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Optical Fiber Cables Near High Voltage Circuits

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The installation of optical fiber near high voltage circuits is a common occurrence. It is especially attractive for utilities or users of utility right-of-ways to provide a communications link with superior broadband characteristics and low attenuation while maintaining immunity to electromagnetic interference.

Industry Standards

The placement of optical fiber cables in a high voltage environment, with typical line voltages of 115 kV or more, requires the evaluation of certain critical parameters. Currently, there are a limited number of industry documents that address the requirements for optical fiber cables near high voltage circuits. One standard that has been developed by the Institute of Electrical and Electronics Engineers, Inc (IEEE) is 1222, “IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable (ADSS) for Use on Overhead Utility Lines.” It defines the requirements for ADSS cables placed aerially in a high voltage environment, and is commonly used by end customers.

Several American Society of Testing and Materials (ASTM) Standards exist for specific material tests such as tracing and erosion resistance. It should be recognized that these tests are specifically targeted at the properties of insulation materials for current carrying conductors, and may or may not be relevant for optical cable design requirements.

High Voltage Effects

The primary considerations for a cable in a high voltage environment are the effects of tracking, dry-band arcing, flashover and corona. Tracking is defined as the “irreversible degradation of surface material from the formation of conductive carbonized paths.” These degradations arise from a breakdown of the dielectric jacketing material induced by strong electric fields. Dust, moisture, and contaminants in the air can produce areas of differing resistivity along the cable jacket, which intensifies the electric field and can initiate tracking at a lower electric field than the pristine material would have to experience. Once tracking has been initiated, the degraded material acts as a focal point for more degradation and the material is effectively eroded away.

Dry-band arcing is a form of tracking. While traditional tracking susceptibility is a function of the materials used, dry-band arcing is also a function of the installation details. The degree of tracking encountered is dependent on the line voltage, the jacket resistance, and the proximity of the optical fiber cable to the power conductors and ground. Dry-band arcing arises from a capacitive coupling effect that occurs on the optical cable due to its proximity to a power cable.

The capacitive coupling effect generates an electric field and a conductive path along the optical cable. When a wetted optical cable (due to rain or mist) begins to dry, the conductive path becomes interrupted as alternating wet and dry regions on the cable surface are formed. The

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sections of dry cable surface have higher levels of surface resistivity than the wet sections, allowing localized buildups of electrical potential to occur and giving rise to discharges that occur between the wet sections on either side of the dry bands. The discharges cause localized melting and degradation of the polyethylene sheath, resulting in the erosion of the outer jacket and a loss of sheath integrity. This erosion is the most damaging effect of the high voltage environment.

Flashover is the abnormal discharge or arcing from a conductor to ground or to another conductor. Flashover occurs as a result of dielectric breakdown of the insulator due to transient field stresses such as switching surges and lightning flashes. It most commonly occurs between a conductor and the grounded tower. If an optical fiber cable occupies the space between the conductor and the grounded tower, the cable may be susceptible to the effects of flashover. This is of importance for cables lashed to metallic messengers because the duration of the arc (on the order of 0.02 to 1 s) can also damage the lashing wire.

Corona, as it applies to voltage transmission lines, is the ionization of the air surrounding the conductor. A corona discharge occurs when the electric field intensity exceeds the breakdown strength of the air, on the order of 25 to 30 kV/cm. Obviously, parameters such as humidity, air pressure, arrangements of the conductors, etc. will impact this value. Corona discharges commonly occur at irregularities on the conductor surface. At these points, the electric field may be intensified. Corona in itself is not a problem for all-dielectric optical fiber cables since they do not introduce a severe voltage stress. However, the by-products of corona are a concern. Corona discharges generate light, noise, conductor vibration, heat, ozone, nitric acid, and oxides of nitrogen. The last four by-products could be detrimental to an optical fiber cable through erosion of the outer jacket. Damage typically occurs only at the metallic support hardware used at the tower attachment points. Information also suggests that corona is only a problem on extra-high voltage transmission systems usually operating at or above 345 kV.

Cable Placement Limitations

Cable placement limitations have three main components; electric field potential, electric field strength, and susceptibility to flashover. Unless special attachment hardware and procedures are used, the maximum limit for the electric field potential will be reached before the electric strength becomes limiting. These possibly damaging electrical effects are, therefore, best minimized by managing the electric field potential in which the cable is placed, while minimizing the voltage potential for flashover damage.

The IEEE 1222 specification referenced earlier categorizes ADSS cables into two classes. The first class is for situations where the electrical stress on the cable jacket does not exceed an electric field potential of 12 kV, while the second class is for cases where the electric field potential is greater than 12 kV. However, as a result of studies by the IEEE and other groups, there is an understanding in the industry that suggests that there are environmental factors and other factors that can adversely affect the ability of ADSS cables to withstand electrical stresses at a given field potential. As a result, Corning Optical Cable offers ADSS cables with an optional Track-Resistant Polyethylene (TRPE) jacket compound for applications where a higher level of tracking resistance is necessary.

Due to the influence of factors such as tower configuration, line phasing, etc., Corning Optical Communications recommends that the owner/operator of the power line be consulted for assistance in determining the optimum locations for the ADSS cable.

It should be noted that optical cables that are direct buried or placed in ducts underground may also be subject to these same high voltage effects, if placed too close to buried high voltage lines. While jacket degradation can occur, the magnitude and severity of the effects are reduced significantly from those evident in aerial installations.

Safety

Personnel trained and certified for high voltage work should perform the installation and construction of an optical fiber cable plant in the presence of high voltage lines. System designers and installers must recognize that even all-dielectric cable can support leakage currents. These leakage currents are predominant at the transition point from phase conductor induced fields to ground, such as at the supporting tower. Special hardware and handling practices may be required. Leakage currents can also be induced by direct contact of the all-dielectric cable with the phase conductor.

If you have any additional questions, please contact Corning Technical Support at 1-800-743-2671.

References:

IEEE Standard 1222: *“IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable (ADSS) for use of Overhead Utility Lines.”*

IEEE Standard 100-1996: *“The IEEE Standard Dictionary of Electrical and Electronics Terms,” 6th edition.*

ASTM D 1711-83: *“Standard Definitions of Terms Relating to Electrical Insulation.”*

C. Jurdens, H.G. Haag, R. Buchwald, “Experience with Optical Fibre Aerial Cables on High Tension Power Lines,” International Conference on Large High Voltage Electric Systems, 1988.

A. Grooten, E. Bresser, A. Berkers, “Practical Experience with Metal-Free Self-Supporting Aerial Optical Fiber Cable in High Voltage Networks,” IWCS Proceedings 1987

R. Schultz, R. Smith, “Introductions to Electrical Power Engineering,” Harper & Row, 1985.

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