

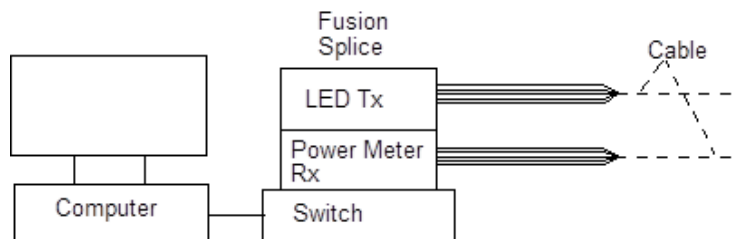
Mechanical and Environmental Cable Testing

Application Note AN-806

Mechanical and Environmental Cable Testing

All mechanical and environmental testing is performed with the cable connected to an apparatus for calculating the attenuation loss as follows:

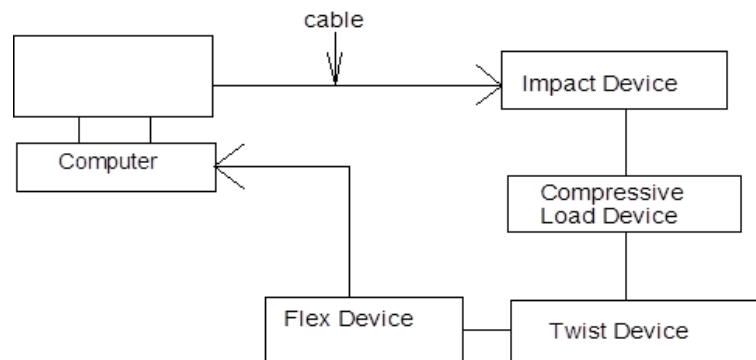
Optical Measurement Bench



- The cables are tested for attenuation at 1550 nm.
- For all mechanical tests, the magnitude of the attenuation change shall be less than or equal to 0.05 dB for 90% of the test fibers and less than or equal to 0.15 dB for the remaining 10% of the test fibers. These attenuation values include a 0.05 dB allowance for measurement repeatability.
- The mechanical tests which conform to these specifications are Low and High Temperature Cable Bend, Impact Resistance, Compressive Strength, Tensile Strength of Cable, Cable Twist, and Cable Cyclic Flexing.

Certain mechanical test are set up in the following format for qualification and re-qualification:

Optical Measurement Bench



Note: All information is subject to revision at the discretion of OFS. All testing performed at OFS is done based on EIA/TIA standards.

IMPACT TEST (EIA/TIA-455-25C)

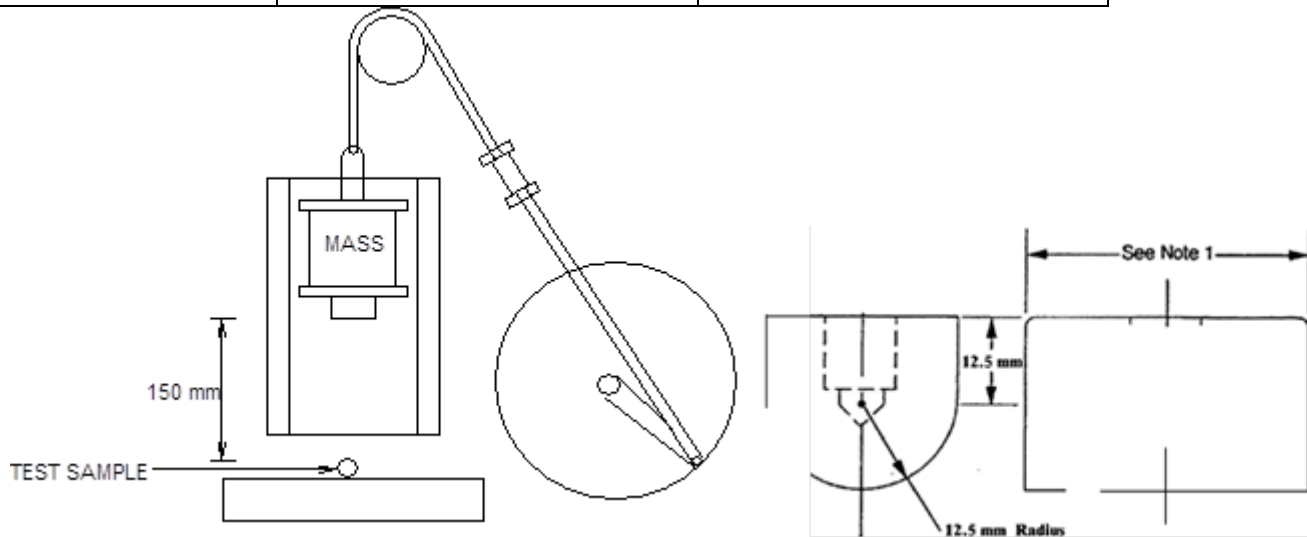
Purpose: This test determines the ability of the cable to withstand abrupt impacts to the cable without causing increased fiber attenuation or fatigue of the outer jacket.

Test Description:

- The test is performed with the cable clamped between two plates.
- The cable is impacted with a drop hammer (see diagram).
- The amount of the load is based on the cables application. Please refer to chart for specific loads.
- A total of 2 impacts at each of 3 locations shall be performed.
- Length of sample varies depending on the test from 10-15 meters

Table 1 – Drop hammer mass and resulting test impact energy

Application	Mass(kg)	Impact Energy N*m
Outside Plant	3.0	4.4
Riser	2.0	2.9
Plenum	2.0	2.9
Drop Cable	2.0	2.9
Interconnect	0.5	0.74



Notes:

- 1.) The length of the striking surface shall be at least twice the maximum diameter of the test sample, but not less than 30 mm (1.2 in.).
- 2.) The radius of curvature shall be 12.5 ± 0.1 mm.
- 3.) These Notes comprise requirements for all applications.

Test Differences:

EIA/TIA 455-25C vs IEC 794-1-E4

OFS tests using 2 impacts at 3 locations according to EIA/TIA 455-25C and GR-20 issue 3. IEC 794-1-2-E4 does not state the number of impacts or any default drop weights.

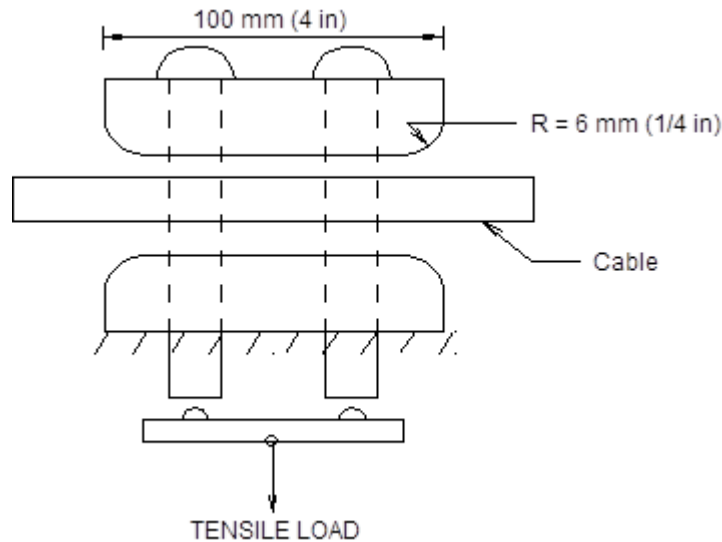
OFS tests using direct force on the cable, which is more stringent than IEC 794-1-E4. IEC the impact energy is transferred from the drop mass to a piece of steel resting on the cable.

COMPRESSIVE STRENGTH (EIA/TIA-455-41A)

Purpose: This test determines the ability of the cable to withstand an applied compressive load.

Test Description:

- OFS is compliant with Telcordia GR-20 Issue 3 which specifies a compressive incidental load of 220 N/cm (125 lbf/in) for non-armored and armored cables applied uniformly over the length of the compression plate for 1 minute or more and a long term load of 110 N/cm (63 lbf/in) for 10 minutes.
- Attenuation is not measured during the incidental load.
- Attenuation is measured with respect to the baseline measurement before releasing the long term load.
- The test utilizes two 100 mm flat plate style compression fixtures.
- Length of sample varies depending on the test from 10-15 meters.



Compressive Load (N/cm)	Cable Type
220	Single Jacket, Double Jacket, PowerGuide, Figure 8, OPTION1, Ribbon, LAP, Light Armor, Armor, Double Armor (DJ/DA), Heavy Armor

Test Differences:

EIA/TIA 455-41A vs IEC 794-1-E3

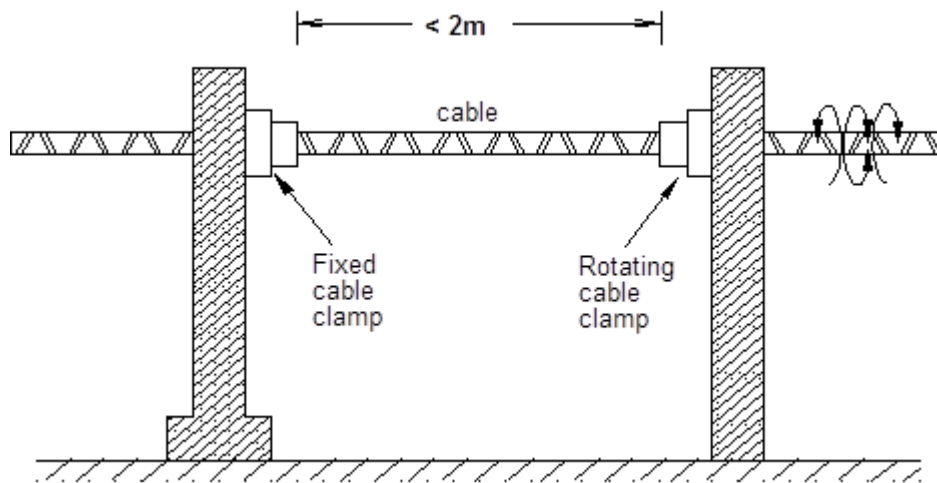
OFS increases the compressive load at a rate of 3mm/ min, versus the IEC 1.5:1 ratio increase. The rate increase does not affect the test results.

CABLE TWIST (EIA/TIA-455-85A)

Purpose: This test determines the ability of the cable to withstand twisting during installation.

Test Description:

- The test utilizes two supports, torque lever, and cable gripping devices.
- The size of the clamps are determined by the cable diameter.
- A cycle consists of rotating the cable sample 180° clockwise, return to starting position, and then rotate 180° counterclockwise.
- A test consists of 10 cycles. A complete cycle takes one minute.
- Length of sample varies depending on the test from 10-15 meters.
- OFS does not use a tensioning load during testing.
- After the cable is subjected to the twist test, the cable jacket shall not exhibit evidence of cracking or splitting when observed under 5x magnification.



Test Differences:

EIA/TIA 455-85A vs IEC 794-1-E7

OFS utilizes a test sample from 10-15 meter in length, EIA/TIA 455-85 states a maximum of 15.24 feet (5 meters) and IEC does not state a sample length. The sample length will not effect the result of the test.

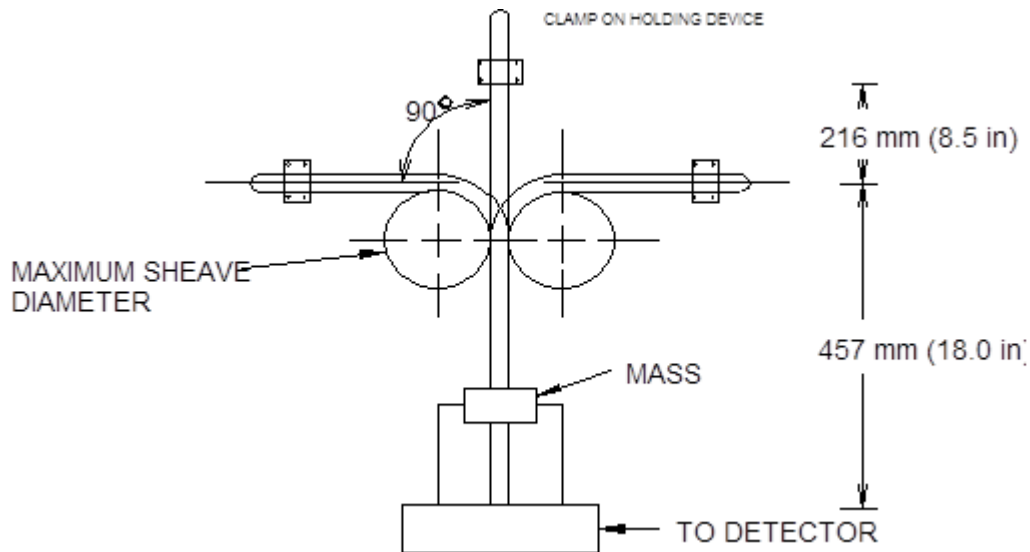
FLEX TEST (EIA/TIA-455-104A)

Purpose: This test determines ability of the cable to withstand repeated flexing which may occur during installation.

Test Description:

- The cable shall be flexed at 30 ± 1 cycles/minute for 25 cycles
- The amount of flexing and the minimum load depend on the sheath diameter.
- One meter cable sample under flex is sufficient.
- The appropriate mandrel diameter is selected based on cable OD and test parameters.
- The cable sample shall be capable of withstanding mechanical flexing without exceeding the allowable attenuation increase at the completion of the test. For armored cables, the inside or outside of the armor surface shall be inspected for fractures. Any visible cracks causing separation of the armor shall not have propagated more than 5 mm (0.20 in). The outer cable jacket shall not exhibit evidence of cracking or splitting when observed under 5X magnification.

FLEX LOADING	
CABLE DIAMETER (MM) INCHES	MINIMUM LOAD KG (POUNDS)
≤ 13 (0.512)	5.0 (11.023)
≤ 18 (0.709)	5.5 (12.125)
≤ 24 (0.945)	6.5 (14.330)
≤ 30 (1.181)	7.0 (15.432)
≥30.1 (1.181)	7.5 (16.535)



Test Differences:

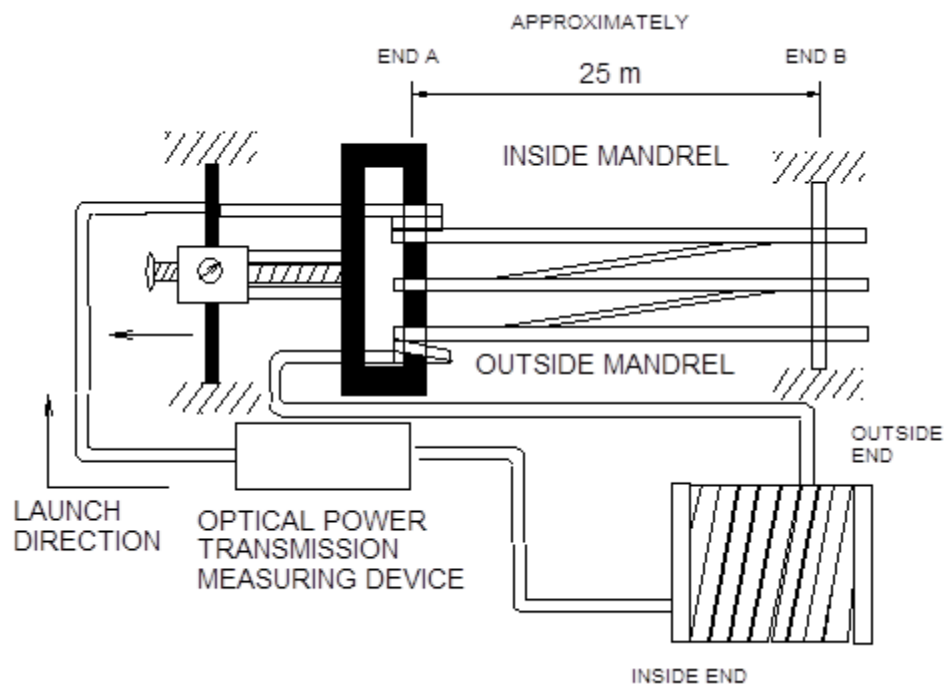
EIA/TIA 455-104A vs IEC 794-1-E6
 OFS tests per EIA/TIA and will meet or exceed IEC requirements.

TENSILE AND BEND TEST (EIA/TIA-455-33B)

Purpose: This test determines the ability of the cable to withstand tensile forces on all components of the cable being tested.

Test Description:

- The test is performed with linear voltage displacement transducer and power monitoring bench.
- The cable is stranded around metal cylinders and then stretched until the desired tensile force is applied.
- The maximum diameter of the mandrels and sheaves shall be 30 times the outside diameter of the cable. A universal mandrel and maximum sheath diameter of 560 mm (22 in) may be used for all cable diameters.
- For standard loose tube cable, the residual cable tensile load rating for long-term operation shall be 890 N (200 lbf). Additionally, the minimum short term load is 2660 N (600 lbf) under a twist of 360 degrees in a length less than 3 meters. High strength cable designs (PowerGuide & Figure 8) are pulled to the rated cable load.



Test Differences:

EIA/TIA 455-33A vs IEC 794-1-2-E1

Although there is not an exact correlation between this FOTP and any of the IEC Test Methods, IEC Test Method E1, Tensile performance, is very similar. The IEC test method, however, does not require the use of mandrels, and a minimum sample test length is not specified.

LOW / HIGH TEMPERATURE BEND (EIA/TIA-455-37A)

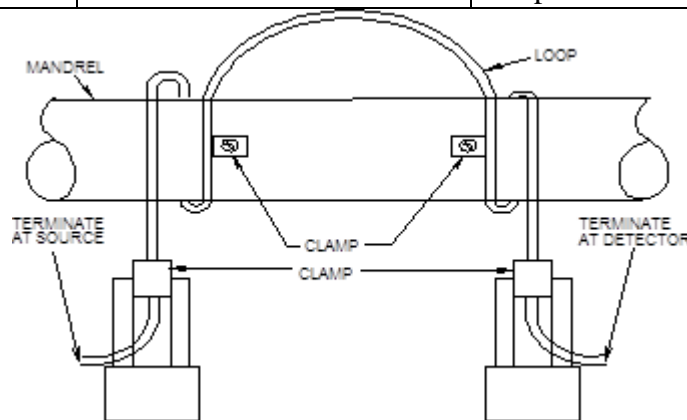
Purpose: This test determines the ability of fiber optic cable to withstand bending at low and high temperatures.

Test Description:

- The test utilizes a cable wrapped around a mandrel of specified diameter under various temperatures.
- The mandrel diameter is less than or equal to 20 times the cable outer diameter.
- The cable is placed inside an environmental chamber and the mass weights are attached to the sample.
- The cable is conditioned for a minimum of 4 hours at the extreme cold temperature, -40°C (-40°F).
- At least 4 wraps are applied to the mandrel, unless otherwise specified.
- The cable is straightened and attenuation measurements are taken.
- The procedure is repeated for the extreme high temperature, 70°C ($+158^{\circ}\text{F}$).
- The test specimen has a minimum length of 10 meters.
- The cable sample shall be capable of withstanding mechanical flexing without exceeding the allowable attenuation increase at the completion of the test. For armored cables, the inside or outside of the armor surface shall be inspected for fractures. Any visible cracks causing separation of the armor shall not have propagated more than 5 mm (0.20 in). The outer cable jacket shall not exhibit evidence of cracking or splitting when observed under 5X magnification.

MASSES

NOMINAL CABLE DIAMETER		TEST MASS
Millimeters	Inches	
6.5 - 12.7	0.252 - 0.500	12.5 kg (27.5 lbs)
12.8 - 15.0	0.501 - 0.590	15 kg (33 lbs)
15.1 - 17.9	0.591 - 0.700	20 kg (44 lbs)
18.0 - 20.0	0.701 - 0.790	22.5 kg (49 lbs)
20.1 - 22.9	0.791 - 0.900	25 kg (55 lbs)
30.0 and over	0.901 and over	Unspecified



Test Differences:

EIA/TIA 455-37A vs IEC 794-1-E11

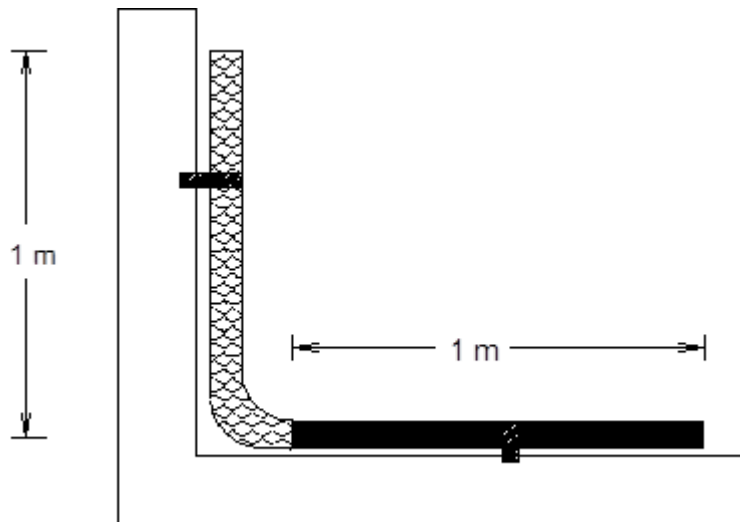
OFS tests per EIA/TIA and will meet or exceed IEC requirements.

FLUID PENETRATION (EIA/TIA-455-82B)

Purpose: This test evaluates the fluid penetration performance of filled fiber optic cable when exposed to water.

Test Description:

- The cable core is exposed and then a 1 meter static head of uranine doped fluid is applied for 24 hours.
- Each cable component is inspected using an ultraviolet lamp. The uranine dye will become incandescent when the ultraviolet rays are applied.
- The criterion for passing is that the unaged cable sample shall not leak with the one meter static head applied for 24 hours. The criterion for the aged cable sample is that it shall not leak with a one meter static head applied for a period of one hour.
- The specimen is 1 ± 0.1 meter in length.



Test Differences:

EIA/TIA 455-82B vs IEC 794-1-F5

OFS does not remove any section of the jacket. IEC has two test methods, F5A which request 25 mm of the outer jacket be removed prior to the static head being applied and method F5B which does not require any jacket section to be removed. Removal of the jacket will not effect the test results.

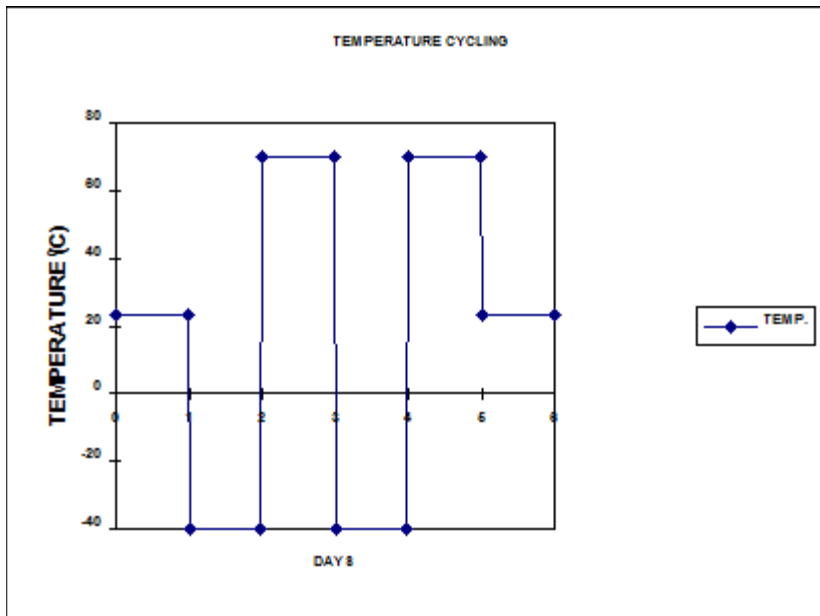
TEMPERATURE CYCLING (EIA/TIA-455-3A)

Purpose: This test determines the ability of each cable to maintain high optical transmission at extreme high and low temperatures.

Test Description:

- An insulated chamber shall be used that is equipped with a thermometer, a circular chart recorder, a digital programmer, and a safety handle inside the door with light switch.
- The average change in attenuation at the temperature extremes of -40°C and 70°C for the measured fibers shall not be greater than 0.05 dB/km. The magnitude of the maximum attenuation change of each individual fiber shall not be greater than 0.15 dB/km.
- No measurements are taken during a temperature transition.

TIME (hrs)	TEMPERATURE ($^{\circ}\text{C}$)
24	23
24	-40
24	70
24	-40
24	70
24	23



Test Differences:

EIA/TIA 455-3A vs IEC 794-1-F1

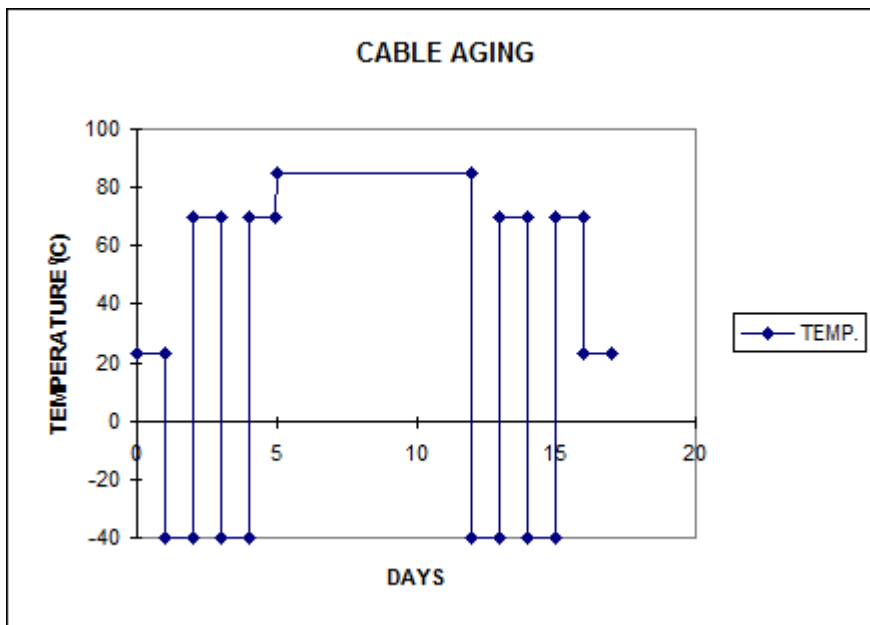
OFS tests per EIA/TIA and will meet or exceed IEC requirements.

CABLE AGING (EIA/TIA-455-3A)

Purpose: Cable aging simulates long term aging effects on the cable by soaking it at high temperatures for an extended period of time. Cable material compatibility and attenuation are the main parameters of concern.

Test Description:

- The cable aging test shall be conducted as a continuation of the temperature cycling test.
- The test chamber is programmed or manually operated to hold a specified elevated temperature of 85⁰C for 168 hours (7 days) to heat soak cable.
- Two meters of the before and after aging cable sample shall be given to the Quality labs to be tested for yield strength and ultimate elongation test on cable components (buffer tubes, binder tapes, yarns, jackets, etc.).
- The temperature is then set for -40⁰C for 24 hours, +70⁰C for 24 hours, -40⁰C for 24 hours, +70⁰C for 24 hours and then returned to 23⁰C. This is similar to the procedure performed during temperature cycling.
- The average change in attenuation from the original values observed before the start of the temperature cycling test shall not be greater than 0.10 dB/km. The magnitude of the maximum attenuation change for each individual fiber shall not be greater than 0.25 dB/km.



Test Differences:

EIA/TIA 455-3A vs IEC 794-1-F9

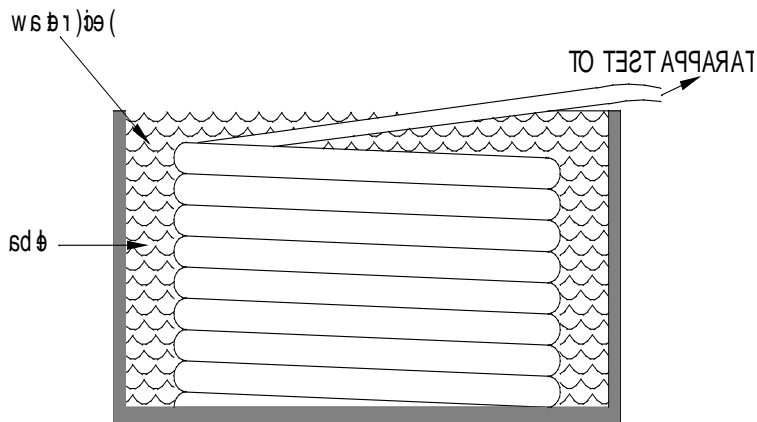
Note: IEC 794 1-F9 is a cable freeze test that is currently under consideration.

TEMPERATURE FREEZE (EIA/TIA-455-98A)

Purpose: This test determines the cable performance when submerged in frozen water.

Test Description:

- Inside a control tank, the cable is submerged in a pail of water which is then frozen.
- The temperature is set for -10°C until frozen. The temperature is then set for -2°C for 24 hours. The temperature is then allowed to rise to 23°C for 24 hours.
- Attenuation is measure for the entire duration of the test. The average attenuation change shall be less than 0.05 dB. The magnitude of the maximum attenuation change of each individual fiber shall not be greater than 0.15 dB.



Test Differences:

EIA/TIA 455-98A vs IEC 794-1-F6

Note: IEC 794 1-F6 is a cable freeze test that is currently under consideration.