



STANDARD FOR
OPTICAL FIBER CABLE
FOR PLACEMENT IN SEWER ENVIRONMENTS

Approved by
AMERICAN NATIONAL STANDARDS INSTITUTE

November 8, 2013

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STANDARD FOR
OPTICAL FIBER CABLE
FOR PLACEMENT IN SEWER ENVIRONMENTS

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FOREWORD

This Standard provides information on specifying optical fiber cables for use in telecommunications applications in sewer environments.

The first edition of this Standard was approved by ICEA on June 12, 2007, and was approved by The American National Standards Institute (ANSI) on April 8, 2008. That edition was adopted by the Telecommunications Industry Association (TIA) as TIA-472G000, in April 2010. This second edition was approved by ICEA on June 4, 2013, and approved by ANSI on November 8, 2013.

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This issue replaces the previous issue, ANSI/ICEA S-112-718-2008/TIA-472G0000, *Standard for Optical Fiber Cable for Placement in Sewer Environments*. Major changes in this revision include the following:

- Addition of new fiber types and reformatting of the fiber out-references
- New, altered definitions of composite and hybrid cables
- Addition of definitions for ribbons
- Addition of a buffer tube kink test
- Addition of an Expanded Ambient Test Condition and designation of those tests which utilize it
- Addition of a Normative Annex on 1625 nm performance

NOTE – The format of the Tables of this issue of the document has been modified from the previous issue and generally follows that of IEC Directives Part 2.

This Standard contains four annexes. Annex C is normative and considered part of this Standard when required by the customer. Annexes A, B, and D are informative and are not considered part of this Standard.

ICEA Standards are adopted in the public interest and are designed to eliminate misunderstanding between the manufacturer and user and to assist the user in selecting and obtaining proper products for a particular need. The existence of an ICEA Standard does not in any respect preclude the manufacture or use of products not conforming to this Standard.

The user of this Standard is cautioned to observe any applicable health or safety regulations and rules relative to the manufacture and use of cable made in conformity with this Standard. This Standard hereafter assumes that only properly trained personnel

using suitable equipment will manufacture, test, install and/or perform maintenance on cables defined by this Standard.

The Secretary can only accept questions of interpretation of ICEA Standards in writing at Headquarters at the address below, and the reply shall be provided in writing. Suggestions for improvements in this Standard are welcome. Questions and suggestions shall be sent to:

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Alternatively, ICEA can be contacted by utilizing the *Contact* link in the ICEA web site:

www.icea.net

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**ICEA STANDARD
FOR
OPTICAL FIBER CABLE FOR PLACEMENT IN SEWER ENVIRONMENTS

PART 1

INTRODUCTION**

1.1 Scope

1.1.1 General Overview

This Standard covers optical fiber communications cables intended for installation in underground sewers, specifically storm and sanitary sewers. Materials, construction, and performance requirements are included in this Standard, together with applicable test procedures. Additional applications-based considerations are discussed as well.

Refer to other ICEA optical cable product Standards which may have relevance to cables of this Standard:

- ICEA S-87-640 for optical fiber communications cables intended for general outside plant use
- ICEA S-104-696 for optical fiber communications cables intended for indoor/outdoor use.
- ICEA S-110-717 for optical fiber cables intended for aerial, duct, and buried outdoor and indoor/outdoor drop applications
- ICEA S-115-730 for optical fiber cables intended for Multiple Dwelling Unit (MDU) applications

Note that the MDU application space may overlap that of drop cables.

Refer to the following published ICEA optical cable product Standard for other applications

- ICEA S-83-596 for optical fiber cables intended for indoor applications.

1.1.2 Applications Space

Products covered by this Standard are intended for use in metropolitan, urban, and suburban communications networks via use of underground infrastructures, in the last portion of all-optical networks, such as storm and sanitary sewers. These products convey communications signals (voice, video, and data) in metropolitan network rings and serve as point-to-point connections to the subscriber's premises via sewer laterals, in the last portion of the optical network.

When a hybrid cable (a cable with both optical fibers and metallic conductors) is required, the applicable metallic conductor requirements shall be as established

by agreement between the end user and the cable manufacturer. The requirements of ICEA S-84-608, the filled OSP copper cable standard, should be considered when determining appropriate requirements.

These products are intended for use in sewer lines, using man-entry and non-man entry techniques. Such installations are intended to have no adverse effect on the efficiency of the sewer system. These cables are generally placed manually in pre-installed trays or conduits or may be secured to the sewer pipe wall by means of hooks, adhesive beds, sewer pipe liners, or may be tensioned intermittently, in order to maintain the cable and/or conduit out of the flow of the effluent. It is the intent that for many of the requirements of this Standard, the conduit or tray may provide the additional protection required of the cable system.

The successful application of optical fiber cables in sewer systems requires that all identified maintenance to or rehabilitation of the sewer pipes be conducted prior to cable installation, in accordance with procedures under development by ASTM¹.

1.1.3 Temperature Ranges

The normal temperature ranges for cables covered by this Standard are given in Table 1-1

Table 1-1
Cable Normal Temperature Ranges^a

	°C	°F
Operation	-20 to +70	-4 to +158
Storage and Shipping	-40 to +70	-40 to +158
Installation	-20 to +60	-4 to +140
Note:		
a) See section 1.4.1.7 for information on sewer-only cables.		

1.1.4 Tensile Rating

For the purposes of this document, the standard tensile rating represents the maximum allowable installation load for the cable. The standard tensile ratings for products covered by this Standard are as follows:

- 1335 N (300 lbf) for cables designed for installation by pulling into ducts.
- 440 N (100 lbf) for cables designed for installation into ducts with the assistance of compressed gases or for installation under low tension using

¹ Systems-level work on sewer-based communications applications is the prerogative of ASTM Technical Committee F36 on Technology and Underground Utilities.

man-entry (i.e., hand-installation), or non-man entry (e.g., robotics), techniques.

For some sewer applications additional considerations for tensile performance may be appropriate to ensure that the cable design is appropriate for the installation. One example is when tensioning a cable designed to stay at the top of a sewer pipe without the use of hooks. Some applications may require higher installation tensile ratings [e.g., 2670 N (600 lbf)] to support pulling of longer span distances or applications requiring larger diameter cables. See Annex B for information on additional sewer cable plant requirements and considerations.

The residual load is defined as a load equivalent to 30% of the standard tensile rating.

1.1.5 Minimum Bend Diameter

The standard minimum bend diameters for cables covered by this Standard are:

<u>Condition</u>	<u>Bend Diameter</u>
Residual (Installed):	20 x Cable OD*
Loaded (During Installation):	40 x Cable OD

*OD = outer diameter

For very small cables, such as those installed in miniature ducts, manufacturers may specify fixed cable minimum bend diameters (e.g., 300 mm) that are independent of the cable OD.

For cables having a non-circular cross-section, bend diameter requirements are to be determined using the thickness (minor axis) as the cable diameter and bending in the direction of the preferential bend.

1.1.6 Fire-Resistance

For purposes of this document, fire resistance listings are not required for cables designed for placement in sewers. However, fire resistance performance may be required for specific applications.

Users of this document are encouraged to consult pertinent Building and Fire Codes, such as those described in 1.9, to ensure product compliance to the requirements for a particular installation. Users are cautioned that the choice of materials needed to achieve adequate fire-resistance may impact the ability of such cables to be installed at the low temperatures of Table 1-1.

1.2 General

This publication is arranged such that cables may be selected from numerous constructions covering a broad range of installation and service conditions.

Parts 2 and 3 designate the materials, material characteristics, dimensions and tests applicable to the particular component.

Part 4 covers assembly, cabling, and identification of individual optical fibers and conductors.

Part 5 describes cable coverings, such as binders, wraps, metallic coverings, jacketing, and ripcords.

Part 6 provides other pertinent requirements not otherwise addressed by Parts 1 through 5 or by Parts 7 and 8 of this Standard.

Part 7 describes the test methods and performance requirements applicable to the component materials, in addition to Parts 2 and 3, and completed cables manufactured under this Standard. If there is a conflict between Parts 1 through 6 and Part 7, the provisions of Part 7 apply.

Part 8 contains routinely specified optical performance, test methods, and requirements for finished cables.

Part 9 contains cross-references to other standards and publications.

Annex A (Informative) contains information for users on ordering the types of cable products covered by this Standard.

Annex B (Informative) contains information on considerations for sewer cable installations.

Annex C (Normative) contains performance requirements for cabled fiber operating in the 1625 nm band (L-band), when required by the customer.

Annex D (Informative) contains information on other ICEA Standards.

1.3 Units

In this Standard, metric (SI) units are used. Their approximate U.S. customary units are included where appropriate. Where approximate equivalents in alternate systems are included they are provided for information only and in most cases are rounded off for measurement convenience. Unless otherwise specified, the Rounding Method of ASTM E 29 shall be used. Rounding of U.S. customary units may be adjusted for measurement convenience. ICEA P-57-653 is a useful guide for metric units used in this publication.

1.4 Definitions

See Annex B for additional definitions for sewer cable applications.

1.4.1 Cable Classification

In this Standard, communications cables are classified as one of the following types:

1.4.1.1 Composite Cables²

Cables containing more than one type of optical fiber.

1.4.1.2 Dielectric Cables

Cables which contain no metallic members or other electrically conductive materials.

1.4.1.3 Gas-Blockable Cable

Cable that is not designed to be gas-blocked, but which can be modified in the field to prevent the escape of gases through the cable ends.

1.4.1.4 Gas-Blocked Cable

Cable designed and manufactured to prevent the axial migration of gases through the cable.

² ICEA Standards prior to 2012 use definitions for *composite* and *hybrid* which are the exact opposite of those shown here. The change in definitions was made in the interest of harmonization with International documents and other National Standards. It must be noted that the definition of *composite* in the National Electrical Code, 2011 and earlier, are consistent with the older ICEA definition. Due to this change, users may see the terms used interchangeably. Regarding the definition for *hybrid*, as altered above: IEC uses a definition which encompasses metallic conductors used for all purposes – not just communication.

1.4.1.5 Hybrid Cables³

Cables having both optical fibers and metallic conductors that are intended for communications use or powering.

1.4.1.6 Metallic Cables

Cables that contain conductive members including those not normally intended to transmit information (voice, video, or data), such as metallic strength members, sheaths, shields, or armors. This also includes elements intended for toning/locating or powering.

1.4.1.7 Sewer-only Cable

Cable designed for use only within the protected confines of a sewer plant. Such cables may not have the requisite performance to withstand the conditions that might be encountered in the unprotected environment of the outside plant, such as extended exposure to solar radiation or temperature extremes. They may also have limitations on their use in indoor applications where fire-resistance is a concern.

1.4.2 Ribbons

1.4.2.1 Traditional Ribbon

Ribbons designed to meet the full mechanical and environmental requirements as an intact unit but which may be dissected into individual units.

1.4.2.2 Unitized Ribbon

Ribbons designed to be divided into pre-designed individual units, i.e. 4 or 6 fiber units. Sub units of the unitized units must meet the mechanical and environmental requirements of a traditional ribbon as stated in part 7 of this document.

1.4.3 Jackets and Sheaths

In this Standard, the term "jacket" refers to a continuous non-metallic covering while "sheath" refers to the protective elements covering the cable core, which may include a combination of metallic coverings, jackets, strength members, and the like.

³ See footnote 2 on the previous page.

1.4.4 Optical Fiber and Electric/Electronic Terms

Refer to TIA -440 and to IEEE-812 for definitions of other optical fiber terms. Refer to ANSI/IEEE Standard 100 for definitions of other electrical and electronic terms.

1.4.5 Detail Specification

The term "Detail Specification" refers to any requirement or set of requirements that are specific to the user's purchase. In case of conflict between a requirement called out in a Detail Specification and this Standard, the requirements of this Standard may be modified by agreement between the manufacturer and user. This definition does not apply to the optical fiber Detail Specifications referenced in Tables 2-1 and 2-2 of this Standard.

1.5 References

All documents referenced herein are listed in Part 9.

1.6 Information to Be Supplied by the User

When requesting proposals from cable manufacturers, the prospective user should describe the cable by referencing the pertinent Paragraphs of this Standard. To help avoid misunderstandings and possible misapplication of cable, the user should also provide pertinent information concerning the intended application. Recommended ordering information is summarized in Annex A.

1.7 Modification of this Standard

Any requirement of this Standard may be modified by agreement between the manufacturer and user, but such modifications shall be clearly denoted as exceptions to this Standard. In this Standard, requirements which are recognized to have various options, but for which preferred values are given, have been introduced by phrases such as, "Unless otherwise specified," or "Unless otherwise modified by manufacturer and user." Requirements not specified in this Standard, and which therefore must be determined in each case, are introduced by phrases such as "...established by agreement between manufacturer and user," or "...as mutually agreed upon."

1.8 Quality Assurance

It is the responsibility of the manufacturer to establish a quality assurance system consistent with TL 9000®, or an alternate system acceptable to the user, which

will assure conformance with the requirements of this Standard. When the user wishes to require a specific quality assurance program or special testing procedures, agreement between the user and the manufacturer should be reached before the order is placed.

1.9 Fire Resistance Codes

Cable type designations and safety performance requirements are determined by the following Codes:

United States Fire Resistance Codes:

1. NFPA 70, National Electrical Code (NEC)
2. Local Codes

Canada Fire Resistance Codes:

1. C22.2 No. 232, Canadian Standards Association (CSA)
2. Local Codes

Mexico Fire Resistance Codes:

1. Telecommunications - Cables - Optical Fiber Cables for Premises Applications (NMX-I-237-NYCE-2001)
2. Local Codes

1.10 Safety Considerations

Materials in the cable shall present no dermal or environmental hazards as defined by current industry Standards or applicable federal or state laws and regulations.

The manufacturer and user of cables made in accordance with this Standard are cautioned to observe any applicable health or safety rules and regulations relative to their manufacture and use. This Standard hereafter assumes that the manufacture, testing, installation, and maintenance of cables, defined herein, will be performed only by properly trained personnel, using suitable equipment, and employing appropriate safety precautions. Cable materials shall comply with the requirements of the European Union Restriction on Hazardous Substances (RoHS) directive, EU Directive 2002/95/EC.

Typically, cable materials should not contain more than specified maximum concentrations of the substances listed below:

- Cadmium
- Hexavalent Chromium
- Lead
- Mercury
- Polybrominated Biphenyls
- Polybrominated Diphenyl Ethers.

Use of these substances in electrical and electronic materials has been banned in the European Union by the Restriction on Hazardous Substances (RoHS) Directive (EU Directive 2002/95/EC) as amended by the Commission Decision of 18 August 2005 (2005/618/EC). Although use of these substances has not been banned throughout the United States at the time this document has been issued, many other nations and jurisdictions have adopted similar legislation.

In addition, it may also be required to comply with Article 33 of the European Directive, REACH Directive 2006/1907/EC (Registration, Evaluation, Authorization, and Restriction of Chemicals), which obligates the manufacture to notify the customers the presence of substances of very high concern (SVHC). A list can be viewed on the European Chemical Agency (ECHA) website for compliance to the REACH Directive (refer to http://echa.europa.eu/chem_data_en.asp).

PART 2

OPTICAL FIBERS

2.1 General

The optical fiber used in the cable shall comply with the requirements set forth in the standards listed in Table 2-1 for multimode and Table 2-2 for single-mode glass core, glass cladding optical fibers.

2.2 Optical Fiber Classes

Optical fibers used shall be one of those shown in Table 2-1 and Table 2-2. Other types of fibers may be used as agreed between manufacturer and customer. Such fibers may include fibers of new design offering performance optimized for particular applications.

2.3 Optical Fiber Requirements

- 2.3.1 Unless otherwise specified, optical fibers shall conform to the requirements of IEC 60793-2-10 or IEC 60793-2-50 detail specifications listed in Table 2-1 and Table 2-2.

Note: Fibers are commonly designated with reference to the IEC fiber specifications. Fibers are commonly designated using the terminology of the parallel ISO/IEC 11801 specifications for cabled multimode fiber and ITU-T G.650 series Recommendations for cabled single-mode fiber. TIA-4920000 series are commonly specified in North America. These mirror the IEC fiber specifications.

- 2.3.2 Each optical fiber shall be continuous throughout its length such that the requirements of Parts 7 and 8 of this Standard are met.
- 2.3.3 Cables shall not contain spliced fibers.

2.4 Optical Fiber Coating and Requirements

- 2.4.1 Optical fibers (glass core and glass cladding) shall be coated with a suitable material to preserve the intrinsic strength of the glass. Such coated fibers are termed "primary coated fibers."
- 2.4.2 The thickness of the coating(s) shall be such that the applicable requirements of this Standard are met. The coating diameter for standard fibers is 235 to 265 μm ; other coating diameters are acceptable provided that all other applicable

requirements are met and that there is agreement between manufacturer and user. Dimensions shall be measured according to the methods of 7.12.

- 2.4.3 The diameter over the coating is defined as the diameter of the fiber as used in the cable; that is, the diameter includes any coloring thickness if the fiber is colored, and is the uncolored coating diameter if the fiber is not colored.
- 2.4.4 Coating materials used shall meet the requirements of Parts 7 and 8 of this Standard or as otherwise permitted by the user.
- 2.4.5 The coating(s) shall be uniform and concentric with the glass. Coating(s) shall be removable by mechanical means without damage to the fiber(s) by using manufacturer's recommended procedures. See 7.19.2 for specific requirements.

Table 2-1

**Multimode Fiber Specifications
(with Informational Cross Reference)**

Fiber Type	ISO/IEC 11801^a	IEC Detail Specification	TIA Detail Specification
62.5/125 μm MM fiber	OM1	60793-2-10, A1b	492AAAA-B
50/125 μm	OM2	60793-2-10, A1a.1	492AAAB-A
50/125 μm Laser Optimized MM fiber	OM3 ^b	60793-2-10, A1a.2	492AAAC-B
50/125 μm Laser Optimized MM fiber	OM4	60793-2-10, A1a.3	492AAD
Notes: a) ISO/IEC 11801 is analogous to TIA 568 series (Commercial Building Wiring Standards). b) 50 μm Laser Optimized MMF (OM-3) are commonly used for ≥ 10 Gb/s Ethernet and Fibre Channel Systems. Mixing OM-2 fibers in OM-3 links can disproportionately degrade performance and should be generally avoided.			

Table 2-2
Single-mode Fiber Specifications^a
(with Informational Cross Reference)

Common Commercial Reference	ITU-T Recommendation	IEC Detail Specification	TIA Detail Specification
Dispersion-Unshifted SM fiber, with Low Water Peak	G.652.C & D	60793-2-50, B1.3	492CAAB
Cut-off shifted SM fiber	G.654	60793-2-50, B1.2	NA
Non-Zero Dispersion-Shifted SM Fiber (NZDS) ^b	G.655.D	60793-2-50, B4_d	492EA00
	G.655.E	60793-2-50, B4_e	492EA00
Non-Zero Dispersion-Shifted SM fiber (NZDS) for Wideband Transport	G.656	60793-2-50, B5	NA
Bend Optimized SM fiber ^c	G.657.A1 G.657.A2	60793-2-50, B6_a1 ^d 60793-2-50, B6_a2 ^d	NA ^e
	G.657.B2 G.657.B3	60793-2-50, B6_b2 ^d 60793-2-50, B6_b3 ^d	NA ^e
Notes: a) Older fiber types not listed in Table 2-2 are typically suitable for use. b) NZDS fiber is rarely used for drop cables. Using Dispersion-Unshifted SM fiber for the final, and typically short, segment of a long-haul NZDS link adds a trivial amount of chromatic dispersion. c) Bend optimized SM fiber (ITU-T G.657.A) is compliant with Dispersion-Unshifted SM fiber, with Low Water Peak (TIA-492CAAB). d) These specifications will be 60793-2-50 ed.4. e) At the time of this publication, no TIA standard was published for Bend Optimized SM fiber.			

PART 3

OPTICAL FIBER CORE UNITS

3.1 General

This Part defines specific types of units that may be used in cables designed for installation in sewers, such as: loose buffer tubes, optical fiber bundles, optical fiber ribbons, and tight buffered fibers. Fiber units are not limited to these types. Other types of units may be used providing that they meet the intent of Parts 3 and 4.

3.2 Buffered Fiber

Individual fibers may be buffered with one or more layers of material that increases their diameters and provides additional robustness and other performance attributes. The buffers may be tight buffer or semi-tight (loosely bound) buffer.

3.2.1 Tight Buffered Fiber

A tight buffer consists of one or more layers of buffer material applied around the individual optical fiber, so that it is in intimate contact with the primary coating of the fiber. The coating of the tight buffered fiber is generally adhered to the primary coating of the fiber such that all coatings are removed during stripping, leaving only bare glass.

3.2.2 Semi-tight Buffered Fiber

A semi-tight buffer (also called loosely bound buffer) is substantially the same in function and construction as a tight buffer, but is not in such intimate contact with the primary coating of the fiber. The semi-tight buffer is capable of being removed without affecting the fiber primary coating.

3.2.3 Buffer Dimensions (both types)

Buffer dimensions are established by the cable manufacturer to ensure that the applicable performance requirements of this Standard are met. Dimensions shall be measured according to the methods of 7.10.

The standard nominal buffer outer diameter is 900 μm . Common alternatives are 500 μm and 600 μm . In all cases, the tolerance about the nominal outer diameter is $\pm 50 \mu\text{m}$.

3.2.4 Buffer Requirements (both types)

- 3.2.4.1 The buffered fiber shall be constructed so that the finished cable meets all applicable performance requirements specified in Part 7.
- 3.2.4.2 Each buffered fiber shall be uniquely identifiable. Methods shall conform to 4.2.
- 3.2.4.3 The buffer shall be uniform and concentric with the optical fiber, consistent with good commercial practice.
- 3.2.4.4 The buffered fiber shall be strippable in accordance with 7.15.

3.3 Loose Buffer Tubes

Loose buffer tubes consist of optical fiber(s) or optical fiber ribbon(s) inside a tube that isolates the fibers from outside stress. The inside dimension is greater than the maximum dimension of the combined optical elements surrounded by the tube. The space between the optical elements and the inside of the tube contains a suitable water blocking material. Loose tubes are typically employed as single central units, or in stranded configurations in multiple unit designs.

3.3.1 Loose Buffer Tube Dimensions

Buffer tube dimensions are set by the manufacturer to ensure that the applicable performance requirements of this Standard are met. Dimensions shall be measured according to the methods of 7.12.

3.3.2 Loose Buffer Tube Requirements

- 3.3.2.1 The loose buffer tubes shall be constructed such that the finished cable meets all applicable performance requirements specified in Part 7.
- 3.3.2.2 The loose buffer tubes shall be uniform and concentric. Buffer tubes must be removable, without damage to the fibers, using the manufacturer's recommended procedures.
- 3.3.2.3 Each loose buffer tube, in multi-tube cable designs, shall be uniquely identifiable. Methods shall conform to 4.3. For cables having a single (i.e., central) buffer tube, no specific identification method is required.

3.4 Optical Fiber Bundles

Bundles are arrays of color-coded optical fibers, held together and identified by a color-coded binder, that reside in a buffer tube(s).

Binders shall comply with 4.3 and 4.5.2.

3.5 Optical Fiber Ribbons

A ribbon is a planar array of optical fibers.

3.5.1 Ribbon Identification

Each ribbon shall be uniquely identifiable. The identification method shall conform to 4.3. Generally, ribbons comprise one unit. However, ribbons may contain more than one unit, in which case separate units shall be appropriately identified.

3.5.2 Fiber Identification in Ribbons

Each fiber within a ribbon shall be uniquely identifiable. Methods shall conform to 4.2 and 4.3, as applicable.

3.5.3 Ribbon Fiber Counts

The following are common fiber counts of optical fiber ribbons that may be used in the applications covered by this Standard: 2, 4, 6, 8, 12, and 24. Fiber counts in ribbons shall be established by agreement between manufacturer and user.

3.5.4 Ribbon Requirements

Ribbons shall be constructed so that the finished cable meets all applicable performance requirements specified in Part 7. The following additional requirements pertain specifically to ribbons:

3.5.4.1 Ribbon Dimensions

Certain ribbon dimensions may be important in cable design, in splice apparatus, or for successful splicing of one ribbon to another. All measurements, except the outer matrix dimensions, shall be referenced from either the cladding edge or the center of the core. Fiber coatings shall not be used for reference. Important dimensions are shown in Figure 7-1 and are listed in Table 7-2. Measure the attributes as established by agreement between manufacturer and user, and as directed by 7.13.