

RETROFIT OF BOTTOM OUTLET NO. 1 AT THE POIANA UZULUI DAM, USING COMPLEX UNDERWATER WORKS

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ABSTRACT

The Poiana Uzului dam is the highest buttress dam of Romania (80 m max. height), creating a multipurpose storage reservoir of 88 hm³ used for water supply for population and industry, hydroelectricity and flood protection.

According to the Romanian safety norms, the dam, commissioned in 1972, is rated into the 1st class of importance, which corresponds to a design discharge value with an annual 0.1% exceedance probability, Q_{0.1%}. Dam's discharge capacity had to be also checked for Q_{0.01%}.

For discharging the floods and regulating the reservoir levels, the dam was provided with 3 bottom outlets equipped with trash racks for floats retaining and 2 butterfly valves on each bottom outlet.

In 2016, during a heavy rain period, operation of the service valve of bottom outlet no. 1 resulted in some strong noises and vibrations. During the investigations that followed, the valve body was found clogged with various submerged solid materials. A program of extensive rehabilitation works was initiated, with the assistance of a specialized team of divers.

Taking into account the long period in the dam operation, the facility being the main source of water supply for the population in the region, the local water directorate intends to accomplish a series of other important works pertaining to the mechanical equipment of Poiana Uzului dam.

1. DATA CONCERNING POIANA UZULUI DAM

Poiana Uzului Dam is a mushroom shaped buttress dam with a maximum height of 80 m, a total volume of concrete of 700,000 m³ and which creates a reservoir of 88 hm³ for the supply of drinking and industrial water and subordinated hydropower. It was designed by ISPIF Bucharest and was commissioned in 1972.



Fig. 1 : View of Poiana Uzului Dam from the downstream left abutment

The “Poiana Uzului” hydraulic development is located on the Uz watercourse, in the Trotus River basin. The dam is located at a distance of 13 km from the confluence of Uz River with the Trotus River, on the outskirts of the town of Dărmănești and 31 km from the spring.

The owner of the Poiana Uzului Reservoir is the Romanian State, through the Ministry of Environment, Waters and Forests and for its management is in charge the “Romanian Water Authority - Siret Water Directorate through the Bacau Water Management System.

Poiana Uzului Reservoir is a complex development built with the goal of fulfilling the following uses:

- The main use of the reservoir is providing water supply for the treatment of a 1,5 m³/s installed flow for the localities on the Trotus valley;
- Seasonal water supply for Darmanesti Refinery (installed flow = 0.5 m³/s);
- Production of electricity by the HPP located at the downstream foot of the dam;
- The flow downstream the reservoir is 100 l/s provided by the aqueduct.
- Flood control, by attenuating the flood flows without the volume of water retained in the reservoir as the tranche of the flood (attenuation only in the overflowing nappe) or by attenuating the flood flows according to the free volume of water in the reservoir.

In the river basin context, as the flows discharged from the dam can have a considerable contribution in the event of a flood on Trotus River, the reservoir is operated to retain the high flows on Uz River and to discharge them after routing the flood peak on Trotus River.

The dam is rated into the 1st class of importance according to the Romanian Standard, STAS 4273/1982. The design and check-up floods are defined in terms of their return periods (probabilistic approach). Thus, they correspond to the 0.1% design flood and to the 0.01% check – up flood. The dam classification in classes of importance is based on the dam dimensions, reservoir volume and reservoir benefits (installed hydropower, water supply discharge, irrigated area, etc).

A dam is rated into a category of importance in terms of its associated risk. The risk is defined in its generally accepted manner as a product of the probability of an event occurring (dam failure) and the consequences of the event, should it occur. Poiana Uzului Dam is rated into category of importance A having a Dam Associated Risk DAR = 0.51 which requires a special surveillance of the dam consisting of, besides visual observations and geodetic evaluations in instrumentation measurements. Monitoring carried out at present at the Poiana Uzului dam satisfies the requirements of the legislation in force.

2. NECESSITY OF REHABILITATION WORKS AT THE BOTTOM OUTLET NO. 1 OF POIANA UZULUI DAM

For discharging the floods and regulating the reservoir levels, the dam was provided with 3 bottom outlets equipped with trash racks for floats retaining and 2 butterfly valves on each bottom outlet.

In October 2016, during a heavy rain period, operation of the service valve of bottom outlet no. 1 resulted in some strong noises and vibrations. During the investigations that followed, the valve body was found clogged with various submerged solid materials (twigs, logs, iron scraps). A program of extensive rehabilitation works was initiated, with the assistance of a specialized team of divers.

This event was analyzed by the experts for the assessment of the dam safety condition and by the Commission for the Safety of the Dams of special importance, being established the measure of restoration of the upstream trash rack of this bottom outlet and the inspection and visualization of the other two bottom outlets, with the help of divers, to ascertain their safety condition too.

In order to accomplish this measure, the Siret Water Directorate, in 2017, carried out through its own investments program, a project called “Restoration of the trash rack and bell cofferdam at bottom outlet no. 1 and rehabilitation of the butterfly (safety) valve at Poiana Uzului Dam” accomplished by a design company in Bucharest

The works within the project could be executed only with the help of a team of divers, which implied lowering the water level in the reservoir to a level that ensured them the normal working pressure.

3. OPERATION PROGRAM OF POIANA UZULUI RESERVOIR DURING THE REHABILITATION WORKS AT THE MECHANICAL EQUIPMENT

In order for the diving team to be able to work safely under high water pressure, it was necessary that during March - April 2019 period, the reservoir level be lowered to the level of 479.00 m ASL, elevation located with approx. 12 m above the water intake no. 2.

During this period, the supply of raw water for the two drinking water-treatment stations in the area was provided from the water intake no. 2.

The storage reservoir had an operation regime that was within the limits of the operation program provided for in the “Operation Rules for the Poiana Uzului Reservoir” updated by Siret Water Directorate in 2017 and approved by the Romanian Water Authority in 2018.

Through this program are established the monthly levels of the reservoir which provide, besides the supply of the raw water and the possibility of storing and partially routing of the floods, provided the unitary value of the warning parameter is not exceeded at the operation of one or all of the 3 bottom outlets.

Compared to the maximum retention height $H = 62.00\text{m}$ admitted in the current Authorization for Safe Operation (maximum level restriction in operation at the elevation of 507 m ASL), during the period of approx. 60 days when the underwater works had to be performed, Poiana Uzului Storage Reservoir was not emptied but was operated at 53% of the hydrostatic load accepted, the height of the water column in the reservoir $H_i = 33\text{m}$, ensuring the safety of the diving teams involved in the execution activity.

After lowering the level in the reservoir, on 06 and 07.03.2019, a visual inspection of the state of the storage reservoir slopes took place, finding that they are in good condition, with no landslides.

4. CARRYING OUT OF TRASH RACK, BELL COFFERDAM AND REHABILITATION OF THE BUTTERFLY (SAFETY) VALVE AT THE BOTTOM OUTLET NO. 1 OF POIANA UZULUI DAM

During stage I, in 2018, the pontoon, the trash rack and the bell cofferdam, the trolley for lowering the trash rack, the bell cofferdam, the pontoon and other equipment parts were built and the trolley was procured.



Figure 2 : The bell cofferdam and the new trash rack.

Stage II was carried out between March and April 2019 with the help of the diving team, the execution of the works for the rehabilitation of the bottom outlet no. 1, having completed the following steps:

- The water level in the reservoir was lowered to 479.00 m ASL, in order to ensure safety conditions for the diving team;
- Before starting the underwater works at the bottom outlet no.1, a visual inspection of the work area was performed with the help of divers. It was found that it was 80% clogged, in front of it being blocked large logs;
- After the completion of the decommissioning works, the maneuvers were performed for extracting the old trash rack, installing the new one and fixing the bell cofferdam to dewater the bottom outlet pipe.



Figure 3 : Placing of the working pontoon on the water

Considering that the Poiana Uzului reservoir is the only source of water supply for many localities in Bacau County, after the bell cofferdam was fixed it was necessary to store water in the reservoir. This avoided the problems generated by the turbidity and manganese indicators in the absence of a sufficient water volume for dilution, as well as the additional costs for the Bacau water distributor Bacau, generated by the neighboring Moinesti pumping station.



Figure 4 : Preparation of the diving team

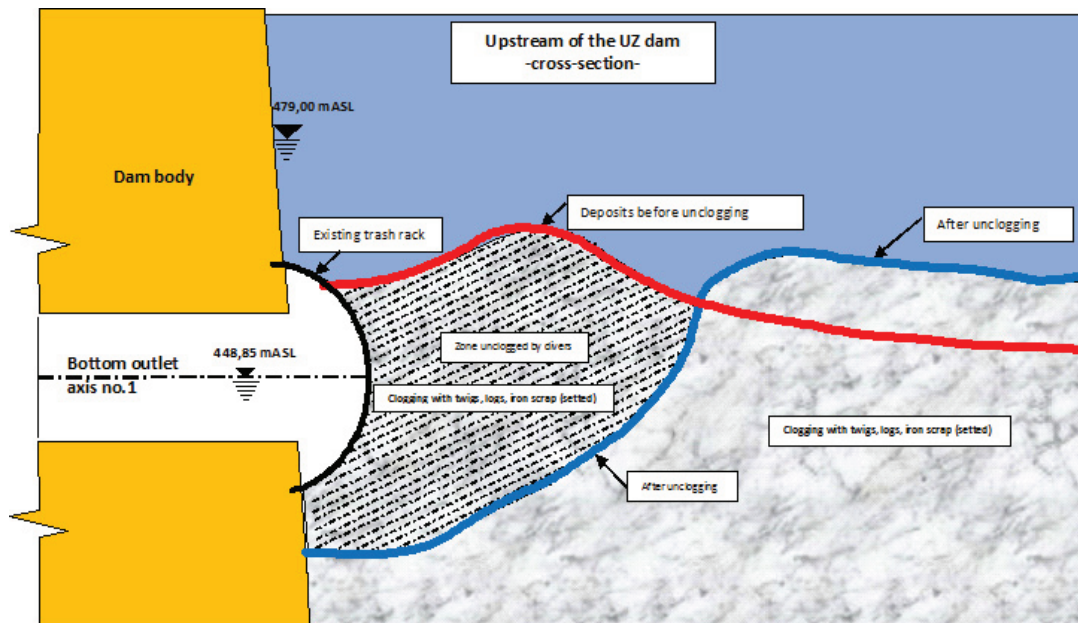


Figure 5 : Scheme of the necessary works for replacing the old trash rack and unclogging the entrance to the bottom outlet no. 1



Figure 6 : Remains of the old trash rack



Figure. 7 : The new trash rack

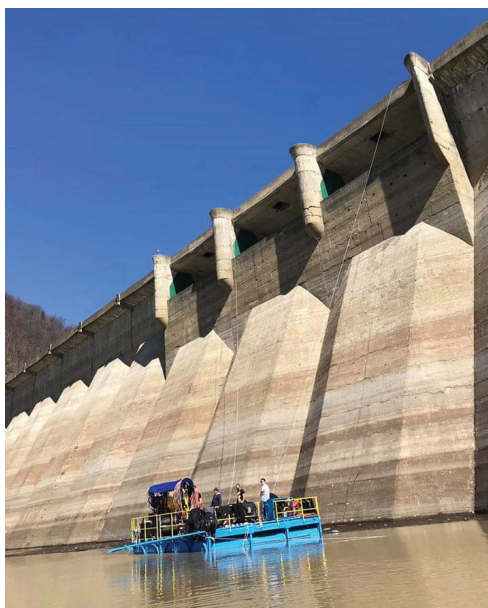


Figure 8 : The pontoon

Stage III took place between May and August 2019. In this interval the outlet pipe was rehabilitated using anti corrosion protection and was disassembled and sent to the factory for the rehabilitation of the Butterfly type safety valve downstream.

- Stage IV unfolded between August and September 2019 and comprised the following works:
- It was mounted the rehabilitated Butterfly valve and were performed safety tests;
- With the team of divers' assistance it was extracted the bell cofferdam;
- After the extraction of bell cofferdam, it started the water storing in the reservoir in conformity with the Operation Rules;
- At the end the rehabilitation works were submitted to the acceptance process.

For removing the bell cofferdam mounted on the bottom outlet no 1, it was necessary to lower the water in the reservoir to the level of 480 m ASL. This elevation was necessary to ensure optimal working conditions for the diving team.

5. CONCLUDING REMARKS

- In the 2018 - 2019 period the following works were carried out on the mechanical equipment of Poiana Uzului Dam:
 - (a) construction and installation of a new trash rack in front of the entrance to the bottom outlet no. 1 (from the block 19), the old one being very damaged, condition which allowed the penetration of various solid materials in the bottom outlet pipe with the risk of blocking the valves;
 - (b) the construction of a new bell cofferdam and its installation for the execution of the rehabilitation works at the butterfly valve from the bottom outlet no.1;
 - (c) disassembly, rehabilitation (sanding, restoration of worn out sections, painting) and reassembly of the butterfly valve at the bottom outlet no. 1.
- Regarding the mechanical equipment, maintenance works should be performed whenever is necessary, prior to the execution of the safety upgrading project, to ensure the proper working of the dam discharge organs.
- Revision of the bottom outlet valve in block 19 (needle valve), where it was noticed that when opening more than 50%, loud noises and vibrations are heard.
- Siret Water Directorate is in the process of promoting other investments based on the various studies, analyses and projects elaborated by Romanian and foreign companies consisting in rehabilitation of the trash racks and butterfly valves at the other two bottom outlets and other important works at the mechanical equipment of Poiana Uzului Dam.

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