Parameter	Requirement
Minimum number of cycles:	20 @ 10 to 20 cycles per minute
Load:	500 g ± 25 g
Rotation:	180 ± 10 degrees in each direction
Ribbon gauge length:	300 mm ± 10 mm

7.15.2 Acceptance Criteria

There shall be no separation of individual fibers from the ribbon sample.

7.16 Ribbon Residual Twist Test

The ribbon residual twist test, or flatness test, evaluates the degree of permanent twist in a cabled optical fiber ribbon.

7.16.1 Test Procedure

7.16.1.1 Test the ribbon residual twist in accordance with FOTP-131.

7.16.1.2 The default test conditions of the FOTP apply and are as follows:

Parameter	Requirement
Ribbon gauge length:	50 cm ± 5 cm
Test load:	100 g ± 5 g
Preconditioning requirements:	Age ribbon at 85 °C in buffer tube compound or low molecular weight oil, with uncontrolled relative humidity for 30 days.

7.16.2 Acceptance Criteria

There shall be no more than 8 degrees of residual twist per linear centimeter exhibited by the ribbon sample.

7.17 Ribbon Separability Test

The ribbon separability test ensures the ability to separate fibers, or groups of fibers, from a ribbon.

7.17.1 Test Procedure

7.17.1.1 Obtain a ribbon fiber sample with a minimum length of 300 mm.

7.17.1.2 The test for separability is to be performed for the number of fibers to be separated from the ribbon in accordance with the Detail Specification.

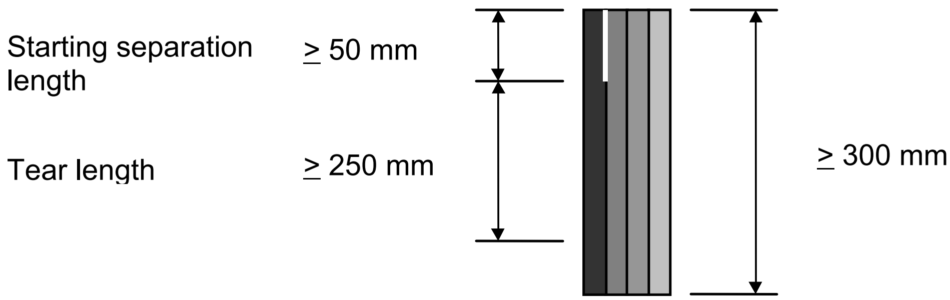
7.17.1.3 A starting separation length of ≥ 50 mm is achieved with a knife, or other appropriate method, in accordance with Figure 7.2. Separation shall be accomplished without specialized tools or apparatus.

7.17.1.4 Each specimen is separated by hand as shown in Figure 7.3. The separation speed shall be approximately 500 mm/min.

7.17.2 Acceptance Criteria

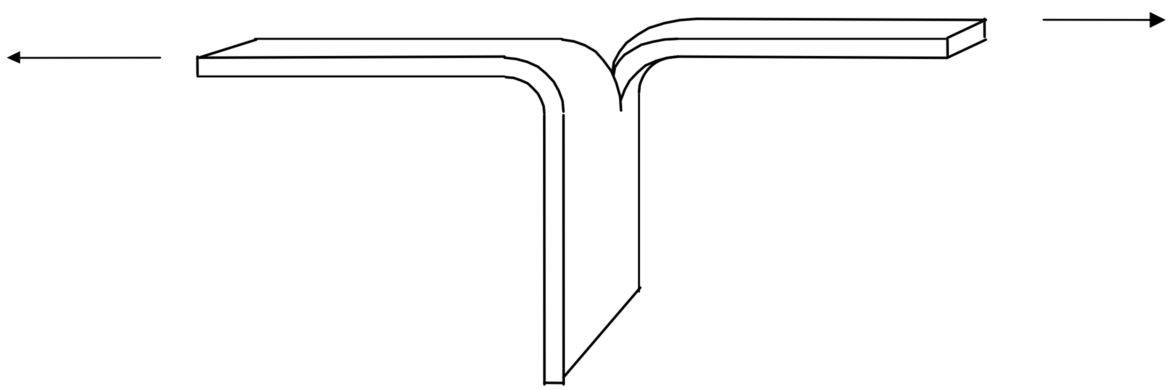
Separation shall be readily accomplished by hand. After separation, there shall be no mechanical damage to the fibers and the color of the fibers shall still be discernible.

Figure 7.2 - Ribbon preparation



Note: Tear length (Figure 7-2) as shown.

Figure 7.3 - Ribbon separation



7.18 Ripcord Functional Test

This test ensures ability of ripcords, when used, to perform in a reliable manner.

7.18.1 Test Procedure

Prepare the specimen to be tested in accordance with the manufacturers recommended procedures. An appropriate length of the end of the cable specimen should be prepared such that the ripcords are accessible for the test. To prevent the ripcord from slipping out of the end of the test sample, use a suitable length of cable or other method to securely couple the ripcord(s) to the other cable materials. Mark off the one meter test length from where the test pull will begin.

The cable shall be conditioned for four hours at the low and high installation temperatures given in Clause 1.1. The cable specimens shall be tested inside the chamber at the low and high installation temperatures

Pull the ripcord in accordance with the manufacturers recommended procedures for a distance of one meter.

7.18.2 Acceptance Criteria

The ripcord(s) shall not break over the test length.

If the ripcord breaks prior to reaching the one-meter mark, two additional follow-up specimens may be tested from the same cable length. The cable passes if neither of the two follow-up specimens breaks prior to reaching the one-meter mark.

If the ripcord pulls out of the end of the cable without slitting the jacket, repeat the test.

7.19 Material Compatibility and Cable Aging Test

This test ensures compatibility between cable components (e.g., fibers, plastics, water blocking materials, metals, etc.). This test applies to all water-blocked cables. Typical water-blocking materials include but are not limited to, gels, absorbent powders, and flooding compounds.

7.19.1 Test Procedure

Sufficient lengths of completed cable shall be aged at 85 °C, uncontrolled relative humidity, for 30 days. The cable ends shall be capped to prevent the migration of water-blocking material out of the cable.

To simulate aging in a flooded cable, filled buffer tubes may alternatively be placed in the water-blocking material. Jacket, and metal tapes, can also be aged per ASTM D 4568.

After aging, the components shall be removed from the cable and tested as described in the applicable Paragraphs.

7.19.2 Acceptance Criteria – after aging

After conditioning, the components in contact with the water-blocking material shall be removed from the cable and tested per 7.19.2.1 - 7.19.2.4 as appropriate.

7.19.2.1 Fiber Strippability – after aging

FOTP-178 shall be used for measuring the strip force needed to remove the optical fiber's protective coating or coating and buffer.

The coating of the fibers shall not show any signs of cracking, splitting, or delamination, when examined under 5X magnification. The force required to remove 30 mm ± 3 mm of the fiber's protective coating shall be between 1.0 N and 9.0 N.

For tight buffer fibers, the force required to strip the buffer material and the fiber coating of a 15 mm ± 1.5 mm specimen, in a single operation, shall be between 1.3 N and 13.3 N.

For semi-tight buffer fibers, the buffer shall be removed in a single operation, leaving the fiber coating intact. The force to remove 30 mm ± 1.5 mm of the buffer shall be lower than 13.3 N.

The strippability of optical fiber ribbons after aging shall meet the requirements of 3.4.4.6.

7.19.2.2 Buffer Tube Bending Test – after aging

Select a mandrel having a diameter that is the larger of 75 mm (3 inches), or 20X the tube diameter.

Samples of the aged buffer tubes shall be wrapped three times around the mandrel within 30 seconds, removed, and then straightened. The buffer tube shall not show signs of splitting, cracking, or delamination under 5X magnification.

7.19.2.3 Jacket Tensile Strength and Elongation Test – after aging

The aged jacket shall retain a minimum of 75 % of its unaged tensile strength and elongation values. Jacket material tensile and elongation shall be tested in accordance with FOTP-89.

7.19.2.4 Delamination – after aging

Plastic coatings on metal tapes shall show no visual evidence of delamination.

7.20 Buffer Strippability Test

The tight buffer strippability test measures the force required to strip the buffer material and for tight buffer, the fiber coating.

7.20.1 Test Procedure

Test tight buffer strippability in accordance with FOTP-178.

7.20.2 Acceptance Criteria - Tight Buffer Fiber

The force required to strip the buffer material and the fiber coating of a 15 mm ± 1.5 mm specimen, in a single operation, shall be between 1.3 N and 13.3 N.

7.20.3 Acceptance Criteria - Semi-Tight Buffer Fiber

The buffer shall be removed in a single operation, leaving the fiber coating intact. The force to remove 30 mm ± 1.5 mm of the buffer shall be lower than 13.3 N.

7.21 Cable Low and High Temperature Bend Test

The low and high temperature bend test determines the ability of an optical fiber cable to withstand bending at low and high temperatures as might be encountered during installation.

7.21.1 Test Procedure

Test in accordance with FOTP-37. Unless otherwise specified, test at the installation temperature extremes of Table 1.1 (Conditions E and N in FOTP-37, respectively).

Test Method I or II (single end or double end) may be used. The number of turns around the mandrel shall be 4 turns for Procedure I and 2 turns for Procedure 2 (FOTP-37, Table 2, test level 3).

The mandrel diameters used shall be 20X the cable outer diameter or 30 x the cable diameter for ribbon cables greater than or equal to 216 fibers.

For cables not having a circular cross-section, bending requirements are to be determined using the thickness (minor axis) as the cable diameter and bending in the direction of the preferential bend.

7.21.2 Acceptance Criteria

There shall be no visible cracks, splits, tears, or other openings on either the inner or outer surface of the jacket.

There shall be no visible cracking of the sheath components when removed successively and examined.

There shall be no broken fibers within the specimen.

Any increase in attenuation shall be:
≤ 0.15 dB at 1550 nm for single-mode fibers
≤ 0.30 dB at 1300 nm for multimode fibers

7.22 Cable External Freezing Test

This test determines the ability of a cable to withstand the effects of freezing water (ice) that may immediately surround the optical fiber cable jacket by observing any changes in the physical appearance of the jacket, or in the measured cable optical attenuation.

7.22.1 Test Procedure

Cable freezing test measurements and data reporting shall be as required by FOTP-98 Method A using the Temperature Exposure Procedure.

7.22.2 Acceptance Criteria

There shall be no visible cracks or other openings on the outer surface of the jacket.

Any increase in attenuation shall be:

- ≤ 0.15 dB at 1550 nm for single-mode fibers
- ≤ 0.30 dB at 1300 nm for multimode fibers

7.23 Compound Flow (Drip) Test for Filled Cable

The compound flow test measures the ability of the cable filling and flooding compounds to resist flowing at an elevated temperature. This test does not apply to cables that are free of gels, and which achieve water-blocking by the use of dry tapes, yarns, powders and the like.

7.23.1 Test Procedure

Compound flow test measurements and data reporting shall be as required by FOTP-81, with preconditioning of specimens permitted. Testing shall be conducted at a temperature of 70 °C ± 2 °C for 24 hours. The cable samples prepared end may be terminated according to the manufacture's recommended installation instructions. The upper (unprepared) end of the cable or buffer tube may be sealed to simulate long length cable sections.

7.23.2 Acceptance Criteria

There shall be ≤ 0.05 grams of material drip from the cable sample under test.

7.24 Cable Temperature Cycling Test

The cable temperature cycling test evaluates the attenuation performance of an optical fiber cable at temperature extremes. Because the thermal expansion coefficient and rigidity modulus of plastic coatings, buffers, armors, and strength members are different from those for the optical fibers themselves, fiber bend effects can occur with temperature changes.

7.24.1 Test Procedure

Cable temperature cycling, measurements and data reporting shall be as required by FOTP-3. The cable shall be tested at the environmental extremes of -40 °C and +70 °C. The test shall be conducted for two complete cycles. Attenuation measurements shall be made after preconditioning and again after the end of the last high and the last low temperature points of the test.

7.24.2 Acceptance Criteria

Any increase in attenuation shall be:

- ≤ 0.15 dB/km at 1550 nm for single-mode fibers
- ≤ 0.30 dB/km at 1300 nm for multimode fibers

7.25 Hydrogen Evolution in Cable

Reactive and non-reactive hydrogen effects target specific optical wavelengths and, depending on temperatures and partial pressures, can become severe enough to effect transmission properties in extreme cases. This test is only appropriate for cables containing single-mode fibers continuously submerged underwater at depths > 10 meters, or for cable constructions which are hermetically sealed. Testing terrestrial outside plant cables for the effects of molecular hydrogen migration is generally not required, as hydrogen will not accumulate in sufficient quantities to cause elevated attenuation levels.

7.25.1 Some older generation optical fibers may be susceptible to the effects of molecular hydrogen, however hydrogen effects are primarily associated with submarine optical fiber cables. For submarine cables, additional metallic components are required to provide the necessary protection and negative buoyancy for the cable. The large quantity of metallic components and the corrosive water environment nurtures hydrogen generation. Additionally, back pressure caused by the water allows a greater partial pressure of hydrogen gas to accumulate.

7.25.2 Test Procedure

Hydrogen evolution in cable measurements and data reporting shall be as required by FOTP-183.

7.25.3 Acceptance Criteria

For single-mode fibers, the increase in attenuation shall be as agreed upon by the manufacturer and user.

7.26 Cable Sheath Adherence Test

The cable sheath adherence test measures the resistance of the cable sheath components (shield or armor and the overlaying jacket) to separation, one from another, by measuring the force required to pull the cable core and metallic covering out of the jacket.

7.26.1 Test Procedure

Cable sheath adherence measurements and data reporting shall be as required by ASTM D 4565 at 23 °C ± 5 °C.

The requirement is specified in force/unit circumference, and the circumference measurement shall be made over the metallic tape.

7.26.2 Acceptance Criteria

The minimum sheath adherence shall be 14 N/mm (80 lbf/in) for shielded or armored cables.

7.27 Cyclic Flexing Test

The cyclic flexing test for cable measures the ability of a cable to withstand flexure through a 180° arc for a prescribed number of cycles. It is used to evaluate the ability of the cable to survive flexing as may be encountered during installation efforts.

7.27.1 Test Procedure

Test in accordance with the requirements of FOTP-104, using Conditions I and IV (attenuation measurements before any tensile loading and after any load is removed). The mandrel diameter used shall be the larger of 20X cable diameter or 150 mm. The test shall be repeated for a total of 25 cycles. Measure or monitor the transmitted optical power or attenuation of selected fibers. The expanded ambient conditions apply.

7.27.2 Acceptance Criteria

There shall be no visible cracks, splits, tears, or other openings on either the inner or outer surface of the jacket.

There shall be no visible cracking of the armor or shielding greater than 5 mm in length.

Any increase in attenuation shall be:

- ≤ 0.15 dB at 1550 nm for single-mode fibers
- ≤ 0.30 dB at 1300 nm for multimode fibers

7.28 Water Penetration Test

The water penetration test measures the degree to which water may penetrate a specimen of cable that is subjected to a specified water head for a specified period of time.

7.28.1 Test Procedure

Water penetration measurements and data reporting shall be as required by FOTP-82 (e.g. 1 m of water head) except a maximum sample length of 3 m shall be used. Test with tap water or distilled water. Sodium Fluorescein dyes may be added at the option of the testing laboratory. The test period shall be 24 hours. Retest per FOTP-82, as required. An orifice with an opening of 1.50 mm ± 0.25 mm may be positioned at the end of the water feed tube just ahead of the open cable end. The orifice length shall not exceed 30 mm. The expanded ambient conditions apply.

As an alternative to the using an orifice for cables using water swellable materials, the cable may be tested in accordance to the test method taken from IEC 60794-1-2 F5. The end of the cable specimen to be connected to the water source may be presoaked in water to a depth of 100 mm ± 10 mm for 10 minutes.

Note: Cables intended for applications in water with a high ionic content (e.g. saltwater) should be tested for compliance as agreed to by the customer and the manufacturer.

7.28.2 Acceptance Criteria

There shall be no evidence of fluid leaking from the exposed end of the cable sample under test.

7.29 Cable Impact Test

The impact test measures the optical transmission and mechanical changes that may occur when the cable, at room temperature, is subjected to an impact perpendicular to its surface. It is used to evaluate the ability of the cable to survive impact forces as may be encountered during installation or during shipping or handling.

7.29.1 Test Procedure

Test in accordance with the requirements of FOTP-25. The expanded ambient conditions apply.

7.29.2 Acceptance Criteria

There shall be no visible cracks, splits, tears, or other openings on the outer surface of the jacket.

There shall be no broken fibers within the specimen.

Any increase in attenuation shall be:
- $\leq$ 0.15 dB at 1550 nm for single-mode fibers
- $\leq$ 0.30 dB at 1300 nm for multimode fibers

7.30 Cable Tensile Loading and Fiber Strain Test

The optical fiber cable tensile loading and bending test measures the optical transmission and mechanical changes that may occur due to tensile loading combined with bending of the cable, primarily as a result of installation related forces. This test evaluates both the strength members and the susceptibility of the fibers to stress due to such forces. The construction and dimensions of the cable, especially the strength member(s), affect the cable's resistance to performance degradation or mechanical damage due to tensile loading and bending forces related to installation.

For aerial self-supporting cables, the requirements of this test do not generally apply as the most restrictive forces are due to post-installation loading of the cable resulting from local environmental conditions (e.g., ice and wind). For All-Dielectric Self Supporting (ADSS) cable, tensile testing should be conducted in accordance to IEEE 1222. For Figure 8 cables intended for aerial self-supporting applications, users should refer to Annex D for additional considerations (see Annex F).

For the purposes of this Standard the requirements of this Section do not apply to aerial self-supporting cables, unless otherwise agreed upon between the manufacturer and user.

7.30.1 Test Procedure

Tensile Loading and Bending measurements and data reporting shall be as required by FOTP-33. The fiber strain test may be performed as part of the tensile load and bend test. Fiber strain measurements and data reporting shall be made as required by FOTP-38.

- Test Condition I is prior to the application of the load.
- Test Condition II is with the cable under the tensile loading: