LOCAL WATER SUPPLY SYSTEMS DEFICIENCIES AND SAFETY MEASURES. - CASE STUDY -

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ABSTRACT: *This paper presents the deficiencies in the execution of the water supply system of Territorial and Administrative Division Alexandru cel Bun, Neamt County deficiencies that led in January 2021 - February 2021 to the impossibility of supplying drinking water to the population. At the same time, the measures taken to ensure the functioning of the system will be presented, as well as the projects and investments made in the short and medium term to restore the system in parameters. In some areas, a rethinking of the pressure management is described, with the help of which a reduction of the losses from the distribution network was managed, as well as the provision of the necessary flow for a certain target group of users. By introducing an integrated partial monitoring system and its interconnection with the SCADA department, it was possible to monitor both the tank level and the network pressure, as well as the operation of the pressure lifting stations.*

Keywords: *deficiencies; solutions;*

1. Introduction

The drinking water supply system from Territorial and Administrative Division Alexandru cel Bun Neamt County was put into operation in 2004. It serves a population of approximately 4800 inhabitants. At the moment, the system is managed by the regional operator CJ ApaServ SA, the owner being ATU Alexandru cel Bun.

2. System description

The water needs come from the Vaduri underground catchment located on the two banks of the CHE Vaduri. The system is supplied by a pipe connected to the bypass with a diameter of DN 800 that connects the two fronts of the underground catchment.

During the abstraction, a pumping station is located, called SP1, fed through the above-mentioned pipeline. This station is equipped with two pumping lines. The first line that serves the village of Vadurele is composed of three pumps with the following characteristics: P = 11Kw; Q = 56 m^3/h; H = 45m. This line will not be the subject of this case study.

The second line, which will be treated in this paper, is the one that transfers water to a tank with a capacity of 550 m^3 located in the courtyard of Alexandru cel Bun town hall. In order to ensure the transfer of water in the tank, two pumps were installed with a power P = 11Kw, a flow rate Q = 56 m^3/h and a pumping height H = 45 m. The pumps are equipped with a soft starter and operate alternately (1 + 1) automatically.

The connection between SP1 and the tank was made through a HDPE pipe of DN 200 and PN6 having a length of 1952 m. This pipe crosses the old riverbed of the river Bistrita, on this portion having an OL protection with DN 300. There is another SP2 pumping station behind the tank and it is equipped with two lines.

The first line is composed of three pumps P = 7.5 Kw; Q = 75-225 m^3/h; H = 219m and supplies the village of Scaricica and the second line supplies the villages of Bistrita

and Viisoara using three pumps P = 15.5Kw; Q = 30-85m^3/h; H = 77.8-44 m. For both lines the operation of the pumps is done automatically (2 + 1) according to the water requirement in the system.

For the Scăricica area, the operation with one pump ensures a pressure of 16.6-17.2 bar, the operation with two pumps ensures a pressure of 18.2 bar. The pumps rotate automatically, operating a maximum of two pumps by rotation, the third being a spare one. For the Bistrita-Viisoara area, the pumps operate according to consumption at a pressure of 5.2 bar.

As a result of the expansion of the water supply network in the high areas of Bistrita village in 2016, three pumping stations were built: Magnolia, Plopuşor and Podişului.

Name	PIF	Pressure (before SP)	Pressure (at the end)	PN (bar)	Technical data
Magnoliei	01.11.2016	4	6.0	6	Two pumps: P=2.75Kw; Q=50-233 l/min; H=71m
Plopusor	02.11.2016	4	6.7	10	3 pumps: P=2.75Kw; Q=50-233 l/min; H=71m
Podisului	02.02.2016	1.3	4.6	6	Two pumps: P=1.5Kw

Apart from this supply system, there is also a system that feeds the Bisericani Hospital fed by two underground wells from the Vaduri catchment.

Name	Wells	Technical data
Abstraction wells Bisericani	P1B	P=13Kw; Q=32mc/h; H=90m
	P2B	P=13Kw; Q=30mc/h; H=108m

Put into operation in the 60's it was modernized in 2007 being replaced the supply pipe with one of Dn 110 Pn 32, remodeled the pumping station with two Grundfos pumps Q = 30m^3/h; H = 450m and a new 200 m3 tank was built. At the same time, a Dn 110 Pn 6 pipeline was built, which connects the two systems, more precisely between the new tank and the end of the pipeline in the village of Scăricica.

3. Main pipiline deficiencies

Starting with the third quarter of 2020, a series of damages appeared at the supply that supplies the tank from Alexandru cel Bun. Although these have been remedied, it has been observed that by operating with a single pump in SP1, the water requirement is no longer ensured. At the same time, the pressure at the exit of the pumping station had dropped by half (from 5.7 bar to 3-3.2 bar). In this situation, at the end of 2020, the second pump was started manually, automatically increasing the specific electricity consumption and water loss. In this context, the pressure increased to 5.5-5.7 bar.

It should be mentioned that the main water distribution pipiline was located in the Bistrita river meadow and most of the times the damages were difficult to detect due to the high permeability of the soil but also to the fact that the ultrasonic detections were not relevant in the respective area.

Attempts have been made to identify sensitive areas of the supply (damage areas) by installing pressure gauges in the manholes to measure pressure but also

portable flow meters. Both indicate large pressure and flow losses along the entire length of the pipe. At the same time, an integrated SCADA system was introduced at SP2 for the company's real-time monitoring of tank level, flow-pressure and monitoring of pump operation.

By adopting this solution, it was possible to ensure the necessary water only until January 2021, when the system went into various stages of problems. In this context, the supply pipe was replaced with a new one.

At the time of the excavations, it was found that the pipiline had multiple cracks over a length of 800 m. Analyzing the factors that led to their appearance, a series of conclusions was reached:

- Lack of both lower and upper layer of sand that must cover the pipe according toP 133 / 1–2011. Being in the Bistrita meadow in a soil made up mostly of boulders, the lack of a layer of sand and the placement of large stones over the pipe led to its cracking;
- Increasing the pressure in the pipe over its nominal pressure of 6 bar. There are two hypotheses:
  - During the dry summer periods when consumption has increased due to the use of water for watering gardens or lawns, it is possible that the SP1 pumps have been switched on manually and that they have operated simultaneously, which has led to a rise in pressure over 6 bar, ie above the pressure supported by the pipe.
  - The tank was fed through the upper part, with a float mounted at the end of the pipe. In SP1 there is a pressure sensor (pressure switch) set to 5.5 bar that controls the start and stop of the pumps. If this sensor was damaged, it would not have correctly detected the pressure in the pipe when the tank was full, thus increasing the pressure over 6 bar.
- As the pumps are not equipped with a frequency converter for a very slow start, it is possible that the repeated starts and stops of the pumps may have produced a series of vibrations, water hammering that over time have affected the structure of the pipe.

4. Solutions adopted to remedy deficiencies in adduction

In order to avoid all the mentioned problems and deficiencies, the following measures were adopted:

- Laying the pipe on a 15 cm sand bed and filling the ditch up to 20 cm from the upper sand pipe generator.
- A pipe of the same diameter DN 200 was installed, but with PN 10.
- Construction of two new manhole valves, the first after crossing the Bistrita riverbed and the second at the exit of the Bistrita meadow.
- Installation of pressure gauges and air vents in manholes.
- Development of two integrated systems in SCADA for remote monitoring and control of SP1 and SP2 equipment. The flows, pressures and operation of the equipment are monitored in real time.
- Installation of a level sensor for the tank and its connection to the integrated system in SP1 so that the start and stop of the pumps can be controlled by it, at the same time disassembling the direction valve and the pressure switch.
- Issuing an order for the system to operate only automatically. In order to start two pumps, it is necessary to approve a commission to analyze the necessity but also the risks.

5. Deficiencies in the distribution network and remedial solutions

Another deficiency of the system was found in the summer of 2021 when it was observed that in the village of Bistrita on certain areas with a higher altitude there are pressure drops leading to fluctuations in the

supply of those areas:

- A group of 3 users in a high area had a pressure of only 0.5-0.7 bar, although the supply contract provided for a minimum of 1.2 bar;
- All users in the Bistrita Monastery area had large pressure fluctuations. The pressure fluctuates between 0.2-1.7 bar in a short period of time.

After an analysis of this situation, two problems and solutions were found:

- The group of 3 users was in a higher area but which benefited from a pumping station - Plopusor. Following the work plan of the trees, it was observed that they were set to start when the mains pressure dropped to 4.5 bar and to stop when it reached 5.5 bar. As the pipe can withstand a nominal pressure of 10 bar, the pumps have been set to start at 5.0 bar and stop at 6.7. Being in a high area, the users did not benefit from the necessary pressure because the pumps maintained a low pressure in the system because, the start was made when it reached a pressure too low of 4.5 bar and stopped at an insufficient pressure of only 5.5 bar. After this change, users benefit from a pressure of over 1 bar.
- Due to the large fluctuations in the high area of the Bistrita Monastery, it was observed that these are caused by the fact that the pumping stations of Magnolia and Plopusor are fed on the pipe that supplies the respective area. The two pumping stations were executed in 2016, so long after SP2. At that time, it was not considered that they would be synchronized with SP2. As in SP2 and in the three pumping stations, the pumps are controlled by pressure switches. Not being synchronized with each other, the SP2 pumps often started too late, failing to provide the necessary water for the Plopusor and Magnolia pumping station, which drew water from the pipe that supplies the Monastery area, being at a higher altitude and facilitating this phenomenon. In order to solve this situation, a directional valve was installed in the same building where the Plopusor pumping station is connected (this being the last one before the mentioned area) on the way to Bistrita Monastery. The working pressure for the Bistrita-Viisoara area changed from 5.2 to 5.8 bar. After the implementation of this solution, the fluctuations in the system disappeared.

Also in the summer of 2021, the damages on two sections of distribution in the Viisoara area increased. There is a 100 OL pipe from the '80s and' 90s where frequent damage was found.

This pipe being doubled by a HDPE pipe Dn 110, the measure was adopted to move all users on it. As the two pipes have an main pipeline of Dn 800 between them which is to be rehabilitated on a European Program in the next period and the number of users to be reconnected was about 100 (unbudgeted work), the measure of mounting a pressure regulator set at 3 bar was adopted, following that in 2022 the pipeline will be scrapped and the users connected to the new pipeline.

Another deficiency of the system is the Dn 110 Pn 6 pipeline that interconnects the system from Bisericani Hospital with the one from Alexandru cel Bun. In the winter of 2020-2021, an attempt was made to supply the village of Scaricica from the Bisericani reservoir by closing the pump in SP2 and opening the bypass valve of the two systems on Scaricica.

This measure was adopted to relieve the system of Alexander the Great of a number of about 100 users, in the context in which the adduction that feeds the system had multiple failures.

When the pipe was put under pressure, it was noticed that it could not be used because there were major damages. Following the excavations to repair the damage, an explosion of the pipeline was observed in certain areas. Following some analysis, it

was found:

- the pressure regulator cascade works but they are not enough (the level difference is too big and requires the installation of 2 more regulators);
- there are no aerators along the entire length of the pipe of about 2000 m;
- being a mountainous area and hard to reach, the builder, when he encountered a rock that he could not break, raised the pipe yard and then lowered it without even mounting aerators. Thus, in the pipe air plugs are formed which by compression lead to the explosion of the pipe;
- for this pipe it is necessary up to 10 nominal pressure and not up to 6.

For the year 2022 it is planned:

- changing the pressure regulators with more efficient ones and installing two more;
- identification of areas for the installation of automatic aerators;
- replacement of pipe lengths with a PN 10 pipe.

6. Conclusions

- Failure to comply with the regulations for the execution of water supply systems can lead in time to their major malfunctions;
- Any modification of the system by adding new components must be based on an analysis of the functionality of the entire system. Solving one problem we do not have to create another;
- The implementation of SCADA monitoring systems has a very big role in performing real-time analysis to prevent system malfunctions;
- Pressure management, as always, plays a key role both in reducing the NRW and in the proper functioning of the system.

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