

Chapter 11

Sheath Overvoltage Due to External Faults in Specially Bonded Cable System

ABSTRACT

In chapter 10, It is shown that the types of the bonding are one of the important factors which affect the sheath losses in single-core cables, and it is concluded that both single-point bonding and cross bonding, which are known as special bonding, introduce the lowest losses in the metallic sheath of the cable. To take the advantages of the specially bonded cable systems it is necessary to insulate the cable sheath from earth to avoid corrosion. This is achieved by having an extruded serving of PVC or PE on the cables and housing the joints in compound filled fiberglass boxes to insulate them from the surrounding soil. The use of special bonding gives rise to sheath over-voltages at sheath sectionalizing insulators in cross bonded cable system and insulators in a single-point bonded cable system due to lightning, switching surges or faults. One of the factors affecting the sheath losses in single-core underground power cables in case of special bonding types is the sheath overvoltage. Those over-voltages may cause the sheath multi-points break-down which result in a large sheath currents and losses and hence may cause overheating of the cables and finally leading to operation faults. As mentioned before, faults are one of reasons which cause sheath over-voltages. System faults may be divided into internal faults occurring within the cables themselves and external faults for which the cables carry some or the entire fault current. The sheath voltages resulting from internal faults may greatly exceed those caused by external faults. A fault in the cables themselves inevitably involves repair work and hence it is not so important if the sheath insulation adjacent to the fault is also damaged. The sheath bonding design should preclude the damage cascading to other parts of the cable system i.e. the cable installation must clearly be capable of safely withstanding the effects of any fault in the system external to the cables . So it is important to consider the performance of special sheath bonding methods in relation to power frequency external fault currents.

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11.1 INTRODUCTION

Three types of external faults are considered:

1. Three-phase symmetrical fault
2. Phase-to-phase fault
3. Single-phase ground fault

These three types represent extreme cases and, hence, may be expected to show maximum values of sheath voltage.

Transient voltages induced in the cable sheaths are particularly important because of the possibility of excessive voltages that can cause harm to personnel, the cable or equipment connected to the cable. Also the level of transient voltages induced in the sheaths will have a direct bearing on measurement actuators and sensors used in any cable monitoring system.

Consideration must be given to assess the magnitude of those over-voltages, so in this chapter over-voltages will be calculated for single-point bonding and cross bonding under three types of external faults which are listed above for systems having solidly earthed neutral, with introducing a suitable method to protect the outer jacket sheath of the cable. More details are reported by Halperin, H. & Miller, K. W. (1929), Buller, F. H. (1949), Thue, W. A. (2003), IEEE Std. 575 (1988), British Standard BS 7430. (1998), King, S.Y., & Halfter, N.A.(1982), Riba, J. R., Ruiz, X., Alabern, M. (2006) and Ma, H., Song, J., Ni, X., & Zhang, L. (2008).

11.2 MATHEMATICAL ALGORITHM

In deriving the equations that give the sheath voltage gradients due to the external faults types which listed above for special sheath bonding methods, the following assumptions are made.

1. The short circuit current is known and is unaffected in value by the characteristics of the cable system.
2. Symmetric currents flow during three-phase faults.
3. No currents flow other than currents in phase conductors for phase to.

Phase fault and three-phase fault, i.e. no induced circulating currents in screens, ecc or any other parallel conductors are considered when calculating the induced voltages. Parallel conductors which are connected to earth at both ends will generally act as screening conductors reducing the induced voltages. So this assumption will give results on the safe side.

4. The cables, for cross bonded systems, be laid with constant spacing and equal lengths.

These assumptions have to be set up in a way that most of the practical cases are covered and the deviations from the exact values will be on the safe side. It must be referring here that; the studies support the use of the following equations to within good accuracy and with the benefit of being simple to apply .

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