foundation portion of the building to the 3.6 meter mark;

the framework of the building;

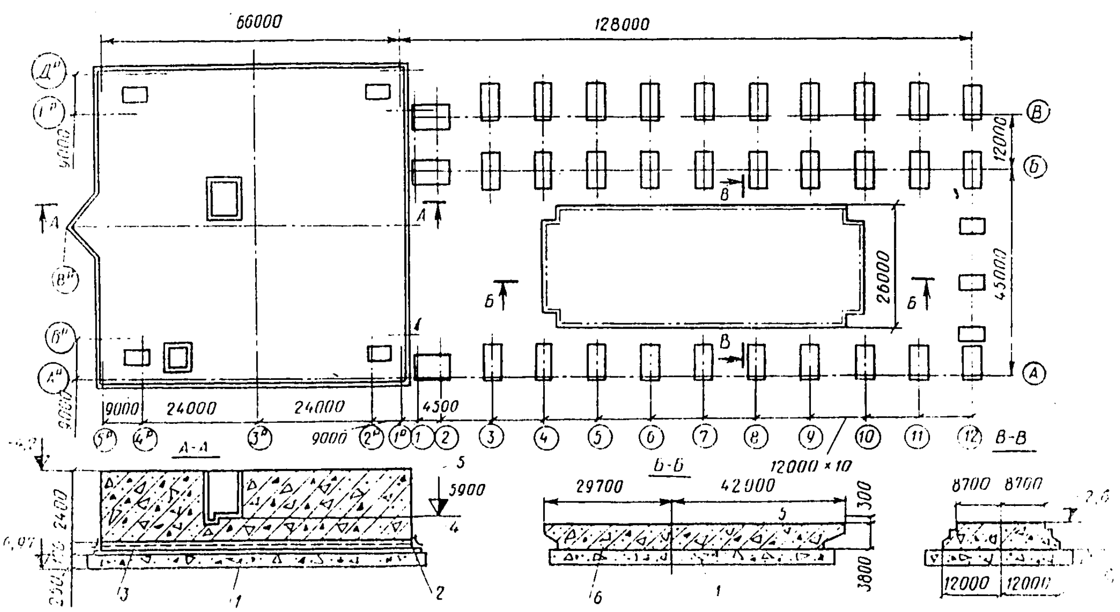
the upper portion of the turbounit's foundation;

the internal structures of the building;

the interior walls and spans of the machine room and the deaerator stack.

In order to generalize and further disseminate experience in the construction undertaking, analysis is performed on everything completed on each structural-technological assembly - on the labor intensiveness, the cost and duration; and the optimal compositions of the production brigades are also determined.

Among the more complicated and important structural-technological assemblies, the work on which has already been completed on the first power unit of the Zaporozhskaya AES, are the foundation slab of the reactor room and the slab beneath the foundation of the turbounit. (See Drawing 1.)



Drawing 1. Foundations of the main housing

Key to Drawing 1: 1) Preparation from M100 concrete with thickness of 250 mm; 2) Equalizing layer with a thickness of 20 mm; 3) polyethylene waterproofing; 4) Protective tightening device from M50 concrete with a thickness of 100 mm; 5) Monolithic reinforced concrete slab; 6) Coated waterproofing made of hot bitumen.

The foundation slab of the reactor room (See Drawing 1, cross-section A-A) is a monolithic reinforced concrete structure, framed by preassembled concrete form slabs, in the manufacturing of which they are waterproofed.

The physical volumes of work in constructing the foundation slab are characterized by the following data:

Preassembled reinforced concrete structures, cubic meters	60
Metal structures (fittings and fastenings), tons	1490
Monolithic concrete, cubic meters:	
in preparation	1918
in the slab	11072
Waterproofing (not counting the waterproofing concrete form slabs), cubic meters	4800
Steel facing, tons:	
carbonaceous	2.91
stainless steel	2.23

In order to analyze the indicators characterizing the accepted design and design-technological solutions are studied: the ratio of the mass of the metal in the monolithic reinforced concrete structure to the amount of concrete in it, t/m3; the ratio of the amount of fastening elements in the metal or reinforced concrete structure to its total volume, items per ton or items per cubic meter.

The PPR in order to cut back on labor expenditures for the reinforcement of the foundation slab called for the upper and lower grids to be consolidated into the adapters to a length of 34 meters and for the bath welding of the fittings to be replaced by contact welding, as a result of which according to the PPR the following indicators were obtained: the use of metal was .13 tons per cubic meter; the coefficient of construction with prefabricated parts was 2.89 parts per ton and .005 items per cubic meter.

In connection with the performance of work during the winter and the need to cut back on the firmness of the concrete as compared with what is called for in the design it was necessary to raise the grade of the concrete: in the cooling layer using M100 to M150, in the protective layer from M50 to M300; moreover the cement coupler is eliminated.

Due to the fact that the line for the waste-free welding of the fittings was not ready and that there were no transportation means for delivering the adapters the slab was fitted with individual rods of a length of 9 to 12 meters, which were connected after they were installed in the design position of the bath welding.

The light-weight installation elements of the fittings were installed by DEK-251 cranes rather than the DEK-50 cranes called for in the design.

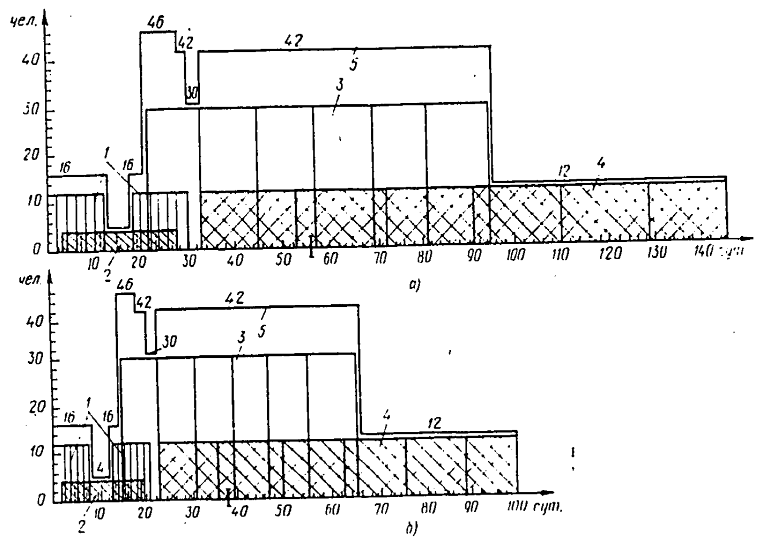
The actual relative labor expenditures and cost of each type of work in building the foundation slab of the reactor room are cited in Table 1.

Table 1

Type of work	Unit of work	Labor expenditures per unit of work, in man-days	Cost per unit of work, in thousands of rubles
Installation:			
preassembled reinforced concrete structures	M^3	.6	.24
Metal structures (fitting and fasteners)	T	2.73	.24
Concrete pouring:	M^3		
preparation beneath the foundation slab		.23	.034
foundation slab		.17	.03
Waterproofing	M^3	.03	.004
Installation of facings of steel:	T		
carbonaceous		7.2	.48
stainless		32.7	2.15

As the result of analysis of the work completed an optimal composition of construction brigades (men) was recommended per shift by types of work: installation of preassembled reinforced concrete structures - 6; installing of fittings and fasteners - 30; concrete pouring - 12; and waterproofing - 4.

In this regard the length of the work on the foundation slab will amount to 147 or 100 days respectively with a two-shift or three-shift operation. The opening of the front for the carrying out of subsequent work can be expected in 56 and 38 days depending upon the work shift configuration chosen (Drawing 2).



Drawing 2. Recommended schedules for doing work in the building of the foundation slab for a reactor room. Key: a, b - for a two-shift and three-shift operation respectively: 1) concrete preparation device; 2) waterproofing work; 3) reinforcement; 4) concrete pouring for the slab; 5) total labor expenditures.

Based upon the analysis of the work completed one can reach several conclusions.

For the design solutions. It is necessary to decrease the list of the materials that are used. In particular, there is no justification to use various grades of concrete in a single structural assembly, since this considerably complicates the execution of work, especially in small amounts. It is wise for the concrete preparation beneath the foundation slab to be done with grade M200 concrete, i.e. the same grade used for the slab itself.

For the technological solutions:

1) the inclination toward large-unit assembly in order to reduce labor expenditures is natural; however, these matters must be viewed as they apply to the conditions of work performance at a specific site;

2) in plans for the execution of work the pace of work must be evaluated for the specific assembly and the time for the most rapid opening of the front must be determined for subsequent work.

The lower slab of the foundation for the K-500-65/1550 turbounit is a monolithic reinforced concrete structure (See Drawing 1, cross-sections B-B and C-C). It is an important structural-technological assembly, which must operate as a dense flexible body to absorb the dynamic loads of the turbounit.

The physical volumes of the construction and installation work during the construction of the slab are characterized by the following data:

Metal structures (fittings and fasteners), t	422.6
Monolithic concrete, cubic meters	5165
Waterproofing (bituminous covering), square meters	735
Chemical coatings of the fasteners, square meters	55
Thermal insulation, square meters	2592

The ratio of the weight of the metal in the monolithic structure to the amount of concrete in it is .082 tons per cubic meter; the ratio of the number of enlarged metal structures in the monolithic reinforced concrete to their total volume is 1,303 items per ton.

In developing the plan for the execution of work the most complicated problem is deciding how to organize the pouring of the concrete for the slab, since the required density of the slab can be ensured only during the continuous pouring of the concrete mixture.

In connection with the requirement that restricts the mobility of the concrete mixture (cone settling of 5 cm) the use of concrete pumps was not possible; for this reason the concrete pouring was done by scoops with a capacity of three cubic meters using two DEK-50 cranes at a pouring rate of the concrete mixture of 35 cubic meters per hour for each crane.

The concrete mixture was poured using the continuous-by-stage method in transverse horizontal strips which were screened by netted membranes forming stages with a step of 1.5 to 1.8 and a height of 1 to .8 meters. In each stage the concrete was poured in two layers at a depth of .5 to .4 meters.

At the Zaporozhskaya AES the method of concrete pouring that was used and the favorable mode for the hardening of the concrete mixture made it possible to remove the thermal insulation after one month after completion of the work (instead of the six months according to recommendations), which reduced the time required for opening the front for the execution of the subsequent work (waterproofing and others).

Table 2

Type of work	Unit of work volume	Labor expenditures per unit of volume, man-days	Cost per unit of work volume, thousands of rubles
Installing of fittings and fasteners	tons	3.12	.21
Concrete pouring	cubic m	.28	.033
Waterproofing	cubic m	.023	.0007
Laying of thermal insulation	sq. m	.097	.007
Painting of fasteners	sq. m	.07	.002

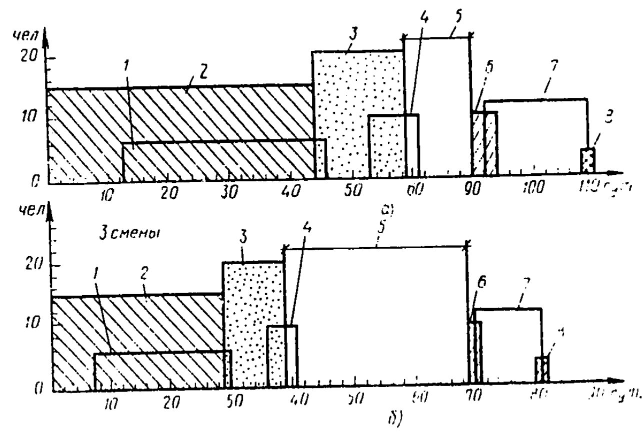
The clear organization of work - the creation of a one-hundred percent supply of cement and fillers at the concrete plant, the continuous operation of the plant, the availability in the installation area of a back-up crane - all of this made it possible to complete the pouring of concrete for the slab in less than seven days.

The actual indicators of the relative labor expenditures and the cost of each type of work completed in building the slab for the foundation beneath the turbounit are cited in Table 2.

For the execution of this work on the subsequent power units one can recommend the following brigade compositions (men) for each shift: reinforcement - 20, concrete pouring - 10, waterproofing - 2, and the laying of the thermal insulation - 10.

Moreover, the length of the work will be 111 and 81 days respectively for a two-shift and three-shift operation. These recommendations were taken into consideration when compiling the work schedule for laying the foundation slab beneath the turbounit of power unit No 2 (Drawing 3).

In order to make use of the experience accumulated at the Zaporozhskaya AES to the degree of completion of the structural and technological assemblies it is necessary to analyze the work that was done on them.



Drawing 3: Recommended work schedules while building the foundation slab beneath the turbounit. Key: a,b - with two-shift and three-shift operations respectively; 1) Installation of the concrete form; 2) Reinforcement; 3) Pouring of the concrete; 4) Installing of the thermal insulation; 5) Lag over a 30-day period; 6) Removal of the thermal insulation;; 7) Disassembly of the concrete form; 8) Waterproofing.

Both the center of the Energostroytrud and the design-technological institutes of the subcontractor organizations must be involved in the performance of this work to improve the methods of analysis and the comprehensive generalization of the experience.

In connection with the fact that the construction and installation work at an AES is performed by many subcontractor organizations (thermal installation, electrical installation, those doing work on special ventilation systems, chemical coatings and thermal insulation), it is necessary at this time to do a detailed analysis of all work in an amount if only of planned-estimated sets.

Such an analysis will make it possible:

to rationally assemble the structural-technological assemblies for all kinds of indicators;

to use the best technology for performing various kinds of work;

to correctly organize flow-lines for all kinds of work considering their length and narrow specialization;

to optimize the intervals between the start-up of power units;

and to develop recommendations for further improving the planning and design solutions called for in the standardized design of atomic power stations with VVER-1000 reactors; and consequently, to reduce the indicators for the use of materials, the use of labor and the cost of the construction of an entire series of atomic electric power stations now being built according to this design.

8927
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ELECTRIC POWER

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METHODS FOR MODERNIZING THERMAL ELECTRIC-POWER PLANTS DESCRIBED

Moscow ELEKTRICHESKIYE STANTSII in Russian No 2, Feb 82 pp 2-5

[Article by engineers V. I. Gorin, I. M. Vol'kenau, V. G. Zhizhokin and V. V. Ptushkina of Glavtekhupravleniye Minenergo USSR--Energoset'proyekt: "Methods of Re-equipping Thermal Electric-Power Plants"]

[Text] Thermal electric-power stations have formed the basis of the Soviet electric-power industry at all stages of its development. Over a long period of time, the relative contribution of thermal electric-power stations to the country's installed capacity has held firmly at the 80-percent level.

The development of the USSR electric-power industry has been accompanied by an increase in the technical level of thermal electric-power stations. This has made it possible to increase the efficiency of thermal electric-power stations and to reduce considerably the per-unit expenditure of fuel. The first thermal electric-power stations were built for low and medium steam parameters. In the 1940's we began building thermal electric-power stations for high steam parameters--90 kgs/cm^2 at temperatures of 510 to 540°C. Elevated parameters--130 kgs/cm^2 at temperatures to 565°C--were used in the 1950's, while in the middle of the 1960's we began commercial production of power units designed for supercritical steam parameters of 240 kgs/cm^2 at temperatures up to 565°C [1,2].

In accordance with these stages, the structure of the thermal electric-power stations' output was also changed, and the relative amount of higher-pressure equipment has increased. At the present time, the relative contribution of equipment for a stream pressure of 240 kgs/cm^2 is 33 percent; for 130 kgs/cm^2 it is 43 percent; for 90 kgs/cm^2 it is about 16 percent; and less than 5 percent for medium pressure.

In the past 20 years, the individual output of GRES power units has risen from 200 to 1,200 MW, while that of TETs units has risen from 50 to 250 MW. The individual output of GRES's has risen from 1,050 to 3,800 MW and that of TETs's from 300 to 1,250 MW. There are 54 thermal electric-power stations which have individual outputs of more than 1 million kW, and their total output comprises more than 50 percent of the installed capacity of thermal electric-power stations.

The improvement of the structure, the rise in steam parameters, the increase in the individual unit outputs, the perfection of their operation and the increase in the portion of electric-power generated in the central-heating cycle made it possible to insure a steady reduction in the per-unit expenditure of fuel [from 590 g/kWh in 1950 to 328 in 1980].

During the operational process, equipment at thermal electric-power stations becomes physically worn and grows obsolete.

Physical wear is caused by active operation and physicochemical processes which take place in the metal under the influence of mechanical loads under high-temperature conditions. During minor overhauls, work is done to keep the equipment in a state of operational readiness and to maintain the normal level of production capacity and the necessary level of performance. In doing so, worn parts are reconditioned and replaced (condenser tubes and preheater pipelines; blades, diaphragms and other parts of the turbines; water economizer coils, firebox seals and boiler flues, etc.) and measures are implemented to improve the reliability and economy of the equipment's operation.

Changes in the physical and chemical properties of the metal accumulate in equipment assemblies which cannot be replaced (cylinder housings, shutoff and actuator valves, cylinders, bindings and other boiler elements and fixed pipelines). The operation of such equipment becomes unreliable after a certain operating time is reached.

A service life of 100,000 hours or 15 years is used to establish standards for determining the operational soundness of the major assemblies in thermal electric-power equipment. Of our present installed capacity, 35 percent has been in operation 15 years or more. This includes 3.5 percent of units which have been in operation 30 years or more. The service life of the most important elements of the basic equipment depends primarily upon the temperature and pressure at which the equipment is operated. Operational experience shows that equipment service life at steam temperatures to 450°C is quite long and amounts to 40-50 years. When steam parameters are increased, the service life is reduced considerably.

The actual service life depends both upon the operational conditions and the equipment's specifications (the actual safety margin, the brand of steel and the calculated temperature level at which the metal must be used) [3,4]. As a rule, the actual service life exceeds the calculated life by a factor of 1.5 to 2. This is the so-called maximum service life.

Based on operational experience and special studies carried out by the Central Scientific Research Institute of Heavy Machine Construction, the Central Committee of Heavy Industry, the All-Union Institute of Heat Engineering imeni F. E. Dzerzhinskiy, Soyuztekhenergo and other organizations, the maximum service life of the basic equipment at electric-power stations can be assessed in combination using the values cited in the table.

Type of station	Steam pressure, kgs/cm^2	Maximum service life Years	Thousands of hours
KES and TETs	45	To 40	270
	90	30-34	200-220
TETs	130	25-30	170-200
KES	130	25-30	170-200
KES and TETs	240	25	170

At the present time (data for the end of 1980), the total installed capacity of equipment at USSR Minenergo thermal electric-power stations which reached its maximum service life and has since been decommissioned is about 4 million kW. For the most part, this is equipment that operates at a pressure of 45 kgs/cm^2 and includes some imported equipment.

In the current decade, the output from equipment that has reached its maximum service life will increase sharply. It is estimated that it will amount to 50-60 million kW by the end of this period. This can be explained by the fact that since the middle of the 1960's the major portion of capacities introduced comes from equipment that operates at steam pressures of 130-240 kgs/cm^2. Such equipment has a shorter service life than that operating at lower parameters. The relative share of equipment operating at a steam pressure of 240 kgs/cm^2 will be more than 30 percent. For equipment at 130 kgs/cm^2, the figure will be more than 40 percent. More than 60 percent of the old capacity will be made up of condensing electric-power stations [KES's] of all types; approximately half will be stations with modular-type equipment.

Thus, the aging of the primary equipment at thermal electric-power stations brings about a number of new, important challenges in electric-power engineering with respect to the further utilization of about 140 million kW of capacity installed at electric-power stations before 1975.

Together with the physical wear there is the obsolescence of the equipment, entailing low economy and a higher degree of labor required to operate existing equipment which is physically suitable. The advisability of keeping it in operation is determined by comparing the yearly outlay for an existing installation with the calculated expenditures for a newly constructed one.

Speaking at the November (1979) Plenum of the CPSU Central Committee, Genral Secretary of the CPSU Central Committee Comrade L. I. Brezhnev noted that "modern power engineering relies more and more on the achievements of science and high-output equipment.

However, since the economy's growing requirements are being satisfied at an accelerated rate, it is necessary time and time again to think over the entire complex of power-engineering problems.

No matter what the pace we establish for the development of the power industry, the conservation of heat and energy will henceforth be a most important statewide task. Therefore it is necessary to incorporate in our plans the growing tasks regarding the replacement of obsolete and extremely energy-intensive equipment."

The Basic Guidelines adopted by the 26th Congress emphasize: "We are to direct capital investment primarily toward the reconstruction and re-equipping of enterprises and toward the completion of construction begun previously."

Technical re-equipping is a specific system of measures provided for in the technical-development plan for an enterprise. It is designed to improve the technical level and increase or maintain a level of production through the replacement of obsolete equipment with new equipment, through mechanization and automation and through the introduction of new production methods. Reconstruction is the total or partial re-equipping of industry on a new technical basis with the construction (where necessary) and expansion of existing auxilliary facilities. This has a most direct bearing on existing thermal electric-power stations at which a great amount of worn and obsolete equipment is installed.

Since the demand for heat continues unabated over the course of the year and, moreover, since some enterprises are supplied with electric power directly from the generators at electric-power stations, it is not possible to take an electric-power station out of commission for extended reconstruction and stop all its power units. This creates great difficulties in organizing reconstruction work at electric-power stations and is one of the reasons why the scope of technical re-equipping and reconstruction operations in the electric-power industry is insignificant (less than 30 percent of capital investment). This being the case, reconstruction is carried out by building a new phase (addition) on the site of an existing electric-power station with the subsequent transfer to this addition of the functions of the old equipment and the decommissioning of the latter.

The absence of sufficient power reserves also hinders the implementation of large-scale work on electric-power station reconstruction.

Up until now, these circumstances have determined the relatively small volume of obsolete equipment which has been decommissioned.

By the middle of the 1980's, the aging of the primary equipment at thermal electric-power stations will become one of the most important and complex problems in power engineering and will acquire an economic significance, since its solution requires not only the organization of a great amount of work at electric-power stations to decommission and, correspondingly, to introduce additional new equipment or to implement a massive exchange of complex parts and assemblies, but also the additional production of new equipment at power-equipment construction enterprises as well as the manufacture of parts and assemblies which have already been removed from production (to replace existing equipment).

The most efficient solution would be the decommissioning of this equipment and the substitution of new equipment for it. This is dictated by the fact that its considerable share--about 25 million kW--has per-unit fuel consumption figures that are more than 30 percent higher compared to average values within the USSR Minenergo. A portion of the obsolete equipment is concentrated at small (to 100,000-kW) electric-power stations where the relative number of personnel is high. The replacement of the equipment, however, would require the volume of new equipment being introduced to be increased by 40 percent with an outlay of more than 15 million rubles. This is not practicable with respect to the volume of construction work, the allocated capital investment and the capabilities of the power-machine construction industry. For many electric-power stations located in the construction zone, the necessary building sites are lacking, for all practical purposes.

Based on the equipment's technical status, the following program of operations is advisable:

the most vital assemblies of thermomechanical equipment to reach maximum service life are to be replaced with assemblies of similar design in order to extend the electric-power station's service life. This relates primarily to TETs's and power units from 150-MW capacity and up;

a certain number of units that have achieved maximum service life are to be dismantled, and the portion that has quit producing power is to be replaced with maneuverable equipment. Sections of the stations' working areas are to be used to build power-system repair enterprises;

a portion of the power units are to be modernized in an effort to improve the economy of their operation.

The dismantling of worn and obsolete equipment will, in the final analysis, make it possible to release fossil fuel, lower the number of operational personnel and reduce the number of repair operations at electric-power stations.

Dismantling was begun as early as the 8th Five-Year Plan. In the 9th Five-Year Plan 2.7 million kW of installed capacity were dismantled and 3.9 million kW in the 10th. The amount of dismantled equipment in this decade is estimated at 16 million kW, including 7 million kW in the 11th Five-Year Plan.

In the long-range, the scope and ratio of dismantled equipment and the equipment subject to modernization in an effort to extend its service life will depend to a considerable degree upon the organization of the growth rates for the measures previously mentioned, as well as upon the equipment's service life after the replacement of worn-out parts and assemblies which, due to a lack of experience in such matters, is estimated at 10 to 15 years. Depending upon the service life, the volume of dismantled equipment could remain at the same level or could increase approximately by a factor of two. In this case, it will be necessary at the same time to continue replacing assemblies to extend the service life of power-production equipment.

Plans have been made in the current five-year plan to replace major assemblies (steam pipes and fittings, stop-valves, cylinders and high-pressure turbine rotors) with new equipment at units totalling about 9 million kW in output. Units totalling 40 million kW are to have equipment replaced in this decade.

Work on technical re-equipping gives the best results in those cases when it is planned ahead of time. Delays cannot be allowed in this work when the engineers begin preparing their plans after a unit has experienced significant malfunctions due to physical wear and obsolescence. An urgent task for the power systems is the timely organization of work in designing and replacing heat and electric-power sources on the basis of a detailed prognosis of the equipment's technical status.

An analysis of the structure of the dismantled equipment points out the following:

On the whole, the equipment dismantled in the 9th Five-Year Plan was equipment that operated at medium steam parameters and equipment of 50,000-kW unit outputs and less from foreign firms.

During the 10th Five-Year Plan we began dismantling equipment which operated at a steam parameter of 90 kgs/cm^2 (its relative contribution to the structure of dismantled equipment was 38 percent) and possessed unit outputs to 100,000 kW.

The relative share of dismantled equipment operating at a steam parameter of 90 kgs/cm^2 will increase in the 11th Five-Year Plan.

The introduction of these measures will make it possible to insure the further improvement of the equipment's operational reliability and the reliability of the power supply to the consumers.

In addition to the indicated measures to insure the further improvement of the efficiency and quality of power production, it is necessary to modernize and renovate power-generation equipment. Modernizing and renovating this equipment diminishes the effects of obsolescence and increases the equipment's reliability.

There are at present about 400 power units of 150 to 1,200-MW capacity operating in the electric-power industry. Studies of the equipment in these units has established that some of this equipment possesses reserves for increasing economy through improvement of the design of individual assemblies in the turbines and boilers. Specific designs have been developed for new, more economical assemblies which can be installed to replace units now in operation. Power systems have the capacity to modernize 180 steam generators and 164 turbine units with a total output of 40 million kW. The potential savings from this work could amount to 10 million tons of conventional fuel over the 11th and 12th Five-Year Plans. The realization of these measures depends upon the capabilities of the power-equipment construction plants to deliver the corresponding equipment assemblies.

The execution of technical re-equipping at electric-power stations will require the solution of many complex economic problems, including matters of financing, material supply, personnel, the manufacture of parts and assemblies, etc.

The problem of utilizing the work sites at the electric-power stations likewise arises.

The All-Union Scientific Research and Planning Institute of the Power Engineering Industry [VNIPIEnergoprom] has completed a number of plans for the construction of boiler plants on the basis of old electric-power plants with the utilization of individual structures and equipment. At large-scale electric-power stations it will be possible to locate new equipment with a maximum utilization of existing structures after the primary equipment has been dismantled.

Teploelektroproyekt and VNIPIEnergoprom have implemented a complex of planning and design work to create small-scale solid-fuel fired boiler-plant equipment for K-210 and T-180 turbines. This will broaden possibilities for utilizing structures at old electric-power stations.

When electric-power stations are decommissioned, it is advisable in a number of cases to maintain their generators, switching them to synchronous-condenser operation. This will make it possible to increase the voltage level considerably. The technical feasibility of using the generators at old power-plants in such a fashion has received preliminary approval from the manufacturing plants and Glavtekhpravleniye of the USSR Minenergo. The start-up of a generator without its turbine requires the creation of a start-up circuit, since the stations do not have special equipment for starting a synchronous condenser.

Thus, the utilization of work sites at old electric-power stations for locating new equipment must be considered one of the directions which insure the most efficient solution with respect to construction-organizational as well as system conditions. This makes it possible to have power sources near the consumers and thereby reduce power losses and maintain voltage levels in power networks. This is the most suitable method of situating maneuverable equipment used only part of the day, since the construction of individual power stations for this purpose causes a number of technical and operational difficulties. According to data from Teploelektroproyekt, the utilization of the work sites at the dismantled electric-power stations of even medium output will insure a savings of capital investment for construction of more than 10 percent in comparison with construction on new sites and, moreover, considerably reduces construction times.

Conclusions

1. Technical re-equipping in the electric-power industry is a complex engineering and planning problem in providing a reliable power supply to the economy and must be insured through the coordinated efforts of the USSR Minenergo and the power-equipment construction ministries.

2. The basic directions for solving the problem are the renovation of equipment through the replacement of major parts and assemblies which have reached their maximum service life, the decommissioning and disassembly of a portion of the equipment and the installation of new, more improved equipment, including peak and semipeak, to replace the old equipment at a number of sites.

In order to conduct work on renovating the equipment, it will be necessary to decommission the equipment and the corresponding capacities in the power system for a considerable period of time in order to replace it.

The realization of these measures requires the corresponding financing and a supply of parts, assemblies, materials, manpower, etc.

3. The systematic renovation and decommissioning of obsolete equipment will require a great many design and scientific studies be done to analyze the status of equipment at old electric-power stations. It will also require a determination of the most efficient solutions to these problems: the renovation of equipment; its disassembly; the utilization of buildings and structures for repair bases and boiler plants; the feasibility and suitability of installing new, more modern equipment; the selection of its type based on regional conditions (district-heating, semipeak, peak); a method for replacing equipment (in old or new buildings constructed on the site of an old electric-power station); etc.

It is necessary to develop standard plans for the various types of work at electric-power stations. It is likewise necessary to standardize plans for the organization of construction under complex conditions at an electric-power station being dismantled.

4. It is necessary to accelerate the work being done to create new types of small-scale condensing and central-heating equipment to replace that which has reached the end of its service life.

5. The decommissioning of a number of electric-power stations delivering their output to the power system on 110 to 330-kV lines will cause difficulties in supplying electric power to the regions where these stations are located. In such cases, therefore, the replacement of worn-out equipment with new is more preferable.

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ELECTRIC POWER

NEW BOOK DISCUSSES DEVELOPMENT OF ELECTRIC POWER INDUSTRY

Moscow REGIONAL'NYYE PROBLEMY RAZVITIYA ENERGETIKI I ELEKTRIFIKATSII SSSR in Russian 1981 (signed to press 27 Aug 81) pp 1-2, 168

/Annotation and table of contents from book "Regional Problems in the Development of Power and Electrification in the USSR", by V. A. Ryl'skiy, Izdatel'stvo "Ekonomika", 2,000 copies, 168 pages/

Annotation

/Text/ This book examines the influence of the electric power industry upon the development of the USSR's production forces and provides an analysis of the extent of the influence of the energy factor upon the improvement of proportions of the placement of production in connection with the long-term prospects of the power picture of regions. The book also examines the regional problems of electrification and the influence of the power industry upon the condition of the environment. Based upon the analysis of the achieved levels of development, trends in the development of the power industry as a component part of the national economic complexes of the union republics are justified.

The book was written for a broad circle of specialists who are studying the problems of the development and placement of the USSR's production forces.

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