



ANSI/ICEA S-112-718-2020

Standard for Optical Fiber Cable For
Placement in Sewer Environments

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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. The second edition was approved by ICEA in June 2013, and was approved by ANSI on November 8, 2013. This third edition was approved by ICEA on March 3, 2020, and was approved by ANSI on [Month dd, yyyy].

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This issue replaces the previous issue, ANSI/ICEA S-112-718-2013, *Standard for Optical Fiber Cable for Placement in Sewer Environments*. Major changes in this revision include the following:

- Updated text on hazardous substances requirements.
- Addition of new fiber types and reformatting of the fiber out-references.
- Addition of OM5 multimode fiber.
- Updated text and a new table explaining bend insensitive single-mode fiber.
- Addition of 200 micron fiber.
- Addition of descriptive text on easily-strippable semi-tight buffer.
- OIT is now required for polyolefin (PE or PP) jacket materials and LSHF jacket materials using polyolefin base resins.
- Some IEC test methods are stated as acceptable alternatives:
 - jacket print test
 - ribbon separability test
- The temperature precision for testing has been changed to $\pm 3^{\circ}\text{C}$ from $\pm 2^{\circ}\text{C}$.
- Partially bonded ribbons have been accommodated in the ribbon requirements.
- The fiber strain criteria regarding high-proof fibers has been inserted into the cable tensile load and bend test.
- Annex D, the listing of ICEA Standards, is deleted. Refer to the ICEA web site for a current listing.

This Standard contains three annexes. Annex C is normative and considered part of this Standard when required by the customer. Annexes A and B 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.

ANSI/ICEA S-112-718-2020

Requests for interpretation of this ICEA Standard must be submitted in writing (hard copy or email) to the Secretary of the Insulated Cable Engineers Association. The mailing address of ICEA Headquarters and a *Contact* link are shown on the ICEA web site - www.icea.net. An official written interpretation will be provided.

CONTENTS

PARAGRAPH	PAGE
Section 1: INTRODUCTION	1
1.1 Scope	1
1.2 General	3
1.3 Units	4
1.4 Definitions	4
1.5 References	5
1.6 Information to Be Supplied by the User	5
1.7 Modification of this Standard	6
1.8 Quality Assurance	6
1.9 Fire Resistance Codes	6
1.10 Safety Considerations	6
Section 2: OPTICAL FIBERS	8
2.1 General	8
2.2 Optical Fiber Classes	8
2.3 Optical Fiber Requirements	8
2.4 Optical Fiber Coating and Requirements	8
Section 3: OPTICAL FIBER CORE UNITS	12
3.1 General	12
3.2 Buffered Fiber	12
3.3 Loose Buffer Tubes	13
3.4 Optical Fiber Bundles	13
3.5 Optical Fiber Ribbons	13
3.6 Slotted Core	15
Section 4: CABLE ASSEMBLY, FILLERS, STRENGTH MEMBERS, AND FIBER AND UNIT IDENTIFICATION	16
4.1 Cabling of Multi-Fiber Optical Fiber Cables	16
4.2 Identification of Fibers within a Unit	16
4.3 Identification of Units within a Cable	16
4.4 Identification of Conductors in Hybrid Cable	16
4.5 Strength Members	18
4.6 Assembly of Cables	18
4.7 Filling and Flooding Materials	18
Section 5: COVERINGS	19
5.1 Binders	19
5.2 Shielding, Armoring, or Other Metallic Coverings	19
5.3 Jackets	20
5.4 Other Coverings	21
5.5 Jacket Repairs	21
5.6 Ripcords	21

<u>PARAGRAPH</u>	<u>PAGE</u>
Section 6: OTHER REQUIREMENTS	22
6.1 Identification and Date Marking	22
6.2 Optical Cable Identification and Other Markings	22
6.3 Length Marking.....	22
6.4 Cable Remarkings.....	23
6.5 Packaging and Marking	23
Section 7: TESTING AND TEST METHODS	24
7.1 Testing.....	24
7.2 Extent of Testing.....	24
7.3 Standard Test Conditions.....	24
7.4 Electrical Testing of Conductive Cable Components	25
7.5 Verification of Physical Construction, Color Code, and Identification	25
7.6 Environmental Stress Cracking Resistance Test	26
7.7 Jacket Shrinkage Test	26
7.8 Cable Chemical Resistance Test.....	26
7.9 Gas-Blocked Cable Test	28
7.10 Weathering Test	29
7.11 Verification of Cable Length and Marking Accuracy.....	29
7.12 Dimensions of Fibers, Buffered Fibers, and Buffer Tubes	30
7.13 Ribbon Dimensions.....	30
7.14 Ribbon Separability Test.....	32
7.15 Ribbon Twist Test.....	33
7.16 Ribbon Residual Twist Test.....	33
7.17 Buffer Strippability Test	34
7.18 Ripcord Functional Test	34
7.19 Material Compatibility and Cable Aging Test	35
7.20 Cable Low and High Temperature Bend Test.....	36
7.21 Cable External Freezing Test	37
7.22 Cable Compound Flow (Drip) Test	37
7.23 Cable Temperature Cycling Test	37
7.24 Cable Cyclic Flexing Test.....	38
7.25 Cable Impact Test	38
7.26 Cable Cold Impact Test.....	39
7.27 Cable Tensile Loading, Bending, and Fiber Strain Test	39
7.28 Cable Compressive Loading Test.....	40
7.29 Cable Twist Test.....	41
7.30 Cable Sheath Adherence Test	41
7.31 Cable Water Penetration Test	42
7.32 Cable Fire Resistance.....	42
7.33 Jacket Tensile Strength, Yield Strength, and Ultimate Elongation Testing	43
7.34 Oxidative Induction Time, OIT	43
7.35 Jacket Thickness Measurements	43
7.36 Buffer Tube Kink Test	44

<u>PARAGRAPH</u>	<u>PAGE</u>
Section 8: FINISHED CABLE OPTICAL PERFORMANCE REQUIREMENTS	45
8.1 Optical Performance	45
8.2 Attenuation Coefficient.....	46
8.3 Multimode Optical Bandwidth	47
8.4 Measurement of Optical Point Discontinuities	48
8.5 Cable Cutoff Wavelength Measurement (Single-mode Fibers).....	48
Section 9 REFERENCES	50
ANNEX A (INFORMATIVE) ORDERING INFORMATION	53
ANNEX B (INFORMATIVE) SEWER CABLE CONSIDERATIONS	54
ANNEX C (NORMATIVE) 1625 NM SINGLE-MODE CABLED FIBER PERFORMANCE REQUIREMENTS	62

TABLES

Table 1-1 Cable Normal Temperature Ranges.....	2
Table 2-1 Multimode Fiber Specifications	9
Table 2-2 Single-mode Fiber Specifications	10
Table 2-3 Fiber Bend Characteristics of G.657 Single-mode Fiber	11
Table 4-1 Individual Fiber, Unit, and Group Identification.....	17
Table 7-1 Fluid Immersion Test Criteria.....	27
Table 7-2 Maximum Dimensions of Optical Fiber Ribbons.....	31
Table 8-1 Attenuation Coefficient Requirements	45
Table 8-2 Multimode Bandwidth Coefficient Performance Requirements.....	46
Table 8-3 Point Discontinuity Acceptance Criteria	46
Table 8-4 Optical Attenuation Measurement Methods	47
Table 8-5 Multimode Optical Bandwidth Measurement Methods.....	48
Table C-1 Acceptance Criteria for L-band Operation.....	62

FIGURES

Figure 7-1 Ribbon Dimensional Parameters.....	31
Figure 7-2 Ribbon Preparation	32
Figure 7-3 Ribbon Separation	33

ICEA STANDARD FOR OPTICAL FIBER CABLE FOR PLACEMENT IN SEWER ENVIRONMENTS

Section 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 cables intended for general outside plant use
- ICEA S-104-696 for optical fiber 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.
- ICEA S-122-744 for microduct cables

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

- ICEA S-83-596 for optical fiber cables intended for indoor applications
- ICEA S-119-741 for fiber to the antenna cables
- ICEA S-120-742 for distributed antenna system cables

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⁽¹⁾

	°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:

1) 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 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.

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

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.

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

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

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

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

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

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

Section 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.

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.

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.

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.

³ See footnote 2 on the previous page.

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. Subunits of the unitized units must meet the mechanical and environmental requirements of a traditional ribbon as stated in Section 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.

1.4.4 Optical Fiber and Electric/Electronic Terms

Refer to TIA-440 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 Section 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, state or local 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 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.

Use of certain potentially hazardous substances above allowed limits in electrical and electronic materials has been banned in the European Union by the Restriction on Hazardous Substances (RoHS2) Directive 2011/65/EU superseding the original RoHS Directive 2002/95/EC which was

officially repealed January 3, 2013. RoHS 2 is applicable to all equipment that has at least one intended function dependent on electrical or electromagnetic fields.

Although use of these substances has not been banned throughout the United States at the time this document has been issued, other jurisdictions and nations including the state of California, have adopted similar legislation banning use of these substances above allowed limits in electrical and electronic materials.

Cable materials shall comply with the requirements of the European Union Restriction on Hazardous Substances RoHS 2 directive as it applies to the cable constituent materials.

The materials restricted by the latest RoHS 2 Directive are listed below:

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

In 2015, a new Directive (EU) 2015/863 was published to add the following 4 phthalates to the list of restricted substances in the RoHS 2 Directive.

- Bis(2-Ethylhexyl) phthalate (DEHP)
- Benzyl butyl phthalate (BBP)
- Dibutyl phthalate (DBP)
- Diisobutyl phthalate (DIBP)

The EU Frequently Asked Questions document on RoHS 2 explicitly notes that optical cables are exempt from RoHS 2 (refer to section Q7.2 of http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf). Although the restrictions of RoHS 2 are not applicable to optical cable, it is best practice to avoid use of these potentially hazardous materials, therefore it is required in this Standard.

In addition, compliance may be required with Article 33 of the European REACH Directive 2006/1907/EC (Registration, Evaluation, Authorization and Restriction of Chemicals), which obligates manufacturers to notify customers in the EU of the presence of cable materials or components that are classified as substances of very high concern (SVHC). A list of current and candidate SVHC can be viewed on the European Chemical Agency (ECHA) website to help determine compliance with the REACH Directive (refer to <https://echa.europa.eu/candidate-list-table>).

Section 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; however, these specifications often lag their IEC and ITU-T counterparts.

- 2.3.2 Each optical fiber shall be continuous throughout its length such that the requirements of Sections 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 colored 250 μm fibers is 235 to 265 μm . The coating diameter for colored 200 μm fiber is 180 to 220 μm . These diameters are per IEC 60793-2-10 for multimode fiber and IEC 60793-2-50 for single-mode fiber. 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 Sections 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
(Informational Cross Reference)**

Fiber Type	ISO/IEC 11801-1⁽¹⁾	IEC Detail Specification	TIA Detail Specification
62.5/125 μ m MM fiber	OM1 ⁽²⁾	60793-2-10, A1-OM1 (A1b)	492AAAA-B
50/125 μ m	OM2 ⁽²⁾	60793-2-10, A1-OM2 (A1a.1)	492AAAB-A
50/125 μ m Laser Optimized MM fiber ⁽³⁾	OM3 ⁽⁴⁾	60793-2-10, A1-OM3 (A1a.2)	492AAAC-B
50/125 μ m Laser Optimized MM fiber ⁽³⁾	OM4 ⁽⁴⁾	60793-2-10, A1-OM4 (A1a.3)	492AAAD
50/125 μ m Laser Optimized MM fiber ⁽³⁾	OM5 ⁽⁴⁾	60793-2-10, A1-OM5 (A1a.4)	492AAAE

Notes:

- 1) ISO/IEC 11801 series is analogous to TIA 568 series (Customer Premises Telecommunications Cabling Standard). ISO/IEC 11801-1 categories define fiber performance when cabled.
- 2) OM1 and OM2 are no longer supported as normative in ISO/IEC 11801-1. They remain as informative, grandfathered for historical references.
- 3) IEC 60793-2-10, edition 7, defines the A1 fiber bandwidth grades, A1-OM2, A1-OM3, A1-OM4, and A1-OM5, with two levels of macrobend loss performance. The "a" suffix, e.g., A1-OM3a, etc., denotes traditional macrobend loss performance levels, and those with the "b" suffix, e.g., A1-OM3b, etc., defines enhanced macrobend loss levels. Therefore, the "b" fibers define bend insensitive multimode fibers.
- 4) 50/125 μ m Laser Optimized MM fiber (OM3, OM4, or OM5) is designed for 850 nm laser based operations but supports legacy LED data rates at 850 nm and 1300 nm. Mixing OM2, OM3, and OM4/5 fibers in links can disproportionately degrade performance and should be generally avoided.

Table 2-2

Single-mode Fiber Specifications⁽¹⁾
(Informational Cross Reference)

Common Commercial Reference	ITU-T Recommendation	IEC Detail Specification⁽²⁾	TIA Detail Specification
Dispersion-Unshifted SM fiber, with Low Water Peak	G.652.D	60793-2-50, B-652.D (B1.3)	492CAAB
Cut-off shifted SM fiber	G.654	60793-2-50, B-654.B&C (B1.2)	NA
Non-Zero Dispersion-Shifted SM Fiber (NZDS)	G.655.D	60793-2-50, B-655.D (B4_d)	492EA00
	G655.E	60793-2-50, B-655.E (B4_e)	492EA00
Non-Zero Dispersion-Shifted SM fiber (NZDS) for Wideband Transport	G.656	60793-2-50, B-656 (B5)	NA
Bend Optimized SM fiber	G.657.A1 G.657.A2	60793-2-50, B-657.A1 ⁽³⁾ (B6_a1) 60793-2-50, B-657.A2 ⁽³⁾ (B6_a2)	NA ⁽⁴⁾
	G.657.B2 G.657.B3	60793-2-50, B-657.B2 ⁽³⁾ (B6_b2) 60793-2-50, B-657.B3 ⁽³⁾ (B6_b3)	NA ⁽⁴⁾

Notes:

- 1) Older fiber types not listed in Table 2-2 are typically suitable for use.
- 2) The IEC fibre designations shown in parentheses are those used in IEC 60793-2-50, Ed 6, and earlier.
- 3) Bend Optimized SM fiber (ITU-T G 657.A) is compliant with Dispersion-Unshifted SMF with Low Water Peak (ITU-T G.652.D). Note that G.657.B fiber may or may not be compliant with G.652.D. The bending characteristics of G.657 fiber are further explained in Table 2-3.
- 4) At time of this publication, no TIA standard was published for Bend Optimized SM fiber.

Table 2-3**Fiber Bend Characteristics of G.657 Single-mode Fiber
(Informative)**

Minimum design radius⁽¹⁾	G.652.D Compliant⁽²⁾	G.652.D Compatible⁽³⁾
10 mm	G.657.A1	
7.5 mm	G.657.A2	G.657.B2
5.0 mm		G.657.B3

Notes:

- 1) The minimum design radii are used to categorize the fibers and are based on the 1-turn specification in the applicable ITU-T Recommendation and IEC fiber specifications.
- 2) Compliant – Fully meets the standard specified.
- 3) Compatible – Can be used with fibers meeting the specification, but does not necessarily meet the specification.
For example: G.652 jumpers are known to be compatible with G.655 fibers. They will work acceptably in any system as long as they are short enough not to impact the chromatic dispersion and the customer is willing to have a slightly higher insertion loss due to the MFD mismatch.

General notes:

Two classes, which come from the systems considerations, are long distance (G.652.D compliant) and short reach applications. The short reach applications do not need to specify CD and PMD as the fiber segments are short enough that these properties do not impact system performance.

Three subcategories come from the cable specifications considerations where minimum design radius is the parameter of importance.

Bend insensitive fibers may also require use of alternative fusion splicer programs.

Section 3

OPTICAL FIBER CORE UNITS

3.1 General

This Section 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 Sections 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.

Semi-tight buffers may also be constructed as easily strippable semi-tight buffer. This allows longer lengths to be stripped at the specified strip force.

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 Section 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.