14 MARCH 1980 (FOUO 1/80) 1 OF 1

JPRS L/8976

14 March 1980

USSR Report

ENERGY

(FOUO 1/80)

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APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200060017-5

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CONTENTS

PAGE

ELECTRIC POWER

UDC 690.9

ELECTRIC POWER INDUSTRY'S RESULTS IN 1979; GOALS FOR 1980

Moscow TEPLOENERGETIKA in Russian No 1, Jan 80 pp 2-4

[Article by Ye. I. Borisov, USSR First Deputy Minister of Power and Electrification: "Results of Work by Electric Power Engineers in 1979 and Tasks for the Final Year of the 10th Five-Year Plan"]

[Text] Our country has entered upon the final year of fulfilling the tasks of the 10th Five-Year Plan.

The historical 25th Congress of the CPSU set before the Soviet people the great task of further reinforcing the economy of our state and of carrying out the task of increasing the efficiency of the entire national economy, based on the achievements of scientific and technical progress. In solving these problems an important role is being played by electric power engineering as one of the economy's most important sectors; to a large extent, the progress of other sectors in the national economy depend on the development and successful operation of this sector.

Having unleashed a socialist competition for carrying out the decisions of the 25th Congress of the CPSU and the tasks of the national economic plan, the country's electric power engineers by their intensified labor are ensuring a power supply to industry, transportation, and the public; they are also making a great contribution to the economical use of our homeland's fuel and energy resources.

During the first four years of the 10th Five-Year Plan the production of electric power increased by 20 percent in comparison with 1975, while the production of thermal power increased by 25 percent.

The annual production of electric power at AES's exceeded 50 billion kW-hrs., and at GES's it surpassed 166 billion kW-hrs; this allowed the country to save approximately 60 million t. u. t. [not further identified].

In 1979 the production of electric power throughout the country exceeded 1,245 billion kW-hrs.; that produced under the jurisdiction of the USSR Ministry of Power and Electrification amounted to 1,148 billion kW-hrs.

During the past year the country's electric power potential achieved further development.

During 1979 the production of electric power throughout the country exceeded 1,245 billion kW-hrs, while under the jurisdiction of the USSR Ministry of Power and Electrification it amounted to 1,148 billion kW-hrs, including 930 billion kW-hrs at thermal electric power stations, burning organic fuel. The centralized discharge of heat from enterprises of the USSR Ministry of Power and Electrification reached 840 million Gcal. (Gigacalories).

Now during a 24-hour period 1.5 times as much electric power is produced in the country as for an entire year in tsarist Russia.

At the present time in comparison with 1940 the power-worker ratio in industry has increased 7-fold, while in agriculture it has increased 14-fold.

During the first four years of the 10th Five-Year Plan more than 40 million kW of new electric power capacity were introduced, as well as more than 120,000 km (kilometers) of high-voltage (35 kV and higher) electric power transmission lines.

In fulfilling their socialist pledges, the electric power builders ensured in 1979 the introduction into use of new electric power equipment with a total capacity of approximately 11 million kW.

The following were put into operation: the first power unit with a capacity of 500 MW at the Ekibastuzskaya GRES-1, inaugurating a series of powerful electric power stations to be built for this magnificent fuel and energy complex, a power unit with the same capacity at the Reftinskaya GRES, power units each having a capacity of 300 MW at the Iriklinskaya GRES and the Stavropol'skaya GRES, power units with 210 MW capacities at the Moldavskaya, Gusinoozerskaya, Maryiskaya, and Surgutskaya GRES's, large-scale, district-heating units with capacities of 250 and 175 MW respectively were introduced at the Mosenergo TETs-25 and the Novo-Irkutskaya TETs, with capacities ranging from 135 to 110 MW at the Ivanovskaya TETs-3, the Minsk TETs-4, Khar'kov TETs-5, Nizhnekamskaya TETs, Saranskaya TETs-2, Mosenergo TETs-9, Krasnoyarskaya TETs-2, Saratovskaya TETs-5, Irkutskaya TETs-9, Ufimskaya TETs-2, the Orlovskaya, Ust'-Ilimskaya TETs's, and others.

Hydroelectric power engineering was also successfully developed during the year just passed. At the Sayano-Shushenskaya GES (the world's largest), thanks to the self-sacrificing labor of the hydroelectric power builders, installers, and operators, the second and third units, with a capacity of 640 MW each, were put into operation. This hydroelectric power station, situated in places where the tsarist government exiled Russian revolutionaries, where V. I. Lenin lived and worked during the period 1888--1890, is the embodiment of his great ideas regarding the widespread electrification of the country.

Units have been introduced at the Inguri GES with a capacity of 260 MW and at the Kegumskaya GES with a capacity of 56 MW.

The builders, installers, and operators of the Nurekskaya GES, by developing a progressive form of organizing a socialist competition among workers in closely related fields, raised this hydroelectric power station to its full capacity--2.7 million kW--a year earlier than the deadline.

For this remarkable victory the group of builders, installers, operators, machine builders, planners, and all those who took part in building the Nurekskaya GES were congratulated by the General Secretary of the CPSU Central Committee, the Chairman of the Presidium of the USSR Supreme Soviet, Comrade L. I. Brezhnev. He remarked that this victory once again convincingly demonstrated the powerful force of socialist competition, in the course of which hydroelectric power builders from Tadzhikistan, machine builders from the Ukraine, Leningrad, and the Urals, as well as workers from the country's other industrial centers were united in order to achieve the common goal. In his greeting it was stated as follows: "It is right and just that the 'Workers' Baton'which came into being on your construction project was taken into the struggle by many labor groups.

It is gratifying to note that the Nurekskaya GES, along with generating cheap electric power, has allowed the cotton fields of three fraternal republics to be liberally irrigated, and it has almost completely returned to the national economy the funds which were expended on its construction. This is a fine example of the comprehensive utilization of natural resources and increasing the effectiveness of capital investments."

An important characteristic of the development of the country's electric power engineering during the year just past was the stepping-up of the rate of construction of new capacities at atomic electric power stations and the rapid growth in the production of electric power by them. At the present time the country has 22 active AES power units with a total capacity of more than 11 million kW.

Operating steadily at the present time are the Leningrad AES, with a capacity of 3 million kW, the Chernobyl'skaya, and Kurskaya AES's, with a capacity of 2 million kW each.

An important moment in the development of the country's atomic electric power engineering was the start-up at the Novovoronezhskaya AES of the main power unit, having a capacity of 1 million kW with a reactor which is cooled by water under pressure. This laid the foundation for creating a new series of power units of this type.

Another important event in the development of the country's atomic electric power engineering during the year just passed was the completion of the structure of the third unit of the Beloyarskaya AES, having a capacity of 600 MW with a breeder reactor equipped with a liquid-metal cooling agent. The pace has been stepped up on construction and installation operations with regard to building AES electric power units which are scheduled to be put into operation in 1980 and during the first few years of the next five-year plan.

The generation of electric power at AES's during the last two years has increased at a rapid rate--by more than one-third each year. And although the AES share in the production of electric power on a nationwide scale is still relatively modest, a steady trend toward its growth is to be observed. In the European part of the country alone, where an acute need for ensuring a supply of organic fuel is particularly felt, the AES share of electric power production in this region has already amounted to approximately 10 percent during the current year.

In 1979 the USSR Ministry of Power and Electrification completed construction on and put into operation a number of important electric power transmission lines and substations with voltages of 330--500--750 kV. The following electric power transmission lines were also built with a voltage of 750 kV: Kurskaya AES--Novobryanskaya Substation and Chernobyl'skaya AES section--Zapadno-Ukrainskaya Substation from the AES to the intersection with the Zhitomir--Rovno Line with a voltage of 330 kV, as well as the high-voltage line from the Leningradskaya AES to the Leningradskaya Substation, which was built to transmit electric power from the 1000-MW power unit No. 3 of the Leningradskaya AES.

Also put into operation was the 500-kV high-voltage line from the Reftinskaya GRES to Kozyrevo, which was designed to transmit electric power from power unit No. 9 with a capacity of 500 MW, introduced at the Reftinskaya GRES.

The Omsk--Petropavlovsk electric power transmission line was switched on; it has substantially increased the reliability of feeding power to the Petropavlovsk electric power region of Tselinenergo and has ensured the transmission of power from the first power units of Ekibastuzskaya GRES-1.

The introduction of an autotransformer group at the Megion Substation permitted a switchover to the rated voltage of 500kV at the Surgutskaya--Megion Line, which increased the reliability of supplying electricity to the oil-and-gas-bearing deposits of Nizhne-Vartovska and Samotlor.

Large-scale and very detailed work is being conducted by the country's electric power engineers in carrying out the most important decisions of the Party and the government, directed at effecting savings in fuel and power resources. During the elapsed four years of the 10th Five-Year Plan the specific outlay of fuel for the production of electric and thermal power throughout the USSR Ministry of Power and Electrification as a whole was reduced by 9.1 g per kW-hr and 0.5 kg per Gcal. In 1979 the specific outlay of fuel reached 330.5 g per kW-hr and 173.1 kg per Gcal. Fuel savings over the past four years amounted to 24 million tons.

In order to increase the economizing effect of the existing electric power plants, a great deal of work is being done on planning measures for the five-year plan with regard to raising the technical level of operation, as well as on redesigning and modernizing the equipment. A large effect is being attained by replacing the flow-through part of turbines with power units and by installing more efficient burners in steam boilers.

A considerable reserve in lowering specific fuel outlays on producing electric power remains, as before, an increase in the effectiveness of introducing district heating systems. During the past four years of the five-year plan the proportionate share of electric power production with regard to the district heating cycle has increased by 1.5 percent, and last year it reached 21.6 percent. This trend must be developed even further.

There has also been improvement as a whole in the structure of electric power production by means of reducing the proportion being produced by poorly economical equipment. The coefficient of use for condensation-type electric power stations at a pressure of 9 MP (megapascals) during the current five-year plan has been reduced by 2.2 percent, and in 1979 it amounted to 60 percent.

As a result of a great deal of work on assimilating the power-unit equipment the specific outlay of fuel on an average for the group of power units with a capacity of 800 MW for 1979 amounted to 330.2 g per kW-hr, for units of 300 MW it was 335.4, and for 200-MW units it was 358.4 g per kW-hr. The lowest specific fuel outlay for electric power produced was achieved by the 800-MW power units at the Zaporozhskaya GRES (using fuel oil) with an amount of 322.0 g per kW-hr, and by the 500MW power units at the Troitskaya GRES (using Ekibastuz coal as fuel) with an amount of 330.5 g per kW-hr. The best indicators among electric power stations with a capacity of 300 MW were possessed by the following: the Kostromskaya GRES (using fuel oil)--319.0 g per kW-hr, Sredne-Uralskay GRES (using gas and fuel oil)--316.5 g per kW-hr, Reftinskaya GRES (using Ekibastuz coal as fuel)--331.1 g per kW-hr. Among electric power stations equipped with power units having a capacity of 200 MW the best indicators with regard to the specific outlay of fuel have been achieved at the Beloyarskaya GRES (using Kuznetsk coal as fuel)--335.6 g per kW-hr. The lowest specific fuel outlays for the production of electric power--less than 170 g per kW-hr--with the turbine units operating on a district heating system cycle were as follows in 1979: Alma-Atinskaya TETs-3, Dzhambulskaya TETs-1, Kachkanarskaya TETs, Mosenergo GRES-1, Ufimskaya TETs-1, and Chelyabinskaya GRES.

It should be noted that far from all electric power stations are waging to the necessary degree the struggle to seek out reserves to economize on fuel, and their groups have been insufficiently mobilized for a more complete utilization of the reserves which they have to increase their economical quality by means of improving the quality of carrying out the repair of equipment and the technical level of its operation. As a result at several electric power stations an over-expenditure of fuel has been noted in comparison with the established norms. Included among them are the following: the Zmievskaya, Pribaltiyskaya, Ali-Bayramlinskaya, Yayvinskaya, Novocherkasskaya, and Slavyanskaya GRES's, the Irkutskenergo

TETs-10, Kazanskaya TETs-2, Novokuybyshevskaya TETs-2, Kirovskaya TETs-4, and the Tol'yattinskaya TETs.

During the final year of the 10th Five-Year Plan, which sums up the results of the Soviet people's heroic labor with regard to implementing the historical decisions of the 25th Congress of the CPSU, the country's electric power engineers will have to solve the very great tasks of further developing the sector, further raising the level of operating the electric power system, the effectiveness of producing electric and thermal energy, and improving work quality.

In 1980 we will be confronted with the problem of conducting an enormous amount of work with regard to repairing electrical power engineering equipment, buildings, and structures, as well as the fuel and transportation system.

There must be capital repair of equipment of electric power stations with a total capacity of more than 50 million kW. Large-scale operations should be conducted in electric and thermal systems.

It is necessary to intensify our attention to measures providing for the modernization of equipment as the most important matter connected with further reduction of specific fuel outlays, as well as to measures for increasing the reliability of electric power equipment operation.

The growth of the electric power engineering system and the volume of repair operations is bringing about a need to convert capital repairs to a year-round cycle, and this requires a further improvement in guaranteeing the supply of spare parts and equipment units on the part of supplier-plants.

It is necessary to constantly improve the conduct of the electric power engineering system in the struggle to economize on energy resources.

Important tasks remain to be solved during the coming year with regard to introducing electric power capacities and the construction of electric power transmission lines.

In the field of atomic electric power engineering we must increase our attention to the assimilation within brief time periods of the rated capacities of the AES power units which were started during the year just past. During the current year we must complete construction on and put into operation new AES power units with a total capacity of 4.8 million kW, including completing the construction of the Leningradskaya AES, whose capacity will reach 4 million kW, and to put into operation the first power units at the following three new atomic electric power stations: Smolenskaya, Yuzhno-Ukrainskaya, and Rovenskaya.

In 1980 construction will be continued at the sites of AES's already underway, and operations will be begun on the assimilation of new sites.

Installation is being done on large-scale power units with capacities of basically 1 million kW each with RBMK-1000 and VVER-1000 reactors, while at the Ignalinskaya AES operations are proceeding on our country's first power unit having a capacity of 1.5 million kW with a RBMK-type reactor. The rapid introduction into operation and assimilation of these facilities will allow us to make a new qualitative leap in the development of Soviet electric power engineering and to make a significant improvement in the country's fuel-energy balance. Every million-kW power unit introduced at an AES will save the country about 2 million tons of fuel oil per year.

From the very beginning of the development of Soviet atomic electric power engineering a great deal of attention has been paid to the safety of atomic electric power stations. During the last few years particular importance has been ascribed to these problems in connection with the rapidly growing scope of atomic electric power engineering. Power units are being equipped with improved systems for ensuring safety, systems of cooling down the reactor in case of an accident, as well as systems for localizing accidents with protective shields and various types of air-lift-condensation apparatus.

In 1980 the scientific-research, design, and planning organizations of a number of ministries must continue to carry out a broad front of research and development, aimed at both guaranteeing a high level of operation of the existing power units as well as at creating a new type of power units, including the creation of atomic TETs's and heat-supply stations; their construction will be carried out during the 11th and 12th Five-Year Plans.

During the current year our country's largest power unit, with a capacity of 1200 MW, will be put into operation at the Kostromskaya GRES. All told this year, new electric power capacities of about 14 million kW are planned to be put into operation.

In the construction of high-capacity electric power stations particular importance is attached to further improving the quality of the equipment being supplied. In connection with this, an especially important initiative was taken by the scientific and technical committee of the "Elektrosila" NPO (Scientific-Production Association) with regard to production output under the motto: "If it's made at 'Elektrosila', it's been made very well."

The country's electric power engineers welcome this initiative, and, for their part, they have called upon the electric power engineering plants and those engaged in electrical engineering machine building to support it and to give the national economy only high-quality equipment.

In 1980 a most important task is the construction of electric power transmission lines, designed to transmit power from the newly built electric power stations and to increase the through-put capacities of inter-system connections as follows:

to a voltage of 750 kV: the Kurskaya AES--Metallurgicheskaya, Smolenskaya AES--Novobryanskaya, Chernobyl'skaya AES--Zapadno-Ukrainskaya;

to a voltage of 500 kV: Ryazanskaya GRES--Tambov, settings of the 500-kV lines Lipetsk--Balashov to the Novovoronezhskaya AES, Kostromskaya GRES--Vologda, Pyt'-Yakh--Dem'ianskaya;

to a voltage of 330 kV: Kurskaya AES--Zheleznogorsk, Smolenskaya AES--Roslavl', Kol'skaya AES--Monchegorskaya, settings of the 330-kV lines Pobuzh'ye--Ukraina to the Yuzhno-Ukrainskaya AES.

Important operations will also be carried out with regard to building high-capacity GES's. Units will be introduced at the Sayano-Shushenskaya GES, the Inguri GES, and the Nizhnekamskaya GES. Operations are being conducted on preparing to start up units at the Zagorskaya GAES, with a capacity of 1.2 million kW, as well as at the Kurpsayskaya and Kolymskaya hydroelectric power stations.

Completing the tasks of the final year of the 10th Five-Year Plan requires a great amount of organization work in all the units of electric power engineering, a widespread development of socialist competition among groups of associations, electric power systems, construction and installation subdivisions and construction projects of the USSR Ministry of Power and Electrification with regard to mobilizing efforts in the cause of further augmenting the country's electric power engineering potential, of raising the technical level and the efficiency of operation of electric power engineering production, of economizing on fuel and energy resources in the system of electric power production as well as throughout the country's entire national economy.

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ELECTRIC POWER

UDC 338.45

ENERGOMASHPROYEKT AND ELECTRIC POWER IN INDUSTRY

Moscow ENERGOMASHINOSTROYENIYE in Russian No 12, 1979 pp 28-30

/Article by L. Ya. Donchak, Candidate of Economic Sciences, and Ye. P. Zelenskiy, Engineer: "Determining Effective Directions for the Sector's Development (Energomashproyekt's Experience)"/

/Text/ Determining effective directions for the development of all units of the country's national economy and, in the first place, of the industrial sectors on which the growth rate of the country's economic potential depends, has become with regard to its essence, purpose, and tasks a necessary element in the planning administration of the socialist economy.

The role and significance of this process for power machinery building has been intensified by the circumstance that the future prospects for the development of electric power engineering are determined by the plans for the most important targeted programs of the national economy and the development of society as a whole. V. I. Lenin emphasized that "it is impossible to work without having a plan which has been designed for a lengthy period and for serious achievement."*

Experience in machine building has shown that only about 50 percent of investments provide a return within five years, 30--35 percent--within ten years, and 15--20 percent--within later time periods. Thus, the five-year and long-term plans have proved to be interconnected. Separating the five-year plan from the long-term plan, on the other hand, could lead to serious errors in the practice of administering the development of sectors and of the national economy as a whole.

We are faced with a two-part dependency: increasing the role of determining the most effective directions for developing the national economy and a more profound development of practical directions, supplementing the theoretical fundamentals and disclosing the essence of the specific forms of planning the

* V. I. Lenin, "Poln. sobr. soch." /Complete Collected Works/, Vol 42, pp 153--154.

development of individual sectors, production associations, and enterprises. Taking into consideration the indissoluble bond between the material-technical and socioeconomic elements of production complexes, their development must be carried out within the framework of the scientifically grounded proportions of the contribution to the national-economic end results and to the satisfaction of the socioeconomic interests of workers' groups.

The principled potential and fruitfulness of such a systems approach to determining the specific directions of investment policy in power machinery building for a five-year period and for the more distant future has been reinforced by the experience of Energomashproyekt--the sector's main planning organization.

Energomashproyekt is the developer of a model scheme for developing and distributing enterprises--a pre-plan document which reflects the results of intra- and inter-sectorial technical-economic research on providing the groundwork for rational territorial proportions of development and distribution, specialization, and the overall development of the sector. For the first time such a scheme was worked out for the period until 1980, then until 1990, and the year 2000.

The scheme constitutes a draft long-range (up to 20 years) plan with regard to a number of technical-economic indicators of the sector's development. The five-year plan for the development of power machinery building, in contrast to the long-term plan, constitutes an instrument of plan direction, a well-developed administrative solution, and hence it is a directive-type plan. The draft of the long-term plan is a system of interconnected forecasts which may in the future be incorporated into a plan, or they may not be.

When one considers that among economists, both Soviet and foreign, there is no unanimous point of view regarding the contents of the forecasting process, as applied to the tasks of the scheme it may be defined as the process of determining the indicators which characterize the dynamics of the sector's development and its individual directions in the future, based upon the action of objective economic laws and an analysis of the past. "And who does not know," wrote V. I. Lenin, "that if we consider how suitable a social phenomenon is in the process of its development, then there will always turn out to be in it the remnants of the past, the fundamentals of the present, and the embryonic beginnings of the future?"*

The basis for the scheme's development is the forecast of the needs of the national economy for the sector's output, taking into consideration the development of user-sectors, as well as the influence of the factors of scientific and technical progress on the structure of output consumption, the process of renovating and modernizing it, the formation of production capacities and the technical-economic parameters of associations, enterprises, etc. A forecast of needs is worked out with the participation of all the scientific-

* V. I. Lenin, "Poln. sobr. soch.," Vol 1, p 181.

research, planning, and plan-technological organizations of the sector, and it is refined (every year or once every two years). The refinements do not introduce any radical changes, but most often they require specific adjustments in the quantitative proportions of production and, consequently, in the program and forms of reproduction.

The principal user of power equipment is the USSR Ministry of Power and Electrification; hence, the sector's main organization--the NPO's (Scientific-Production Association's) TsKTI (Central Scientific-Research and Planning-Design Boiler Turbine Institute imeni I. I. Polzunov)--has aimed the development of forecasting the needs for the output of power machinery building at forecasting the development of a model scheme for the country's power system. The developers of this scheme--the All-Union Institute for Planning Electric Power Transmission Lines and Sub-stations--, in turn, has studied the development of the sectors using power, and, on the basis of balanced accounts of the expected production and the consumption of electric power, it has prepared possible variants for satisfying the forecasted requirements of the national economy. The variants contain proposals on the modernization of existing electric power stations, their redesign and expansion, as well as the construction of new ones. The influence of factors of technical progress finds its expression in the specific forms of a power system's development.

At the present time the general trend in satisfying electric power needs is to build atomic electric power plants (AES), as well as to increase significantly the unit capacities of the power units of atomic and thermal electric power stations.

The requirements for power equipment which have been disclosed are being refined in the appropriate subdivisions of USSR Gosplan. Taking into consideration the forecasted proportions for the development of sectors of the national economy, based on the opinions of specialists, the maximum and minimum levels of future needs for power equipment are being determined.

In order to monitor the forecasted needs for equipment comprising a power system, we have carried out a retrospective analysis of the ties between the rated capacity of electric power stations, the production of electric power, the requirement for electric power by industry, and the growth rate of the total volume of production (See Table below). From the data in the Table we can see the close ties between the growth rate of the capacities of the electric power stations, the production of electric power, its consumption by industry, and the increase in the total volume of production. During the period from 1950 through 1975 the difference in rates remained within the bounds of 10 percent.

Having such a prolonged and steady conformance to principle at our disposal, we can be confident that it will not be altered essentially in the immediate future as well. The deviation in 1975 of the rates regarding the introduction of capacities from the steady trend, in all likelihood, does not signify a violation of the principle but is rather an individual instance, having particular causes.

Basic Data on the Production and Consumption of Electric Power (1950--1975)*

Years	Production of electric power (in bil. kW-hrs.)	Rated capacity of electric power stations (in thou. kW.)	Consumption of electric power by industry (in bil. kW-hrs.)	Growth rates in production of electric power (in percentages)	Growth rates in capacities of electric power stations (in percentages)	Growth rates in the consumption of electric power by industry (in percentages)	Growth rates in the total volume of industrial output (in percentages)
1950	91.2	19,614	65.2	100	100	100	100
1955	170.2	37,242	123.6	186.6	189.8	189.5	180.9
1960	292.2	66,721	207.5	171.6	179.1	167.8	165.7
1965	506.7	115,033	349.4	173.4	172.4	168.3	149.2
1970	740.9	166,150	488.4	146.2	144.4	139.7	151.0
1975	1,038.6	217,484	656.8	140.2	130.9	134.7	142.9

*Computations based on the collection, "Narodnoye khozyaystvo SSSR za 60 let" [National Economy of the USSR over a 60-Year Period]. Moscow, Statistika, 1977, pp 167, 194, 201.

On the basis of this data, Energomashproyekt is enabled to determine the requirements for production capacities necessary to produce the appropriate types of output in the amounts called for and, consequently, for the supplementary capacities which, at a specific moment, must be added to the existing capacities or to those which are still in the stage of being created. Taking into consideration the need for a comprehensive and well-balanced development of the sector, there has also been a determination, at the same time, of the anticipated requirement for facilities in the non-production sphere: apartment houses, facilities for cultural and everyday purposes, etc.

The Council for the Development of Production Forces under the jurisdiction of USSR Gosplan has recommended the possible variants for the distribution of the sector's enterprises. An analysis of the proposed variants and their economic evaluation is carried out by Energomashproyekt at the stage when the plans are being worked out. It could be said that in working out the scheme a strategy is determined for developing the sector--the goal of development and the tactics--the means of attaining the goal which has been set for us.

Naturally, the means of attaining the goal which has been set for us (in this case--capital investments in the development of the sector's production capacities up to the necessary level) depend on those possibilities which the sector's associations and enterprises have at their disposal at a given moment. The determination of these possibilities, taking into consideration reserves possessed but not fully utilized, as well as the discovery of hidden reserves for increasing the volumes of production, occupies an important place in the process of working out a scheme.

This work is conducted in accordance with the method of analyzing the use by associations and enterprises in the sector of the fixed production assets in the pre-planning stage, as developed by Energomashproyekt in conjunction with the Department of Economic Analysis of the Leningrad Institute of Finance and Economics imeni N. A. Voznesenskiy.

At the concluding stage there arises the task of determining the most effective directions in making up deficient production capacities. Its solution requires a knowledge of the specifics of associations and enterprises, as well as of those "bottlenecks" which limit production output in each of them. Generally speaking, an increase in production capacities is possible with the aid of technical re-tooling, modernization, the expansion of existing enterprises, and the construction of new ones.

If we take as a unit the cost of capacity being introduced in creating a new enterprise, then in expanding an existing enterprise, according to Energomashproyekt's experience, it amounts to 0.8, in modernization 0.6, and in technical re-tooling 0.3. But all these forms of reproduction have natural limits of implementation. In particular, technical re-tooling is limited by an enterprise's existing areas, the characteristics of the shop buildings, the industrial site, etc., modernization--by the areas and characteristics of the production shops, expansion--by the dimensions of the industrial site, the possibilities for enlarging it, and so forth.

Thus, the development of the scheme's first variant is proceeding, as it were, along an ascending line: that which cannot be achieved by a lower form of reproduction is supplemented by a higher one. Moreover, taking into consideration the experience of the planners, a selection is made of the optimum scales of production (for example, the construction of foundries or forge shops producing less than 30,000 tons of output annually is not optimum with respect to net production costs, utilization of production areas, etc.).

In principle, many variants of the scheme for the sector's development could be worked out. But in its operating procedures Energomashproyekt limits itself to a calculation of two or three variants, ensuring the sector's development. Among these it chooses the most economical with regard to the criterion of the expenditures cited above. It would be incorrect, however, to use this basis only in considering the best of the variants reviewed as satisfactory. Therefore, along with calculating the economical qualities of the variants, consideration is given to the anticipated technical-economic indicators of the associations, enterprises, and the sector as a whole. Their correspondence to the anticipated rate of development of the national economy is mandatory.

In working out a scheme consideration is given to the specialization of associations and enterprises, well-balanced proportions of development and tie-ins of the capacities being introduced, social and everyday conditions, and volumes of housing construction, but each of these problems constitutes the object of an independent examination.

As a result of working out a scheme, the following factors have been determined: indicators of the sector's development throughout the USSR, the economic regions, and the Union republics, the balance between output consumption and production, a list of new construction projects and a list of enterprises subject to modernization or expansion, capital investments in the sector's development with regard to types of reproduction, capital investments in facilities in the non-production sphere, the principal indicators of production specialization, and the principal techical-economic indicators with regard to the sector. After they are examined and approved, these indicators comprise the basis for working out technical-economic grounds and draft plans.

Taking into account the importance of such pre-planning work, Energomashproyekt in conjunction with the Ministry's GIVTs (Main Data Processing Center) has begun at the present time to prepare methods to implement it, using the computer's abundant possibilities for optimization.

2384
CSO: 1822

ELECTRIC POWER

EXPERIENCE AT THE SAYANO-SHUSHENSKAYA GES

Moscow ENERGOMASHINOSTROYENIYE in Russian No 12, 1979 pp 40-41

/Article by the Scientific and Technical Council: "On the Results of Installation, Operation, and Full-Scale, Natural Research at the Sayano-Shushenskaya GES"/

/Text/ The NTS (Scientific and Technical Council) has examined the question "Experience in the Installation, Operation, and Early Results of Full-Scale, Natural Research on Hydroelectric Turbines with Interchangeable Runners at the Sayano-Shushenskaya GES and the System for Regulating Them."

In 1975 the LMZ (Leningrad Metal Plant imeni 23rd Congress) worked out an engineering draft for the turbine equipment, manufactured it in 1977, and on 19 December 1978 put into operation the first assembly unit of the Sayano-Shushenskaya GES. In worldwide hydroelectric turbine building practice there was created for the first time a radial-axis turbine with a rated capacity of 650 MW (megawatts) at the design head of 194 m (meters), capable of developing a maximum capacity of 735 MW at heads of 212 m and higher.

Parameters of the Hydroelectric Turbine Equipment at the Sayano-Shushenskaya GES

Maximum head (in meters)	220
Design head (in meters)	194
Minimum head (in meters)	175
Start-up head (in meters)	120
Diameter of the regular D_1 runner (in meters)	6.77
Frequency of rotation n (r.p.m.)	142.8
Maximum coefficient of efficiency (percentage)	96

The first two units have been equipped with interchangeable runners with a diameter of D_1 = 6.05 m, which are designed for operation with heads ranging from 60 to 140 m, while the capacity being developed therein varies from 130 to 400 MW.

The regular runners (weighing 150 tons) are being made as welded out of stainless steel OOX12N3D, while the interchangeable runners (weighing 90 tons) are made of carbon steel, with the facing of the convex side of the blades made of stainless steel.

In planning and manufacturing the hydroelectric turbine equipment for the Sayano-Shushenskaya GES, use was made of the following new, progressive, design and engineering solutions: large, all-welded runners, made of stainless steel, individual servomotors, oil pressure in the regulating system equal to 63 kgs/sq. m (kilogram-force per square meter), spiral chambers operating in conjunction with the unit's armature, segmented rubber bearings, designed for a specific pressure of p = 7 kgs/sq. m and a linear flow velocity of v = 15 m/s (meters per second), a regulator using integral microschemes, etc. Based on the solutions adopted, highly effective equipment was created, technically good in its manufacture and installation, suitable and reliable in its operation.

The design of the assemblies and installation fittings allowed large-unit installation to be carried out, by means of which labor consumption was reduced and the cycle of installation operations was curtailed. With the aid of a special crosshead (with a hoisting capacity of 300 tons), which was worked out and manufactured at the plant, it became possible to assemble at the installation site and then transfer into the plant well units of the completely assembled controlling apparatus (the turbine cover, base of the servomotors, the servomotors themselves, the bearing support, etc.). Such a solution considerably facilitates installation and improves its quality, while the presence of a beam-crane with a hoisting capacity of three tons allows installation work to be conducted when the generator roofing has been installed.

By means of increasing the rapid action, a hydroelectric turbine with a capacity of 650 MW was installed in a unit which had been designed for a turbine with a capacity of 540 MW. This allowed the number of units to be curtailed, the length of the GES building to be reduced, and the most progressive assembly of the hydro-complex as a whole to be worked out.

The installation at the first two units of the Sayano-Shushenskoye GES of interchangeable runners has allowed a beginning to be made in operating the station with lower heads and an incompletely built dam. The first unit with an interchangeable runner was put into industrial operation at a head of 60 m two years ahead of the intended deadline (19 December 1978). The unit operated for 2,000 hours and produced 200 million kW-hrs of electric power; it developed a maximum capacity of 130 MW, which corresponded to its operational characteristics at the given head.

The operation of the hydroelectric turbines with temporary runners has permitted us to obtain data which are necessary to finish equipment linked with the future further improvement in the designs of individual elements and schematic solutions; it has also allowed the service personnel of the GES to be given up-to-date training.

Thus, in addition to the economic effect derived from the supplementary output of electric power, a definite effect is obtained from the timely finishing of equipment, an increase in its reliability, and its skilled operation. Experience in manufacturing, installation, and successful operation has confirmed the correctness of the design and engineering solutions which were adopted with regard to the hydroelectric turbine equipment of the Sayano-Shushenskaya GES, and it also testifies to the high quality of the equipment manufactured at the LMZ.

At the present time we have made it possible to introduce the results of research on finishing the unit's control system, which must increase the pressure in the regulating system to the design level of 63 kgs per sq. cm.

The Scientific and Technical Council Section has recommended that approval be accorded to the work of the "Leningrad Metal Plant" Planning Unit and the "Khar'kov Turbine Plant" Planning Unit with regard to the planning and introduction of model schemes for installing units with interchangeable runners at the Sayano-Shushenskaya GES and the Nurekskaya GES.

In order to accumulate experience in operating the units with interchangeable runners at the Sayano-Shushenskaya GES in 1980--1981, it is necessary to conduct comprehensive, full-scale, natural tests.

It is also recommended to the turbine plants and Gidroproyekt that in their future solutions to the problems of grouping hydroelectric turbine equipment, they should place the hydromechanical part of the regulator and the oil-pressure unit as close as possible to the servomotors of the controlling apparatus, thereby ensuring convenient access to the equipment as well as good operating conditions.

In view of the abandonment of the policy of assembling spare parts at the plant (in accordance with the USSR Ministry of Power and Electrification) the LMZ has proposed to conduct a supplementary examination of the problems of improving the technology of their manufacture and control, taking into consideration the experience of installation.

2384
CSO: 1822

ELECTRIC POWER

UDC 627.825:621.311.21(479.22)

ARCH DAM OF THE INGUR' GES[1]

Moscow GIDROTEKHNICHESKOYE STROITEL'STVO in Russian No 12,1979 pp 3-10

[Article by V. I. Bronshteyn, candidate of technical sciences, and engineers I. I. Lomov, A. Ya. Menabde and G. V. Rubinshteyn]

[Text] From the Editorial Staff

The final design decisions and changes, introduced into the plan during formulation of the working papers, are stated in this proposed article. The changes indicated are associated with refining the nature of the dam's operation under load as a result of obtaining additional data from engineering surveys and investigations.

Such changes in the design noted in the article, as the replacement of the reinforced concrete saddle with an expanded concrete saddle (primarily for considerations in facilitating the work and decreasing the expenditure of reinforcements), the improvement in the shape of the dam, the elimination of water conducting equipment from the second level, the change in quake-proof reinforcements, the design of the saddle's fracture zone, etc., will arouse undoubted interest in the reader of this journal.

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[1] The technical design for the arch dam at the Ingur' GES was developed by the Moscow departments of the "Gidroproyekt" Institute imeni S. Ya. Zhuk together with the Institute's Tibilisi branches. The working design-planning documentation is published by the Moscow departments of the "Gidroproyekt" Institute with the inclusion of specialized organizations (Gidroproyekt, the Special Design Bureau of "Mosgidrostal'") and the participation of Gidroproyekt's Tibilisi branch.

In the opinion of the editorial staff, it would be helpful to state in greater detail a number of questions while they are in the process of development, in particular, the evaluation of the engineering-geological situation of the construction platform, the idea of quake-proof reinforcements and the improvement of the dam's structure.

On the eve of the 61st anniversary of the October Revolution, the first power unit of the Ingur' hydro-electric power station was placed under an industrial load. The station is the primary step of the hydro-electric station cascade on the Ingur' river which uses the river's fall downstream.

Comprising the structures of the Ingur' GES are: an arch dam, a deep tunnel-type water intake, a diversion pressure tunnel (with more than a 100 m head) 9.5 m in diameter and 15 km long, an underground station building with five vertical 260 MW power units, each with a 3 km unpressurized discharge tunnel.

The full static head of the GES amounts to 409.5 m, of which 226 m is comprised of the arch dam and the remaining 183.5 m is from the diversion structure, consisting of the pressure and discharge tunnels. The rated power of the Ingur' GES comprises 1300 MW (total power of the Ingur' GES cascade is 1640 MW) and the mean long-life electric power output is 4330 million kW·hr (for the cascade as a whole--5460 million kW·hr).

Engineering-geological and seismotectonic conditions along the line of the dam are being carried out under complex engineering-geological conditions in an area characterized by high background seismic activity (8-scale). The foundation of the dam is composed of limestone, dolomitized limestone and Barremian dolomites (bottom chalk), strata of which have an acute (50-60 degree) monoclinal gradient toward the under water (with a slight anticlinal discontinuity in the riverbed portion of the ravine). The bedrock is composed of stable rock strata (with a temporary compressive strength on the order of 80-90 megapascals), but they are greatly fissured with deformation moduli in the relief zones from 4-8 megapascals and less, and up to 13 megapascals and greater in the natural safety zones. According to the nature of the composition, the physical-mechanical properties and the degree of fissuring, six bands of rock strata from 40 to 150 m in thickness have been isolated.

The main disjunctive dislocations in the line of the dam are: an edge dislocation where the Jurassic and chalk strata meet, traveling for 1.0-1.5 km above the dam; an Ingirishskiy upthrust shift with a vertical amplitude on the order of 1000 m, located 1.4 km above the dam: a tectonic fracture with a vertical amplitude of 100-120 m, but without signs of recent differential shifts, and a leading Ingirishskiy upthrust and intersecting right-bank abutment of the dam 110 m below its crest (the right-bank fracture). Pertaining to the fractures of lesser order are about two dozen large fractures with a width of 10 cm at the mouth as well as lesser fracturing. Six primary fracture systems have been formed in the strata that have developed here. The thickness of the conglomerate river-bed alluvium on line with the dam reaches 38 m. Sink-hole phenomena occur only in the foundation of the high left-bank bench where caverns as well as leaching of carbonaceous strata along the fractures and layers are observed.

The seismic danger in the construction zone, according to investigations done by the Gidroproyekt's department of geophysical surveys and research, is determined by earthquakes which may arise in the earthquake-generating zones of the Caucasas enumerated below

in the region of the Major Caucasian Fault (magnitude of maximum possible earthquake is M_{MAX}=6.75-7.0, depth of the seat of the disturbance h=20-30 km, minimum distance from the dam $\Delta \approx 30$ km);

in the region of the Ingirishskiy fault (M_{MAX}= 5.5, h=5-10 km, $\Delta \approx 0$);

in the tail segment of the Major Caucasian Fault, in the region of the Kakuro-Uskurskiy upthrust (M_{MAX}=6.5, h=20 km, $\Delta \approx 25$-30 km);

in the region of the discontinuities in the middle portion of the Abkhazo-Svanetskaya step (M_{MAX}=5.5, h=5-10 km, $\Delta \approx 10$-15 km).

The maximum seismic effect in the line of the dam can reach 8-scale. In order to describe the earthquakes named above, which present a danger to the structure, an assembly of accelerograms with much more liekly maximum acceleration values of 0.11-0.26 g was constructed in the Gidroproyekt's department of geophysical surveys and research (I. P. Kuzin, A. I. Savich, A. V. Suvilova) on the basis of the genetic approach.

The indicated peak acceleration values conform well with results of calculations from the Gidroproyekt's department of dynamic research in the Scientific Research Sector (V. M. Lyatkher, A. D. Kaptsan). These calculations were carried out by a statistical method of treating data from earthquakes that were classified according to macroseismic intensity, taking into account the structure's time in service and the frequency of earthquakes of the calculated intensity. With probabilities equal to 0.5-0.97 that there would be no earthquake effect exceeding predicted values for the structure's period of controlled status τ= 100 years, the maximum acceleration values determined by this method, carried out for the bottom of the canyon, are within limits of 0.08-0.20 g.

The shape of the dam. The dam is an arc with double curvatures and gravity abutments on the upper points on both banks (fig. 1). The overall construction height of the dam is 271.5 m, which puts it in first place among arch dams worldwide. The length of the dam along the crest is 758 m, including the length of the abutments--118 m.

The design of the coupling of the dam with the foundations on the upper points on the right bank, where the strata are characterized by lowered moduli of deformation (on the order of 2.0 megapascals) and a considerable decrease in strength characteristics during irrigation, was selected as a result of comparing the accepted version (gravity foundation with an anti-filtration stub-wing, and cementing and drainage aprons inclined toward the upper water) with alternative versions in the forms of a concrete slab-block, a dipping crest (of the "Kurobe"-type) and a pile foundation made using a mining method. The dimensions of the foundation can be reduced through further designing, since the magnitude of the forces transmitted by the dam to the foundations will decrease as a result of widening the saddle at the upper points and improving the shape of the dam. These changes are provided for in the working drawings.

The supporting section of the structure is made in the shape of a saddle, separated from the arch portion of the dam by a smooth perimetrical seam. In comparison with technological designs the saddle is considerably widened and expanded in height as a means to decrease pressure on the foundation, the quality of which turned out to be lower than estimates made at that phase of the engineering plan. The "plug," included in the body of a single saddle for the entire supporting periphery, has been eliminated as an independent structural element. The height of the saddle is 15-20 m along the sides and reaches 50 m in the lower portion of the ravine.

Coupling the arch dam with the foundation in the form of a saddle, separated from the arch by a perimetrical seam, has made it possible to:

(1) reduce the compression stresses transmitted to the rock mass by increasing the area of the supporting surface and differentiate the stresses in relation to the supporting capacity of the rock;

(2) decrease the danger of the appearance of tensile stresses by opening the perimetrical seam, equipped with special seals that guarantee its water impermeability. These stresses could arise in the foundation's area of contact as a consequence of a non-uniformity in the foundation, as well as from seismic effects, and could lead to a fracture in the cementing apron;

(3) accelerate the filling of rock excavations in the foundation pit with concrete in order to prevent the development of an unpacking process in the rock, and, in connection with this, to decrease the additional volume of rock.

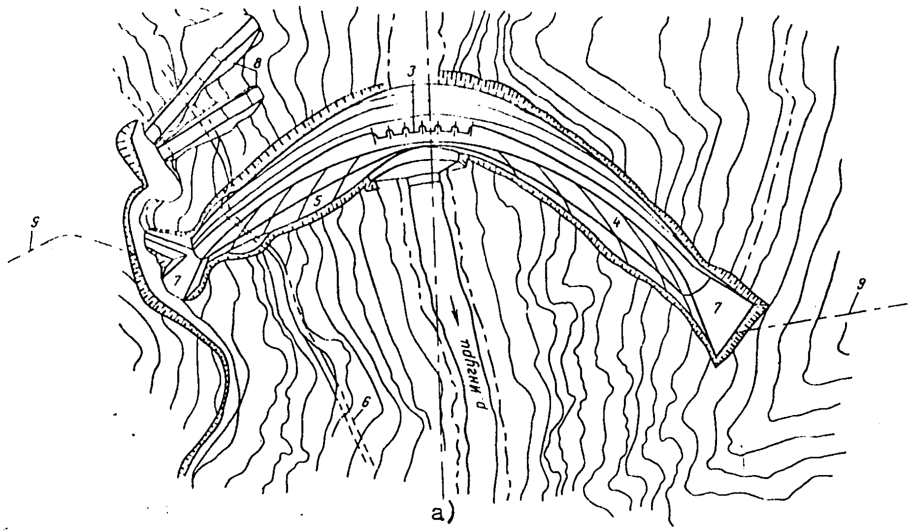
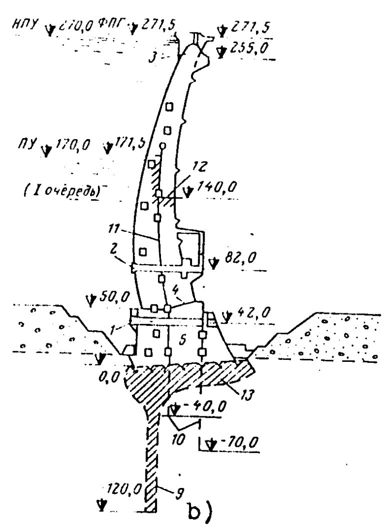


Fig. 1 Arch dam of the Ingur' GES



a-Plan; b-Section through the central console. 1-Structural apertures; 2-Deep water outlet; 3-Surface water outlet; 4-Perimetrical seam; 5-Saddle; 6-Right-bank fracture; 7-Gravity foundations; 8-Water inlet; 9-Cementation apron; 10-Drainage aprons; 11-Longitudinal seam; 12-Border of first line of the dam; 13-Reinforcing cementation

(4) Smooth out the effects that local irregularities in the rock surface along the foundation contour have on the arch dam.

In cooperation with the Moscow Civil Engineering Institute imeni Kuybyshev (A. D. Dobysh), an original analytical device was constructed using two independent polynomical functions: a function for the mean surface and a generalized function for the thickness [1]. The unknown coefficients of the polynomial expressions are determined from the minimization conditions of the weighted sum of the squares of the differences between the given values, taken graphically from the drawings of the dam and from the unknown functions.

The development of a description of the dam's geometry created the prerequisites for properly carrying out calculations of its stress and deformation states and for solving the problems of designing the dam's elements. It also made it possible, with the aid of a computer, to automate extremely labor-consumptive operations in delivering the coordinates of the construction blocks, columns and sections to the construction site. The economic impact from putting into practice just the automated system for calculating the coordinates and parameters for on-site delivery of the blocks amounts to 50,000 rubles per year, owing to a reduction in labor-consuming calculations.

The configuration of the perimetrical seam was selected taking into account the mean direction (in the mean-square sense) of the dam's reactions in the presence of six various combinations of loads and reactions on the structure, including the hydrostatic pressure, the natural weight of the concrete and the temperature and seismic effects. The perimetrical seam in cross-section normal to its centerline describes an arc (fig. 2) of a circle with a radius equal to double the thickness of the dam at point M and a center, the angular displacement α of which relative to a unit vector $\bar{t}$ of the tangent to the mean surface of the dam is selected from a condition for the passage through this center of an mean (in direction) resultant of the forces $\bar{R}$ transmitted from the dam to the foundation.

The thickness of the dam in the cross-section of the central console comprises (see fig. 1) 10 m along the crest, 50 m along the perimetrical seam and 90 m along the contact surface at the foundation. The total volume of concrete in the dam, determined by the engineering design, is 3.96 million m^3 (including the gravity foundations and the anti-leakage wing on the right bank).

The dam is erected in an assymetrical line with a near-parabolic shape and a ratio of length (along the crest) to height equal to 2.3:1.

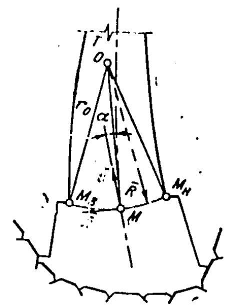


Fig. 2 Scheme of the structure in cross section at the perimetrical seam.

O and r_0 --Center and radius, correspondingly, of the arc of the circle $M_B MM_H$; n--Unit vector normal to the mean surface at point M; $\bar{R}$--Vector of the resultant forces in the dam at point M; $\bar{t}$--Unit vector relative to the mean surface at point M; α--Angle between vector $\bar{t}$ and the straight line OM.

The dam's shape was chosen as a result of its subsequent development, beginning with a circular configuration on the basis of numerous estimated theoretical write-ups and experimental research on flexible, friable and geomechanical models in which the All-Union Scientific Research Institute, the Gidroproyekt Scientific Research Sector, the Georgian Scientific Research Institute of Power Engineering and Hydrotechnical Construction and other organizations took part in the research along with Gidroproyekt. The dam variant which had been adopted in the engineering design has continued to be improved in the course of the working design's development. The dam possesses arcs of a five-centered configurations whose stressed state is characterized by a high level of compressive stress σ^{co}_{MAX} on the order of 10 megapascals (in the case of a fundamental combination of stresses and reactions), by the smallness of the values and the propagation zones of the tensile stresses and, at the same time, by considerable nonuniformities in the body of the dam. Optimization of the structure's shape was done by a series approximation method. The problem was solved by an estimation method [2], and the results of the solution were checked on a large-scale (1:150) geomechanical model at the All-Union Scientific Research Institute of Hydraulic Engineering imeni B. E. Vedenev (S. S. Antonov and L. E. Kogan were responsible for executing the work). In the first step, the dam's mean surface was optimized for fixed thicknesses that were smoothed out in the mean-square sense and reduced somewhat (on an average of 3 percent) relative to the thicknesses in the adopted variant, but satisfying the previous principle of their distribution in the dam. As a result, a more uniform distribution of stresses in the body at the dam was obtained in comparison with the adopted version, the greatest compressive stresses were reduced by up to 1 megapascal and the volume of concrete in the dam was reduced by approximately 100,000 m^3. The dam's mean surface in the working drawings is characterized by an absence of rapid changes in the curvatures and the stress concentrations associated with them. These are unavoidable in dams which utilize multicentered curvatures, as well as strict regularity in both horizontal and vertical curvatures for the description of its arch elements.

The reduction obtained in the greatest compressive stresses has made it possible to raise the question of decreasing the thicknesses in the dam while preserving the stress level that satisfies the confirmed engineering design.

The following circumstances demanded consideration during the solving of this problem under conditions of intensive construction at the dam:

(1) a variation in the dam's geometric parameters may be carried out within such limits as would insure that the changes in the shape of the dam would not appear to be a reason for delays in the course of design and construction work;

(2) a smooth coupling (to the second derivative, inclusively) of the lower portion of the dam, laid according to the geometry of a refined engineering design, with its upper section;

(3) trimming of concrete can be carried out only from the dam's downstream face, since changes in the upstream face would require changes in the design of the passages for the inclined gates, the position of the anti-leakage and drainage equipment, the galleries and the shafts;

(4) a new geometry of the dam must have an analytic description

Through calculations that were carried out and confirmed by testing done on a geomechanical model, a contour for the trimming was established which, when the volume of the body of the dam was decreased by 50,000 m^3 (primarily within the limits of the upper third of the structure), ensured minimal changes in the stressed state relative to the original version with its optimized mean surface (not more than 0.5-0.6 megapascals). A diagram of the trimming is represented in fig. 3. Along the height of the structure the trimming from zero on a certain given point Z_0 grows to a maximum, after which it diminishes to zero on the crest; in the horizontal cross-sections it increases from the key to the perimetrical seam. The maximum extent of the trimming is 2.6 meters. In the final version of the dam's geometry the arcs have varying thicknesses, increasing inconsiderably from the key to the abutments in the structure's central zone and increasing sharply near the abutments. The geometry also posses gradually changing variable contours with maximums at the key and at the abutments of the arcs.

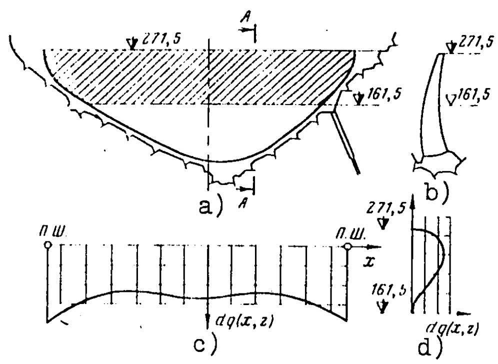


Fig. 3 Scheme for trimming concrete from the dam's downstream face.

a--View from the side of the downstream face; b--Cross section from A-A; c and d--Diagram of change in thicknesses in the horizontal and vertical cross sections of the dam, respectively, with the area of trimming depicted in cross-hatched lines.

The stress-deformation state. The stress-deformation state of the final version of the dam's geometry with fundamental combinations of stresses and reactions (hydrostatic pressure with a normal backwater level of 270 m and a supported level of 210 m, the natural weight of the concrete and the temperature effects) is based on dam calculations done by an automated method of test stresses [3], as well as by research on geomechanical [4] and temperature [5] models. The results of calculations and experimental research are in satisfactory agreement with one another. The dam's stress field is characterized by good uniformity, a high degree of utilization of the concrete's strength under compression (the greatest compressive stresses amount to 9.4 megapascals) and a practical absence of tensile stresses in the arch portion of the dam.

In order to evaluate the stress-deformation state of the structure during seismic activity, calculations have been carried out on the linear spectral-dynamic theory by methods of test stresses [6] and of isoparametric terminal elements (at the Gidroproyekt GVTs [further expansion not provided]); research has been done on the harmonic mode of friable models with the models brought to destruction on a seismic platform [7]; experimental-analytical research has been done (at the All-Union Scientific Research Institute of Hydraulic Engineering imeni B. E. Vedeneyev) with loading of large-scale models placed on the VP-1000 vibrating platform and with the help of an impulse source and computer calculations of stresses that correspond to the given accelerogram of an earthquake; the Gidproproyekt's scientific research sector has carried out calculations based on a solution for overall equations of narrow moment envelopes by means of a method of finite differences for the seismic reaction given by the accelogram [8]. While carrying out the latter calculations they took into account three components of seismic reaction, a change in the latter along the foundation contour, as well as the feasibility of opening the inter-section, block and perimetrical seams of the dam.

Structural elements of the dam. The body of the dam is divided into 38 sections by helical inter-section seams, normal in each horizontal cross section to the axis of the corresponding arc. The seam axes are constructed on the mean surface of the dam at a distance of approximately 16 m from each other. In the riverbed portion of the saddle (the plug) the sections are erected in three columns; in the arch portion of the dam to the 176.0 m mark the sections are built in two columns; higher up they are built in one column. The longitudinal seam, dividing the dam sections into the upstream and downstream columns, is made approximately along the mean surface of the dam. The joint operation of the individual sections and the structure's columns is insured by vertical toothing and cementing of the inter-section and longitudinal seams.

The initial cementing of the seams is accomplished at closing temperatures established on the basis of analysis of the overall stress state of the dam. The analysis is done according to the criterion of technical economic expedience in cooling the concrete work to some bonding temperature or another, with consideration given to insuring the extent of the seam opening necessary for cementation; the saddle and the arch portion of the dam up to the 120.0 m mark consolidate at a concrete temperature of 10°C and the arch portion of the dam over the 120.0 m mark at 12°C. The design of the cementing outlets makes it possible to carry out repeat and frequent cementation of the dam's seams. Five floors of service galleries located approximately every 50 m along the height of the structures and continuing in the form of cementation and drainage tunnels in the sides of the ravine, as well as several additional galleries, including perimetrical galleries, are being constructed for cementation of the seams during the construction period and their repeat cementation during the structure's period of service, for the intake and discharge of leakage water, for observation of the drainage operation, for controlling the status of the structure and executing repair work, for internal dam communications, for laying communication lines and for the placement of communications equipment. Each level represents a system of longitudinal and transverse galleries having an exit to the service bridges located on the downstream face at 20-25 m intervals along the height of the dam. For communications between the gallery levels and the crest of the dam, the installation of freight elevators and staircases has been provided for.

Anti-leakage seals in the form of brass sheets with hinged expansion joints are installed in the dam's seams. The number and width of the seals are determined as a result of the allowable pressure gradient in the presence of leakage in the concrete. The accepted gradient is equal to 40. With a 200 m head or greater, there are three rows of seals 1360 mm wide; with a 100-200 m head these are two rows 1360 mm wide; with a 100 m head or less--2 rows 687 mm wide.

The drainage system in the body of the dam has undergone essential changes in comparison with the engineering design. In the lower two-thirds of the structure, drainage is accomplished with the help of horizontal drains installed in the top part of the concrete work blocks in 1.5 m increments along the height of the dam. They lead to drainage sumps located in the inter-section seams. In the upper third of the dam drainage is accomplished in the form of blind apertures of 105 mm diameter that are bored out of the longitudinal or transverse galleries. The erection of the dam is accomplished in two lines (fig. 1).

Reinforcement. In the technical design, provisions were made for the reinforcement of the dam's faces, the perimetrical seam, the saddle, galleries, elevator shafts and drainage sumps, as well as for a special anti-earthquake reinforcement with an overall expenditure of reinforcement steel on the order of 70,000 tons and a specific expenditure per m^3 of dam concrete of approximately 17.5 kg. In addition, the number of reinforcements was determined from conditions under which the reinforcements were to absorb all the tensile stresses in the concrete. These were the stresses that arose in calculated cross sections in the presence of the worst combinations of estimated stresses and reactions, taking into account the concentration of stresses around the aperatures, excluding those cases when the tensile forces did not present a danger to the stability and long life of the dam or its elements.

As a result of carrying out additional computational-experimental processing and refining the computational scheme and stresses, a transition was made from the principle of reinforcing according to the overall tensile stresses to a structurally dispersed reinforcement [9] that exceeds the concrete's limit of resistance to tension. A dispersion-reinforced dam located in zones where tensile stresses arise works practically like a monolithic concrete structure. According to the dispersion scheme, a vertical reinforcement of the dam is carried out, as well as reinforcement of the structure's sections in the horizontal (arch) direction.

The number of vertical reinforcements in the inter-section seams is chosen for a condition in which they absorb the overall tensile stresses, since the seams do work under tension.

In the engineering design provisions were made for a reinforced concrete saddle structure with an average expenditure of reinforcements of 40 kg per m^3 of concrete. In the working design based an additional computational-structural processing and the analysis of results of research done on geomechanical models, the engineers were successful in practically eliminating reinforcements from the saddle, except for two small areas on the structure's downstream face where tensile stresses of considerable magnitude occur, directed along the foundation's contour, and for several localized areas located in highly fractured and non-uniform areas of the foundation, where, as a result of reaching the rock strata, there have been formed acute fractures in the foundation's surface. Provisions have also been made for reinforcing the downstream face of the saddle, the surfaces of the perimetrical seam and the areas around the galleries and the sumps. The unit expenditure of reinforcements has been decreased to 6.5 kg/m^3 of cement in the saddle--a total reduction of 11,500 tons.

The average expenditure of reinforcements in the first line of the dam comprised 8.2 kg/m^3 in which a considerable portion of these went for reinforcing the concrete around the galleries and shafts as well as for sectional reinforced concrete in the balconies, gallery linings and inter-section seams.

In order to approximate a flexible type of deformation for the dam during seismic activity of the calculated intensity, an original design was developed for the horizontal reinforcements in the upper quarter of the structure, in which the reinforcements pass through the inter-section seams. A foregone notion about the operation of the arch dam only during compression was the reason for the unfounded objections to the estimated reinforcement of individual portions of a dam that was in the form of a distended arc. For example, when there is a considerable drop in the water level in the Ingur' GES reservoir (up to 90 m) its upper zone turns out to be not ready for service. In this case the inertial forces during seismic activity cause considerable off-center stretching which cannot be absorbed with the insertion of the estimated reinforcement.

As experimental research has shown [14], in the absence of such reinforcement the oscillations in the dam are accompanied by considerable opening of the inter-section seams and the formation of open horizontal cracks in the presence of accelerations that are considerably smaller than those calculated. Such a state for the dam is not permissible. The accepted layout for anti-earthquake reinforcement has made it possible to improve the operational characteristics of the structure while simultaneously reducing the number of anti-earthquake reinforcements by 10,000 tons in respect to the engineering design.

The reliability of the dam, along with the special selection of a shape for the dam and the anti-earthquake reinforcements, is guaranteed by the installation of seals of enhanced dependability in the inter-section and perimetrical seams. It is also insured by protecting the contact area between the dam's saddle and the rock in the lower portion of the ravine on the upper water side with asphalt mastic; by covering the pressure face in the lower third of the dam with epoxy resin waterproofing; by installing in the concrete a system for repeat and multiple cementation; by installing a developed drainage system and a system of passages and galleries in the sides and the body of the dam, making it possible to conduct repair operations in case it becomes necessary; as well as by engineering measures for making the foundation monolithic.

The underground contour. Engineering reinforcement measures in the foundation. In the body of the dam's underground contour there are: reinforcing cementation in the foundation to a depth of 30 m, having a design volume of 250,000 m^3; an antileakage cementation apron, having in the plan an overall length of 1106 m and a depth of up to 120 m, made from six layers of cementation passages in outgoing and ascending fragments; and a drainage apron up to 70 m deep in the riverbed portion of the ravine and up to 150 m in the sides of the ravine.

The strength of the dam is based upon calculations done by a maximum equilibrium method for the shore foundations with the required safety factor of 1.8, and by calculations for the stress state of the foundation, which is considered as a flexible, plastic medium, as well as by a terminal element method [10, 11]. The calculations which have been carried out have established the necessity of filling in with concrete the right-bank fracture and five large-scale tectonic fractures of 25-30 cm and greater in width.

They are filled in primarily with clay and heavy loam with calculated parameters of shear strength tgφ=0.65; c = 0.05 megapascals. Filling the fracture (fig. 4) is accomplished by a mining process in the form of a solid concrete massif approximately 10 m thick in its upper portion adjacent to the body of the dam (within the 115-150 m marks) and columns of 10 x 8 m cross section in the lower part of the dam (within the 75-115 m marks). Such a design provides for a gradual change in the rigidity of the fill and makes it possible in this manner to reduce the stress concentrations and distortions in the seepage flow in the surrounding rock. The overall length of the fill is 150 m, the depth 75 m and the volume of concrete in the solid portion is 22,000 m^3 and 12,000 m^3 in the columnar portion.* For reinforcing the rock massif in the vicinity of the fill in the fracture and the cracks, as well as for eliminating the unfavorable effects of weight redistribution during the cutting of the passageways, provisions have been made for a reinforcing cementation of 100,000 linear meters total volume. It is connected to the reinforcing cementation in the foundation of the dam and the anti-leakage apron. Provisions have been made principally for a solid concrete fill in the cracks, with the removal of virgin rock from the foundation massif in the peripheral areas of the fill, where the stresses are not great. The volume of fill in the cracks is 42,000 m^3 of concrete.

The calculations carried out for the foundation have also shown areas of plastic deformation in the rock massif at the downstream face of the dam, at the lower marks in areas of shallow cutting. The formation of the plastic regions in the foundation is associated with a local increase in its deformability, which adversely affects the stress state of the dam. With the aim of neutralizing this effect, reinforcing measures have been planned in the under water of the dam at the lower marks on both banks. These reinforcements are in the form of a concrete slab and the installation of prestressed anchors.

A special design for that area of the saddle located over a fracture [12], represented in fig. 5, has been developed in order to compensate for possible near-surface differential shifts in the vicinity of the right-bank fracture, the appearance of which might be induced by the construction of the dam and the formation of the reservoir, which accumulates a great mass of water. The height of the saddle over the fracture has been increased to twice its thickness, and the saddle itself is sectioned by two systems of smooth seams which guarantee the foundation a certain freedom of movement. The seams of the first system are oriented approximately along the fracture. Some of the seams join up with the inter-section seams, while others are located within the sections and partition the saddle from the surface of the rock to one half of its height. The seams of the second system are oriented parallel to the mean surface and lead as far as the middle of the saddle.

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*Here and further on, the design volumes of the reinforcement measures in the foundation are cited. The actual volumes have grown approximately by a factor of 1.5.

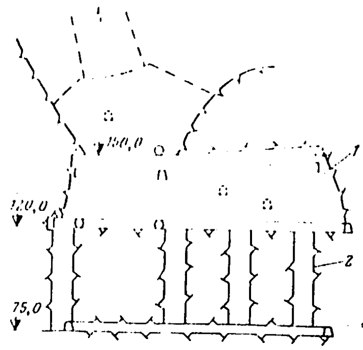

Fig. 4 Sealing the right-bank fracture.

1--Solid concrete fill; 2--Columnar fill

As the All-Union Scientific Research Institute of Hydraulic Engineering's investigations have shown [13], such a design for the saddle insures that shifts of up to 10 cm will be absorbed practically without change in the dam's stress state.

Water-discharge installations. In the body of the dam, 182.5 m below the crest, seven deep apertures 5 m in diameter have been made. Four of them, equipped as free-running water outlets, are capable of passing a 1200 m^3/sec maximum structural discharge with a 1 percent probability of overrun when pressure heads are 25 m or greater. With a 271.5 m forced backwater level and installed current deflectors, the discharge is 1860 m^3/sec with a 0.1 percent probability of overrun. After construction of the Ingur' hydro-accumulation electric power station with attached dam, which is planned for the future, five of these seven apertures will be employed for bringing water to the power units of the GAES, while the two remaining will be used as the dam's water outlets. The Mosgidrostal' Special Design Bureau has developed a unique mechanical apparatus, designed to absorb the static head and to regulate the discharge with pressure heads of up to 181 m. The development indicated has made it possible to eliminate the second level of water-discharge apertures, the installation of which had been provided for in the engineering design.

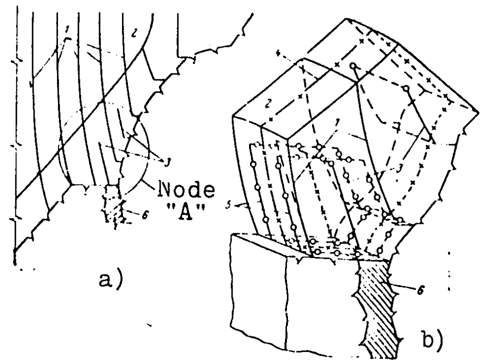

Fig. 5 Design of the saddle's above-fracture zone.

a--Right-bank abutment of the dam; b--Node A; 1--Inter-section seams; 2--Perimetrical seam; 3--Additional seams, oriented along the fracture; 4--Longitudinal seam; 5--Additional seams, oriented parellel to the mean surface; 6--Fracture.

The primary regulating and emergency repair flood gates have been built, in the design sense, as flat slides. The special configuration of the blade, developed for the operational flood gates insures compactness of the water stream with any opening of the flood gates and the absence of cavitation on its downstream side. The design of the emergency repair flood gate with its accompanying ring makes it possible to considerably reduce the dynamic stresses on the dam. In order to seal the flood gates, polyethylene seals had been used at first. These seals had been developed at the Mosgidrostal' Special Design Bureau and guarantee greater strength and a lower coefficient of friction with smaller dimensions than those of traditional rubber seals. The elimination of the two-level design solution for the deep water outlets has made it possible to reduce the dam's cost by approximately six million rubles.

A surface spillway with 6 apertures, each 9 m wide, is planned for the crest of the dam. It is calculated to pass 1200 m^3/sec with a normal backwater level. With a 1.5 m increase in the water level, the spillway is capable of passing a maximum calculated flood with a 2500 m^3/sec peak (0.01 percent probability of overrun with guaranteed correction). In addition, the maximum outlet discharge through the surface spillway reaches 1800 m^3/sec.

Three auxiliary apertures of 3x5 m cross section, intended to pass the winter flooding in a discharge up to 400 m^3/sec, have been built in the plug of the dam in order to pass the discharge of water in the period between the closing of the construction tunnel and the commissioning of the deep water outlets. At the present time these apertures are closed from the upper water side by plane flood gates, intended to absorb pressure heads of up to 160 m. Provisions have been made for filling the apertures with concrete after the first power units are placed into service in 1979-1980.

In order to protect the riverbed and the banks from erosion when the water outlets are operating, provisions have been made for a damping sump in the under water of the dam. With the aim of lightening the sump's apron, it has been made in the form of a reverse arch resting on the banks on concrete massifs.

Natural observations. Within the body and the foundation of the dam are installed control and measurement devices which are included in the structure's complement of 7000 instruments. These devices are intended for operational control of the stress-deformation state; the seepage and temperature conditions; the displacements; the operation of the water-discharge apparatus and conditions in the under water; as well as for the control of long-term research into seismic phenomena and tectonic shifts in the earth's crust, beginning with the erection of the dam and the filling of the reservoir.

By the time operations had begun, 1278 monitor-measuring devices had been installed, of which 11.3 percent had gone out of service.

Basic stages of construction. The construction of the arch dam had been begun in 1965 with the cutting of a construction tunnel, 560 m long and 130 m^2 in cross section, in the left bank of the river. The tunnel was completed in 1969, the Ingur' river was spanned and operations expanded on the development of the dam's excavation pit, which had been started in 1967. The depth of the excavation had been determined by the stability and strength of the bank foundations with consideration given to the depth of the eroded zone and the relief of rock on the banks which amounted, on the average, to 35-40 m on the banks and about 50 m in the riverbed. The development of the excavation pit was carried out in descending steps using a smooth blasting method and the transport of rock on intermediate roads on the banks of the ravine. The overall (section) volume of the excavation amounts to 2.6 million m^3, including 1.7 million m^3 of rock.

The preparation of the rock foundation under the concrete work was carried out in three stages. First, rough excavation was carried out down to the design depth. Then, an additional removal of rock was performed according to data from the geological documentation and special geophysical investigations. Finally, the final finishing excavation and cleaning was done in order to obtain a rock surface of the necessary quality (with a longitudinal seismic wave propagation velocity of $v_w \geq 1$ km/sec).

The first concrete was laid in the left-bank saddle of the dam in 1971. The laying of concrete during the years when the first line of the dam was under construction was accomplished in the following volumes: 1972 - 48,000 m^3, 1973 - 185,000 m^3, 1974 - 268,000 m^3, 1975 - 332,000 m^3, 1976 - 350,000 m^3, 1977 - 450,000 m^3, 1978 - 530,000 m^3. The delivery of concrete in 1.5 m blocks was accomplished using four cable cranes with a 934 m run and each with a 25 ton lifting capacity. M350 and B12 Concrete, the primary batch of which (batch 3) had been awarded the State seal of quality in 1978, was prepared in a continuous-operation plant with a productivity of 300 m^3/hr and in cyclic-operation plant with a productivity of 100 m^3/ hr.

Construction was accomplished in two lines. The first line of the dam (fig. 1c), which had insured the commissioning of the power units with a 170.0 m backwater level, was built up to the 171.5 m mark along upstream columns and from the 140.0 to 161.0 m marks along the downstream columns. Consolidation along the upstream columns had been done from the 161.0 to 164.0 m marks, and to the 120.0 m mark along the downstream columns, including the cementation of the longitudinal seam.

The dam's stress state in the first line, based upon the Gidroproyekt's calculations and model research at the All-Union Scientific Research Institute of Hydraulic Engineering, is characterized in the following manner: the compressive stress does not exceed 4.0 megapascals in the direction of the console and 2.3 megapascals in the direction of the arch. Slight tensile stresses in the console (0.7 megapascals) obtained from a calculation in the central portion of the upper water face, will be converted into compressive stresses with finishing work on the dam and the raising of the water level to the normal backwater level.

The design forecast for the dam's stress state in the first line is confirmed by data from devices which measured the dam's deformation under load. The data were obtained by the Georgian Scientific Research Institute of Power Engineering and Hydrotechnical Construction after the water level was brought up to the starting mark of 170.0 m.

In December 1977 the first line of the sump apron, 210 m long, was completed, after which the Ingur' river was directed through the structural apertures in the body of the dam, while the construction tunnel was closed and sealed off with a concrete plug. In April 1978 the flood gates in the structural apertures were lowered, the flood gates of the operational water outlets were tested, and the first stage of filling the reservoir was accomplished (to a depth of 60-65 m). In the subsequent process of filling the reservoir to the starting level, the water level was reduced three times by a depth of more than 10 m.

In October 1978 the dam and its underground contour were filled with the minimum volume of concrete needed for the start of operations (by November 1, 1979 2.08 million m^3 of concrete had been laid). At the beginning of November the level in the reservoir reached the starting marks, and on November 5 the first power unit at the underground GES was connected into the Transcaucasian consolidated power system. By the end of 1978 two more units were placed into industrial service, after which the installed power of the first step of the cascade in the Ingur' GES reached 780 MW. By the end of August 1979 the Ingur' GES had produced its first billion kW·hr of electric power. The start of the fourth and fifth power units is planned for 1979-1980. After which the GES will reach its design output of 1.3 million kW. The completion of construction of the dam is planned for 1982.

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9512
CSO: 1822

ELECTRIC POWER

BRIEFS

CONSTRUCTION WORK SHORTCOMINGS--At its 16 August 1979 session, presided over by First Deputy Minister P. P. Falaleyev, an economic commission on construction work examined the economic results of the work of the USSR Minenergo's construction and installation organizations for 1978 and the first half of 1979. In the discussion of the report particular attention was devoted to existing shortcomings in the work and to the measures necessary for improving the results of economic activity, in particular, in the organizations of Glavzavodspetsstroy, Glavenergokompleksstroy, Glavgidroenergostroy and Glavenergostroy. In the process of discussing the question, many concrete proposals for the further improvement of the work of construction and installation organizations were introduced. [Text] [Moscow ENERGETIKA I ELEKTRIFIKATSIYA Seriya: EKONOMIKA ENERGETICHESKOGO STROITEL'STVA in Russian No 10, 1979 pp 29-30] 9512

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FUELS

UDC 622.33.103.3:658.589.011.46(477)

ADVANCES MADE, NEW DEVELOPMENTS PLANNED IN UKRAINIAN COAL INDUSTRY

Kiev UGOL' UKRAINY in Russian No 12, Dec 79 pp 4-8

[Article by Director of Donetsk Scientific Research Institute of Coal, Candidate of Technical Sciences S. A. Saratikyants: "Main Problems in Development of Coal Industry of the Ukrainian SSR and Realization of Scientific Developments"]

[Text] In the years of the Eighth and Ninth Five-Year Plans the increase in coal extraction in the Ukraine was primarily achieved thanks to the improvement in labor productivity based on the technical re-equipping of the coal mines. In this period mechanized stoping complexes were created and introduced with special scope, which was the most prominent qualitative shift in the coal extraction equipment. The complexes became the basis for the technical re-equipping. Re-equipping of the breakage faces was accompanied by the use of new technical solutions in all links of the production chain of coal extraction.

However, with time an inevitable obsolescence occurs of both the equipment and the technology. In addition, the coal industry is characterized by negative shifts in the conditions of working mainly associated with the depth and with the reduction in output of the beds. The spread of mechanized complexes at the Donbass mines is accompanied by the involvement in working of beds with unstable wall rocks (9% of the longwalls in 1973, and 36% in 1978). The mining pressure, temperature, gas release into the drifts, number of vibration-dangerous beds and intensity of the sudden emissions of coal, rock and gas are increased with depth. To prevent the negative effect of these phenomena on the technical and economic indices of the mine operation qualitatively new scientific, technical and organizational solutions are needed. The purpose of the article is to present the possibilities for realization of such solutions in the Ukrainian mines in the next decade that are available in the arsenal of scientific, planning and design organizations.

Perfection of methods for preparing the mine fields and systems of working. An important link in guaranteeing the conditions of highly effective use of the equipment is the constant perfection in the spatial-planning solutions and regulation of the mining. Development of the preparation and systems of working the gently sloping and inclined beds occurs in a direction of transition towards more progressive methods of preparation, panel and layer-by-layer. The only restricting factor in the application of the layer-by-layer method is the angle of incidence of the beds. Currently a highly effective utilization of such preparation with stripping of the beds by upwalls (downwalls) is attained with angles of incidence to 6° (maximum to 8°).

Fulfillment of work by scientific research and planning-design organizations to modernize the excavation complexes of equipment for their use in excavating coal by upwalls (downalls) on beds with angle of incline to 12-18° will permit a considerable expansion in the volume of the layer-by-layer method of preparation (complex KM-87 in a new layout of the equipment, etc.).

In 1978 the columnar system of working was responsible for about 70% of the total coal extraction. The transition to columnar systems in past years in many cases was accompanied by an increase in coal losses in the inter-longwall blocks, and at deep layers the spatial-planning solutions with preservation of the drifts in blocks become ever more inefficient. Such preservation results not only in an increase in coal losses in the depths, but also in a rise in the volume of drifts made, causes increased danger of gas-dynamic phenomena, collapse of the longwalls and drifts in the zones of influence of the blocks left in the neighboring beds, complicates transportation and increases the gas abundance of the excavation sections.

Broad realization of the recommendations [1] prepared by Donugi [Dontesk Scientific Research Institute of Coal] will begin in the mines in 1980. For complicated mining and geological conditions block-free systems of preparation and stripping the excavation fields have been worked out, two of which are presented in figure 1.

The realization of joint scientific developments of Donugi and VNIMI [All-Union Scientific Research Institute of Mining Geomechanics and Mine Surveying] in the area of utilization of protective beds will promote the further improvement in the spatial-planning solutions and increase in the safety of working formations that contain beds prone to sudden emissions of coal and gas. In long-term plans [2] a specific definition is given for each mine of the order (sequence) of stripping the beds in the formation based on their relative danger for emissions, the completeness of the protection, and the extant state and outlook for development of the mining operations.

On the whole the set of measures to improve planning, order of conducting work and broad realization of scientific developments will permit:

the volume of application of the panel and layer-by-layer method of preparing gently sloping and inclined beds respectively to be brought to 49 and 35%;

an increase in the percentage participation of the columnar system of working in the total coal extraction to 81%;

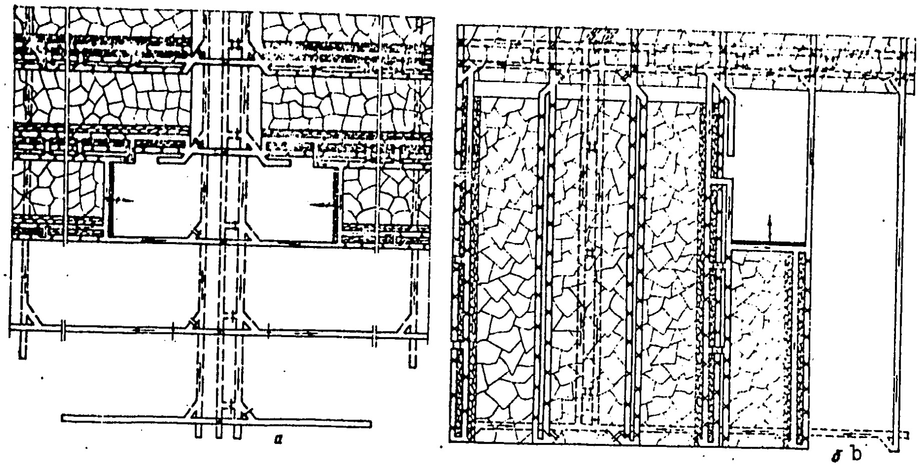

Figure 1. Method of Working Bed by Long Columns along the Spread (a) and Uprise (b) with Making of Air-Feeding Drifts in the Section, and Ventilation Drifts after the Longwalls That Guarantees Direct-Flow Ventilation of the Excavation Sections with Freshening of the Issuing Air Stream

a guarantee in stripping roughly 60% of the excavation sections according to the block-free plans;

an increase by more than 2-fold (as compared to 1975) in the number of breakage faces in the explosion-dangerous beds to be stripped under complete protection.

Mechanization of Work in Breakage Faces

The primary coal extracting machines at the mines of the Ukrainian SSR Ministry of the Coal Industry are the complexes KM-87, KMK-97 and "Donbass" that were made 10-15 years ago. The area of their effective use that covers beds with favorable mining and geological conditions has been practically exhausted. A further increase in the volume of use of the complexes will result in an impairment in the technical and economic indices of their operation. The real lowest limit of use of these complexes is with bed thickness 0.9-0.95 m with a hanging wall not lower than the average stability. It needs to be remembered that in 10-12 years the level of complex mechanization of the stoping operations will reach 85%, while the level of extraction by the resources of machine extraction 15%. Therefore complexes must be set up and introduced almost for all the mining and geological conditions (thin beds, unstable hanging wall, steep beds).

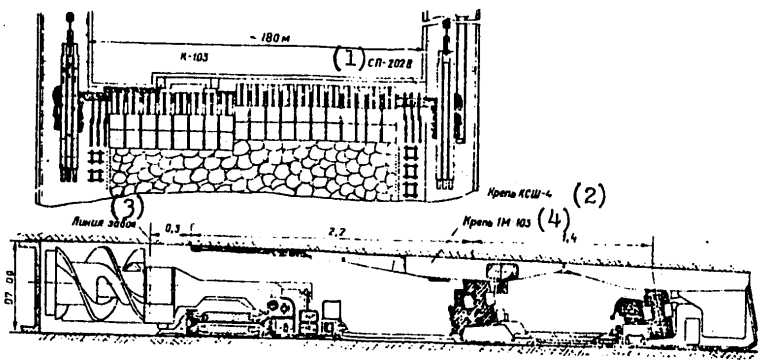

Figure 2. Complex of Equipment 1KM-103

Key:

1. SP-202 V
2. Timbering KSSh-4
3. Line of face
4. Timbering 1M-103

Donugi in cooperation with the planning and design institutes is engaged in creating a new generation of machines that will permit a significant change in the volume and indices of mechanized excavation. In 1979-1980 tests will be made on the complexes KD-80 and KM-103 (fig 2) designed for excavation of gently sloping beds with thickness no less than 0.8 and 0.7 m with a broader range of mining and geological conditions than "Donbass" and KMK-97. Mine tests have started on the complex "Zapadnyy Donbass" (fig 3) that should provide effective operation with unstable hanging walls.

A promising trend in mechanization of excavation of very thin and thin beds is acceleration of work on developing grading units of a new generation--SO-75, SN-75 and USV that are distinguished by high degree of power supply and permit effective working of beds with great resistance to cutting. In addition, development is underway of a KTSCh type complex and updating of the UST-2a grading unit designed for excavating very thin beds. In the immediate years their series production and introduction at the mines is planned. The area of spread of individual means of securing the breakage faces remains fairly vast. Donugi has suggested a complex program for creating individual metal timberings for the breakage faces.

Changes will also take place in the equipment for transporting the coal along the longwall. There will be an increase in the delivery to mines of basic scraper conveyers with flat-top drive heads that permit elimination of excavation of the niches with lower undermining of the drift adjacent to the longwall in combination with self-notching combines. At the Dzerzhinskiy

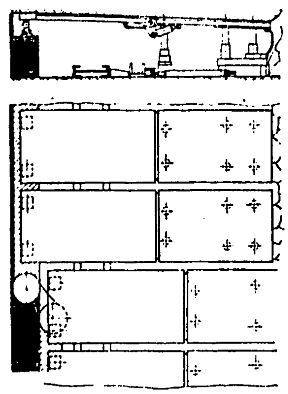

Figure 3. Coal-Extracting Complex "Zapadnyy Donbass"

mine of the association Donbassantratsit a horizontally-closed scraper conveyer with load height 150 mm is passing mine tests. The end sections of the conveyer have the same height as the linear and do not obstruct movement of the combine along it, by which excavation of the niches is eliminated. The institute has made a niche-excavating machine with whose help the question of reducing labor-intensity of niche-excavation must be solved before the mass appearance of the self-notching combines.

The mechanized timberings of conjugation KSU have been introduced at 120 breakage faces. Based on this timbering Donugi has made a timbering of more advanced design, RAD-1.

In order to improve the efficient operation of the mechanized complexes in the longwalls with main timbering that is difficult to collapse preliminary weakening of the rocks is being successfully used by means of advance torpedoing as a consequence of which the conditions of excavation are significantly simplified, and clamping of the timbering sections in the process of setting the timbering is not observed. Advance torpedoing is being used at 32 excavation sections. It has permitted an increase in the load on the longwall on the average by 30%, doubling of labor productivity, and reduction in the net cost of 1 T of coal by 80%. According to annual computations this method can be employed in 50 faces.

Considerable reserves of coal extraction are contained in the use of equipment and in quality repairs. Donugi has executed and transferred to the production associations a number of developments for the comprehensive perfection in technical servicing and maintenance of equipment whose introduction will make it possible to considerably increase the level of this work at the mines. The periodicity of technical servicing and repair has been scientifically substantiated depending on the actual operating time of the equipment and the operating conditions, and on the necessary outlays of time and labor for their execution.

The main means of stoping excavation of coal at the mines with steep beds in the near future will be the narrow-coverage combines of the KND type and "Poisk." The mechanized KGU timbering for steep beds with thickness 0.6 m is being produced in series. In the future this timbering will be perfected. A program has been compiled for modernization that includes improvement in the timbering supports, collapse guards, systems of dust-suppression, attachment of the combine to the timbering, etc. Questions of active buttressing during movement of the timbering and guarantee of its automated remote control are in the stage of resolution. Series output of the KGU-D timbering is planned for start in 3 years. Starting in the same period it is planned to manufacture mechanized complexes with remote control KG to excavate steep beds 0.6 m thick with weak side rocks; their output is 500-600 T per day. The use of heading aggregates ANShch of type-size 1 (15-20 longwalls additionally) will be expanded. It should be noted that the creation of resources for working steep beds has not been comprehensively solved. There are no means of excavating and securing the assembly niches, means for mechanizing the assembly of aggregates, effective means of making and securing the coal-descent crosscuts, etc. As a result the daily load on the aggregate is 180-190 T (400-600 T is possible). Donugi jointly with the Dongiprouglemash, Avtomatgormash and the IGTM of the Ukrainian SSR Academy of Sciences [expansion unknown] are working on the production of a unified heading aggregate.

The delivery of the timbering lumber to the longwall is very labor-intensive at the steep beds. The introduction of the mechanized units developed in Donugi for this purpose will permit 600 people to be released.

Making and Maintenance of Mining Drifts

The level of combine-making of drifts is 22%, and in 5-7 years it is planned to bring this to 40% thanks to the introduction of the 4PP-2 and KN combines. The main trend in improving the technical and economic indices for making preparatory drifts is the creation of tunneling combines for operation on rocks with hardness 6-10 which should provide no less than average rates of driving of 150 m per month.

Despite the annual increase in the volumes of making drifts by combines the drilling and blasting method still remains the dominant. Loading machines of type EPM-2, PML-5 and UP-3 will be replaced by machines 1PNB-2 and 2PNB-2 with side coverage, as well as the bucket machine 1PPN-5 and PPN-1s. The drilling technique will also be qualitatively altered.

Taking into consideration that the loading machines 1PHB-2U made for drifts with angle of incline over 10° are not produced in series, and for angle above 18° there are none at all, the Donugi has updated the PNB and PPM-4U machines for making drifts at an angle up to 25°.

Due to the intensification in coal excavation in longwalls and increase in the depth of working questions of securing and protecting the mining drifts acquire ever greater importance. In the years of the Ninth and 10th

Five-Year Plans the labor-intensity of maintaining the drifts was reduced by 33%, frequency of their re-timbering in a year--by 11%. The scientific research of Donugi makes it possible to substantiate and in the future to confirm the possiblity of repair-free maintenance of the drifts. In order to attain such a technical goal special timberings were developed with directed design pliability to 1000 mm. These are metal arched timberings AP-5 and AKP-5 for drifts on gently sloping beds, special form of timbering PAK and KPK for drifts on steep beds, the pliable timbering of rectangular section of increased load-bearing capacity 20-25 T-f/m^2. A special low-alloy steel has been developed that permits a reduction in the metal-consumption of the timbering by 15% and a considerable increase in its load-bearing capacity.

The provision of stability of the drifts occupies an important place in the general complex of mining preparatory work. Ever greater use is being made of discharge of the solid mass interfering with the working, protection of drifts with double rubble belts of variable density and belts made of fast-hardening materials that will be further developed.

The question of leaving rocks in the mine requires special examination from the viewpoint of increasing the effectiveness of operation of the mines and reduction in its negative effect on the environment during storage on the surface. On the Donbass territory about 2 billion T of rock have already been accumulated. At the same time the blocking up of the worked space would promote the solution of such technical problems as the finishing off of beds with unstable interfering rocks, working of beds at great depths, excavation of enormous supplies of coal preserved under rocks and working settlements, etc. Positive results have been obtained with the use of crushing-blocking complexes "Titan."

Donugi jointly with the Kopeysk Kirov Machine Plant, Giprouglemash and other organizations have developed the technology and KSV set of equipment for making paired drifts with advance common coal face and blocking of the worked space between them with rock (fig 6). Starting in 1981 series production of the KSV is planned. The application of one complex will permit up to 40,000 T of rock per year to be left in the mine. With coal excavation by the BUG type units the rock obtained from making the drifts is blocked-up in the wells by worm conveyers during their extraction. One unit leaves up to 20,000 T of rock per year in the mine.

Ventilation of Mines

Donugi has made a number of scientific searches directed towards solving the tasks of neutralizing the negative effect of unfavorable mining and geological and mining engineering factors. A basically new method has been developed for ventilating the excavation sections that makes it possible to overcome the gas barrier, to have a load on the longwall over 1000 T per day with respect to the gas factor, and to simultaneously improve the safety of the work. The method is based on individual dilution and removal by streams of hazards (methane, dust, heat) according to the sources of their release and entrance into the atmosphere. The efficient magnitude of depression is one of the important parameters on which the effectiveness of utilization of the resources invested in the construction of coal enterprises depends to a considerable degree. The institute has suggested a technique for establishing the efficient amount of depression of coal mines with regard for the set of factors that determines it on the principle of improving the indices characterizing the safety of the work and the sanitary-hygienic conditions. Donugi jointly with Giproshakht [State Institute for Planning of Mines] has suggested a plan (fig 7) that lacks insulating ventilation structures, and consequently, leaks of air into the underground drifts. During the five-year plan it is planned to triple the volume of introduction of new plans of ventilation. In the plans for construction and reconstruction of mines effective plans of ventilation with optimal parameters, including an efficient amount of depression are widespread.

At the mines typical mechanized and automated sluice devices and their technological plans almost for all mining and geological conditions of the basin in drifts with any means of transportation will be introduced. These devices will promote an improvement in the ventilation of underground drifts and will improve the labor safety.

In the process of working gas-bearing beds of Donbass it has been established that the attainment of high loads on the breakage face is impossible without taking a set of measures for controlling methane, including degasification. Donugi has conducted studies, experimental-industrial verification and introduction at 14 mines of the Ukrainian SSR Ministry of the Coal Industry of the method of degasification of the bed with hydraulic separation through wells drilled over the bed from the drifts. The efficiency of the method reaches 70%. For example, at the mine "Almaznaya" of the association Donbassantratsit the use of this method in two longwalls has made it possible to increase the load from 700 to 1300 T per day. At the mine "Vergelevskaya" of the association Stakhanovugol' hydraulic separation has made it possible to remove the load limitation with respect to the gas factor. However for the broad introduction of the method specialized sections should be set up for hydraulic separation during the expeditions of the association Ukrgeoligya to duplicate the sections of control of Spetsshakhtomontazhdegazatsiya functioning in the Karagandinsk basin.

In the space of 5-7 years it is planned to mainly complete work on normalization of the thermal conditions in the deep mines of the Donbass. Solutions are planned that guarantee the maintenance in the mines of the normal thermal conditions, and a program for the material supply of the mines in solving this problem.

Underground Mine Transportation

The technical re-equipping of transportation has been implemented by installing conveyers for delivery along the horizontal and inclined drifts, introduction of haulage by powerful locomotives with the use of heavy-freight cars, and mechanization of the auxiliary transport. All of this has led to a rise in the number of faces with continuous transportation (up to 74%), to an increase in the level of conveyerization on the horizontal (up to 19.1%) and inclined (up to 53.4%) drifts, and to an improvement in output of the electric locomotives to 17,400 T·km per month.

As the main trend in the further development of underground transportation the task is advanced of perfecting the production plans of the main and auxiliary types of transportation in order to create at the mines efficient plans for transporting rock, materials, equipment, and especially moving people. It is planned to perfect the production plans of transportation at 74 mines of Donbass that have operational supplies of coal for 10 and more years, based on regulation of the mining operations, growth and concentration in the underground cargo traffic, and the maximum use of the technical potentialities of the series-manufactured transportation equipment. The high effectiveness of work in this direction is indicated by the experience of reconstructing the production transportation plan in the Chelyuskintsy mine of the Donetskugo' association where the equipment with cage elevation of the air-feed column permitted elimination of two stages of transportation of people and reduction in the duration of transfer of workers from 70 to 25 minutes. At the mines of the Ukrainian SSR Ministry of the Coal Industry the line technology of coal transportation will be further spread, including rail with the use of modern designs of storage battery electric locomotives ARP-14 and ARP-10 with thyristor control, sectional trains PS-3.5 and PS-1.5, and self-unloading cars VD-2.5 and VD-1.5. Work will be finished on mastery of the series production of a number of new and efficient transportation equipment: high-frequency electric locomotives V-14, mining diesel locomotives D-8, explosion-proof storage battery electric locomotives ARV-7, telescopic belt conveyers, etc. The broad introduction of this equipment will permit the replacement of obsolete electric locomotives AM-8 and 5ARV, the belt conveyers KIA-250 and KL-150, etc. The planned program of technical re-equipping of the underground transportation will make it possible in 7 years to bring the level of conveyerization of the horizontal drifts to 26%, the inclined drifts to 93%, and the output of the electric locomotives to 23,000 T·km per month.

Surface of Mines

More than 20% of the industrial workers of the total number are engaged on the surface of the mines, and the percentage of manual labor here exceeds 40%. During the years of the Ninth Five-Year Plan and the 3 years of the 10th the institute has prepared the scientific and technical base for perfecting a number of processes on the surface of the mines. Production plans have been formulated for exchanging and haulage of the cars in the above-mine buildings, purification of the mining mass from oversizes and foreign objects, and formation of flat rock dumps. Basic research has been conducted on the creation of basically new machines on linear induction engines. Equipment has been put into series production for mechanization of work on the exchange complexes--aggregates, pushers, interchange platforms, on-route stopping devices, etc. This will permit elimination of the gravity haulage and implementation of forced movement of cars on the path of their motion. Based on generalization of the leading experience and the set of studies advanced production processes have been developed for the warehouse processing of the timber, a number of standard-method materials have been prepared for planning and operation of timber warehouses, and over 10 types of equipment have been produced for mechanization of the warehouse operations (stacking unit, complexes and machines for longitudinal sawing of supports and a set for transverse sawing, timber feeder, timber kicker, timber-sorting unit, and others). The principles of continuity of the timber processing, packaging of the timbering materials and comprehensive mechanization of the warehouse processes have been placed in the production plans of the timber warehouses and the timber-finishing shops.

In 1971-1978 on the surface of the mines about 2000 units of production hoisting-transporting and timber-finishing equipment was introduced. There was a double reduction in the specific weight of the heavy manual labor at the main loading-unloading operations, and a number of processes were mechanized for haulage of the cars, loading the coal, timber and material warehouses. At the same time, the state of the mine surfaces in the republic according to the level of mechanization, technical equipping and employed technology still does not meet the requirements of accelerated technical re-equipping of the mines. This is explained by the low rates of reconstruction of the production complexes, centralization of the auxiliary services, construction of objects of material-warehouse facilities and insufficient volumes of production of new and delivery of series equipment.

Quality of Extracted Coal

Donugi is conducting scientific research and experimental work directed towards creating and introducing a complex system for controlling the quality of the extracted and shipped coal, measures for reducing its ash content and improving the grade, as well as systems and means of technical quality control. Model techniques for construction and functioning of the compressor station of the unit of complex preparation of the mine, the compressor station of the unit of complex preparation of the association [3, 4] and a number of other method manuals including drafts of primary (general) standards of the enterprises covering planning, standardization and quality control, evaluation of the quality of labor, and information supply have been formulated and given to all the mines. The introduction of the standards will permit in 1980 completion of the first stage in work to create a compressor station of the unit of complex preparation at five orientation mines and to spread their experience to others.

The set of work on radical reorganization of technical control of the coal ash content at the mines with use of automatic ash meters has permitted development of a computer system VSKZ that affords continuous and automatic measurement of the coal ash content coming from the mine without taking, preparing and analyzing samples. Jointly with the Skochinskiy

Mining Institute an ash content rapid analyzer EAZ has been developed with whose help one can analyze coal of the class 0-25 mm without additional sample preparation. The EAZ and VSKZ instruments have been introduced at three mines of the association Donetskugol' and at mine No 3 "Velikomost-ovskaya" of the association Ukrzapadugol'. For the first time in domestic practice the production plan of automatic ash content control and charging of the shipped coals has been used at the Skochinskiy mine.

In the immediate years it is planned to introduce into practice of planning coal extraction and other primary technical-economic indices the optimization methods with use of a computer. A system of control over the net cost of coal will be introduced with the use of modern computer equipment, as well as the recommendations of Donugi for the pattern of production, work and rest of the miners, and the results of the finished work to create and renew the extant standards for material and technical supply of the branch. The broad industrial spread of scientific and technical developments will promote the attainment of the planned goals: increase in the level of comprehensively mechanized coal extraction to 67%, making of drifts with combines to 38%, use of advanced methods of working (column and combines) to 90%, and improvement in other technical and economic indices of the work of the work of the coal industry of the Ukrainian SSR.

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FUELS

UKRAINIAN COAL INDUSTRY NINE MONTH PRODUCTION RESULTS

Kiev UGOL' UKRAINY in Russian No 12, Dec 79 pp 42-43

[Article: "Ukrainian SSR Coal Industry for 9 Months of 1979"]

[Text] The miners of the republic in 3 quarters of 1979 have brought to the surface 155.3 million T of coal which is 97.9% of the plan. The miners of the associations Donetskugol' (9-month plan of coal extraction fulfilled by 102.9%), Ordzhonikidzeugol' (103.1%), Torezantratsit (104.2%), Voroshilovgradugol' (101.7%), and Pavlogradugol' (100.5%) have labored successfully. The collectives of 29 mines, 184 sections, 352 brigades and over 4800 cutters have reached high indices, and even before Miner's Day they finished ahead of schedule the 4-year plan for coal extraction, and are aiming in the final year of the five-year plan to make new advances in the competition for the worthy meeting of the 110th anniversary of V. I. Lenin's birth. The leading tunneling collectives labored well on fulfilling the important task of timely preparation of the front of stoping work. However, a number of collectives in the associations,mines and sections did not cope with the coal extraction plans. Table 1 presents the main mining engineering indices for the coal industry of the republic, while table 2 gives data on the work of the complex-mechanized breakage faces equipped with combines and graders on beds with angle of incidence to 35°. The number of such faces has risen as compared to the plan by 17 units, and from them 76.1 million T of coal have been extracted with daily average load 623 T. Sixty-three longwalls with individual timbering were equipped with grading units on beds with angle of incidence to 35°, from them 4.6 million T of coal were extracted with daily average load on the breakage face 278 T. In the mechanized faces on beds with angle of incidence over 35° about 2.2 million T of coal were extracted with daily average load on the breakage face 181 T.

A lot of attention was focused on the development of preparatory work and increase in the level of their technical equipping. The plan for conducting all preparatory drifts was fulfilled by the tunnelers of the republic by 100.5% (table 3), and the plan for making stripping and preparatory drifts--by 98%. Table 4 presents data on making the preparatory drifts with mechanized loading of the coal and rock, from which it is apparent that the actual volume of such drifts was lower than the planned, including with the

TABLE 1

Производственные объединения (1)	(2) Добыча угля, тыс. т	(3) Кол-во действующих очистных забоев	(4) Среднедействующая линия очистных забоев, км	(5) Среднемесячное подвигание действующих очистных забоев, м	(6) Суточная нагрузка, т: (7) на действующий забой	(8) на шахту-разрез (адм. ед.)
Донецкуголь (9)	16 208	173	33,52	29,4	331	2905
Макеевуголь (10)	11 506	138	22,37	30,9	312	2866
Красноармейскуголь (11)	10 540	76	12,98	42,0	471	3455
Добропольеуголь (12)	8 171	41	7,40	61,1	778	3576
Артемуголь (13)	8 308	203	23,74	28,9	137	2058
Орджоникидзеуголь (14)	4 608	99	10,98	31,2	173	1771
Шахтерскантрацит (15)	8 978	[illegible]	18,49	30,4	318	1838
Торезантрацит (16)	8 323	39	15,34	29,6	325	1927
Ворошиловградуголь (17)	8 855	72	12,31	40,3	437	3095
Стахановуголь (18)	6 869	116	19,14	25,5	220	1425
Первомайскуголь (19)	7 165	84	16,87	25,1	312	1764
Краснодонуголь (20)	6 623	55	7,93	45,4	462	2649
Донбассантрацит (21)	16 522	154	26,94	32,5	403	2751
Свердловантрацит (22)	6 890	36	6,39	54,2	652	2109
Павлоградуголь (23)	6 968	53	8,22	56,1	517	3085
Укрзападуголь (24)	11 362	98	12,83	46,8	492	2089
Александрияуголь (25)	7 865	12	1,01	61,5	818	4113
(26) Минуглепром УССР	155 236	1594	256,44	34,4	342	2438

Key:

1. Production associations
2. Extraction of coal, thous. T
3. Number of active breakage faces
4. Average active line of breakage faces, km
5. Average monthly advance of active breakage faces, m
6. Daily load, T
7. on active face
8. on mine-open pit (adm. unit)
9. Donetskugol'
10. Makeyevugol'
11. Krasnoarmeyskugol'
12. Dobropol'yeugol'
13. Artemugol'
14. Ordzhonikidzeugol'
15. Shakhterskantratsit
16. Torezantratsit
17. Voroshilovgradugol'
18. Stakhanovugol'
19. Pervomayskugol'
20. Krasnodonugol'
21. Donbassantratsit
22. Sverdlovantratsit
23. Pavlogradugol'
24. Ukrzapadugol'
25. Aleksandriyaugol'
26. Ukrainian SSR Ministry of the Coal Industry

use of rock-tunneling combines. However, as compared to the indices for 9 months of 1978 the level of combine tunneling rose by 1.8%. Today almost a quarter of the volume of all drifts where loading is required are tunneled with the help of combines.

There was a considerable rise in the number of tunneling brigades who make drifts by high-speed methods. Whereas in 1978 there were 183 of them, in 1979 there were already 211, i.e., the increase was 15.3%.

TABLE 2

(1) Производственные объединения	(2) Комплексно механизированные забои, оборудованные комбайнами и стругами, на пластах с углом падения до 35°			
	(3) Кол-во	(4) Добыча, тыс. т	(5) Уровень, %	(6) Нагрузка на лаву, т
Донецкуголь (7)	50	7262	46,3	596
Макеевуголь (8)	39	5808	54,8	618
Красноармейскуголь (9)	52	6240	70,5	533
Добропольеуголь (10)	32	6238	82,6	891
Шахтерскантрацит (11)	20	2342	26,9	452
Торезантрацит (12)	44	4773	63,7	498
Ворошиловградуголь (13)	28	4563	60,6	698
Стахановуголь (14)	16	1565	26,8	437
Первомайскуголь (15)	17	2249	36,7	570
Краснодонуголь (16)	30	4828	89,0	664
Донбассантрацит (17)	44	7245	47,4	676
Свердловантрацит (18)	33	6065	94,7	732
Павлоградуголь (19)	51	6201	93,3	561
Укрзападуголь (20)	60	8522	77,5	635
Александрияуголь (21)	10	2205	100,0	818
(22) Минуглепром УССР	525	76106	60,6	623

Key:

1. Production associations
2. Complex-mechanized faces equipped with combines and graders, on beds with angles of incidence to 35°
3. Number
4. Extraction, thous. T
5. Level, %
6. Load on longwall, T
7. Donetskugol'
8. Makeyevugol'
9. Krasnoarmeyskugol'
10. Dobropol'yeugol'
11. Shakhterskantratsit
12. Torezantratsit
13. Voroshilovgradugol'
14. Stakhanovugol'
15. Pervomayskugol'
16. Krasnodonugol'
17. Donbassantratsit
18. Sverdlovantratsit
19. Pavlogradugol'
20. Ukrzapadugol'
21. Aleksandriyaugol'
22. Ukrainian SSR Ministry of the Coal Industry

In the 9 months of 1979 at the enrichment plants of the Ukrainian SSR Ministry of the Coal Industry 100.87 million T of coal were processed which is 98.2% of the plan and 101.4% of the level of the comparable period. There were 60.06 million T of concentrate produced, 18.53 million T of coal of large and medium classes, including 13.42 million T of anthracites; 8.32 million T of coal were processed on the units of mechanized sorting. The plan for production of the coal briquets was overfulfilled, and the plan for output of lignite briquets was underfulfilled.

On the whole the plan for realization of the products of the industry in wholesale prices was mastered by 96%, the plan for labor productivity of the worker for extraction by 96%. The highest indices in the socialist

TABLE 3

Производственные объединения (1)	(2) Проведение подготовительных выработок					
	(3) всех			(4) вскрывающих и подготавливающих		
	(5) План, км	(6) Факт., км	(7) % к плану	(5) План, км	(6) Факт., км	(7) % к плану
Донецкуголь (8)	223,8	225,1	100,6	160,7	162,6	101,2
Макеевуголь (9)	163,9	164,3	100,2	112,7	112,8	100,0
Красноармейскуголь (10)	127,7	125,1	98,0	113,1	105,4	93,1
Добропольеуголь (11)	135,6	145,2	107,1	92,6	93,6	101,0
Артемуголь (12)	244,4	246,8	101,0	123,9	123,9	100,0
Орджоникидзеуголь (13)	91,8	99,0	107,8	54,2	54,6	100,7
Шахтерскантрацит (14)	110,0	111,3	101,2	72,5	71,7	98,9
Торезантрацит (15)	99,3	104,4	105,1	64,8	67,1	103,5
Ворошиловградуголь (16)	131,5	136,2	103,6	73,8	75,4	102,2
Стахановуголь (17)	160,7	154,6	96,2	92,5	88,2	95,3
Первомайскуголь (18)	122,5	110,6	90,3	86,9	75,8	87,2
Краснодонуголь (19)	92,7	94,7	102,2	63,4	62,2	98,1
Донбассантрацит (20)	205,4	201,9	98,3	111,5	108,5	97,3
Свердловантрацит (21)	81,1	82,7	102,0	55,5	54,8	98,7
Павлоградуголь (22)	89,8	88,2	98,2	86,1	81,7	94,9
Укрзападуголь (23)	104,9	105,8	100,9	90,3	91,3	101,1
Александрияуголь (24)	21,3	21,3	100,0	21,6	19,5	90,3
(25) Минуглепром УССР	2206	2217	100,5	1478,2	1449,1	98,0

Key:
1. Production associations
2. Conducting of preparatory work
3. all
4. stripping and preparatory
5. Plan, km
6. Actual, km
7. % of plan
8. Donetskugol'
9. Makeyevugol'
10. Krasnoarmeyskugol'
11. Dobropol'yeugol'
12. Artemugol'
13. Ordzhonikidzeugol'
14. Shakhterskantratsit
15. Torezantratsit
16. Voroshilovgradugol'
17. Stakhanovugol'
18. Permovayskugol'
19. Krasnodonugl'
20. Donbassantratsit
21. Sverdlovantratsit
22. Pavlogradugol'
23. Ukrzapadugol'
24. Aleksandriyaugol'
25. Ukrainian SSR Ministry of the Coal Industry

competition of the fourth year ofthe 10th Five-Year Plan were attained by the leading extraction brigades of A. A. Asyutchenko (mine imeni "Sotsialisticheskiy Donbass" newspaper), A. D. Polishchuk ("Trudovskaya"), P. A. Kaminskiy ("Burtovka-Donetskaya"), V. N. Pikhterev (imeni Abakumov), G. Ye. Abramov (mine/administration "Butovskoye") and others.

Among the tunneling collectives who reported fulfillment ahead of schedule of the plans for the 4 years of the 10th Five-Year Plan are the brigades of N. Ye. Stepin (mine "Krasnolimanskaya"), D. G. Khomich ("Chervona zirka"), I. P. Kushnarev ("Removskaya") and V. Ye. Trofimov (mine/administration ("Aleksandrovskoye").

TABLE 4

Производственные объединения (1)	(2) Проведение подготовительных выработок с механизированной погрузкой угля и породы				
	(3) План, км	(4) Факт., км	(5) % к общей длине проведения выработок, где требуется погрузка	(6) в т. ч. комбайнами (3) План, км	(4) Факт., км
Донецкуголь (7)	177,0	177,0	78,6	62,6	60,0
Макеевуголь (8)	116,0	116,4	74,2	36,0	38,9
Красноармейскуголь (9)	93,2	94,2	75,3	31,7	30,0
Добропольеуголь (10)	127,4	138,7	95,5	88,6	97,6
Артемуголь (11)	120,5	118,1	100,0	9,5	4,6
Орджоникидзеуголь (12)	51,5	51,6	88,1	2,1	0,3
Шахтерскантрацит (13)	71,4	69,4	62,4	17,1	18,3
Торезантрацит (14)	63,0	66,1	64,1	6,4	3,7
Ворошиловградуголь (15)	92,6	93,7	79,1	18,1	18,9
Стахановуголь (16)	109,1	108,9	81,8	3,9	2,9
Первомайскуголь (17)	85,5	66,7	63,5	11,5	8,3
Краснодонуголь (18)	66,9	64,8	85,4	17,3	15,4
Донбассантрацит (19)	106,2	93,5	53,3	9,2	6,4
Свердловантрацит (20)	53,4	52,9	64,0	3,6	0,8
Павлоградуголь (21)	89,5	85,7	97,4	85,0	83,3
Укрзападуголь (22)	86,9	85,0	80,3	49,5	49,5
Александрияуголь (23)	19,9	17,0	84,0	19,9	17,9
(24) Минуглепром УССР	1530,0	1498,8	77,9	472,0	456,8

Key:
1. Production association
2. Making of preparatory drifts with mechanized loading of coal and rock
3. Plan, km
4. Actual, km
5. % of total length of making drifts where loading is required
6. including by combines
7. Donetskugol'
8. Makeyevugol'
9. Krasnoarmeyskugol'
10. Dobropol'yeugol'
11. Artemugol'
12. Ordzhonikidzeugol'
13. Shakhterskantratsit
14. Torezantratsit
15. Voroshilovgradugol'
16. Stakhanovugol'
17. Pervomayskugol'
18. Krasnodonugol'
19. Donbassantratsit
20. Sverdlovantratsit
21. Pavlogradugol'
22. Ukrzapadugol'
23. Aleksandriyaugol'
24. Ukrainian SSR Ministry of the Coal Industry

The planned volume of state capital investments was assimilated on the whole for the Ukrainian SSR Ministry of the Coal Industry by 96%, including the plan for construction-installation work by 97%; for the facilities of production purpose the plan for assimilation of capital investments was fulfilled by 98%, including the plan of construction-installation work by 99%.

In the 9 months of 1979 growth in the production output for extraction by 1.570 million T per year was provided. The mine "Zapadno-Donbasskaya" No 6/42 of the association Pavlogradugol' was put into operation with planned output of 1.500 million T of coal per year. The mine "Krasnyy partizan" of the association Sverdlovantratsit was reconstructed with an increase in the annual output of 70,000 T of coal.

9035
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FUELS

SEVENTY-FIFTH BIRTHDAY OF SERGEY ANDRONIKOVICH VOLOTKOVSKIY

Kiev UGOL' UKRAINY in Russian No 12, Dec 79 p 44

[Article: "Seventy-fifth Birthday of Sergey Andronikovich Volotkovskiy"]

[Text] On 23 January 1980 the eminent Soviet scientist in the area of electrification and automation of the mining industry, Doctor of Technical Sciences and honored scientist and technician of the Ukrainian SSR Sergey Andronikovich Volotkovskiy, professor in the department of electrification of mining operations and industrial enterprises of the Dnepropetrovsk Mining Institute will celebrate his 75th birthday and 60th anniversary of production, scientific-pedagogical and social activity.

S. A. Volotkovskiy after finishing the Dpenpropetrovsk Mining Institute in 1930 stayed for scientific and pedagogical work in the department of mining electrical engineering. From 1930 to 1941 S. A. Volotkovskiy worked in the DGI [Dnepropetrovsk Mining Institute] first as an assistant, then associate professor. In 1935 he was awarded the scientific degree of candidate of technical sciences.

During the years of the Great Patriotic War S. A. Volotkovskiy labored in the Urals as the chief mechanic of the mine and the head of the TsEMM [Central Electromechanical Shops] of the trust Egorshinugol'. In the space of 15 years (from 1944 to 1959) he led the department of mining electrical engineering in the Sverdlovsk Mining Institute. In 1950 Sergey Andronikovich defended his doctoral dissertation, and in 1959 switched to the DGI where until 1976 he headed the department of electrification of mining operations and industrial enterprises.

During the years of his activity S. A. Volotkovskiy received 34 certificates of authorship and published over 360 scientific works, including 34 textbooks, educational manuals and monographs on electric drive, automatics and remote control, mining transportation, quarry excavators, on electrification and automation of mining operations. A number of books and scientific articles were published abroad.

Starting in 1934 S. A. Volotkovskiy began to engage in studies on the questions of mining electric locomotive traction, and developed new methods for rating the traction networks of mines and quarries. In the Dnepropetrovsk Mining Institute he created a scientific school for the mining electric locomotive traction. On the initiative of Sergey Andronikovich the DGI set up a branch scientific research laboratory of electrical safety at mining enterprises.

S. A. Volotkovskiy, member of the CPSU since 1927 takes active part in the social life of the institute, and since 1971 has headed the Dnepropetrovsk oblast organization of the Ukrainian society for preservation of the monuments of history and culture, and is the responsible editor of the interdepartmental republic scientific and technical collection "Gornaya elektromekhanika i avtomatika" [Mining Electromechanics and Automatics], as well as a member of the editorial staff of the journal IZVESTIYA VUZOV. GORNYY ZHURNAL.

S. A. Volotkovskiy was awarded the Orders of Lenin and "Badge of Honor," four medals, the breastplates "Miner's Glory," and he was given the title of Honored Miner and Honored Scientist and Technician of the Ukrainian SSR. For services to the Komosomol he was awarded the Honorable Certificate of the Komsomol Central Committee.

Professor S. A. Volotkovskiy has been teaching in the higher educational institutions for over 50 years. He has educated a generation of scientists and specialists of high qualification.

We warmly congratulate Sergey Andronikovich on his anniversary and wish him good health and new creative successes.

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END