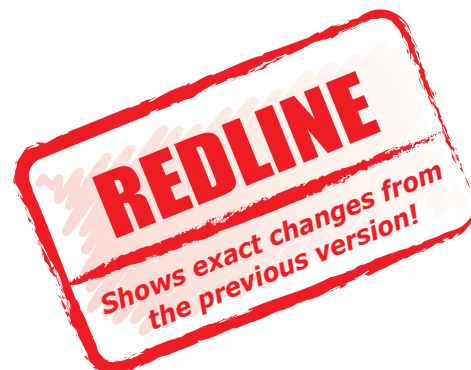


IEEE Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines

IEEE Power & Energy Society

Sponsored by the
Power System Communications Committee



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3 Park Avenue
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USA

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IEEE Standard for Testing and Performance for All-Dielectric Self- Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines

Sponsor

**Power System Communications Committee
of the
IEEE Power & Energy Society**

Approved 31 March 2011

IEEE-SA Standards Board

Abstract: The construction, mechanical, electrical, and optical performance, installation guidelines, acceptance criteria, test requirements, environmental considerations, and accessories for an all-dielectric, nonmetallic, self-supporting fiber optic (ADSS) cable are covered by this standard. The ADSS cable is designed to be located primarily on overhead utility facilities.

Keywords: ADSS, all-dielectric self-supporting fiber optic cable, IEEE 1222, overhead utility

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Introduction

This introduction is not part of IEEE Std 1222-2011, IEEE Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines.

This standard was first published in 2004 and is used worldwide to purchase and specify the performance of ADSS cables. The original purpose of the standard was written to fill a need for standardization of terminology, performance and test requirements for ADSS cables.

The original title was “IEEE Standard for All-Dielectric Self-Supporting Fiber Optic Cable.” Over the years, the document has been used primarily as a test standard. To better reflect how the standard is presently used, the title has been changed to “IEEE Standard for Testing and Performance for All Dielectric Self-Supporting Fiber Optic (ADSS) Cable for Use on Electric Utility Power Lines.”

This revised standard documents the collective experience gained by the industry since the original publication of the standard in 2004. Changes have been made in the following areas:

- Organization of contents
- Functional requirements
- Test requirements
- Installation recommendations
- Hardware
- Packaging requirements
- Updating of all references and annexes

Additional requirements related to ADSS Cable Hardware and Cable/Hardware Compatibility are being addressed in IEEE P1591.2 [B4].^a

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^a The numbers in brackets correspond to those of the bibliography in Annex F.

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1. Overview

1.1 Scope

This standard covers the construction, mechanical, electrical, and optical performance, installation guidelines, acceptance criteria, test requirements, environmental considerations, and accessories for an all-dielectric, nonmetallic, self-supporting fiber optic (ADSS) cable. The ADSS cable is designed to be located primarily on overhead utility facilities.

~~The standard provides both construction and performance requirements that ensure within the guidelines of the standard that the dielectric capabilities of the cable components and maintenance of optical fiber integrity and optical transmissions are proper.~~

~~This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.~~

1.2 Purpose

This standard provides both construction and performance requirements for maintenance of the proper optical fiber integrity and optical transmission capabilities of ADSS cable.

This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

2.1 Optical fiber standards

[ASTM D1603, Standard Test Method for Carbon Black Content in Olefin Plastics.](#)¹

[EIA/TIA-598, Color Coding of Fiber Optic Cables.](#)²

[IEC 60793-2-10, Optical fibers—Part 2-10: Product specifications—Sectional specification for category A1 multimode fibers.](#)³

[IEC 60793-2-50, Optical fibers—Part 2-50: Product specifications—Sectional specification for class B single-mode fibers.](#)

2.2 Test standards

[IEC 61395, Overhead Electrical Conductors—Creep Test Procedures for Stranded Conductors.](#)

[TIA-455-3, FOTP 3, Procedures to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components.](#)

[TIA-455-25, FOTP 25, Impact Testing of Optical Fiber Cables.](#)

[TIA-455-33, FOTP 33, Optical Fiber Cable Tensile Loading and Bending.](#)

[TIA-455-37, FOTP 37, Low or High Temperature Bend Test for Fiber Optic Cable. TIA-455-41,](#)

[FOTP 41, Compressive Loading Resistance of Fiber Optic Cables. TIA-455-78, FOTP 78,](#)

[Measurement Methods and Test Procedures—Attenuation. TIA-455-81, FOTP 81, Compound](#)

[Flow \(Drip\) Test for Filled Fiber Optic Cable.](#)

[TIA-455-82, FOTP 82, Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable.](#)

¹ ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (<http://www.astm.org/>).

² EIA/TIA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>).

³ IEC publications are available from the Sales Department of the International Electrotechnical Commission, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iec.ch/>). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

[TIA-455-85, FOTP 85, Fiber Optic Cable Twist Test](#)”[TIA-455-104, FOTP-104, “Fiber Optic Cable CyclicFlexing Test.](#)

[TIA-455-244, FOTP 244, Expressed Buffer Tube Optical Loss Measurement Methods.](#)



3. Definitions

For the purposes of this document, the following terms and definitions apply. *The IEEE Standards Dictionary: Glossary of Terms & Definitions* should be referenced for terms not defined in this clause.⁴

3.1 General definitions

ADSS: All-Dielectric Self-Supporting Fiber Optic Cable.

breaking strength or breaking tension: Breaking strength is the maximum tensile load that the cable shall withstand without mechanical failure. The Maximum Rated Cable Load (MRCL) is typically less than 60% of the breaking strength. The breaking strength should be calculated. The design model must be validated; the cables do not need to be tested to their breaking strength.

everyday tension (EDT): The everyday tension is the final tension with no ice and no wind at the average annual mean temperature throughout the year. This temperature is assumed as 16°C (60 °F). This number is often used in specifying motion control devices such as vibration dampers.

hardware: Attachments or fittings that are in direct contact with the cable.

maximum installation tension (MIT) or sagging tension (SAT): This is the initial tension at which the cable is pulled during the sagging portion of the installation process. This tension is used to achieve the appropriate installation sag defined by the manufacturer.

NOTE—This is the same as the initial everyday tension (EDT) when specified at 16 °C (60 °F).⁵

maximum rated cable load (MRCL): This is the maximum tensile load the cable is designed to withstand during its lifetime. This is sometimes called the maximum rated design tension (MRDT) by the IEEE or the maximum allowed tension (MAT) by IEC. This is typically the load the cable is designed to take when the cable is installed in its maximum specified span length while experiencing the maximum specified weather load.

stringing tension (STT): The stringing tension, also known as the pulling tension is defined as the tension used to pull the cable through sheaves during the stringing portion of the installation process. This should never be greater than the sagging tension.

System (ADSS system): The cable and hardware described in IEEE Std 1222 function as an integrated unit.

⁴ *The IEEE Standards Dictionary: Glossary of Terms & Definitions* is available at <http://shop.ieee.org/>.

⁵ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

3.2 Electrical definitions

dry band arcing: When wet pollution on ADSS cable jacket dries, high resistance dry bands form. Induced voltage of sufficient magnitude across dry bands will produce an arc that can potentially damage the jacket.

electric field: The change in space potential over a change in distance. Basic concept is $E \cong dV/ds$ and E is a vector that has magnitude and direction. Magnitude described in units of volts/meter (common abbreviations are V/m, kV/m, and kV/cm). Direction may be in the form of components such as E_x , E_y , and E_z or given by unit direction vectors (U_x , U_y , U_z).

induce voltage (Voc): In IEEE Std 1222, Voc refers to the induced voltage across a formed dry band in the absence of an arc, often called “Voltage open circuit.”

NOTE—Refer to Annex D for more information.

pollution resistance: Is the wet pollution resistance on ADSS jacket surface in ohms/meter. This parameter is used to determine currents in the wet pollution layer as well as for computing dry band arc voltage.

NOTE 1—These currents and voltages form the basis of the test described in Annex E.

NOTE 2—ADSS cable wet pollution is normally very conductive compared to dry pollution. In general, 10^8 ohm/meter or less is considered conductive.

pollution index: This is the exponent of the wet pollution linear resistance in ohm/meter. For example, an index of 5.7 indicates a resistance of $10^{5.7}$ or 501 kilo-ohm/meter.

space potential: A level of voltage in space between energized as well as grounded objects (e.g., conductors of a high-voltage transmission line and tower members). The magnitude is described in units of volts. Mathematically this is a scalar value. (See: **electric field**.)

surface gradient: Defined as the electric field on a surface. Levels near 20 kV/cm are high enough to break down air resulting in corona.

3. Test requirements

~~Each requirement in this clause is complementary to the corresponding paragraph in Clause 4 that describes a performance verification or test procedure.~~

3.1 Cable tests

3.1.1 Design tests

~~An ADSS cable shall successfully pass the following design tests. However, design tests may be waived at the option of the user if an ADSS cable of identical design has been previously tested to demonstrate the capability of the manufacturer to furnish cable with the desired performance characteristics.~~

3.1.1.1 Water blocking test

~~A water block test for cable shall be performed in accordance with 4.1.1.1. No water shall leak through the open end of the 1 m sample. If the first sample fails, one additional 1 m sample, taken from a section of cable adjacent to the first sample, may be tested for acceptance.~~

3.1.1.2 Seepage of filling/flooding compound

~~For filled/flooded fiber optic cable, a seepage of filling/flooding compound test shall be performed in accordance with 4.1.1.2. The filling and flooding compound shall not flow (drip or leak) at 65 °C.~~

3.1.1.3 Electrical tests

~~Electrical tests shall be performed for Class B cables in accordance with 4.1.1.3. Tracking on the outside of the sheath resulting in erosion at any point that exceeds more than 50% of the wall thickness shall constitute a failure.~~

3.1.1.4 Aeolian vibration test

~~An aeolian vibration test shall be carried out in accordance with 4.1.1.4. Any damage that will affect the~~
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mechanical performance of the cable or causes permanent or temporary increase in optical attenuation greater than 1.0 dB/km of the tested fibers at 1550 nm for single mode fibers and at 1300 nm for multimode fibers shall constitute failure.

²Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

3.1.1.5 Galloping test

A galloping test shall be carried out in accordance with 4.1.1.5. Any damage that will affect the mechanical performance of the cable or causes permanent or temporary increase in optical attenuation greater than 1.0 dB/km of the tested fibers at 1550 nm for single mode fibers and at 1300 nm for multimode fibers shall constitute failure.

3.1.1.6 Sheave test

A sheave test shall be carried out in accordance with 4.1.1.6. Any significant damage to the ADSS cable shall constitute failure. A permanent increase in optical attenuation greater than 1.0 dB/km of the tested fibers at 1550 nm for single mode fibers and at 1300 nm for multimode fibers shall constitute failure.

Or successful completion of the following three tests may be a substitute for the sheave test:

- a) *Tensile strength of a cable*: The maximum increase in attenuation shall not be greater than 0.10 dB for single mode and 0.20 dB for multimode fibers when the cable is subjected to the maximum cable rated tensile load.
- b) *Cable twist*: The cable shall be capable of withstanding mechanical twisting without experiencing an average increase in attenuation greater than 0.10 dB for single mode and 0.20 dB for multimode fibers.
- c) *Cable cyclic flexing*: The cable sample shall be capable of withstanding mechanical flexing without experiencing an average increase in attenuation greater than 0.10 dB for single mode and 0.20 dB for multimode fibers.

3.1.1.7 Crush test and impact test

3.1.1.7.1 Crush test

A crush test shall be performed in accordance with 4.1.1.7.1. A permanent or temporary increase in optical attenuation value greater than 0.2 dB change in sample at 1550 nm for single mode fibers and 0.4 dB at 1300 nm for multimode fibers shall constitute failure.

3.1.1.7.2 Impact test

An impact test shall be performed in accordance with 4.1.1.7.2. A permanent increase in optical attenuation value greater than 0.2 dB change in sample at 1550 nm for single mode and 0.4 dB at 1300 nm for multimode fibers shall constitute failure.

3.1.1.8 Creep test

A creep test shall be carried out in accordance with 4.1.1.8. Values shall correspond with the manufacturer's recommendations.

3.1.1.9 Stress/strain test

A stress/strain test shall be carried out in accordance with 4.1.1.9. The maximum rated cable load (MRCL);

cable design shall be verified. Any visual damage to the cable or permanent or temporary increase in optical attenuation greater than 0.10 dB at 1550 nm for single-mode fiber and 0.20 dB at 1300 nm for multimode fibers shall constitute failure.

3.1.1.10 Cable cutoff wavelength (single-mode fiber)

The cutoff wavelength of the cabled fiber, λ_{ce} , shall be less than 1260 nm.

3.1.1.11 Temperature cycle test

Optical cables shall maintain mechanical and optical integrity when exposed to the following temperature extremes: -40°C to $+65^{\circ}\text{C}$.

The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.20 dB/km, with 80% of the measured values no greater than 0.10 dB/km. For single-mode fibers, the attenuation change measurements shall be made at 1550 nm.

For multimode fibers, the change shall not be greater than 0.50 dB/km, with 80% of the measured values no greater than 0.25 dB/km. The multimode fiber measurements shall be made at 1300 nm unless otherwise specified.

A temperature cycle test shall be performed in accordance with 4.1.1.11.

3.1.1.12 Cable aging test

The cable aging test shall be a continuation of the temperature cycle test.

The change in attenuation from the original values observed before the start of the temperature cycle test shall not be greater than 0.40 dB/km, with 80% of the measured values no greater than 0.20 dB/km for single-mode fibers.

For multimode fibers, the change in attenuation shall not be greater than 1.00 dB/km, with 80% of the measured values no greater than 0.50 dB/km.

There shall be no discernible difference between the jacket identification and length marking colors of the aged sample relative to those of an unaged sample of the same cable. The fiber coating color(s) and unit/bundle identifier color(s) shall be in accordance with TIA/EIA-598-A-1992 [B43].

A cable aging test shall be performed in accordance with 4.1.1.12.

3.1.1.13 Ultraviolet (UV) resistance test

The cable and jacket system is expected to perform satisfactorily in the user-specified environment into which the cable is being placed into service. Because of the numerous possible environmental locations available, it is the user's and supplier's joint responsibility to provide the particular performance requirements of each installation location. These performance criteria are for nonsevere environments. The IEC 60068-2-1 [B12] performance standards should be used to define particular environmental testing requirements for each unique location.

The cable jacket shall meet the following requirements:

Where carbon black is used as a UV damage inhibitor, the cable shall have a minimum absorption coefficient of 0.32 per meter.

Where the other cable UV blocking systems are being employed, the cable shall

a) Meet the equivalent UV performance of carbon black at 0.32 per meter

b) Meet the performance requirements as stated in 4.1.1.13 for IEC 60068-2-1 [B12] testing

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3.1.1.14 Complete ADSS

~~Tests for rated strength of the completed ADSS cable are not required, but they may be made if agreed on by the manufacturer and the purchaser at the time of order placement. If tested, the breaking strength of the completed ADSS cable shall not be less than its specified rating breaking strength unless the failure occurs in the laboratory gripping device. If the failure occurs in the laboratory grip, the test value must not be less than 95% of the specified rated breaking strength of the cable.~~

3.1.2 Routine tests

~~Except where noted, routine tests shall be performed on a sampling basis such that each reel will meet 3.1.2 criteria.~~

3.1.2.1 Fiber optic cable dimensions

3.1.2.1.1 Jacket thickness

~~The minimal thickness of the outer jacket at any cross section may not be less than 70% of the nominal thickness.~~

3.1.2.1.2 Cable O.D.

~~The maximum deviation of the cable outside diameter shall be ± 0.25 mm for cables 13 mm and smaller and ± 0.5 mm for cables larger than 13 mm.~~

3.1.2.2 Optical acceptance tests

- ~~a) These tests shall be performed on each reel in accordance with 4.1.2.2.~~
- ~~b) Attenuation loss values exceeding those specified shall constitute failure.~~

3.2 Fiber tests

3.2.1 Design tests

3.2.1.1 Attenuation variation with wavelength

~~For dispersion unshifted single mode fibers, the attenuation coefficient for wavelengths between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.1 dB/km. For multi-mode fibers, the window requirements should be mutually agreed to among the component suppliers and the user.~~

3.2.1.2 Attenuation at the water peak

~~For unshifted single mode fibers, the attenuation coefficient at the water peak found within 1383 ± 3 nm shall not exceed 3 dB/km.~~

~~For multimode fibers, the attenuation coefficient at 1380 nm shall not exceed the attenuation coefficient at the 1300 nm wavelength by more than 3 dB/km.~~

3.2.1.3 Attenuation with blending

For multimode fibers, the attenuation per 100 turns on a 75 mm diameter mandrel shall not exceed 0.5 dB at 850 nm and 1300 nm, including the intrinsic attenuation of the 23.6 m of fiber. For single-mode fibers, the attenuation per 100 turns shall not exceed 0.5 dB at 1550 nm. Also, the additional attenuation introduced when a single turn of a single-mode fiber is wound around a 32 ± 0.5 mm diameter mandrel shall not exceed 0.5 dB at 1550 nm.

NOTE—A 32 mm diameter bend in a fiber is only recommended for making short term bend attenuation measurements. For considerations of long term mechanical survivability, the recommendations of the manufacturer relative to minimum bend diameter should be followed.

3.2.1.4 Environmental requirements

3.2.1.4.1 Temperature cycling

Optical fibers shall maintain mechanical and optical integrity when exposed to the following operational temperature extremes: -55°C to $+85^{\circ}\text{C}$.

The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.05 dB/km. For unshifted single-mode fibers, the attenuation change measurements shall be made at 1310 nm and 1550 nm. For dispersion shifted single-mode fibers, the measurements shall be at 1550 nm. For multimode fibers, the change shall not be greater than 0.2 dB/km. The multimode fiber measurements shall be made at 850 nm and 1300 nm.

3.2.2 Routine tests

3.2.2.1 Optical requirements

3.2.2.1.1 Attenuation coefficient

The multimode fiber attenuation coefficient shall be specified at 850 nm and/or 1300 nm (unless otherwise required by the user). The attenuation coefficient shall be specified on the basis of the maximum individual fiber attenuation coefficient in the cable.

The attenuation coefficient for unshifted single-mode fiber shall be specified at 1310 nm and at 1550 nm unless otherwise required by the user. The dispersion shifted attenuation coefficient shall be specified at 1550 nm. The attenuation coefficient shall be specified on the basis of the maximum individual fiber attenuation coefficient in the cable.

3.2.2.1.2 Attenuation uniformity

The attenuation of the fiber shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1 dB for single-mode fiber and 0.2 dB for multimode fiber at any design wavelength. If factory splicing is permitted by the user, the spliced fiber shall meet all optical, geometrical, and environmental requirements as stated in this standard.

3.2.2.1.3 Chromatic dispersion (single-mode fiber)

For dispersion unshifted single-mode fibers, the zero dispersion wavelength, λ_0 , shall be between 1295 nm and 1322 nm. The nominal zero dispersion wavelength should be 1310 nm. In the context of this objective, the nominal zero dispersion wavelength is defined as the median of the measured distribution of λ_0 . In addition, the maximum value of the dispersion slope at λ_0 , $S_{0\text{max}}$, shall be no greater than $0.095 \text{ ps}/(\text{km} \times \text{nm}^2)$.

For dispersion unshifted single-mode fibers, D_{max} , the maximum absolute value of the dispersion coefficient over a window, λ_{min} to λ_{max} , can be found as the larger of the absolute value of

$$\left\{ \frac{S_{\text{omax}} \lambda_{\text{min}}}{4} \left[1 - \frac{\lambda_{\text{omax}}^4}{\lambda_{\text{min}}^4} \right] \right.$$

or

$$\frac{S_{\text{omax}} \lambda_{\text{max}}}{4} \left[1 - \frac{\lambda_{\text{omin}}^4}{\lambda_{\text{max}}^4} \right]$$

For dispersion-shifted single-mode fibers, the nominal zero-dispersion wavelength should be 1550 nm. In the context of this objective, the nominal zero-dispersion wavelength is defined as the median of the measured distribution of λ_0 . The required maximum tolerance on the zero-dispersion wavelength, $\Delta\lambda_{\text{omax}}$ (i.e., $1550 \text{ nm} \pm \Delta\lambda_{\text{omax}}$), is dependent on the specified maximum dispersion slope, S_{omax} :

If $S_{\text{omax}} < 0.06 \text{ ps}/(\text{km} \times \text{nm}^2)$, then

$$\Delta\lambda_{\text{omax}} < 25 \text{ nm}$$

If $S_{\text{omax}} < 0.085 \text{ ps}/(\text{km} \times \text{nm}^2)$, then

$$\Delta\lambda_{\text{omax}} < 15 \text{ nm}$$

Fibers with values of low S_{omax} and wide $\Delta\lambda_{\text{omax}}$ have different potential upgrade possibilities than the fibers with values of high S_{omax} and narrow $\Delta\lambda_{\text{omax}}$. Therefore, the two different dispersion-shifted fiber designs cannot be considered totally interchangeable.

3.2.2.1.4 Multimode bandwidth

The minimum bandwidth(s) shall be specified at the wavelength(s) of intended use by either the end-to-end bandwidth requirement of the cable span or by an individual reel bandwidth requirement.

3.2.2.1.5 Mode field diameter (single-mode fiber)

The nominal mode field diameter (MFD) for dispersion-unshifted single-mode fibers at 1310 nm shall be no less than 8.3 microns and no greater than 10 microns. For dispersion-shifted single-mode fiber at 1550 nm, the nominal should be between 7 and 8.7 microns. A range about the specified nominal shall be less than $\pm 8\%$ for both the dispersion-unshifted and the dispersion-shifted single-mode fibers.

3.2.2.2 Geometric requirements

3.2.2.2.1 Multimode optical fibers

- a) ~~Core diameter:~~ The fiber shall have a core diameter of either 50.0 microns or 62.5 microns, as appropriate. The permissible deviation from the nominal value for all designs shall be less than or equal to 3 microns.
- b) ~~Core noncircularity:~~ Core noncircularity error shall be $< 6\%$.
- c) ~~Concentricity error:~~ The concentricity error shall be $< 6\%$.
- d) ~~Numerical aperture (NA):~~ The nominal value of NA shall be as follows:
 - 1) ~~50/125~~ The nominal NA shall be between 0.20 and 0.23.
 - 2) ~~62.5/125~~ The nominal NA shall be between 0.27 and 0.29.

For a given design, the permissible deviation from the nominal value of NA shall be less than or equal to ± 0.02 .

~~The requirements on cladding diameter and cladding noncircularity shall conform to the dimensions for single-mode fiber specified in 3.2.2.2.2 and 3.2.2.2.3.~~

~~3.2.2.2.2 Single-mode optical fibers~~

~~Concentricity error: The offset between the center of the core and the center of the cladding shall be <1.0 microns.~~

~~3.2.2.2.3 Parameters common to both multimode and single-mode fibers~~

~~Cladding diameter: The cladding outside diameter shall be 125.0 microns $\pm$ 1.0 microns.~~

~~Cladding noncircularity: The cladding noncircularity shall be <1%.~~

~~Coating diameter: The nominal coating diameters should be 250 microns for standard protective coating. For use in tight buffered cable designs, an additional buffering with a nominal diameter of 400, 500, 700, or 900 microns may be used.~~

~~3.2.2.3 Mechanical requirements~~

~~Fiber tensile proof test: All single-mode fibers shall be subjected to a minimum proof stress of 0.69 GN/m² for 1 second equivalent by the fiber manufacturer (100% testing). All multimode fibers shall be subjected to a minimum proof stress of 0.35 GN/m² for 1 s equivalent by the fiber manufacturer (100% testing).~~

4. ADSS cable and components

4.1 Description

The ADSS cable shall consist of coated glass optical fibers contained in [one or more](#) protective dielectric fiber optic units surrounded by or attached to suitable dielectric strength members and jackets. The cable shall not contain metallic components. The cable shall be designed to meet the ~~design~~ requirements ~~of the optical cable~~ under all [specified](#) installation conditions, operating temperatures, and environmental loading.

4.2 Fiber optic cable core

The fiber optic cable core shall be [all-dielectric and shall be](#) made up of coated glass optical fibers housed to protect the fibers from mechanical, environmental, and electrical stresses. Materials used within the core shall be compatible with one another, shall not degrade under the electrical stresses to which they may be exposed, and shall not evolve hydrogen [in quantities](#) sufficient to degrade optical performance of fibers within the cable.

4.2.1 Fiber strain allowance

The cable ~~core~~ shall be designed such that fiber strain does not exceed the limit allowed by the cable manufacturer under the operational design limits ([MRCL](#)) of the cable. Maximum allowable fiber strain will generally be a function of the proof test level, and [the](#) strength and fatigue parameters of the coated glass fiber. [The maximum fiber strain shall not exceed the limit specified in 6.5.1.2. The optical fiber attenuation increase while under fiber strain shall also meet the requirements listed in this subclause.](#)

4.2.2 Central ~~strength structural~~ element

If a central strength element is necessary, it shall be of reinforced plastic, epoxiglass, or other dielectric material. If required, this element shall provide the necessary tensile strength to limit axial stress on the fibers and minimize fiber buckling due to cable contraction at low temperatures. [The strength element shall also meet the stress strain fatigue requirements in 6.5.1.3.](#)

4.2.3 Buffer tube filling compound

Loose buffer tubes shall be [water blocked](#) ~~filled~~ with a suitable [material](#) ~~compound~~ compatible with the tubing material, fiber coating, and coloring, to protect the optical fibers and prevent moisture ingress.

4.2.4 Cable core water blocking compound

The design of the cable may include suitable water blocking materials in the interstices to prohibit water migration along the fiber optic cable core. The water blocking material shall be compatible with all components with which it may come in contact.

4.2.5 Binder/tape

A binder yarn(s) and/or a layer(s) of overlapping non-hygroscopic tape(s) may be used to hold the cable core elements in place during application of the jacket.

4.2.3.6 Inner jacket

A protective inner jacket or jackets of a suitable material may be applied over the fiber optic cable core, isolating the cable core from any external strength elements and the cable outer jacket.

4.3 Optical fibers

Single-mode fibers [such as](#) dispersion-unshifted, dispersion-shifted, or non-zero dispersion shifted; and multimode fibers with 50/125 [μm](#) ~~mm~~ or 62.5/125 [μm](#) core/clad diameters are considered in this standard.

[All single-mode fibers shall meet the requirements of IEC 60793-2-50.⁶ All multimode fibers shall meet the requirements of IEC 60793-2-10.](#) The core and the cladding shall consist of [all](#) glass that is predominantly silica (SiO₂). The coating is usually made from one or more ~~plastic materials or compositions, shall be provided to~~ [such as acrylate, and shall](#) protect the fiber during manufacture, handling, and ~~use~~ [operation](#).

⁶[Information on references can be found in Clause 2.](#)

4.4 Buffer construction

The individually coated optical fiber(s) or fiber ribbon(s) may be surrounded by a [tube buffer](#) ~~for~~ protection from physical damage during fabrication, installation, and [operation performance](#) of the ADSS [cable](#). Loose ~~buffer or tight~~ buffer construction [is a typical type](#) ~~are two types~~ of protection that may be used to isolate the fibers. The fiber coating ~~and buffer~~ shall be strippable for splicing and termination.

4.4.1 Loose buffer

Loose buffer construction shall consist of a tube ~~or channel~~ that surrounds each fiber or fiber group such that the inner diameter. ~~The inside of the tube or channel shall be filled with a filling compound is greater than the outside diameter of the fiber or fiber group. The interstices inside and outside the tube shall contain a water blocking material.~~

2.5.2 Tight buffer construction

~~Tight buffer construction shall consist of a suitable material that comes in contact with the coated fiber.~~

4.5 Color coding and performance

Color coding is essential for identifying individual optical fibers and groups of optical fibers. The colors shall be in accordance with EIA/TIA-598-A-1995 [B43]. The original identification of fibers and units shall remain be discernible ~~color coding system and permanent, in accordance with EIA-359-A-1985 [B3],~~ throughout the design life of the cable when cleaned and prepared per manufacturer's recommendations.

2.2 Support systems

- ~~a) ADSS cable shall contain support systems that are integral to the cable. The purpose of the support system is to ensure that the cable meets the optical requirements under all specified installation conditions, operating temperatures, and environmental loading for its design life. This standard excludes any "lashed" type of cables.~~
- ~~b) The basic annular construction may have aramid or other dielectric strands or a channeled dielectric rod as a support structure. In addition, other cable elements, such as central members, may be load bearing.~~
- ~~c) Figure 8 constructions may have a dielectric messenger and a fiber optic unit, both of which share a common outer jacket. In addition, other cable elements, such as central members, may be load bearing.~~
- ~~d) Helically stranded cable systems may consist of a dielectric optical cable prestranded around a dielectric messenger.~~
- ~~e) The design load of the cable shall be specified so that support hardware can be manufactured to perform under all environmental loading conditions. For zero fiber strain cable designs, the design load is defined as the load at which the optical fibers begin to elongate. For other cable designs, the design load is defined as the load at which the measured fiber strain reaches a predetermined level.~~
- ~~f) Other designs previously not described are not excluded from this specification.~~

4. Test methods

~~Each procedure in this clause is complementary to Clause 3 that describes the specific requirement. For all test procedures described in this clause, the test temperature is $25 \pm 5^{\circ}\text{C}$ unless otherwise stated. All measured and computed values shall be rounded to the number of decimal places given in the corresponding requirement using the procedures of ASTM E29-2002 [B2].~~

4.1 Cable tests

4.1.1 Design tests

4.1.1.1 Water blocking test

A water blocking test for cable shall be conducted in accordance with the requirements for TIA 455-82-B-1991 [B23], except that the retest length, if used, is 1 m rather than 3 m. This test may optionally be performed on the cable core assembly.

4.1.1.2 Seepage of filling/flooding compound

A 0.3 m sample of cable shall be tested in accordance with EIA/TIA 455-81-A-1992 [B9]. The optional pre-conditioning cycle as described in EIA/TIA 455-81-A-1992 [B9] may be used. The unprepared cable end may be sealed.

4.1.1.3 Electrical tests

The electrical tests shall be performed on a sample cable in accordance with Annex A.

4.1.1.4 Aeolian vibration test

The aeolian vibration test shall be performed on a sample cable in accordance with Annex B.

4.1.1.5 Galloping test

The galloping test shall be performed on a sample cable in accordance with Annex C.

4.1.1.6 Sheave test

4.1.1.6.1 Sheave test

The sheave test shall be performed on a sample cable in accordance with Annex D.

4.1.1.6.2 Tensile strength of cable

The tensile strength of a cable shall be conducted in accordance with TIA 455-33-A-1988 [B17].

4.1.1.6.3 Cable twist

The cable twist test shall be conducted in accordance with TIA 455-85-A-1999 [B24]. The cable length subjected to the test shall be a maximum of 4 m.

4.1.1.6.4 Cable cyclic flexing

The cable cyclic flexing test shall be conducted in accordance with TIA/EIA 455-104-A-1993 [B37]. The sheave diameter shall be a maximum of 20 times the cable outside diameter. The cable shall be flexed at 30 ± 1 cycles/minute for 25 cycles. (For some cable designs, the sheave diameter must be greater than 20 times the cable outside diameter. For those designs, the sheave diameter shall be specified by the cable manufacturer and be stated to the customer prior to purchase.)

4.1.1.7 Crush test and impact test

4.1.1.7.1 Crush test

~~The crush test shall be carried out on a sample of cable according to the method provided by TIA/EIA 455-41 A-1993 [B30]. The cable shall withstand a compressive load of 220 N/cm for 10 minutes.~~

4.1.1.7.2 Impact test

~~The impact test shall be carried out on a sample of cable according to the method provided by EIA/TIA 455-25 A-1989 [B8].~~

4.1.1.8 Creep test

~~A creep test shall be performed on an ADSS sample approximately 10 m long. The cable shall be terminated at each end, and a tension of at least 50% of the maximum rated cable loads shall be applied and sustained for a duration of at least 1000 h. The elongation of the cable versus time shall be measured at suitable intervals and recorded.~~

4.1.1.9 Stress/strain test

~~A static tensile test shall be conducted in accordance with TIA 455-33 A-1988 [B17] with the following exceptions. The use of sheaves is not mandatory. A sample of cable shall be placed in a tensile testing apparatus, such that a minimum of 25 m of cable within the middle of the test length can be subjected to tensile loading. The test sample shall be terminated at both ends prior to strain, in a manner such that the optical fiber ends cannot move relative to the cable ends.~~

~~The tensile test shall first be used to obtain a stress/strain curve. Load the cable stepwise to the manufacturer's maximum rated cable load (MRCL). Record~~

- ~~a) The load and strain on the cable~~
- ~~b) The maximum fiber attenuation increase in decibels~~
- ~~c) Maximum *added* fiber strain~~

~~A cyclic loading test shall be performed subsequent to the initial tensile test to gauge the cables dynamic performance. Cycle the cable from 0% ($\pm 10\%$) to 100% ($\pm 10\%$) of the MRCL for 50 cycles at approximately one to three cycles per minute. Take measurements at the high and low loading extremes for the first two cycles and last two cycles. Record~~

- ~~a) The load and strain on the cable~~
- ~~b) The maximum fiber attenuation increase in decibels~~
- ~~c) Maximum *added* fiber strain~~

~~The MRCL, MRCS, and the maximum added fiber strain shall be specified by the manufacturer and verified through this test. MRCS/MRCL (%/load) is the effective modulus for the cable design for the purpose of sag and tension calculations.~~

~~The overall change in length of the ADSS may be measured by suitable displacement transducers. Fiber strain measurements shall be performed using phase shift or time of flight techniques. The accuracy is limited by index of refraction changes under strain.~~

4.1.1.10 Cable cutoff wavelength (single-mode fiber)

~~The cutoff wavelength of cabled fiber, λ_{cc} , shall be measured according to EIA/TIA 455-170-1989 [B10]. The cable sample shall be 20 m long with additional 1 m fiber ends, each having one 76 mm loop to simulate~~