Seepage of water through concrete members inevitably accompanies the operation of hydraulic structures and power-houses. It causes anxiety, mainly as a possible cause of a decrease of stability of structures under pressure and of the strength and operating reliability of their elements. Studies show that water saturation or even an increase of the moisture content of concrete can reduce its strength by half [1, 4].

Specialists occupied with technical maintenance of operating hydraulic structures, unlike designers, researchers, and builders, are no less worried about other negative consequences of this phenomenon. Seepage reduces the life of structural members, causing leaching or frost cracking of the concrete, corrosion of metal, rotting of wood, peeling of coatings, warping or breaking of linings, unsealing of joints and transitions. Seepage is one of the most widespread causes of deterioration of the exterior appearance of structures and interior of offices. The long and continuous effect of water can lead to considerable damages even from low-rate seepage.

The harmfulness of seepage is displayed also in a decrease of insolation of current-conducting devices, right up to accidents and failures on electrical equipment, imposition of more stringent operating conditions on the drains, making the working conditions of the personnel more difficult, and in an increase of danger for the workers both due to an increase of injurious factors in a wet environment and under the direct effect of the water flow, for example, during discharge into chambers or stilling basins. In individual cases seepage requires special attention also as a source of nonproductive water losses.

Careful monitoring of seepage and its control are among the main concerns of the hydrotechnical and maintenance departments of a power station. The expenditures of material and labor resources related to it amount to a considerable part of operating and maintenance expenses.

Unlike earth hydraulic structures, the body of which is constantly penetrated by a water flow over the entire length, seepage has a random, local character on concrete structures. A uniformly distributed seepage flow under the usual heads is absent here, movement of water gravitates toward defective and weakened sections of structural members.

On the whole the following phenomena caused by seepage can be distinguished on concrete hydraulic structures: water invasion (subirrigation), concentrated flow, multistream discharge, gushing jet, free-flowing discharge, dripping, oozing, wetting, dampening.

This list, compiled on the basis of on-site observations of operating structures, predetermines to a greater degree the variety of manifestations of seepage than the state of the visible part of its centers and broadens their division into leaks and spots noted in the works of V. V. Kind [1, 2] and used in the "Methodological Instructions on the Organization of Visual Control Observations..." [3].

Water invasion of structures, their partial or complete flooding are possible when the inflow of seeping water exceeds the outflow from the space surrounding the structure. A concentrated flow and discharge as a single or several gushing jets are varieties of centers of pressure seepage in which movement of the water occurs with separation from the concrete. Free-flowing centers of seepage can be in the form either of tranquil outflow of a compact or dispersed stream (without separation from the concrete) or drops falling from roofs or running down the walls, or slow oozing wetting the surfaces. Centers without visible movement of water form damp (the hand applied to the concrete is moistened) and wet, darkened spots.

*The instructions specify seven gradations for assessing seepage outlet sites, the author of the present article recommends nine (editor's note).
The character of seepage manifestations is related to the site on the structure and its structural characteristics. Galleries and the bases of cavities in dams, behind-wall spaces of powerhouses, basements, floors with an underlying drainage layer, areaways, wells, and drainage pump rooms are subjected to subirrigation.

Pressure seepage centers predominate on thin-walled structures both on the upstream side and downstream side at elevations below the lower pool level. They are confined to expansion and interblock joints, cracks, cavities, and boundaries of the concrete—rock contact.

Free-flow seepage centers can occur on any elements of all concrete hydraulic structures: nonoverflow and overflow dams, gravity and lightweight-type dams, powerhouses, diversion intakes, water conduits, tunnels, retaining and transition walls, etc. Such manifestations are tied in locally to sections of a loose structure of the concrete, disturbed expansion and construction joints, uncompacted transitions of the concrete layers, contour of the toothing, contact of the concrete with the rock or metal, intersections and butts of the joints, cracks and fissures in the concrete, anchor heads or rods fastening the formwork, outlets of pipes and embedded parts from the concrete, edges of shaft linings and holes drilled in it, old grouting holes, or other caulked holes.

The manifestations of seepage on structures can also not be related to the head from the pools and can occur from other causes inherent to all ordinary structures, such as precipitation, groundwaters, leaks in the water-conveying engineering networks, water spills, condensation, etc. The seepage centers of such origin are located on ceilings and walls under defective sections of roofs, eaves, or pipelines, below the abutments of roofs to walls, parapets, and concrete stairs, along the outlets of ventilation pipes and inside storm drains, on the inside surfaces of walls with outside horizontal projections or furrows, near the support joints of walls at the level of outdoor platforms and balconies, on joints and cracks of walls surcharged from the outside with the fill of earth dams or station platforms, in ceilings under laundries, showers, lavatories, boiler rooms, pump rooms, etc.

For preparing measures to eliminate seepage, just a classification of its external manifestations is not enough.

In addition to the type and place of location, seepage centers should be characterized by the source of their direct feeding with water, which can be: the upper pool (reservoir, forebay, regulating basin); lower pool (initial stretch of the discharge diversion, downstream water area, sea); free-flow sections of the diversion and water-conveying channels (water intake, surge chamber, tunnels, canals, outlet drain); pressure sections of the diversion and water passage (tunnels, penstocks, scroll casing, runner pit, draft tube); water-collecting devices (wells, pits, ditches, collector drain); engineering service lines (technical or domestic water lines, heating systems, sewage systems, storm drains, pipelines of monitoring and measuring equipment); groundwaters of the foundations and abutments (banks, floodplain, channel, base of the structure itself, backfill, fill of the grounds, body of earth dams and embankments); precipitation (rain- and meltwaters); random sources (accumulations of water spilled or that had already seeped in "dry" rooms, waves and their overtopping, splashes from dripping).

The presence of a water source and pressure still does not determine the unconditional occurrence of a seepage center. Many concrete members under pressure do not have any traces of seepage. The initiation of seepage on concrete structures is provoked by anomalies in their state caused by design shortcomings, structural errors, building defects, maintenance or operating infractions, and natural effects. The experience of hydrotechnical construction shows the inevitability of these anomalies in concrete structures. Therefore, when constructing them, the construction of drainage (water intercepting, collecting, and discharging) systems are, as a rule, specified beforehand, despite the fact that the entire set of antiseepage measures is originally directed at the creation of a completely impermeable enclosure of the reservoir or flow, excluding the foundation.

The following direct causes of seepage are possible: insufficient drainage of the foundation; poor quality of joining the concrete with the bank abutments and rock surface; unreliability of the antiseepage elements in the expansion joints or their disturbance; absence or incomplete covering of the block construction joints, including along the contour of the toothing; leaking of joints at their intersections and butts; weak contour sealing of pipes, linings, grooves and other embedded steel members in concrete; presence of zones or interlayers of loose concrete (not compacted during placement, frozen or overdried during hardening); formation and opening of cracks; disturbance of waterproof coverings and fastening of their edges; defects of roofs, their abutments, overhands, and gutters; insignificant slope of surfaces subjected to moistening (outdoor platforms, ledges, bridges, drains, floors); leaking of pipelines, gutters, and drains laid in concrete, and also covers, manholes, and reinforcement of pressure systems; leaks in seals of gates, guard gates, needles, and other fillings of outlets; unorganized drainage of water, its everyday spilling; rise of the water level in the pools and conduits above the allowable elevations.

The structural characteristics of the structure orient the location both of the source and remaining part of the hidden seepage path. Obviously, it is necessary to examine not only the path of the seepage flow as a whole but also its source and route separably. The causes promoting the flow of water in them and, consequently, the methods of intercepting it can be different.