Transient Overvoltage Distribution in Sectionalized Screens of HV Joints

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ABSTRACT

The overvoltages between screens of the sectionalized joints depend not only on the chosen surge voltage limiters, but also on the type of bonding lead cable used to connect them. Connection cables of unipolar type instead of coaxial lead to higher overvoltages. This negative influence is accentuated the longer the length of the bonding lead cable. This article demonstrates the use of unipolar cable is equivalent to increasing the length of the cable more than 5 times that of the coaxial cable. The article also analyses the voltage distribution between each screen of a joint with respect to earth.

KEYWORDS

Sectionalized joints; surge voltage limiters, link-boxes, bonding lead cables, transient overvoltages, lightning.

INTRODUCTION

The protection against fast transient overvoltages between metal sheaths of sectionalized joints used in cross-bonding and single-point bonding system is carried out by means of surge voltage limiters (SVL) arranged inside link-boxes. The selection of the SVL is performed taking into account the maximum temporary overvoltage that can appear in the cable system [1]. Analytical equations for the transient sheath-overvoltages of atmospheric origin were deduced in [2], in which formulas to determine the overvoltage between sheaths of sectionalized joints were presented for different cases, as analytical functions depending on the length of the bonding lead cable between the sheaths and SVL in order to ensure an appropriate protection margin for the insulation of the cable accessories. However no formulas were established for the voltage distribution between one and another sheath of the sectionalized joint.

Furthermore, it is possible to evaluate the overvoltages between sheaths and between sheaths and ground, using electromagnetic transients software (ATP), but it is not easy to determine the voltage distribution that appears on each sheath.

The limited transient overvoltage between sheaths of sectionalized joints depends on the type of bonding lead cable used to connect them to the surge voltage limiters (SVL) placed in the link-box (unipolar bonding lead cable or coaxial bonding lead cable) and its length.

It is known that the overvoltage is lower when coaxial bonding lead cables are used, but it is not well known the voltage distribution between one and another sheath. This voltage distribution depends on whether the metal sheath of each side of the sectionalized joint is connected to the inner conductor or to the outer conductor of coaxial bonding lead cable.

In addition, the voltage distribution between sheaths is different depending on whether it is a joint arranged as a cross-bonding bonding system, where the metal sheath of each side of the joint is connected to a SVL, or whether it is a joint arranged as a single-point bonding system, in which the metal sheath of one side of the joint is connected to a SVL and the other side is directly connected to earth.

The effect of the length of the bonding lead cable in the transient overvoltage distribution should also be considered, as well as the effect of using limiters of different rated voltage to achieve an appropriate limited overvoltage at each sheath.

The paper presents an analysis of the transient overvoltages transmitted through a cable system and how they are distributed at metal sheath of each side of the sectionalized joint taking into account the influence factors indicated above.

ANALYSIS OF OVERVOLTAGE DISTRIBUTION ON CABLE SHEATH

The analysis of the overvoltage distribution on cable sheaths is supported by the results of a set of laboratory tests carried out on a 66 kV cable system (cable + sectionalizing joint). The testing setup is composed by a sample of cable (66kV 1x1000Al+H135) of 50 m length, in which a sectionalizing joint was assembled in the middle of the cable. Lightning impulses 1,2/50 up to 1,5kV were applied between conductor and the cable sheath at one cable end for two configurations of bonding lead cables (coaxial and unipolar) used for cross-bonding or single-point bonding system:

a) Coaxial bonding lead cable to link:
   - Each metal sheath of the sectionalizing joint connected to a different SVL simulating a cross-bonding system.
   - One metal sheath of the sectionalizing joint connected to a SVL. The other connected to earth, simulating a single-point bonding system.

b) Unipolar bonding lead cable:
   - Each metal sheath of the sectionalizing joint connected to a different SVL simulating a cross-bonding system.
   - One metal sheath of the sectionalizing joint connected to a SVL. The other connected to earth, simulating a single-point bonding system.

The overvoltages between sectionalized sheaths can be calculated by formulas (1) to (4) introduced in [2] and the ones between cable sheath and earth are given by the in formulas (5) to (8), in which the voltage distribution factor K_{emp_cb} and K_{emp_cb} can't be easily estimated.