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IMPROVEMENT OF THE CONDITIONS OF THE EXPLOITATION OF OVERGROUND DISTRIBUTIVE NETWORK USING MODERN METHODS OF REMOTE CONTROL, SUPERVISION AND MAINTENANCE

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SUMMARY

In the article the problems connected to exploitation and maintenance of the radial overground distributive network (with grounded neutral point over small impedance) of the big length, which supplies the area out of the city with small population density and mostly elemental disposition of the living objects are being shown. The problems which shorten the exploitation time of disassemble device in supply distributive transformation unit are being explained and analyzed under conditions of modern market operation of the electric distributive company, by which we attempt to decrease the costs of maintenance. Also, we described advantages of usage and binding of the program package for operative management with distributive network DSP (Dinamyc Sinoptic Panel) with SCADA system aiming to decrease exploitation costs and switching to corrective maintenance towards real condition of the electro energetic project and importance of such a solution, in the conditions of regulation and deregulation of electric industry.

1. INTRODUCTION

Approaching transformations in the electro energetic sector here as well as in the countries of our encirclement brings significant innovations and changes in so far way of working in the area of production, transmission and distribution of electrical energy. It is essential to emphasize the forming of the market of electrical energy, new rate system, as well as important role of the distributive company, which will have to be prepared to perform delivery of the electric power to the consumers under changed conditions. It will be requested quality and sufficient quantities of the electric power, with as little as possible number of interruptions in supplying, as well as short as possible time of those interruptions when they occur while supplying the consumers with electrical power.

To make a quality correspond to this situation, it is necessary among regular work on maintenance of the electro energetic objects and eventual interventions, to work intensively in introduction and where necessary modernization , of the automatisation processes for conduction of electro energetic system.

Today, this job could be done easier in the era of new and modern technologies in this branch, including faster and easier accomplishing of the communications.

Introducing this kind of solutions is connected to purchase and mounting appropriate equipment which can fulfill necessary conditions, considering that in some cases small construction rebuilding will be needed. All this has been limited by available capital assets. At the beginning investment of money are not small, but investment of money for automatisation will get back trough certain period of time, along with, among other effects as follows:

- Decreasing technical as well as commercial loss of the electrical power;
- Decreasing of the expenses of exploitation of distributive networks trough effective elimination of supply interruptions and fast restauration of supply of consumers, and with all mentioned decreasing damages raised because of non supplying the consumers with electric energy;
- Decreasing the number of manipulation and damages which impacts to the longer duration of the equipment;
- Decreasing costs of development of distributive networks trough optimization of sections as well as better usage of available distributive capacities. Regarding supplying low-tension stations, by this system it is provided effective reservation of those objects, in other words postponing of capital investments;
- Increasing of the quality of delivered electrical power trough optimal regulation of voltage and increasing of reliability in supplying with electrical power;
- Increasing of safety during work on electrical structures.

In the article it has been processed the introduction of automatisation in supply low-tension station (SCADA – system) as well as introduction (DMS – system for monitoring, effective management, analyze, optimization and development of distributive networks), together with installing of remote disassembled machines for outdoor installation (rekloser) on the specific shares of the monitored long-distance power line. Prerequisite of good functioning of the above mentioned programs are good communications for transmission of the data, which is possible to have today as well as software connection of these programs.

2. ELECTRO ENERGETIC OBJECTS IN THE AREA OF ELEKTROKRAJINA

The area of Elektrokrajina includes area of 8 629 km^2, with 179 km of 110 kV long-distance power line, 12 pieces of trafo stations 110/20/110 kV, of installed power 348 MVA, 3 256 middle-voltage trafo stations with installed power of 884 MVA. The length of middle-power network is 4 808 km and the length of lo-power network is 15 223 km.

The main characteristics of the network in the area of Elektrokrajina are : huge length of the electrical duct, huge number of malfunctions and huge number of elements which are at the end of their exploitation era. The big impact to such a condition of those have had the difficult conditions of the functioning of the equipment during the past war time.

It is important to say that the configuration of the terrain in rural area is such that it additionally impedes exploitation of the objects in such a bad conditions.

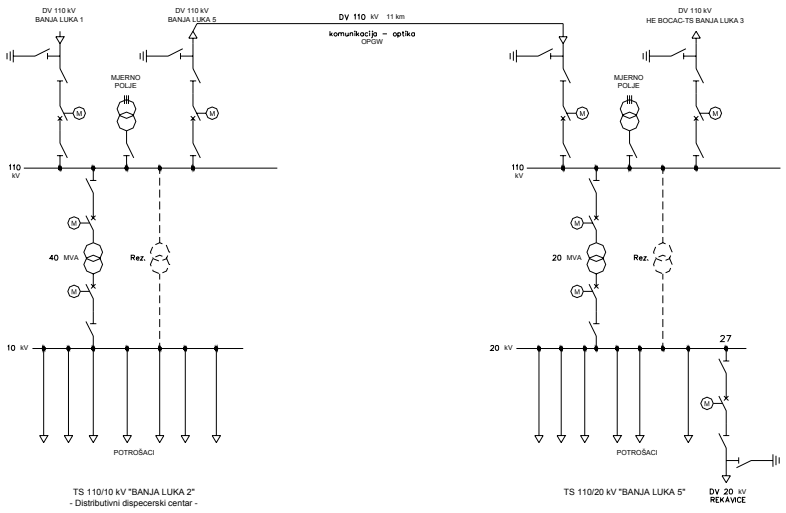
The network with such a characteristics causes unpredictable interruptions in the exploitation process while supplying consumers with electric energy, long period until the malfunction section is found, long period to eliminate the malfunction, damages made to consumers and high expenses of exploitation.

In the article the trafo station (TS) 110/20 kV "Banja Luka 5" as well as 20 kV long-distance power line to Rekavice will be considered.

3. EXISTING CONDITION TS 110/20 kV BANJA LUKA 5

TS 110/20 Kv Banja Luka 5 is a trafo station located in the south-eastern part of Banja Luka city. It was planned (in energetic sense) to supply the water company of Banja Luka, the part of southern industrial zone as well as suburban part of the zone of individual living.
Factory for disassembling (RP) 20 kV has 28 cells, one part of exits are overground lines for village area (exits until first poles of overground lines are derived by 20 kV cables).

TS 110/20 kV "Banja Luka 5" is a part of 110 kV ring around Banja Luka. One connection is TS 110/10 kV "Banja Luka 2", and the other so far "antenna" is towards DV 110 kV "HE Bocac – TS Banja Luka 3 – TS Banja Luka 6". Diclinous block scheme of the disposition of above mentioned electro energetical objects (EEO) has been given at the picture 1.



Picture 1.- Diclinous block scheme of the disposition of EEO

Long – distance power lines 110 kV have installed defense ropes with fiber optic (OPGW), so that the communication connections are reliable and secure. Therefore, distributive dispatcher center (DC) which is located in the 110/10 kV "Banja Luka 2" also has this communication connection with TS 110/20 kV "Banja Luka 5", and of course quality connection to DC of Elektroprenos.

Above mentioned data are important, considering that the aim is to remote control of work of the TS 110/20 kV "Banja Luka 5" from DC as well as monitoring of the condition of the complete 20 kV consumption, taking over of the data, manipulation, and more important section and isolating of the section which has malfunction in this analyzed line for Rekavice.

And, in the existing regime of selective and quality adjustment of the relay protection, the interruptions are being located mostly on the line which has the malfunction. TS 'Banja Luka 5' has crew only in the first and second ship, meaning that the third ship is not covered by crew, so on duty dispatcher in the DC often have significant problems, specially on the 20 kV lines towards village area. Above mentioned regards also to the DV exit for Rekavice.

On 110 kV side TS "Banja Luka 5 " exist : 2 long-distance power line 110 kV fields, 1 measuring field and 1 trafo field with transformer 20 MVA (reserve: one more trafo field and energetic transformer).

RP 20 kV has been derived with cells of type D6/V. All exits are with vacuum switches controlled by engine power. Collection points and exit separators are with knifes for grounding. Also, the corresponding electric measuring transformers are built.

In the commanding part of the plant, there are: measuring and protection – KRO cabinets, auxiliary alternating and direct current tension, corrector with stabilization and battery. The solution is completely standard, dimensioned for final number of 20 kV cells as well as for final number of fields of outside equipment.

RP 20 kV with cells in two lines is lengthen separated with separator in juncture field, by which the consumers are selected (most important ones, water company ...which are connected from one side, and some village exits come out on the another part of the 20 kV collector). So far, during the work of one transformer above mentioned has some important significance.

Commanding, measuring and protection, as mentioned above, are set in the KRO cabinets with wires on ordinal terminals for local and remote control, signalization and registration of all factory events. In the cabinets there are places for installation of corresponding electrical measuring deceivers, by which the function of all measuring, signalization and signalization of location could be transferred to DC for monitoring and further treatment. Installing these tools would provide remote controlling of monitored trafo station from DC – dispatcher center.

All cells, drainage ones (cable or air), trafo cells, measuring as well as corresponding 110 kV fields have necessary relay protections needed for that level. So, there are existing corresponding electrical, grounded protections, APU, differential protections in trafo cells have all necessary protections of energetic transformer for standard 20 MVA unit, sub-tension and over-tension protection, distance protection of long-distance power line 110 kV and the rest auxiliary relay protections. In diclinous block scheme (picture 1.) there is basic view of the condition of the elements in the cell number 27 for Rekavice exit. Commanding – mechanizing element is tripolar vacuum switch 24 kV, 50 Hz, 1250 A, commanding tension 220 V – direct current, feasting of the spool of magnet 220 V direct current, auxiliary contacts 8 “in” + 8 “out”, counter of operations, AP relay, and heater.

In KRO there is shown measuring of electric power, over electric relay with two modules (I> i I>>), ground juncted relay for asterisk gorunded over small electrical resistance (40 Ω), tripolar again automatic fit and attached necessary auxiliary modules, relays and automats, light signalization of the condition of all events, signalization of the location : on – off, collective alarm and registration of the most important section events.

4. DESCRIPTION OF SN LINES

Overground line 20 kV for Rekavice was built combined with AI/Č ropes cross section of 50/8 25/4. Total length of the line is 73 km, and the line supplies 38 pillar transformer stations (STS) dispositioned according to the scheme shown on the picture 2.

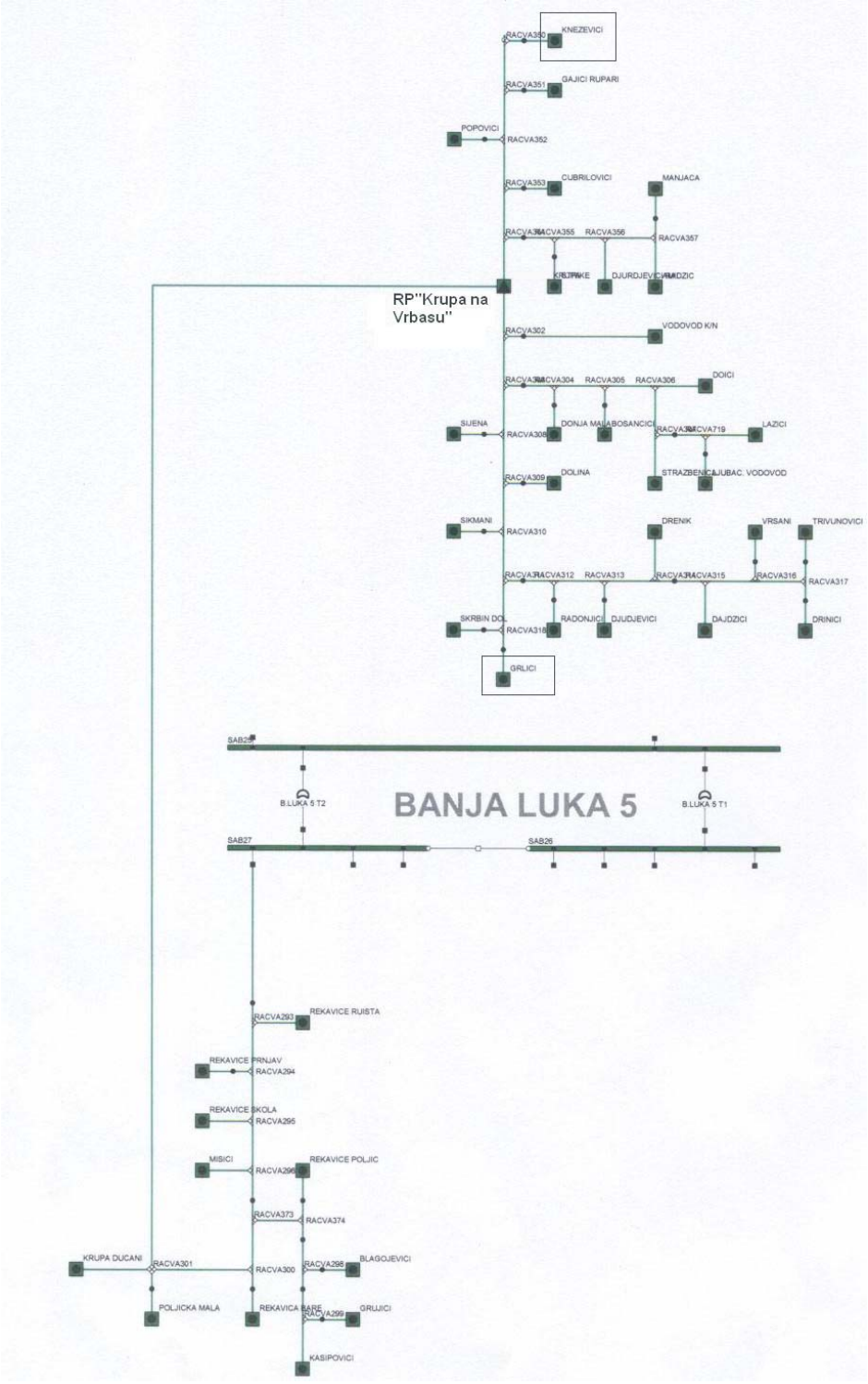
Total installed power of above mentioned STS is 2630 kVA and they supply the area out of the city, with mainly elemental disposition of the living objects and small density of living. The line spreads trough inaccessible terrains, covered by high vegetation. Also, some sections of the line differ from each other with real exploitation era of the elements of the line because of the reconstruction made as well as because of building of the new STS.

Existence of the unfolding elements (RP) “Krupa na Vrbasu” permits the possibility of functioning of the line but the working era of the mounted equipment such that the relation between costs and maintenance investments closer to the one, of course considering the price of the delivered and undelivered kWh as well as relation of the costs of investments and price of kWh of electric power.

In the RP “Krupa na Vrbasu” there are two exits:

- Dobrnja (Kneževići) (8 STS installed power of 400 kVA)č
- Grlići (19 STS installed power of 1370 kVA).

Maintenance of the line with such a structure of the elements in the conditions of transfer to remote controlling, demands careful analyze of the condition of the line as well as events registered in TS “Banja Luka 5”. Number of interruptions, depending on the cause, in one month in the year has been shown on the picture 3. It is taken into consideration 2003. with remark that the structure of the events as well as their quantity has been representative comparing to the previous years no matter to reconstructions made or building the new transformer stations.


RP"Krupa na Vrbasu"
KNEZEVICI
GAJICI RUPARI
POPOVICI
CUBRILOVICI
MANJACA
VODOVOD K/N
DOICI
SUENA
DONJA MAJA
BOSANCICI
LAZICI
DOLINA
STRAZBENICA
JUBAC. VODOVOD
SIKMANI
DRENIK
VRSANI
TRIVUNOVICI
SKRBIN DO
RADONJICI
DJUDJEVICI
DAJDZICI
DRINICI
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B.LUKA 5 T1
SAB27
SAB26
REKAVICE RIJEKA
REKAVICE PRNJAV
REKAVICE SKOLA
MISICI
REKAVICE POLJIC
KRUPA DUCANI
BLAGOJEVICI
POLJICKA MALA
REKAVICA BARE
GRUJICI
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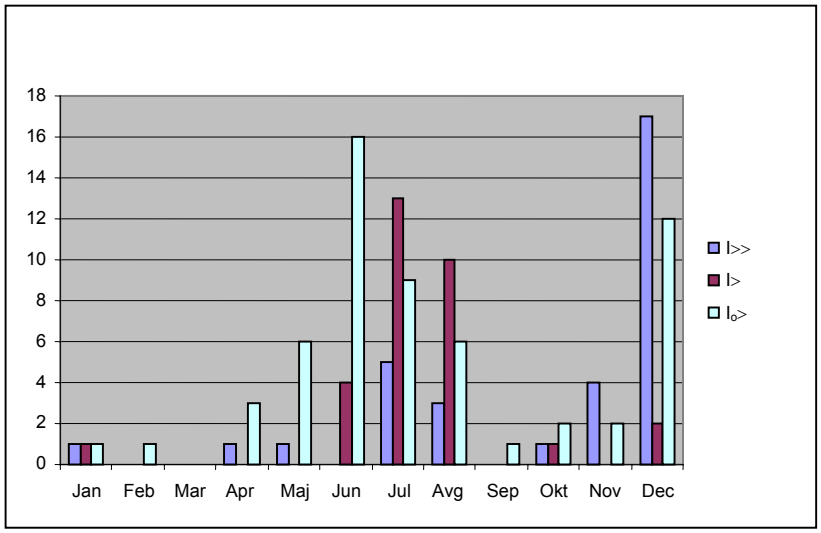


Slika 3.- Number of malfunctions regarding causes during months

Structure, time duration, and percentages of contribution of specific events registered in TS ¨Banja Luka 5¨ on year basis (for 2003.) are shown in the table 1.

TABELA 1.- STRUCTURE, TIME LENGTH I CONTRIBUTION IN PERCENTS OF SPECIFIC CAUSES TO INTERRUPTION IN SUPPLY

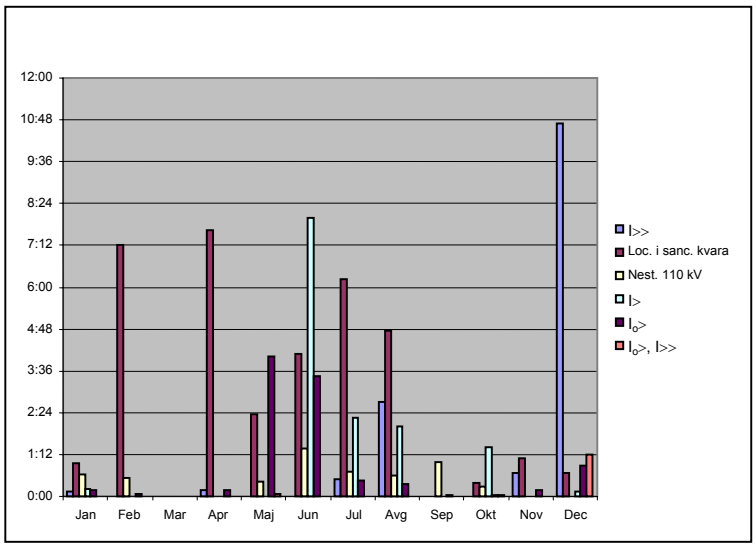
Cause	**length of interruption** [hours]	**Contribution in percents** [%]
I>>	14:52	18
I>	14:00	17
I_o>	9:52	12
I>>, I_o>	1:19	2
Locating and sanation of the malfunction	35:23	44
Interruption of 110 kV tension	5:30	7
TOTAL	**80:56**	**100**

Structure of the malfunctions tells us that the big part of the time of the malfunctions fall off to the locating and sanation of the malfunction on the line (44% from total time of interruption of supplying). Also, because of heavy locating of the malfunction on the line, there exists intensive presentation of unfolding machine in the cell number 27 of the TS ¨Banja Luka 5 to the electrical short circuits which decreases his working era (the standard version of vacuum switcher has been taken which can suffer 80 interruptions in supplying, short circuit of 16 kA (normal exploitation era of the unfolding element is 10000 cycles)).

The loss of 110 kV tension is a consequence of island regime of work of electric company of RS, and in this case it is 7% of total time of the length of interruption in supply.

Graphical view of the values shown in the table 1. sorted during months is shown on the picture 4. The quality of the distribution of the electric energy beside continous supplying has to have the economy as important parameter which is in present condition of reconstruction hard to fullfil.

The basic problem reflects in multi dimension of the damage caused by interruption in supply. Increasing of the reliability has to be connected with the importance of specific electro energetic object, meaning the importance of the key elements as unfolding devices. The condition of the unfolding devices and protection in RP ¨Krupa na Vrbasu¨ exploitatively and technologically doesn`t satisfy the conditions forced by need for remote controlling and manipulating. The need for constructive reconstruction of the object makes investments more expencive.



Picture 4.- Graphical view of the values shown in the table 1. sorted during months

Natural growth of the consumption on the specific breaks places new demands in a front of the exploitation and maintenance of the overground line, of course, it is necessary to look at the facts from the quality of delivered electrci energy view as well as forming of the market of electrical energy.

Increase of the technical equipment of the teams for dicovering and sanation of the malfunctions could shorten the time of interruption as well as their engagement on the hughe area and their specialist trainings demands additional investments which could be handled only in conditions of remote controlling or locally controlled devices. Since RP ¨Krupa na Vrbasu¨ demands complete reconstruction to satisfy demands forced by remote controlling and monitoring there is specific need for rekloser. Usage of rekloser of the new generation, thanks to decreasing of prices, permits remote control as well as tuning of local automatic toward terrain. Fast locating of the malfunction and his isolating with remote monitoring and controlling, would shorten the period of interruption on the part of the line which is operating normally.Rekloser, with multifunctional protection and remote control permits big possibilities of tuning of the specific parameters and installations by which the previous solutions are beeing exceeded.

5. CONCLUSION

In modern countries of the World, there are more and more remotely controlled unfolding devices in usage, prepared for outdoor mounting in middle-tension overgrounded electric distributive networks which supply rural areas. There are several variations of this equipment which differ one from each other mostly with usable unfodling device.

The authors are determined to usage of switches for outdoor mounting on the pillar (mostly cement ones) with quality elements connected to remote controlling and modern system of protection. There are sevrak solutions possible with remote controlled unfolder and switcher, mounted on separate pillars.

With such a solution it is possible to eliminate RP ¨Krupa na Vrbasu¨ and avoidance of complete reconstruction of the objects, and at the same time to improve the parameters of exploitation of the analyzed line for Rekavice.

Authors posess pozitive practical experienses, connected to exploitation of remotely controlled unfolding devices (switch and separator), completed in the frame of pilot project, which are basis for planing and future ralization of the solutions which treats as well as complexed distributive middle-tension lines similar sa line for Rekavice.

Since TS 110/20 kV Banja Luka 5 has quality equipment for mounting all kind of transformers as well as quality communication lines, it is possible simple installation of remote unit which would be controlled by main SCADA system in distributive dispatcher center DC. Existence of the quality software (DMS)

gives the possibility of controlling remotely controlled unfolding devices in real time which would have hughe influence in achieving modern parameters forced by electric energy market.

6. LITERATURE

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