2. Optimization of the discharges along the Great Stavropol' Canal on the basis of the criterion of minimum specific discharges of hydrostations of the cascade and approximation of the regime of the hydrostations to these conditions additionally increase the effectiveness of using the stream.

3. The conduction of analogous hydropower calculations can be useful in other power systems and cascades of hydroelectric stations.

LITERATURE CITED

EXPERIENCE IN THE OPERATION OF OVERFLOW BUTTRESS DAMS
UNDER SEVERE CLIMATIC CONDITIONS

D. M. Yashkul' and V. V. Belov

Buttress dams whose total length exceeds 0.5 km and the maximum height is equal to 26 m have been operating for a long time as part of the structures of the three hydroelectric stations of the Paz cascade — the Janiskoski (constructed by the Finnish joint-stock company "Imatran-Vojma"), Hevoskoski, and Borisogleb (both constructed by the Norwegian firm "Norelektro"). A part of the spans of these dams are made overflow [1].

The Paz (Paatsjoki) River flows in the western part of the Kola Peninsula in a region with a severe climate. The mean annual air temperature is close to zero with a drop during the year from +35°C to −45°C. The winter lasts 7 months. The number of winter days with a mean daily temperature below −15°C is more than 16 and with a temperature below −30°C up to 10–15.

The maximum range of variation of temperature during the day is 25°C.

Exposed concrete structures outside the zone of fluctuation of the water level are subjected daily to the effect of an average of 30 surface free–thaw cycles. For structures located within the zone of fluctuation of the water level of the reservoirs the number of these cycles reaches 400.

Despite the severe natural conditions the thin-walled structures of the hollow overflow dams are completely reliable in operation. The capacity of each of the spillway outlets is 250–480 m³/sec. The spillways are located on a rock foundation and do not have stilling basins. The wasteways beyond the dams are usually drained and are filled with water only during idle releases.

The main service outlet of the Janiskoski overflow dam is closed by a sector gate with a span of 12.5 m and head on the sill of 4.5 m. The spillway is formed by buttresses with a thickness of 4.1 and 3 m with massive heads 5.5 and 8 m thick (Fig. 1).

The enlargements of the buttresses form not only the vertical upstream face of the dam but also the bottom of the gate chambers and ogee-type spillway surface.

The 11.5-m-spare surface outlet of the spillway of the Janiskoski hydrostation is closed by a vertical lift gate [2].

The Hevoskoski overflow dam (Fig. 2) consists of two 12-m-wide bays closed by radial gates. The head on the sill of the gates is 5.5 m. The spillway profile is formed by the thin slabs of the upstream face, crest, and downstream spillway surface with a thickness in the middle section respectively of 1.0, 2.0, and 1.2 m. The spillway face has the outline of an ogee and by means of a radial curvature is connected with the bottom of the wasteway.
The base of the dam is located on firm fine-grained granite-gneisses and is carried down to a depth of 1-2 m into the rock mass. The rock foundation in the hollow is left exposed.

The slabs of the spillway bays rest on concrete abutments and the middle pier with a thickness of 2 m each. To increase the reliability of connecting the abutment with the earth dam, its outside surface is made with a slope of 10:1 and concrete watertight spurs are constructed toward the embankment.

The connecting wall linking the spillway with the powerhouse is made buttressed, at a height of 18.5 m it has a thickness from 0.55 m in the upper part to 0.75 m in the lower. A concrete wall constructed from the downstream side creates a warming hollow. The slab and wall are separated from the supports by expansion joints in which a shaped polyvinyl chloride strip seal is installed and coated with bitumen. The foundation of the hollow is leveled by a thin layer of sand-gravel soil. The top of the hollow is covered by the bridge superstructure running along the crest of the spillway piers.

The seepage water is discharged from the hollows of the spillway and connecting wall by 22.9-cm-diameter concrete pipes into a common drain well.

The buttress dam of the Borisogleb hydrostation (Fig. 3) has two spillway bays. Their openings, each 12 m wide, are closed by radial gates with a head of 7.5 m for the left spillway adjacent to the bank and 5.0 m for the right.

The load from the gate hinges is absorbed by three 3.5-m-thick piers.

The spillway profile of each bay between piers is formed by two 2-m-thick buttresses with massive heads each 6 m wide, creating both the vertical upstream face and ogee-type spillway face. The connection of the heads and foundation is reinforced by 25-mm-diameter anchors. The joints of the buttresses with the abutment and with each other are sealed by a shaped rubber strip, layer of bitumen, and cords of mastic sealant. The transverse expansion joint with the same such seal cuts off the downstream face of the spillway from the upstream face and crest at a distance of 2 m from the gate sill.

The rock foundation in the hollow of the spillway dam is leveled by rubble fill. The water that seeped into the hollow is drained. It should be noted that the drain outlet, in the form of a pipe laid at the lowest point of the spillway bucket, is clogged with ice in the winter and does not operate. This proves the need for constructing a backup nonfreezing drain outlet.

The bays of the Hevoskoski and Borisogleb overflow dams were used during construction.