Journal of Energy

VOLUME 60 Number 1–4 | 2011 Special Issue

journal homepage: http://journalofenergy.com/

First Experience in Monitoring of Line Surge Arresters Installed on 110 kV Transmission Line Ston – Komolac in Croatia

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SUMMARY

In paper are presented some first results and experience in real time monitoring of line surge arresters installed on 110 kV transmission line Ston – Komolac in southern part of Croatia. Mentioned line is the first line in Croatian transmission network equipped with line surge arresters (LSA).

The line with its length of 43,95 km is situated in region with high soil resistance, exposed to one of the highest level of lightning activity in Croatia. At the same time it is the most important line in connecting HPP Dubrovnik (240 MVA) to the main part of 110 kV transmission network.

Due to all mentioned reasons and great number of annual outages, it was decided to equip the line with LSA for improving the lightning performance and the availability of line. As result of performed numerical simulations on simulation line model it was decided to install 110 kV gapless, IEC Class II line arresters. Also, to improve analysis of expected results the 61 line arresters were equipped with Excount-II type of monitoring sensors. The main goal was to determine the behaviour of line arresters arrangement across the line during overvoltage events on towers. This installed "real-time" monitoring system enables remote control and wireless exchange the collected data from local data logger installed on LSA. Line arresters activity is monitoring through numbers, date and time and level of surges and the condition state of LSA, through the measuring of leakage current.

First results in application of LSA are showing significant reduction of line outages with registered relatively strong activity of monitored line arresters. Also, as it was expected some particular part of line is espied to be exposed to higher frequency and higher level of registered arresters surge current. During collecting the data of LSA activity, some practical problems were encountered with time synchronization between monitoring devices and it is mentioned and discussed in paper, too.

Although the analysed time period of eight months with LSA application is too short to allow strong final conclusions, obtained first experience will be very helpful in assessment of further LSA application in Croatian transmission network.

KEYWORDS

Line surge arrester, Line outages, Monitoring, Line surge arrester monitoring, Arrester activity, Arrester surge current, Collected data base.

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1. INTRODUCTION

Today metal oxide arresters (MOA) in polymer housing take a part more and more in line application because of low weight and simplicity in installation, high efficiency, long time of availability and finally, because of acceptable prices. They offer several possibilities to improve availability of transmission lines, spatially on double or multi-systems lines to solve the problem of back flashovers on insulators, in line up-rating, in insulation coordination etc. [1], [2], [3].

There were several reasons for application of line surge arresters (LSA) on transmission line 110 kV Ston – Komolac. This line is the shortest connection of HPP Dubrovnik (2x120 MVA) to the other part of transmission network in south of Croatia (Fig. 1). The line was constructed in 1961 and a big reconstruction has been done in 1994 with increasing transmission power capability installing TACSR/ACS conductors [4]. Further, it is crossing the region with high soil resistance and it is often exposed to strong lightning-storms. Outages due to lightning usually stopped down the generators of HPP and finally cause black out in region of town of Dubrovnik.

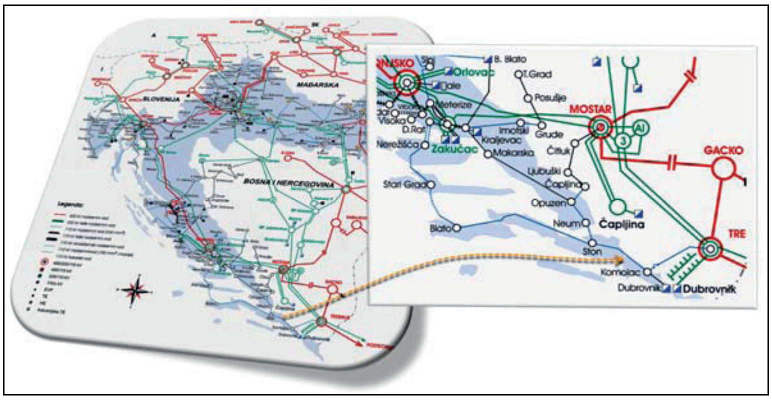


Figure 1-View to 110 kV transmission network in southern part of Croatia (blue lines)

Due to that reasons it was decided to improve lightning performance of line with application of 110 pieces of gapless, IEC Class II line surge arresters [5], [6], [10]. Also, due to improving the analysis of expected results it was planned to equip the 61 line arresters with Excount-II type of monitoring sensors (Fig. 2).

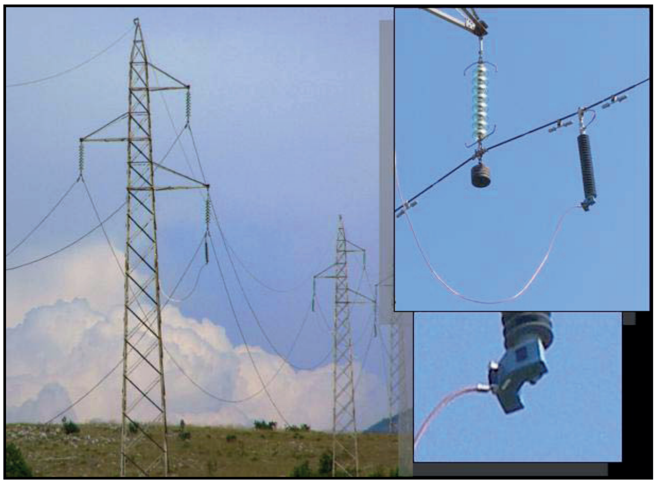


Figure 2-LSA on transmission line equipped with Excount II monitoring sensor

The main goal was to determine the behaviour of line arresters arrangement across the line during overvoltage events on towers. This installed "real-time" monitoring system enables remote control and wireless data exchange from local data logger installed on LSA. The LSA activity is monitoring through numbers, date and time and level of surges. The condition state of LSA is assessing by measuring the leakage currents [7], [8], [9]. The whole system has been installed at the end of June 2007, but only 49 monitoring sensors were put in service.

2. ARRESTERS ARRANGEMENT AND FIRST RESULTS OF MONITORING

2.1 Arresters arrangement

The installation and LSA arrangement on 110 kV line Ston-Komolac was based on performed study and computation on line simulation model [10], [11]. It was studied the lightning performance of line for different arresters arrangement along the line, also as a function of different tower earthing resistance. The goal was to find the optimal LSA arrangement to decrease a great number of backflashovers on insulator strings and a number of annual outages of line [12], (Fig. 3).

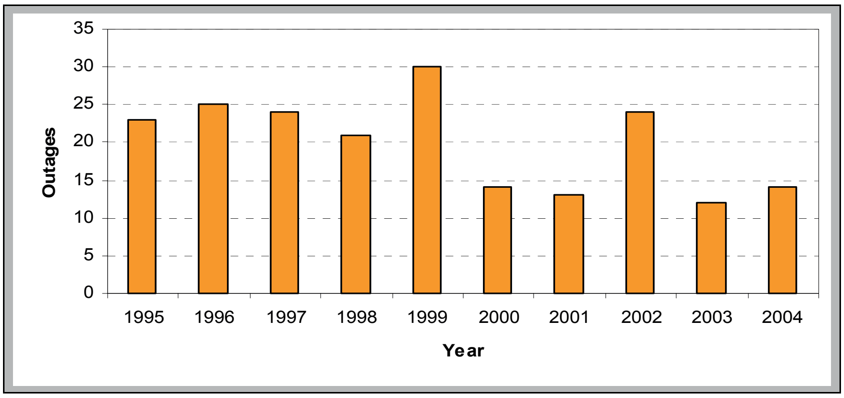


Figure 3-Number of annual outages during period of 10 years on 110 kV line Ston-Komolac (2004-up to June, 2 nd only)

As a result of computation it was chosen the LSA arrangement with one or two arresters per tower what is showed on schematic diagram on Fig. 4. In Table 1 are given the necessary numerical data. Also it is showed schematic phase arrangement on tower top.

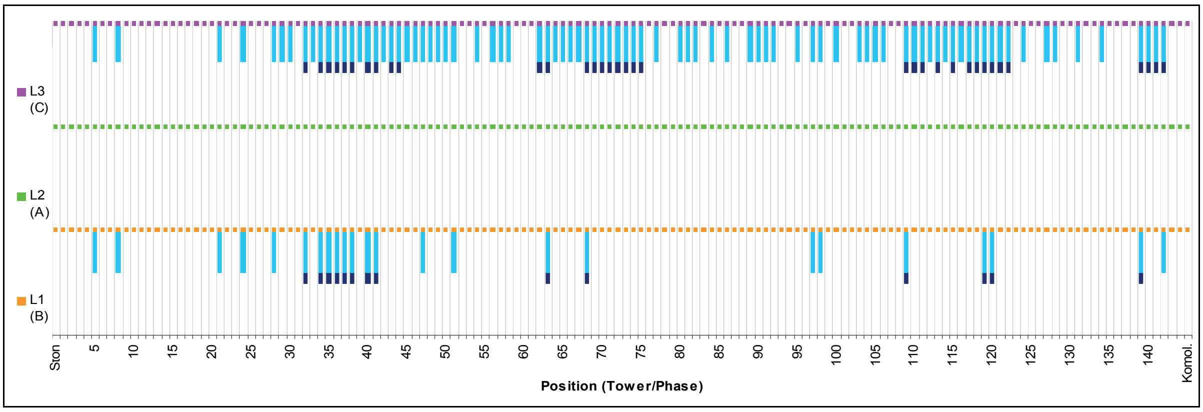
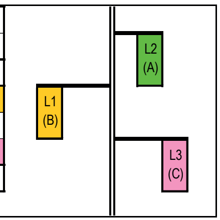


Figure 4-LSA arrangement along the line and installed Excount II monitoring sensors (dark blue or black)

Table 1-LSA and Excount II monitoring sensor arrangement data

Phase	Number of possible possitions	Mounted LSA			Mounted EXCOUNT II			Surges		
		pcs.	% of LSA	% of Towers	pcs.	%	% of Towers	registered	%	normalize to line
(1)	(2)	(3)	(4)	(5)=(3)/(2)*100	(6)	(7)	(8)=(6)/(2)*100	(9)	(10)	(11)=(2)/(6)*(9)
L1 (B)	145	24	21,8	16,6	14	28,6	9,7	37	32,5	383,2
L2 (A)	145	0	0	0,0	0	0	0,0	-	-	-
L3 (C)	145	86	78,2	59,3	35	71,4	24,1	77	67,5	319,0
Summa		110	100		49	100		114	100,0	



Further, expected reduction of number of annual outages of line - based on performed analyses on line simulation model - must be around 50 percent for chosen arrangement of LSA. For monitoring the LSA activity and for further analyses it was taken 49 Excount II sensors arranged and positioned on lightning exposed line structures what is also showed on Fig. 4 and in Table 1.

2.2 First results in monitoring of LSA activity

After the line surge arresters (LSA) installation have been completed on transmission line 110 kV Ston - Komolac in June 2007 started the "operation period" for so called "Pilot Project".

First results after 9 months of application show that a number of line outages has been reduced (more than 50 percent during 6 months in 2007), particularly in summer time period (Fig. 5). Also, it is in expected range according to calculated values [10].

But, the observed period is not long enough to make appropriate statistical evaluation for sturdy conclusions. The real estimation of effects is possible to make after comparison and analysing longer time periods and bigger data collections. But the reduction in number of outages is very significant for taken protective measures on line even in the first short period.

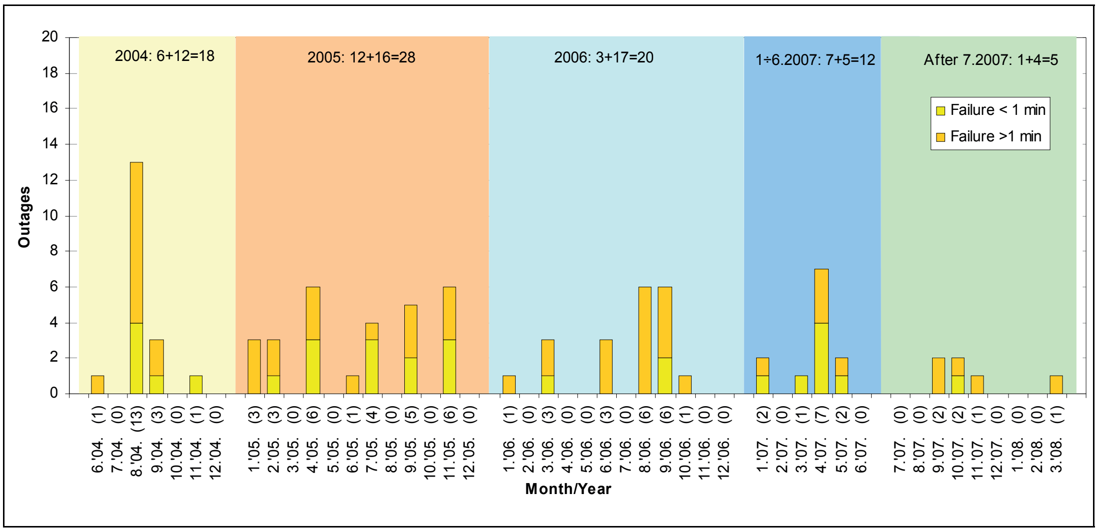


Figure 5-Review of outages on line 110 kV Ston-Komolac (before and after LSA application) (2007: 1-6 without LSA (blue), 2007: 1-12/2008:1-3 with LSA (green))

Further, the collected data from installed Excount II monitoring sensors exactly shows high level activity of LSA during observed time period. Additionally, it confirms the high level of the lightning in region of considered transmission line, because all of installed monitoring sensors have registered a lot of surges in their data loggers.

On Figures 6 and 7 it is shown the registered LSA surge current activity in accordance to sensor position (tower number) and corresponding phase. Additionally, it is shown the number of surges and level of surge current too.

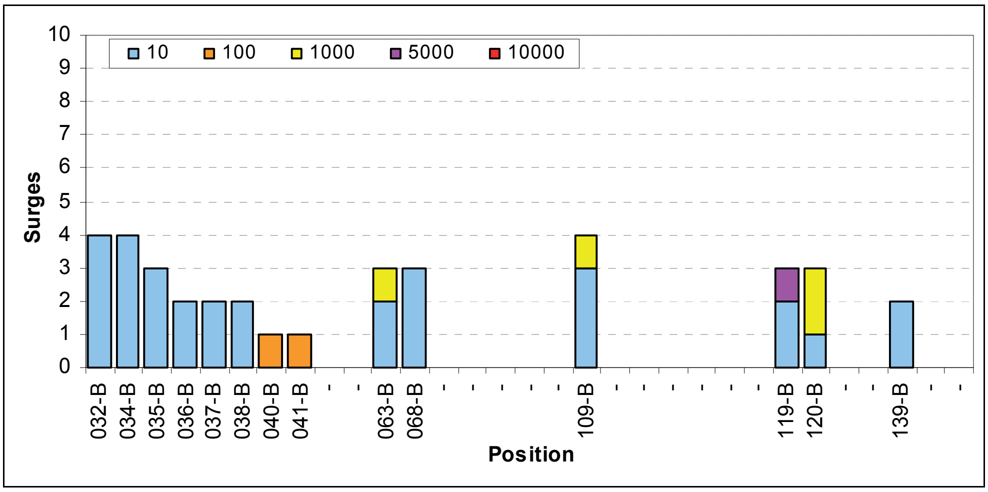


Figure 6-Review of LSA surges registered by Excount II monitoring sensors in Phase L1 (B)

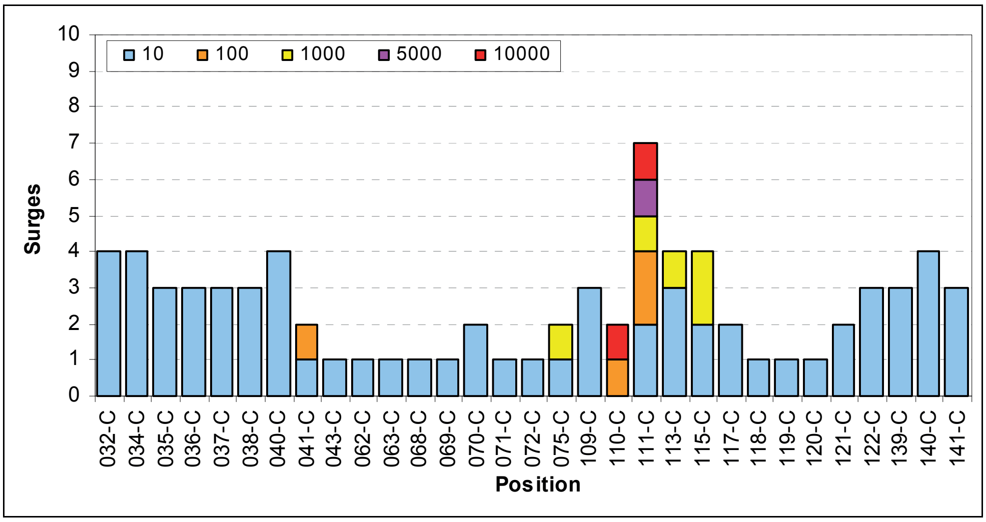


Figure 7- Review of LSA surges registered by Excount II monitoring sensors in Phase L3 (C)

In comparison the LSA activity in phase L1(B) with activity in phase L3(C) it can be concluded that the maximum number and level of surges are registered in phase L3(C). More intensive LSA activity was noticed in phase L3(C) on line tower No. 111 and on several neighbouring towers, too.

But, relating the installed number of monitoring sensors (monitored LSA) per phase and line length a little higher relative values can be calculated for LSA activity in phase L1(B), (see Table 1).

Of course, those are only the first results given in relatively short time of monitoring. In that sense on Fig. 8 is shown simple statistic review of failures due to events on line registered by distant relay protection during long time period. A portion of three-phase events is very significant.

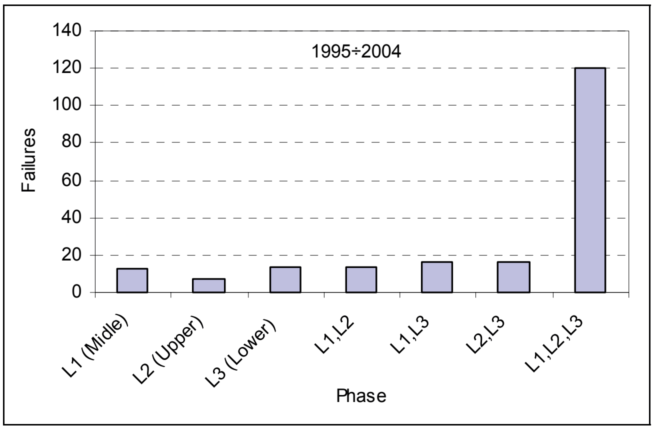


Figure 8- Review of events on line registered by distant relay protection

3. SOME PRACTICAL FIELD EXPERIENCES

First experience with installed monitoring system based on EXCOUNT II type of sensors showed good and practical basic system for wireless collecting the data of LSA activities on related transmission line. System makes possible to record surges on surge arresters including the data such as date, time and surge amplitude. Using that data it is possible to make advanced analyses of surges and overvoltage events on line and also in network.

In order to get good and reliable data from the system it is necessary to take into consideration some practical notes from equipment producers [8], [13]. The most important is the precise time synchronisation between sensors, transceiver and PC device with installed data base software.

Also, some problems could appear with “real time data” during practical work because of winter-summer time difference between the clocks of monitoring system devices, particularly in cases when collecting the data from all of system sensors is not “simultaneous”.

4. CONCLUSIONS

In the first application of line surge arresters (LSA) in Croatian transmission network on 110 kV line Ston-Komolac were installed 110 polymer housed LSA in order to improve line lightning performance. As a part of project a number of arresters were equipped with current sensors for real time monitoring of arresters current activity (49 sensors).

After 9 months of LSA application first results shown that a number of line outages have been significantly reduced according to expected and calculated estimation. Using the data collected from the whole system it is possible to make advanced analyses of surges and overvoltage events on line insulator strings, towers and their earthing system. In that sense the first analyses show that several line towers are much more exposed to lightning than others.

Experiences so far in application of installed monitoring system based on Excount II type of sensors also showed the advantages of wireless collecting data of LSA activities on related transmission line.

Due to short period of only 9 months of monitoring system field application, now it is too short time to achieve much more reliable estimations of all final effects and possibilities.

BIBLIOGRAPHY

[1] J. L. de Franco, A. C. Bezerra, A .D. Andrade: "Improvement of the Transmission Lines Lightning performance using Line Arresters: Experience of the Brazilian Utilities"; CIGRE Session 2006, A3-102, Paris 2006.

[2] S. A. Corrales, J. C. Martinez, J. L. Barragan: "Analysis of the Performance of a 400 kV Transmission Line against Lightning"; CIGRE Session 2006, C4-107, Paris 2006.

[3] M. Kitilcay, C. Neumann: "Backflashovers Analysis for 110-kV Lines at Multi-Circuit Overhead Line Towers"; IPST'07, Lion, France on June 4-7 2007.

[4] S. Bojić, J. Kučak, Z. Firšt, D. Đurđević, G. Čubra: "Testing of "Hot Conductors" with Suspension Equipment and Monitoring of Overhead Transmission Line 110 kV Ston-Komolac"; (In Croatian), II conference of Croatian CIGRE Committee, R 22.09, Primošten, 1995, Croatia

[5] IEC 60099-4/2004, Surge Arresters – Part 4: Metal-Oxide Surge Arresters without Gaps for A.C. Systems

[6] A. Schei: "Application of Metal Oxide Surge Arresters to Overhead Lines, Working Group 06 of Study Committee 33, ELECTRA No. 186

[7] "Operation manual for leakage current monitor – LCM", rev. 91-10, ABB HV Switchgear AB, Sweden

[8] "EXCOUNT-II – Technical information", ABB Power Technology Products AB – High Voltage Products – Surge Arresters, Ludvika, Sweden, 2001.

[9] I. Dolić, S. Bojić: "Testing of Metal Oxide Arresters"; Technical Study, Energy Institute Inc., (In Croatian), Zagreb 2007, Croatia

[10] M. Puharić, S. Sadović: "Implementation of Surge Arresters on the 123 kV Line Ston-Komolac", Technical Study, Energy institute "Hrvoje Požar" (in Croatian), Zagreb 2003, Croatia

[11] I. Uglešić, V. Milardić, B. Filipović-Grčić, Z. Rubinić, G. Mirošević: "Application of Polymer Housed Line Surge Arresters for Improving the Lightning Performance of High Voltage Overhead Lines", (in Croatian), VIII conference of Croatian CIGRE Committee, B2-12, Cavtat, 2007, Croatia

[12] "Annual report of Outages and Failures on Transmission Lines", HEP OPS, PrP Split, (Internal Working Document of Croatian Power Utility), (In Croatian)

[13] "1HSA 801 080-15en EXCOUNT-II Users Manual", Edition 3, 2005-08, ABB Power Technologies AB, High Voltage Products, Surge Arresters, LUDVIKA, Sweden