# NATIONAL INTELLIGENCE SURVEY

# U.S.S.R.

## ELECTRIC POWER

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*This Section 62P supersedes the material on Electric Power in the Section 62, dated September 1963.*





## FIGURES





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25X1

## GLOSSARY

| ABBREVIATION | RUSSIAN | ENGLISH |
|---|---|---|
| GRES | *Gosudarstvennaya rayonnaya elektricheskaya stantsiya* | State regional electric powerplant |
| TET | *Teplovaya elektricheskaya tsentral'naya stantsiya* (also *Teploelektrotsentral'*) | Heat and electric central powerplant |
| TES | *Teployaya elektrostantsiya* | Thermal electric powerplant |
| GES | *Gosudarstvennaya elektricheskaya stantsiya* | State electric powerplant |
| GES | *Gidroelektricheskaya stantsiya* (also *Gidroelektrostantsiya*) | Hydroelectric powerplant |
| AES | *Atomnaya elektrostantsiya* | Atomic electric powerplant |

# *Electric Power*

## A. General

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The electric power industry occupies a very prominent place in the economy of the Soviet Union and its development ranks as one of the country's more successful endeavors. Power production during 1966 is estimated as 544.6 billion kilowatt-hours (kw.-hr.), or 41% of that in the United States. At the end of 1966, the installed capacity of generating facilities reached 123 million kilowatts (kw.), equivalent to 46.2% of that of U.S. generating plants. The Soviets now boast the world's largest powerplants of both hydro and thermal types: the 4,050,000-kw. Bratsk GES (No. 311) hydroelectric station (FIGURES 1 and 26A and 26C) and the 2.4 million-kw. Dnepropetrovsk, Pridneprovskaya GRES (No. 138) thermal powerplant (FIGURE 17A).

The growth rate of power-generating facilities has consistently been greater than that of the U.S.S.R. economy as a whole. Virtually all factory machinery is electrically driven, and the use of electricity by metallurgical and processing industries is growing. In transportation, nearly half of all rail freight haulage and more than two-thirds of passenger movement is by electric traction.

In 1966 Soviet power production reached 2,323 kw.-hrs. per capita (approximately one-third of U.S. production, 6,660 kw.-hrs. per capita), but the proportion of power for residential consumers is far smaller in the U.S.S.R. than in most Western countries and there are greater regional variations in power availability.

Power facilities are better developed in the western parts of the country than in the outlying sections, which have smaller systems and individual powerplants operating in isolation. Development emphasis is being shifted to the Central Siberian and Central Asian regions where abundant sources of fuel and good hydropower sites offer the lowest power production costs in the country. Prospective developments in transmission technology will make it feasible to send power over the great distances which separate these regions from the centers of high demand in European U.S.S.R. and the Urals. At present, most areas of industrial concentration receive their power from groups of nearby interconnected powerplants, with larger generating stations situated between these groupings and linked to them by high-capacity powerlines. The Soviet Union is self-sufficient in power generation and in the planning and operation of its power systems, as well as in design and manufacture of power machinery. In 1966, the U.S.S.R. exported 1.6 billion kw.-hr.; virtually all went to the Communist countries of Eastern Europe. Although this is less than 0.3% of Soviet power production, it constitutes a significant addition for the recipient countries.

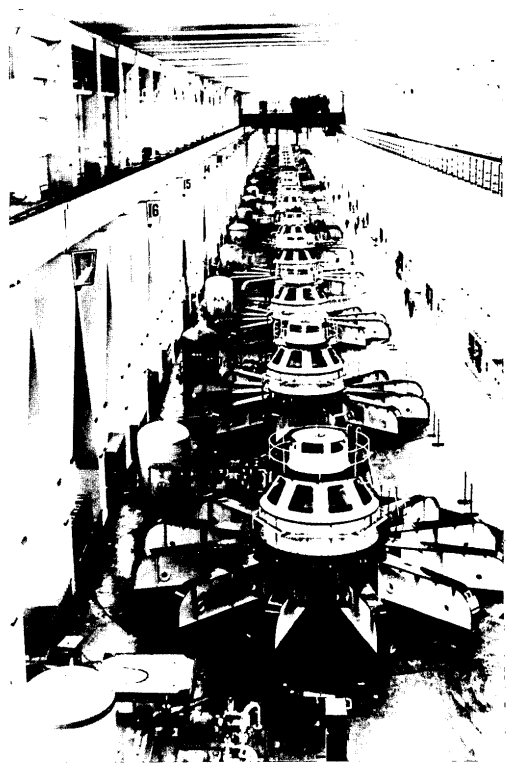

FIGURE 1. GENERATOR HALL OF BRATSK GES (No. 311). This hydroelectric station contained eighteen 225,000-kw. units at the end of 1966; two more units may be added.

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Ever since their assumption of authority, the Soviets have accorded favored treatment to the power industry in allocations of capital, materials, and personnel. The great differences in costing methodology between Soviet and Western nations preclude comparison of investments in the industry or of the income derived from it, but few other sectors of Soviet industry have physical plants that would compare as favorably with their U.S. counterparts. The industry is also well supplied with personnel. There are more than 1.5 million electric power industry employees. This number does not include an estimated 100,000 engaged in the construction of power equipment



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by other ministries. The principal labor problems appear to lie in shortages of highly skilled welders for boiler assembly, and of some categories of powerplant and transmission system operators. The Ministry of Power and Electrification has some capability for manufacturing equipment but the bulk of power machinery is built by the Ministries of the Electro-Technical Industry and of Heavy, Power, and Transport Engineering.

Vulnerability of the Soviet power industry varies greatly in different parts of the country. In highly developed areas of European U.S.S.R., the Urals, and West Siberia there are elaborate power networks and dependent industries which may be as vulnerable to disruption as those in the northeastern United States proved to be during the November 1965 power failure. In some cases, huge reservoirs at the larger hydroelectric stations constitute a potential danger to communities downstream. Vulnerability of the Soviet power transmission system is being increased by the trend toward construction of new generating plants in low-cost areas, necessitating transmission across great distances by means of easily damaged facilities. Vast reaches of the country, however, are served by scattered, small-scale power sources whose destruction would cause little disruption of the nation's economy.

## B. Organization of the industry

All U.S.S.R. facilities for generating and transmitting electric power are owned and operated by the government. The principal governmental body that administers the electric power industry is the Ministry of Power and Electrification. Its chief, Peter Stepanovich Neporozhnyy, is a member of the Council of Ministers of the U.S.S.R.

The primary function of the Ministry of Power and Electrification is to exercise control over all phases of planning, construction, operation, and maintenance of powerplants and transmission networks, and to regulate the exchanges of power among systems. This national ministry performs its tasks through subordinate bureaus and regional power administrations. Through its subordinate organizations, the Ministry supervises powerplants and systems comprising over 80% of the Soviet generating capacity and producing nearly 90% of the electric power output. Other generating plants are controlled by various ministries concerned with other industries, with transportation and agriculture, or by local authorities.

The Ministry of Power and Electrification supplies materials, technical equipment, and specialized construction crews to powerplant construction sites, and it is responsible for installing power equipment in newly constructed facilities. Other equipment and labor are supplied as needed at the republic or oblast administrative level. Construction of major transmission lines is handled in a similar manner. Operation of power grids and powerplants is supervised directly by the republic or oblast power authorities; construction of transmission lines of 110 kv. and less is also handled at this level. The Ministry of Power and Electrification provides technical and organizational direction for the operation of powerplants and controls supplies of fuel; however, the manufacture of electrical equipment is largely the responsibility of two other national organizations: the Ministry of the Electro-Technical Industry and the Ministry of Heavy, Power, and Transport Engineering. Although the Ministry of Power and Electrification does not govern the making of all power machinery, its research and planning staffs formulate recommendations on equipment design. Specific details concerning the Ministry's organization cannot be determined, but there are centralized entities for administration and finance, interregional planning and project design, and research and development.

The primary political units of the U.S.S.R., the associated republics, oblasts, and krays have their own electric power administrations that are subordinate to the national Ministry. These organizations are responsible for local electric power matters, such as extension of service to villages and collective farms, collection of payments for service, and the staffing of local power facilities. Where local power systems have been consolidated into larger networks, bureaus designated by region (such as Donbassenergo and Uralenergo) operate the facilities that link up the component parts of the larger system.

25X1

In late 1967, the Ministry of Power and Electrification had more than 1.5 million employees distributed as follows: 730,000 in operating power stations and transmission systems, 620,000 engaged in construction of new facilities, 87,000 in manufacturing, and about 60,000 in planning and scientific research. It is estimated that the ministries responsible for manufacturing the bulk of power equipment must have at least 100,000 workers employed on this phase of their operations. Supervision of the tens of thousands of small rural and isolated powerplants, often criticized as wasteful of personnel, has required the services of an estimated 200,000 to 300,000 additional persons.

The power industry is handicapped by shortages of semiprofessional personnel, technicians, and highly skilled labor; unskilled labor is plentiful. Most top-echelon men are well qualified engineers with long years of experience, but a lack of experience among lower-echelon engineers causes considerable difficulty in introduction of new technology and equipment. The shortage of qualified men is especially apparent in the fields of transmission line construction and equipment assembly. For the last 10 to 20 years the supervision of major construction projects has been the responsibility of a small number of top-level engineers, and little effort has been devoted to preparing new engineers to assume this leadership.

Training of power engineers, under the control of the Ministry of Power and Electrification, is carried out by five power and electro-technical institutes; the leading one is the Moscow Power Institute. Courses at these establishments run for 5 years, with 10 years of primary school as prerequisite. Job placements are the final decision of special committees set up by each institute.

Upon employment, engineers receive continued training in new techniques at individual power stations. It is believed that the Ministry of Power and Electrification also operates an academy for advanced training; the prerequisite for entrance is a diploma from one of the institutes plus 5 years experience in the electric power field. Engineering training is also available at 26 polytechnical institutes which give courses in power engineering, electrical engineering, steam power engineering, electromechanical engineering, and electric machinery building.

Training of technicians, also the responsibility of the Ministry of Power and Electrification, is carried out in 16 technical schools. Courses run for 4½ years, with 7 years of primary school required for entrance. Technical training is also available at many evening schools located at power stations and construction sites and through accredited correspondence courses. Training of skilled labor is controlled by an agency under the U.S.S.R. Council of Ministers. Courses are available at various establishments. Students with a 10-year background of primary schooling attend a 1-year course in order to qualify for such jobs as boiler or turbine operator and senior electrician; students with less primary schooling may attend a 2-year course to qualify for less responsible posts. It is noteworthy that women account for approximately one-third of the qualified labor force available to the power industry. Unskilled labor is easily obtainable from the general populace, and one of the leading suppliers is the Komsomol', or Soviet youth organization.

The government employs various incentives to attract qualified people to the power industry. Training is free and students receive subsistence allowances. Wages in the industry are relatively high, and longevity payments and special bonuses are added attractions.

Continued efforts are made to offset a large-scale diversion of engineers, technicians, and skilled labor from the production end of the industry to the management field. A high frequency of mechanical breakdowns, however, still points to incompetent handling of many production jobs. This situation is made worse by low-quality repairs and long periods required for repair work. The labor supply of the industry has been reduced also by diversion of numerous power construction specialists to projects not connected with the industry and to power projects outside the U.S.S.R. The effectiveness of the available working force is reduced further by constant revisions and changes to power facilities at new projects, even while construction is underway.

## C. Generating plant

### 1. General

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At the end of 1966, the total installed capacity of powerplants in the U.S.S.R. exceeded 123 million kw. This total consisted of almost 100 million kw. in thermal powerplants (including more than 1 million kw. in nuclear plants), and more than 23.1 million kw. in hydroelectric powerplants. In generating capacity the U.S.S.R. is second only to the United States, where total installed capacity was 266.8 million kw. in 1966. The Soviet electric power industry has developed greatly since the beginning of the 7-Year Plan; generating capacity was more than doubled during the period 1959-65 (Figure 2).

In recent years the U.S.S.R. has emphasized the construction of extremely large powerplants to supply regional and interregional power systems. Although there are more than 210,000 powerplants presently operating, 237 have capacities of 100,000 kw. or more and their combined capacity of 90 million kw. accounts for 73.1% of the national capacity. In the future, increasing shares of the national capacity are to be provided by large central power stations. By the end of 1970 at least 80% of the installed capacity is to be provided by powerplants of 100,000 kw. capacity or more.

Figure 2. GROWTH OF ELECTRIC POWER GENERATING CAPACITY AND PRODUCTION

25X1

| YEAR | YEAR-END CAPACITY | | | | PRODUCTION | | | | PER CAPITA PRODUCTION |
|---|---|---|---|---|---|---|---|---|---|
| | Thermal | Hydro | Nuclear | Total | Thermal | Hydro | Nuclear* | Total | |
| | *Thousand kw.* | | | | *Million kw.-hr.* | | | | *Kw.-hr.* |
| 1916.......... | 1,176 | 16 | 0 | 1,192 | 2,538 | 37 | 0 | 2,575 | *na* |
| 1921.......... | 1,210 | 18 | 0 | 1,228 | 510 | 10 | 0 | 520 | *na* |
| 1928.......... | 1,784 | 121 | 0 | 1,905 | 4,577 | 430 | 0 | 5,007 | 28 |
| 1932.......... | 4,173 | 504 | 0 | 4,677 | 12,728 | 812 | 0 | 13,540 | 84 |
| 1937.......... | 7,191 | 1,044 | 0 | 8,235 | 31,989 | 4,184 | 0 | 36,173 | 218 |
| 1940.......... | 9,606 | 1,587 | 0 | 11,193 | 43,196 | 5,113 | 0 | 48,309 | 254 |
| 1946.......... | 10,911 | 1,427 | 0 | 12,338 | 42,525 | 6,046 | 0 | 48,571 | 283 |
| 1950.......... | 16,396 | 3,218 | 0 | 19,614 | 78,535 | 12,691 | 0 | 91,226 | 500 |
| 1955.......... | 31,245 | 5,996 | 5 | 37,246 | 147,052 | 23,165 | 8 | 170,225 | 864 |
| 1958.......... | 42,673 | 10,863 | 105 | 53,641 | 188,814 | 46,478 | 58 | 235,350 | 1,137 |
| 1962.......... | 63,632 | 18,622 | 207 | 82,461 | 296,917 | 71,944 | 414 | 369,275 | 1,667 |
| 1965.......... | 91,757 | 22,244 | 987 | 114,988 | 422,810 | 81,431 | 2,468 | 506,709 | 2,185 |
| 1966.......... | 98,863 | 23,144 | 1,017 | 123,024 | 450,257 | 91,800 | 2,543 | 544,600 | 2,323 |

*na* Data not available.

* Estimated.



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FIGURE 3. DISTRIBUTION AND GROWTH OF GENERATING CAPACITY, BY POWERPLANT SIZE



| INSTALLED CAPACITY GROUP | 1958 | | | 1962 | | | 1966 | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of plants | Capacity | | No. of plants | Capacity | | No. of plants | Capacity | |
| *Thousand kw.* | | *Million kw.* | *Percent* | | *Million kw.* | *Percent* | | *Million kw.* | *Percent* |
| 1,000 and over | 1 | 2.3 | *4.3* | 8 | 12.7 | *15.4* | 18 | 29.7 | *24.1* |
| 300 to 1,000 | 23 | 14.6 | *27.2* | 50 | 22.2 | *26.9* | 78 | 37.7 | *30.6* |
| 100 to 300 | 94 | 15.3 | *28.5* | 131 | 21.7 | *26.3* | 141 | 22.6 | *18.4* |
| 25 to 100 | 142 | 7.7 | *14.4* | 162 | 8.1 | *9.8* | 172 | 8.8 | *7.2* |
| Less than 25 | 157,500 | 13.7 | *25.6* | 171,000 | 17.8 | *21.6* | 211,591 | 24.2 | *19.7* |
| Total | 157,770 | 53.6 | *100.0* | 171,351 | 82.5 | *100.0* | 212,000 | 123.0 | *100.0* |

The pattern and trend of Soviet plant size distribution are indicated in FIGURE 3. In the size range of 1 million kw. and over, there has been a great increase in the number of powerplants since 1958. Only one Soviet powerplant of this capacity existed in 1958, but 18 such plants with a combined capacity of 29.7 million kw. were operating at the end of 1966. In comparison, the electric power industry of the United States at the end of 1966 included 29 powerplants of 1 million kw. or more, with a total capacity approximating 38.5 million kw. By the end of 1970, it is expected that the U.S.S.R. will have 40 powerplants of this size in operation and their combined capacities will exceed that of powerplants in any other size range.

Small and inefficient powerplants located in rural and isolated areas are gradually being phased out as the more remote areas of the country are connected to power systems supplied by large central power stations. The 342 powerplants listed and described in FIGURE 13 and shown on the maps, FIGURES 23, 24D, 25B, 26D, and 27B, include all powerplants of 100,000 kw. and over (existing and under construction in 1966), and selected powerplants of less than 100,000 kw. capacity. FIGURE 27B includes three unnumbered plants, not described in FIGURE 13.

The bulk of the total capacity is installed in general-purpose powerplants designed to serve various classes of consumers. These plants, directly controlled by the Ministry of Power and Electrification, represent more than 82% of the generating capacity and produce about 88% of the output. The remainder of the capacity, controlled by other ministries, is installed in various industrial, municipal, rural, and special-purpose powerplants. The importance of these plants in the overall economy is decreasing in favor of centralized service from the larger, more efficient general-purpose plants.

About 43% of the generating capacity is installed at condensation thermal powerplants, 26% in heat and power plants; 19% in hydroelectric powerplants; and 12% in non-turbine powerplants. A major effort is under way to reduce the number of standard designs for powerplants, to install larger generating units, and to automate equipment. Construction of all types of generating stations is facilitated by repetitive use of a limited number of plans that include standardized equipment and components, and by widespread use of prefabricated building panels and structural elements. The use of similar blueprints, equipment and structural elements also simplifies the construction of power facilities in widely separated parts of the country where the physical environments are similar. In addition, construction engineers and laborers may be moved, as a group, from one building site to another to perform essentially the same jobs, and the experience gained at one site facilitates the work at the next. This is especially important in the Soviet Union where labor is plentiful, but experienced and proficient technical personnel are still relatively scarce. Standard designs for hydroelectric stations have also been attempted, although generally such powerplants must be tailored to the requirements of individual sites.

Soviet technology is somewhat ahead of that of advanced Western nations in installation of the largest hydroelectric equipment and somewhat behind in thermal equipment. Two 500,000-kw. hydroelectric turbogenerators were installed at the Divnogorsk, Krasnoyarsk GES (No. 258) in 1967, and 8 more units are scheduled for commissioning by the end of 1970. (Krasnoyarsk construction site, FIGURE 24A.) These units are the most powerful in the world, with more than twice the capacity of the turbogenerators at Bratsk GES (No. 311), formerly the most powerful. The largest thermal units, also installed in 1967, are the 500,000-kw. unit at the Nazarovo GRES (No. 257, FIGURE 24B) and an 800,000-kw. unit at Slavyansk GRES (No. 134, FIGURE 17B). These are the first units of these sizes in the U.S.S.R.; they are to be followed by several more by the end of the current 5-Year Plan (1966-70). Higher-capacity thermal units are already in operation in the United States.

Soviet technology is attempting automation of powerplant equipment to bridge the gap which currently exists between the U.S.S.R. and Western nations in this field. The current 5-Year Plan (1966-70) calls for a considerable reduction in the number of workers controlling the operation of power facilities. Automatic control systems have been installed and are undergoing testing at several of the major regional powerplants and at some heat and power plants. At the Zmiyev GRES (No. 135), an automatic control system designed for regulation of a 200,000-kw. unit was recently installed, and at the

Moscow Kaluzhskaya TETs-20 (No. 68) another system was installed whereby a single operator controls the operation of six units. With experience gained at these and other test sites, the Soviets are planning new automatic control systems for many of the large plants of the electric power systems.

Two other new features that may have wide application in the future are: an open-type thermal powerplant in which units are installed under protective shelters rather than in a building, and a hydroelectric powerplant in which turbogenerators are incorporated in the spillway section of a dam, rather than in a separate powerhouse. Examples of new powerplants in these respective categories are the Ali-Bayramly GRES (No. 187) and the Sheksna, Cherepovets GES (No. 55).

Soviet power technology continues to lag far behind that of the United States and several other Western countries. Qualities of Western powerplant equipment such as precise engineering and compactness are being sacrificed to quantity production. In addition, adjustments and machining of components, normally performed at the factory in Western countries, must be undertaken in the field. This is one of the main factors contributing to frequent slippage in Soviet powerplant construction schedules.

The U.S.S.R. possesses ample energy resources to fulfill electric power requirements. Reserves of major sources of energy—coal, petroleum and gas, peat, and water power—are collectively so abundant that no shortage of energy sources will occur in the foreseeable future. The percentage of power derived from various sources of energy has been as follows:

| | 1958 | 1962 | 1966 |
|---|---|---|---|
| Coal | *56.9* | *58.0* | *45.8* |
| Water power | *19.7* | *19.1* | *16.9* |
| Natural gas | *9.2* | *10.5* | *19.4* |
| Petroleum | *7.0* | *7.0* | *11.3* |
| Peat | *6.5* | *4.9* | *3.7* |
| Other | *.7* | *.5* | *2.9* |

**2. Thermal**

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Thermal powerplants, including conventional and nuclear steam plants, gas-turbine, diesel, and mobile units, numbered about 200,000 at the end of 1966 and had an installed capacity of 99.9 million kw. Representing 81% of total installed capacity, they generated roughly 83% of the electric power output of the U.S.S.R. About 1,000 general purpose powerplants with a total capacity of 77.4 million kw., contain most of the significant thermal generating capacity. Other thermal powerplants, although numerous, are generally less than 200 kw. in size. Some 60,000 industrial powerplants have a total installed capacity of about 14 million kw. and the nearly 120,000 rural plants have a total capacity of about 5 million kw. In addition, there are about 25,000 powerplants totaling over 3.5 million kw. in a special-purpose group. These powerplants supply urban utility and transport systems, military facilities, research institutes, and scientific projects.

The largest thermal powerplants in the U.S.S.R. are big regional installations, referred to as GRES. About 100 of these regional powerplants, with a combined installed capacity of 45.6 million kw., contained 37% of the total U.S.S.R. generating capacity at the end of 1966. They function as public utility powerplants supplying regional power systems and their consumers with electricity. Fourteen of these powerplants had installed capacities of 1 million kw. or more at the end of 1966 and accounted for 19.8 million kw., or almost 20%, of installed thermal capacity. By the end of 1970, the Soviets plan to have 34 such powerplants in operation, with a combined installed capacity of 53.5 million kw.

The regional powerplants include the largest thermal powerplant in the world, the 2.4 million-kw. Dnepropetrovsk, Pridneprovskaya GRES (No. 138, FIGURE 17A). Its construction, extending over 14 years, was completed in 1966 and reflects changes in Soviet power technology during that period. The first six turbogenerators installed in this plant were put in operation in the mid-1950's and are rated at 100,000 kw. each. Four of these units are coupled with two boilers each, but since a changeover from coal to gas in mid-1957, a unit system (one boiler per turbine) has been employed. Four 150,000-kw. turbines were installed during 1958-61. The final stage consists of four 300,000-kw. units installed during 1963-66. The last four units were the largest Soviet units in operation at the end of 1966.

By comparison, in the United States there were 23 thermal powerplants with capacities of 1 million kw. or more at the end of 1966; their total installed capacity exceeded 30 million kw. The largest was rated at 2 million kw.

One of the more important features of Soviet power engineering is the centralization of heat supply based on the distribution of steam and hot water by heat and power plants, referred to as TETs. In 1940 the TETs group had a combined installed capacity of 2 million kw. and a heat output of 30 billion megacalories. By 1958, however, TETs capacity had risen to 14 million kw. and heat output to nearly 225 billion megacalories. At the end of 1966, 119 heat and power plants, with capacities of 100,000 kw. or more, contained 25.4 million kw. of the capacity in regional power systems. The combined installed capacity of all TETs exceeded 32.4 million kw. at the end of 1966 and they produced about 500 billion megacalories of heat distributed through mains totaling more than 11,000 km. As in the past, the majority of new heat and power plants are to be located in or adjacent to urban areas and industrial concerns. Heat supply for the majority of newly constructed industrial enterprises in such leading branches of Soviet industry as metallurgy, chemistry, oil refining, synthetic fibers, and machine building, as well as their associated residential areas, comes from powerful regional heat and power plants. In 1965, about 50% of all the steam and hot water consumed in Moscow and Leningrad was supplied by local heat and power plants. The largest heat and power plant in the Soviet Union, composed entirely of heating turbines, is the Moscow Kaluzhskaya TETs-20 (No. 68). This plant, which began operation in 1952, contains four 25,000-kw. units, one 50,000-kw.

unit, and four 100,000-kw. units. It includes the three largest types of heating units currently in use. The boilers are fueled by gas, except in winter, when low-grade coal is burned. Hot water is distributed over an 8-km. radius through a network of pipelines totaling more than 100 km. in length. Plans for 1970 call for the capacity in heat and power plants to be raised to 45 million kw. and for their heat output to reach 730 billion megacalories.

Seven powerplants operating on steam produced by nuclear reactors accounted for more than 1 million kw. at the end of 1966. The largest of these plants is the Siberian AES at Tomsk (No. 240), which is reported to have an installed capacity of 600,000 kw. Electric power is produced as a by-product of waste heat from two dual-purpose, graphite-moderated, water-cooled reactors. The Arkhangel'skoye AES, Novo-Voronezh (No. 92) has an installed capacity of 240,000 kw. and employs a pressurized water reactor which drives three 80,000-kw. steam turbines (FIGURES 18A and 18B). A second section, under construction, is to raise capacity to over 600,000 kw. The Beloyarskoye AES, Uralskaya (No. 208), presently rated at 100,000-kw. (FIGURE 24C), is being enlarged to 300,000 kw. The remainder of the Soviet nuclear capacity is contained in the Melekess AES, Ul'yanovskaya (No. 104), 70,000 kw.; the Maloyaroslavets AES, Obninskaya 5,000 kw.; the Moscow TES-3 nuclear powerplant, 1,500 kw. (FIGURE 4); and the Melekess nuclear powerplant, *Arbus,* 750 kw. The last two are experimental mobile sets located at research institutes. They are prototypes for the transportable and mobile nuclear sets to be utilized in remote areas of the country and by the military forces.

Nuclear powerplants presently under construction are the Tomsk-2 AES (No. 241), the Shevchenko AES (No. 277), and the Bilibino AES, Chukotskaya (No. 328), and the Kola AES which went under construction not far from Murmansk in 1967. Operation of the Shevchenko plant will be of considerable importance to the Soviet nuclear power program. This will be the first power

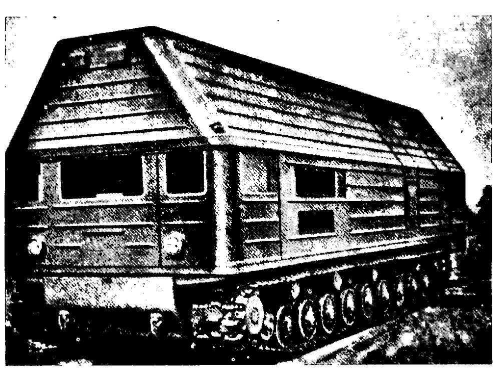

FIGURE 4. EXPERIMENTAL MOBILE NUCLEAR POWERPLANT TES-3. Four tracked units such as this are required to house the reactor, turbogenerator, and associated equipment of 1,500-kw. powerplant, which can operate for 250 days without refueling.

reactor of the fast-neutron, sodium-cooled type in the U.S.S.R.; the majority of earlier Soviet power reactors have been of the pressurized water type. The Shevchenko plant is to support a major water-desalting plant with heat and electric power. A considerable effort has been made in research on the fast-neutron sodium-cooled reactor, and the Soviets have evinced some interest in cooperating with the United States in this development, particularly for desalinization programs. Larger nuclear installations associated with desalting projects have been planned and designed, but actual construction is awaiting the successful operation of the Shevchenko plant. By the end of 1970, the total generating capacity of the nuclear installations of the U.S.S.R. is to exceed 2 million kw.

Although the Soviet Union built the first successful nuclear powerplant, the Maloyaroslavets AES, Obinskaya, in 1954, the United States is well ahead of the U.S.S.R. in the number and size of nuclear powerplants and is rapidly increasing its lead. At the end of 1966, the United States had 15 operating nuclear powerplants with a combined capacity approaching 2 million kw. These include the world's largest, the Hanford nuclear powerplant, near Richland, Washington, with an installed capacity of 786,000 kw. By the end of 1970, the United States is to have in operation 34 nuclear powerplants with a total installed capacity exceeding 13.5 million kw.

The first gas-turbine powerplant in the U.S.S.R. went into experimental operation in 1957. With experience gained in the operation of the 12,000-kw. Shatsk gas turbine powerplant, the Soviets are building two more stationary powerplants composed entirely of gas-turbine units. The Nebit-Dag GRES (No. 280) has two 12,000-kw. 825 turbine units installed and two more of the same capacity under construction. The Yakutsk GRES (No. 309) will have four 25,000-kw. 825 turbine units installed. In addition, a floating gas-turbine powerplant containing two 10,000-kw. units is scheduled to be built. It is to be towed to the mouth of the Kolyma River, in the Yakut A.S.S.R. in eastern Siberia, to supply the local power system. Similar shipborne powerplants are to be situated in other remote areas, where fuel sources are scarce and access is difficult.

Powerplants driven by internal combustion engines are used principally in rural areas and also as supplementary sources of electric power for industrial installations. These plants are powered mainly by diesel engines, and in 1966 contained about 15% of thermal generating capacity (nearly 15 million kw.). Gasoline engines are widely used in rural and remote locations.

Soviet attempts at direct exploitation of natural sources of energy, principally in geothermal stations, have been publicized. The first Soviet powerplant utilizing natural underground steam (FIGURE 27A) was put into operation in 1966 on the Kamchatka Peninsula in the Soviet Far East. Its initial capacity of 5,000 kw. was reached in 1967; it is to have a final capacity of 15,000 kw. Underground steam for this powerplant has been tapped by drilling a number of wells, one to a depth of 500 meters. Construction of a 25,000-kw. 25X1 geothermal powerplant also is planned for the Kamchatka Peninsula at Bolshe-Bannaya hot springs, some 75 km. from Petropavlovsk-Kamchatskiy. Other geothermal powerplants of greater capacity, now in the design stage, are planned for the Caucasus, Central Asia, and other locations in the Far East.

Conversion efficiency is being increased by the Soviets. Thermal powerplants, using a variety of fuels, generated 452.8 billion kw.-hr. of electric energy in 1966. Of the 1,033 million tons of standard fuel* produced in the U.S.S.R. during that year, 31.8% was consumed by powerplants in the production of electric power and heat. Almost 63% of the thermal production was derived from solid fuels and about 37% from petroleum products and natural gas. Unlike other industrialized countries, which use high-grade coal for the bulk of their thermal generation, the U.S.S.R. depends largely on low-grade coal, coal fines and tailings, peat, oil shale, and lignite. The use of such fuel (having low caloric value, low percentages of volatile matter, and high content of moisture and ash) has resulted in lower thermal efficiency despite construction of specialized combustion equipment. Total fuel consumption, therefore, has been considerably greater than it would have been if using higher grade fuels. As modern thermal plants, using better equipment, constitute an increasing share of capacity each year, specific fuel consumption in the U.S.S.R. is being reduced considerably. The following tabulation showing specific fuel consumption for selected years at general purpose powerplants, indicates a considerable growth of efficiency, and reflects the retirement of much of the worn-out, inefficient equipment:

| | Grams of standard fuel per kw.-hr. |
|---|---|
| 1940 | 645 |
| 1945 | 627 |
| 1950 | 590 |
| 1958 | 485 |
| 1962 | 448 |
| 1965 | 415 |
| 1966 | 405 |

Many of the larger heat and powerplants, as well as the regional powerplants have attained rates of efficiency much better than 405 grams. The current 5-Year Plan calls for decreases of 11% to 14% in fuel expenditure norms at thermal powerplants, in accordance with the overall Soviet drive to conserve fuel.

The principal fuels used in Soviet thermal plants are coal, natural gas, *mazut* (residual oil) and diesel oil, peat, and wood. Coal is the main primary energy source for electric power production, accounting for 55% of the thermal output. In 1966 about 145 million tons of coal were consumed by thermal powerplants, or about 25% of total coal production. Another 10% of the national coal production is used to produce heat energy distributed by heat and power plants. The largest coal basins currently being exploited are the Donets Basin in the eastern Ukraine, supporting thermal powerplants with a total installed capacity of 8.3 million kw., and the Kuznets Basin in Western Siberia, supporting plants with a total installed capacity of 3.7 million kw. Other major coal basins supporting large power systems are located in the Urals, Karaganda, and Irkutsk areas. Huge coal deposits presently being developed are the Kansk-Achinsk fields, lying east and west of Krasnoyarsk in central Siberia, and the Ekibastuz deposits in northeastern Kazakhstan, where a number of major powerplants are under construction.

Despite the present and future dependence upon coal as a source of energy for power production, a significant change in the fuel balance is being realized through the rapid increase in the use of natural gas. About 23% of the total thermal output is now obtained from the burning of natural gas. Delivered to the powerplants by an extensive and growing pipeline system, natural gas consumption by powerplants has more than quadrupled in the last 10 years. Gas not only is being used in new powerplants, but also is being used on a large scale as an auxiliary fuel at plants burning coal and other fuels. On the other hand, many powerplants which burn natural gas as the primary fuel stockpile coal throughout the year and use it in winter in order to free gas supplies for other uses, especially heating.

Powerplants in such large urban centers as Moscow, Leningrad, Khar'kov, Kiev, and Baku are operating to a considerable extent on gas. Many of the country's larger powerplants burn gas; these include some of the largest thermal stations such as the Dnepropetrovsk, Pridneprovskaya GRES (No. 138, Figure 17A), Lugansk GRES (No. 126, Figure 19A), Zmiyev GRES (No. 135), Bereza GRES (No. 42), Ali-Bayramly GRES (No. 187), Konakovo GRES (No. 51), Navoi GRES (No. 283), Tashkent GRES (No. 293, Figure 25A) and Gardabani, Tbilisi GRES (No. 176). The introduction of more gas turbines and associated steam-gas turbines, which only now are approaching the serial production stage, will also materially increase the use of this fuel. The Bukhara gas fields in the Uzbek S.S.R. are being exploited to provide natural gas to European U.S.S.R. over the Bukhara-Urals gas pipeline. Other major natural gas reserves are being developed in northern West Siberia and in the Turkmen S.S.R. Gas manufactured by the underground gasification of coal has been developed only to a limited extent. Such gas is presently being used in only a few powerplants, the largest of which is the Angren GRES (No. 292).

Petroleum products, principally *mazut* and diesel fuel, are being used at an increasing number of powerplants. In 1966, 13.6% of the thermal output was produced by the use of *mazut*, diesel oil, and oil shale. *Mazut* is employed as a primary source of energy principally at stations built at or near petroleum refineries. Most of these are in the Caucasus, the Volga-Urals region, and in Central Asia. *Mazut*-burning powerplants are generally of medium size, usually less than 200,000 kw. in capacity; the 1.2 million-kw. Zainsk GRES (No. 102) is an exception. Many powerplants which formerly burned coal are being converted to *mazut*, particularly in the Volga-Urals region. Diesel fuel is used predominantly by rural and small municipal and industrial plants throughout

*7,000 kilocalories per kilogram.

the country, but probably to a greater extent in Soviet Central Asia and the Soviet Far East than elsewhere.

The use of oil shale is concentrated in the Estonian S.S.R. and on the adjacent territory of Leningrad Oblast. Here, thermal powerplants consume almost all of the 21.4 million tons of oil shale produced in the U.S.S.R. One of the largest plants in the country, the Narva, Pribaltiyskaya GRES-1 (No. 31, FIGURE 19B), burns oil shale as will the Narva, Estonian GRES (No. 32) which is presently under construction. By the end of 1970, oil shale production is scheduled to reach 28 million tons per year.

As a result of its relatively low caloric value and high natural moisture, peat is among the least valuable of the power fuels in Western countries. In the U.S.S.R., however, it has played an important historical role in the development of Soviet power engineering. At present, almost 5% of the thermal output is produced by the burning of peat, and 63 electric power stations with a total capacity of about 3,133,000 kw. operate on this fuel. The largest peat-fueled plants are the 312,000-kw. Dubrovka, LGES-8 (No. 27) and the 259,000-kw. Balakhna, Gor'kiy GRES-1 (No. 83). Dubrovka, LGES-8 has a peat consumption rate of 600 tons per hour. The specific fuel consumption in peat-fueled powerplants is very high, totaling 470 to 550 grams of standard fuel per kw.-hr. This is partially due to the presence of old equipment and low individual unit capacity. Large new peat-fueled powerplants of 600,000 to 1.2 million kw. are in the design stage. On a basis of preliminary estimates of 229 million tons in a peat deposit near Cherepovets, there are plans to build two regional powerplants with an ultimate capacity of 1.2 million kw. each. Other peat-fired regional powerplants are planned for the north-central and northwestern parts of European U.S.S.R. where large peat deposits are available. Although units now operating on peat are of no more than 50,000-kw. capacity, 200,000-kw. units are scheduled for the new powerplants. Establishment of high-capacity, peat-fired boilers is expected to present difficult problems for Soviet technologists.

Use of wood for electric power generation is nearly insignificant in the fuel balance. Wood is used chiefly by small woodworking and paper mills, and by very small rural powerplants.

Powerplants operating on nuclear fuel account for less than 1% of the thermal power output, but they are of great local importance in areas lacking conventional fuels. Uranium, the principal fuel for nuclear power generation, appears to be available in sufficient quantity to satisfy existing needs. In addition to exploitation of domestic resources, the U.S.S.R. also imports large quantities of uranium-bearing ore from several satellite countries.

Conventional steam powerplants account for 83.5% of the thermal generating capacity and, except for some use of reciprocating steam engines in older stations, steam-driven turbines are used. Most of the remaining thermal capacity is in plants operating on internal-combustion, chiefly diesel engines (approximately 15%), and in nuclear powerplants (approximately 1%). At present, stations using gas turbines account for an insignificant part of the total thermal capacity.

Before World War II the majority of Soviet turbogenerators had capacities of 25,000 kw. or less. Although turbines rated at 50,000 and 100,000 kw. had been introduced, they did not comprise a significant share of the installed capacity. Since the end of World War II Soviet technology has successively introduced, and put into serial production, condensing turbines of 50,000, 100,000, 150,000, 200,000 and 300,000 kw. By the end of 1966, condensing turbines of 100,000 kw. and over accounted for almost 35% of U.S.S.R. thermal capacity. In the future, units of 100,000, 200,000 (FIGURE 20A), and 300,000 (FIGURE 20B) kw. are to be the basic types for newly built powerplants. The 150,000-kw. unit, which had become of considerable importance, is to be phased out by the end of the current 5-Year Plan (1966-70). Units of 300,000 kw. were first introduced in 1963; these numbered 20 at the end of 1966 and are to total 82 by the end of 1970 (FIGURE 5). Units of 500,000 kw. and 800,000 kw. were installed for the first time in 1967; by the end of 1970, seven of these large units are scheduled for operation. At that time units of 100,000 kw. and over are to account for more than 50% of the planned 144,400,000 kw. of thermal capacity. A unit of 1.2 million kw. is now in the design stage and may be constructed after 1970.

By comparison, in the United States at the end of 1966 there were in operation more than 70 units of 300,000-kw. or greater capacity. The largest unit presently in operation in the United States is a 1 million-kw. two-shaft turbogenerator at the Ravenswood thermal powerplant in New York City. A unit of 1,130,000 kw. is scheduled for operation at the Paradise thermal powerplant in Kentucky by late 1969.

Turbogenerators installed in heat and power plants (TETs) were until recently rated up to 25,000 kw. and operated primarily at low and medium pressures. During the 7-Year Plan (1959-65), turbines of a larger, higher-pressure variety were introduced into the Soviet power industry. Several 50,000- and 100,000-kw. units have been installed since 1961, allowing a great increase in the size and efficiency of heat and power plants. At several TETs, heating turbines have been grouped with 150,000-kw. condensing turbines to produce a fairly large-size thermal powerplant. The Yerevan TETs (No. 180), for example, contains five 50,000-kw. heating turbines and two 150,000-kw. condensing turbines. More powerful heating turbines are in the design stage. Units of 135,000 and 250,000 kw. are being developed to be installed for the first time after 1970.

The use of gas and steam-gas turbines to generate electricity has been under development for several years. Fewer than ten gas turbine units with installed capacities totaling about 130,000 kw. are presently in operation. Thirteen additional units, totaling about 325,000 kw., are planned or under construction. Originally the Soviets planned to use gas turbines for base-load operations.



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Figure 5. GROWTH IN SIZE AND USE OF LARGE THERMAL GENERATORS 25X1

| UNIT SIZE | 1962 | | | 1966 | | | PLANNED 1970 | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Capacity | Percent* | No. | Capacity | Percent* | No. | Capacity | Percent* |
| *Thousand kw.* | | *Thousand kw.* | | | *Thousand kw.* | | | *Thousand kw.* | |
| 26 to 99 (nonstandard units) | 37 | 1,626 | *2.6* | 41 | 1,785 | *1.8* | 41 | 1,785 | *1.2* |
| 25 | 462 | 11,550 | *18.2* | 515 | 12,875 | *13.0* | 556 | 13,900 | *9.6* |
| 50 | 206 | 10,300 | *16.2* | 330 | 16,500 | *16.7* | 439 | 21,950 | *15.2* |
| 100 | 76 | 7,600 | *11.9* | 105 | 10,500 | *10.6* | 150 | 15,000 | *10.4* |
| 150 | 30 | 4,500 | *7.1* | 67 | 10,050 | *10.2* | 89 | 13,350 | *9.2* |
| 200 | 11 | 2,200 | *3.5* | 51 | 10,200 | *10.3* | 96 | 19,200 | *13.3* |
| 300 | 0 | ... | ... | 20 | 6,000 | *6.1* | 82 | 24,600 | *17.0* |
| 500 | 0 | ... | ... | 0 | ... | ... | 4 | 2,000 | *1.4* |
| 800 | 0 | ... | ... | 0 | ... | ... | 3 | 2,400 | *1.7* |
| Total | 822 | 37,776 | ***59.5* | 1,129 | 67,910 | ***68.7* | 1,460 | 114,185 | ***79.0* |

... Not pertinent.
* Percent of total U.S.S.R. thermal capacity.
** Remainder of thermal capacity is provided by smaller generators.

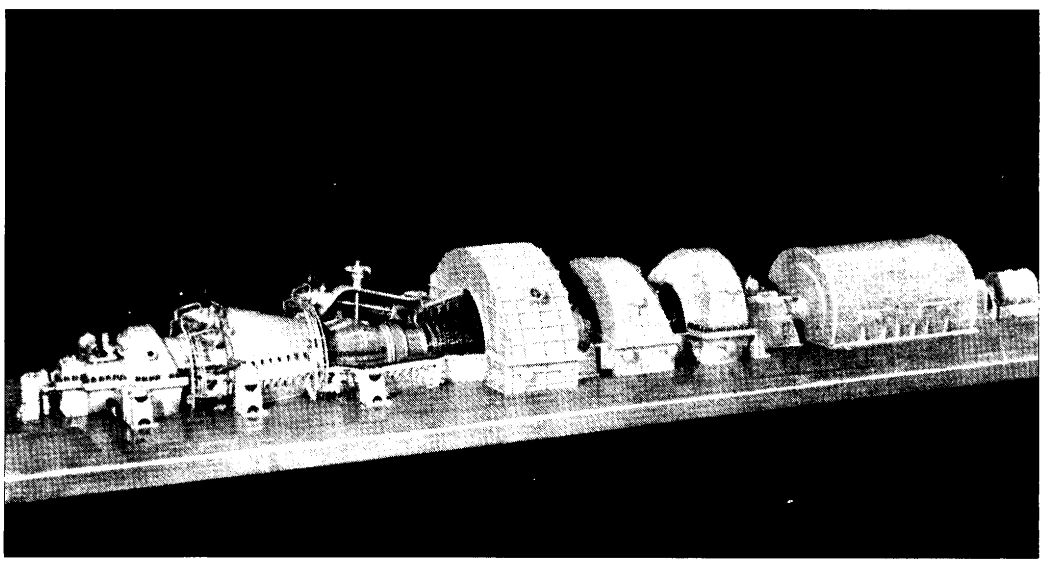

Figure 6. Model of an experimental 100,000-kw. gas turbine generator 25X1

Experimental units of 25,000, 50,000, and 100,000 kw. were designed and built; the first two were installed at the Kiev TETs-2 (No. 151) and Khar'kov TETs-3 (No. 137) heat and power plants. Economically and technically they have proved to be extremely inefficient as compared to conventional steam turbines, and at present the use of gas turbine units for base-load operations is to be restricted to powerplants being built in areas with limited water resources, such as at Nebit-Dag (No. 280) in Turkmen S.S.R. and Yakutsk (No. 309) in eastern Siberia. The Soviets now consider the most promising applications for gas turbines during the period 1970-80 to be for meeting peak loads and for provision of emergency service. Besides eliminating boilers (Figure 6) the relatively short time required between start-up and full-load operation makes gas turbines well suited for peak-load use. Gas turbines are highly flexible, require little cooling water, and can be installed in relatively small spaces; however, low efficiency and reduced hours of operation are prevalent. One promising development for gas turbines is the utilization of their exhaust to heat water for domestic systems. The Soviets are standardizing designs for gas turbines with capacities of 25,000, 50,000, and 100,000 kw.

Steam-gas units utilize a gas turbine and an associated steam turbine. The gas turbine discharges its hot exhaust into a boiler furnace for further burning in combination with a solid fuel or low-ash liquid fuel to provide steam for the main turbogenerator. The furnace operates under several atmospheres (about 30 to 60 pounds per square inch) pressure, increasing the rate of heat transfer into the water tubes and making the installation more compact. Four of these units with a total capacity of 74,000 kw. are currently in experimental operation. A 36,000-kw. steam-gas unit has been in operation at the Leningrad, LGES-1 (No. 21) since 1964. The advantages of steam-gas installations over ordinary boilers and turbines are as follows: they promise to be compact and highly efficient, their boiler installations can burn all types of organic fuels, and they can be produced in large unit capacities. The disadvantages are slow adaptability to load fluctuations, large requirements for cooling water, the need for higher-quality metals in boilers and turbines, and the relatively great capital investment. Steam-gas units ranging in size up to 200,000 kw. are planned for installation at Salavat TETs-2 (No. 217), Nevinnomyssk GRES (No. 164), and other plants. Altogether, current plans call for the installation of 14 steam-gas units with a total capacity of about 1.6 million kw.

The Soviet Union has developed and is producing a fairly complete range of equipment for nuclear powerplants; several types are in operation, ranging from large industrial installations to transportable, mobile, and special-purpose types. At least seven large nuclear reactors, actuating eleven turbines, are known to be in use at the five major nuclear powerplants. The largest working units at the end of 1966 were probably at the Tomsk nuclear powerplant (No. 240), where some 100,000-kw. turbines may be in use. At the Arkhangel'skoye nuclear powerplant, Novo-Voronezh (No. 92), a second reactor is under construction to power five turbines with rated capacities of 73,000 to 80,000 kw. each, while the Beloyarskoye nuclear powerplant, Uralskaya (No. 208) also has a second reactor under construction to power a single 200,000-kw. turbine. The Bilibino nuclear powerplant, Chukotskaya (No. 328) is scheduled to receive four 12,000-kw. turbines, supplied by four nuclear reactors. Two standard types of steam turbines for nuclear powerplants are to be introduced. The first type, rated at 200,000 kw., is already scheduled for installation at the Beloyarskoye powerplant and probably also at the Tomsk-2 nuclear powerplant (No. 241). The second type, rated at 500,000 kw. is presently being developed at the Kharkov turbine plant; it is unlikely to be ready for construction until the 1971-80 period.

In 1967, construction began on one of the largest nuclear powerplants in the U.S.S.R. The design calls for two reactors and an installed capacity of about 800,000 kw. It is to be built on the Kola Peninsula in far northwestern European U.S.S.R.

Prior to World War II, the greater part of U.S.S.R. thermal power was produced by equipment operating on steam at 29 atmospheres (426 pounds per square inch) and 400°C. (752°F.) or lower pressures and temperatures. In 1940 less than 3% of thermal capacity was in high-pressure units, defined as those operating at 90 atmospheres (1,323 p.s.i.) and 500°C. (932°F.) or higher. Following the war, high-pressure units were emphasized, particularly for condensing plants and later for the large heat and power plants. During the last few years, the Soviet power equipment industry has produced several new types of boilers designed for supercritical pressures and for burning different types of fuels. There appeared boiler units capable of burning various grades of coal, gas, *mazut,* and combinations of fuels. High-capacity boilers for burning peat are being designed; currently, peat-fueled powerplants are predominantly low-capacity installations. Almost all of the generating capacity now being installed in thermal plants consists of high-capacity, high-pressure units. The 300,000-kw. units (FIGURE 20B), operate on steam at supercritical pressures of 240 atmospheres (3,528 p.s.i.) and 560°C. (1040°F.), well below the pressures and temperatures used by modern equipment in the United States. At the Slavyansk GRES (No. 134) thermal powerplant, an experimental 800,000-kw., two-shaft unit was put in operation in 1967. It operates on steam at 255 atmospheres (3,744 p.s.i.) and 565°C. (1050°F.) produced by two boilers having a steam productivity of 1,250 tons per hour each. These boilers are designed to burn culm, and for possible future conversion to burn natural gas. At the Nazarovo GRES (No. 257) thermal powerplant, a single-shaft turbine rated at 500,000 kw. was also being installed in 1967. It operates on steam at 240 atmospheres, (3,528 p.s.i.) and 565°C. (1054°F.) produced by two boilers each having a capacity of 800 tons of steam per hour. These two designs are the latest steps in Soviet power engineering, and will be utilized at several plants now under construction, such as the Novodneprovka GRES (No. 144) and the Troitsk GRES (No. 225). An experimental 100,000-kw. unit (FIGURE 6) using steam at a pressure of 300 atmospheres (4,410 p.s.i.) and a temperature of 650°C. (1170°F.) was put in operation in 1966 at the Kashira MoGRES-4 (No. 78). These are the highest steam parameters in use by Soviet power engineers and are expected to result in much higher efficiencies in power generation. The new turbine set, designated SKR-100, is expected to save 4% to 5% in fuel and to result in further economies by feeding the steam exhausted by the turbine into three 50,000-kw. turbines operating at 30-atmosphere pressure (441 p.s.i.). The overall gain in efficiency could be between 25% and 30%, representing a savings of over 180,000 tons of fuel a year. The new turbine and boiler units are designed to use less expensive heat-resistant metal than is usual in such installations. Until recently, few boilers manufactured in the U.S.S.R. had capacities equal to those of the large turbogenerators. Steam plants, therefore, often contained many more boilers than turbogenerators, the practice being to direct steam output to a central collector before applying it to the turbines. The introduction of the boiler-turbine bloc system, whereby one or two boilers and one turbogenerator operate as a unit, has led to the production of boiler units with larger capacities. At present, Soviet-made boilers producing 230 tons of steam per hour are used extensively with turbines of up to 100,000 kw.; boilers producing up to 950 tons of steam per hour are coupled with larger units up to 300,000 kw. The steam parameters, the calculated overall efficiency, the overall dimensions, and the weights of Soviet boiler units are basically in line with boiler construction engineering in Western countries. However, many problems remain unsolved, principally in the installation and operation of the units. Poor Soviet construction techniques have resulted in extended periods of partial operation, testing, and repairs before the unit can be made to operate properly.

Condensation of steam at thermal powerplants is handled in various ways, including the use of cooling towers, spray ponds, rivers, and reservoirs. Powerplants situated in areas of inadequate water supply are characterized by massive cooling towers, such as those at the Moscow, Lyubertsy TETs-22 (No. 70, Figure 21A). On the other hand, the new major GRES powerplants are characterized by huge reservoirs, such as the one associated with the Zelenodol'sk, Krivoy Rog GRES-2 (No. 143).

Most of the machinery in thermal powerplants is relatively new, over 80% of the capacity being in equipment installed in the past 15 years. Equipment in many of the older plants is undergoing reconstruction and reconditioning, while other outmoded equipment is being replaced. A considerable effort is being made to increase plant efficiency which has been generally poor in the past, and to improve methods of installation which have heretofore led to numerous breakdowns and unduly high expenditures of fuel. Lack of replacement parts, poor quality of those available, and shortages of qualified personnel add to the difficulties in maintaining operating efficiency.

In the past the primary consideration for physical location of thermal powerplants were their proximity to consumers and the local availability of fuels. However, the considerable advance in transmission technology has made it possible to establish power facilities in fuel-bearing regions and then supply consumers over high-tension lines. In the future, therefore, the largest powerplants will probably be constructed in the eastern regions of the country near the major sources of fuel.

### 3. Hydroelectric



The hydroelectric construction program is one of the U.S.S.R.'s outstanding successes. Always granted a prominent and publicized place as a national endeavor, liberally funded and enjoying fairly high priorities for materials, the program has provided the U.S.S.R. with the world's three largest hydroelectric stations: the 4,050,000-kw. Bratsk GES (No. 311), the 2,563,000-kw. Volgorgrad GES (No. 117), and the 2,300,000-kw. Zhigulevsk, Kuybyshev GES (No. 109). These stations also contain the largest individual generating units: 225,000-kw. size at the Bratsk station and 115,000-kw. size at the Kuybyshev and Volgorgrad plants. In November 1967, the first two 500,000-kw. turbogenerators were commissioned (for partial output) at the Divnogorsk, Krasnoyarsk GES (No. 258). If this station receives ten such units by 1970, as planned, it will surpass Bratsk as the world's largest powerplant. At the end of 1966 the U.S.S.R. had in operation four hydroelectric stations of more than 1 million kw. installed capacity, totaling 9,913,000 kw. In comparison, the United States had six such stations in operation but their total capacity was less, 8,417,000 kw.

At the end of 1966 total hydroelectric capacity was more than 23.1 million kw. (Figure 7), nearly 19% of total U.S.S.R. generating capacity. Although there are almost 3,300 hydroelectric stations, the great majority of them are small rural plants averaging less than 200 kw. each. Eighty-two stations with capacities exceeding 25,000 kw. have a total installed capacity of 21,559,000 kw., or over 93% of the U.S.S.R.'s installed hydroelectric capacity. When all additional units planned for installation in these major hydro powerplants are completed, the 82 stations will have a generating capacity approaching 23.4 million kw. In addition, 24 very large stations with an ultimate capacity of 30 million kw. are under construction, and during the 1967-70 period 14 more stations with a total capacity exceeding 9.5 million kw. will be started.

A characteristic feature of the major hydroelectric plants is the use of huge reservoirs. The initial development

Figure 7. UTILIZATION OF HYDROPOWER RESOURCES, SELECTED RIVERS, 1966



| RIVER | TOTAL NUMBER OF EXISTING AND PLANNED HYDROPLANTS | ESTIMATED USABLE CAPACITY | ESTIMATED POTENTIAL PRODUCTION | INSTALLED CAPACITY | ESTIMATED PRODUCTION | CAPACITY UNDER CONSTRUCTION | CAPACITY PLANNED | UNDEVELOPED CAPACITY |
|---|---|---|---|---|---|---|---|---|
| | | *Million kw.* | *Billion kw.-hr.* | *Million kw.* | *Billion kw.-hr.* | *Million kw.* | *Million kw.* | *Million kw.* |
| Yenisey | 6 | 31.0 | 158.0 | 0 | ........ | 11.4 | 19.6 | 31.0 |
| Lena | 3 | 23.0 | 144.0 | 0 | ........ | 0 | 23.0 | 23.0 |
| Angara | 6 | 15.0 | 94.0 | 4.7 | 24.6 | 4.3 | 6.0 | 10.3 |
| Volga and Kama | 13 | 13.1 | 66.7 | 7.2 | 29.9 | 3.8 | 2.1 | 5.9 |
| Ob' | 10 | 11.6 | 51.0 | 0.4 | 1.8 | 0 | 11.2 | 11.2 |
| Amur | 7 | 9.7 | 83.0 | 0 | ........ | 1.0 | 8.7 | 9.7 |
| Irtysh | 16 | 4.5 | 25.0 | 1.0 | 4.2 | 0 | 3.5 | 3.5 |
| Dnepr | 14 | 4.1 | 14.6 | 2.1 | 8.7 | 0.6 | 1.4 | 2.0 |
| All other rivers | *approx* 3,500 | 128.0 | 1,193.7 | 7.7 | 22.6 | 9.0 | 111.3 | 120.3 |
| Totals | *approx* 3,600 | 240.0 | 1,830.0 | 23.1 | 91.8 | 30.1 | 186.8 | 216.9 |

took place in regions of flat terrain, particularly European U.S.S.R., where rivers have gentle gradients and great seasonal variations in flow. Long dams were constructed to provide the tremendous water storage needed. Construction of new plants of this type is being carried out at the Balakovo, Saratov GES (No. 113) and the Cheboksary GES (No. 97) on the Volga River, and at the Naberezhnyye Chelny, Nizhnekamskaya GES (No. 100) on the lower Kama River.

A new development in Soviet hydroelectric schemes is the utilization of gorge sites, which are most common on Siberian, Central Asian, and Caucasus rivers. Such sites, offering possibilities for higher heads and requiring less reservoir area, are being utilized for construction of the largest hydroelectric powerplants both in the U.S.S.R. and throughout the world. The Bratsk GES (No. 311), the largest hydroelectric powerplant in the world, exemplifies this type of installation (FIGURE 26A). Other major examples are the Divnogorsk, Krasnoyarsk GES (No. 258, FIGURE 24A) and the Mayna, Sayan GES (No. 260), both of which are under construction on the Yenisey River and whose capacities will exceed that of the Bratsk station. Similar hydroelectric stations with dams at gorge sites and scheduled capacities exceeding 1 million kw. are under construction in the Caucasus, Central Asia, East Siberia, and the Soviet Far East. These include: Novyy Chirkey, Chirkeyskay GES (No. 167), Dzhvari, Ingurskaya GES (No. 169), Toktogul GES (No. 297), Nurek GES (No. 286), Nevon, Ust'-Ilimskaya GES (No. 313), and Berezovka, Zeyskaya GES (No. 330).

Turbines built in the Soviet Union are similar to those produced elsewhere; both Kaplan turbines for low heads and Francis turbines for medium heads are installed, the former type having the widest application at present. The manufacture of encased horizontal turbines to be emplaced directly in the dam is currently being undertaken. Two experimental units are currently operating at the Sheksna, Cherepovets GES (No. 55).

Because of local shortages of cement and other construction materials, the Soviets have developed techniques for constructing large hydraulically filled earth and rock gravity dams which limit the use of concrete mainly to locks, spillways, and powerhouses. Such construction is used for dams with low or medium heads built on flat terrain. Widespread use is made of precast elements which can be fabricated in working areas protected from the weather. Such prefabrication is being used in construction of the Balakovo, Saratov GES (No. 113), the Jaunjelgava, Plavinas GES (No. 38), and the Kiev GES (No. 152). Designs for the Balakovo, Saratov GES provided for standard precast blocks up to 70 tons each for the combined spillway and powerhouse structure; precast elements amount to 45% of the total volume of concrete to be used. Another illustration is the Divnogorsk, Krasnoyarsk GES complex which includes a gravity concrete dam with a maximum height of 124 meters and a crest length of 1,150 meters (FIGURE 24A).

High-capacity hydroelectric stations with extremely high heads also are under construction. The 2.7 million kw. Nurek GES (No. 286) in Central Asia will upon completion have a maximum head of 258 meters. The 1.3 million kw. Dzhvari, Ingurskaya GES (No. 169) will have a maximum head of 445 meters. The dams for these power stations, a rockfill at Nurek GES and a dome-type, thin concrete arch at the Dzhvari, Ingurskaya GES, will be approximately 300 meters high, somewhat higher than the existing 221-meter Hoover Dam in the United States and the 284-meter Grande Dixence Dam in Switzerland.

Most of the hydroelectric powerplants in the U.S.S.R. are base-of-dam type; however, in the Caucasus and other mountainous sections, diversion plans are often used, with powerplants located away from the dams. Such designs achieve higher heads for the generating equipment (FIGURE 8) but may require long tunnels and open canals, to convey water from reservoirs to penstocks. The Dzhvari, Ingurskaya GES (No. 169), under construction, is another example of this type of separated plant; a tunnel 19 km. long will carry water from the Inguri River to the underground powerhouse.

Some of the longest dams in the world have been constructed in the Soviet Union. The dams of the Tsimlyansk GES (No. 121) and the Gorodets, Gor'kiy GES (No. 82) are almost 14 km. long, and the

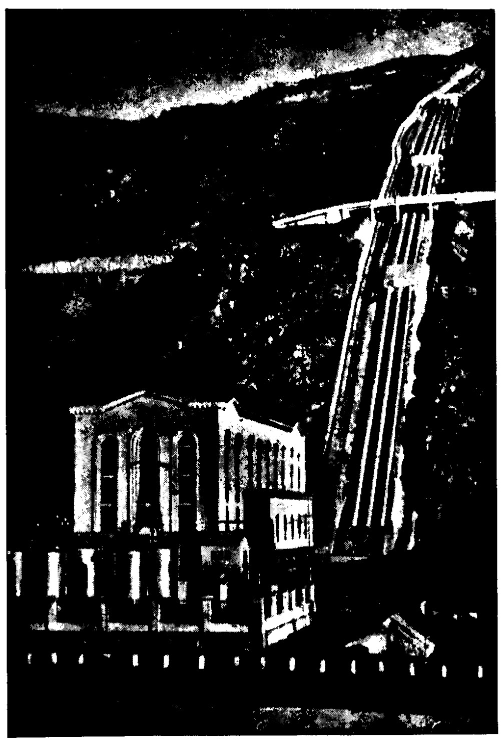

FIGURE 8. TYPICAL HIGH-HEAD HYDROELECTRIC POWERPLANT. Water is conveyed from high-level reservoir through tunnel and long penstocks to achieve great pressure for turbines of Tsalka, Khram GES-1 (No. 173). This is one of the highest-head hydroelectric stations in the U.S.S.R. 25X1



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Kremenchug GES (No. 145) dam is approximately 12 km. long. All three are gravity earthfill dams.

The Bratsk GES reservoir, the largest in the world, has a capacity of 179 billion cubic meters (140 million acre-feet); it is 540 km. (340 miles) long and covers an area of 6,000 square km. (2,306 square miles). The capacity of the Krasnoyarsk reservoir will be 73.3 billion cubic meters (60 million acre-feet); it will become the second largest in the world. The capacity of the Kuybyshev reservoir is 52.3 billion cubic meters (42.4 million acre-feet). The United States' Lake Mead (Hoover Dam) has, in comparison, a capacity of 36.7 billion cubic meters (29.8 million acre-feet).

Plans have been drawn for the construction of the first three pumped-storage hydroelectric powerplants in the Soviet Union. The first of these is to be built in association with the Kiev GES (No. 152). The others will be built in the area of Zagorsk, north of Moscow, and near Mogilev-Podol'skiy on the Dnestr River in the western Ukraine. Their respective capacities will be 180,000 kw., 585,000 kw., and 300,000 kw. These plants will serve peak-load requirements, delivering power for about five hours daily, and should all be under construction by the end of 1970. Plants of this type are contemplated for other parts of the country.

The first tidal powerplant (FIGURE 21B) is under construction at a bay, Kislaya Guba, on the Kola Peninsula in northwestern European U.S.S.R. Although only 1,200 kw. in capacity, it is to be the prototype for several very large tidal powerplants planned for the northern European part of U.S.S.R. and the Soviet Far East. Tidal powerplants with capacities ranging from 384,000 kw. to 14,000,000 kw. are planned for bays of the Barents, White, and Okhotsk Seas.

The U.S.S.R. possesses extensive waterpower resources. More than 108,000 rivers, totaling over 2.5 million km. in length and with an annual discharge of 3.9 billion cu. m., make up about 11.4% of the world's waterpower potential. Waterpower, as a primary source of energy, accounted for almost 17% of the electric power output of the U.S.S.R. in 1966, or approximately 91.8 billion kw.-hr. Comprehensive surveys of more than 1,800 of the larger rivers indicate that the country has a potential hydroelectric capacity of 378 million kw. This capacity, based on mean annual flow, is theoretically sufficient to produce about 3.3 trillion kw.-hr. annually. In addition, the power resources of smaller rivers, which were not surveyed, are estimated at 56 million kw. Thus, the maximum potential installed waterpower capacity of the U.S.S.R. is about 434 million kw. and sufficient to produce 3.8 trillion kw.-hr. It is estimated, however, that only about 240 million kw., or 55% of the theoretical capacity, is practically usable and this would produce approximately 1.8 trillion kw.-hr. annually (FIGURE 7). Estimated practical potential production of all rivers in the United States and Canada are 550 billion kw.-hr. and 220 billion kw.-hr., respectively.

Of the estimated total water power potential, 70% is in the central and eastern parts of Siberia and in the Soviet Far East, 15% in Soviet Central Asia, 10% in the Caucasus, and only 5% in European U.S.S.R. Twenty-three rivers have about 75% of the potential installed capacity of hydroelectric resources; of these, 15 are in Siberia, 5 are in Central Asia, and 3 are in European U.S.S.R. The most important of these rivers, having more than 45% of this potential are tabulated in FIGURE 7. To date, only 9.6% of the practically usable capacity of 240 million kw. has been utilized, while an additional 12.5% will be utilized by stations now under construction.

**4. Other** 25X1

The U.S.S.R. has been experimenting with several types of power generation using direct conversion methods for producing electric power. These include thermoelectric, thermionic, magnetohydrodynamic (MHD), and thermonuclear conversion methods, and also fuel cells. At present, Soviet scientists are working on a prototype for an MHD powerplant, in which a stream of ionized gas heated to 2,500° or 3,000°C. and moving at high speed through a magnetic field, induces electric current. One of the greatest problems involved in this project is the dearth of materials resistant to extremely high temperatures. The experimental MHD generator "U-02" (FIGURE 9) is located in Moscow. Engineers of the Ministry of Power and Electrification, working in

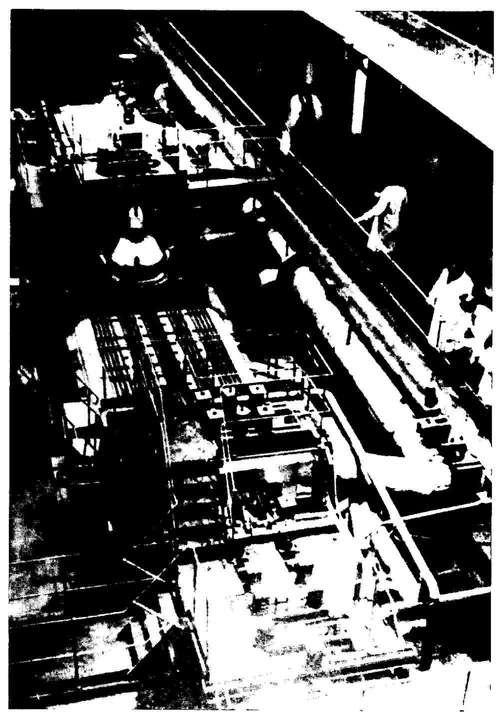

FIGURE 9. U-02 EXPERIMENTAL MAGNETOHYDRODYNAMIC DIRECT CONVERSION UNIT. One of the largest units of its type yet built, it is expected to attain a 25,000-kw. level of output. 25X1



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conjunction with scientists of the Institute of High Temperatures of the U.S.S.R. Academy of Sciences, are conducting experiments on this converter. Practical application is not expected until after 1980. Soviet specialists also have been experimenting with the use of solar radiation to produce electric current. One of several methods under investigation is the use of photoelectric cells, where electric energy is generated by directly employing solar light.

A relatively small number of wind-driven powerplants, mostly of low capacity, are operating. Development so far has been limited to Central Asia, some remote areas in the Arctic, and the Ukraine, where the velocity and constancy of winds are favorable. The largest, with a capacity of 480 kw., is located in Tselinograd Oblast' in the Kazakh S.S.R.

## D. Transmission and distribution facilities

25X1

The U.S.S.R. has developed some of the most powerful and extensive transmission networks in the world in recent years, and has in immediate prospect the sending of far larger blocks of power over even greater distances. Transmission networks now incorporate nearly 90% of the country's generating capacity, and cover virtually all developed areas. They provide generally reliable service and are adequate to meet normal demands, but there is relatively little provision for alternate routing among the major intersystem powerlines.

There are approximately 90 major power system authorities, conforming generally to U.S.S.R. administrative subdivisions. In the western and southern parts, these district power systems have been joined together into regional networks, which are in turn linked by high-capacity, long-distance powerlines to form a consolidated system serving almost the entire area from the Urals westward and from approximately the 60th parallel (the latitude of Leningrad) southward. The Soviets call this the Unified Power System of European U.S.S.R. Other major district system groupings cover central Siberia from west of Novosibirsk to east of Irkutsk, and southern Soviet Central Asia from west of Bukhara to east of Tashkent. Some of the district power administrations in outlying areas, as in the Yakutskaya A.S.S.R., have several small, isolated, local systems under their control. Further interconnection is progressing, both within and among the major subsystems.

The power networks in the Soviet Union comprise more than 330,000 km. of powerlines operating at voltages from 35 kv. to 800 kv. (FIGURE 14). The main systems and subsystems as of 1966 (FIGURE 10) included plants whose combined capacity accounted for nearly 90% of the U.S.S.R.'s total capacity. Selected transmission lines and substations are described in FIGURES 15 and 16, respectively, and indicated on the maps, FIGURES 23, 24D, 25B, 26D, and 27B.

In European U.S.S.R., the Urals, and the Caucasus areas, interconnection of power facilities has left few sizable powerplants or local systems operating separately.

FIGURE 10. GENERATING CAPACITY OF MAJOR POWER SYSTEMS, 1966

25X1

| | MILLIONS OF KW. | MAP |
|---|---|---|
| European U.S.S.R., unified power system: | | |
| Southern system | | |
| Central Ukraine | 8.9 | FIG. 23 |
| Donbass area | 7.8 | *Do.* |
| Lower Volga area | 3.5 | *Do.* |
| Northwest Ukraine | 2.1 | *Do.* |
| Moldavia-Odessa area | 1.1 | *Do.* |
| Total | 23.4 | |
| Urals system | | |
| Sverdlovsk area | 4.7 | FIG. 24D |
| Chelyabinsk area | 4.2 | *Do.* |
| Northwest Urals area | 3.8 | FIGS. 23 and 24D |
| Bashkir A.S.S.R. | 1.6 | *Do.* |
| Total | 14.3 | |
| Central Regional system | | |
| Moscow-Gor'kiy area | 12.3 | FIG. 23 |
| Voronezh-Lipetsk-Tambov area. | 1.0 | *Do.* |
| Saransk-Penza | .6 | *Do.* |
| Total | 13.9 | |
| Northwest system | | |
| Leningrad-Baltic area | 5.8 | *Do.* |
| Belorussian S.S.R. | 1.5 | *Do.* |
| Karelian A.S.S.R. | .4 | *Do.* |
| Total | 7.7 | |
| Middle Volga system | 6.4 | *Do.* |
| North Caucasus system | 2.7 | *Do.* |
| Total European U.S.S.R. | 68.4 | |
| Central Siberian system | | |
| East Siberia (Krasnoyarsk, Irkutsk areas). | 9.1 | FIGS. 24D and 26D |
| West Siberia (Kuzbass area) | 6.9 | FIG. 24D |
| Total Central Siberia | 16.0 | |
| Transcaucasus system: | | |
| Azerbaijan S.S.R. | 2.6 | FIG. 23 |
| Georgian S.S.R. | 1.5 | *Do.* |
| Armenian S.S.R. | 1.2 | *Do.* |
| Total Transcaucasus | 5.3 | |
| Central Asia system (Tashkent-Fergana area). | 3.0 | FIG. 25B |
| Altay Pavlodar system | 1.7 | FIG. 24D |
| Karaganda system | 1.6 | FIG. 25B |
| Murmansk system | 1.2 | FIG. 23 |
| Petropavlovsk-Omsk system | .9 | FIG. 24D |
| Orsk-Aktyubinsk system | .7 | *Do.* |
| Noril'sk system | .6 | FIG. 27B |
| Dushambe system | .5 | FIG. 25B |
| Primorskiy system (Vladivostok area). | .5 | FIG. 27B |
| Total (systems with 500,000 kw. or more generating capacity). | 100.4 | |
| Total of other systems | 9.6 | |
| Total connected to all systems | 110.0 | |





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Most of these are in the sparsely settled northern reaches of the country. Isolated powerplants or localized systems serve Vorkuta and Inta in far northeastern European U.S.S.R., and Syktyvkar, Kotlas, and Archangel in the central far northern area. The Murmansk area is served by a better-developed system, based largely on hydro powerplants, linking facilities from the U.S.S.R.-Norwegian border and the Murmansk vicinity in the north, to beyond Kandalaksha in the south. The Murmansk area system comprises powerplants totaling 1.2 million kw., linked mainly by 154- and 110-kv. powerlines. A higher-voltage circuit is soon to link the Murmansk area system to Kem', the present northern terminus of the Northwest system, one of the major regional networks.

The Northwest system serves the Karelian S.S.R., the Leningrad area, the Baltic States, and Belorussia. It incorporates powerplants having capacities totaling over 7 million kw. Hydroelectric stations predominate in the north while thermal powerplants are more typical of the southern subsystems.

The Karelian subsystem consists mainly of groups of small hydroelectric stations linked by 110-kv. powerlines to their load centers, such as Petrozavodsk and Kem'. These are joined by higher-voltage lines to the powerful Leningrad area network.

The greatest concentration of transmission facilities in northwestern European U.S.S.R. is centered on the Leningrad-Narva area. This network serves the area from Lakes Ladoga and Onega on the north, to Novgorod, Pskov, and Estonia across its southern periphery. Its most important circuits radiate from the 1.6 million-kw. Narva, Pribaltiyskaya GRES (No. 31 FIGURE 19B) from which 330-kv. lines extend southwest into Latvia and Lithuania, and eastward beyond Leningrad. Two-circuit, 220-kv. powerlines also link this powerplant to Leningrad and to Tallinn. Other 220-kv. lines connect Leningrad with hydroelectric stations situated 100 - 250 km. from the city, which is also supplied by several local thermal powerplants. A 330-kv. powerline extends southeast from Leningrad to the Moscow area, providing a tie to the Central regional network.

The various power systems of the Baltic States and Belorussia have been effectively linked in recent years by the 330-kv. powerline from the Leningrad-Narva area powerplants through major load centers at Riga, Kaunas, Vilnius, and Minsk. At these points and others, local powerplants are linked to the intersystem tie by lower-voltage lines. The main generating plants are the 825,000-kw. Jaunjelgava, Plavinas GES (No. 38) hydroelectric station, and the 600,000-kw. Elektrenai, Litovskaya GRES (No. 39) thermal powerplant. A high-capacity line bringing power to the Riga area from the Plavinas GES is being extended eastward toward Polotsk, where it will form a second connection for power exchanges between the Baltic States and Belorussia.

The main components of the Belorussian subsystem are 220-kv. circuits linking Minsk to thermal powerplants in southwestern and southeastern Belorussia. A giant thermal powerplant, the Lukoml', Belorusskaya GRES (No. 47) under construction northeast of Minsk, are to be the focal point of high-capacity lines providing a second tie between the Northwest system and the Central regional network, and possibly also to the Southern system.

Central European U.S.S.R., especially in the vicinity of Moscow, contains the most highly developed transmission network in the U.S.S.R. A major fraction of the area's needs are met by inputs from the giant Volga hydroelectric plants, Zhigulevsk Kuybyshev (No. 109) and Volgograd (No. 117) through 2-circuit, 500-kv. powerlines linking them to Moscow. These lines join the local network at five main substations on the periphery of the urban area; one 500-kv. circuit from the huge Konakovo GRES (No. 51) thermal powerplant also connects through these substations, thereby forming a ring of 500-kv. powerlines joining the peripheral substations. FIGURE 22 illustrates the size of substation equipment at one of the Moscow 500-kv. substations, Moscow/Zapadnaya transformer station (18).* A similar ring of 220-kv. substations nearer the city's center receives the input from the large thermal powerplants—Cherepet' GRES (No. 72), Shchekino GRES (No. 75), Novomoskovsk GRES (No. 76), and Kashira GRES (No. 78)—to the south of the city, and from the Uglich (No. 52) and Rybinsk (No. 53) hydroelectric stations to the north. Through the Vladimir transformer station (21) this Moscow area system is linked to adjoining, formerly independent subsystem serving the Yaroslavl' - Kostroma – Ivanovo area and the Gor'kiy area. Major ties project to Cherepovets and Vologda on the north, to Saransk and Penza on the east, to Orel and Bryansk on the south and southwest, and to Smolensk and Kalinin on the west and northwest.

From the Arzamas transformer station (23) on the 500-kv. Kuybyshev - Moscow line, 220-kv. circuits tie in power facilities to the south at Saransk (No. 88) and Penza (No. 89). Similar powerlines from the Gryazi transformer station (24) on the 500-kv. Volgograd - Moscow line link up a subsystem comprising Voronezh, Lipetsk, and Tambov. In all, this Central Regional Network comprises powerplants with installed capacities totaling almost 14 million kw.; the 500-kv. lines from the Volga hydroelectric stations contribute about 3 million additional kw. The network is being augmented by the construction of two very large (2.8 million kw. each) thermal powerplants, the Volgorechensk, Kostroma GRES (No. 81) and the Perkino, Ryazah' GRES (No. 80). High-capacity powerlines from the former will strengthen the system's connections to the north and east, while lines from the latter will provide added ties to the south and southeast.

The power systems serving the major cities of the middle and lower Volga regions have not yet been consolidated by high-capacity ties. The network serving Kazan' draws most of its power from the 1.2 million-kw. Zainsk GRES (No. 102) thermal powerplant, situated at the extreme east of the Tatar A.S.S.R. From this plant, a

*Substation reference number in FIGURES 16 and 23.

220-kv. powerline extends west through Kazan' to Cheboksary, with a 110-kv. branch north to Yoshkar-Ola. The system will be greatly augmented by million-kw. hydroelectric stations now under construction on the Volga at Cheboksary (No. 97) and on the lower Kama (No. 100); as these near completion, they will be linked by 500-kv. lines extending into the central European U.S.S.R. region through the Gor'kiy area system and the big Volgorechensk, Kostroma GRES (No. 81), and similar powerlines into the Urals system on the east.

Farther down the Volga, Kuybyshev is the focal point of a sizable power network, although most of the power from the giant hydroelectric station, the Zhigulevsk, Kuybyshev GES (No. 109) goes to central European U.S.S.R. and the Urals. Main sources of the local supply are medium-sized thermal powerplants in and near Kuybyshev (Nos. 106 through 112). These are joined by 220-kv. lines to similar powerplants in Ul'yanovsk (No. 105), Syzran', Balakovo (No. 114), and Saratov (No. 115). The relatively small power output of the atomic facilities at Melekess (No. 104) is linked to this system by 110-kv. lines. As the Balakovo, Saratov GES (No. 113) hydroelectric station nears full power, 1,290,000 kw., high-capacity lines from it are to unite the middle and lower Volga systems.

To the east of the Middle Volga power system area, the networks of the major subdivisions of the Urals area have been consolidated into another of the U.S.S.R.'s largest power systems. In all, the Urals system comprises thermal powerplants with nearly 12.5 million kw. capacity and hydroelectric stations with nearly 2 million kw. The component subsystems are effectively joined by 500-kv. powerlines from the 2.3 million-kw. Zhigulevsk, Kuybyshev GES (No. 109) on the Volga and the 1 million-kw. Chaykovskiy, Votkinsk GES (No. 192) on the Kama River, to Chelyabinsk and Sverdlovsk, respectively; the terminal substations at these cities are linked by a 500-kv. line extending north from the 1.2 million-kw. Troitsk GRES (No. 225) thermal powerplant, and reaching Nizhniy Tagil. These high-capacity circuits make possible massive inputs of power from the west, and allow substantial exchanges of power between the northern and southern halves of the Urals system. As construction progresses on the 2.4 million-kw. Karmanovo GRES (No. 193) thermal powerplant and the 1,080,000-kw. Naberezhnyye Chelny, Nizhnekamskaya GES (No. 100) hydroelectric station, both near the border between the Bashkir A.S.S.R. and Perm' Oblast, their associated powerlines will form a high-capacity tie in the western Urals similar to that between Sverdlovsk and Chelyabinsk on the east.

Within the Urals network there are four well-defined subdivisions. In the northwest, the Perm' system links a group of small to medium-sized thermal powerplants (Nos. 194, 195, and 196), near coalfields north of Perm', with the Perm', Kamskaya GES (No. 197) hydroelectric station and with thermal powerplants (Nos. 198, 199, and 200) closer to the city. Farther south, powerlines radiating from the 1 million-kw. Chaykovskiy, Votkinsk GES (No. 192) hydroelectric station link power facilities from the Kirov area to Sverdlovsk. Generating capacity in this northwestern Urals area exceeds 3.8 million kw., but most of the output from the large hydroelectric station is transmitted to the Sverdlovsk Yuzhnaya transformer station (65), for support of the entire Urals system. Within the Perm' network, the main transmission lines are 220-kv. circuits, with 110-kv. lines radiating to the west.

In the northeast, the well developed Sverdlovsk system also consists mainly of north-south 220-kv. lines with two major branches to the west to link up with the Perm' system, and 110-kv. lines east to Tavda and Tyumen'. The system's 5 million-kw. capacity includes only a few very small hydroelectric plants. The largest plant in the system, the 1.6 million-kw. Verkhniy Tagil GRES (No. 205), sends most of its output to the neaby Verkh-Neyvinskiy uranium isotope separation plant. The other largest powerplants, the Serov GRES (No. 202) and Nizhnaya Tura GRES (No. 203), are near the northern end of the system; much of their power is transmitted southward to load centers at Nizhniy Tagil and Sverdlovsk, to meet needs beyond the capacity of local powerplants (Nos. 204, 206, and others).

In the southern Urals, there are the relatively simple Bashkir A.S.S.R. system in the west and the more complex Chelyabinsk regional network to the east. The Bashkir system is centered on the Ufa transformer station (61) on the 500-kv. powerline across the southern Urals, focal point for the main powerlines linking the Ufa area powerplants (Nos. 211 through 214) and those in the oil-producing centers to the south (Nos. 215 through 218). A 220-kv. powerline from Ufa links these powerplants and extends southward to Orenburg. This is the main circuit of the system, which includes generating plants with a total capacity approximating 2 million kw. The 1.2 million-kw. Zainsk GRES (No. 102) and the 237,000-kw. Urussu GRES (No. 103), in the Tatar A.S.S.R. to the west, contribute a substantial part of their output to the Baskir system.

Like the Sverdlovsk system to which it is linked by high-capacity 500- and 200-kv. circuits, the Chelyabinsk area system is dependent almost entirely on thermal powerplants; hydroelectric stations constitute barely 1% of the system's 5 million kw. of installed capacity. The main powerplants of the system, the 1.2 million-kw. Troitsk GRES (No. 225) and the 1 million-kw. Yuzhno-Ural'sk GRES (No. 224) are connected by 500- and 220-kv. lines to load centers in the major cities, which also have local medium-sized thermal powerplants, chiefly at Chelyabinsk (Nos. 220 through 223), Magnitogorsk (Nos. 227 and 228), and Rudnyy (No. 229). The network extends into neighboring districts, reaching Kurgan on the east and Kustanay in Kazakhstan on the southeast. A high-capacity (probably 500-kv.) line is to be extended from the Troitsk GRES (No. 225) to the southwest to join the power facilities of Orsk (Nos. 231 and 232) and Aktyubinsk (No. 233). This is being done in connection with building a 1.8 million-kw. thermal powerplant, the

Iriklinskiy GRES (No. 230), near Orsk. Within the next five years, the 500-kv. lines in this vicinity are to be extended to join the North Kazakhstan system centered on Karaganda and Pavlodar.

The Southern power system, extending throughout the Ukraine and Crimea, and beyond to Kursk on the north and Volgograd on the east, is second only to those of central European U.S.S.R. and the Urals in capacity and complexity. Power facilities are developed much more intensively in the eastern half of the Ukraine than in the less industrialized western parts. The Southern system is linked to the Central Regional system through the Volgograd GES (No. 117) hydroelectric station along the 500-kv. lines to Moscow and over the unique 800-kv. line (FIGURE 11) to the northern Donbass industrial area. The Lower Volga area also has several medium-sized local thermal powerplants (Nos. 116, 118, and 119) linked by 220-kv. lines, which extend north to Kamyshin and west to the Tsimlyansk GES (No. 121) hydroelectric station. A 110-kv. line extends to the southeast to serve the Kapustin Yar missile test area. Astrakhan', at the mouth of the Volga, operates in isolation.

The adjacent network of the Donbass industrial area is one of the most powerful subsystems in the Ukraine. This network serves the area southeast of Khar'kov, its limits being Slavyansk and Lugansk on the north, and Zhdanov and Rostov on the south. The grid comprises some very large powerplants and is almost entirely thermal. The main components are the 2.1 million-kw. Staro-Beshevo GRES (No. 129) and the 1.5 million-kw. Lugansk GRES (No. 126) thermal powerplants. There are six other powerplants more than 300,000-kw. size within the system, as well as many smaller powerplants.

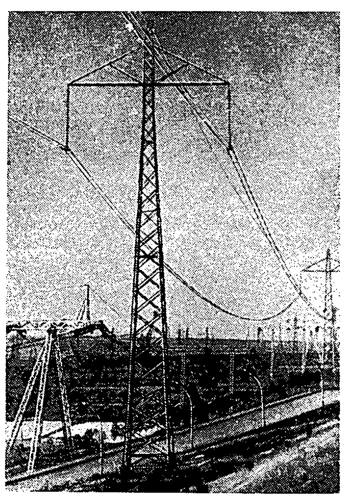

FIGURE 11. HIGH-VOLTAGE, DIRECT-CURRENT, 800-KV. TRANSMISSION LINE. One of the highest-capacity circuits in regular operation, this links the Volgograd GES hydroelectric station (No. 117) with Mikhaylovka substation (34) in the Donbass.

The Donbass system totals about 7.8 million kw. in installed capacity. It receives nearly a million kw. additional input over the 800-kv. d.c. powerline from the Volgograd GES hydroelectric station, and smaller increments over a 330-kv. connection with the Zaporozh'ye, Dnepro GES (No. 139) on the west, over 220-kv. lines from the Khar'kov area on the northwest, and from the Tsimlyansk GES (No. 121) hydroelectric station on the east. Within the Donbass system, the network consists chiefly of multiple-circuit, 220-kv. powerlines joining the generating plants to large substations near major load centers in the cities. The Mikhaylovka transformer station (No. 34), terminus of the 800-kv. d.c. connection with the Volgograd GES hydroelectric station, is the focal point of the internal lines of the network. A "super-giant" 3.6 million-kw. thermal powerplant, the Uglegorsk GRES (No. 127), is under construction in the center of the Donbass area. Its associated powerlines will make the network considerably more dense and provide many alternate routings for its power.

Another very large group of powerplants are linked together in the area from Khar'kov to the south and southwest; this is referred to as the Central Ukraine system. It includes the world's largest thermal powerplant, the 2.4 million-kw. Pridneprovskaya GRES (No. 138) at Dnepropetrovsk (FIGURE 17A), several other major thermal powerplants, and large hydroelectric stations on the Dnepr River. In all, the system comprises powerplants having about 9 million kw. installed capacity. The system serves the area between Chernigov and Belgorod on the north, and Nikolayev and Kerch' on the south. Several 330-kv. powerlines link up the major generating plants; Khar'kov, Kremenchug, Krivoy Rog, Dnepropetrovsk, and Zaporozh'ye are the main focal points of this high-capacity transmission system.

In northwestern Ukraine, a system links Kiev and L'vov, and numerous smaller urban areas. The main sources of its power are two large thermal powerplants: the 700,000-kw. Dobrotvor GRES (No. 154) and the 800,000-kw. Burshtyn GRES (No. 155), north and south of L'vov, respectively. Numerous smaller powerplants raise the total capacity of the system to nearly 2 million kw. The L'vov area powerplants are linked to Kiev by 220- and 330-kv. lines, and from Kiev to the Central Ukraine system by 330-kv. lines to Chernigov and to Kremenchug. The Northwest Ukraine system exports a substantial part of its output to Czechoslovakia, Hungary, and Rumania by 400-kv. powerlines into those countries from a key transformer station at Mukachevo (49). The Dobrotvor GRES (No. 154) powerplant also exports power into Poland by a 220-kv. line.

A small system in the southwest Ukraine links Odessa, Kishinev, and Chernovtsy. Its main power source is the 800,000-kw. Dnestrovsk, Moldavskaya GRES (No. 159) thermal powerplant, which supplies over two-thirds of the capacity in the system. Transmission within the system is handled mainly by 220-kv. lines, but a higher-capacity 330-kv. line is being built to link the Dnestrovsk, Moldavskaya GRES to the Central Ukraine system at Nikolayev.

25X1

The Caucasus area is served by two major systems with only low-capacity connections to each other and to the rest of European U.S.S.R. The North Caucasus system unites the small networks around Krasnodar, Pyatigorsk, and Groznyy. Its main power sources are thermal: the 800,000-kw. Krasnodar TETs (No. 163), the 600,000-kw. Nevinomyssk Gres (No. 164), and the 350,000-kw. Novogroznenskiy TETs-1 (No. 165) at Groznyy. From the centrally located Nevinnomyssk GRES (No. 164), a 220-kv. powerline to Krasnodar and a 330-kv. powerline to Groznyy constitute the main circuits of the system. Small hydro and thermal powerplants raise the system's total capacity to 2.7 million kw. Through powerlines from Krasnodar to the Rostov area, the North Caucasus system is linked to the Donbass grid and to the Trans-Caucasus network. A 110-kv. circuit serves the railroad joining the North Caucasus and Transcaucasus regions, but does not permit exchanges of significant amounts of power between the two systems.

The Trans-Caucasus system joins together the networks of Georgia, Armenia, and Azerbaijan. Exchanges of power among these three are accomplished through the Akstafa transformer station (56). The most extensive of the networks is the Georgian, with subsystems in the vicinities of Kutaisi and Tbilisi. Each of these subsystems comprises several small hydroelectric stations and one or two larger thermal powerplants. The former are linked by 110-kv. lines, but the larger thermal powerplants and major substations are connected by 220-kv. circuits. The Georgian system will be greatly improved by the commissioning of the Dzhvari, Ingurskaya GES (No. 169) hydroelectric station, now under construction. This 1.3 million-kw. project incorporates the world's highest dam. The powerplant is to be connected to the Tbilisi area by a 500-kv. powerline, a high-capacity tie which will facilitate power exchanges throughout the Trans-Caucasus area.

The main circuits of the Armenian system connect Yerevan with a series of hydroelectric stations on the Razdan River, north and east of the city. Major thermal powerplants have been added in the Yerevan area, and powerlines are being extended to the southeast where more hydroelectric stations are to be built. The system now has about 1.2 million kw. installed capacity. A 220-kv. powerline connects it to the Akstafa substation.

The Azerbaijan system is the most powerful in the Trans-Caucasus. Several large thermal powerplants in the vicinity of Baku are linked by 220-kv. lines, and from this area, a 330-kv. powerline extends westward to the Akstafa substation.

A major power system is being formed in the areas of northern Kazakhstan and southern West Siberia. The networks of the Urals and of the Novosibirsk area are linked by powerlines intended primarily for electrification of the Trans-Siberian Railway; these 2-circuit, 110-kv. lines do not have sufficient capacity to transfer significant amounts of power between the systems involved. The main power facilities of the area, in Petropavlovsk and Omsk, are therefore somewhat isolated and localized. The situation is to be remedied by the extension of high-capacity lines to these cities from the power system evolving in northern Kazakhstan.

At the end of 1966, this area contained the extensive Karaganda system, the more compact Altay system in easternmost Kazakhstan, and between them, the localized but rapidly expanding Pavlodar system. A series of giant thermal powerplants are to be built around the extensive deposits of easily mined brown coal near Ekibastuz, and west of Pavlodar. Construction on the first of these, the Yermak GRES (No. 270), is well advanced. As its units are commissioned, 220- and 330-kv. powerlines are being extended to join the Karaganda, Pavlodar, and Altay systems into a single network. As other, even larger powerplants, such as the Zhingyldysor, Ekibastuz GRES-1 (No. 266) are built in this area, higher-capacity powerlines are to be extended northward to Omsk and westward to join the Urals system at Kustanay, thereby creating a new major system covering the broad area between the Urals and central Siberia.

The central Siberian area is served by a major system extending from west of Novosibirsk to east of Irkutsk. The system now contains three well defined sections, linked together mainly by 500-kv. powerlines radiating from the 4,050,000-kw. Bratsk GES (No. 311) hydroelectric station, the world's largest single generating plant. Within the component networks, the main circuits are 220-kv. lines.

On the west, the Central Siberian system incorporates the Kuzbass network, which unites the power facilities between Novosibirsk and Barnaul on the west, and those from north of Tomsk to south and east of Novokuznetsk. The Kuzbass grid joins powerplants with capacities totaling about 4 million kw.; less than 5% of the capacity is hydroelectric. Each of the large cities in the area has several medium-sized thermal powerplants and these concentrations are linked together with 220-kv. circuits, now being augmented by a 500-kv. line. The biggest powerplants serving the Kuzbass grid are situated outside the main cities; the 1.3 million-kw. Myski, Tom-Usinskaya GRES (No. 253) and the 500,000-kw. Kaltan, Yuzhno-Kuzbasskaya GRES (No. 254) are near the southern end of the network, while the 800,000-kw. Belovo GRES (No. 249) is near the system's center and is a focal point for its principal circuits.

The two-circuit 500-kv. powerline extending west from Bratsk forms the backbone of the Krasnoyarsk regional power network. The other major circuits are 220-kv. lines radiating from the main powerplants—the 900,000-kw. Nazavovo GRES (No. 257) and the 650,000-kw. Zaozernyy, Krasnoyarsk GRES-2 (No. 310)—and a 220-kv. line extending from the southern Kuzbass area through Abakan to Tayshet. At the end of 1966, the Krasnoyarsk system included powerplants, nearly all thermal, with an aggregate capacity approximating 2.2 million kw.

Power facilities in the Krasnoyarsk region are being developed rapidly and on the largest scale. Soviet power planners believe the region offers sites for both hydro and thermal powerplants that should provide the lowest intrinsic power costs in the country. Two hydroelectric stations even more powerful than that at Bratsk are under construction on the Yenisey River, upstream from Krasnoyarsk and Abakan. In areas near the Trans-Siberian Railway, for hundreds of kilometers east and west of Krasnoyarsk, there are rich deposits of brown coal suitable for open-pit mining and several rivers to furnish great quantities of cooling water. On these coal deposits, Soviet power authorities intend to erect a series of multimillion-kilowatt thermal powerplants to work in conjunction with the huge hydroelectric stations being built on the Yenisey and Angara Rivers. These 4- to 6-million kw. powerplants are to be connected by extremely high-capacity powerlines to a central substation; this will probably be built near Nazarovo. From this point, the bulk of the power is to be transmitted to the Urals and European U.S.S.R.

The other main powerlines from the Bratsk GES, two 500-kv. (FIGURE 26B) and two 220-kv. circuits, are the principal components of the Irkutsk regional system. These lines terminate at the large substation (98) near the 1.1 million-kw. Angarsk, Sukhovskaya TETs-10 (No. 317). This substation also is the focal point for powerlines from several other nearby thermal powerplants and from the 660,000 kw. Irkutsk, Angara GES (No. 318) hydroelectric station. From Irkutsk, 220-kv. powerlines extend to the east along the Trans-Siberian railroad; these are the main element of the rudimentary Buryat A.S.S.R. power system. Lower-voltage lines radiating from Irkutsk constitute the remainder of the regional power system.

To the north and east of the Irkutsk region there are a number of isolated small local power systems. Those near the Trans-Siberian railroad are to be consolidated by the gradual extension of 220-kv. lines for electrification of the railway. In the vicinity of Chita (No. 322) and much farther to the east from Svobodnyy through Khabarovsk (No. 332) to Vladivostok, construction of these lines is well advanced. For the sparsely populated region between Chita and Svobodnyy, no specific plans for the construction have been published by the Soviets.

The Amur Oblast, east of Chita, has a relatively simple power system, now based primarily on a medium-sized thermal powerplant, the 160,000-kw. Raychikhinsk GRES (No. 331). A million-kw. hydroelectric station, the Berezovka, Zeyskaya GES (No. 330) under construction in the northern part of the region, is to be the basis for extension of the network, especially to the west.

The powerplants and local systems serving the main cities of the Khabarovsk region have not yet been interconnected. More progress has been made in the vicinity of Vladivostok, where a network of 110- and 220-kv. powerlines links the main thermal powerplants to load centers in the cities and towns of the area. A 2.4 million-kw. thermal powerplant, the Nadarovka, Primorskaya GRES (No. 337) is under construction between Vladivostok and Khabarovsk. High-capacity lines from this powerplant will link up the Amur, Khabarovsk, and Vladivostok area power facilities.

There are several noteworthy power systems in northern Siberia. The most powerful is that serving the Noril'sk mining area, in the far northern part of Krasnoyarsk Kray. The system at present depends almost entirely on the 575,000-kw. Norilsk TETs (No. 303), but another thermal powerplant and a hydroelectric plant are being added. In eastern Irkutsk Oblast, a system based mainly on the 84,000-kw. Bodaybo, Mamakanskaya GES (No. 307) serves nearby gold and mica mining centers.

To the north of Bodaybo, recently discovered diamond deposits in the Mirnyy area are to be served by the 600,000-kw. Chernyshevskiy, Vilyuyskaya GES (No. 306), a hydroelectric station now under construction. From Lensk (formerly Mukhtuya) on the Lena River, base for the construction operations and site of a small thermal powerplant, a 110-kv. powerline extends to Mirnyy and the dam site; a 200-kv. circuit is being extended to the north to newly-found deposits at Aykhal.

In the Soviet Far East, an extensive system has developed to link the port of Magadan with gold fields along the Kolyma River and its tributaries. The main power source is the 120,000-kw. Myaundzha, Arkagala GRES (No. 325), from which 110-kv. powerlines go to the principal mining and dredging centers. A circuit is being extended to Magadan, and the system's capacity is to be greatly increased by construction of the 750,000-kw. Debin, Kolyma GES (No. 326). Even farther to the northeast, to permit the exploitation of valuable tin deposits near Bilibino, a small system has been developed to transmit power from the 42,000-kw. Pevek, Chaunskaya GRES (No. 329) and a smaller thermal powerplant at Zelenyy Mys over 110-kv. powerlines to the Bilibino area. Because of the extreme difficulty of delivering fuel to this area, a 48,000-kw. nuclear powerplant (No. 328) is being built near Bilibino to augment the system. Other small systems in the Soviet Far East similarly connect remote deposits of valuable ores with powerplants near coal deposits or at places where fuel may be delivered without long hauls over difficult terrain.

Across southern Soviet Central Asia, another extensive system is being evolved, linking up the once widely separated facilities of the Turkman, Uzbek, and Kirgiz Republics with those of southeastern Kazakhstan. Before 1970, this area is to have an effectively integrated system extending from west of Ashkhabad to beyond Alma-Ata on the east. The central part of the system, between Samarkand and Tashkent, has good proportions of thermal and hydro power, but the outlying segments are almost entirely dependent on thermal powerplants. Smaller, isolated systems operate in the vicinity of Gur'yev and Krasnovodsk on the east side of the Caspian Sea, in the Amu-Dar'ya delta area, and in the Tadzhik Republic.

The best-developed power network in Soviet Central Asia serves the Tashkent-Fergana Valley area. The system comprises powerplants totaling about 3 million kw. About one-fifth of this capacity is in hydroelectric stations, but the main base loads are sustained by two large modern thermal powerplants, the 750,000-kw.

Tashkent GRES (No. 293) and the 600,000-kw. Angren GRES (No. 292). The main generating plants and distribution points are connected by 220-kv. powerlines with 110-kv. connections to outlying components. From the Tashkent area, a 220-kv. line extends through Samarkand and Bukhara to Mary, with construction under way to Ashkhabad. This circuit links up the power facilities of the main oases in the broad desert.

A 500-kv. connection is being established between Tashkent and the rapidly developing network serving the area from Chimkent to beyond Alma-Ata. The main generating plants now are located in Frunze (No. 299) and Alma-Ata (No. 300), but a much larger thermal powerplant (No. 298) is being built near Dzhambul, and a 1.2 million kw. hydroelectric station (No. 297) is under construction at Toktogul, between Frunze and the Fergana area. High-capacity powerlines from these facilities to Frunze will link up the communities lying between the larger cities, and provide ample power input to the now inadequately served local networks. A 110-kv. line to the northwest from Chimkent meets the modest needs of the small communities along the Syr-Dar'ya River and the adjacent railroad, while similiar lines from Frunze serve sparsely settled areas to the north and to the southeast.

One of the largest of the isolated systems in Soviet Central Asia is that of the Tadzhik Republic, south of the Tashkent-Fergana area. A thermal powerplant (No. 287) at Dushanbe and hydroelectric stations nearby—Kalininabad, Golovnaya GES (No. 284) is the largest—furnish the bulk of the power in a system which is being extended to the west. This Tadzhik system also will be linked to the Tashkent and Samarkand areas by high-capacity powerlines when sufficient generating plant has been installed at the 2.7 million-kw. Nurek GES (No. 286) hydroelectric station, now being built east of Dushanbe.

A number of international transmission lines are now in operation across the western borders of the U.S.S.R. From the Mukachevo transformer (49) in the southwest Ukraine, 400-kv. transmission lines extend to substations at Lemešány in Czechoslovakia and Ludus in Rumania, and two 220-kv. lines are connected to a substation at Sajószöged in Hungary. Another 220-kv. line to East Europe operates between the Ross transformer station (10) in Belorussia and a substation in Bialystok, Poland. These connections are all part of the Mir (Peace) grid, an international power system under development to join U.S.S.R. and East European Communist countries into a single network. The control system for the Soviet Union's portion of the Mir grid is located at Mukachevo transformer station. The U.S.S.R. contributed a net total of almost 1.6 billion kw. in exports to the system in 1966. The system is being strengthened by the addition of another 400-kv. powerline which is being built between the Mukachevo transformer station (49) and Sajószöged, Hungary. Two smaller international connections are also in operation: a 110-kv. line between Kaliningrad, U.S.S.R., and Ketrzyn, Poland, and a 110-kv. powerline from Svetogorsk, Enso LGES-11 (No. 19) to Imatra, Finland. Each of these lines furnishes about 200 million kw.-hr. to the respective foreign country.

The Soviet Union has been negotiating agreements with most of the surrounding countries for the utilization of power resources of boundary rivers. Generally, such agreements have provided that each country build powerplants at separate sites on respective sides of the river, rather than pool resources and benefits. Such powerplants have been built on rivers separating the U.S.S.R. from Finland and Norway, and construction was to be started in 1967 on a project on the Araks River between the U.S.S.R. and Iran. Joint efforts between the U.S.S.R. and Communist China for exploitation of the great power potential of the border section of the Amur River have been abandoned.

Power distribution is generally standardized throughout the country as 3-phase, 50-cycle, alternating current. Centralized administration of the Soviet electric power system has resulted in standardization of transmission at a small number of voltages. The following tabulation shows the range of voltages, by percent of use, in 1966:

| Percent of 334,000-km. network | Operating voltages *Kv.* |
|---|---|
| *39.6* | 35 |
| *40.0* | 110 |
| *15.6* | 220-330 |
| *2.9* | 400-500 |
| *1.7* | 154 |
| *0.2* | 800 |

The 90-km. Konakovo GRES to Moscow 750-kv. transmission line, put in operation in 1967, is the first powerline in the Soviet Union to operate at that voltage. One of the largest transformers in the country (Figure 12) is on this powerline.

Local distribution is accomplished by 35-, 20-, 10-, 6-, and 3-kv. lines. The length of low-voltage distribution lines totaled almost 2 million km. in 1966. During the recent 7-Year Plan (1959-65) more than 1 million km. of low-voltage lines were installed, while 1.4 million km. are planned for installation in the current 5-Year Plan (1966-70). Almost all transmission is by overhead lines, except in the centers of the largest cities, where some underground cables are used. One such long-distance high-voltage transmission line, employing underground conduit, was the experimental 200-kv. direct-current, Kashira-Moscow powerline.

Current for consumers is being standardized at 220/380 volts. In many of the older cities, especially in European U.S.S.R., current is now supplied to private and communal consumers at 127/220 volts. However, these will gradually be converted to 220/380 volts. All industrial consumers receive their power at these standard voltages.

## E. Consumptio [redacted]

25X1

Consumption of electric power in the U.S.S.R. is a significant indicator of industrial growth and of the expansion of the transportation and agricultural sectors of the economy; the absolute increase in power consumption in these areas during the last 7-Year Plan

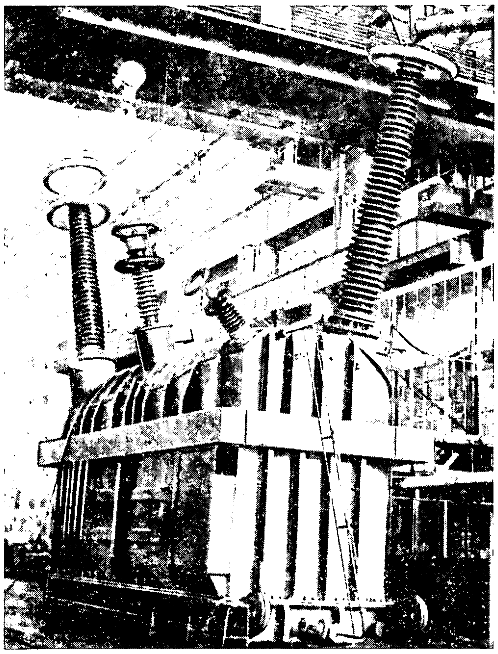

FIGURE 12. A 417,000-KV.-A. AUTOTRANSFORMER FOR THE KONAKOVO GRES (No. 51)-MOSCOW 750-KV. TRANSMISSION LINE. One of the largest transformers manufactured in the U.S.S.R.

25X1

(1959-65) has been outstanding. Production of electric energy in the U.S.S.R. amounted to 544.6 billion kw.-hr. in 1966; after discounting energy consumed by powerplants, transmission losses, and net exports, 466.5 billion kw.-hr. were consumed by end users. As in the past, industry consumed the bulk of the available output, although allocations for transport and rural use have increased sharply in the past few years. The 1966 power production was distributed as follows:

| | BILLION KW.-HR. | PERCENT OF TOTAL OUTPUT |
|---|---|---|
| Industrial | 334.9 | *61.5* |
| Municipal | 52.6 | *9.6* |
| Transport | 40.6 | *7.4* |
| Rural | 23.2 | *4.3* |
| Construction | 15.2 | *2.8* |
| Transmission losses | 38.5 | *7.1* |
| Powerplant use | 38.0 | *7.0* |
| Net exports | 1.6 | *.3* |

In 1966, the United States power industry produced about 1,327 billion kw.-hr., and consumption of electric energy was almost 2.5 times that of the Soviet Union. The distribution by class of consumer also differed sharply as the electric power industry in the United States is geared to meet the requirements of non-industrial consumers and less than half of its power output is allocated to industry.

The pattern and distribution of consumption is extremely uneven and is governed by concentrations of industrial development and major urban populations. Regions of highest power consumption are in the vicinity of Moscow, the Donets Basin, the central Urals, the Kuznetsk Basin in western Siberia, and the Angarsk-Irkutsk region in eastern Siberia. Areas of lesser power consumption are in the vicinity of Leningrad, the Krasnoyarsk-Zaozernyy region in eastern Siberia, and in Soviet Central Asia in the areas surrounding Karaganda, Tashkent, and the Fergana Valley; these are now growing rapidly. Other significant power consumption centers—especially along the Volga River and in the Ukraine—are scattered around the country, but the bulk of the power consumption in the U.S.S.R. occurs in the areas named.

During the past several years, there has been an increase in the development of power production facilities and accompanying consumption in the eastern half of the country, based on the availability of huge fuel resources. Although a further extensive build-up of power production facilities is anticipated over at least the next 15 years, the consumption pattern in eastern Siberia and Central Asia, would remain substantially the same as a result of transmission from these areas to the Urals and to European U.S.S.R. European U.S.S.R. and the Urals will continue to account for as much as two-thirds of the power consumed.

In 1966, industrial consumption of electric power amounted to approximately 61.5% of the total output of the U.S.S.R.; the industrial share of final consumption, after deduction of transmission losses, powerplant use, and net exports, was more than 70%. These percentages, though high, are somewhat less than those prevailing in the past, as the basic needs of other consumers are now gradually being fulfilled.

The principal industrial consumers of electricity are the metallurgical, nuclear, chemical, and heavy machine-building and metalworking industries. These use almost 70% of the industrial consumption and will continue to account for the largest share. The 1966 power consumption by various industries was as follows:

| INDUSTRY | BILLION KW.-HR. | PERCENT CONSUMED |
|---|---|---|
| Ferrous metallurgy | 55.6 | *16.6* |
| Nonferrous metallurgy | 48.6 | *14.5* |
| Nuclear materials | 46.6 | *13.9* |
| Machine building and metal working | 41.5 | *12.4* |
| Chemical | 40.5 | *12.1* |
| Solid fuel | 22.4 | *6.7* |
| Petroleum extraction and processing | 20.8 | *6.2* |
| Construction materials | 18.8 | *5.6* |
| Light industry | 13.7 | *4.1* |
| Timber, wood, paper | 11.4 | *3.4* |
| Food | 8.0 | *2.4* |
| Other | 7.0 | *2.1* |

During the recent 7-Year Plan (1959-65), the greatest gain occurred in the chemical and nuclear industries, moving them up among the industrial leaders as volume consumers of electricity. In the current 5-Year Plan (1966-70), additional Soviet output is to be concentrated in the chemical and non-ferrous metallurgy industries to promote their planned rapid growth. Significantly increased electric power allocations are also planned for machine-building and metalworking, nuclear, and light manufacturing. Among other industries a sizable increase is planned for the production of consumer goods and household appliances. By the end of 1970, industrial consumption of electric power is to approach 500 billion kw.-hr. per year.

The principal use of electricity in Soviet industry is as motive power for production machinery; this takes more than 60% of the supply. Electric motors account for almost 100% of the machine driving power in stationary processes. However, the share of electric energy consumed for electrothermal and electrochemical processes is increasing rapidly. In 1966, these processes required more than 30% of industrial consumption as compared to less than 20% in 1940. Less than 10% is used for lighting, ventilation, and other purposes. In 1965, the per capita consumption of electric power per industrial worker was 11,800 kw.-hr.

Despite industrial priorities, there are periodic shortages in all branches of industry. As a result, industrial enterprises are expected to operate within specified norms to conserve electricity. Since the beginning of the 7-Year Plan (1959-65), a great deal of effort has been expended in national power-saving compaigns; monthly accounts on the fulfillment of electric power norms have been maintained by the industry, and permanent local commissions have been organized to supervise consumption at individual industrial enterprises. The resultant savings have been reported at between 6 and 9 billion kw.-hr. annually over the last 7 years. The current 5-Year Plan (1966-70) calls for an average reduction of consumption norms for electric power by 6% to 8%.

In the transport category, an extensive railroad electrification program has necessitated a steady increase in power allocation. It is estimated that from 75% to 85% of the electric power consumed for transportation is for traction. At the end of 1966, more than 27,000 km. of railroad were electrified, or more than 20% of the railroad lines in the U.S.S.R. Almost 16,000 km. of electrified railroad operate on direct-current catenary systems, but at least four-fifths of all newly electrified lines use alternating current throughout. In 1966, almost 42% of the freight and more than two-thirds of the passengers were transported on electrified railroads. According to the current 5-Year Plan (1966-70), about 37,000 km. of electrified route are to be completed by the end of 1970. This and other increases will raise the consumption of electric power by transport to almost 60 billion kw.-hr. Also included in the transport consumption statistics, is power used to operate navigation locks and canals, and that used for pumping stations on oil and gas pipelines; these are estimated to have required approximately 8 billion kw.-hr. in 1966. Consumption by pipeline pumping stations will probably be allocated an increasing proportion of transport consumption in the future.

Rural electrification has lagged far behind agricultural power requirements in the past, and only in the recent 7-Year Plan (1959-65) were concerted programs initiated to improve the rural power supply. In 1966, 23.2 billion kw.-hr. of electricity were allocated to the rural economy, as compared to 6.9 billion kw.-hr. in 1958. Almost 120,000 small rural powerplants with a total capacity of about 5 million kw. supply less than 25% of the rural consumption, with the remainder being supplied by connections to regional, industrial, and municipal power systems. Intensive efforts are now underway to link the rural economy to the regional grids and to retire thousands of the small, uneconomical stations now being used. Of the power supplied to the rural economy, about 60% is used in agricultural production processes, while the remainder is supplied to the rural populace. Only about two-thirds of the farm houses have electricity, utilized almost entirely for illumination. The per capita consumption of electric power in the rural sector amounted to about 218 kw.-hr. in 1966.

The current 5-Year Plan (1966-70) calls for consumption of electric power in the rural sector to reach 60 billion kw.-hr. by the end of 1970, with the entire increase to be supplied by the power systems. Almost all state and collective farms are to be connected to the systems and an adequate base for the mechanization of all production processes in agriculture is to be formed; secondarily, an effort will be initiated to improve living conditions of the farm workers, based upon increased allocations of electric power.

The extensive building program of the Soviet Union requires a significant expenditure of power. The share of consumption of electric power by the construction industry has remained fairly constant over the last 20 years. The current 5-Year Plan (1966-70) includes widespread construction of new industrial enterprises, large-scale renovation of cities, and a considerable extension of the electric power transmission facilities, pipeline systems, and railroad networks. Most of the electric power consumed by construction is used for the operation of construction machinery. By the end of 1970, the total amount of electric power allocated to the construction sector will probably exceed 25 billion kw.-hr.

By U.S. standards, consumption in urban areas for public, residential, and commercial purposes is extremely low, amounting to less than one-sixth of the U.S. level, and there is little prospect that the inadequacies of urban electrification will be appreciably relieved. The development of additional housing in the urban areas and the growing output of electrical products for household use, has resulted in a gradual increase in consumption in the major urban centers. Despite Soviet claims that massive progress has been made in the electrification of urban housing and communal facilities, the Soviet householder is losing in the domestic competition for electric power resources. In contrast to the U.S., where householders are gaining an increasingly greater share of the total output of electric power, the Soviet householder is being allotted a constantly decreasing share. At the end of 1966, the municipal sector consumed about 9.6% of the total output, while in 1962 the share was 10.9%. By the end of the current 5-Year Plan (1966-70), the consumption of electric power by the municipal sector is expected to be about 77 billion kw.-hr. or 9.2% of the total output. In the U.S.S.R., electrical appliances are perennially in short supply, electrical circuits in new apartments are not built to carry heavy appliance loads, and residential use of electricity is discouraged if not actually rationed. Charging high rates for electricity is another effective means used to reduce domestic consumption. Consumption is about equally divided between household and public needs. The latter principally consists of electricity for government buildings and utilities, with only a negligible amount used for street lighting and virtually none for commercial advertising.

In order to increase the amount of electricity actually reaching the consumer, efforts are underway to reduce losses in transmission by a more careful selection of transmission-line voltages and distances, and to reduce the use of electric power within powerplants. However, the introduction of longer lines means that transmission losses will continue to appropriate an increasing percentage of output. It is estimated that by the end of 1970, about 7.5% of production will be lost in transmission. On the other hand, for the past few years, the Soviets have succeeded in stabilizing electric power for powerplant use at approximately 7%.

Consumption of electric power in the U.S.S.R. has increased spectacularly in the last seven years and is expected to make considerable gains in the future. The greater availability of electricity is still primarily directed toward increasing productivity and only secondarily to provide amenities to the populace. By the end of 1970, the annual consumption of electric power will have grown to approximately 680 billion kw.-hr.

## F. Development

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Soviet power generating capacity can be expected to continue its growth at a rate approximating 10% per year, somewhat greater than most other phases of the Soviet economy. Within the industry, emphasis on construction of thermal rather than hydroelectric powerplants will probably increase. During the 1966-70 period, the principal share of the increase is to be in very large regional thermal powerplants, incorporating larger and more efficient units. After 1970, a greater share of growth will probably come from installation of gas-fired heat and power plants in urban areas near their loads. This is to follow the construction of gas pipelines and storage facilities, to link the major population centers with gas deposits recently discovered in Soviet Central Asia and in northern West Siberia. Integration and consolidation of transmission systems is to continue, with the introduction of higher-voltage, longer-distance transmission during the 1970-75 period. Direct-current 1,500-kv. powerlines are expected to make it economical to transmit power into central European U.S.S.R. over 2,500- to 3,000-km. distances from concentrations of giant powerplants in northeastern Kazakhstan and in the Krasnoyarsk region of Central Siberia. The Soviet power industry is supported by a well developed electrical equipment manufacturing establishment which would not require substantial enlargement to fully support the prospective growth of generating capacity, transmission, and distribution. Research and development facilities have proven capable of originating solutions for technical problems in equipment design and in system planning and operation, and must be considered adequate to meet foreseeable demands.

In the period of the present 5-Year Plan (1966-70), generating plant capacity is to be raised from 115 million kw. to 180 million kw. This 65 million-kw. increase is to be distributed as follows:

| Type of plant | Capacity (*Million kw.*) | Percent |
|---|---|---|
| Large thermal (condensation) | 38.0 | *58* |
| Heat and power | 15.0 | *23* |
| Hydroelectric | 11.0 | *17* |
| Nuclear | 1.0 | *2* |

Annual production of electric power in this period is to increase 66% to reach 800 billion kw.-hr.

Growth during the 1966-70 period is to be accomplished primarily by commissioning and expanding large regional thermal powerplants, which would account for 58% of the new generating capacity. By 1970 they are to provide 40% of power production. Manufacture of generating equipment is currently focused on the production of 300,000-kw. units, but in the next 5-Year Plan period (1971-75) emphasis is to be shifted to the production of 500,000- and 800,000-kw. units. One 500,000-kw. unit has already been installed in the Nazarovo GRES (No. 257), and an 800,000-kw. unit has been assembled for experimental operation at the Slavyansk GRES (No. 134). Six more of these large units are scheduled for production before 1971. Looking farther into the future, Soviet engineers are working on designs for a 1.2 million-kw. unit.

Expansion of existing heat and powerplants, and construction of new ones in the 300,000- to 500,000-kw. size range, is to account for 23% of the total new capacity to be added in the 1966-70 period. In the near future, plants of this type as large as 1 million kw. may be built to meet the rapidly growing needs of large industrial combines for both electric power and steam. The largest heat and power generating units presently being manufactured are of 100,000-kw. capacity, but larger units of up to 250,000 kw. are being developed.

New hydroelectric generating capacity is to amount to 11 million kw. or 17% of the new capacity to be added in this period. Most of this is to be installed at large plants in Central Siberia and Soviet Central Asia. Despite the propaganda advantages derived from these "power giants," enthusiasm for new construction of this type has flagged considerably in recent years, and for the foreseeable future, hydroelectric plants will continue to generate only about 17% of the country's electric power.

In the period of the current 5-Year Plan, the capacity of nuclear powerplants is to be increased by about 1 million kw. This is to be done by expanding the Arkhangel'skoye, Novovoronezhskaya (No. 92) and

Beloyarsk, Uralskaya (No. 208) nuclear powerplants, and by commissioning the Tomsk-2 (No. 241), Shevchenko (No. 277), and Bilibino, Chukotskaya (No. 328) nuclear powerplants. Also in this period, the 800,000-kw. Kola nuclear powerplant will be under construction. Soviet planners do not consider nuclear powerplants the most attractive investment in view of the U.S.S.R.'s enormous fuel and hydropower resources. They are, however, vigorously pursuing research in fields closely related to nuclear power, such as magneto-hydrodynamic generation, heat transfer media other than water, high-temperature resistant materials, and desalination by surplus heat from nuclear reactors.

The U.S.S.R. also has intensive efforts underway for development of geothermal power sources in Kamchatka and in the Caucasus area. Research on solar power is conducted on a more modest scale, chiefly by institutes at Yerevan in Armenia and at Tashkent in Central Asia. Work on devices for generating power from wind apparently receives relatively little attention, probably because the building of small generators is contrary to the Soviet emphasis on large units, and the existence of independent power sources is discouraged. Soviet publications do not indicate a large-scale effort on the development of fuel cells, although foreign technical literature on this topic is closely followed.

Hydroelectric construction will be well advanced within the next five years on the last remaining major projects planned for the Volga and Kama Rivers and for the major part of the Dnepr River. The Cheboksary GES (No. 97) under construction on the Volga, and the Naberezhnyye Chelny, Nizhnekamskaya GES (No. 100) under way on the lower Kama River, will complete the conversion of these rivers into a series of reservoirs. There has been little recent mention of starting construction on schemes to divert water from northward-flowing rivers of European U.S.S.R. into the upper Volga and Kama to augment their flow. On the Dnepr River, work has been started on the Kanev GES (No. 148), which will complete the use of all but the upper course of that river. With the additional storage provided by the reservoirs upstream, it has become practical to more than double the 651,000-kw. installed capacity of the Zaporozh'ye, Dnepro GES (No. 139).

Other major hydroelectric projects are located in the Caucasus, central and eastern Siberia, and Soviet Central Asia. In the Caucasus, work is well advanced on the 1.3 million-kw. Dzhvari, Ingurskaya GES (No. 169); this will be the world's highest concrete arch dam, rising 301 meters (988 ft.) from foundation to crest. In Central Siberia on the Yenisey River, the 6 million-kw. Divnogorsk, Krasnoyarsk GES (No. 258) will be completed by 1970, and construction has started on the 6,360,000-kw. Mayna, Sayan GES (No. 260). On the Angara River, the 4,320,000-kw. Nevon, Ust'-Ilimskaya GES (No. 313) is being built, and farther east, the 1,020,000-kw. Berezovka, Zeyskaya GES (No. 330) on the Zeya River. The outstanding project in Soviet Central Asia is the 2.7 million-kw. Nurek GES (No. 286); this will have the world's highest rockfill dam, rising 298 meters (977 ft.). In the 1970's the concentration on sites in Siberia and Soviet Central Asia will probably continue, as there will be few economically attractive sites remaining in European U.S.S.R., the Caucasus, and the Urals.

Within the next 10 years, the Soviets may be expected to make substantial progress toward one of their primary goals, the transmission of massive amounts of power from low-cost sources in Kazakhstan and Central Siberia to centers of industry and population in the western parts of the U.S.S.R. where fuel costs are much higher. During 1967, a 750-kv. alternating current powerline from the Konakovo GRES (No. 51) thermal powerplant to the Moscow/Belyy Rast transformer station (11) was commissioned. This is an extended field test of this facility to determine the reliability or shortcomings of the novel equipment involved. When proven, many of the components can be adapted for direct-current lines to be operated at 750 kv. positive and negative with reference to ground, and consequently at 1500 kv. with reference to each other. Well proven conversion equipment, now in use on the 800-kv. direct-current line from the Volgograd GES (No. 117) hydroelectric station to the Mikhaylovka Transformer Station (Substation No. 34) in the Donbass, can probably be adapted to operate at the higher voltage with little difficulty. Such 1500-kv. direct-current powerlines are calculated to reduce losses to quite acceptable levels over the 2,500- to 3,000-km. distances involved. The formulation of plans for the Ekibastuz-Center powerlines (from northeastern Kazakhstan to central European U.S.S.R.) has been announced, although details as to terminals and route are not yet available. Other major transmission lines, uniting or consolidating existing systems, have been described in Subsection D, Transmission and Distribution Facilities.

The Soviet electric power industry has long demonstrated ability to make the largest-scale plans and to solve major technical and production problems related to carrying out tremendous engineering projects. The country has exceptionally great resources for both thermal and hydro power development, and may be expected to devote the necessary capital and materials to continue the improvement of its electric power supply.

## G. Statistical data

This subsection consists of detailed data in the general order of reference in the text. 25X1

FIGURE 13. SELECTED POWERPLANTS, OPERATING OR UNDER CONSTRUCTION, 196

| MAP REF. NO.* | NAME | INSTALLED CAPACITY | TYPE | MAJOR GRID AREAS SERVED | REMARKS |
|---|---|---|---|---|---|
| | | *Thousand kw.* | | | |
| 33 | Ahtme TETs | 157 | Steam | Leningrad-Baltic | Burns oil shale. |
| 233 | Aktyubinsk TETs | 150 | ...do | Urals | Located in and serves Aktyubinsk ferroalloy-steel plant. |
| 73 | Aleksin TETs-15 | 150 | ...do | Moscow-Gor'kiy | ... |
| 187 | Ali-Bayramly GRES | 750 | ...do | Azerbaijan | Under expansion; 900,000 kw. in 1967, to reach 1.2 million kw. by 1970. One of the largest powerplants in system. |
| 300 | Alma-Ata, Pokrovka GRES | 200 | ...do | Alma-Ata | Under expansion; to be 300,000 kw. by 1970. |
| 335 | Amursk TETs-1 | 25 | ...do | ... | Under expansion; to be 125,000 kw. in 1968. Principal consumer is the Amursk cellulose plant. |
| 317 | Angarsk, Sukhovskaya TETs-10 | 1,100 | ...do | Eastern Siberia | Principal consumer is the Angarsk uranium isotope separation plant. |
| 315 | Angarsk TETs-1 | 320 | ...do | ...do | Principal consumer is the Angarsk synthetic fuels plant. |
| 316 | Angarsk TETs-9 | 100 | ...do | ...do | Under expansion; to be 300,000 kw. by 1970. Principal consumer is Angarsk petroleum refinery. |
| 292 | Angren GRES | 600 | ...do | Tashkent-Fergana | Under expansion; to be 1.2 million kw. by 1971. |
| 219 | Argayash TETs | 250 | ...do | Urals | ... |
| 92 | Arkhangel'skoye Novo-Voronezh AES | 240 | Steam-Nuclear | Moscow-Gor'kiy | Under expansion; to be 640,000 kw. by 1970. |
| 338 | Artem GRES | 397 | Steam | Far East, Primorskiy | Under expansion; to be 497,000 kw. in 1968. |
| 207 | Asbest, Reftinskaya GRES | ... | ...do | Urals | Under construction; first 300,000 kw. unit to be commissioned in 1969, capacity of the first stage to be 1.2 million kw., final capacity to be 3.2 million kw. To be one of the largest powerplants in Urals system. |
| 281 | Ashkhabad, Bezmein GRES | 173 | ...do | ... | Serves small Turkmen grid. |
| 120 | Astrakhan', Astra GRES | 115 | ...do | ... | ... |
| 177 | Atarbekyan GES | 81 | Hydro | Armenian | ... |
| 191 | Baku, Krasnaya Zvezda TETs | 114 | Steam | Azerbaijan | Under expansion; capacity to be 164,000 kw. in 1970. |
| 190 | Baku, Severnaya GRES | 600 | ...do | ...do | Under expansion; 750,000 kw. in 1967. Has "outdoor" boilers, first of type installed in U.S.S.R. |
| 83 | Balakhna, Gor'kiy GRES-1 | 259 | ...do | Moscow-Gor'kiy | One of first and largest peat-fired powerplants in U.S.S.R. |
| 113 | Balakovo, Saratov GES | ... | Hydro | Middle Volga | Under construction; first units commissioned in 1967; capacity to be 1,290,000 kw. by 1971. |
| 114 | Balakovo TETs | 300 | Steam | ...do | ... |
| 302 | Balkhash TETs | 200 | ...do | Karaganda | ... |
| 238 | Barabinsk GRES | 300 | ...do | Kuzbass | ... |
| 255 | Barnaul TETs-2 | 200 | ...do | ...do | Under expansion; 250,000 kw. in 1967. |
| 319 | Baykal'sk TETs | 50 | ...do | Eastern Siberia | Under expansion; to be 100,000 kw. in 1968. |
| 288 | Begovat, Farkhad GES | 124 | Hydro | Tashkent-Fergana | ... |
| 294 | Begovat, Syrdar'inskaya GRES | ... | Steam | ...do | Underconstruction; final capacity to be 4.4 million kw. First unit to be in operation by 1970. |
| 249 | Belovo GRES | 800 | ...do | Kuzbass | Under expansion; 1 million kw. in 1967, to reach 1.2 million kw. by 1968. Focal point of important powerlines of Kuzbass system. |
| 208 | Beloyarskoye, AES | 100 | Steam-Nuclear | Urals | Being enlarged; 300,000 kw. in 1967. Also referred to as Urals nuclear powerplant. |

Footnotes are at end of table.

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FIGURE 13. SELECTED POWERPLANTS, OPERATING OR UNDER CONSTRUCTION, 1966 (Continued)

| MAP REF. NO.* | NAME | INSTALLED CAPACITY | TYPE | MAJOR GRID AREAS SERVED | REMARKS |
|---|---|---|---|---|---|
| | | *Thousand kw.* | | | |
| 42 | Bereza | 750 | Steam | Belorussian | Largest powerplant in Belorussian system. |
| 194 | Berezniki, BMZ TETs-2 | 100 | ....*do* | Urals | Located at and serves Berezniki magnesium plant. |
| 330 | Berezovka, Zeyskaya GES | ... | Hydro | ... | Under construction; final capacity to be 1.5 million kw. by 1974. Will serve the Soviet Far East power system. |
| 256 | Biysk TETs | 90 | Steam | Kuzbass | To be expanded. |
| 328 | Bilibino, Chukotskaya AES | ... | Steam-Nuclear | ... | Under construction; first units to be in operation by 1970. Final capacity to be 48,000 kw. |
| 307 | Bodaybo, Mamakan GES | 84 | Hydro | ... | Serves small Mamakan grid. |
| 311 | Bratsk GES | 4,050 | ....*do* | Eastern Siberia | World's largest powerplant. Major power source for the Central Siberian power system. |
| 312 | Bratsk TETs-1 | 100 | Steam | ....*do* | Located at and serves Bratsk lumber combine. |
| 296 | Brichmulla, Charvak GES | ... | Hydro | Tashkent-Fergana | Under construction; final capacity to be 600,000 kw. Will be in operation by 1970. |
| 155 | Burshtyn GRES | 800 | Steam | West Ukraine | Under construction; reached 1.2 million kw. in 1967, to be 2.4 million kw. by 1975. Largest powerplant in system. |
| 295 | Chardara GES | 100 | Hydro | Tashkent-Fergana | ... |
| 192 | Chaykovskiy, Votkinsk GES | 1,000 | ....*do* | Urals | ... |
| 97 | Cheboksary GES | ... | ....*do* | Middle Volga | Under construction; first units to be commissioned in 1972; capacity to be 1.4 million kw. by 1975. |
| 96 | Cheboksary TETs | 100 | Steam | ....*do* | ... |
| 222 | Chelyabinsk, Bakal'stroy TETs | 135 | ....*do* | Urals | Located in and serves the Bakal'stroy steel plant. |
| 221 | Chelyabinsk GRES | 150 | ....*do* | ....*do* | Under expansion; to be 200,000 kw. in 1968. |
| 220 | Chelyabinsk TETs-1 | 300 | ....*do* | ....*do* | ... |
| 223 | Chelyabinsk TETs-2 | 100 | ....*do* | ....*do* | Under expansion; 200,000 kw. in 1967, to be 300,000 kw. in 1968. |
| 72 | Cherepet', MoGRES-19 | 1,500 | ....*do* | Moscow-Gor'kiy | One of largest plants serving Moscow; No. 19 of the Moscow area system. |
| 54 | Cherepovets TETs | 132 | ....*do* | ....*do* | Located at and serves Cherepovets metallurgical combine. |
| 147 | Cherkassy TETs | 100 | ....*do* | Central Ukraine | Under expansion; to reach 300,000 kw. by 1970. Serves Cherkassy chemical combine. |
| 153 | Chernigov TETs | 100 | ....*do* | ....*do* | ... |
| 306 | Chernyshevskiy, Vilyuyskaya GES | ... | Hydro | ... | Under construction; first 75,000 kw. unit went into operation in 1967. Final capacity to be 300,000 kw. |
| 322 | Chita GRES | 200 | Steam | ... | Under expansion; to be 500,000 kw. by 1970. |
| 136 | Chuguyev, Khar'kov GRES-2 | 270 | ....*do* | Central Ukraine | ... |
| 324 | Chul'man GRES | 24 | ....*do* | ... | To be expanded. Serves small Chul'man grid. |
| 326 | Debin, Kolyma GES | ... | Hydro | ... | Under construction; final capacity to be 750,000 kw. by 1975. |
| 258 | Divnogorsk, Krasnoyarsk GES | ... | ....*do* | Eastern Siberia | Under construction on the Yenisey; first two 500,000 kw. units commissioned in 1967, capacity to reach 56 million kw. by 1970. It will then be world's most powerful hydroelectric station. |
| 140 | Dneprodzerzhinsk, Dzerzhinskiy GRES | 248 | Steam | Central Ukraine | ... |
| 141 | Dneprodzerzhinsk GES | 350 | Hydro | ....*do* | ... |
| 138 | Dnepropetrovsk Pridneprovskaya GRES | 2,400 | Steam | ....*do* | Largest thermal powerplant in the world. |

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| | | | | | |
|---|---|---|---|---|---|
| 159 | Dnestrovsk, Moldavskaya GRES | 800 | ....do | Moldavian | Under expansion; reached 1.2 million kw. in 1967, to be 2.4 million kw. by 1975. |
| 154 | Dobrotvor GRES | 700 | ....do | West Ukraine | One of main powerplants in system. |
| 49 | Dorogobuzh GRES | 200 | ....do | Moscow-Gor'kiy | ... |
| 27 | Dubrovka, LGES-8 | 312 | ....do | Leningrad-Baltic | Largest peat-fired powerplant in U.S.S.R. No. 8 of Leningrad area powerplants. |
| 287 | Dushanbe TETs | 218 | ....do | Tadzhik | ... |
| 84 | Dzerzhinsk, Igumnovskaya TETs | 195 | ....do | Moscow-Gor'kiy | ... |
| 86 | Dzerzhinsk TETs | 300 | ....do | ....do | ... |
| 298 | Dzhambul GRES | ... | ....do | Tashkent-Fergana | Under construction; first 200,000 kw. unit installed in 1967. Final capacity to be 1.2 million kw. |
| 274 | Dzhezkazgan, Kingir TETs | 150 | ....do | Karaganda | ... |
| 169 | Dzhvari, Ingurskaya GES | ... | Hydro | Georgian | Under construction; first unit of 260,000 kw. to be commissioned in 1970, capacity to reach 1.3 million kw. by 1973. Project incorporates world's tallest concrete arch dam, 301 meters (988 feet) high. |
| 39 | Elektrenai, Litovskaya GRES | 600 | Steam | Leningrad-Baltic | Being enlarged; capacity to be 1.2 million kw. in 1968. |
| 115 | Engel's TETs-3 | 50 | ....do | Middle Volga | Under construction; to be 200,000 kw. in 1968. |
| 290 | Fergana TETs-2 | 150 | ....do | Tashkent-Fergana | Under expansion; to be 200,000 kw. in 1968. Located in and serves petroleum refinery. |
| 299 | Frunze TETs | 400 | ....do | Frunze | Under expansion; to be 800,000 kw. by 1970. |
| 176 | Gardabani, Tbilisi GRES | 450 | ....do | Georgian | Under expansion; capacity to be 900,000 kw. in 1968. |
| 87 | Gor'kiy, Novogor'kovskaya TETs | 200 | ....do | Moscow-Gor'kiy | ... |
| 85 | Gor'kiy, GAZ-1 TETs | 249 | ....do | ....do | Located at and serves Gor'kiy motor vehicle plant. |
| 82 | Gorodets, Gor'kiy GES | 520 | Hydro | ....do | Major dam on Volga River. |
| 165 | Groznyy, Novogroznenskiy TETs-1 | 350 | Steam | North Caucasus | ... |
| 166 | Groznyy TETs-3 | 50 | ....do | ....do | Under construction; second 50,000 kw. unit commissioned in 1967, to reach 200,000 kw. by 1970. |
| 196 | Gubakha, Kizel GRES-1 | 102 | ....do | Urals | ... |
| 276 | Gur'yev TETs-2 | 49 | ....do | ... | Under expansion; to be 99,000 kw. in 1968. Serves small Gur'yev grid. |
| 320 | Guzinoozersk GRES | ... | ....do | Eastern Siberia | Under construction; final capacity to be 600,000 kw. |
| 178 | Gyumush GES | 224 | Hydro | Armenian | ... |
| 301 | Ili, Kapchagay GES | ... | ....do | Alma-Ata | Under construc[illegible], to be in operation by 1970. Final capacity to be 440,000 kw. |
| 12 | Inta TETs-2 | 49 | Steam | ... | ... |
| 230 | Iriklinskiy GRES | ... | ....do | Urals | Under construction; first 300,000 kw. unit to be commissioned in 1968, capacity to reach 900,000 kw. in 1970, 1.8 million kw. by 1975. |
| 318 | Irkutsk, Angara GES | 660 | Hydro | Eastern Siberia | ... |
| 59 | Ivanovo TETs-2 | 123 | Steam | Moscow-Gor'kiy | ... |
| 38 | Jaunjelgava, Plavinas GES | 825 | Hydro | Leningrad-Baltic | Largest hydroelectric plant in northwest European U.S.S.R. |
| 161 | Kakhovka GES | 312 | ....do | Central Ukraine | ... |
| 50 | Kalinin TETs-4 | 172 | Steam | Moscow-Gor'kiy | ... |
| 284 | Kalininabad, Golovnaya GES | 210 | Hydro | Tadzhik | ... |
| 41 | Kaliningrad GRES-2 | 90 | Steam | Leningrad-Baltic | ... |
| 254 | Kaltan, Yuzhno-Kuzbasskaya | 500 | ....do | Kuzbass | One of main base load plants in Kuzbass system. |
| 156 | Kalush TETs | ... | ....do | West Ukraine | Under construction; first two 50,000 kw. units in 1967. Capacity to reach 300,000 kw. |
| 209 | Kamensk-Ural'skiy, Krasnogorsk TETs | 350 | ....do | Urals | ... |

Footnotes are at end of table.

FIGURE 13. SELECTED POWERPLANTS, OPERATING OR UNDER CONSTRUCTION, 1966 (Continued)



| MAP REF. NO.* | NAME | INSTALLED CAPACITY | TYPE | MAJOR GRID AREAS SERVED | REMARKS |
|---|---|---|---|---|---|
| | | *Thousand kw.* | | | |
| 5 | Kandalaksha, Niva GES-3 | 150 | Hydro | Murmansk | ... |
| 148 | Kanev GES | ... | ....*do* | Central Ukraine | Under construction; first units to be commissioned in 1970, capacity to reach 420,000 kw. by 1972. This powerplant will complete development of major part of Dnepr River. |
| 193 | Karmanovo GRES | ... | Steam | Urals | Under construction; first 300,000 kw. unit is to be commissioned in 1968, capacity to reach 1.2 million kw. in 1970, 2.4 million kw. by 1975. Powerlines from this plant will strengthen tie between Urals and European U.S.S.R. systems. |
| 78 | Kashira, MoGRES-4 | 312 | ....*do* | Moscow-Gor'kiy | Under expansion; to be 1,262,000 kw. in 1970. Has highest temperature and pressure unit in U.S.S.R. |
| 98 | Kazan' TETs-2 | 325 | ....*do* | Middle Volga | ... |
| 99 | Kazan' TETs-3 | ... | ....*do* | ....*do* | Under construction; first 50,000 kw. unit to be commissioned in 1968, capacity to be 350,000 kw. |
| 37 | Kegums GES | 70 | Hydro | Leningrad-Baltic | Under expansion; to be 200,000 kw. by 1969. |
| 15 | Kem', Putkinskaya GES | ... | ....*do* | ....*do* | Under construction; capacity 84,000 kw. in 1967. |
| 247 | Kemerovo TETs | 224 | Steam | Kuzbass | Under expansion; capacity to be 274,000 kw. in 1968, and 374,000 kw. by 1970. |
| 248 | Kemerovo, Novo-Kemerovskiy TETs | 142 | ....*do* | ....*do* | Under expansion; capacity to be 192,000 kw. in 1968, and to reach 292,000 kw. by 1970. |
| 332 | Khabarovsk, Ussuriyskiy TETs-1 | 150 | ....*do* | ... | Under expansion; 250,000 kw. in 1967. To be linked to the Far East power system. |
| 150 | Kiev, Darnitsa TETs-4 | 250 | ....*do* | Central Ukraine | ... |
| 152 | Kiev GES | 163 | Hydro | ....*do* | Under construction; capacity to be 526,000 kw. by 1972. |
| 151 | Kiev TETs-2 | 120 | Steam | ....*do* | ... |
| 28 | Kirishi GRES | 150 | ....*do* | Leningrad-Baltic | Under construction; capacity to 1,350,000 kw. by 1970. Associated with major petroleum refinery. |
| 94 | Kirov, Kirovo-Chepetskiy TETs-3 | 198 | ....*do* | Urals | ... |
| 95 | Kirov TETs-4 | 200 | ....*do* | ....*do* | Reached 250,000 kw. in 1967. |
| 183 | Kirovabad TETs | 75 | ....*do* | Azerbaijan | Under expansion; 100,000 kw. in 1967. |
| 4 | Kirovsk GRES | 200 | ....*do* | Murmansk | Largest thermal powerplant in system. |
| 40 | Klaipeda GRES | ... | ....*do* | Leningrad-Baltic | Under construction; capacity to be 600,000 kw. by 1975. |
| 6 | Knyazhaya Guba GES | 128 | Hydro | Murmansk | ... |
| 34 | Kohtla-Järve TETs-2 | 108 | Steam | Leningrad-Baltic | Burns oil shale. |
| 1 | Kolttakengyas, Borisoglebskaya GES | 56 | Hydro | Murmansk | ... |
| 333 | Komsomol'sk, Amurstal' TETs-1 | 125 | Steam | ... | Under expansion; to be 200,000 kw. by 1969. Principal consumer is the Amurstal' steel plant. |
| 58 | Komsomol'sk, Ivanovo GRES | 134 | ....*do* | Moscow-Gor'kiy | ... |
| 334 | Komsomol'sk TETs-2 | 74 | ....*do* | ... | Under expansion; to be 124,000 kw. by 1969. |
| 51 | Konakovo GRES | 1,200 | ....*do* | Moscow-Gor'kiy | Under construction; capacity to be 2.4 million kw. in 1968. Largest powerplant in Moscow area. |
| 7 | Konets-Kovdozero, Iovskaya GES | 80 | Hydro | Murmansk | ... |
| 10 | Kotlas TETs-2 | 100 | Steam | ... | Located at and serves Koryazhma cellulose plant. |

| | | | | | |
|---|---|---|---|---|---|
| 163 | Krasnodar TETs | 800 | ....do | North Caucasus | Under expansion; capacity to be 950,000 kw. in 1968, 1.2 million kw. by 1972. |
| 200 | Krasnokamsk, Zakam TETs-5 | 150 | ....do | Urals | ... |
| 201 | Krasnoturinsk, Bogoslovskiy TETs | 175 | Steam | Urals | Located in and serves Bogoslov aluminum combine. |
| 279 | Krasnovodsk TETs-2 | 20 | ....do | ... | Under construction; final capacity to be 170,000 kw. |
| 259 | Krasnoyarsk TETs-1 | 524 | ....do | Eastern Siberia | Under expansion; capacity to be 624,000 kw. in 1968. |
| 122 | Krasnyy Sulin, Nesvetay GRES | 300 | ....do | Donbass | ... |
| 145 | Kremenchug GES | 625 | Hydro | Central Ukraine | Dam impounds largest reservoir on Dnepr River; powerplant is focal point for several major powerlines. |
| 146 | Kremenchug TETs | 100 | Steam | ....do | Under construction; capacity 150,000 kw. in 1967. |
| 137 | Khar'kov TETs-3 | 149 | ....do | ....do | ... |
| 142 | Krivoy Rog, Krivorozhskiy TETs-1 | 107 | ....do | ....do | ... |
| 8 | Kundozero, Kumskaya GES | 83 | Hydro | Murmansk | ... |
| 234 | Kurgan TETs | 300 | Steam | Urals | ... |
| 93 | Kursk, Ryshkovo TETs | 200• | ....do | ... | ... |
| 171 | Kutaisi, Namakhvanskaya GES | ... | Hydro | Georgian | Under construction; first units to be commissioned in 1970, capacity to reach 480,000 kw. by 1974. |
| 110 | Kuybyshev, Bezimyanka TETs | 150 | Steam | Middle Volga | ... |
| 112 | Kuybyshev, Novokuybyshev TETs-1 | 255 | ....do | ....do | ... |
| 111 | Kuybyshev, Novokuybyshev TETs-2 | 200 | ....do | ....do | ... |
| 275 | Kzyl-Orda TETs | 24 | ....do | Tashkent-Fergana | Under expansion; capacity to reach 98,000 kw. by 1972. |
| 158 | Ladyzhin, Yuzhnaya GRES | ... | ....do | West Ukraine | Under construction; first 300,000 kw. unit to be commissioned in 1970, capacity to reach 1.8 million kw. by 1975, 2.6 million kw. by 1978. Powerlines from this plant will link networks of central and western Ukraine. |
| 289 | Leninabad, Kayrak-Kum GES | 126 | Hydro | Tashkent-Fergana | ... |
| 25 | Leningrad, Kirovskaya TETs-15 | 100 | Steam | Leningrad-Baltic | Under expansion; to be 200,000 kw. by 1970. No. 15 of Leningrad area. |
| 23 | Leningrad, Krasnyy Oktyabr GRES-5 | 111 | ....do | ....do | No. 5 of Leningrad area system. |
| 21 | Leningrad, LGES-1 | 101 | ....do | ....do | No. 1 of Leningrad area system; acronym is applied to either thermal or hydro powerplants within system; this practice is found only in Leningrad and Moscow area systems. |
| 22 | Leningrad, LGES-2 | 111 | ....do | ....do | ... |
| 24 | Leningrad TETs-14 | 200 | ....do | ....do | ... |
| 26 | Leningrad TETs-17 | 50 | ....do | ....do | Under expansion; capacity to be 250,000 kw. by 1971. |
| 265 | Leninogorsk TETs-2 | 149 | ....do | Altay-Pavlodar | ... |
| 90 | Lipetsk TETs | 124 | ....do | Moscow-Gor'kiy | ... |
| 132 | Lisichansk TETs-2 | 150 | ....do | Donbass | Under expansion; to be 300,000 kw. by 1970. |
| 126 | Lugansk GRES | 1,500 | ....do | ....do | Under expansion; to be 2.3 million kw. by 1969. |
| 131 | Luganskoye, Mironovskaya GRES | 500 | ....do | ....do | ... |
| 47 | Lukoml', Belorusskaya GRES | ... | ....do | Belorussian | Under construction; capacity to be 600,000 kw. in 1969, 2.4 million kw. by 1975. Will be largest powerplant in Belorussia. |
| 327 | Magadan TETs | 26 | ....do | ... | Under expansion; to be 500,000 kw. by 1970. Serves small Magadan grid. |
| 228 | Magnitogorsk TETs-1 | 152 | ....do | Urals | ... |
| 227 | Magnitogorsk TETs-3 | 200 | ....do | ....do | ... |
| 282 | Mary, Prikopetdagskaya GRES | ... | ....do | Tashkent-Fergana | Under construction; to be 200,000 kw. by 1970. Final capacity to be 1.8 million kw. |

Footnotes are at end of table.

25X1

FIGURE 13. SELECTED POWERPLANTS, OPERATING OR UNDER CONSTRUCTION, 1966 (Continued)

| MAP REF. NO.* | NAME | INSTALLED CAPACITY | TYPE | MAJOR GRID AREAS SERVED | REMARKS |
|---|---|---|---|---|---|
| | | *Thousand kw.* | | | |
| 260 | Mayna, Sayan GES | ... | Hydro | Eastern Siberia | Under construction; capacity to be 1,060,000 kw. by 1971, 6,360,000 kw. by 1975. |
| 104 | Melekess, Ul'yanovskaya AES | 70 | Steam-Nuclear | Middle Volga | ... |
| 185 | Mingechaur GES | 359 | Hydro | Azerbaijan | ... |
| 44 | Minsk TETs-4 | ... | Steam | Belorussian | Under construction; capacity to be 600,000 kw. by 1975. |
| 43 | Minsk, Zavodskaya TETs-3 | 400 | ....*do* | ....*do* | ... |
| 68 | Moscow, Kaluzhskaya TETs-20 | 550 | ....*do* | Moscow-Gor'kiy | ... |
| 69 | Moscow, Khovrinskaya TETs-21 | 300 | ....*do* | ....*do* | Under expansion; to be 1.1 million kw. by 1972. |
| 67 | Moscow, Leningradskiy TETs-16 | 400 | ....*do* | ....*do* | Under expansion; to be 600,000 kw. in 1968. |
| 63 | Moscow, Smidovich TETs-1 | 108 | ....*do* | ....*do* | One of the oldest powerplants in U.S.S.R. |
| 64 | Moscow TETs-9 | 248 | ....*do* | ....*do* | Also referred to as VTI TETs; serves a Moscow research institute. |
| 65 | Moscow TETs-11 | 300 | ....*do* | ....*do* | Under expansion; to be 600,000 kw. by 1969. |
| 66 | Moscow TETs-12 | 312 | ....*do* | ....*do* | Also referred to as Frunze TETs. |
| 70 | Moscow TETs-22 | 500 | ....*do* | ....*do* | Also referred to as Lyŭbertsy TETs. |
| 71 | Moscow TETs-23 | 100 | ....*do* | ....*do* | Under construction; capacity to be 300,000 kw. in 1968. Also referred to as Izmaylovŏ TETs. |
| 325 | Myaundzha, Arkagala GRES | 120 | Steam | ... | Under expansion; to be 151,000 kw. by 1968. Serves small Magadan grid. |
| 253 | Myski, Tom-Usinskaya GRES | 1,300 | ....*do* | Kuzbass | Largest powerplant in Kuzbass system. |
| 100 | Naberezhnyye Chelny, Nizhnekamskaya GES. | ... | Hydro | Middle Volga | Under construction; first 54,000 kw. unit to go on line in 1970, capacity to reach 1,080,000 kw. by 1974. Also referred to as Lower Kama GES. |
| 337 | Nadarovka, Primorskaya GRES | ... | Steam | Far East, Primorskiy | Under construction; first 200,000 kw. unit to be in operation by 1970. Final capacity to be 1.2 million kw. |
| 16 | Nadvoytsy, Ondskaya GES | 80 | Hydro | Leningrad-Baltic | ... |
| 32 | Narva, Estonskaya GRES | ... | Steam | ....*do* | Under construction; capacity to be 1 million kw. by 1970, 1.6 million kw. by 1974. To burn oil shale. |
| 30 | Narva GES | 144 | Hydro | ....*do* | ... |
| 31 | Narva, Pribaltiyskaya GRES-1 | 1,600 | Steam | ....*do* | Largest powerplant in northwestern European U.S.S.R.; uses oil shale as fuel. |
| 283 | Navoi GRES | 400 | ....*do* | Tashkent-Fergana | Under expansion; 600,000 kw. in 1967, to be 1,250,000 kw. by 1971. |
| 257 | Nazarovo GRES | 900 | ....*do* | Eastern Siberia | Under expansion; to reach 1.4 million kw. in 1968, after commissioning of first 500,000 kw. unit in U.S.S.R. Capacity to reach 2.4 million kw. by 1971; this is first of several giant powerplants to be built in this central Siberian area. |
| 280 | Nebit-Dad gas turbine powerplant | 24 | Gas turbine | ... | Under expansion; to be 48,000 kw. by 1970. |
| 164 | Nevinnomyssk GRES | 800 | Steam | North Caucasus | Under expansion; capacity to be 1.1 million kw. in 1968. |
| 313 | Nevon, Ust'Ilimskaya GES | ... | Hydro | Eastern Siberia | Under construction on Angara River; to be in operation by 1972. Final capacity to be 4,320,000 kw. |
| 101 | Nizhnekamsk TETs | ... | Steam | Middle Volga | Under construction in 1966; first 50,000 kw. unit in 1967; to be 200,000 kw. by 1969. Power supply for builders' settlement at construction site of Nizhnekamskaya GES (No. 100). |

| | | | | | |
|---|---|---|---|---|---|
| 204 | Nizhniy Tagil TETs | 100 | ....*do* | Urals | Located in and serves Nizhniy Tagil railroad car manufacturing plant. |
| 203 | Nizhnaya Tura GRES | 525 | ....*do* | ....*do* | ... |
| 304 | Noril'sk TETs–2 | ... | ....*do* | Noril'sk | Under construction; to be 100,000 kw. by 1970. Final capacity to be 300,000 kw. Located at the Talnakh mines. |
| 303 | Noril'sk TETs–1 | 575 | ....*do* | ....*do* | Under expansion; 625,000 kw. in 1967. |
| 29 | Novgorod TETs | ... | ....*do* | Leningrad-Baltic | Under construction; final capacity to be 300,000 kw. |
| 124 | Novocherkassk GRES | 600 | ....*do* | Donbass | Under construction; final capacity to be 2,400,000 kw. |
| 144 | Novodneprovka GRES | ... | ....*do* | Central Ukraine | Under construction; first 800,000 kw. unit to be commissioned in 1970, capacity to reach 3.2 million by 1975. |
| 252 | Novokuznetsk TETs–1 | 208 | ....*do* | Kuzbass | Located at the Novokuznetsk metallurgical combine. |
| 251 | Novokuznetsk TETs–2 | 300 | ....*do* | ....*do* | Located at the Novokuznetsk aluminum plant. |
| 250 | Novokuznetsk, ZapSib TETs | 200 | ....*do* | ....*do* | Being enlarged; to be 350,000 kw. in 1968. Located at the Novokuznetsk West Siberian metallurgical plant. |
| 76 | Novomoskovsk GRES–10 | 400 | ....*do* | Moscow-Gor'kiy | ... |
| 246 | Novosibirsk GES | 400 | Hydro | Kuzbass | Only major hydroelectric station serving Kuzbass system. |
| 243 | Novosibirsk TETs–2 | 300 | Steam | ....*do* | ... |
| 244 | Novosibirsk TETs–3 | 200 | ....*do* | ....*do* | ... |
| 245 | Novosibirsk TETs–4 | 100 | ....*do* | ....*do* | Under construction; to be 200,000 kw. in 1968, 400,000 kw. by 1970. |
| 167 | Novyy Chirkey, Chirkeyskaya GES | ... | Hydro | North Caucasus | Under construction; capacity to be 250,000 kw. in 1970, 1 million kw. by 1972. |
| 286 | Nurek GES | ... | ....*do* | Tadzhik | Under construction; final capacity to be 2.7 million kw. To serve the Central Asian power system. |
| 160 | Odessa TETs–3 | 138 | Steam | Moldavian | ... |
| 236 | Omsk TETs–3 | 450 | ....*do* | Petropavlovsk-Omsk | Located in and serves Omsk petroleum refinery. |
| 237 | Omsk TETs–4 | 100 | ....*do* | ....*do* | Under construction; to reach 350,000 kw. by 1970. |
| 232 | Orsk, Novo-Troitskaya TETs–3 | 198 | ....*do* | Urals | Located in and serves Novo-Troitsk steel plant. |
| 231 | Orsk TETs–1 | 253 | ....*do* | ....*do* | ... |
| 267 | Pavlodar TETs–1 | 150 | ....*do* | Altay-Pavlodar | Under expansion; 200,000 kw. in 1967. Principal consumer is Pavlodar alumina and aluminum plant. |
| 268 | Pavlodar TETs–2 | 100 | ....*do* | ....*do* | Under expansion; to be 200,000 kw. in 1969. |
| 269 | Pavlodar TETs–3 | ... | ....*do* | ....*do* | Under construction; capacity to be 50,000 kw. in 1970, 300,000 kw. in 1975. Principal consumer will be the new oil refinery. |
| 211 | Pavlovka, Ufa GES | 170 | Hydro | Urals | ... |
| 89 | Penza TETs–1 | 124 | Steam | Moscow-Gor'kiy | ... |
| 80 | Perkino, Ryazan' GRES | ... | ....*do* | ....*do* | Under construction; capacity to be 300,000 kw. in 1970, 1.8 million kw. by 1975. |
| 197 | Perm', Kamskaya GES | 505 | Hydro | Urals | First large hydroelectric station on Kama River. |
| 199 | Perm' TETs–9 | 200 | Steam | ....*do* | Located in and serves Perm' petroleum refinery. |
| 198 | Perm' TETs–14 | 50 | ....*do* | ....*do* | Under construction; 150,000 kw. in 1967. |
| 235 | Petropavlovsk TETs–2 | 250 | ....*do* | Petropavlovsk-Omsk | Under expansion; to be 450,000 kw. in 1968. |
| 342 | Petropavlovsk-Kamchatskiy TETs | 24 | ....*do* | ... | Under expansion; to be 99,000 kw. in 1968. |
| 226 | Petrushino, Ala-Kul'skaya GRES | ... | ....*do* | Urals | Under construction; first 500,000 kw. unit to be commissioned in 1970, capacity to reach 3 million kw. by 1975. To be one of the largest powerplants in Urals system. |
| 329 | Pevek, Chaunskaya GRES | 42 | ....*do* | ... | Under expansion; to be 68,000 kw. by 1970. Serves small Pevek-Bilibino grid. |
| 17 | Podporozh'ye, Svir' GES–2 | 160 | Hydro | Leningrad-Baltic | ... |
| 46 | Polotsk TETs–2 | 200 | Steam | Belorussian | Located at Polotsk petroleum refinery. |

Footnotes are at end of table.

25X1

Figure 13. SELECTED POWERPLANTS, OPERATING OR UNDER CONSTRUCTION, 1966 (*Continued*)

| MAP REF. NO.* | NAME | INSTALLED CAPACITY | TYPE | MAJOR GRID AREAS SERVED | REMARKS |
|---|---|---|---|---|---|
| | | *Thousand kw.* | | | |
| 323 | Priargunsk, Nerchinsk TETs | 36 | Steam | ... | Under expansion; 48,000 kw. in 1967. Final capacity to be 98,000 kw. Serves local grid. |
| 62 | Ramenskoye, Tsagi TETs | 100 | ....do | Moscow-Gor'kiy | ... |
| 331 | Raychikhinsk TETs | 160 | ....do | ... | Under expansion; to be 460,000 kw. by 1970. To be linked to the Far East power system. |
| 182 | Razdan GRES | ... | ....do | Armenian | Under construction; first 200,000 kw. unit to be commissioned in 1969, capacity to reach 1.2 million kw. by 1975. |
| 181 | Razdan TETs | 50 | ....do | ....do | Under construction; to be 150,000 kw. in 1968, 300,000 kw. by 1972. |
| 36 | Riga, Dole GES | ... | Hydro | Leningrad-Baltic | Under construction; capacity to be 384,000 kw. by 1970. |
| 35 | Riga TETs | 125 | Steam | ....do | ... |
| 2 | Ristikent, Verkhne-Tulomskaya GES | 228 | Hydro | Murmansk | Largest powerplant in system. |
| 20 | Roukhiala, LGES-10 | 108 | ....do | Leningrad-Baltic | No. 10 of Leningrad area system. |
| 130 | Roya, Kurakhovka GRES | 400 | Steam | Donbass | ... |
| 133 | Rubezhnoye TETs-2 | ... | ....do | ....do | Under construction; capacity to be 300,000 kw. Will serve chemical industry. |
| 229 | Rudnyy, Sokolovskoye TETs | 100 | ....do | Urals | Located in and serves Sokolovskoye-Sarbay ore enriching combine. |
| 175 | Rustavi TETs | 149 | ....do | Georgian | ... |
| 77 | Ryazan' TETs | 300 | ....do | Moscow-Gor'kiy | Also referred to as Novo-Ryazan TETs. |
| 53 | Rybinsk, MoGES-14 | 330 | Hydro | ....do | Has exceptionally large reservoir, establishing regulation of upper Volga River. No. 14 of Moscow area system. |
| 216 | Salavat TETs-1 | 200 | Steam | Urals | ... |
| 217 | Salavat TETs-2 | 100 | ....do | ....do | Under expansion; to reach 300,000 kw. by 1970. |
| 88 | Saransk TETs-2 | 250 | ....do | Moscow-Gor'kiy | ... |
| 264 | Serebryanka, Bukhtarma GES | 675 | Hydro | Altay-Pavlodar | Dam impounds very large reservoir, providing regulation of Irtysh River. |
| 3 | Serebryanskiy GES-1 | ... | ....do | Murmansk | Under construction; capacity to be 84,000 kw. |
| 9 | Severodvinsk TETs | 100 | Steam | ... | Serves small Arkhangel'sk grid. |
| 202 | Serov GRES | 600 | ....do | Urals | ... |
| 123 | Shakhty, Artem GRES | 150 | ....do | Donbass | ... |
| 184 | Shamkor GES | ... | Hydro | Armenian | Under construction; capacity to be 100,000 kw. in 1970, 350,000 kw. by 1972. |
| 61 | Shatura, MoGRES-5 | 168 | Steam | Moscow-Gor'kiy | Under expansion; capacity to be 332,000 kw. in 1968, 732,000 kw. by 1970. No. 5 of Moscow area system. |
| 75 | Shchekino GRES-18 | 1,010 | ....do | ....do | Powerplant is No. 18 of Moscow area system. |
| 74 | Shchekino TETs | 120 | ....do | ....do | ... |
| 55 | Sheksna, Cherepovets GES | 40 | Hydro | ....do | Reservoir north of dam forms part of Volga-Baltic Waterway, important inland navigation route. Final capacity to be 100,000 kw. |
| 277 | Shevchenko AES | ... | Steam-Nuclear | ... | Under construction; final capacity to be 350,000 kw. First breeder reactor of its type in U.S.S.R. Associated with desalting plant. |
| 125 | Shterovka, Shter GRES | 242 | Steam | Donbass | ... |
| 162 | Simferopol' GRES | 100 | ....do | Central Ukraine | Largest powerplant in Crimea. |
| 134 | Slavyansk GRES | 500 | ....do | Donbass | Under expansion; 800,000 kw. unit, largest in U.S.S.R., to be commissioned in 1968, a similar unit to be added by 1969. |

| | | | | | |
|---|---|---|---|---|---|
| 45 | Smolevichi GRES | 140 | ....do | Belorussian | Under expansion; capacity to be 740,000 kw. by 1971. |
| 305 | Snezhnogorsk, Khantayskaya GES | ... | Hydro | Noril'sk | Under construction; to be in operation by 1971. Final capacity to be 455,000 kw. |
| 336 | Sovetskaya Gavan' thermal powerplant | 42 | Steam | ... | Under expansion. |
| 129 | Starobeshevo GRES | 2,100 | ....do | Donbass | Largest powerplant in system. |
| 215 | Sterlitamak TETs | 350 | ....do | Urals | Under expansion. |
| 79 | Stupino TETs-17 | 250 | ....do | Moscow-Gor'kiy | No. 17 of Moscow area system. |
| 339 | Suchan GRES | 207 | Steam | Far East, Primorskiy | ... |
| 188 | Sumgait TETs-1 | 450 | ....do | Azerbaijan | ... |
| 189 | Sumgait TETs-2 | 50 | ....do | ....do | Under construction; to reach 250,000 kw. by 1969. |
| 206 | Sverdlovsk, SUGRES | 472 | ....do | Urals | Under expansion; to be 1,372,000 kw. in 1970. Also referred to as Sredne-Ural'skaya GRES. |
| 48 | Svetlogorsk, Vasilevichi GRES | 200 | ....do | Belorussian | Under expansion. |
| 19 | Svetogorsk, Enso LGES-11 | 100 | Hydro | Leningrad-Baltic | No. 11 of Leningrad system. |
| 18 | Svir'stroy, Svir' GES-3 | 100 | ....do | ....do | ... |
| 11 | Syktyvkar TETs-2 | ... | Steam | ... | Under construction; capacity to be 300,000 kw. |
| 278 | Takhia-Tash GRES | 48 | ....do | ... | Under expansion; to be 248,000 kw. in 1968. Serves small local system. |
| 293 | Tashkent GRES | 750 | ....do | Tashkent-Fergana | Under expansion; to be 1.2 million kw. by 1969. |
| 186 | Tatev GES | ... | Hydro | Armenian | Under construction; to be 157,000 kw. by 1969. |
| 271 | Temir-Tau, Karaganda GRES-1 | 400 | Steam | Karaganda | ... |
| 272 | Temir-Tau, KMZ TETs | 125 | ....do | ....do | Located at the Karaganda metallurgical plant. |
| 174 | Tetri-Tskaro, Khram GES-2 | 110 | Hydro | Georgian | ... |
| 168 | Tkvarcheli GRES | 124 | Steam | ....do | ... |
| 297 | Toktogul GES | ... | Hydro | Tashkent-Fergana | Under construction; final capacity to be 1.2 million kw. To be in operation in 1971. |
| 106 | Tolyatti, Privolzhskaya GRES | ... | Steam | Middle Volga | Under construction; capacity to be 300,000 kw. in 1970, to reach 3.2 million kw. by 1975. Will be largest thermal powerplant in area. |
| 107 | Tolyatti TETs-1 | 300 | ....do | ....do | Under expansion; to be 400,000 kw. by 1968. |
| 108 | Tolyatti TETs-2 | ... | ....do | ....do | Under construction; capacity to be 50,000 kw. in 1969, to reach 500,000 kw. by 1975. |
| 242 | Tomsk GRES-2 | 324 | ....do | Kuzbass | ... |
| 240 | Tomsk AES No. 1 | 600 | Steam-Nuclear | ....do | Located near and serves Tomsk uranium isotope separation plant. |
| 241 | Tomsk AES No. 2 | ... | ....do | ....do | Under construction; capacity probably will reach 600,000 kw. by 1970. |
| 239 | Tomsk Thermal Powerplant, North | 700 | Steam | ....do | Located at and serves Tomsk uranium isotope separation plant. |
| 149 | Tripol'ye GRES | ... | ....do | Central Ukraine | Under construction; first 300,000 kw. unit to be commissioned in 1969, capacity to reach 2.4 million kw. by 1975. Powerplant will serve as major link between Central Ukraine and West Ukraine systems. |
| 225 | Troitsk GRES | 1,200 | ....do | Urals | Being enlarged; reached 1.5 million kw. in 1967, to be 2.5 million kw. in 1971. |
| 121 | Tsimlyansk GES | 164 | Hydro | Lower Volga | Large dam and reservoir of project are key structures of Volga-Don Canal. |
| 170 | Tsageri, Ladzhanurskaya GES | 112 | ....do | Georgian | ... |
| 173 | Tsalka, Khram GES-1 | 113 | ....do | ....do | ... |
| 210 | Tyumen' TETs | 150 | Steam | Urals | Being expanded to 450,000 kw. |
| 291 | Uch-Kurgan GES | 180 | Hydro | Tashkent-Fergana | ... |
| 212 | Ufa, Novo-Chernikovskiy TETs-4 | 350 | Steam | Urals | ... |
| 213 | Ufa, Novo-Ufimskiy TETs-3 | 150 | ....do | ....do | ... |

Footnotes are at end of table.



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FIGURE 13. SELECTED POWERPLANTS, OPERATING OR UNDER CONSTRUCTION, 1966 (Continued) 25X1

| MAP REF. NO.* | NAME | INSTALLED CAPACITY | TYPE | MAJOR GRID AREAS SERVED | REMARKS |
|---|---|---|---|---|---|
| | | *Thousand kw.* | | | |
| 214 | Ufa TETs-2 | 98 | Steam | Urals | Under expansion; capacity to be 198,000 kw. in 1969. Located in and serves Ufa petroleum refinery, Staro-Ufimskiy. |
| 127 | Uglegorsk GRES | ... | ....*do* | Donbass | Under construction; first unit of 300,000 kw. to be commissioned in 1970, capacity to be 1.2 million kw. in 1972, 3.6 million kw. by 1977. Will be largest powerplant in Donbass system. |
| 52 | Uglich MoGES-13 | 110 | Hydro | Moscow-Gor'kiy | No. 13 of Moscow area system. |
| 321 | Ulan-Ude TETs | 226 | Steam | Eastern Siberia | Under expansion; to be 326,000 kw. by 1970. |
| 105 | Ul'yanovsk TETs | ... | ....*do* | Middle Volga | Under construction; capacity to be 50,000 kw. in 1968, 300,000 kw. by 1971. |
| 103 | Urussu GRES | 238 | ....*do* | Urals | Powerplant is in Tatar A.S.S.R., but works in conjunction with Bashkir A.S.S.R. power system. |
| 314 | Usol'ye-Sibirskoye TETs | 200 | ....*do* | Eastern Siberia | Under expansion; to be 300,000 kw. in 1968. |
| 263 | Ust'-Kamenogorsk, Irtyshskaya GES | 331 | Hydro | Altay-Pavlodar | ... |
| 262 | Ust'-Kamenogorsk, Sogrinskaya TETs | 100 | Steam | ....*do* | ... |
| 261 | Ust'-Kamenogorsk TETs | 110 | ....*do* | ....*do* | ... |
| 341 | Vakhrushev, Yuzhno-Sakhalinskaya GRES | 100 | ....*do* | ... | Under expansion; to be 250,000 kw. by 1970. Serves small southern Sakhalin grid. |
| 172 | Vartsikhe GES | ... | Hydro | Georgian | Under construction; capacity to reach 170,000 kw. by 1971. |
| 205 | Verkhniy Tagil GRES | 1,600 | Steam | Urals | Most of power output is used by neighboring Verkh-Neyvinskiy uranium isotope separation plant. |
| 157 | Vinnitsa TETs | ... | Steam | West Ukraine | Under construction; capacity to be 50,000 kw. in 1970, to reach 300,000 kw. by 1974. |
| 60 | Vladimir TETs-2 | 200 | ....*do* | Moscow-Gor'kiy | Also called Novo-Vladimirskaya TETs. |
| 340 | Vladivostok TETs | ... | ....*do* | Far East, Primorskiy | Under construction; to be 100,000 kw. by 1970. Final capacity to be 300,000 kw. |
| 117 | Volgograd GES | 2,563 | Hydro | Lower Volga | Also called Volzhskaya GES imeni XXII S'yezda KPSS meaning Volga hydroelectric station named for the 22nd Congress of the Communist Party of the Soviet Union. Also serves the Moscow-Gor'kiy and Donbass grids. |
| 118 | Volgograd GRES-1 | 290 | Steam | ....*do* | ... |
| 119 | Volgograd TETs-2 | 350 | ....*do* | ....*do* | Reached 400,000 kw. in 1967. |
| 116 | Volgograd, Volzhskiy TETs | 200 | ....*do* | ....*do* | Under expansion; to be 300,000 kw. by 1970. |
| 81 | Volgorechensk, Kostroma GRES | ... | ....*do* | Moscow-Gor'kiy | Under construction; capacity to be 300,000 kw. in 1968, 1.2 million kw. by 1970, 2.8 million kw. by 1975. To be one of largest powerplants in system. |
| 13 | Vorkuta TETs-1 | 83 | ....*do* | ... | ... |
| 14 | Vorkuta TETs-2 | 103 | ....*do* | ... | Under expansion. |
| 91 | Voronezh GRES | 324 | ....*do* | Moscow-Gor'kiy | ... |
| 309 | Yakutsk gas turbine powerplant | ... | Gas turbine | ... | Under construction; first 25,000 kw. unit to be in operation by 1970. Final capacity to be 100,000 kw. |
| 308 | Yakutsk thermal powerplant | 19 | Steam | ... | Under expansion; to be 69,000 kw. by 1969. |
| 56 | Yaroslavl' TETs-1 | 249 | ....*do* | Moscow-Gor'kiy | Principal consumer is the Yarak tire and asbestos combine. |
| 57 | Yaroslavl' TETs-3 | 100 | ....*do* | ....*do* | ... |

| | | | | | |
|---|---|---|---|---|---|
| 285 | Yavan TETs | ... | ....*do* | Tadzhik | Under construction; to be 70,000 kw. by 1970. Final capacity to be 220,000 kw. |
| 195 | Yayva GRES | 600 | ....*do* | Urals | Main thermal powerplant in northwestern Urals. |
| 179 | Yerevan, Kanaker GES-2 | 102 | Hydro | Armenian | ... |
| 180 | Yerevan TETs | 550 | Steam | ....*do* | Largest thermal powerplant in Armenian system. |
| 270 | Yermak GRES | ... | ....*do* | Altay-Pavlodar | Under construction; first 300,000 kw. unit to be commissioned in 1968, capacity to reach 2.4 million kw. by 1972. Powerlines from this powerplant are to link up Karaganda and Altay-Pavlodar systems. |
| 218 | Yermolayevo, Kumertau TETs | 125 | ....*do* | Urals | ... |
| 224 | Yuzhno-Ural'sk GRES | 1,000 | ....*do* | ....*do* | One of the largest powerplants in Urals system. |
| 102 | Zainsk GRES | 1,200 | ....*do* | Middle Volga | Under expansion; to be 2.4 million kw. by 1972. |
| 310 | Zaozernyy, Krasnoyarsk GRES-2 | 650 | ....*do* | Eastern Siberia | Under expansion; to be 1.1 million kw. by 1970. Principal consumer is the Zaozernyy uranium isotope separation plant. |
| 139 | Zaporozh'ye, Dnepro GES | 651 | Hydro | Central Ukraine | To be expanded; second generator hall to have first units commissioned in 1972, to reach 828,000 kw. by 1974, making station total of 1,479,000 kw. |
| 143 | Zelenodol'sk, Krivoy Rog GRES-2 | 900 | Steam | ....*do* | Under construction; capacity to be 2.4 million by 1970. |
| 273 | Zhartas, Karaganda GRES-2 | 600 | ....*do* | Karaganda | Principal high-capacity station of the Karaganda grid. |
| 109 | Zhigulevsk, Kuybyshev GES | 2,300 | Hydro | Middle Volga | Also referred to as Volzhskaya GES imeni Lenin. Also serves Moscow-Gor'kiy and Urals grids. |
| 266 | Zhingyldysor, Ekibastuz GRES-1 | ... | Steam | Altay-Pavlodar | Under construction; first 300,000 kw. unit to be commissioned in 1970, capacity to reach 1.2 million kw. in 1973, 4 million kw. by 1980. First of the "super-giant" powerplants to be built on Ekibastuz coal deposits. Will transmit power to European U.S.S.R. over 1,500 kw. powerlines. |
| 135 | Zmiyev GRES | 1,200 | ....*do* | Donbass | Under expansion; capacity to be 2.4 million kw. by 1970. |
| 128 | Zuyevka, ZuGRES | 330 | ....*do* | ....*do* | ... |

... Not pertinent.

* FIGURES 23, 24D, 25B, 26D, and 27B.

FIGURE 14. LENGTH OF TRANSMISSION LINES, 35 KILOVOLTS AND OVER

25X1

| LINE VOLTAGE | 1928 | 1932 | 1936 | 1940 | 1945 | 1950 | 1955 | 1958 | 1962 | 1965 | 1966 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Kilovolts* | | | | | | *Kilometers* | | | | | |
| 35 | 500 | 4,125 | 5,681 | 8,000 | 8,465 | 11,941 | 16,418 | 23,900 | 44,400 | 122,300 | 130,942 |
| 110 | 965 | 4,111 | 7,780 | 10,575 | 11,287 | 16,509 | 28,434 | 44,400 | 85,100 | 128,100 | 141,542 |
| 154 | 0 | 202 | 438 | 498 | 422 | 483 | 927 | 1,500 | 4,100 | 5,100 | 5,162 |
| 220–330 | 0 | 0 | 475 | 1,107 | 1,363 | 2,498 | 5,671 | 9,800 | 25,200 | 42,500 | 46,939 |
| 400–500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,700 | 7,100 | 8,300 | 8,985 |
| 800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 500 | 500 | 563 |
| Total | 1,465 | 8,438 | 14,374 | 20,180 | 21,537 | 31,431 | 51,450 | 82,300 | 166,400 | 306,800 | 334,133 |

FIGURE 15. SELECTED TRANSMISSION LINES, 1966

25X1

| SUBSTATION OR TERMINAL WITH MAP REF. NO.* | LENGTH | VOLTAGE | NUMBER OF CIRCUITS | REMARKS |
|---|---|---|---|---|
| | *Km.* | *Kv.* | | |
| Main interregional powerlines: | | | | |
| Zhigulevsk, Kuybyshev GES (No. 109)–Veshkayma substation (26)–Arzamas substation (23)–Vladimir substation (21)–Moscow. | See Remarks | 500 | 2 | Joins Central regional network and Middle Volga system. One 813 km. circuit terminates at Noginsk/Vostochnaya substation (20) east of Moscow, and one 891 km. circuit terminates at Moscow/Beskudnikovo substation (13) north of the city. |
| Volgograd GES (No. 117)–Novo-Nikolayevskaya substation (25)–Gryazi substation (24)–Mikhaylov substation (22)–Moscow area. | 1,157 | 500 | 2 | Joins the Central regional network to the Southern power system. One circuit terminates at Moscow/Chagino substation (16) in southeastern outskirts of Moscow, second circuit terminates at Moscow/Pakhra substation (19), south of Moscow. |
| Zhigulevsk, Kuybyshev GES (No. 109)–Bugul'ma substation (60)–Ufa/Dema substation (61)–Zlatoust substation (62)–Chelyabinsk/Shagol substation (64)–Sverdlovsk/Yuzhnaya substation (65). | 1,240 | 500 | 1 | Joins the Central regional network to the Urals power system. |
| Ludus, Rumania-Mukachevo substation (49)–Lemesany, Czechoslovakia. | 350 | 400 | 1 | International powerline; joins U.S.S.R. to the Mir network. |
| Mukachevo substation (49)–Sajoszoged, Hungary | 220 | 400 | 1 | Under construction. To provide higher-capacity link to Mir network. A 2-circuit, 220-kv. powerline presently ties the two areas. |
| Konakovo GRES (No. 51)–Okulovka substation (5)–Chudovo substation (4)–Leningrad/Vostochnaya substation (2). | 580 | 330 | 1 | Joins the Central regional network to the Northwest power system. |
| Zmiyev GRES (No. 135)–Khar'kov/Podvorki substation (38)–Belgorod substation (39)–Kursk area. | 320 | 330 | 1 | Portion between Belgorod and Kursk is under construction. Powerline will provide another link between the Central regional network and the Southern power system. |
| Tkvarcheli GRES (No. 168)–Sukhumi area-Tuapse area-Krasnodar area. | 450 | 220 | 1 | Portion between Sukhumi and Tuapse is under construction. Line will be the first high-capacity link between the Trans-Caucasus and the Southern power systems. |
| Novosibirsk area-Barabinsk GRES (No. 238)–Omsk area. | 640 | 220 | 1 | First high-capacity link between the grids of West Siberia and the Petropavlovsk-Omsk area. |
| Northwest system: | | | | |
| Minsk/Yuzhnaya substation (9)–Electrenai, Litovskaya GRES (No. 39)–Kaunas substation (8)–Siauliai substation (7)–Salaspils substation (6)–Narva, Pribaltiyskaya GRES-1 (No. 31)–Leningrad/Vostochnaya substation (2)–Petrozavodsk area-Kem' substation (1)–Murmansk area. Kem' substation (1)–Murmansk area. | 3,000 | 330 | 1 | Powerline ties the grids of the Northwest into a single power system. The portion between Kem' and Murmansk is presently under construction. A second circuit between Salaspils and Narva is also under construction. Powerline is supplied by several major powerplants along its route. |

Footnotes are at end of table.



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FIGURE 15. SELECTED TRANSMISSION LINES, 1966 (*Continued*)

25X1

| SUBSTATION OR TERMINAL WITH MAP REF. NO.* | LENGTH | VOLTAGE | NUMBER OF CIRCUITS | REMARKS |
|---|---|---|---|---|
| | *Km.* | *Kv.* | | |
| Central Regional system: | | | | |
| Konakovo GRES (No. 51)–Moscow/Belyy Rast substation (11). | 90 | 750 | 1 | Highest-capacity alternating-current powerline in U.S.S.R. To supply Moscow area. Line nearing completion at end of 1966. |
| Noginsk/Vostochnaya substation (20)–Moscow/Chagino substation (16)–Moscow/Pakhra substation (19)–Moscow/Zapadnaya substation (18)–Moscow/Beskudnikovo substation (13)–Noginsk/Vostochnaya substation (20). | 347 | 500 | 1 | High-capacity circular link between the Moscow 500-kv. substations. |
| Konakovo GRES (No. 51)–Moscow/Belyy Rast substation (11)–Moscow/Beskudnikovo substation (13). | 110 | 500 | 1 | Supplies Konakovo GRES power to Moscow area. |
| Moscow/Belyy Rast substation (11)–Moscow/Zapadnaya substation (18). | 130 | 500 | 1 | Distributes Konakovo GRES power to Moscow city. |
| Moscow/Beskuknidovo substation (13)–Sofrino substation (12)–Rybinsk MoGES 14 (No. 53)–Kostroma area-Kovrov area-Gorodets, Gor'kiy GES (No. 82)–Arzamas substation (23). | 850 | 220 | 1 | High-capacity northern link of the Moscow-Gor'kiy grid. |
| Middle Volga system: | | | | |
| Zhigulevsk, Kuybyshev GES (No. 109)–Syzran' substation (31)–Balakovo, Saratov GES (No. 113)–Saratov substation (32). | 375 | 220 | 2 | Conveys power to major Volga River dam construction site; serves Saratov; scheduled for extension to Volgograd to link Middle Volga system with Lower Volga grid. Section between Zhigulevsk, Kuybyshev GES (No. 109) and Syzran' is 330 kv. |
| Zhigulevsk, Kuybyshev GES (No. 109)–Kinel' substation (29)–Ural'sk substation (30). | 360 | 220 | 1 | High-capacity link from Middle Volga system to northwestern Kazakh S.S.R. |
| Urussu GRES (No. 103)–Bugul'ma substation (60)–Zainsk GRES (No. 102)–Kazan' area-Cheboksary area. | 450 | 220 | 1 | Main line of northern part of Middle Volga system. Section between Zainsk GRES (No. 102) and Bugul'ma substation (60) is 2-circuit and paralleled by 500-kv. line. |
| Urals system: | | | | |
| Chaykovskiy, Votkinsk GES (No. 192)–Sverdlovsk/Yuzhnaya substation (65)–Nizhniy Tagil substation (66). | 615 | 500 | 1 | Transmits Kama River power to central Urals area. First 500 kv. line on ferroconcrete towers. |
| Zlatoust substation (62)–Miass substation (63)–Troitsk GRES (No. 225). | 170 | 500 | 1 | High-capacity link between Troitsk GRES and the Urals system. |
| Troitsk GRES (No. 225)–Chelyabinsk/Shagol substation (64). | 150 | 500 | 1 | Transfers large blocks of power to Chelyabinsk area from Troitsk GRES. |
| Troitsk GRES (No. 225)–Rudnyy/Sarbay substation (70)–Dzhetygara substation (71)–Iriklinskiy GRES (No. 230). | 505 | 500 | 1 | Presently under construction. Will join the Orsk area to the Urals system. |
| Nizhnyaya Tura GRES (No. 203)–Chusovoy substation (67)–Yayva GRES (No. 195)–Berezniki area. | 312 | 220 | 1 | Northern link between the Sverdlovsk and Perm' regional systems, also serves local needs in northwestern Urals area. |
| Perm', Kamskaya GES (No. 197)–Krasnoufimsk substation (68)–Sverdlovsk/Yuzhnaya substation (65). | 368 | 220 | 2 | Southern link between Sverdlovsk and Perm' grids. |
| Southern system: | | | | |
| Volgograd GES (No. 117)–Mikhaylovka substation (34). | 473 | 800 | 1 | Direct-current powerline. Provides a high-capacity link between the Lower Volga and other southern power systems. |
| Zmiyev GRES (No. 135)–Kremenchug GES substation (41)–Cherkassy substation (45)–Kiev substation (46)–Chernigov area-Konotop area-Khar'kov, Podvorki substation (38). | 1,160 | 330 | 1 | High-capacity powerline ring serving northern Central Ukraine. |
| Dnepropetrovsk, Pridneprovsk GRES (No. 138)–Zaporozh'ye substation (40)–Zelenodol'sk, Krivoy Rog GRES–2 (No. 143)–Trikhaty substation (43)–Odessa area-Dnestrovsk, Moldavian GRES (No. 159)–Moldavia. | 640 | 330 | 1 | High-capacity powerline serving southern Central Ukraine and Moldavia. Portion between Trikhaty and Moldavia is under construction. |

Footnotes are at end of table.

FIGURE 15. SELECTED TRANSMISSION LINES, 1966 [redacted] (*Continued*)

25X1

| SUBSTATION OR TERMINAL WITH MAP REF. NO.* | LENGTH | VOLTAGE | NUMBER OF CIRCUITS | REMARKS |
|---|---|---|---|---|
| | *Km.* | *Kv.* | | |
| Southern system (*Continued*): | | | | |
| Kremenchug GES (No. 145)–Pyatikhatki substation (42)–Zelenodol'sk, Krivoy Rog GRES–2 (No. 143). | 180 | 330 | 2 | Main line of Central Ukraine system; 80-km. long, single-circuit from Pyatikhatki substation to Kremenchug GES substation. Links power systems of north Central Ukraine and south Central Ukraine. |
| Kiev substation (46)–Vinnitsa substation (47)–Burshtyn GRES (No. 155)–Stryy substation (48). | 600 | 330 | 1 | High-capacity link between power systems of Central Ukraine and Northwest Ukraine. |
| Zaporozh'ye, Dnepro GES (No. 139)–Roya, Kurakhovka GES. | 170 | 330 | 1 | High-capacity link between the power systems of Central Ukraine and the Donbass. |
| Novocherkassk GRES (No. 124)–Krasnyy Sulin, Nesvetay GRES (No. 122)–Lugansk GRES (No. 126)–Mikhaylovka substation (34). | 250 | 220 | 1 | Major circuit of eastern Donbass region. Lugansk GRES-Mikhaylovka substation section is multiple-circuit. |
| North Caucasus system: | | | | |
| Novocherkassk GRES (No. 124)–Krasnodar TETs (No. 163)–Nevinomyssk GRES (No. 164). | 650 | 220 | 1 | Joins the power systems of the North Caucasus and the Donbass. |
| Nevinomyssk GRES (No. 164)–Pyatigorsk/Mashuk substation (51)–Ordzhonikidze substation (52)–Groznyy area. | 430 | 330 | 1 | Basic high-capacity powerline of North Caucasus system; being extended to northwest to Novocherkassk GRES (No. 124) to provide higher-capacity link to Southern power system. |
| Transcaucasus system: | | | | |
| Gldani substation (54)–Zestafoni substation (53).... | 180 | 500 | 1 | Powerline is under construction. To be the start of a 500-kv. powerline system in the Caucasus. Line will extend north from Gldani to Ordzhonikidze and west from Zestafoni to Tkvarcheli area. |
| Sumgait area and Baku, Severnaya GRES (No. 190)–Baku/Khurdalan substation (59)–Ali-Bayramly GRES (No. 187)–Agdam substation (57)–Kirovabad area. | 480 | 330 | 1 | Main high-capacity powerline in Azerbaijan. Portion between Agdam and Kirovabad is under construction. Line will be extended to join Georgian system at Akstafa substation (56). |
| Mingechaur GES (No. 185)–Kirovabad area-Akstafa substation (56)–Tbilisi/Naftlugi substation (55). | 235 | 220 | 1 | High-capacity line joining the Georgian and Azerbaijan grids. A 110-kv. connection between these points ties many urban areas to the system. |
| Yerevan area-Akstafa substation (56)............ | 160 | 220 | 1 | High-capacity powerline ties Armenia to the Georgian and Azerbaijan power systems. |
| North Kazakhstan system: | | | | |
| Ust'-Kamenogorsk area-Yermak GRES (No. 270)–Tselinograd substation (83). | 880 | 500 | 1 | Powerline is under construction. This is the start of a 500-kv. power system to link the separate grids of North Kazakhstan into a single system. A branch line from Yermak will be built to Omsk. Line will extend from Tselinograd to Rudnyy/Sarbay substation (70) to unite with the Urals power system. |
| Ust'-Kamenogorsk area-Nikolayevka substation (80)–Semipalatinsk substation (81)–Pavlodar area-Ekibastuz substation (82)–Karaganda area-Tselinograd substation (83)–Yesil' substation (84)–Lisakovka area. | 1,400 | 220 | 1 | Main powerline of the North Kazakhstan power system. Portions between Pavlodar and Karaganda and between Yesil' and Lisakovka are under construction. Will link the North Kazakhstan system to the Urals system. |
| Central Siberian system: | | | | |
| Angarsk substation (98)–Bratsk GES (No. 311)–Tayshet substation (96)–Zaozernyy/Kamala substation (95)–Krasnoyarsk/North substation (75)–Nazarovo GRES (No. 257)–Anzhero-Sudzhensk/East substation (74). | 1,690 | 500 | 2 | Main high-capacity transmission line of the Central Siberian power system. Second circuit between Krasnoyarsk and Nazarovo is presently under construction but the second circuit between Nazarovo and Anzhero-Sudzhensk has not yet started. Power flow is generally south from Bratsk GES to the major consumers in the Angarsk area and west from Bratsk GES to link the grids of eastern Siberia and western Siberia. |
| Anzhero-Sudzhensk/East substation (74)–Belovo GRES (No. 249)–Novokuznets area-Barnaul substation (79)–Novosibirsk/Inskaya substation (73)–9 Anzhero-Sudzhensk/East substation (74). | 900 | 500 | 1 | High-capacity power ring of the West Siberian grid. Portion between Anzhero-Sudzhensk and Belovo is completed, the remainder is under construction. |

Footnotes are at end of table.

FIGURE 15. SELECTED TRANSMISSION LINES, 1966 (Continued) 25X1

| SUBSTATION OR TERMINAL WITH MAP REF. NO.* | LENGTH | VOLTAGE | NUMBER OF CIRCUITS | REMARKS |
|---|---|---|---|---|
| | *Km.* | *Kv.* | | |
| Central Siberian system (*Continued*): | | | | |
| Myski, Tom-Usinskaya GRES (No. 253)–Prokop'yevsk substation (77). | 100 | 500 | 1 | Powerline feeds power from the Tom-Usinskaya GRES to the existing 220-kv. transmission line system serving western Siberia. |
| Myski, Tom-Usinskaya GRES (No. 253)–Abakan substation (76)–Tayshet substation (97)–Tulun/Perevoz substation (87). | 1,000 | 220 | 1 | Alternate link between the grids of eastern Siberia and western Siberia. |
| Angarsk substation (98)–Irkutsk, Angara GES (No. 318)–Sludyandka area-Baykal'sk area-Ulan-Ude area-Chita GRES (No. 322)–Kholbon area. | 1,250 | 220 | 1 | First leg of the main high-capacity transmission line to join the Central Siberia power system to the Soviet Far East power system. Portion between Ulan-Ude and Kholbon is under construction. To be extended to Berezovka, Zeyskaya GES (No. 330) in the future. |
| Far East system: | | | | |
| Tetyukhe-Pristan' area-Kavalerovo/Kintukha substation (102)–Suchan GRES (No. 339)–Artem GRES (No. 338)–Lesozavodsk substation (101)–Iman area-Bikin, Primorskaya GRES (No. 337)–Khabarovsk area-Birobidzhan substation (100)–Arkhara area-Raychikhinsk TETs (No. 331)–Svobodnyy substation (99)–Berezovka, Zeyskaya GES (No. 330). | 2,050 | 220 | 1 | Main transmission line of the Far East power system. Sections between Tetyukhe-Pristan and Kavlerovo, Iman and Khabarovsk, Birobidzhan and Arkhara, and Svobodnyy and Zeyskaya GES are presently under construction. Alternate routes between Kavlerovo and Lesozavodsk and between Raychikhinsk and Svobodnyy are also under construction. Future plans call for a branch line from Khabarovsk, through Komsomol'sk to the northeast, and for the extension of a line from Zeyskaya GES to join the Central Siberian power system. |
| Vakhrushev, Yuzhno-Sakhalinskaya GRES (No. 341)–Yuzhno-Sakhalinsk/Severnaya substation 103)–Kholmsk area. | 340 | 220 | 1 | Main transmission line of the Sakhalin Island power system. Section between Yuzhno-Sakhalinsk and Kholmsk is under construction. Powerline will be extended to the north to encompass the entire island. |
| Central Asia system: | | | | |
| Tashkent GRES (No. 293)–Chimkent substation (93). | 100 | 500 | 1 | Powerline is under construction. Start of 500-kv. power system in Central Asia. Will extend south to Nurek GES (No. 286) to link with the Dushanbe grid and east to serve Dzhambul, Frunze, and Alma-Ata. |
| Ashkhabad area-Mary substation (85)-Chardzhou substation (86)–Bukhara substation (87)–Navoi GRES (No. 283)–Samarkand substation (88)–Yangi-Yer/Uzlovaya substation (90)–Almalyk substation (91)–Tashkent/Kuylyuk substation (92)–Tashkent GRES (No. 293)–Chimkent substation (93)–Dzhambul substation (94)–Frunze area-Alma Ata, Pokrovka GRES (No. 300)–Taldy-Kurgan area. | 2,150 | 220 | 1 | Main high-capacity powerline of the Central Asia power system. Portions between Ashkhabad and Mary, and between Dzhambul and Alma Ata are under construction. Portion between Tashkent and Chimkent has two circuits; second circuit supplies 110-kv. powerline heading northwest from Chimkent. Powerline will be extended from Ashkhabad westward to Krasnovodsk in the future. |
| Tashkent/Kuylyuk substation (92)–Almalyk substation (91)–Angren GRES (No. 292)–Kokand area-Fergana area-Uch-Kurgan GES (No. 291)–Toktogul GES (No. 297)–Frunze area. | 750 | 220 | 1 | Secondary high-capacity powerline in the Central Asia power system. Portion between Uch-Kurgan and Frunze is under construction. Will tie Kirgiz S.S.R. and the future Toktogul GES to the power system. |

* FIGURES 23, 24D, 25B, 26D, 27B.

FIGURE 16. SELECTED SUBSTATIONS, 1966

25X1

| MAP REF. NO.* | NAME OR LOCATION | VOLTAGE RATIO OF TRANSFORMERS | REMARKS |
|---|---|---|---|
| | | Kv. | |
| 76 | Abakan | 220/110 | A major transformer and switching substation on lines from Nazarovo GRES (No. 257), Novokuznetsk, and Tayshet. |
| 57 | Agdam | 330/110 | A major substation on the Ali Bayramly-Akstafa 330-kv. transmission line. |
| 56 | Akstafa | 330/220/110 | Most important transformer and switching substation in the Transcaucasus. Junction point for transmission lines connecting powerplants of Georgia, Armenia, and Azerbaijan. |
| 91 | Almalyk | 220/110 | Transformer and switching substation. A major distribution point in the Tashkent area. |
| 98 | Angarsk | 500/220/110 | A major transformer and switching substation. Connects the Angarsk-Irkutsk area to Bratsk GES (No. 311) by a 2-circuit 500-kv. transmission line. Capacity is 910,000 kv.-a. |
| 74 | Anzhero-Sudzhensk/East | 500/220/110 | The main substation for distribution of power to the northern part of the West Siberian grid. Capacity is 540,000 kv.-a. |
| 23 | Arzamas | 500/220 | Transformer and switching substation on the Zhigulevsk, Kuybyshev GES (No. 109)–Moscow 500-kv. transmission line. Capacity is 405,000 kv.-a. |
| 59 | Baku/Khurdalan | 220/110 | The main substation of the Baku area. Connects Baku to the Transcaucasian system. |
| 79 | Barnaul | 500/220 | Transformer and switching substation. Under construction. Will be connected to Novosibirsk and Novokuznetsk. |
| 39 | Belgorod | 330/110 | Receives power from Zmiyev GRES (No. 135). Important point for future connections between the Ukraine and the Central Industrial region. |
| 100 | Birobidzhan | 220/110 | Transformer and switching substation. Receives and distributes power from Khabarovsk. Will be connected to Raychikhinsk GRES (No. 331) by a 220-kv. powerline. |
| 60 | Bugul'ma | 500/220/110 | Transformer and switching substation on the Zhigulevsk, Kuybyshev GES (No. 109)–Urals 500-kv. transmission line. Capacity is 675,000 kv.-a. |
| 87 | Bukhara | 220/110 | A major transformer and switching station on the Tashkent-Mary 220-kv. transmission line. |
| 86 | Chardzhou | 220/110 | A major transformer and switching substation on the Tashkent-Mary 220-kv. transmission line. |
| 64 | Chelyabinsk/Shagol | 500/220/110 | A major transformer and switching substation on the 500-kv. Zhigulevsk, Kuybyshev GES (No. 109)–Urals and the 500-kv. Troitsk-Chelyabinsk transmission lines. Capacity is 405,000 kv.-a. |
| 45 | Cherkassy | 330/110 | A major distribution substation on the Kremenchug GES (No. 145)–Kiev 330-kv. transmission line. |
| 93 | Chimkent | 500/220 | Transformer and switching substation. 500-kv. section under construction. Connects Tashkent with Dzhambul. To be connected to Tashkent by a 500-kv. transmission line. |
| 4 | Chudovo | 330/220 | Important substation on the Leningrad-Moscow 330-kv. transmission line. |
| 67 | Chusovoy | 220/110 | A major transformer and switching substation linking the Perm' and Sverdlovsk areas. Connects the northwestern Urals area to the network. |
| 35 | Donetsk/Chaykino | 220/110 | Transformer and switching station. Receives power from Mikhaylovka substation (34) and most of the powerplants in the area, for distribution locally. |
| 89 | Dushanbe/Novaya | 220/110 | Transformer and switching substation. The main distribution point for the Dushanbe area. |

Footnotes are at end of table.

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FIGURE 16. SELECTED SUBSTATIONS, 1966 (*Continued*)

| MAP REF. NO.* | NAME OR LOCATION | VOLTAGE RATIO OF TRANSFORMERS | REMARKS |
|---|---|---|---|
| | | *Kv.* | |
| 37 | Dzerzhinsk | 220/110 | Distributes power to the western Donbass area. |
| 94 | Dzhambul | 220/110 | Transformer and switching substation. Connected to Chimkent by a 220-kv. transmission line. Will be connected to Frunze by a 220-kv. transmission line. |
| 71 | Dzhetygara | 500/220 | Transformer and switching station. 500-kv. section under construction. Receives and distributes power from Rudnyy/Sarbay substation (70). |
| 82 | Ekibastuz | 500/220 | Transformer and switching substation. 500-kv. section is under construction. Will connect Pavlodar with Karaganda and Tselinograd. |
| 54 | Gldani | 500/220 | Transformer and switching substation. 500-kv. section under construction. Will eventually connect with Dzhvari, Ingurskaya GES (No. 169) and supply Georgia, Armenia, and Azerbaijan. |
| 24 | Gryazi | 500/220 | Transformer and switching substation on the Volgograd GES (No. 117)–Moscow 500-kv. transmission line. Capacity is 810,000 kv.-a. |
| 8 | Kaunas | 330/110 | A major substation on the Riga-Minsk 330-kv. transmission line. |
| 102 | Kavalerovo/Kintukha | 220/110 | Transformer and switching substation. Receives power for area from Suchan GRES (No. 339). |
| 1 | Kem' | 330/110 | An important substation on the Leningrad-Murmansk 330-kv. transmission line. Connects northern Karelian A.S.S.R. with the Northwest grid. |
| 38 | Kharkov/Podvorki | 330/220/110 | Transformer and switching substation. Connects Kharkov to the Central Ukraine power system with 220-kv. and 330-kv. transmission lines. |
| 46 | Kiev | 330/220/110 | A major transformer and switching substation in the Kiev area. |
| 29 | Kinel' | 220/110 | Transformer and switching substation. Important distribution point in the Kuybyshev area. |
| 44 | Kishinev | 220/110 | To be connected to the 330-kv. system by way of the Dnestrovsk, Moldavian GRES (No. 159). |
| 36 | Krasnodon | 220/110 | A major substation of the Donbass power system. |
| 68 | Krasnoufimsk | 220/110 | Transformer and switching substation. Receives and distributes power from Sverdlovsk. |
| 75 | Krasonyarsk/North | 500/220/110 | A major transformer and switching substation. Tied by two 500-kv. transmission lines to Bratsk GES (No. 311) and Nazarovo GRES (No. 257). Capacity is 540,000 kv.-a. |
| 41 | Kremenchug GES | 330/220/154 | Distributes power of the Kremenchug GES (No. 145). It is also the central substation for the Zmiyev GRES (No. 135)–Kharkov-Kremenchug-Kiev 330-kv. transmission line. |
| 2 | Leningrad/Vostochnaya | 330/220/110 | The principal substation in Leningrad area; connects the city to Northwest grid. |
| 3 | Leningrad/Yuzhnaya | 220/110 | One of the main substations of Leningrad. Supplies southern and eastern parts of city. |
| 78 | Leninsk-Kuzentskiy | 220/110 | A major transformer and switching substation in the central Kuzbass. |
| 101 | Lesozavodsk | 220/110 | Transformer and switching station. Receives power from Artem GRES (No. 338). Will be connected to Bikin, Primorskaya GRES (No. 377) by a 220-kv. transmission line. |
| 85 | Mary | 220/110 | Transformer and switching substation. Receives and distributes power from the Tashkent area. To be connected to Ashkhabad. |
| 63 | Miass | 500/110 | Transformer and switching substation on the 500-kv. Zlatoust-Troitsk transmission line. Capacity is 405,000 kv.-a. |

Footnotes are at end of table.

FIGURE 16. SELECTED SUBSTATIONS, 1966 [redacted] (*Continued*)

25X1

| MAP REF. NO.* | NAME OR LOCATION | VOLTAGE RATIO OF TRANSFORMERS | REMARKS |
|---|---|---|---|
| | | *Kv.* | |
| 22 | Mikhaylov | 500/220 | Transformer and switching substation on the Volgograd GES (No. 117)–Moscow 500-kv. transmission line. Capacity is 810,000 kv.-a. |
| 34 | Mikhaylovka | 800/220 | Transformer and converter/rectifier substation. Terminus of the Volgograd-Donbass 800-kv. direct current transmission line. Capacity is 1,080,000 kv.-a. |
| 9 | Minsk/Yuzhnaya | 330/220/110 | An important substation receiving power for the Belorussian network. |
| 11 | Moscow/Belyy Rast | 750/500 | Terminus of the 750-kv. Konakovo GRES (No. 51)–Moscow transmission line. Supplies power to the Moscow/Beskudnikovo (13) and Moscow Zapadnaya (18) substations. Capacity is 400,000 kv.-a. |
| 13 | Moscow-Beskudnikovo | 500/220/110 | Terminus of one circuit of the Kuybyshev-Moscow 500-kv. transmission line. Distributes power to the northern Moscow area. Capacity is 405,000 kv.-a. |
| 15 | Moscow/Butyrki | 220/110 | A major distribution substation for the northwest part of the Moscow area. |
| 16 | Moscow/Chagino | 500/220/110 | A major substation southeast of Moscow on the Volgograd GES (No. 11)–Moscow 500-kv. transmission line. Distributes power to the Moscow area. Capacity is 1 million kv.-a. |
| 17 | Moscow/Kolomenskoye | 220/110 | Main 220-kv. distribution substation in the southern part of Moscow. |
| 19 | Moscow/Pakhra | 500/220/110 | A major substation on the Volgograd GES (No. 117)–Moscow 500-kv. transmission line. Distributes power to the area south of Moscow. Capacity is 780,000 kv.-a. |
| 14 | Moscow/Reutov | 220/110 | A major distribution substation in the eastern Moscow area. |
| 18 | Moscow/Zapadnaya | 500/220/100 | Terminus of one circuit of the Volgograd GES (No. 117)–Moscow 500-kv. transmission line. Distributes power to the Moscow area. Capacity is 950,000 kv.-a. |
| 49 | Mukachevo | 400/220/110 | Transmits power from Burshtyn GRES (No. 155) and Dobrotvor GRES (No. 154) to the western Ukraine and to the eastern European Mir grid. Connected to the 400-kv. Ludush (Rumania)-Lemeshany (Czechoslovakia) transmission line. |
| 80 | Nikolayevka | 220/110 | Transformer and switching substation. Connects Semipalatinsk and Rubtsovsk with Ust'-Kamenogorsk. |
| 66 | Nizhniy Tagil | 500/220 | Transformer and switching substation. Currently under construction. Will be connected to Sverdlovsk. Capacity is 675,000 kv.-a. |
| 20 | Noginsk/Vostochnaya | 500/220/110 | A major substation east of Moscow on the 500-kv. Volgograd GES (No. 117)–Moscow transmission line. Functions as a major regional switching station, sends power to Moscow and areas east of the city. Capacity is 1,380,000 kv.-a. |
| 25 | Novo-Nikolayevskaya | 500/110 | Transformer and switching substation on the Volgograd GES (No. 117)–Moscow 500-kv. transmission line. Capacity is 540,000 kv.-a. |
| 73 | Novosibirsk/Inskaya | 500/220 | Transformer and switching station. 500-kv. section under construction. Will connect Anzhero-Sudzhensk with Barnaul. |
| 5 | Okulovka | 330/220 | Major substation on the Leningrad-Moscow 330-kv. transmission line. |
| 72 | Omsk | 220/110 | A major transformer and switching substation on the Trans-Siberian Railway transmission line. |

Footnotes are at end of table.

UNCODED

FIGURE 16. SELECTED SUBSTATIONS, [illegible] (Continued)

25X1

| MAP REF. NO.* | NAME OR LOCATION | VOLTAGE RATIO OF TRANSFORMERS | REMARKS |
|---|---|---|---|
| | | *Kv.* | |
| 52 | Ordzhonikidze | 330/110 | A major transformer and switching substation on the Nevinnomyssk-Groznyy 330-kv. transmission line. |
| 33 | Petrov Val | 220/110 | On the Kamyshin-Volgograd 220-kv. transmission line. |
| 77 | Prokop'yevsk | 220/110 | A primary transformer and switching substation in the southern part of the Kuzbass grid. |
| 51 | Pyatigorsk/Mashuk | 330/110 | A major substation of the North Caucasus network. Distributes power to the Pyatigorsk area. |
| 42 | Pyatikhatki | 220/110 | A primary transformer and switching substation in the Dnepr River network. Serves as a junction and switching point for transmission lines from the Kremenchug, Dnepropetrovsk, and Krivoy Rog areas. |
| 10 | Ross | 220/110 | A major substation on the Bereza GRES (No. 42)–Grodno-Bialystock (Poland) international transmission line. |
| 50 | Rostov | 220/110 | Main substation in the Rostov area. |
| 70 | Rudnyy/Sarbay | 500/220 | Transformer and switching substation. Under construction. Connects the Urals power system with northern Kazkhstan. |
| 6 | Salaspils | 330/220/110 | A major substation in the Latvian grid. Connects Riga and Daugava River powerplants to the Northwest grid. |
| 88 | Samarkand | 220/110 | A major transformer and switching substation on the Tashkent-Mary 220-kv. transmission line. |
| 32 | Saratov | 220/110 | The major substation in Saratov. |
| 81 | Semipalatinsk | 330/220 | Transformer and switching substation. Connects Altay and Pavlodar grids. |
| 58 | Shinuayr | 220/110 | A major substation of the Armenian power system. |
| 7 | Siauliai | 330/110 | Main distribution point for power from the Northwest grid to the Baltic and Belorussian republics. |
| 12 | Sofrino | 220/110 | A major transformer and switching station in the northern Moscow area. |
| 48 | Stryy | 330/220/110 | Receives power from Burshtyn GRES (No. 155) and Dobrotvor GRES (No. 154) and sends it to Mukachevo substation (49). |
| 65 | Sverdlovsk/Yuzhnaya | 500/220/110 | The main substation of the Urals power system. Terminus of the 500-kv. Zhigulevsk, Kuybyshev GES (No. 109)–Urals transmission line. Connected to Chaykovskiy, Votkinsk GES (No. 192) by a 500-kv. transmission line. Distributes power to the Sverdlovsk area and to the northern and western Urals. Capacity is 810,000 kv.-a. |
| 99 | Svobodnyy | 220/110 | Transformer and switching substation. Receives and distributes power from Raychikhinsk GRES (No. 331). Will be connected to Berezovka, Zeyskaya GES (No. 330). |
| 31 | Syzran' | 330/220 | A major substation on the 330-kv. Zhigulevsk-Saratov transmission line. |
| 92 | Tashkent/Kyuylyuk | 220/110 | Largest substation in the Central Asian grid. Serves primarily to distribute power to large consumers in Tashkent. |
| 96 | Tayshet | 500/220/110 | Large regional substation. Also serves electrified railroad. Capacity is 810,000 kv.-a. |
| 55 | Tbilisi/Naftlugi | 220/110 | Main distribution point for Tbilisi. Receives power from Zestafoni substation (53), Tsalka, Khram GES–1 (No. 173), Tetri Tskaro, Khram GES–2 (No. 174), and Akstafa substation (56). |
| 43 | Trikhaty | 330/220/110 | Receives and distributes power from Krivoy Rog. |

Footnotes are at end of table.

FIGURE 16. SELECTED SUBSTATIONS, 1966 [redacted] (*Continued*)



| MAP REF. NO.* | NAME OR LOCATION | VOLTAGE RATIO OF TRANSFORMERS | REMARKS |
|---|---|---|---|
| | | *Kv.* | |
| 83 | Tselinograd | 500/220 | A major transformer substation on the Karaganda-Yesil' transmission line. 500-kv. section is under construction. |
| 97 | Tulun/Perevoz | 220/110 | Transformer and switching substation. A major substation of the East Siberian power system. |
| 61 | Ufa/Dema | 500/220 | A major transformer and switching substation on the Zhigulevsk, Kuybyshev GES (No. 109)–Urals 500-kv. transmission line. Capacity is 675,000 kv.-a. |
| 30 | Ural'sk | 220/110 | A major substation on the transmission line connecting west Kazakhstan with the European U.S.S.R. grid. |
| 69 | Verkh-Neyvinskiy | 220/110 | Transformer and switching substation. Receives power from Verkhne-Tagil GRES (No. 205) and Urals grid for Uranium isotope separation plant. |
| 26 | Veshkayma | 500/220 | Transformer and switching substation on the Zhigulevsk, Kuybyshev GES (No. 109)–Moscow 500-kv. transmission line. Capacity is 540,000 kv.-a. |
| 47 | Vinnitsa | 330/110 | A major transformer and switching substation on the Burshtyn GRES (No. 155)–Kiev 330-kv. transmission line. |
| 21 | Vladimir | 500/220 | On the Zhigulevsk, Kuybyshev GES (No. 109)–Moscow 500-kv. transmission line. Functions as a regional switching station, serving a large area to the north and south, capacity is 500,000 kv.-a. |
| 28 | Volgograd GES | 800/500/220 | Main substation of Volgograd GES (No. 117). Feeds the 500-kv. Volgograd-Moscow and the 800-kv. direct current Volgograd-Donbass transmission lines. Capacity is 3,510,000 kv.-a. |
| 90 | Yangi-Yer/Uzlovaya | 220/110 | A major transformer and switching substation in the Tashkent area. Will probably be connected to Nurek GES (No. 286) by a 500-kv. transmission line. |
| 84 | Yesil' | 220/110 | Transformer and switching station. Receives and distributes power from the Karaganda area. |
| 103 | Yuzhno-Sakhalinsk/Severnaya. | 220/110 | Main substation in area. Supplies city with power from Vakhrushev, Yuzhno-Sakhalinsk GRES (No. 341). |
| 95 | Zaozernyy/Kamala | 500/220/110 | A major transformer and switching substation on the Bratsk-Krasnoyarsk 500-kv. transmission line. Capacity is 540,000 kv.-a. |
| 40 | Zaporozh'ye | 330/220/110 | A major substation in the Ukrainian network. Connects the Zaporozh'ye area, the Donbass, Crimea, Krivoy Rog, and Dnepropetrovsk areas. |
| 53 | Zestafoni | 220/110 | A primary substation in the Transcaucasus. Receives power from Tkvarcheli GRES (No. 168) and Tsageri, Ladzhanur-skaya GES (No. 170) for transmission to Tbilisi and the Black Sea coast. A 500-kv. section is being added. |
| 27 | Zhigulevsk, Kuybyshev GES. | 500/220/110 | Main substation for the Zhigulevsk, Kuybyshev GES (No. 109). Transmits power over 500-kv. transmission lines to Moscow and to the Urals region. Supplies power to the Volga River region by way of a 220-kv. network. Capacity is 2,942,000 kv.-a. |
| 62 | Zlatoust | 500/110 | Transformer and switching substation on the Zhigulevsk, Kuybyshev GES (No. 109)–Urals 500-kv. transmission line. Capacity is 540,000 kv.-a. |

* FIGURES 23, 24D, 25B, 26D, 27B.

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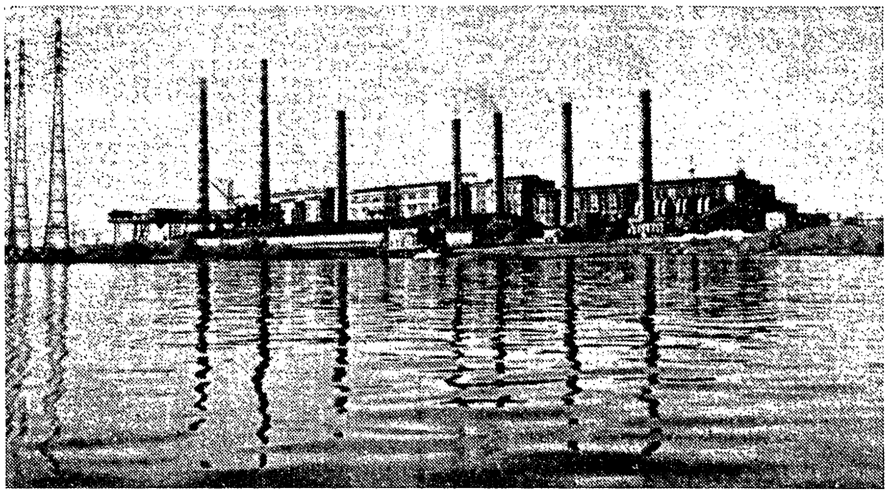
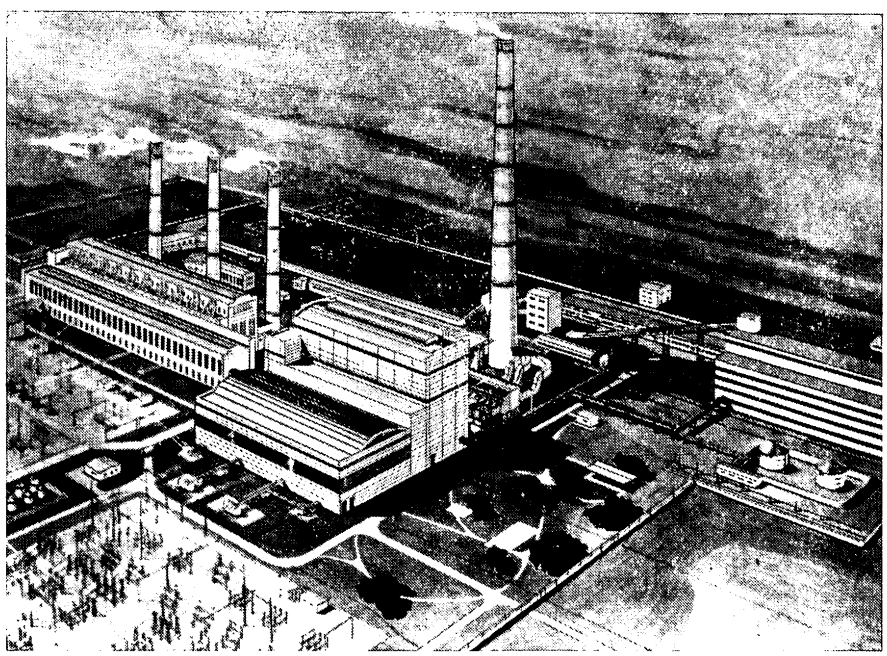


A. Dnepropetrovsk, Pridneprovskaya GRES (No. 138). This 2.4 million-kw. installation, central Ukraine, was the world's largest thermal powerplant at the end of 1966. Tall transmission towers (*left*) support powerlines crossing the Dnepr River. 25X1



B. Model of Slavyansk GRES thermal powerplant (No. 134). New section (*left-center foreground*) to house 800,000-kw. turbogenerator. Commissioned in November 1967, this is the largest thermal unit yet built in the U.S.S.R. 25X1



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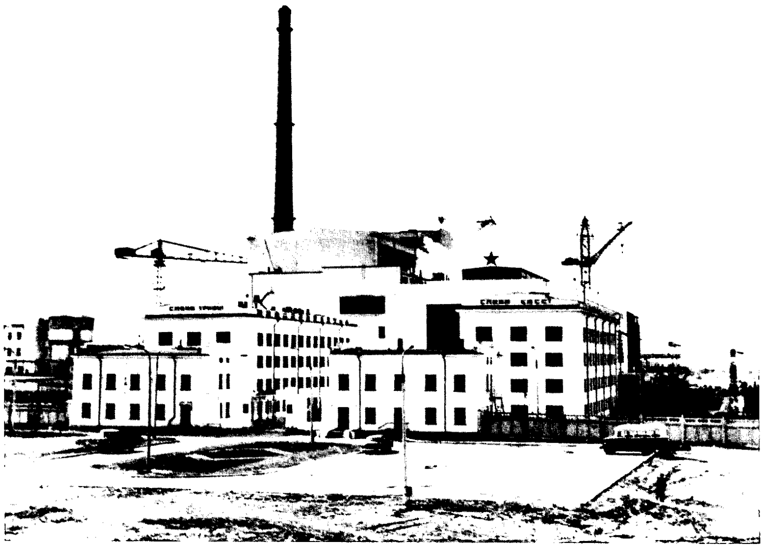
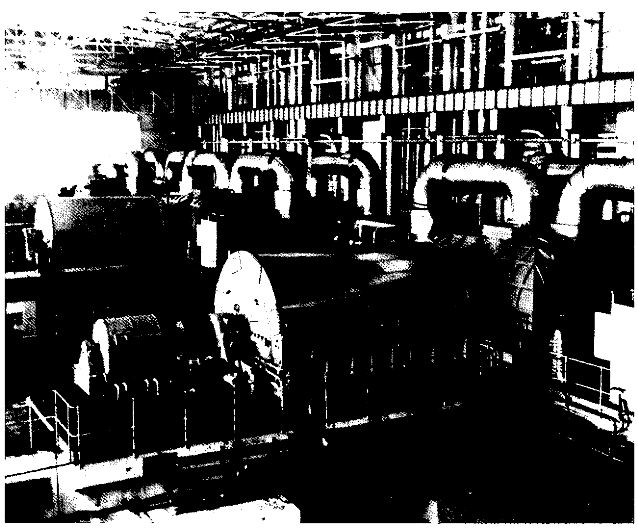


A. Arkhangel'skoye, Novo-Voronezh AES (No. 92). Rated at 240,000 kw. and being expanded to 640,000 kw. by 1970, this is the largest nuclear powerplant in European U.S.S.R.

25X1

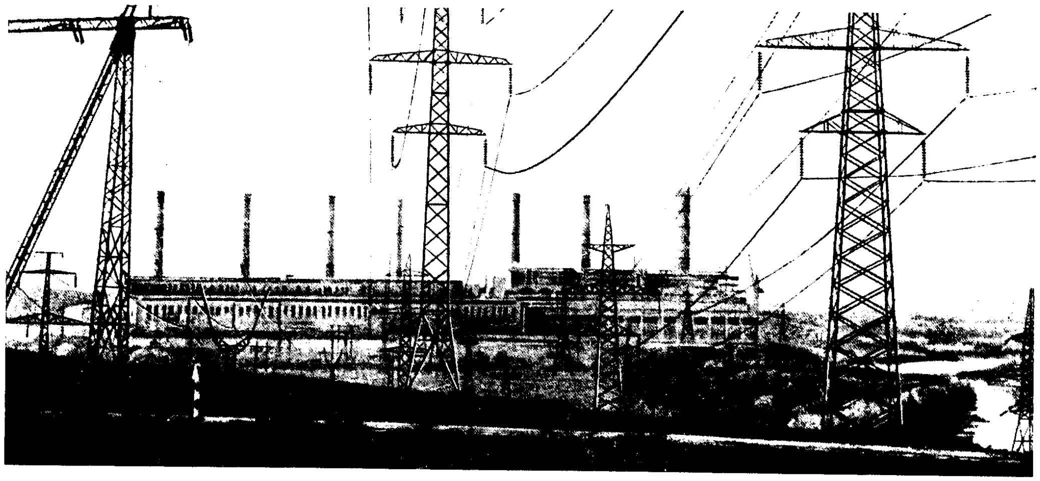


B. Turbogenerators at the Arkhangel'skoye, Novo-Voronezh AES (No. 92). These three 80,000-kw. units are supplied with steam by a single pressurized water reactor.

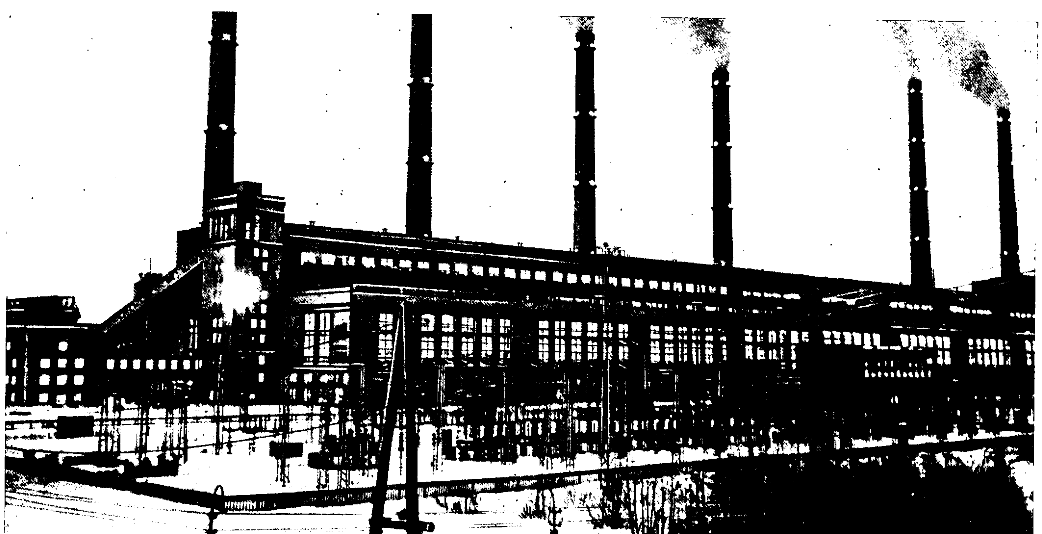
25X1

Figure 18

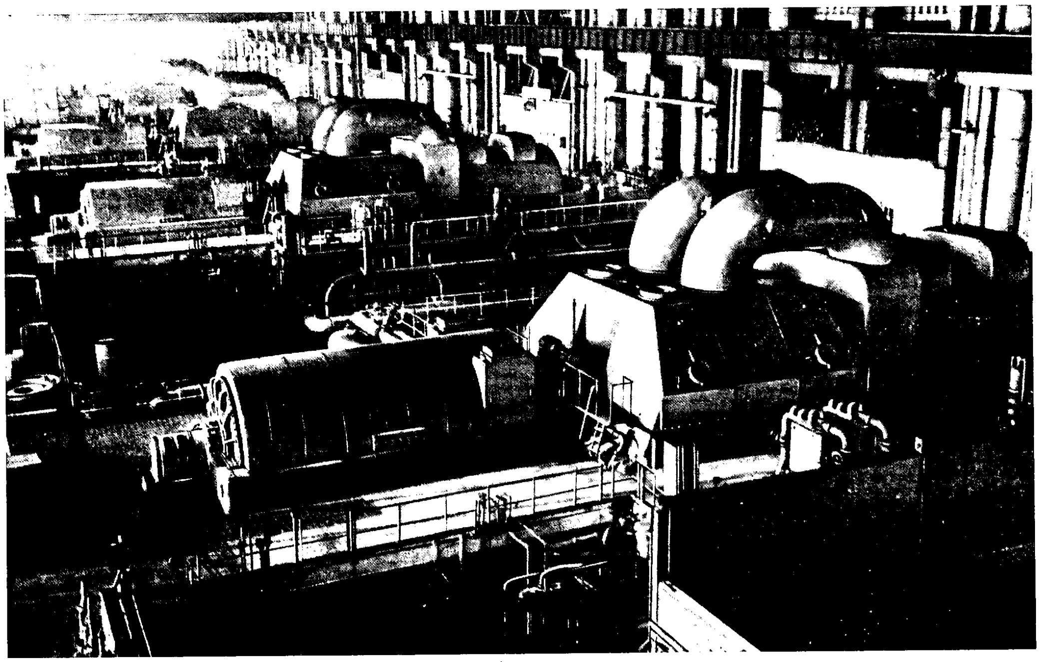
Secret



A. Lugansk GRES thermal powerplant (No. 126). One of the largest in the U.S.S.R., this powerplant has seven 100,000-kw. units in the long section (*left*) and four 200,000-kw. in the higher section (*right*) latter is being extended for installation of four more such units. Total capacity to be 2.3 million kw. by 1970. 25X1

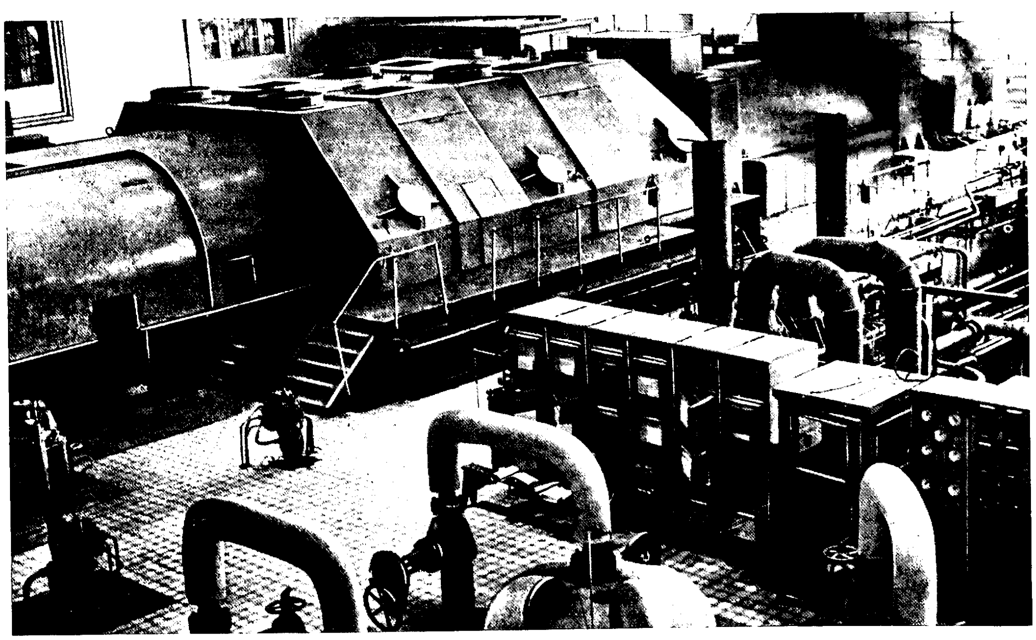


B. Narva, Pribaltiyskaya GRES-1 (No. 31). This 1.6 million kw. thermal plant using oil shale as fuel, is the largest powerplant in the network serving Leningrad and the Baltic States. 25X1



A. Soviet-produced 200,000-kw. turbogenerators. Installed in the 1.2 million-kw. Zmiyev GRES (No. 135) central Ukraine. Many of the larger thermal powerplants contain such high-pressure units. [redacted]

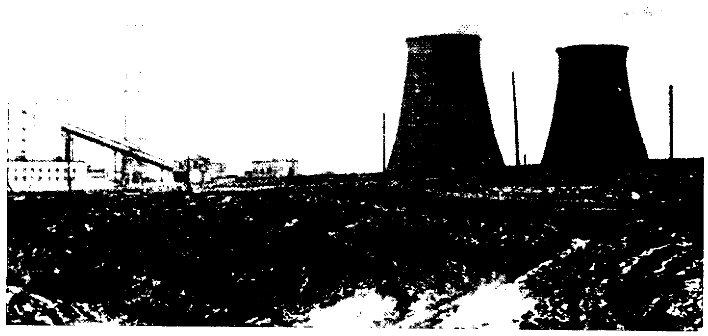
25X1



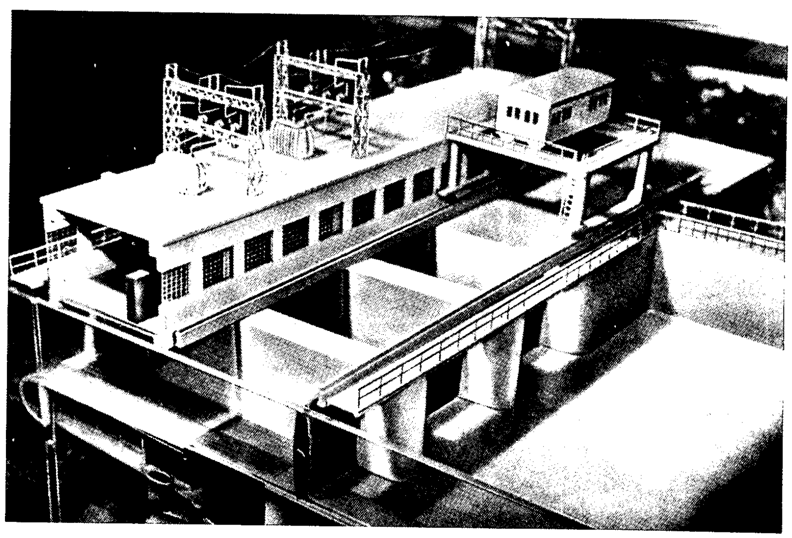
B. Turbogenerator of 300,000-kw. capacity. Installed in the Cherepet', MoGRES-19 (No. 72), southwest of Moscow. During the current 5-Year Plan (1965-70), this size unit is to be the standard installation in the large new thermal powerplants. [redacted]

25X1

Figure 20



A. Cooling towers at Moscow, TETs-22 (No. 70). Typical of the large cooling towers needed at many heat and power plants. These must be located close to the centers of the heating networks. 25X1



B. Model of Kislaya Guba experimental tidal powerplant. This installation is to be situated on a remote stretch of the Arctic Ocean coast east of Murmansk. The main components are being built at more convenient places and floated to Kislaya Guba. 25X1

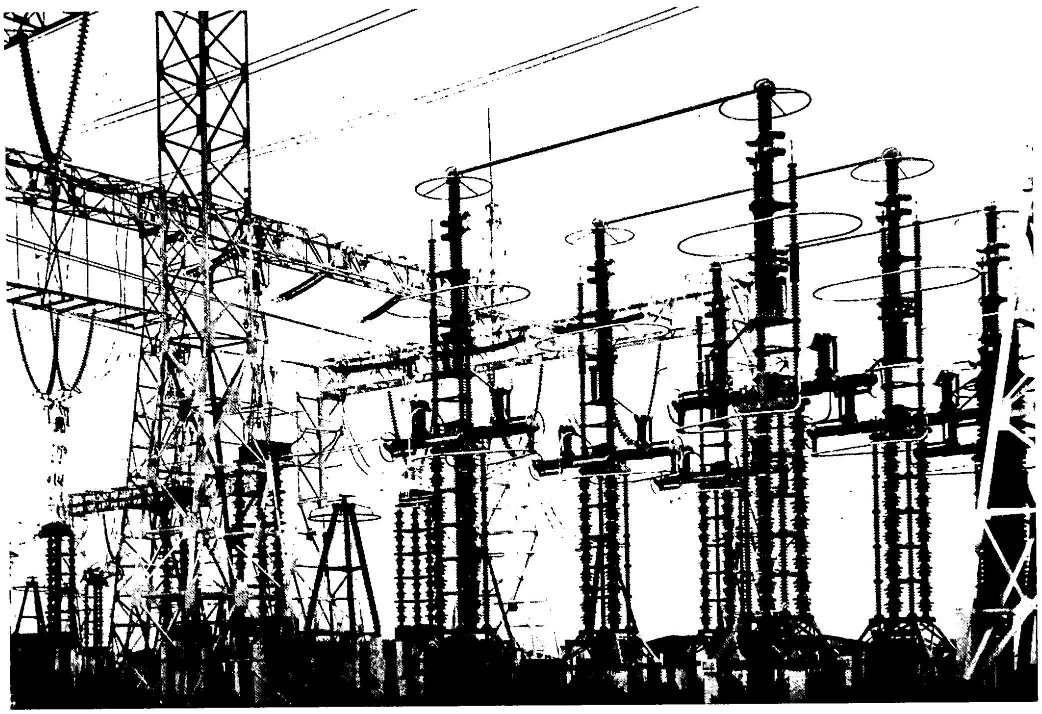


FIGURE 22. 500-KV. CIRCUIT BREAKERS AT THE MOSCOW/ZAPADNAYA SUBSTATION (18). These air-blast circuit breakers are more than 40 feet in height. [redacted]







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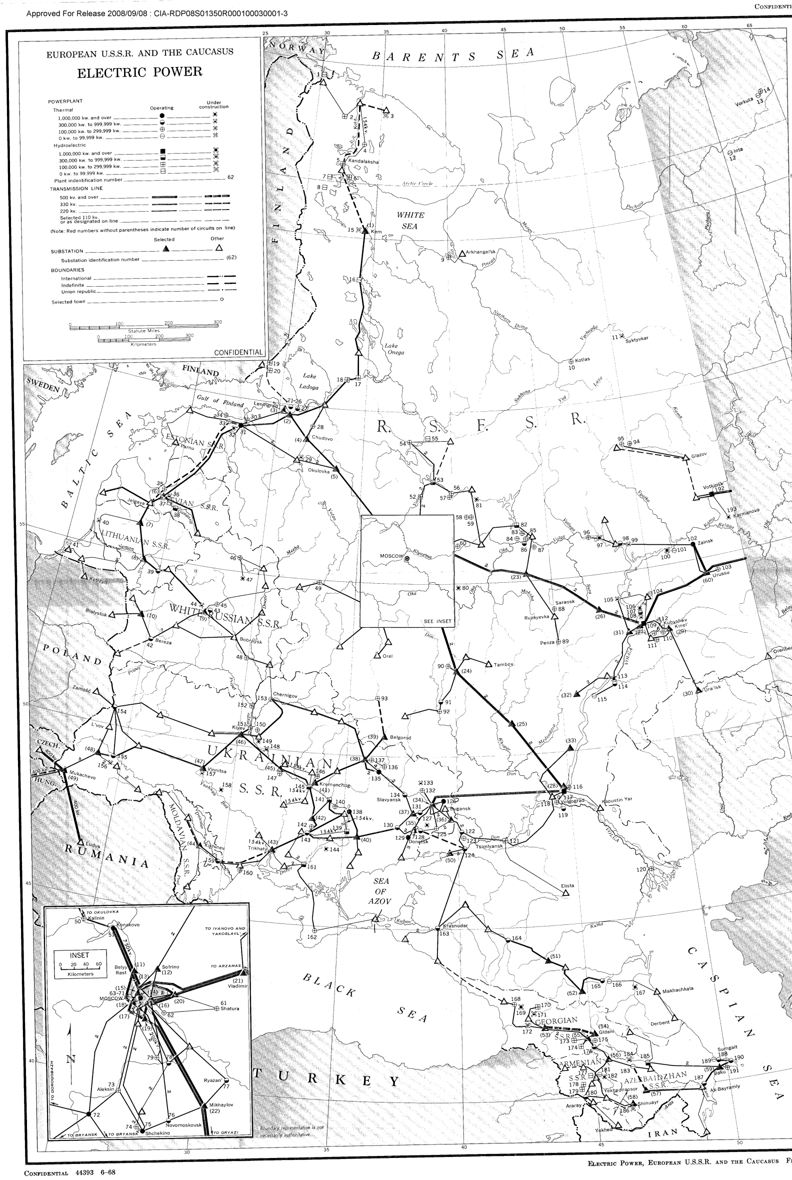
## POWERPLANTS

| MAP REF. NO. | IDENTITY |
|---|---|
| 1 | Kolttakengyas, Borisoglebskaya GES |
| 2 | Ristikent, Verkhne-Tulomskaya GES |
| 3 | Serebryanskiy GES–1 |
| 4 | Kirovsk GRES |
| 5 | Kandalaksha, Niva GES–3 |
| 6 | Knyazhaya Guba GES |
| 7 | Konets-Kovdozero, Iovskaya GES |
| 8 | Kundozero, Kumskaya GES |
| 9 | Severodvinsk TETs |
| 10 | Kotlas TETs–2 |
| 11 | Syktyvkar TETs–2 |
| 12 | Inta TETs–2 |
| 13 | Vorkuta TETs–1 |
| 14 | Vorkuta TETs–2 |
| 15 | Kem', Putkinskaya GES |
| 16 | Nadvoytsy, Ondskaya GES |
| 17 | Podporozh'ye, Svir' GES–2 |
| 18 | Svir'stroy, Svir' GES–3 |
| 19 | Svetogorsk, Enso LGES–11 |
| 20 | Roukhiala, LGES–10 |
| 21 | Leningrad, LGES–1 |
| 22 | Leningrad, LGES–2 |
| 23 | Leningrad, Krasnyy Oktyabr GRES–5 |
| 24 | Leningrad TETs–14 |
| 25 | Leningrad, Kirovskaya TETs–15 |
| 26 | Leningrad TETs–17 |
| 27 | Dubrovka, LGES–8 |
| 28 | Kirishi GRES |
| 29 | Novgorod TETs |
| 30 | Narva GES |
| 31 | Narva, Pribaltiyskaya GRES–1 |
| 32 | Narva, Estonskaya GRES |
| 33 | Ahtme TETs |
| 34 | Kohtla-Järve TETs–2 |
| 35 | Riga TETs |
| 36 | Riga, Dole GES |
| 37 | Kegums GES |
| 38 | Jaunjelgava, Plavinas GES |
| 39 | Elektrenai, Litovskaya GRES |
| 40 | Klaipeda GRES |
| 41 | Kaliningrad GRES–2 |
| 42 | Bereza GRES |
| 43 | Minsk, Zavodskaya TETs–3 |
| 44 | Minsk TETs–4 |
| 45 | Smolevichi GRES |
| 46 | Polotsk TETs–2 |
| 47 | Lukoml', Belorusskaya GRES |
| 48 | Svetlogorsk, Vasilevichi GRES |
| 49 | Dorogobuzh GRES |
| 50 | Kalinin TETs–4 |
| 51 | Konakovo GRES |
| 52 | Uglich, MoGES–13 |
| 53 | Rybinsk, MoGES–14 |
| 54 | Cherepovets TETs |
| 55 | Sheksna, Cherepovets GES |
| 56 | Yaroslavl' TETs–1 |
| 57 | Yaroslavl' TETs–3 |
| 58 | Komsomol'sk, Ivanovo GRES |
| 59 | Ivanovo TETs–2 |
| 60 | Vladimir TETs–2 |
| 61 | Shatura, MoGRES–5 |
| 62 | Ramenskoye, Tsagi TETs |
| 63 | Moscow, Smidovich TETs–1 |
| 64 | Moscow TETs–9 |
| 65 | Moscow TETs–11 |
| 66 | Moscow TETs–12 |
| 67 | Moscow, Leningradskiy TETs–16 |
| 68 | Moscow, Kaluzhskaya TETs–20 |
| 69 | Moscow, Khovrinskaya TETs–21 |
| 70 | Moscow TETs–22 |
| 71 | Moscow TETs–23 |
| 72 | Cherepet', MoGRES–19 |
| 73 | Aleksin TETs–15 |
| 74 | Shchekino TETs |
| 75 | Shchekino GRES–18 |
| 76 | Novomoskovsk GRES–10 |
| 77 | Ryazan' TETs |
| 78 | Kashira, MoGRES–4 |
| 79 | Stupino TETs–17 |
| 80 | Perkino, Ryazan' GRES |
| 81 | Volgorechensk, Kostroma GRES |
| 82 | Gorodets, Gor'kiy GES |
| 83 | Balakhna, Gor'kiy GRES–1 |
| 84 | Dzerzhinsk, Igumnovskaya TETs |
| 85 | Gor'kiy, GAZ–1 TETs |
| 86 | Dzerzhinsk TETs |
| 87 | Gor'kiy, Novogor'kovskaya TETs |
| 88 | Saransk TETs–2 |
| 89 | Penza TETs–1 |
| 90 | Lipetsk TETs |
| 91 | Voronezh GRES |
| 92 | Arkhangel'skoye, Novo-Voronezh AES |
| 93 | Kursk, Ryshkovo TETs |
| 94 | Kirov, Kirovo-Chepetskiy TETs–3 |
| 95 | Kirov TETs–4 |
| 96 | Cheboksary TETs |
| 97 | Cheboksary GES |
| 98 | Kazan' TETs–2 |
| 99 | Kazan' TETs–3 |
| 100 | Naberezhnyye Chelny, Nizhnekamskaya GES |
| 101 | Nizhnekamsk TETs |
| 102 | Zainsk GRES |
| 103 | Urussu GRES |
| 104 | Melekess, Ul'yanovskaya AES |
| 105 | Ul'yanovsk TETs |
| 106 | Tolyatti, Privolzhskaya GRES |
| 107 | Tolyatti TETs–1 |
| 108 | Tolyatti TETs–2 |
| 109 | Zhigulevsk, Kuybyshev GES |
| 110 | Kuybyshev, Bezimyanka TETs |
| 111 | Kuybyshev, Novokuybyshev TETs–2 |
| 112 | Kuybyshev, Novokuybyshev TETs–1 |
| 113 | Balakovo, Saratov GES |
| 114 | Balakovo TETs |
| 115 | Engel's TETs–3 |
| 116 | Volgorad, Volzhskiy TETs |
| 117 | Volgograd GES |
| 118 | Volgograd GRES–1 |
| 119 | Volgograd TETs–2 |
| 120 | Astrakhan', Astra GRES |
| 121 | Tsimlyansk GES |
| 122 | Krasnyy Sulin, Nesvetay GRES |
| 123 | Shakhty, Artem GRES |
| 124 | Novocherkassk GRES |
| 125 | Shterovka, Shter GRES |
| 126 | Lugansk GRES |
| 127 | Uglegorsk GRES |
| 128 | Zuyevka, ZuGRES |
| 129 | Starobeshevo GRES |
| 130 | Roya, Kurakhovka GRES |
| 131 | Luganskoye, Mironovskaya GRES |
| 132 | Lisichansk TETs–2 |
| 133 | Rubezhnoye TETs–2 |
| 134 | Slavyansk GRES |
| 135 | Zmiyev GRES |
| 136 | Chuguyev, Khar'kov GRES–2 |
| 137 | Khar'kov TETs–3 |
| 138 | Dnepropetrovsk, Pridneprovskaya GRES |
| 139 | Zaporozh'ye, Dnepro GES |
| 140 | Dneprodzerzhinsk,Dzerzhinskiy GRES |
| 141 | Dneprodzerzhinsk GES |
| 142 | Krivoy Rog, Krivorozhskiy TETs–1 |
| 143 | Zelenodol'sk, Krivoy Rog GRES–2 |
| 144 | Novodneprovka GRES |
| 145 | Kremenchug GES |
| 146 | Kremenchug TETs |
| 147 | Cherkassy TETs |
| 148 | Kanev GES |
| 149 | Tripol'ye GRES |
| 150 | Kiev, Darnitsa TETs–4 |
| 151 | Kiev TETs–2 |
| 152 | Kiev GES |
| 153 | Chernigov TETs |
| 154 | Dobrotvor GRES |
| 155 | Burshtyn GRES |
| 156 | Kalush TETs |
| 157 | Vinnitsa TETs |
| 158 | Ladyzhin, Yuzhnaya GRES |
| 159 | Dnestrovsk, Moldavskaya GRES |
| 160 | Odessa TETs–3 |
| 161 | Kakhovka GES |
| 162 | Simferopol' GRES |
| 163 | Krasnodar TETs |
| 164 | Nevinnomyssk GRES |
| 165 | Groznyy, Novogroznenskiy TETs–1 |
| 166 | Groznyy TETs–3 |
| 167 | Novyy Chirkey, Chirkeyskaya GES |
| 168 | Tkvarcheli GRES |
| 169 | Dzhvari, Ingurskaya GES |
| 170 | Tsageri, Ladzhanurskaya GES |
| 171 | Kutaisi, Namakhvanskaya GES |
| 172 | Vartsikhe GES |
| 173 | Tsalka, Khram GES–1 |
| 174 | Tetri Tskaro, Khram GES–2 |
| 175 | Rustavi TETs |
| 176 | Gardabani, Tbilisi GRES |
| 177 | Atarbekyan GES |
| 178 | Gyumush GES |
| 179 | Yerevan, Kanaker GES–2 |
| 180 | Yerevan TETs |
| 181 | Razdan TETs |
| 182 | Razdan GRES |
| 183 | Kirovabad TETs |
| 184 | Shamkor GES |
| 185 | Mingechaur GES |
| 186 | Tatev GES |
| 187 | Ali-Bayramly GRES |
| 188 | Sumgait TETs–1 |
| 189 | Sumgait TETs–2 |
| 190 | Baku, Severnaya GRES |
| 191 | Baku, Krasnaya Zvezda TETs |
| 192 | Chaykovskiy, Votkinsk GES |
| 193 | Karmanovo GRES |

### SUBSTATIONS

| MAP REF. NO. | IDENTITY |
|---|---|
| 1 | Kem' |
| 2 | Leningrad/Vostochnaya |
| 3 | Leningrad/Yuzhnaya |
| 4 | Chudovo |
| 5 | Okulovka |
| 6 | Salaspils |
| 7 | Siauliai |
| 8 | Kaunas |
| 9 | Minsk/Yuzhnaya |
| 10 | Ross |
| 11 | Moscow/Belyy Rast |
| 12 | Sofrino |
| 13 | Moscow/Beskudnikovo |
| 14 | Moscow/Reutov |
| 15 | Moscow/Butyrki |
| 16 | Moscow/Chagino |
| 17 | Moscow/Kolomenskoye |
| 18 | Moscow/Zapadnaya |
| 19 | Moscow/Pakhra |
| 20 | Noginsk/Vostochnaya |
| 21 | Vladimir |
| 22 | Mikhaylov |
| 23 | Arzamas |
| 24 | Gryazi |
| 25 | Novo-Nikolayevskaya |
| 26 | Veshkayma |
| 27 | Zhigulevsk, Kuybyshev GES |
| 28 | Volgograd GES |
| 29 | Kinel' |
| 30 | Ural'sk |
| 31 | Syzran' |
| 32 | Saratov |
| 33 | Petrov Val |
| 34 | Mikhaylovka |
| 35 | Donetsk/Chaykino |
| 36 | Krasnodon |
| 37 | Dzerzhinsk |
| 38 | Kharkov/Podvorki |
| 39 | Belgorod |
| 40 | Zaporozh'ye |
| 41 | Kremenchug GES |
| 42 | Pyatikhatki |
| 43 | Trikhaty |
| 44 | Kishinev |
| 45 | Cherkassy |
| 46 | Kiev |
| 47 | Vinnitsa |
| 48 | Stryy |
| 49 | Mukachevo |
| 50 | Rostov |
| 51 | Pyatigorsk/Mashuk |
| 52 | Ordzhonikidze |
| 53 | Zestafoni |
| 54 | Gldani |
| 55 | Tbilisi/Naftlugi |
| 56 | Akstafa |
| 57 | Agdam |
| 58 | Shinuayr |
| 59 | Baku/Khurdalan |
| 60 | Bugul'ma |






Electric Power, European U.S.S.R. and the Caucasus Figure 23

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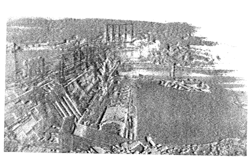
SECRET

POWERPLANTS [redacted]

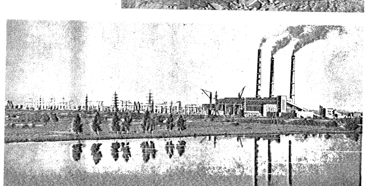
| MAP REF. NO. | IDENTITY |
|---|---|
| 194 | Berezniki, BMZ TETs–2 |
| 195 | Yayva GRES |
| 196 | Gubakha, Kizel GRES–1 |
| 197 | Perm', Kamskaya GES |
| 198 | Perm' TETs–14 |
| 199 | Perm' TETs–9 |
| 200 | Krasnokamsk, Zakam TETs–5 |
| 201 | Krasnoturinsk, Bogoslavskiy TETs |
| 202 | Serov GRES |
| 203 | Nizhnaya Tura GRES |
| 204 | Nizhniy Tagil TETs |
| 205 | Verkhniy Tagil GRES |
| 206 | Sverdlovsk, SUGRES |
| 207 | Asbest, Reftinskaya GRES |
| 208 | Beloyarskoye, Uralskaya AES |
| 209 | Kamensk-Ural'skiy, Krasnogorsk TETs |
| 210 | Tyumen' TETs |
| 211 | Pavlovka, Ufa GES |
| 212 | Ufa, Novo-Chernikovskiy TETs–4 |
| 213 | Ufa, Novo-Ufimskiy TETs–3 |
| 214 | Ufa TETs–2 |
| 215 | Sterlitamak TETs |
| 216 | Salavat TETs–1 |
| 217 | Salavat TETs–2 |
| 218 | Yermolayevo, Kumertau TETs |
| 219 | Argayash TETs |
| 220 | Chelyabinsk TETs–1 |
| 221 | Chelyabinsk GRES |
| 222 | Chelyabinsk, Bakal'stroy TETs |
| 223 | Chelyabinsk TETs–2 |
| 224 | Yuzhno-Ural'sk GRES |
| 225 | Troitsk GRES |
| 226 | Petrushino, Ala-Kul'skaya GRES |
| 227 | Magnitogorsk TETs–3 |
| 228 | Magnitogorsk TETs–1 |
| 229 | Rudnyy, Sokolovskoye TETs |
| 230 | Iriklinskiy GRES |
| 231 | Orsk TETs–1 |
| 232 | Orsk, Novo–Troitskaya TETs–3 |
| 233 | Aktyubinsk TETs |
| 234 | Kurgan TETs |
| 235 | Petropavlovsk TETs–2 |
| 236 | Omsk TETs–3 |
| 237 | Omsk TETs–4 |
| 238 | Barabinsk GRES |
| 239 | Tomsk Thermal powerplant, North |
| 240 | Tomsk AES No. 1 |
| 241 | Tomsk AES No. 2 |
| 242 | Tomsk GRES–2 |
| 243 | Novosibirsk TETs–2 |
| 244 | Novosibirsk TETs–3 |
| 245 | Novosibirsk TETs–4 |
| 246 | Novosibirsk GES |
| 247 | Kemerovo TETs |
| 248 | Kemerovo, Novo-Kemerovskiy TETs |
| 249 | Belovo GRES |
| 250 | Novokuznetsk, ZapSib TETs |
| 251 | Novokuznetsk TETs–2 |
| 252 | Novokuznetsk TETs–1 |
| 253 | Myski, Tom-Usinskaya GRES |
| 254 | Kaltan, Yuzhno-Kuzbasskaya GRES |
| 255 | Barnaul TETs–2 |
| 256 | Biysk TETs |
| 257 | Nazarovo GRES |
| 258 | Divnogorsk, Krasnoyarsk GES |
| 259 | Krasnoyarsk TETs–1 |
| 260 | Mayna, Sayan GES |
| 261 | Ust'-Kamenogorsk TETs |
| 262 | Ust'-Kamenogorsk, Sogrinskaya TETs |
| 263 | Ust'-Kamenogorsk, Irtyshskaya GES |
| 264 | Serebryanka, Bukhtarma GES |
| 265 | Leninogorsk TETs–2 |
| 266 | Zhingyldysor, Ekibastuz GRES–1 |
| 267 | Pavlodar TETs–1 |
| 268 | Pavlodar TETs–2 |
| 269 | Pavlodar TETs–3 |
| 270 | Yermak GRES |
| 271 | Termir-Tau, Karaganda GRES–1 |
| 272 | Termir-Tau, KMZ TETs |
| 273 | Zhartas, Karaganda GRES–2 |

SUBSTATIONS

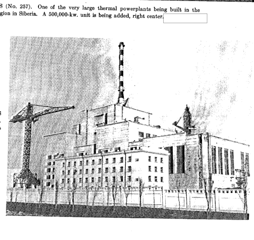
| MAP REF. NO. | IDENTITY |
|---|---|
| 60 | Bugul'ma |
| 61 | Ufa/Dema |
| 62 | Zlatoust |
| 63 | Miass |
| 64 | Chelyabinsk/Shagol |
| 65 | Sverdlovsk/Yuzhnaya |
| 66 | Nizhniy Tagil |
| 67 | Chusovoy |
| 68 | Krasnoufimsk |
| 69 | Verkh-Neyvinskiy |
| 70 | Rudnyy/Sarbay |
| 71 | Dzhetygara |
| 72 | Omsk |
| 73 | Novosibirsk/Inskaya |
| 74 | Anzhero-Sudzhensk/East |
| 75 | Krasnoyarsk/North |
| 76 | Abakan |
| 77 | Prokop'yevsk |
| 78 | Leninsk-Kuznetskiy |
| 79 | Barnaul |
| 80 | Nikolayevka |
| 81 | Semipalatinsk |
| 82 | Ekibastuz |
| 83 | Tselinograd |
| 84 | Yesil' |



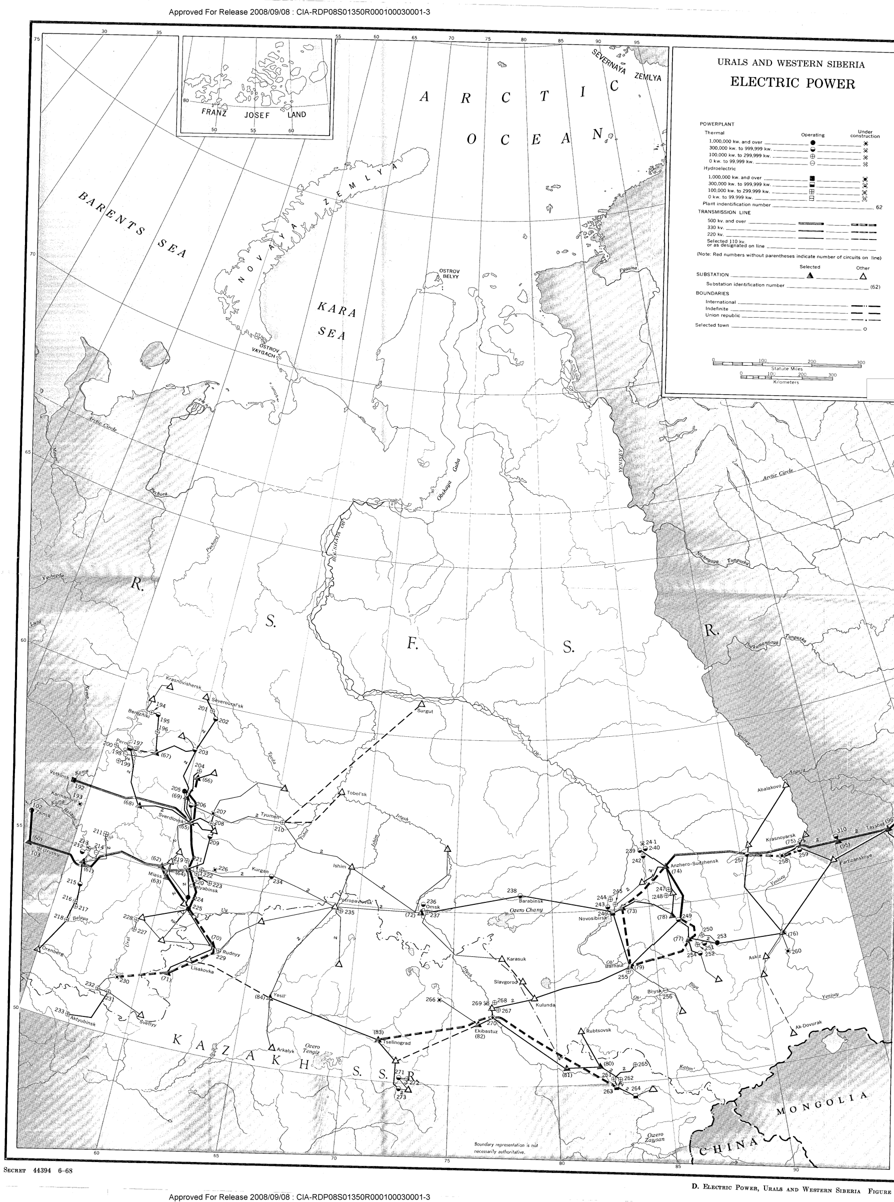
A. DIVNOGORSK, KRASNOYARSK GES (No. 258) CONSTRUCTION SITE. This huge hydroelectric dam spans the Yenisey River in Siberia. Its first two 500,000-kw. units, served by four penstocks (left) were commissioned in November 1967. [redacted]



B. NAZAROVO GRES (No. 257). One of the very large thermal powerplants being built in the Krasnoyarsk region in Siberia. A 500,000-kw. unit is being added, right center. [redacted]



C. BELOYARSKOYE, URALSKAYA AES (No. 208). Contains a single 100,000-kw. turbogenerator, supplied with steam by a pressurized water reactor. [redacted]

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D. ELECTRIC POWER, URALS AND WESTERN SIBERIA FIGURE 24

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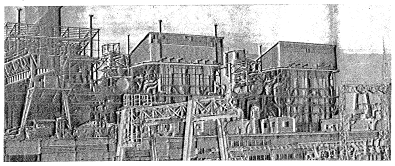
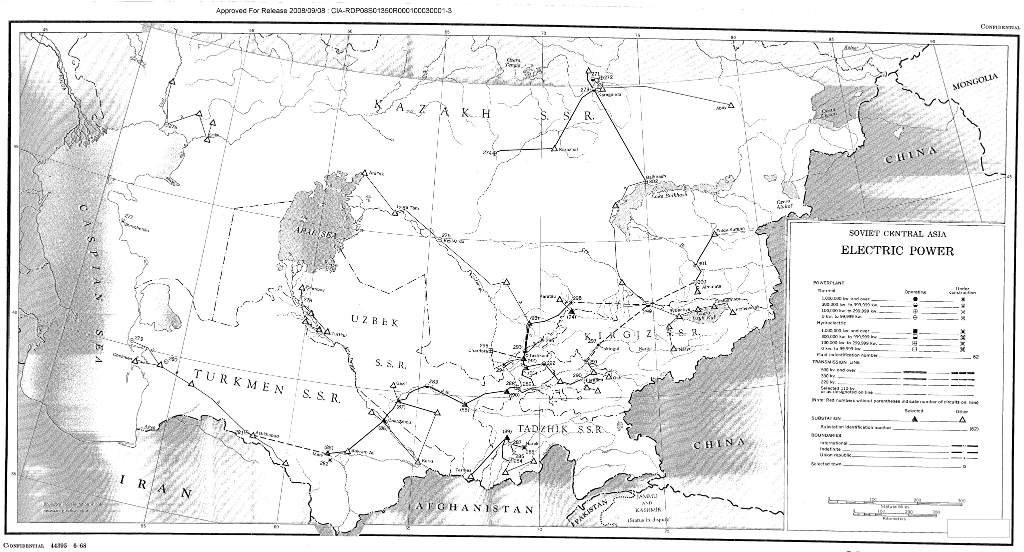
POWERPLANTS

| MAP REF. NO. | IDENTITY |
|---|---|
| 274 | Dzhezkazgan, Kingir TETs |
| 275 | Kzyl-Orda TETs |
| 276 | Gur'yev TETs-2 |
| 277 | Shevchenko AES |
| 278 | Takhia-Tash GRES |
| 279 | Krasnovodsk TETs-2 |
| 280 | Nebit-Dag gas turbine powerplant |
| 281 | Ashkhabad, Bezmein GRES |
| 282 | Mary, Prikopetdagskaya GRES |
| 283 | Navoi GRES |
| 284 | Kalininabad, Golovnaya GES |
| 285 | Yavan TETs |
| 286 | Nurek GES |
| 287 | Dushanbe TETs |
| 288 | Begovat, Farkhad GES |
| 289 | Leninabad, Kayrak-Kum GES |
| 290 | Fergana TETs-2 |
| 291 | Uch-Kurgan GES |
| 292 | Angren GRES |
| 293 | Tashkent GRES |
| 294 | Begovat, Syrdar'inskaya GRES |
| 295 | Chardara GES |
| 296 | Brichmulla, Charvak GES |
| 297 | Toktogul GES |
| 298 | Dzhambul GRES |
| 299 | Frunze TETs |
| 300 | Alma-Ata, Pokrovka GRES |
| 301 | Ili, Kapchagay GES |
| 302 | Balkash TETs |
| | SUBSTATIONS |
| 85 | Mary |
| 86 | Chardzhou |
| 87 | Bukhara |
| 88 | Samarkand |
| 89 | Dushanbe/Novaya |
| 90 | Yangi-Yer/Uzlovaya |
| 91 | Almalyk |
| 92 | Tashkent/Kyuylyuk |
| 93 | Chimkent |
| 94 | Dzhambul |



A. Open-air boilers and turbogenerators at Tashkent GRES (No. 293). This economical type of construction can be employed only in the southernmost parts of the U.S.S.R.






B. Electric Power, Soviet Central Asia Figure 25

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25X1

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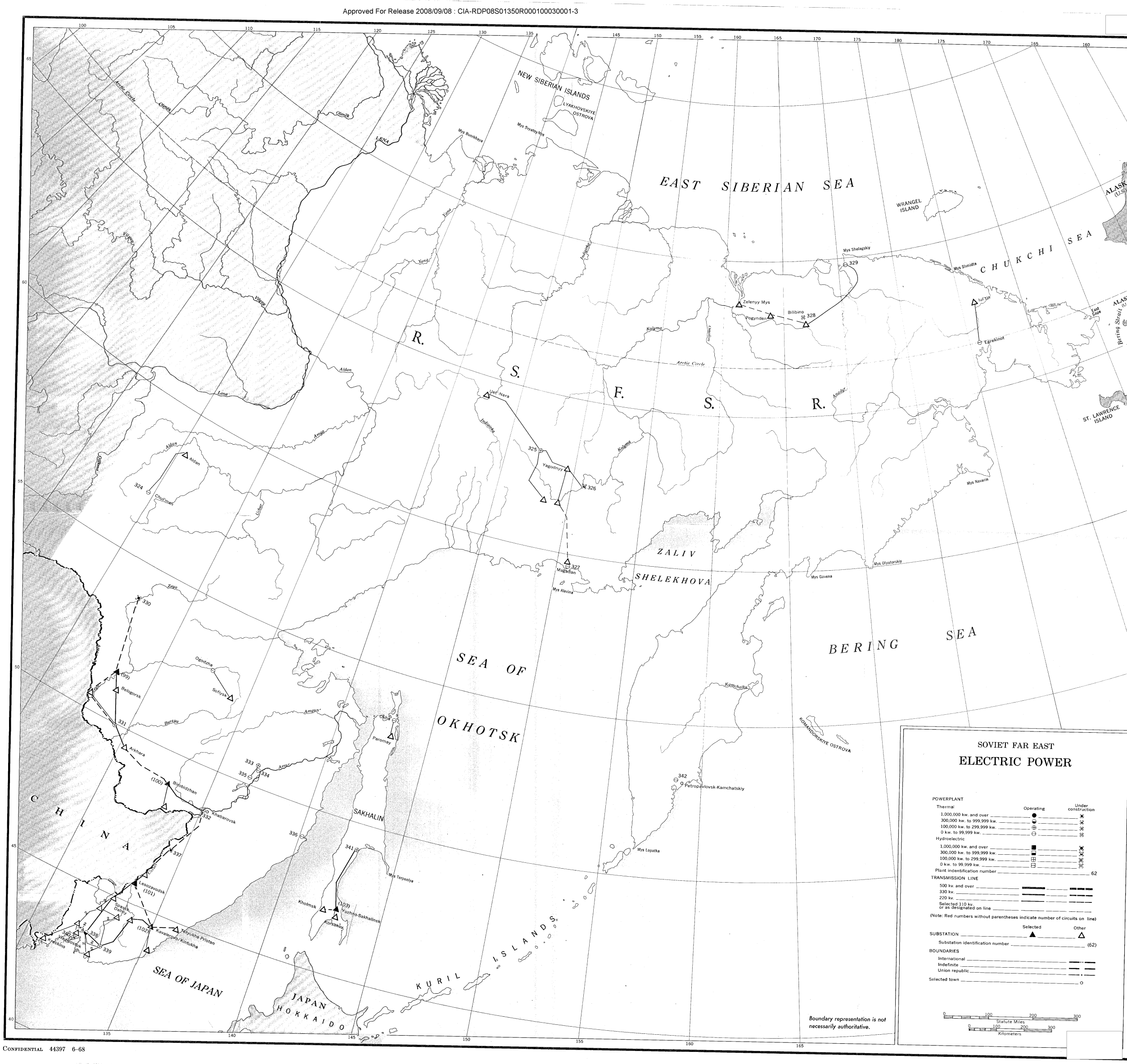


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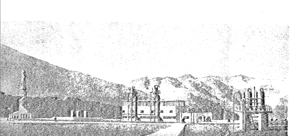
### POWERPLANTS

| MAP REF. NO. | IDENTITY |
|---|---|
| 324 | Chul'man GRES |
| 325 | Myaundzha, Arkagala GRES |
| 326 | Debin, Kolyma GES |
| 327 | Magadan TETs |
| 328 | Bilibino, Chukotskaya AES |
| 329 | Pevek, Chaunskaya GRES |
| 330 | Berezovka, Zeyskaya GES |
| 331 | Raychikhinsk TETs |
| 332 | Khabarovsk, Ussuriyskiy TETs-1 |
| 333 | Komsomol'sk, Amurstal' TETs-1 |
| 334 | Komsomol'sk TETs-2 |
| 335 | Amursk TETs-1 |
| 336 | Sovetskaya Gavan' thermal powerplant |
| 337 | Nadarovka, Primorskaya GRES |
| 338 | Artem GRES |
| 339 | Suchan GRES |
| 340 | Vladivostok TETs |
| 341 | Vakhrushev, Yuzhno-Sakhalinskaya GRES |
| 342 | Petropavlovsk-Kamchatskiy TETs |
| | **SUBSTATIONS** |
| 99 | Svobodnyy |
| 100 | Birobidzhan |
| 101 | Lesozavodsk |
| 102 | Kavalerovo/Kintukha |
| 103 | Yuzhno-Sakhalinsk/Severnaya |



MCHATKA EXPERIMENTAL GEOTHERMAL POWERPLANT. Utilizes two 2,500-kw. turbogenerators, operating on steam from nearby wells.

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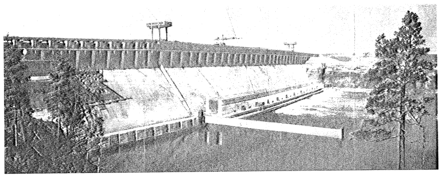
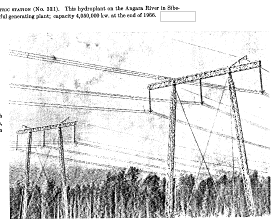
B. ELECTRIC POWER, SOVIET FAR EAST FIGURE 27

POWERPLANTS

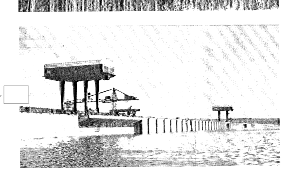
| MAP REF. NO. | IDENTITY |
|---|---|
| 303 | Noril'sk TETs–1 |
| 304 | Noril'sk TETs–2 |
| 305 | Snezhnogorsk, Khantayskaya GES |
| 306 | Chernyshevskiy, Vilyuyskaya GES |
| 307 | Bodaybo, Mamakan GES |
| 308 | Yakutsk thermal powerplant |
| 309 | Yakutsk gas turbine powerplant |
| 310 | Zaozernyy, Krasnoyarsk GRES–2 |
| 311 | Bratsk GES |
| 312 | Bratsk TETs–1 |
| 313 | Nevon, Ust'Ilimskaya GES |
| 314 | Usol'ye-Sibirskoye TETs |
| 315 | Angarsk TETs–1 |
| 316 | Angarsk TETs–9 |
| 317 | Angarsk, Sukhovskaya TETs–10 |
| 318 | Irkutsk, Angara GES |
| 319 | Baykal'sk TETs |
| 320 | Guzinoozersk GRES |
| 321 | Ulan-Ude TETs |
| 322 | Chita GRES |
| 323 | Priargunsk, Nerchinsk TETs |
| | SUBSTATIONS |
| 95 | Zaozernyy/Kamala |
| 96 | Tayshet |
| 97 | Tulun/Perevoz |
| 98 | Angarsk |



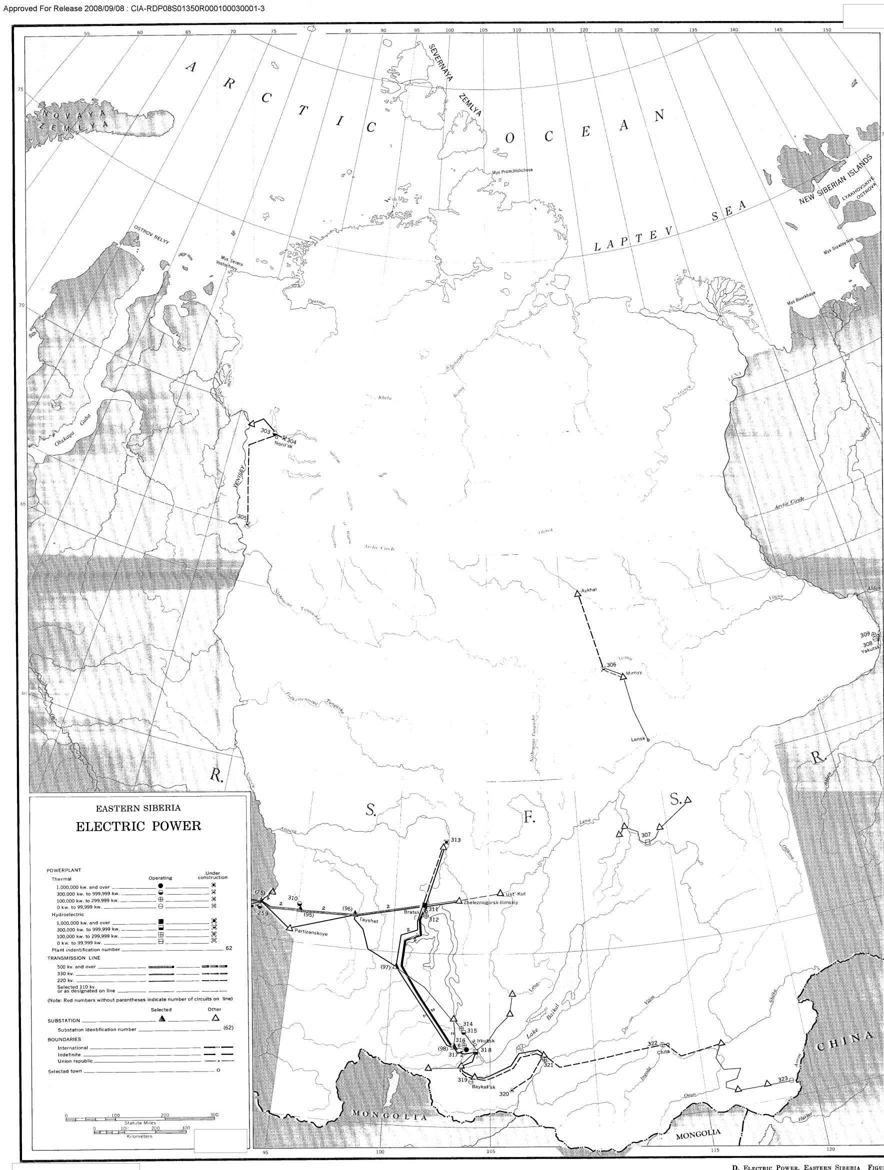
A. Bratsk GES hydroelectric station (No. 311). This hydroplant on the Angara River in Siberia, is the world's most powerful generating plant; capacity 4,050,000 kw. at the end of 1966.



B. Typical 500-kv. transmission line. Links Bratsk with Irkutsk. Guyed steel portal towers, more than 120 feet high, and long insulators characterize Soviet 500-kv. transmission networks.



C. Bratsk. 1966 Reservoir level.





D. Electric Power, Eastern Siberia Figure 26

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030001-3