



IEEE Standard for Testing and Performance of Optical Ground Wire (OPGW) for use on Electric Utility Power Lines

STANDARDS

IEEE Power and Energy Society

Developed by the
Power Systems and Cybersecurity Committee

IEEE Std 1138™-2021
(Revision of IEEE Std 1138-2009)



IEEE Standard for Testing and Performance of Optical Ground Wire (OPGW) for use on Electric Utility Power Lines

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Power Systems and Cybersecurity Committee
of the
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Approved 23 September 2021

IEEE SA Standards Board

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Abstract: The performance, test requirements, procedures, and acceptance criteria for a transmission line overhead ground wire (a.k.a. shield wire, static wire, earth wire, skywire) with optical fibers commonly known as optical ground wire (OPGW) are covered in this standard. Functional requirements such as electrical, mechanical, optical fiber, environmental, and packaging, and test requirements related to design, installation, in-service, and maintenance, including routine tests are also covered.

Keywords: fiber optic ground wire, IEEE 1138™, laboratory tests, OPGW, optical ground wire, type tests

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Introduction

This introduction is not part of IEEE Std 1138-2021, IEEE Standard for Testing and Performance of Optical Ground Wire (OPGW) for use on Electric Utility Power Lines.

IEEE Std 1138-1994 [B6] for optical ground wire (OPGW) was first published in 1994, and since then has been used worldwide to purchase and specify the performance of OPGW cables.¹ The original purpose of the standard was to fill a need for standardization of terminology, performance, and test requirements for OPGW cables. The original title was “IEEE Standard Construction of Composite Fiber Optic Overhead Ground Wire (OPGW) for Use on Electric Utility Power Lines.” Over the years, the document has been used primarily as a test standard. To better reflect how the standard is presently used, in 2009 the title was changed to “IEEE Standard for Testing and Performance for Optical Ground Wire (OPGW) for Use on Electric Utility Power Lines.”

The 2020 revised standard documents the collective experience gained by the industry since the original publication. Changes have been made in the following areas:

- a) Organization of contents
- b) Functional requirements
- c) Test requirements
- d) Installation recommendations
- e) Hardware
- f) Packaging requirements
- g) Updating of all references and annexes

Representatives of the following IEEE subcommittees have reviewed this document:

- Fiber Optics Subcommittee—Power Systems Communications Committee, PES
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- ESMOL Subcommittee—Transmission and Distribution Committee, PES
- Lightning and Insulator Subcommittee—Transmission and Distribution Committee, PES

¹The numbers in brackets correspond to those of the bibliography in [Annex A](#).

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1. Overview

1.1 Scope

This standard covers the performance, test requirements, procedures, and acceptance criteria for a transmission line overhead ground wire (a.k.a. shield wire, static wire, earth wire, skywire) with optical fibers commonly known as optical ground wire (OPGW). An OPGW cable has the dual performance functions of a ground wire with telecommunications capabilities.

This standard includes functional requirements, such as electrical, mechanical, optical fiber, environmental and packaging, and test requirements related to design, installation, in-service, and maintenance, including routine tests.

This standard is not intended to supersede any established safety rules, codes, regulations, or practices associated with the use of OPGW cables. 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 covers the construction, mechanical and electrical performance, acceptance criteria, and test requirements for overhead ground wire (OPGW) designed to be located primarily on overhead power utility facilities. The standard provides performance and testing requirements that insure within the guidelines of this standard that the mechanical and electrical capabilities of the cable and cable components properly maintain mechanical integrity, optical fiber integrity, and optical transmission.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*)^{2,3}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

²The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

³The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

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.

ANSI/AA 53, Packaging Standards for Aluminum Conductor and ACSR.^{4†}

[ASTM B 117, Standard Practice for Operating Salt Spray \(Fog\) Apparatus.](#)⁵

ASTM B230/B230M, Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes.²

ASTM B398/B398M, Standard Specification for Aluminum-Alloy 6201-T81 [and 6201-T83](#) Wire for Electrical Purposes.

ASTM B415, Standard Specification for Hard-Drawn Aluminum-Clad Steel Wire.

ASTM B416, Standard Specification for Concentric-Lay-Stranded Aluminum-Clad Steel Conductors.

ASTM B498, Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR).

⁴[ANSI publications are available from the American National Standards Institute \(https://www.ansi.org/\).](https://www.ansi.org/)

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⁵~~ASTM publications are available from the American Society for Testing and Materials (<https://www.astm.org/>), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (http://www.astm.org/).~~

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

ASTM B502, Standard Specification for Aluminum-Clad Steel Core Wire for [Use in Overhead Electrical](#) Aluminum Conductors, ~~Aluminum-Clad Steel Reinforced~~.

IEC 60104, Aluminum-Magnesium-Silicon Alloy Wire for Overhead Line Conductors.^{6,4}

IEC 60888, Zinc-Coated Steel Wires for Stranded Conductors.

IEC 60889, Hard-Drawn Aluminum Wire for Overhead Line Conductors.

IEC 61089, Round Wire Concentric Lay Overhead Electrical Stranded Conductors.

IEC 61232, Aluminum-Clad Steel Wires for Electrical Purposes.

IEC 61395, Overhead Electrical Conductors—Creep Test Procedures for Stranded Conductors.

IEEE Std 524™, IEEE Guide to the Installation of Overhead Transmission Line Conductors.^{7,8,5,6}

[IEEE Std 1591.1™, IEEE Standard for Testing and Performance of Hardware for Optical Ground Wire \(OPGW\).](#)

[ISO 9227, Corrosion Tests in Artificial Atmospheres—Salt Spray Tests.](#)⁹

⁶IEC publications are available from the International Electrotechnical Commission (<https://www.iec.ch>) and the American National Standards Institute (<https://www.ansi.org/>).

~~⁴IEC publications are available from the Central Office of the International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, CH 1211, Geneva 20, Switzerland (<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/>).~~

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⁹ISO publications are available from the International Organization for Standardization (<https://www.iso.org/>) and the American National Standards Institute (<https://www.ansi.org/>).

[NEMA WC-26, Binational Wire and Cable Packaging Standard.](#)¹⁰

TIA/EIA-455-3, FOTP-3~~A~~, Procedures to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components.^{11~~7~~}

TIA/EIA-455-41 ~~A~~, FOTP-41 ~~A~~, Compressive Loading Resistance of Fiber Optic Cables.³

TIA/EIA-455-81~~-B~~, FOTP-81 ~~A~~, Compound Flow (Drip) Test for Filled Fiber Optic Cable.

TIA/EIA-455-82, FOTP-82 ~~B~~, Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary* ~~[Online: Glossary of Terms & Definitions](#)~~ should be [consulted](#) ~~referenced~~ for terms not defined in this clause.^{12~~8~~}

factory acceptance test: Specific tests and frequency that are agreed upon between manufacturer and end-user to confirm the product meets the specifications. Testing is done to allow shipment.

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

¹⁰~~NEMA publications are available from the National Electrical Manufacturers Association (<https://www.nema.org/>).~~

¹¹~~TIA/EIA publications are available from the Telecommunications Industry Association (<https://www.tiaonline.org/>).~~

¹²~~IEEE Standards Dictionary Online is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.~~

⁷~~TIA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>).~~

⁸~~The IEEE Standards Dictionary: Glossary of Terms & Definitions is available at <http://shop.ieee.org/>.~~

maximum design load (MDL): The maximum design load the cable is expected to experience in service under meteorological loading conditions (e.g., wind, ice loads, temperature). The MDL is used in determining the maximum rated design tension. Syn: maximum working load (MWL).

maximum rated design tension (MRDT) [also known as maximum rated cable load (MRCL) or maximum operating tension]: The maximum tension rating on ~~of~~ the cable so it will function over its lifetime without degrading the performance of the optical fibers. Exceeding the MRDT may degrade ~~reducing~~ the performance of the optical fibers. MRDT is the maximum acceptable operating tension on the cable. This tension rating will be determined by the cable manufacturer. MRDT may be expressed in terms of tension or as a percentage of its rated tensile strength (RTS). ~~MRDT may also be known as maximum rated cable load (MRCL).~~

optical fiber unit: A component of the optical ground wire (OPGW), the optical fiber unit is comprised of a protective mechanical support tube housing the optical fibers.

optical ground wire (OPGW): OPGW cable has the dual performance functions of a ground wire with telecommunications capabilities.

~~system (OPGW system):~~ The cable and hardware working together.

NOTE—The cable and hardware described in this standard function as an integrated unit.^{13 9}

optical time domain ~~delay~~ reflectometer (OTDR): Used to determine the degree and location of attenuation in optical fibers by transmitting a light source and measuring time of flight and strength of reflected optical signal.

rated tensile strength (RTS): The calculated tensile load that the cable shall withstand without mechanical failure.

routine testing: Testing conducted by the manufacturer during routine production to confirm cable is being manufactured according to their internal specifications to meet the end-user's specifications.

^{13 9}Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

sagging tension (SAT): 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 sag relative to other conductors and the ground.

stringing tension (STT): The tension used to pull the cable through sheaves during the stringing portion of the installation process. This is never greater than the sagging tension. Syn: ~~Also known as~~ **installation or pulling tension.**

ultimate tensile strength (UTS): The actual measured breaking strength of cable.

3.2 Acronyms and abbreviations

EDS energy dispersive spectroscopy

MDL maximum design load

MOE modulus of elasticity

MRDT maximum rated design tension

MRCL maximum rated cable load

MWL maximum working load

OPGW optical ground wire

OTDR optical time domain reflectometer

RTS rated tensile strength

SAT sagging tension

STT stringing tension

UTS ultimate tensile strength

4. Description of [optical ground wire \(OPGW\)](#) cable and components

[4.1 Overview](#)

There are multiple acceptable designs of [optical ground wire \(OPGW\)](#). Typically, they consist of one or more layers of metallic wires stranded about a cable core comprised of components such as tubes, wires and/or slotted rods, and optical fibers in optical fiber units. [The optical fiber unit and the outer stranded metallic wires shall serve together as an integral unit to protect the optical fibers from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects that may produce hydrogen.](#)

4.2 Stranded metallic wires

[The stranded metallic wires shall be designed in accordance with the following considerations:](#)

- a) The composition and stranding of the metallic wires shall be in accordance with the appropriate industry standard for metallic wires and cabling such as those referenced in Clause 2.
- b) For consistency and operability with existing materials and methods used in power transmission lines, the stranded metal wires shall, where applicable, meet the appropriate wire and cabling standards as they will apply to conventional ground wire.
- c) At the supplier's option, the rated tensile strength (RTS) may include the strength of the optical [fiber](#) unit. In this case, the supplier shall notify the customer if the [optical](#) fiber ~~optic~~ unit is considered a load-bearing tension member when determining the total RTS of the composite conductor.
- d) The finished galvanized or aluminum-clad steel wires shall contain no joints or splices unless otherwise agreed upon between the supplier and the purchaser. [Aluminum alloy wires may contain joints per the applicable standard.](#)

4.3 Design of optical fiber ~~optic~~-unit

The optical fiber ~~optic~~-unit shall be designed to house and protect the optical fibers from damage due to forces such as crushing, bending, twisting, tensile stress, and moisture. ~~The fiber optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibers from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects that may produce hydrogen.~~ The optical fiber optic unit may include an aluminum tube, channeled aluminum rod, stainless-steel tubing, or aluminum-coated stainless-steel tubing; but is not limited to these designs.

4.3.1 Optical fiber unit

~~4.2.1 Metallic tube~~

The fiber optic unit may include a tube such as stainless steel or aluminum to house the fibers. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

The cable may consist of one or more optical fiber units. The optical fiber unit may consist of a stainless-steel tube, an aluminum tube, ~~optic-unit may include~~ a stainless-steel tube with an aluminum protective coating or a dielectric tube to house the fibers. The metallic tube(s) may be fabricated as a seamless or seam-welded tube.

Where an aluminum protective layer is utilized to avoid dissimilar metal contact (avoid potential corrosion), the aluminum ~~The coating~~ shall completely cover the internal tube(s) tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc., with the surrounding aluminum-coated, stranded wires described in 4.2.1.

4.2.2 Grooved rod or spacer

A grooved rod or spacer may be fabricated with one or more grooves and formed into a helix to house the optical fibers. The fibers may be contained inside a tube placed in the groove(s). An outer protective shield may be applied around the rod or spacer such as a tube or a helically applied overlapping tape to provide an additional mechanical and environmental barrier. Note that a grooved rod is an obsolete technology.

4.3.2 Buffer construction

A buffer for protection from physical damage during fabrication, installation, and performance of the OPGW cable may surround the individually coated optical fiber(s). Loose buffer or tight structure ~~buffer~~ constructions are two types of protection that may be used to isolate the fibers. The buffer material ~~fiber coating and buffer~~ shall be removable or strippable for splicing and termination.

4.3.2.1 Loose buffer tube

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

4.3.2.2 Tight structure unit ~~buffer~~

Tight structure ~~buffer~~ construction shall consist of the individual fibers being fixed into place around a strength member and coated with a suitable material that comes into direct ~~in~~ contact with the ~~coated~~ fiber. The fibers are locked into place with the internal strength member.

4.3.3 Filling compound

If required, the interstices of the optical fiber ~~optic~~-unit shall be water blocked ~~filled~~ with a suitable material compatible with the tubing material, fiber coating, and coloring to protect the optical fibers and inhibit moisture ingress. ~~compound to prohibit any moisture ingress from outside or any water migration along the fiber-optic unit. The filling compound used shall be compatible with all the components with which it may come in contact.~~

4.3.4 Structural members of the optical fiber ~~optic~~ unit

Structural member(s) may be used to limit the stress on the fiber inside the ~~central fiber~~-optical fiber unit. These structural member(s) shall be made of non-conductive dielectric materials that do not pose an electrical hazard to the optical fiber ~~optic~~ splicing or terminations processes.

4.4 Optical fiber

The core and the cladding shall consist of all glass that is predominantly silica (SiO₂). The coating is usually made from one or more synthetic materials, such as plastic or acrylate, or compositions and shall be provided to protect the fiber during manufacture, handling, and operation. The optical fiber shall be in accordance with the appropriate industry standard such as those referenced in Clause 2.

4.4.1 Means for identifying fibers

~~4.4.3 Color coding~~

The fiber ~~coloring~~ shall be colored in accordance with an appropriate ~~industry~~-standard for fiber color as referenced in Clause 2.

In cases where the number of fibers per unit exceeds the number of color variances ~~fibers per unit~~ ~~provided~~ in the appropriate color ~~applicable~~ standard, the supplier shall implement other means for identifying fibers in the same unit. In case of multiple fiber units, these units shall be also uniquely identified.

4.4.4 ~~Color performance~~

The original means of fiber identification ~~of fibers~~ and units shall remain discernible throughout the design life of the cable when cleaned and prepared per manufacturer's recommendations.

5. Requirements and recommendations for OPGW cable ~~cables~~

~~OPGW serves two purposes:~~

- ~~a) —To replace a conventional ground wire, to protect the transmission system from lightning, and to serve as a conductive medium for carrying fault currents to ground.~~
- ~~b) —To provide telecommunications capacity utilizing optical fibers.~~

~~As such, an OPGW cable is required to withstand the effects from installation and long term in-service exposure to mechanical, electrical, and environmental loads without significant degradation in performance. An OPGW cable shall be made up of optical telecommunications fibers contained in one or more protective fiber optic units combined with concentric lay stranded metallic wires in single or multiple layers.~~

5.1 Electrical

5.1.1 Fault current performance

An OPGW cable shall be designed so that fault currents due to short circuits do not damage the integrity or impair the functionality of any component of the cable and its optical, electrical, and mechanical performance. Fault current in this context is defined ~~that which enters the OPGW~~ as current injected in an OPGW, a result of a line to tower short circuit. The end-user will provide the initial cable temperature and at least two of the following parameters: either I^2t requirement of the OPGW and its duration (t), or I and t. ~~(1) a description of short circuit fault current adequate for establishing the required I^2t requirement of the OPGW, or (2) I^2t as specified by the end user.~~

5.1.2 Lightning performance

An OPGW cable shall be designed so that lightning arcs striking the cable do not impair the long-term functionality of any component of the cable and its optical, electrical, and mechanical performance. [The end-user should consider the relative lightning density and frequency level in the area of installation.](#)

5.2 Mechanical

5.2.1 Sag and tension performance

The following are recommended as minimum sag and tension criteria when designing OPGW cable:

- a) OPGW cable sags shall be such that the tensions do not exceed the limits for open supply conductors, which are given in the [applicable regional or national code \(e.g., ~~most recent~~ ~~edition of the~~ National Electrical Safety Code[®] \(NESC[®]\) \[or other document specified by the governing entity for the design of overhead electrical facilities\]\(#\)\). ~~\(Accredited Standards Committee C2-2007\) \[B1\] or appropriate national code\(s\) for the country where installed.~~¹⁰](#)

These limitations are based on the use of recognized methods for reducing the likelihood of fatigue failures by minimizing chafing and stress concentrations.

- b) OPGW cable placement and sags shall be designed to provide [the desired](#) ~~sufficient~~ lightning protection.
- c) The [maximum rated design tension](#) (MRDT) of the OPGW cable shall not be exceeded.
- d) It is recommended that tension limits for a specific application be chosen through a coordinated study that shall include the requirements of the user, recommendations from the cable supplier, and recommendations from the supplier of all supporting hardware.

5.2.2 Vibration performance

The following should be considered when designing for vibration performance:

- b) The cable shall be designed such that the optical fibers will not experience ~~it can withstand aeolian vibrations with~~ either permanent or temporary attenuation increases when exposed to Aeolian vibrations less than the criteria indicated in the Aeolian vibration test.
- b) Vibration protection recommendations shall be coordinated between the end-user, ~~obtained from~~ the OPGW cable supplier, and the ~~or from a~~ vibration protection hardware supplier ~~approved by the cable supplier~~.

5.3 Optical – Field acceptance testing

5.3.1 Optical tests

Upon receipt of the OPGW cable from the supplier, it is recommended that the purchaser perform acceptance tests in order to verify that the optical characteristics of the fiber meet the order requirements and to determine if optical fibers have been damaged during shipment. The number of fibers to be tested is at the discretion of the purchaser. The results of these tests and the supplier's certified quality control information, which is normally attached to each reel, shall be compared to the fiber requirements specified in the purchase order.

These tests may be performed by either of the following two methods: ~~The first method is to use an~~

- a) Optical time domain ~~delay~~ reflectometer (OTDR) ~~and the second is to use a light source and a power meter.~~

Access to only one end of the cable is required using the OTDR. ~~Therefore, Use of the OTDR method means~~ it is not necessary to remove the protective covering from ~~one end.~~ both ends ~~of the cable shall be accessible when using the light source and power meter method. It is necessary to remove at least a portion of the covering to use the light source and power meter.~~ A 1 km length of fiber may be spliced between the OTDR and the cable to improve resolution near the cable end. However, it shall be noted when using an OTDR, breaks or damage within the final 10 m of ~~either end of the fiber from where the OTDR is connected~~ may not be detectable. If a reel fails using the single-end OTDR method, then before rejection of the reel, the fiber(s) in question shall be tested from the opposite end and the results for the fiber(s) averaged. Reference FOTP-78 [B9].¹⁴ ~~Mechanical splices or a bare fiber adapter have been used successfully to conduct these tests. If using a bare fiber adapter, there shall be no attenuation loss.~~

b) A light source and a power meter

Both ends of the cable shall be accessible when using the light source and power meter method. It is necessary to remove at least a portion of the covering to use the light source and power meter. Reference TIA 526-7 [B10].

5.3.2 Visual inspection

~~The end of the cable shall be sealed after completion of these tests in order to prevent entry of moisture into the fiber.~~ A visual inspection should ~~shall~~ be made of each reel. If any indication of physical damage to either the reel, wood ~~or~~ lagging, or other protective covering is found, then the additional tests discussed in 5.3.3 are recommended ~~following tests shall be made.~~

5.3.3 Additional tests

The following additional tests are recommended if there is any indication of physical damage to either the reel, wood lagging, or protective covering:

¹⁴⁴⁰ The numbers in brackets correspond to those of the bibliography in Annex A.

- a) Fiber continuity—A continuity check of each fiber may be made to determine if any fiber is broken or if any attenuation irregularities exist.
- b) Attenuation—Total attenuation for the entire reel length and attenuation per kilometer shall be measured on each fiber. Attenuation uniformity shall meet the requirements as specified by the end-user.
- c) Fiber length—The fiber length may be measured using an OTDR. The index of refraction to be used in this measurement shall be furnished by the fiber supplier. A check shall be made to verify received reel numbers and lengths correspond to ordered quantities.

NOTE—All uncovered cable ends are to be resealed after completion of these tests in order to prevent entry of moisture into the fiber.

5.4 Environmental corrosion

An OPGW cable shall be able to withstand the natural elements that exist at its installation location, for its expected service life. The corrosive nature of installation sites can vary vastly from location to location. Therefore, some OPGW designs are more suitable for certain locations than other designs. Locations that are basically low-corrosion sites ~~such as deserts~~ do not require extreme corrosion protection for problems like dissimilar metals or thin aluminum coatings. ; Whereas high corrosion sites, such as high-moisture zones, saltwater ~~salt-water~~ zones, industrial corrosion zones, volcanic sulfur zones, or combinations of zones may require special protection from corrosion for the OPGW.

5.4.1 Low-corrosion installation sites

These areas are defined as installation locations that have low or very low levels of corrosive materials such as moisture, salts, industrial pollution, volcanic pollution, naturally occurring atmospheric/animal corrosive pollutants, or any combinations of these materials. Care shall still be taken when considering OPGW that may be affected by other corrosive or damaging elements such as wind-blown sand.

All types of OPGW cables defined in this standard can be installed in low-corrosion installation sites. This includes, but is not limited to, designs of similar and dissimilar materials such as aluminum tube, aluminum channel, stainless-steel tube, and aluminum-coated stainless-steel tube.

5.4.2 High-corrosion installation sites

These areas are defined as installation locations that receive high or very high levels of corrosive materials such as moisture, salts, industrial pollution, volcanic pollution, [desert-ocean interfaces](#), naturally occurring atmospheric/animal corrosive pollutants, [agricultural operations](#) or any combinations of these or other non-listed corrosive materials. Care shall be taken when considering OPGW that may be affected by additional corrosive or damaging elements such as wind-blown sand.

Corrosion resistant OPGW (CR-OPGW) shall pass the qualifications tests shown in 6.5.4.3.8.

Not all types of OPGW cables defined in this standard can be installed in high-corrosion installation sites. Only designs that have passed the CR-OPGW corrosion qualification test specified in 6.5.4.3.8 ~~may can~~ be [acceptable](#) ~~installed~~ in these locations, [however, additional tests may be appropriate](#). This generally includes, but is not limited to, designs of similar materials such as aluminum tube and aluminum channel. Unless they meet the requirements specified in 6.5.4.3.8, designs of dissimilar materials such as stainless-steel tube with aluminum or aluminum-clad steel wire strands as defined in 4.2.4 are generally not allowed. Aluminum coated stainless-steel tube can be acceptable if the coatings are such as to allow the cable to pass the 6.5.4.3.8 qualification tests for CR-OPGW.

5.5 Installation

It is recommended that IEEE Std 524TM and the OPGW cable supplier's recommended procedures be used for the installation of an OPGW cable. ¹⁵⁺¹

¹⁵⁺¹ Information on references can be found in Clause 2.

An OPGW manufacturer may specify a maximum stringing tension, bend radius, or sheave diameter that is more restrictive than that required by IEEE Std 524. In the event of a conflict, the manufacturer's installation requirements shall prevail.

5.5.1 Use of anti-rotation device

A cable manufacture may require the use of an anti-rotational device to prevent damage to the optical fiber unit (e.g., tube enclosure).

When a cable supplier does not recommend an anti-rotation device be used during installation, they ~~the following information~~ shall provide the maximum stringing tension ~~be provided~~ to the end-user:

- ~~a) — Maximum stringing tension~~
- ~~b) — Maximum number of cable rotations per unit of length~~
- ~~c) — Maximum effect on strain margin~~

5.6 Hardware

Suspension and dead-end hardware, some types of vibration damper hardware, and bonding clamps for OPGW cable are usually designed for a specific size and/or type of OPGW cable. Hardware is generally not designed to accommodate a range of sizes of OPGW cable. Specific OPGW hardware test requirements are defined in IEEE Std 1591.1TM.

Factors that may influence the interaction of the hardware to OPGW cable interface are as follows:

- a) Mechanical—Excessive contact pressure under hardware can exceed the designed crushing limits of the OPGW cable.
- b) Electrical—The connection resistance increases between the hardware and the OPGW if there is insufficient contact area, which reduces the current transfer capability.
- c) Corrosion—Contact between dissimilar materials may cause excessive corrosion in some environments.