Assessment the sensitivity of the High Set Instantaneous Overcurrent Relays for feeder 20 kV, supplying distribution substation

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Abstract – **The paper considers the sensibility of the High Set Instantaneous Overcurrent Relays (HSIOR). HSIOR is used for quick tripping of the medium voltage feeders at the interphase fault. That's why the research of the reserve of the sensibility of the HSIOR is a question of present interest.**

Keywords – **Distribution network, Relay Protection, High Set Instantaneous Overcurrent Relays.**

I. INTRODUCTION

High Set Instantaneous Overcurrent Protection Relays (HSIOR) are used for quick tripping of the part of the distribution networks 20 kV under fault. It is recommended that the setting up of HSIOR for the feeders, supplying distribution substation [2] to be according to the current of the three-phase short circuit on the busbars of the distribution substation t the maximum mode:

(1) $$I_{pt} = K_r . I^{(3)}_{sc\max}, \text{A}$$

I_{pt} - primary tripping current of the HSIOR;K_r is a redundancy factor; $I^{(3)}_{scmax}$ - a current of the three-phase short circuit on the busbars of the distribution substation at the maximum mode.

The redundancy factor is 1,2 for Electromechanical Relay Protection (EMRP) and 1,1 for Numerical Relay Protection (NRP).

The sensitivity of the Relay Protection is ascertained by sensitivity factor (K_S) [1,2]:

(2) $$K_S = \frac{I^{(2)}_{sc\min}}{I_{pt}} \geq 1,5,$$

$I^{(2)}_{sc\min}$ is a current of the phase-to-phase fault on the medium voltage busbars of the substation at the minimum mode.

The aim of the paper is to determine the reserve according to the sensitivity of HSIOR of the feeders, supplying distribution substation, depending on the length and the kind of feeder.

At setting up of HSIOR using the formula (1) and after replacement of I_{pt} in the formula (2):

(3) $$\frac{I^{(2)}_{sc\min}}{I^{(3)}_{sc\max}} \geq K_r .1,5.$$

If $k_r .1,5$ is replaced with $K_{\min}$ in (3), it can be determined the condition for the reserve according to sensitivity of HSIOR (K_{res})

(4) $$K_{res} = \frac{I^{(2)}_{sc\min}}{K_{\min} . I^{(3)}_{sc\max}} \geq 1.$$

The coefficient K_{res} is 1,81 for EMRP and 1,65 for NRP, taking into account the values of the redundancy factor. The assessment according to the conditions for ensuring of the needed sensitivity of HSIOR can be done researching K_{res}.

II. RESEARCHED NETWORK. RESULTS.

Electrical network 20 kV, built from overhead power line with conductors type AC (Aluminum-Steel) with cross section 50, 70 and 95 and cable power lines type CAXEκT (Cable with polythene insulation) with cross section 120 and 185 and lengths from 2 to 10 km. The power of the supply transformer is 40 MVA. Researches about the alteration of the phase-to-phase fault current in the beginning and the three-phase short circuit current at the end of the considered power line are fulfilled. The researches took into account the alteration depending on the length and type of the power line. The received results are used for determination of the coefficient K_{res}.

Table 1 and Figure 1 show the values of K_{res} for EMRP.

Figure 2 shows analogical results for NRP.

TABLE I
VALUES OF K_{RES} FOR EMRP

L, km / Conductor	1	2,2	3	5	10
AC 50	0,71	1,06	1,32	1,97	3,62
AC 70	0,67	0,95	1,15	1,66	2,96
AC 95	0,65	0,89	1,06	1,48	2,57

Figures 3 and 4 present results for Cable Power Lines type CAXEκT 120 and 185.

III. ANALYSIS

The conditions that the relay protection does not have needed sensitivity are deduced from fulfilled esearches concerning the alteration of the phase-to-phase fault current in the beginning and the three-phase short circuit current at the end of the considered power line.

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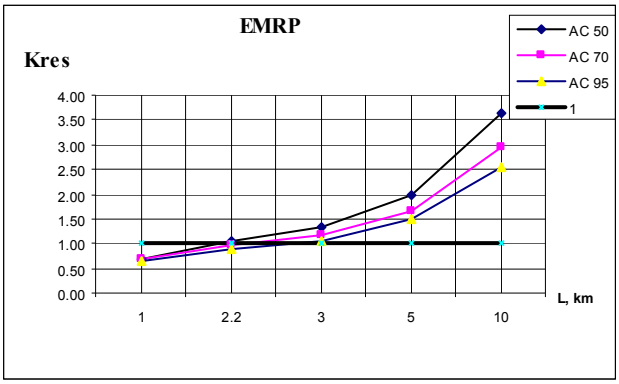

Fig.1. Alteration of K_{res} for EMRP

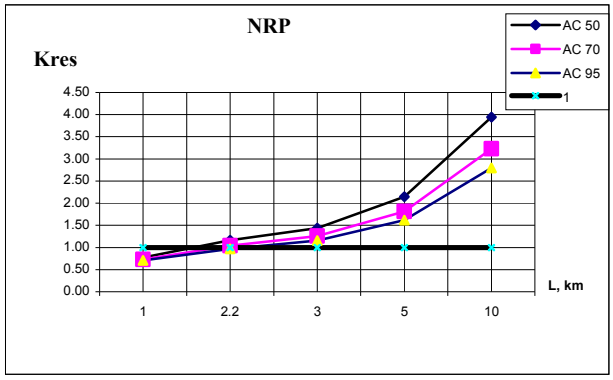

Fig. 2. Alteration of K_{res} for NRP

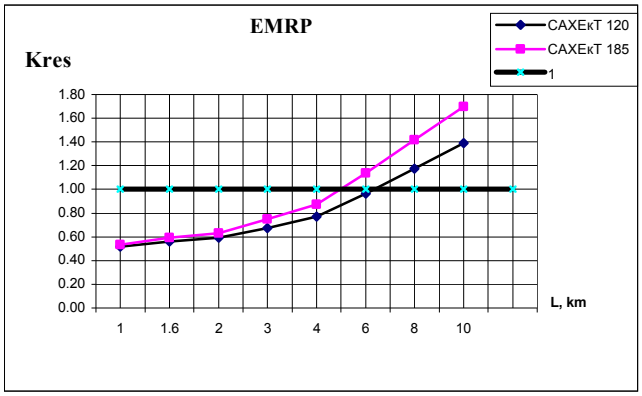

Fig. 3. Alteration of K_{res} for EMRP

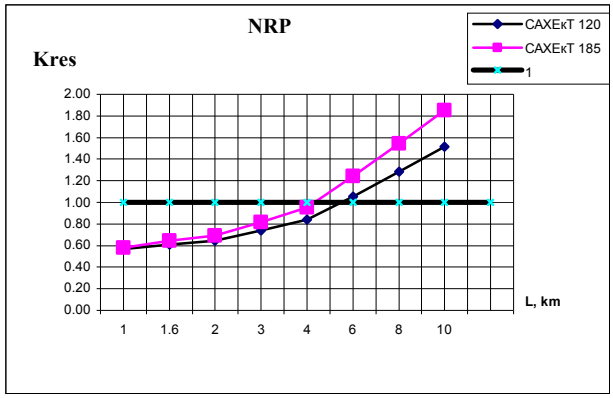

Fig. 4. Alteration of K_{res} for NRP

The results (Figures 1 and 2) for overhead power lines and interphase faults show that NRP does not have needed reserved according to sensitivity and NRP may not trip when the length of power line is less than fixed value.

1. For Electromechanical Relay Protection:

The reserve according to sensitivity is less than 1 for Overhead Power Lines, built with:

a) Conductors AC 50 and a length up to 2 km;

b) Conductors AC 70 and a length up to 2,5 km;

c) Conductors AC 95 and a length up to 2,8 - 3 km;

2. For Numerical Relay Protection:

The reserve according to sensitivity is less than 1 for Overhead Power Lines, built with:

a) Conductors AC 50 and a length up to 1,5 km;

b) Conductors AC 70 and a length up to 2,0 km;

c) Conductors AC 95 and a length up to 2,5 km;

Figures 3 and 4 shows that NRP does not have needed reserve according to sensitivity when is used for protection of **Cable Lines** and at the following circumstances:

1. For Electromechanical Relay Protection:

a) The reserve according to sensitivity is less than 1 for CAXEκT 120 with a length up to 6,2 km and for CAXEκT 185 with a length up to 5 km.

2. **For Numerical Relay Protection**:

b) The reserve according to sensitivity is less than 1 for CAXEκT 120 and 185 respectively for length up to 5,5 and 4,5 km.

IV. Conclusion

The received results for alteration of the short circuit current and analysis thus conducted lead to the following essential conclusions for discussed power lines with supply transformer 40 MVA:

1. Instantaneous Relay Protection has the reserve according to sensitivity for Overhead Power Lines with a length greater than 3 km.

2. Instantaneous Relay Protection is not sensitive for Cable Power Lines with a length up to 5- 6,2 km.

3. Instantaneous Relay Protection, built with numerical relays has bigger reserve according to sensitivity than Electromechanical Relays at the same conditions.

References

[1] Ordinance №3 regarding structure of electrical devices and power lines, State gazette, issue 90 and 91/ 2004.

[2] Instruction for organization and setting up of Relay Protection in Distribution Networks in "ECO" EAD, Bulgaria.