**Engineering Services Department**
**800 17th St NW | PO Box 489**
**Hickory, North Carolina 28603-0489**

800 743-2671
f 828 901-5533
www.corning.com/optcomm

Applications Engineering Note

# Outdoor Cabled Optical Fiber Reliability

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This Applications Engineering Note (AE Note) addresses the reliability of optical fibers in outside plant cables comprising a black, medium density polyethylene (MDPE) jacket. It addresses both fiber reliability and cable component (materials) reliability. Many factors also affect cable reliability and this AE Note addresses these factors as well.

### Fiber Reliability

Mechanical reliability models predict structural failure rates for optical fibers under given stress conditions. Corning supports the Two Region Power Law Model which describes crack growth for low stress applied over a long time (i.e. deployed fiber in a cable) and crack growth for fast events such as proof testing. These results, coupled with manufacturing test data are used to determine safe stress guidelines. When adhering to Corning fiber and cable manufacturer's recommended practices, modeling indicates reliable fiber operation for 30 years or more. Furthermore, Corning Optical Communications is aware of deployed systems continuing to operate reliability for over 30 years.

### Cable Component Reliability

The materials most impacted by aging are the cable jacket and the optical fiber itself. Outside plant cable jacket materials used today are not exceptionally different from those used in early installations and were chosen for their proven long-term performance in copper cable designs. Material and cable manufacturers continue to use industry approved aging tests to support material selection.

Fiber designs and manufacturing techniques have improved significantly over the years and fibers that were once cutting edge may not be capable of meeting the demands of today's higher performance systems. Performance parameters such as polarization mode dispersion, now considered critical for high data rate systems, were not even specified or measured for fibers manufactured before or around 1994. Other optical parameters previously specified have also improved. Therefore, care must be taken to not mistakenly label a cable's performance as degraded when it could just simply be that the legacy fiber was never designed for the specific application or current specified performance.

### Installed Cable Fiber Performance Factors

The performance of installed cabled fiber depends on a number of factors listed below including the cable environment, the type of installation, cable design, and the cable material. Factors which may affect certain installations are: structural cable damage caused during or after initial installation, improper cable design, the splicing quality and splice closure work, exposure to periods of severe environmental loading or certain chemicals, or exposure to temperature and humidity conditions outside of specified performance levels.

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**Direct Buried Installations**

- Type of soil (e.g., rocky, sandy, etc.)
- Depth of cable
- Underground hazards (e.g., rodents, pressure points)
- Soil settling or erosion
- Chemicals if present (contamination from hydrocarbon or other chemical spills)
    - type of chemical(s)
    - concentration
    - duration of exposure
- Cable structural damage due to improper installation, dig-ups, lightning strikes, rodents, or other means
- Cable design (e.g., armored or all-dielectric, and type of armoring if present)
- Residual cable stress
- Improper hardware solution or improper use of correct hardware
- Violation of tension or minimum bend radius

**Duct Installations**

- Chemicals (e.g., use of incompatible pulling lubricants, or presence of other chemicals)
- Residual cable stress
- Number, type and size of other cables present in the duct
- Damage from subsequent cable pulls into the same duct
- Damage from installation
- Improper duct construction
- Exceeding the tensile rating and fiber strain rating
- Violation of tension or minimum bend radius
- Routing in manholes
- Frozen water in duct (from not using duct plugs) resulting in compression failures
- Improper hardware solution or improper use of correct hardware

**Aerial Installations**

- Environmental loading conditions (e.g., ice/wind)
- Periods of severe environmental loading (e.g., hurricane, ice storm, etc.)
- Damage from rodents, debris (e.g., falling tree limbs), or shotguns
- Improper hardware solution or improper use of correct hardware

**Conclusion**

There are many considerations when addressing cabled fiber lifetime performance. Assuming the appropriate cable is selected for the application and the cable is installed correctly, modeling and real world experience indicates reliable operation for approximately 30 years for outside plant cables with black, MDPE jackets. The fiber reliability estimates contained herein are not a warranty or guarantee. They are only estimates based on Corning's experience. Corning's warranty and/or guarantee obligations are set forth in its terms and conditions of sale available at:

https://www.corning.com/catalog/coc/documents/misc/COC-StandardTermsandConditions-COR-0141-AEN.pdf
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The best gauge of the health of a system is typically the optical properties of the cabled fiber when compared to industry standards at time of purchase. Measurements such as multi-wavelength attenuation, Polarization Modal Dispersion, and Chromatic dispersion, as well as bi-




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directional OTDR and Optical Spectral Analyses can be taken in order to determine the ability of a link to support higher data rates. While this testing can not guarantee against future failure due to cable aging, it can confirm the performance and potential upgradeability of the link or integration of an older cable into a new telecommunications system.




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