LONGITUDINAL INDUCTION VOLTAGE MEASUREMENT ON COMMUNICATION CABLES RUNNING PARALLEL TO OVERHEAD LINES OR POWER CABLES

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ABSTRACT

Overhead lines and power cables carrying electrical currents induce voltages in other parallel lines and cables. The induced voltage, otherwise known as Low Frequency Induction (LFI) can result into malfunction and damage of the connected instrument and can endanger lives of people coming into contact with these conductors.

Eliminating the effect of induced voltages is practically not possible in most occasions, because the communication cables normally run in the same easement and corridors used by electrified power cables and overhead lines. Engineers must ensure the power system is designed in such a way that induced voltages on adjacent conductors are kept within the acceptable limits, safe for humans and connected equipment. The design can only be proven by commissioning tests once the power and communication systems are ready to be put in service.

This paper intends to briefly explain methods by which the longitudinal induced voltage can be measured and introduce a new method for this measurement.

KEYWORDS

Signal cables; longitudinal induction; Variable frequency

INTRODUCTION

Electro-magnetic field is created in the surrounding of a conductor as a result of current passing through the conductor. This field induces a voltage on adjacent conductors depending on the distance (separation) from the source of the field and other specific conductor's conditions such as angle with the electrified line, screening and bonding.
Power System Engineers are confronted with the task of designing a system, which induces voltages on adjacent conductors only within allowable limits. These limits are set by standards and achieved through collaboration of power and telecommunication industries.

Effect of electrical overhead conductors and power cable installations into telecommunication cables need to be measured by commissioning tests before energisation to ensure that these voltages are within the safe limits and then periodical tests need to be carried out to prove that the induced voltages are maintained safe for human beings and connected equipment. The magnetic field of buried power cables is less than that of overhead lines because the phases are closer together, however the signal cables are potentially also closer to the power cable so the problem is more or less the same.

SAFE VOLTAGE LIMITS

According to International Telecommunication Union's guidelines, there are two categories for induced voltages to be considered:

- Normal conditions
- Fault conditions

Under system normal operation, cables to which members of public may come in contact with, can have induced voltage of up to 60 Vrms with reference to earth. Cables that are not accessible by the public are allowed to have up to 150 Vrms under normal operating conditions provided that only technicians can access them.

An electrical fault due to insulation breakdown or other reasons can cause a rapid rise in the current flowing through a conductor. This excessive current creates a powerful changing magnetic field, which in turn generates a greater induced voltage on adjacent conductors. Under these conditions, the induced voltage of up to 430V is regarded as the allowable limit.

The above voltage values have been allowed to exceed provided that the probability of the higher induced voltages are low and protection fault clearing time is very quick. If the above two conditions are met, then the allowable induced voltage can go up to 1000 Vrms if the protection operates within 350 msec to 500 msec. In cases where the fault clearing time is less than 350 msec, the limit is allowed to rise up to 1500 Vrms. These allowable voltage limits are summarised in Table 1.

Line Category	Description	LFI V-Limit
A	High Reliability line with protective equipment that would clear an earth fault within 0.35 secs	1500 V_{rms}
B	High Reliability line with protective equipment that would clear an earth fault in, from 0.35 secs to 0.5 secs	1000 V_{rms}
C	Line not classed as a High Reliability as protective equipment would not clear an earth fault within 0.5 secs	430 V_{rms}
All	Normal operating conditions where the cable can be accessed by technicians	150 V_{rms}
All	Normal operating conditions where the cable can be accessed by the public	60 V_{rms}

Table 1 : Power Line Categories and LFI Voltage Limits