3M

2178-S Fiber Optic Splice Case and Accessories

Tech Report

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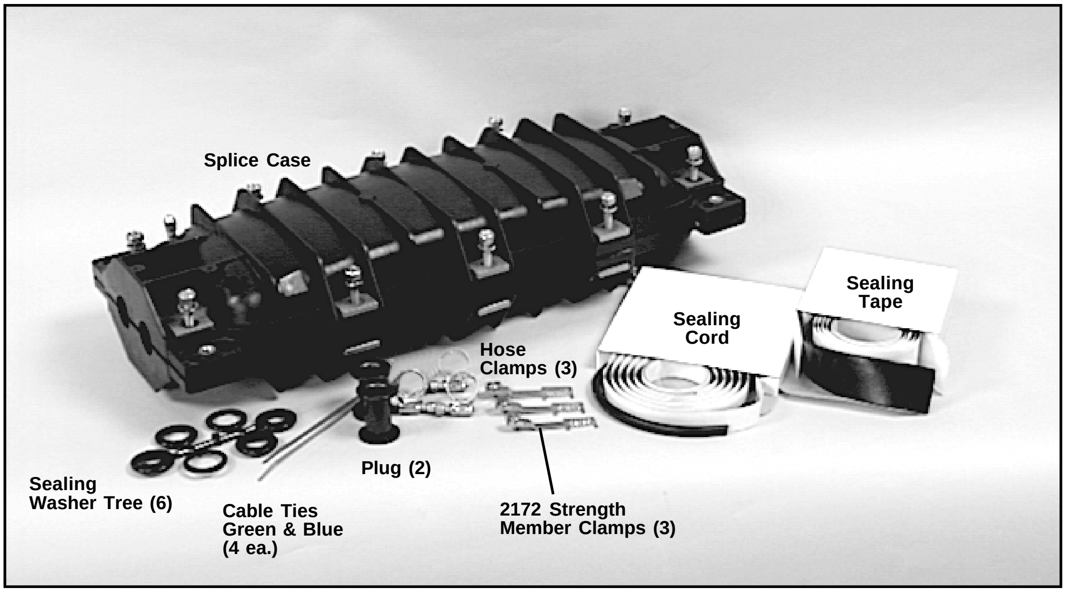
Contents:

1.0 Product Description

The 3M™ 2178-S Fiber Optic Splice Case is a molded plastic enclosure designed for protecting splices in fiber optic cables. It is suitable for direct buried, underground, aerial, and pedestal applications.

The splice case has two cable entrance ports on each end. Port plugs allow the case to be used for butt or in-line splices. The rigid, non-encapsulated case provides moisture protection. The splice case is suitable for short term pressurization during flash testing.

1.1 Kit Contents:



Note: Not shown – Sheath scuff, two cable tie down brackets

1.2 Material Composition:

Injection molded base	Polypropylene
External hardware	Stainless steel
Air Valve	Stainless steel
Sealing cord and tape	Acrylic rubber
Sealing washer tree	PST engineering thermoplastic
Plugs	PST engineering thermoplastic

1.3 Closure Capacity:

Maximum cable diameter:	1.0"	(25 mm)
Minimum cable diameter:	0.4"	(10 mm)
Closure length:	21.9"	(55.7 cm)
Closure width:	8.5"	(21.5 cm)
Closure height:	4.7"	(11.9 cm)

Available splice chamber space:

length:	16.4"	(41.6 cm)
width:	5.5"	(14 cm)
height:	1.2"	(3 cm)

1.4 Splice Tray Capacity:

Note: ***The closure will accommodate up to four 1.0" (25 mm) diameter cables in-line when using two 3M™ 2522 splice tray organizers. When using two 3M™ 2523 or 3M™ 2524 splice trays it is limited to four 0.5" (12.5 mm) diameter cables in-line. For butt applications, the maximum cable diameter is 1.0" (25 mm).***

Number of cables installed	2 - 4
Maximum number of 2524 Splice Trays*	2
Maximum number of 2523 Splice Trays*	2
Maximum number of 2522 Splice Trays	2

**Maximum cable diameter: 0.5" (12.5 mm)*

Capacity of 2524 Splice Tray	24 3M™ Fibrlok™ Splices
	24 Fusion Splices
Capacity of 2523 Splice Tray	24 Fibrlok™ Splices
	12 -12 fiber 3M™ Fibrlok™ Multi-Fiber Splices*
	48 Discrete Fusion Splices
	12 -12 fiber Fusion Splices
Capacity of 2522 Splice Tray	12 Fibrlok™ Splices
	8 -12 fiber Fibrlok Multi-Fiber Splices*
	24 Discrete Fusion Splices
	10 -12 fiber Fusion Splices

****Varies with ribbon size***

2.0 Test Program Overview

To predict the long-term performance reliability of the 3M™ 2178-S Fiber Optic Splice Case, the cases have been subjected to a number of tests which expose them to conditions more severe than anticipated in actual field use. The tests are based upon telephone industry performance specifications and are believed to represent the most severe requirements of that industry. The following list outlines the major areas which were examined in this test program:

- Environmental
- Mechanical Strength
- Material Integrity
- Bonding System Integrity

The following sections describe each of these test series and report the results obtained.

3.0 Environmental Tests

The 3M™ 2178-S Fiber Optic Splice Cases were subjected to a series of environmental tests in order to determine the ability of the splice case to withstand worst-case environmental conditions that may be experienced in outside plant. Two splice cases were subjected to the test series. Each splice case was assembled with two plastic rods on one end and two cable plugs on the other.

3.1 Thermal Aging

The thermal aging test simulates long-term exposure of the 2178-S splice case sealing components to the environment. The sealing components for both splice cases (Sealing tape, sealing cord, and ground stud O-rings) were aged at 194° F (60° C) for 30 days.

Results: No visible deterioration of the aged sealing components was observed.

3.2 Assembly

The assembly test verifies that the 2178-S splice case can be assembled at extreme temperatures. The above thermal-aged components for one of the above splice cases (ground stud O-rings assembled prior to conditioning) were conditioned at 32° F (0° C) prior to assembly. Watesmo paper (moisture indicating paper) was placed inside the splice case to aid with moisture detection in the subsequent tests. The above procedure was repeated with the remaining splice case components at 104° F (40° C).

Results: The splice cases could be assembled as intended at both temperature extremes.

3.3 Temperature and Humidity Cycling

The temperature and humidity cycling test determines if rapid thermal expansion and contraction has any effect on the mechanical integrity of the 2178-S splice case. The two closures from the previous test were exposed to 120 one-hour cycles from -40° F (-40° C) to 150° F (65° C) and 95% relative humidity. Chamber humidity was left to fluctuate uncontrolled below 150° F. The six hour cycle includes two hour transition periods and one hour dwell times at the two temperature extremes.

Results: No splice case degradation was apparent.

3.4 Freeze / Thaw

The freeze / thaw test determines if an alternately freezing and thawing environment has any effect on the ability of the 2178-S splice case to maintain a watertight seal. The two splice cases from the previous test were placed horizontally in a water tank containing a water soluble fluorescent dye (sodium fluorescein or equivalent) to a depth which exceeds the top of the splice cases by a minimum of 1 in. (2.5 cm).

The splice cases were subjected to ten 28 hour freeze / thaw cycles from -40° F (-40° C) to 158° F (70° C). The 28-hour cycle includes 1/2 hour transition periods with 17 hours at -40° F (-40° C) and 10 hours at 158° F (70° C). At the end of cycling, the closures were opened and inspected.

Results: No water intrusion or mechanical damage to the closure was apparent.

3.5 Water Resistance

The water resistance test determines if the 3M™ 2178-S splice case can withstand the rigors of the previous environmental test series without degradation of its seal. The two splice cases from the previous test were subjected to 20 feet (6 m) water immersion for seven days.

Results: There was no water intrusion or mechanical damage to the closure.

4.0 Mechanical Tests

The 2178-S splice case was subjected to a series of mechanical tests in order to determine the ability of the closure to protect splices from external mechanical forces and stresses. This series of tests is intended to simulate the actual stresses that the splice case may be exposed to under normal installation and operating conditions.

Two 2178-S splice cases were subjected to the test series. The cables used were as follows:

Sample	Cable
1 In-line	1) Siecor 36 fiber, loose tube buffer, dielectric (0.45 in. / 11mm OD) 2) Pirelli 432 ribbon fiber, loose tube, dielectric (0.92 in. / 23mm OD)
2 Butt	1) Siecor 36 fiber, loose tube buffer, dielectric (0.45 in. / 11mm OD) 2) Pirelli 432 ribbon fiber, loose tube, dielectric (0.92 in. / 23mm OD)

In each splice case, two cables were spliced together using 12 completed splices (jumper #11 broke) in sample #1 and #12 completed splices (jumper # 10 broke and jumper 2 has a high reading) in sample #2.

For the 36 fiber cable in sample #1, six fibers from the blue buffer tube were used and six fibers from the orange buffer tube were used.

For the 36 fiber cable in sample #2, six fibers from the brown buffer tube were used and six fibers from the white buffer tube were used.

For the ribbon fiber cable, one fiber from the blue ribbon and one fiber from the orange ribbon was used from each of the six buffer tubes. The fibers from the two cables were joined using a fusion splicer. To allow for optical measurements, the opposite ends of the cables were spliced to ST connector jumpers using mechanical splices. Before and after the test series, the attenuation, or light loss, was recorded using an optical source operating at a wavelength of 1550 nm ± 20 nm. The absolute value of this attenuation change (difference in the before and after readings) is shown in the following tables.

4.1 Cable Clamping

The cable clamping test determines the effect the installation of the 2178-S splice case and shield bond connectors has on the optical transmission qualities of the fibers and splices. The cables in the two splice cases described above were spliced and initial attenuation readings were taken. The splice cases were then fully assembled. Final attenuation readings were taken. The results are shown in the table below.

CABLE CLAMPING TEST—SAMPLE # 1 (IN-LINE SAMPLE)

	FIBER #	1	2	3	4	5	6	7	8	9	10	12		
AFTER CABLE CLAMPING													AVERAGE	STD. DEV.
	CHANGE	0.01	0.00	0.01	0.00	0.00	-0.01	0.01	-0.01	-0.01	0.00	-0.01	0.00	0.01
	ABS(CHANGE)	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00

CABLE CLAMPING TEST—SAMPLE # 2 (BUTT SAMPLE)

	FIBER #	1	2	3	4	5	6	7	8	9	11	12		
AFTER CABLE CLAMPING													AVERAGE	STD. DEV
	CHANGE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.0
	ABS(CHANGE)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.0

4.2 Sheath Retention

The sheath retention test determines the ability of the 2178-S splice case to isolate fibers and splices from tensile forces applied to the cable during installation. An axial load of 50 lb. (22 kg) was applied to a cable for 30 minutes. A final reading was taken with the load applied. The results are shown in the table below. Sample #2 was used for this test.

CABLE SHEATH RETENTION TEST—SAMPLE # 2 (BUTT SAMPLE) ONLY

	FIBER #	1	2	3	4	5	6	7	8	9	11	12		
AFTER 50lb PULL ON SMALL CABLE													AVERAGE	STD. DEV.
	CHANGE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	0.00	0.00	0.00	0.01
	ABS(CHANGE)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.01

4.3 Cable Flexing

The cable flexing test determines the ability of the 2178-S splice case to isolate fibers and splices from cable bending which may occur during installation. The splice case (sample #1) was conditioned at 0° F (-18°C) for two hours prior to initial readings. At a distance of 39 in. (1 m) from the closure/cable interface, the assembly was given a 90° bend in four directions with a return to the original position after each bend. The four bends were repeated and final readings were taken. This procedure was then repeated at 104° F (40°C). The cable jacket and shield bond connector showed no signs of mechanical damage.

CABLE FLEXING TEST AT 0° F (-18° C) ON SAMPLE #1 (IN-LINE SAMPLE ONLY)

	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
AFTER FLEXING SMALL CABLE	CHANGE	0.01	0.00	-0.01	0.00	0.00	0.00	0.01	-0.01	-0.01	0.00	-0.01	0.00	0.01
	ABS(CHANGE)	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.00

	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
AFTER FLEXING LARGE CABLE	CHANGE	-0.01	0.01	0.00	0.02	0.01	0.01	0.02	-0.01	-0.02	0.00	-0.02	0.00	0.01
	ABS(CHANGE)	0.01	0.01	0.00	0.02	0.01	0.01	0.02	0.01	0.02	0.00	0.02	0.01	0.01

CABLE FLEXING AT 104° F (40° C) ON SAMPLE #1 (IN-LINE SAMPLE ONLY)

	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
AFTER FLEXING SMALL CABLE	CHANGE	0.09	-0.14	-0.07	0.00	-0.04	0.01	0.04	0.09	0.10	0.06	-0.05	0.01	0.08
	ABS(CHANGE)	0.09	0.14	0.07	0.00	0.04	0.01	0.04	0.09	0.10	0.06	0.05	0.06	0.04

	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
AFTER FLEXING LARGE CABLE	CHANGE	0.10	-0.14	-0.07	-0.02	-0.03	0.03	0.04	0.09	0.09	0.06	-0.05	0.01	0.08
	ABS(CHANGE)	0.10	0.14	0.07	0.02	0.03	0.03	0.04	0.09	0.09	0.06	0.05	0.06	0.04

4.4 Cable Torsion

The cable torsion test determines the ability of the 2178-S splice case to isolate fibers and splices from torsion which may occur during installation. The sample #1 used in the previous test was conditioned at 0° F (-18° C) for two hours prior to initial readings. At a distance of 39 in. (1 m) from the closure/cable interface, the cable was twisted for ten cycles. A cycle involves a 90° clockwise twist followed by a 180° counter-clockwise twist followed by a 90° clockwise twist back to the original position. Final readings were taken. This procedure was repeated at 104° F (40° C). The cable jacket and shield bond connector showed no signs of mechanical damage.

CABLE TORSION TEST AT 0° F (-18° C) ON SAMPLE #1 (IN-LINE SAMPLE ONLY)

AFTER TORSION SMALL CABLE	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
	CHANGE	0.00	-0.10	-0.07	-0.05	-0.02	-0.13	-0.06	-0.07	-0.04	-0.01	-0.04	-0.05	0.04
	ABS	0.00	0.10	0.07	0.05	0.02	0.13	0.06	0.07	0.04	0.01	0.04	0.05	0.04

AFTER TORSION LARGE CABLE	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
	CHANGE	0.03	0.01	-0.04	-0.05	0.04	0.02	0.05	-0.02	-0.05	-0.04	-0.02	-0.01	0.04
	ABS(CHANGE)	0.03	0.01	0.04	0.05	0.04	0.02	0.05	0.02	0.05	0.04	0.02	0.03	0.01

CABLE TORSION TEST AT 104° F (40° C) ON SAMPLE #1 (IN-LINE SAMPLE ONLY)

AFTER TORSION SMALL CABLE	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
	CHANGE	0.10	-0.14	-0.06	-0.02	0.00	0.03	0.05	0.09	0.09	0.07	-0.05	0.01	0.08
	ABS(CHANGE)	0.10	0.14	0.06	0.02	0.00	0.03	0.05	0.09	0.09	0.07	0.05	0.06	0.04

AFTER TORSION LARGE CABLE	FIBER #	1	2	3	4	5	6	7	8	9	10	12	AVERAGE	STD. DEV.
	CHANGE	0.10	-0.12	-0.07	-0.02	0.00	0.04	0.06	0.09	0.11	0.08	-0.05	0.02	0.08
	ABS(CHANGE)	0.10	0.12	0.07	0.02	0.00	0.04	0.06	0.09	0.11	0.08	0.05	0.07	0.04

4.5 Vertical Drop

The vertical drop test simulates an impact that could occur if the 3M™ 2178-S splice case was dropped during installation. Sample #1 used in the previous test was conditioned at 0° F (-18° C) for two hours. The splice case was dropped from a height of 30 in. (75 cm) onto a 1/2" (12.7 mm) thick steel plate. The above procedure was repeated at 104° F (40° C). Since this test does not affect the splice case/cable interface, optical measurements are not necessary.

Results: The splice case experienced no external mechanical damage (no cracks in the splice case housing or a break in the splice case seal).

4.6 Compression

The compression test determines if the 2178-S splice case can withstand heavy loads that may be applied during installation or maintenance. Two splice cases were conditioned at 0° F (-18° C) for two hours. Each closure was placed horizontally in a compression fixture device and a height measurement of the closure was taken. A uniformly distributed 300 lb (136 kg) compressive load was applied for 15 minutes and the measurement was repeated. The load was removed, the closure was allowed to return to room temperature, and the measurement was repeated again. The above procedure was repeated with two new cases at 104° F (40° C).

Results: The cases experienced no visible physical damage at both extreme temperatures under 300 lb (136 kg) compression load. There was a 1% change in dimension height during and after a 300 lb compression load at 0° F (-18° C) and a 2% change in dimension height during and after a 300 lb compression load at 104° F (40° C). This is well within the 20% deformation during load limit and well within the 10% permanent deformation limit.

4.7 Impact

The impact test determines if the 2178-S splice case can withstand a sudden impact from a foreign object. Two splice cases were conditioned at 0° F (-18° C) for two hours. Each splice case was subjected to a 50 ft•lb (68 J) vertical impact, in the center of the splice case, using a 2 in. (5.1 cm) spherical radius impact head. The above procedure was repeated at 104° F (40° C).

Four splice cases were conditioned at 104° F (40° C) for two hours. Each splice case was subjected to a 100 ft•lb (136 J) vertical impact, in the center of the splice case using a 2 in. (5.1 cm) spherical radius impact head.

Results: The splice cases experienced no external mechanical damage at either temperature at the specified loads (no cracks in the splice case housing).

4.8 Water Resistance

The water resistance test determines if the 2178-S splice case can withstand the rigors of the previous mechanical test series without degradation of its environmental seal. Watesmo paper (moisture indicating paper) was placed inside the three splice cases. The splice cases were subjected to a 20 ft (6 m) water resistance test for seven days.

Results: Upon opening the splice cases no water was present.

5.0 Material Integrity Tests

The materials used in the 3M™ 2178-S splice case were tested to determine their ability to withstand the severe conditions that could exist in the outside plant environment.

5.1 Chemical Resistance - Material Degradation

The first of four chemical resistance tests, the Material Degradation Test evaluates the resistance of the 2178-S splice case material to chemicals that may be used during installation and maintenance.

The splice case material was fabricated into samples having the dimension 2.5 in. x 0.5 in. x 0.125 in. (6.4 cm x 1.3 cm x 0.32 cm). Each sample bar was placed into a three-point test fixture and loaded to a deflection of 0.04 in. (1 mm). Five samples each were coated with the following chemicals for a period of 24 hours at room temperature.

- WD-40 Water Displacing Lubricant
- 10% Igepal® CO-630 Solution
- Cable Filling Compound (Flexgel® and PEPJ)
- Splice Encapsulating Compound (3M™ 4442 High Gel and CasChem 126)
- Isopropyl Alcohol
- Wasp and Hornet Spray

Results: No evidence of stress cracking of the material was observed.

5.2 Chemical Resistance - Weight, Hardness, and Tensile Strength

This chemical resistance test determines if the external splice case can withstand immersion in three different chemicals for seven days without a reduction in their physical properties. Tensile samples of the material were fabricated. The average weight, hardness, and tensile strength of the samples was measured and recorded as the baseline values. For tensile strength measurements, a crosshead speed of 2 in/min. (50 mm/min.) was used. Five samples each were immersed in the following chemicals for a period of seven days.

- Sulfuric Acid (3% H2SO4 by weight)
- Sodium Hydroxide (0.2N NaOH)
- 10% Igepal® CO-630 Solution

The weight, hardness, and tensile strength of each sample was measured again. It was desired that each sample exhibit no more than a 10% change in weight or hardness and no more than a 20% reduction in tensile strength when compared to the baseline values.

Results: All samples met the above requirements. The average changes are as follows:

Chemical	Material	% Weight Change	% Hardness Change	% Tensile Reduction
Sulfuric Acid	Splice Case	0.0	-0.4	-0.4
Sodium Hydroxide	Splice Case	0.0	0.0	-0.5
Igepal® CO-630 Solution	Splice Case	0.0	-1.0	-0.2

5.3 Chemical Resistance -Splice Cases

This chemical resistance test determines if the 3M™ 2178-S splice cases can withstand immersion in four different chemicals for seven days without loss of its water resistant characteristics. Four splice cases were prepared, one splice case was immersed in the following four chemicals for a period of seven days.

- Sulfuric Acid (3% H_2SO_4 by weight)
- Sodium Hydroxide (0.2 NaOH)
- 10% Igepal® CO-630 Solution
- Kerosene

The samples were flash tested after each test at 8 psi to detect for leaks. The splice cases were checked for chemical intrusion and then subjected to the 300 lb (136 kg) compression test and the impact test. The samples were then subjected to 20 ft (6 m) water immersion test for seven days. The results of this testing are as follows:

Chemical	Compression @ 0°F	Compression @ 104°F	Impact @ 0°F (-18°C)	Impact @ 104°F (40°C)	20 ft water immersion
Sulfuric Acid	Passed	Passed	Passed 40 ft lbs	Passed 100 ft lbs	Passed
Sodium Hydroxide	Passed	Passed	Passed 25 ft lbs	Passed 100 ft lbs	not performed
10% Igepal®	Passed	Passed	Passed 35 ft lbs	Passed 100 ft lbs	not performed
Kerosene	Passed	Passed	Passed 35 ft lbs	Passed 100 ft lbs	Passed

5.4 UV Resistance

The UV resistance test determines the effect that extreme UV exposure has on the external materials of the 2178-S splice case. Ten tensile samples of each material were fabricated. The tensile strength of half the samples was measured per ASTM D638 using a crosshead speed of 2 in/min. (50 mm/min.). The average of these measurements constituted the baseline values for the two materials. The remaining samples were exposed to ultraviolet radiation per ASTM G53 using UVB-313 type fluorescent lamps. The cycle consisted of eight hours of UV exposure at 150°F (65°C) followed by four hours of condensation at 122°F (50°C) with no UV exposure. After the end of 90 days of cycling, the tensile strength of the samples was measured. The UV radiation should cause no more than a 20% reduction in tensile strength when compared to the unexposed baseline values.

Results: The molded material exhibited an average tensile strength change of -0.9 %.

5.5 Fungus Resistance

The fungus resistance test ensures that the external closure materials of the 2178-S splice case do not support fungus growth. Three samples of the molded material were tested per ASTM G21.

Results: A rating of 0 (no visible growth) was obtained.

6.0 Shield Bond Connector Tests

6.1 AC Fault

The AC Fault test verifies that the shield bond connector provides a sufficient electrically conductive path for grounding of the metallic components of the cable. Two 3M™ Scotchlok™ 4460-D / FO Shield Bond Connectors were installed on the ends of two 3 in. (7.6 cm) pieces of AT&T 216 ribbon fiber, metallic cable. The two shield bond clamps were connected using a #6 AWG copper lead. The circuit was completed by connecting an AC power source to the shields on the opposite ends of the two fiber cables. A 350 amp current was applied to the circuit until the cable failed.

Results: No damage occurred to the shield bond connector.

6.2.1 Strength Member Protrusion for Scotchlok 4460-D/FO Shield Bond Connectors

The strength member protrusion test verifies that the strength member clamp will prevent bowing, pistoning, or breaking of the cable strength member when the member exerts a 100 lb. (445 N) force on the clamp. This verification is accomplished with two separate tests. The first test determines the amount of force that can be applied to the strength member before it moves more than 0.05 in. (1.3 mm) inside the clamp. The second test determines the amount of force that can be applied to the clamp before it is pulled from the cable shield. It is desired that both force levels exceed 100 lb. (445 N). Six samples were prepared using the shield bond connector on three different types of fiber cable (see table below).

For the first test, the amount of force required to move the strength member within each cable was measured. The strength member was then terminated in the clamp and the amount of force required to move each strength member more than 0.05 in. (1.3 mm) within the clamp was measured. The difference in these two measurements is the amount of force required to move the strength member in the strength member clamp (see table below).

For the second test, the same samples were used but the strength member was first disconnected from the clamp. The amount of force required to pull the strength member clamp from the cable shield was then measured (see table below).

Results: All samples met the 100 lb (445 N) requirement for both tests. The results were as follows:

Sample	Cable	Force to Move SM	Force to Move Clamp
1	AT&T 12 fiber, dielectric (0.49"/ 12.5mm OD)	197 lb (877 N)	106 lb (472 N)
2	AT&T 12 fiber, dielectric (0.49"/ 12.5mm OD)	188 lb (837 N)	102 lb (454 N)
3	AT&T 216 fiber, metallic (0.69"/ 17.5mm OD)	167 lb (743 N)	180 lb (801 N)
4	AT&T 216 fiber, metallic (0.69"/ 17.5mm OD)	169 lb (752 N)	166 lb (739 N)
5	Siecor 24 fiber, dielectric (0.45"/ 11.4mm OD)	187 lb (832 N)	142 lb (632 N)
6	Siecor 24 fiber, dielectric (0.45"/ 11.4mm OD)	192 lb (854 N)	152 lb (677 N)

6.2.2 Strength Member Protrusion for 3M™ 2172 Strength Member Clamp

The 2172 strength member clamp was tested under tension to check for clamp deflection. Nine samples were pulled to determine how far the central strength member lock position would move when 100 lbs(445 N) was applied to this area.

Results: The average deflection of the nine samples was .01 inch (0.25 mm). This position is allowed to move .050 inch (1.3 mm) per the Bellcore specification. The 2172 clamp meets this requirement.

6.3 Thermal Cycle / Light Loss for 3M™ 4460-D/FO Shield Bond Connector and 2172 Strength Member Clamp

The thermal cycle / light loss test examines the ability of the shield bond connector to constrain strength member / sheath movement and prevent light loss over a wide range of operating temperatures. The following two cable types were used for testing the shield bond connector strength member clamps.

Sample	Cable Type
#1—4460-D/FO	Siecor 24 fiber, loose tube buffer, dielectric
#2—4460-D/FO	AT&T 216 ribbon fiber, single tube, dielectric
#3—2172	Siecor 24 fiber, loose tube buffer, dielectric
#4—2172	AT&T 216 ribbon fiber, single tube, dielectric

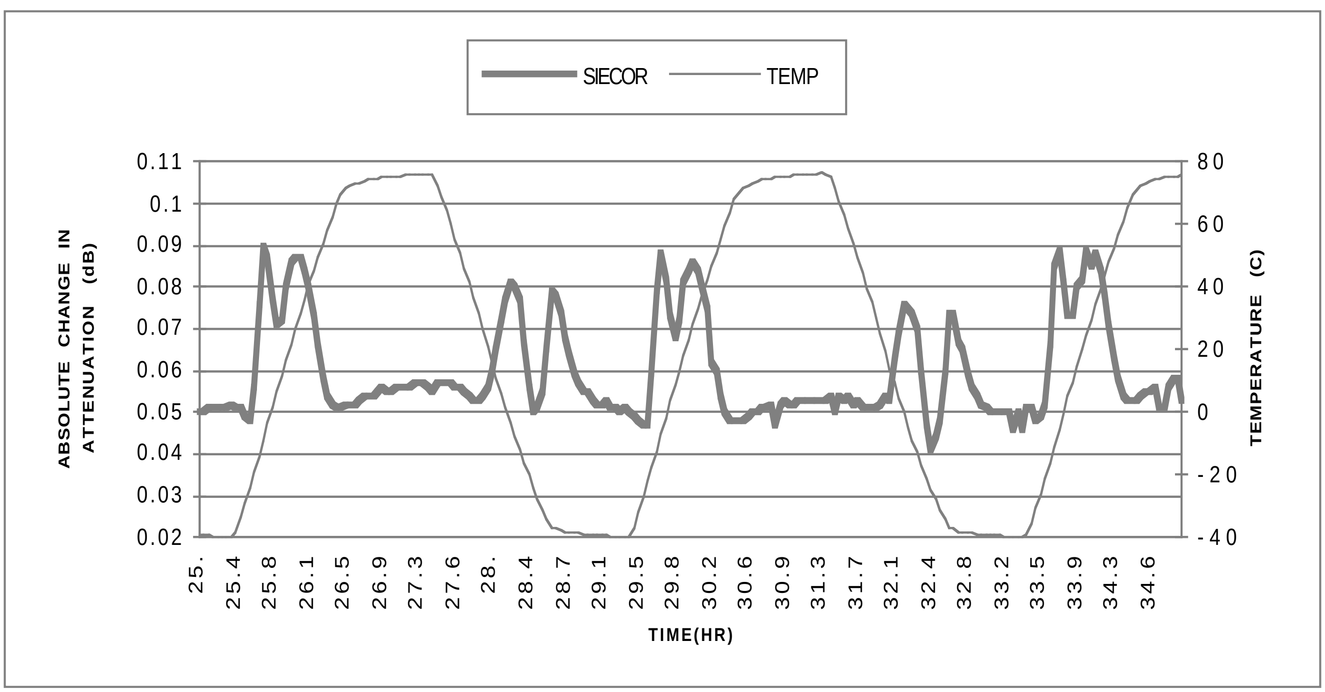
For each sample, approximately 70 ft (21 m) of cable was coiled in a 5 ft (1.5 m) diameter loop on the floor of an environmental chamber. One end of the cable was terminated inside the chamber and the other end was spliced to jumpers outside of the chamber to allow for optical measurements. Inside the chamber, a minimum of ten fibers from each cable were fusion spliced to each other (accounting for a minimum of five splices / data points) to simulate splicing in a splice case. At least one fiber from every buffer tube was used. The strength member of each cable was clamped using either a 4460-D / FO Shield Bond Connector or a 2172 strength member clamp. The samples were subjected to ten 4-hour cycles from -40° F (-40° C) to 176° F (80° C). The four-hour cycle includes one hour transition periods and one hour dwells at temperature extremes. Attenuation (light loss) was monitored continuously during this cycling using an optical source operating at a wavelength of 1550 nm ± 20 nm.

Results: The attenuation data (in dB's) was compiled and is recorded in the table and chart below. The table shows the maximum light power increase and decrease of the readings that occurred over all monitored fibers during the 40 hour cycling period. The table also shows the maximum power change in light loss after cycling.

Power Variation in dB's

Sample	Max. Light Power Decrease	Max Light Power Decrease	Max Power Change Before / After Cycling
#1—4460-D/FO	0.050	-0.120	0.040
#2—4460-D/FO	0.090	-0.110	0.030
#3—2172	0.110	-0.070	0.050
#4—2172	0.110	-0.130	0.090

The chart shows a typical fiber response in one of the cables (Siecor 24 fiber) from sample #1 during the seventh and eight cycles of the test. This chart exhibits the relationship between temperature and attenuation, and also demonstrates the repeatability of the data.



7.0 Conclusions

The 3M™ 2178-S fiber optic splice cases were examined through a variety of tests which cover the product's ability to protect the fiber cable splice. Throughout these tests, the 2178-S fiber optic splice case met the severe requirements and performed with excellent results.

The 3M™ Scotchlok™ 4460-D/FO Shield Bond Connectors and 3M™ 2172 Strength Member Clamp were tested with excellent results also.

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