USE OF ELECTRICAL POWER FOR HEAT SUPPLY
AT HYDRAULIC ENGINEERING PROJECTS

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Hydraulic engineering projects, which are generally located far from populated areas and industrial centers, require the creation of housing, building-industry installations, transportation lines, and power supply sources during the initial period of construction. Shortening of the construction period of hydraulic structures requires a marked increase in the available power at the projects and a decrease of the total time for construction, including that for providing it with power resources.

The heat supply occupies an essential place in providing a project with power resources, especially if construction begins in uninhabited regions with a rigorous climate in the absence of heat supply sources which could be used during the initial period. Such installations include especially the hydroelectric power stations being built in regions of Siberia, the North, and Far East.

The climatic conditions and considerable volume of construction operations determine the comparatively large calculated heat loads. For example, in the construction of the Bratsk hydroelectric station the calculated maximum heat load with consideration of the construction of a regional building industry base was about 300 Gcal/h (which is equivalent to an installed capacity of electrical boiler rooms of 360,000 kW); Krasnoyarsk hydroelectric station, 150 Gcal/h (180,000 kW); Ust'-Ilimsk hydroelectric station under construction, 200 Gcal/h (240,000 kW).

Heat expenditures are roughly distributed as follows (%):

By heat consumers
- industrial installations of construction site ............... 75-85
- housing .................................... 15-20
- construction of dam and powerhouse .................. 10-15

By items of expenditure
- heating .................................... 25-35
- ventilation .................................. 20-25
- hot water supply ............................... 5-10
- technological construction needs .................... 50-30

More than 50% of the heat consumers are temporary (concrete plants, construction bases, foundation areas of the main station, structures etc.); more than 70% of the heat loads (heating, ventilation, and partially the technological needs) are seasonal.

Depending on the electrical and fuel supply conditions of the construction region, the heat load can be covered from various sources. The most common sources are fixed and mobile boiler units using solid, liquid, or gaseous fuel. In a number of instances electrical power is used for the heat supply of hydraulic engineering projects (Bratsk, Ust'-Ilimsk, etc.).

The main criterion for selecting the heat supply sources is their economic effectiveness, which is determined by technical and economic calculations of the alternatives being compared. Long experience in the design of heat supply systems for hydraulic engineering projects makes it possible to give a general evaluation of the effectiveness of various sources.

The construction of a central heating and power plant during the initial period of construction of hydraulic structures is, as a rule, not effective economically, considering the temporary and seasonal nature of the heat use. When constant heat consumers (industrial plants and housing), with their specific concentrations of heat loads and heat consumption schedules, appear in the area of hydraulic structures under construction, the construction of a
central heat and power plant can prove to be advantageous in the middle or at the end of the construction period. The use of firewood stocked up from the flooded zone as the main fuel for the boiler houses is in most cases unacceptable with respect to available resources and economic effect. Thus, for example, during the projected construction period of the Ust'-Illimsk hydroelectric station the consumption of heat will amount to about 3.8 million Gcal (at a maximum consumption of 750,000 Gcal per year). To produce this amount of heat energy it is necessary to burn about 0.9 million tons of ideal fuel (at a boiler house efficiency of 60%), or 4.9 million m³ of firewood having an average moisture content of 33%. The volume of wood intended for use as fuel has been calculated to be 2.5 million m³, or 51% of the volume necessary for supplying heat during the projected construction period. The forest will be cleared over an area of about 130,000 ha with a maximum distance of 250 km from the site, which determines the large amount of manpower involved and the high cost of procurement and transportation of the firewood to the site, considering the lack of roads in the flooded zone.

The possibility of using electrical power as the heat supply source is determined by the state of the transportation lines and conditions of the electrical supply of the hydraulic engineering projects. In comparison with fuel-type boiler houses, electrical heat supply systems require smaller investments and manpower for their construction and greatly reduce the number of maintenance personnel, owing to the greater possibility of automating the production of heat energy. However, electrical heat supply systems, despite their indisputable technical perfection, can be inferior in economic indices to heat supply systems with fuel-type boiler houses in those cases when fuel is delivered to the site by railroad, waterways, or pipelines.

For construction areas not having these transportation lines, the expenditures for fuel in the case of delivery of solid or liquid fuels by vehicles over long distances can prove to be commensurable with the expenditures for electrical power, as a result of which the electrical heat supply systems can be economically justified.

We will consider below the specific features of electrical heat supply systems which should be taken into account in their technical and economic comparison with heat supply systems equipped with fuel-burning devices.

**Degree of Centralization of Heat Supply.** Centralization should be maximum in heat supply systems with fuel-type boiler houses, since in this case there is an increase of efficiency of the plant, a reduction of the number of maintenance personnel, and a decrease in the prime cost of the heat energy being produced. However, there is an increase in the volume of work for laying the heating mains, which can have an adverse effect for the initial construction period.

In electrical heat supply systems the number of heat supply sources is determined by the density of the heat loads, sequence of constructing the heat-consuming installations, and need to use a higher voltage (6-10 kV in existing electrical boiler houses) for reducing investments in step-down substations. The length of the heating mains should be minimized as much as possible. The number of electrical boiler houses has a smaller effect than fuel-type ones on the cost of producing heat energy, since the efficiency of electrode boilers is close to unity, and the number of maintenance personnel does not increase sharply with an increase of the number of electrical boiler houses owing to the possibility of complete automation of their operation. However, when planning industrial plants and housing areas at construction sites one should, as a rule, strive for the densest buildup area, which will allow maximum centralization of the heat supply by shortening the length of the heating mains. This solution is warranted when temporary electrical boiler houses are subsequently replaced by permanent heat supply sources (central heat and power plants, fuel-type boiler houses).

An example of intelligent planning is the construction site of the Ust'-Illimsk hydroelectric station, * where heat is supplied from a central electrical boiler house with an installed capacity of 240,000 kW with electrode boilers operating on a voltage of 10 kV.

**Design Considerations.** The duration of operation of the electrical heat supply systems should be taken into account when selecting the engineering equipment of the buildings and structures and the number and sites of location of the heat supply sources. If the electrical power is used for heat supply temporarily, just during the construction period, the internal heating, ventilating, hot-water supply, and construction steam and water-supply systems should not have to undergo radical reequipping when converted to a heat supply from fuel sources. For example, if houses are temporarily heated by electrical power and this heating will subsequently be converted to

*See the article of T. I. Orlov and V. L. Kagan in this issue.*