The water should be drained from the drainage system to the lower elevations of the powerhouse, for which there are pits within the powerhouse for collecting water and a room for accommodating the pumping station and the necessary pipe fittings are installed for discharging the water to the surface.

A well being built up level by level outside the limits of the powerhouse and equipped with submersible pumps of the appropriate delivery can serve as a variant of pumping from the horizontal drainage system in the case of small water inflows into the pit.

3. As far as possible, the designs should provide for groundwater lowering equipment such that it provides the minimum number of levels of groundwater lowering inside the pit.

LITERATURE CITED


DAMMING OF THE IRTYSH RIVER AT THE CONSTRUCTION SITE OF THE SHUL'BINSK HYDROELECTRIC STATION

V. S. Panteleev, R. F. Gorlatov, and V. S. Kolesnik

The site of the Shul'binsk hydroelectric station is located in the middle course of the Irtysh River. Upstream are two operating hydroelectric stations: the Bukhtarma and Ust'-Kamenogorsk.

The Irtysh River, the largest tributary of the Ob River, originates on the southern slopes of the Altai. The total length of the Irtysh is 4248 km, the drainage area is 1,643,000 km².

The climate of the region of the Shul'binsk hydrostation is distinguished by continentality and insufficient moisture. Here are observed a cold winter with little snow, late spring and early fall frosts, hot summer, and large temperature differences. The mean annual air temperature in the region is plus 3-3.2°C. The average temperature of the coldest month (January) is minus 16.2°C. The absolute minimum in one of the winter months drops to minus 49°C. Persistent subfreezing temperatures last from the third decade of November to mid-March. During the harsh winter thaws are possible, the average duration of which is 4 days. Passage of the mean daily temperature through 0°C occurs in the spring in early April and in the fall at the end of November. In the spring frosts usually last until mid-April and in the fall they begin in mid-September. The hottest month is July. Its average temperature is plus 20-22°C. The absolute maximum reaches plus 42-43°C in July and August.

The stretch of the river in the region of the structures of the Shul'binsk hydrostation is a straight pool. The river banks are high, rocky. Upstream of the site of the structures is the lower Shul'binsk riffle and downstream the group of Vetlovoi Islands and riffle.

Near the right bank in the upper pool of the structures is located Verigin Island separating the river into the main channel and right branch. The river channel is stable, pebble. The width of the main channel is 250-300 m and of the branch, 30-100 m.

The average depths of the river channel vary from 2-3 m in the low-flow period to 5.0-7.5 m in the flood period. The maximum depths reach 7-10 m. The slopes of the water surface under natural conditions varied from 0.0002 to 0.0007. The average current velocities in the low-flow period were 0.3-1 m/sec and in the flood period reached 3 m/sec. The Irtysh River belongs to rivers having mixed feeding. The water regime of the river in the region of the Shul'binsk hydrostation was determined by the characteristics of the runoff of the upper part of the drainage basin, strongly regulated by Lake Zaisan, and runoff of the right-bank mountain tributaries being fed by melting of the mountain snows and glaciers and rain. Under natural conditions the spring rise of the water level began usually in late
March–early April. On average breakup of the river occurred at the start of the second decade of April. During the ice run the rise of the levels was determined not only by an increase of the water discharges but also by ice jams, often reaching maximum elevations. The height of rise of the water levels in the presences of jams reached 3–3.5 m.

The maximum water discharges of the Irtysh River in the region of the Shul'binsk hydrostation occurred in late April–early May and were equal to 9450 m³/sec during the 25-yr series of observations, and the elevation of the level corresponding to it was 17.74 m.

The minimum summer discharges and stages were observed usually in September–October. The minimum summer discharge was 321 m³/sec (1951) at a level of 12.03 m. After the Bukhtarma hydrostation was put into operation (1960) the minimum discharge of the open-channel period at the site of the Shul'binsk hydrostation was observed on November 21, 1977 and was 298 m³/sec.

The fall ice run usually began between late October and the first half of November and lasted from 6 to 42 days.

The discharge and stage regime at the site of the Shul'binsk hydrostation is determined by releases of the Bukhtarma and Ust'-Kamenogorsk hydrostations and by the local inflow in the stretch between the Ust'-Kamenogorsk and Shul'binsk hydrostations. The bulk of the local inflow in this stretch belongs to the Ul'ba and Uba rivers, which produce 80–85% of the inflow, which in the total volume of the runoff of the Irtysh River amounts to 35%.

In conformity with the regulations on using the water resources of the reservoirs of the Bukhtarma and Ust'-Kamenogorsk hydrostations, the mean daily discharges during the navigation season on the Irtysh River were specified in an amount of 550 with a minimum base release of 500 m³/sec.

The mean annual discharges of the Irtysh River at the site of the Shul'binsk hydrostation of various probability of exceedance are:

<table>
<thead>
<tr>
<th>Probability of exceedance, %</th>
<th>0.01</th>
<th>0.1</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>90</th>
<th>95</th>
<th>97</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water discharges, m³/sec</td>
<td>1560</td>
<td>1210</td>
<td>9040</td>
<td>7100</td>
<td>6260</td>
<td>5420</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

The maximum water discharges of various probability of exceedance of the Irtysh River in the stretch of the construction site of the Shul'binsk hydrostation under natural conditions are:

<table>
<thead>
<tr>
<th>Probability of exceedance, %</th>
<th>0.01</th>
<th>0.1</th>
<th>1</th>
<th>5</th>
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</tr>
</thead>
<tbody>
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<td>Water discharges, m³/sec</td>
<td>1560</td>
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<td>7100</td>
<td>6260</td>
<td>5420</td>
</tr>
</tbody>
</table>

The maximum water discharges of the Irtysh River at the site of the Shul'binsk hydrostation under conditions of streamflow regulation by the Bukhtarma reservoir are given in Table 1.

By September 1987 mainly the preparatory works on damming the channel and diversion of the water through concrete structures had been performed at the construction site of the Shul'binsk hydrostation.

The hydrological conditions on the stretch of the hydrostation site by the start of works on damming were distinguished by a smooth variation of the stages and discharges. The range of variation of water levels in the first decade of September did not exceed 0.12 m, and the water discharges varied within 665–725 m³/sec, which created favorable conditions for performing works on damming the river.

To observe the change in the hydrological and hydraulic elements of the flow in the stretch of the hydrostation construction site during damming, temporary gauges and gauge lines were established in addition to the existing ones (Fig. 1).