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CONTIBUTION TO THE ANALYSIS OF THE OPERATIONAL AVAILABILITY OF WATER SUPPLY SISTEMS IN THE FRACTAL ARRANGEMENT

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ABSTRACT
Availbility is a measure of system state system in terms of efficiency and achieve the size of the default output function of criterion in a given time and the conditions of exploitation.
Likely to successfully operate the system in the set at allowable deviation function critera for the relevant time period and conditions of the environment the operational availability of the system, and is determined by the ratio at total time in the work and the duration of the system.
Fractal arrangement of water supply system during operation, allows to increase the operational availability of systems specific objective function, the minimum number of stoppages and the number of users without drinking water during at the time of removal delay.
Keywords: Operational availbiliti,water supply sistem, fractal.

1. INTRODUCTION

Having in maid increase of the population in the area of Srebrenik and the needs for water supply, a strong need has been expressed for a rational and qualified satisfying of the consumers irrelevan of the monopol acces to water system infrastructure.
When a qualitative satisfying of the need is mentioned, thenby that we mean water supply in every houshold during 24 hours except in the time of the removal of the standstill.
Finding and removing the standstill means finding the cause of standstill and effocient removal in the shortest time possible of the standstill of water system and with the least consumers possible who will be cut off the water supply.

2. THEORETICAL PRESUMTIONS

2.1. Comparatible elements

Operational Availability (OR (t)) can be calculated through the appropriate relationship between the time the system is running (Tur) and systems in failure (Tuo):

$$OR(t) = \frac{Tur}{Tur + Tuo} \qquad (1)$$

Weather picture of the state in the process of maintaining the system provides the structure of the

maintenance period that takes into account qualitative elements that affect the operational availability:

$$T_{od} = t_1 + t_2 + t_3 + t_4 + t_5 + t_6 \qquad (2)$$

where is: t_{od} – the time of realising of procedures of maintenance (the time of the standstill), t_1 – the standstill on the connented elements in shafts, t_2 – the standstill on the connector piping, t_3 – the standstill on the distributive piping, t_4 – the standstill on armature, t_5 – the standstill on repressed piping, t_6 – the standstill on pumping cell,

Operating system availability of fractal arrangement should provide the objective function with the condition: minimum number of delays, minimum time of standstill, minimum maintenance costs.

Fractal arrangement of water supply system provides increased operational availability of the system over the elements that define the fractal: self-similarity, orientation towards the goal, self-organization, dynamism, self-optimization.

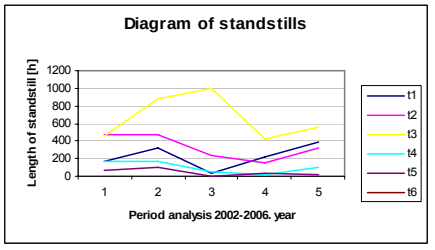
3. EXPERIMENTAL RESEARCH

3.1. Plan of experiment

As the range of research is defined by a subsystem of Water Supply – Gradski vodovod. To provide the objective function defined by the parameters of research, time picture of the state, standstills, causes standstills, ABC analysis and fractals.

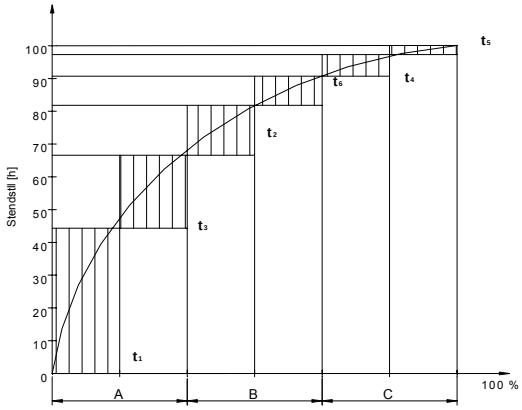
Table 1. Time picture of the state standstills of subsystem – Gradski vodovod

Standstill	The time analysis				
	'02.	'03.	'04.	'05.	'06.
t_1	166	319	37	220	391
t_2	468	481	242	146	324
t_3	448	877	1000	418	563
t_4	162	161	58	15	96
t_5	70	99	0	28	12
t_6	138	72	142	152	159



4. EXPERIMENTAL RESULTS

4.1. ABC the time analysis of intermission



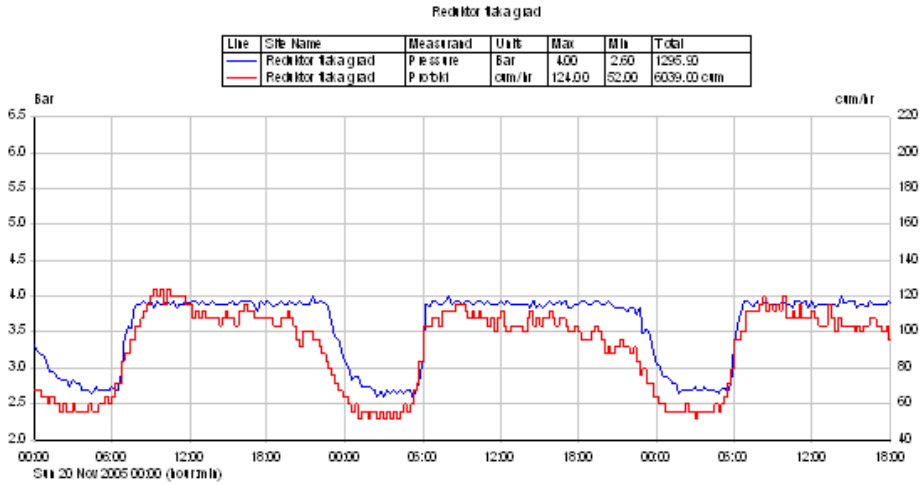
O/N	Stendstill [h]	[%]
t_1	1133	15,2
t_2	1661	22,3
t_3	3306	44,3
t_4	492	6,6
t_5	209	2,8
t_6	663	8,9

Picture 1. ABC the time analysis of intermission

According to the percentage share of total standstills in ABC analysis, we found that standstill t_3 and t_1 are the group A with 59.5% share of total standstills, which represents the essential elements of the total stendstills.

Table 2. Analysis of the types of pipe material and measuring the pressure in fractals

Name of fractal	Types of pipe material [%]				Measuring the pressure of pipe [bar]				
	LŽ	AC	PVC	PEHD	Point 1.	Point 2.	Point 3.	Point 4.	Point 5.
A_{GV}	8	44	25	23	4,2	5,5	4,5	4,2	4,3
B_{GV}	-	74	8	18	4,8	3,7	4,5	4,7	4,0
C_{GV}	-	12	67	21	4,5	4,6	3,8	3,3	3,2
D_{GV}	-	-	12	88	3,8	5,5	5,5	4,2	5,3
E_{GV}	-	81	6	13	3,9	4,6	3,5	4,0	5,0
F_{GV}	-	45	15	40	7,0	6,2	6,5	6,0	6,3
G_{GV}	-	13	35	52	6,7	6,1	7,2	5,4	3,5
I_{GV}	-	-	42	58	6,8	6,3	6,5	5,0	4,5



Picture 2. Measuring pressure with DATA Logger, before and after the establishment of a fractal design

After the establishment of a fractal arrangement subsystems are geographically located parts of subsystems that have characteristic fractal. Differentiating delay t_3 analyzes the elements that influence the occurrence of standstill: material of pipe, year of installation, pressure of pipe (Table 2.).
Experimental pressure regulation was performed in fractal G_{GV} depending on the requirements for delivering water to consumers (Picture 2.).

5. CONCLUSION

The analysis of data collected on the basis of maintenance work orders subsystems – Gradski vodovod Srebrenik, using the ABC method, led to results on the participation of some standstill in the total time of all stendstills. In addition to the checks carried out by factor analysis, and confirmed the results obtained by the ABC analysis.
Differentiating standstill t_3, as the most influential standstill in defined fractal arrangement, led to the data that the pressure in the pipeline main cause of standstills. (at night the water supply is reduced and increases the pressure in the pipeline).

Measurements confirmed that the fractals F_{GV}, G_{GV} and I_{GV}, it is evident that the biggest cause of standstills high pressure, which must be maintained in the system due to elevation zones.
The introduction of parallel connections between fractals creates the possibility of reducing the number of customers who remain without water during the removal of standstill and the possibility of distributing water from two directions, reducing the length of the isolated part of the pipeline which performs repair standstills.
Construction of another water tank opens the possibility of a valve to regulate and control the pressure in fractals depending on the quantity of water delivery to users.
Based on the analysis of the effectiveness of valve regulation and control of pressure is expected to reduce the number of standstill, and reduce network losses by 10%, which represents a saving of water produced m^3/Year 4186 and 4647.00 KM/Year (1,00 € ≈ 1,95 KM).
Period forecast the effects of fractal arrangement a water supply for 5 years. Estimated burden of the budget of the company is 0.076 KM/m^3/5 years. These investments would be secured from the cost of water, or part of amortization.
In this way creates the preconditions for increasing the operational availability of water supply system.
Directions for further research would be directed into fractal arrangement of the entire water supply system Srebrenik and the establishment of remote monitoring and management of fractals.

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