

# Are Epoxy and Polish Connectors Compliant to GR-326?

AEN 77, Revision: 3

## Introduction

Users of patchcords and cable assemblies frequently use Telcordia™ GR-326-CORE, “Generic Requirements for Single-mode Optical Connectors and Jumper Assemblies,” when specifying basic performance requirements for connectors and connectorized cable assembly products. Customers frequently ask if Corning Optical Communications’ epoxy and polish connector products are compliant to GR-326.

Essentially, GR-326 is a performance specification for cable assemblies. Since connector installation techniques can affect the performance of the assembly product, Corning Optical Communications cannot predict the performance of assemblies that are manufactured using Corning Optical Communications epoxy and polish connectors. This document provides an overview of GR-326, the detailed performance requirements, and issues that can affect whether or not product is compliant.

## General

Together with the Regional Bell Operating Companies (RBOCs), Bellcore published specifications for many products used by Telecommunications Service Providers. Examples of the more widely mentioned of these specifications are GR-20-CORE, “Generic Requirements for Optical Fiber and Optical Fiber Cable,” for outside plant cables and GR-409-CORE, “Generic Requirements for Premises Fiber Optic Cable,” for intrabuilding cable. In 1997, Bellcore was purchased by SAIC (Science Applications International Corporation) and renamed Telcordia. Telcordia continues to maintain various product specifications.

Telcordia GR-326 is a specification for single-mode connectors and cable assemblies only. GR-326 does not address requirements for multimode connector products, which are rarely utilized in the targeted market, nor does GR-326 address requirements for field installable connectors which can be used to create assemblies in the field.

Note: In the context of this document, the term “connector” refers to an epoxy and polish connector that is not yet installed onto fiber; the term “assembly” or “cable assembly” refers to an epoxy and polish connector that has been installed onto a fiber optic cable.

## Products Covered

GR-326 contains detailed performance requirements for single-fiber, single-mode connectors

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and cable assemblies. GR-326 includes requirements applicable to cable assemblies installed in the central office and in outdoor environments. Most of the requirements are applicable to completed assemblies, but a few requirements can be applied just to the connector.

## **Overview of GR-326 Requirements**

GR-326 can be divided into four distinct groups of product and system requirements: General Requirements, Service Life Tests, Reliability Tests and Reliability Assurance Program. Additional sections of the document cover specific details about the equipment needed to perform the tests and other reference documents.

## **General Requirements in GR-326**

In many cases the General Requirements can be applied to the connector or the adapter. One example of a requirement that can be applied to just the connector is the requirement that the products meet dimensional requirements of the applicable TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS). Other general requirements that can be applied to just the connector are the flammability requirement and product marking requirements.

## **GR-326 Service Life Tests**

In general, the Service Life Tests can be used as a basis for evaluating assembly products and/or processes. The Service Life Tests are designed to simulate the stresses that cable assemblies may be subject to while in service in the telecommunications plant. They are a series of individual tests conducted such that the same set of assemblies is subjected to each test sequentially. Twenty-five (25) assemblies are required for the Service Life Tests. The Service Life Tests start with measuring endface geometries on each connector in the set, followed by randomly mating connectors in adapters and gathering the New Product Measurements of insertion loss and reflectance. The resulting connector pairs are subjected to approximately five weeks of environmental testing, followed by seven mechanical tests. (See Figure 1 – GR-326, Service Life Tests.)

Each of the environmental tests lasts for seven days: Thermal Age, Thermal Cycle, Humidity Age, Humidity/Condensation Cycling, and Post-Condensation Thermal Cycle. Following the environmental tests, the assemblies are subjected to the following mechanical tests: Vibration, Flex, Twist, Proof, Transmission with Applied Tensile Load, Impact, Durability, and Connector Installation. Completing this battery of environmental and mechanical tests on one set of assemblies typically takes up to four months.

During environmental and mechanical portions of the Service Life Tests, the assemblies are monitored for insertion loss, insertion loss change, reflectance and reflectance change. Each Service Life Test details the parameters for conducting the test and the requirements for insertion loss and reflectance performance. For example, Thermal Cycle consists of testing the assemblies from  $-40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$  with one hour transition and one hour soak times. The assemblies under test are measured for insertion loss and reflectance before the test begins, at least every 2 hours during the test at the temperature extremes, and at the completion of the test. The criteria for thermal cycling are 0.50 dB maximum insertion loss, 0.30 dB mean loss

(of the twenty-five assemblies), 0.30 dB loss increase, -40 dB maximum reflectance, and 5 dB reflectance increase. These criteria are applied to all measurements made before, during and after thermal cycling. Each Service Life Test has loss and reflectance criteria specified.

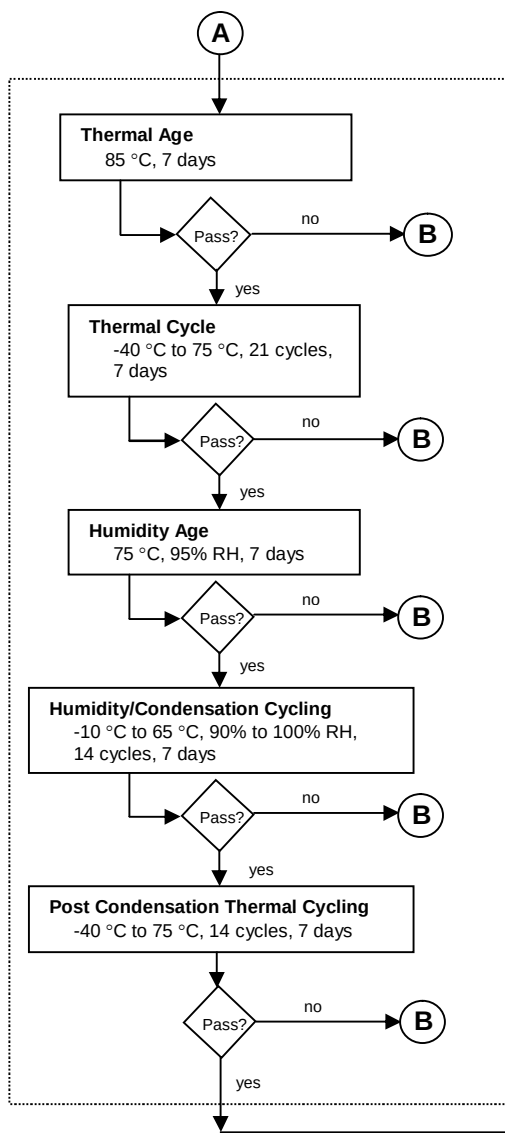
Note that in order to evaluate the necessary 25 connector pairs, and gather all of the test data needed in a reasonable timeframe, a computer controlled test system utilizing optical switches is virtually a requirement for successfully completing testing. GR-326, Section 5, details the requirements for switch-based testing apparatus.

## **GR-326 Reliability Tests**

The Reliability Tests are designed to establish the long-term reliability of cable assemblies under test. The Reliability Tests are performed on a minimum of 22 assemblies. The mated pairs are subjected to the test, similar to the Service Life Tests. Each reliability test can be performed on a new set of samples; there is no requirement to perform the reliability tests sequentially on the sample set. The Reliability Tests consist of Extended Thermal Age, Extended Humidity, Extended Thermal Cycle, Salt Spray, Airborne Contaminants, Dust, Groundwater Immersion, and Immersion/Corrosion Test. (The test procedures for Extended Thermal Age, Extended Humidity, and Extended Thermal Cycle tests are specified in GR-1221-CORE, "Reliability Requirements for Passive Optical Components.")

The Reliability Tests are requested by a small number of customers and are relevant for specific applications. Typically, reliability tests are not performed as a part of standard or normal product evaluations as they are very expensive to perform. The extended environmental tests require test equipment to be devoted to one test for long periods of time, up to seven months. Many of the tests are highly specialized and would typically be performed by outside test agencies. The high cost of designing and testing product to these requirements must be balanced against the relatively small portion of the market that has requirements for assemblies to be installed in the environments that these tests are intended to simulate. See Figure 2 for a summary of the reliability tests.

## Environmental Tests



**A:** 15 single-sided (pigtail) assemblies and 10 as double-sided (jumper) assemblies. (Jumper samples tested in first two environmental tests only.)  
Measure insertion loss, reflectance, and endface geometry prior to test.

**B:** Determine Failure Mechanism.  
Take corrective action in product or process.

**C:** End of Test.  
Measure insertion loss, reflectance, endface geometry, damage.

For each "Pass" decision, the assemblies are evaluated for insertion loss, reflectance, change in insertion loss, and change in reflectance.  
Mechanical loads depend on product tested; see GR-326.

## Mechanical Tests

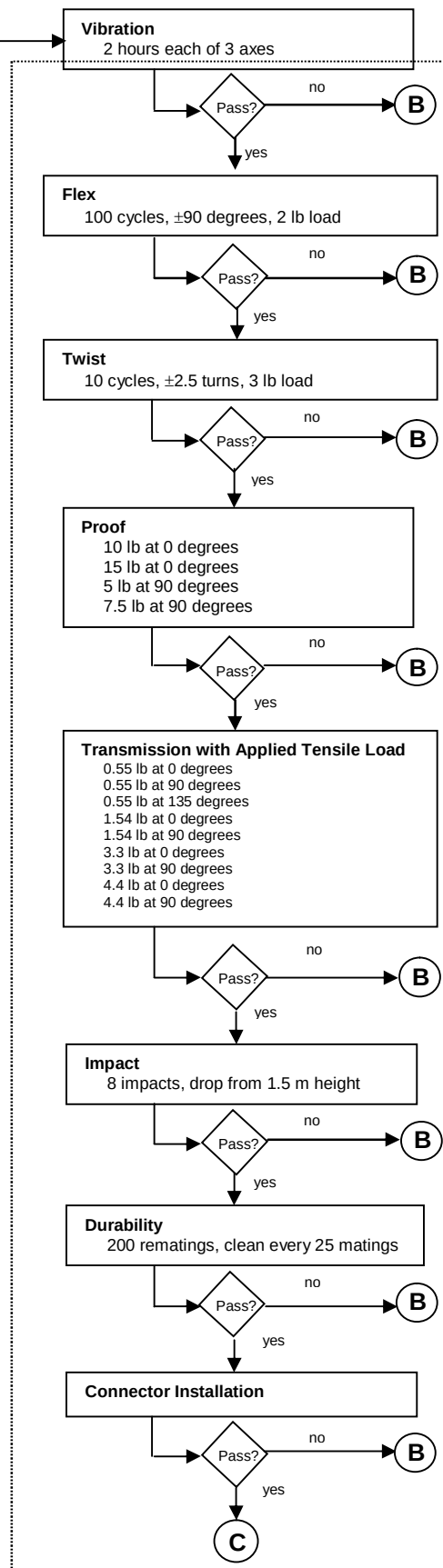


Figure 1 – GR-326, Service Life Tests

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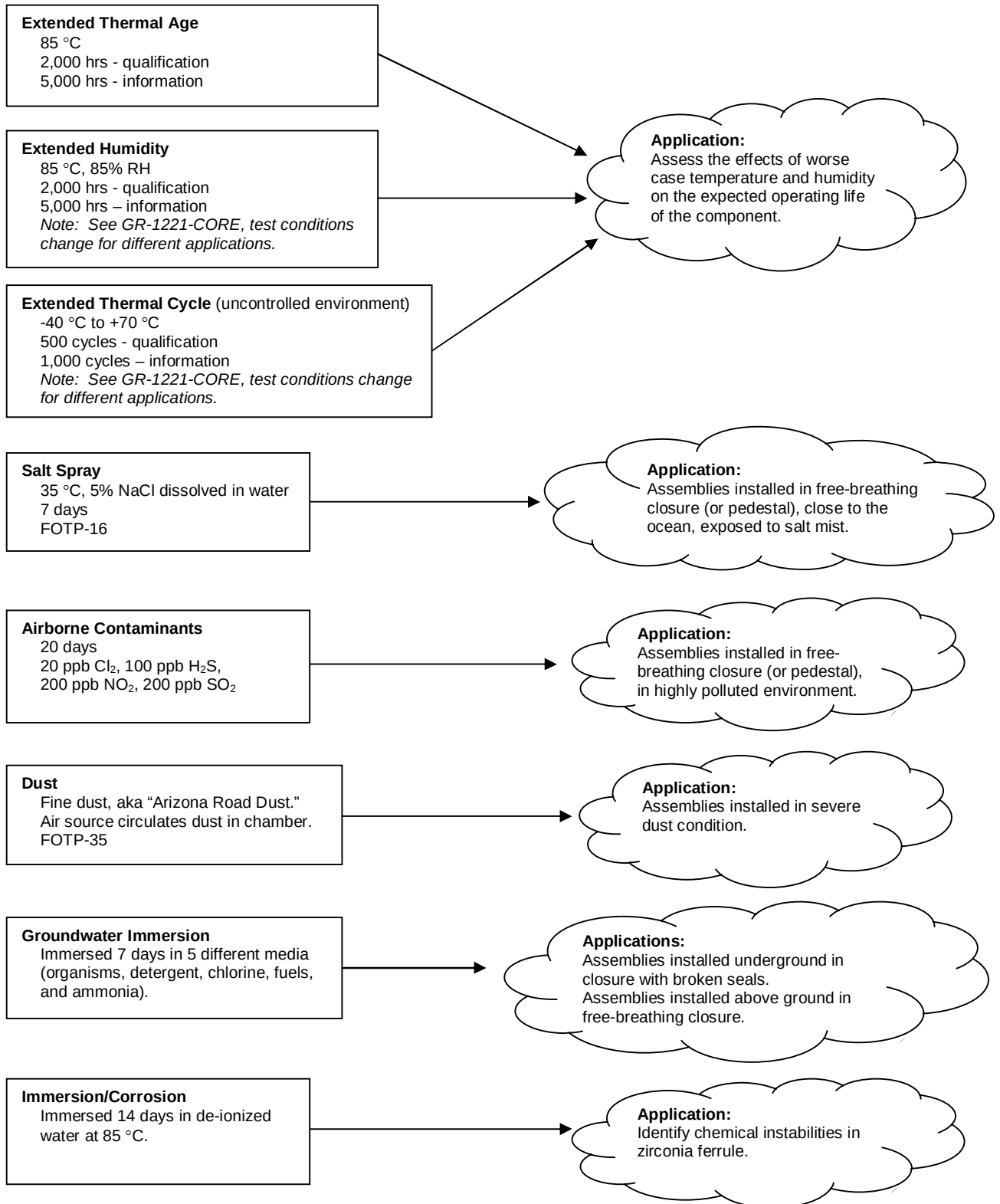


**Figure 2 – GR-326, Reliability Tests**

## Factors that Influence Assembly Performance

GR-326 is a specification for connectors and cable assemblies. A small portion of the requirements contained in GR-326 can be applied to a connector that has not been installed onto fiber. Corning Optical Communications supplies epoxy and polish connectors that have the potential to perform well against GR-326 requirements. Factors such as material selection and processing, connector installation, polishing, etc., must be considered in designing, building, and installing a connector onto an assembly that is intended to perform well in GR-326 testing. Corning Optical Communications uses engineering plastics in many of the injection molded parts for added strength and stability to make the connector capable of meeting GR-326 requirements.

One of the major factors in achieving good results to the environmental and mechanical requirements is the initial selection and subsequent processing of the epoxy. As a general rule, the epoxy should be handled such that there is a minimum amount of air in the epoxy. (Traditionally, the epoxy can be “de-gassed” in a vacuum chamber prior to injecting it into the ferrules.) Air pockets in the epoxy can cause high attenuation during environmental testing due to microbending effects at the air/epoxy transitions. Air pockets in the epoxy along the cladding can also lead to the potential for a surface flaw on the optical fiber to propagate into the fiber, eventually leading to a fiber break.

The correct amount of epoxy also needs to be injected into the ferrule and the connector body. Injecting too much epoxy can lead to epoxy leaking out of the back of the connector body and wicking into the strength yarn of the cable. When the epoxy is cured, the yarn may be rigidly attached to the buffered fiber. As this connector is subsequently mated in an adapter, there may not be enough movement allowed for the optical fiber as the ferrule compresses into the connector body. The optical fiber can bind inside of the connector body resulting in increased attenuation or a broken fiber. Injecting too little epoxy into the ferrule can also lead to problems, primarily insufficient support of the fiber. There must be enough epoxy in the ferrule and just behind the ferrule (inside the connector body) to encapsulate the portion of the fiber that is stripped to the 125  $\mu\text{m}$  cladding. If a portion of the glass fiber is exposed, there will be a much higher probability of having the fiber break at the exposed glass portion.

The endface geometry requirements in GR-326 are based on the system of two connectors mated in an adapter. The applicable FOCIS documents state requirements for the force applied to the ferrule by the spring inside of the connector body. These force requirements were considered along with the connector materials (such as the zirconia ferrule) to develop the endface geometry requirements such that the fibers in each connector will maintain physical contact during all environmental conditions defined. The endface geometry of the installed connector is highly dependent on the polishing processes used. Endface geometry is affected by the choice of polishing films (or other polishing media), the polishing fixtures, the pressures applied to the connector endface during polishing, and the amount of time the endface is polished.

Both the processes for installing the connector onto the fiber and the polishing processes will greatly influence the performance of assemblies tested to GR-326.

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## Summary

Corning Optical Communications is committed to supplying customers with high quality connector products. However, in the case of epoxy and polish connectors, the installation processes can significantly impact the performance of the completed cable assembly as required by GR-326.

When requesting an assembly product that is “compliant to GR-326,” it is prudent to gain an understanding of the level of compliance needed or required. Is full compliance to every requirement in GR-326 required or relevant? Or just some portion of the full GR-326 set of requirements satisfactory, (e.g. endface geometry).

Corning Optical Communications supplies high-quality cable and epoxy and polish connector products, but since compliance to GR-326 is highly dependent on processing techniques, Corning Optical Communications cannot guarantee the resulting cable assemblies.

Corning Optical Communications customers who purchase epoxy and polish connectors and install the connectors onto cable must test the assemblies resulting from their process to determine their level of compliance to GR-326. Corning Optical Communications cannot predict the performance of cable assemblies that are not manufactured at Corning Optical Communications’ factories.