

Recommended Practice for the Application of Electrical Submersible Cable Systems

API RECOMMENDED PRACTICE 11S5
SECOND EDITION, APRIL 2008

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Upstream Segment

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Recommended Practice for the Application of Electrical Submersible Cable Systems

1 Scope

This document covers the application (size and configuration) of electrical submersible cable systems by manufacturers, vendors, or users.

2 Normative References

This recommended practice includes by reference, either in total or in part, other standards and recommended practices listed below. The latest edition of these standards and recommended practices should be used unless otherwise noted:

API RP 11S6, *Recommended Practice for Testing of Electric Submersible Pump Cable Systems*

ASTM A90¹, *Standard Test Methods for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings*

ASTM A459, *Standard Specification for Zinc-Coated Flat Steel Armoring Tape*

ASTM B3, *Standard Specification for Soft or Annealed Copper Wire*

ASTM B8, *Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft*

ASTM B33, *Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes*

IEEE 1018², *Recommended Practice for Specifying Electric Submersible Pump Cable Ethylene-Propylene Rubber Insulation*

IEEE 1019, *Recommended Practice for Specifying Electric Submersible Pump Cable Polypropylene Insulation*

NEMA³ WC-Code

NFPA 70⁴, *National Electric Manufacturers Association—High Performance Wire and Cable Section*

3 Terms and Definitions

3.1 General

3.1.1

american wire gauge

AWG

Standard wire gauge systems used for nonferrous electrically conducting wires where increasing gauge number gives decreasing wire diameters.

3.1.2

ampacity

The current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding the temperature rating of the cable.

¹ASTM International, 100 Bar Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

²Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08854, www.ieee.org.

³National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1752, Rosslyn, Virginia 22209, www.nema.org.

⁴National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169-7471, www.nfpa.org.

3.1.3**antioxidants**

Materials added to polymer compounds used to prevent degradation (oxidation) in rubber or plastic by retarding hardening and embrittlement.

3.1.4**compound**

A mechanical blend of base polymer with other ingredients added to obtain the desired properties that are usually proprietary formulations varying between each manufacturer and that may affect the cable performance.

3.1.5**corrosion**

The destruction of the surface of a metal by oxidation that can be initiated by the action of chemicals alone or in combination with well fluids.

NOTE Galvanic corrosion results from an electrochemical reaction in which an electric current flows between two dissimilar metals in a conductive medium, such as salt water.

3.1.6**cross linked polyethylene****XLPE**

A polyethylene modified through a chemical reaction, which becomes permanently shaped when cured.

3.1.7**cure**

The process of changing the physical characteristics of raw rubber during the manufacturing of a cable that requires a curing agent, heat, and pressure to produce a suitable insulation or jacketing material.

NOTE Vulcanizing and cross-linking are forms of curing.

3.1.8**dielectric strength**

The maximum electrical potential gradient that a material can withstand without rupture, usually specified in volts per millimeter (or mils) of thickness.

NOTE This is also referred to as electric strength.

3.1.9**ethylene chlorotetrafluoroethylene****ECTFE**

A chlorofluorinated thermoplastic copolymer composed of ethylene and chlorotetrafluoroethylene belonging to the group of plastic materials known as fluoropolymers, that is chemically inert and a good low voltage electrical insulator.

3.1.10**elastomer**

A rubber-like material that can stretch under low stress and return to its original shape when the stress is removed.

3.1.11**electrical insulation resistance**

The resistance which varies between compounds and cable geometry of the insulation to the radial flow of direct current through the insulation.

NOTE A measure of performance is balanced values of insulation resistance or leakage current for each phase.

The formula to measure insulation resistance (IR) is:

$$IR = \frac{E}{I}$$

where

IR is megohms at 60 °F;

E is the voltage applied between the conductor and ground in volts;

I is the DC leakage current in microamps.

3.1.12

ethylene propylene diene monomer

EPDM

A polymer composed of ethylene, propylene, and diene units that can be cured with a sulfur or peroxide.

3.1.13

ethylene propylene monomer

EPM

A polymer composed of ethylene and propylene units that must be cured with a peroxide-curing agent resulting in useful properties that are similar to EPDM.

3.1.14

ethylene propylene rubber

EPR

A term used to describe either EPDM or EPM.

3.1.15

ethylene tetrafluoroethylene

ETFE

A fluorinated thermoplastic copolymer composed of ethylene and tetrafluoroethylene belonging to the group of plastic materials known as fluoropolymers, that is chemically inert and a good low voltage electrical insulator.

3.1.16

fillers, compound

Materials added to compounds to enhance various properties such as mechanical strength, moisture resistance, and electrical characteristics.

3.1.17

fillers, physical

Materials used to fill interstices in cable construction, such as rubber and polypropylene.

3.1.18

fluorinated ethylene propylene

FEP

A thermoplastic fluorinated ethylene propylene copolymer belonging to the group of plastic materials known as fluoropolymers, that is chemically inert and a good low voltage electrical insulator.

3.1.19

hoop strength

A measure of the tangential resistance to elongation.

NOTE Internal gas pressure pushes in a radial direction creating a tendency for the surface of the insulation and jacket to elongate and rupture tangentially which the hoop strength resists, aided by additional wraps applied over the round components.

3.1.20**leakage current**

The current that flows across the surface or through the insulation when a DC voltage is applied defining the insulation resistance at the specified DC potential.

NOTE Regardless of the quality of the dielectric material, all materials will exhibit some leakage current.

3.1.21**monomer**

A basic chemical unit that forms a polymer by chemical linking.

3.1.22**nitrile**

A copolymer of butadiene and acrylonitrile monomers, also referred to as Buna N, nitrile rubber, and nitrile butadiene rubber (NBR), which varying ratios of acrylonitrile to butadiene to provide trade off between oil resistance or low temperature properties for specific applications.

3.1.23**pigtail**

A length of cable that is spliced onto the main power cable.

3.1.24**plasticizers**

Chemicals added to compounds to impart flexibility, workability, and stretchability.

3.1.25**polyamide**

A high molecular weight polymer thermoplastic material composed of polymers that contain an amide (-COHN-) group exhibiting a modest degree of chemical inertness and has a high tensile strength.

3.1.26**polyester**

A thermoplastic material made by esterification of polybasic organic acids with polyhydric acids typically used as an alternative to polyamide as a braid material over taped barriers, most commonly over fluoropolymer barrier tape materials.

3.1.27**polyethylene****PE**

A thermoplastic material composed of chemically linked ethylene monomer units.

3.1.28**polyimide**

A fully reacted linear polymer incorporated with the imide group in the polymer main chain.

3.1.29**polymer**

A material formed by linking together monomers through a chemical reaction, consisting of a chain of repeated structural units.

NOTE Prefixes denoting one, two or three basic units are "homo," "co," and "ter," respectively.

3.1.30**polyphenylene sulfide****PPS**

A material that provides good high temperature and chemical resistance.