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# IEEE Guide for Selection and Installation of Electrical Cables and Cable Systems in Hazardous (Classified) Locations on Oil and Gas Land Drilling Rigs

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IEEE Industry Applications Society

Developed by the
Petroleum and Chemical Industry Committee

and the

IEEE Power and Energy Society

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# IEEE Guide for Selection and Installation of Electrical Cables and Cable Systems in Hazardous (Classified) Locations on Oil and Gas Land Drilling Rigs

Developed by the

**Petroleum and Chemical Industry Committee**
of the
**IEEE Industry Applications Society**

**Insulated Conductors Committee**
of the
**IEEE Power and Energy Society**

Approved 3 December 2020

**IEEE SA Standards Board**

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**Abstract:** Selection, performance requirements, and procedures for flexible electrical cables and cable systems installed in hazardous (classified) locations on oil and gas land drilling rigs are covered by this guide.

**Keywords:** cables, cable installation, cable retention, cable selection, cable systems, Class I Division 1, Class I Zone 1, Class I Division 2, Class I Zone 2, classified locations, flexible applications, hazardous locations, IEEE 2740™, oil and gas land drilling rig, portability

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## Introduction

This introduction is not part of IEEE Std 2740-2020, IEEE Guide for Selection and Installation of Electrical Cables and Cable Systems in Hazardous (Classified) Locations on Oil and Gas Land Drilling Rigs.

The oil and gas industry depends on working within regulatory requirements, industry standards, and industry guidelines. In the case of oil and gas well land drilling rigs in the United States, there are no standards or governing codes that directly address cables and cable systems. Land drilling rig applications often combine hazardous (classified) locations, extreme ambient temperature ranges, vibration, temporary installations, flexibility, and ability to transport over various terrains. The National Electrical Code® (NEC®) NFPA 70 standard does not cover the selection, performance requirements, and procedures for flexible electrical cables and cable systems installed in hazardous (classified) locations on oil and gas land drilling rigs. Instead, its focus is on fixed installations in hazardous (classified) locations. When users have tried to apply National Electrical Code regulations for fixed hazardous (classified) locations, they have encountered conflicts between portability, flexibility, and solutions permitted for fixed hazardous (classified) locations; therefore, users have relied on the API RP 14F and API RP 14FZ recommended practices for installation methods that are not specific to oil and gas land drilling rigs since they reference offshore facilities. This gap creates confusion for new engineers and inspectors trying to understand cables and cable systems for oil and gas well land drilling rigs. However, within the 2020 edition of NFPA 70, an entirely new article (Article 337) has been added along with new language in Article 501 to address this gap. This guide should be consulted only in addition to consideration and evaluation of site-specific circumstances, risks, and applicable safety requirements.


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# IEEE Guide for Selection and Installation of Electrical Cables and Cable Systems in Hazardous (Classified) Locations on Oil and Gas Land Drilling Rigs

## 1. Overview

### 1.1 Scope

This guide covers the selection and procedures for electrical cables and cable systems installed in hazardous (classified) locations on oil and gas land drilling rigs.

### 1.2 Purpose

The intent of this guide is to present generally accepted practices for the selection and installation of electrical cables and cable systems in hazardous (classified) locations on oil and gas land drilling rigs. Experience in the oil and gas land rig drilling industry has shown these practices result in safer, more reliable, efficient, and maintainable operations. The practices in this guide should be applied with sound engineering judgment.

This guide will address gaps in the selection, performance, and installation of cables and cable systems for Class I hazardous (classified) locations on oil and gas land drilling rigs not adequately addressed in present standards, recommended practices, and guides. The key drivers are flexibility, portability, allowance for innovation, and expanded use of cables and systems utilized in other industries.


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### 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*).[1,2]

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*).

## 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.

API RP 500, Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2.[3]

API RP 505, Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2.

ICEA P-32-382, Short Circuit Characteristics of Insulated Cables.[4]

ICEA P-45-482, Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables.

ICEA S-75-381/NEMA WC 58, Portable and Power Feeder Cables for Use in Mines and Similar Applications.

ICEA S-95-658/NEMA WC 70, Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.

IEC 60287-1-1, Electric Cables—Calculation of the Current Rating—Current Rating Equations (100% Load Factor) and Calculation of Losses—General.[5]

IEEE Std 45.8™, IEEE Recommended Practice for Electrical Installation on Shipboard—Cable Systems.[6,7]

IEEE Std 835™, IEEE Standard Power Cable Ampacity Tables.

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[1] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.
[2] The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.
[3] API publications are available from the American Petroleum Institute (https://www.api.org/).
[4] ICEA publications are available from the Insulated Cable Engineers Association (https://www.icea.org/).
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IEEE Std 1580™, IEEE Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Facilities.

NFPA 70, National Electrical Code® (NEC®).[8,9]

# 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* should be consulted for terms not defined in this clause.[10]

## 3.2 Acronyms and abbreviations

**adjustable speed drive (ASD):** Electronic power conversion equipment that provides a means of adjusting the speed of an electric motor.

**AEx:** Required marking prefix for electrical apparatus to be installed in hazardous (classified) locations meeting one or more types of protection in accordance with harmonized American National Standards (ANSI) as defined in Article 505 of the NEC.

**approved:** Acceptable to the authority having jurisdiction. (Electrical devices that are approved by a Nationally Recognized Testing Laboratory normally are acceptable.)

NOTE—The means for identifying approved equipment can vary for each organization concerned with product evaluation, some of which do not recognize equipment as approved unless it is also labeled. The authority having jurisdiction normally utilizes the system employed by the certifying organization to identify an approved product.[11]

**Class I location:** A Class I location is one in which flammable gases or vapors are or may be present in the air in quantities enough to produce explosive or ignitable mixtures. (See NEC Article 500, NEC Article 505, API RP 500, and API RP 505.)

**Class I, Division 1 location:** A Class I, Division 1 location is a location: 1) in which ignitable concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions; or 2) in which ignitable concentration of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or 3) in which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electrical equipment. (See NEC Article 500 and API RP 500.)

**Class I, Division 2 location:** A Class I, Division 2 location is a location: 1) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only if accidental rupture or breakdown of such containers or systems or abnormal operation of equipment

[8] NFPA publications are published by the National Fire Protection Association (https:// www.nfpa.org/).
[9] The NEC is published by the National Fire Protection Association (https://www.nfpa.org/). Copies are also available from the Institute of Electrical and Electronics Engineers (https://standards.ieee.org/).
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occurs; or 2) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, but that might become hazardous through failure or abnormal operation of the ventilating equipment; or 3) that is adjacent to a Class I, Division 1 location, and to which hazardous concentration of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided. (See NEC Article 500 and API RP 500.)

**Class I, Zone 0:** A Class I, Zone 0 location is a location 1) in which ignitable concentrations of flammable gases or vapors are present continuously; or 2) in which ignitable concentrations of flammable gases or vapors are present for long periods of time. (See NEC Article 505 and API RP 505.)

**Class I, Zone 1:** A Class I, Zone 1 location is a location 1) in which ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or 2) in which ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or 3) in which equipment is operated, or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or 4) that is adjacent to a Class I, Zone 0 location from which ignitable concentrations of vapors could be communicated, unless communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. (See NEC Article 505 and API RP 505.)

**Class I, Zone 2:** A Class I, Zone 2 location is a location 1) in which ignitable concentrations of flammable gases or vapors are not likely to occur in normal operation, and if they do occur, will exist only for a short period; or 2) in which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used, but in which the liquids, gases, or vapors normally are confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or system, or as the result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or 3) in which ignitable concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilation equipment; or 4) that is adjacent to a Class I, Zone 1 location, from which ignitable concentrations of flammable gases or vapors could be communicated, unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided. (See NEC Article 505 and API RP 505.)

**classified location:** A hazardous (classified) location is a location classified as Division 1 or Division 2, or Zone 0, Zone 1, or Zone 2.

**communication and electronics circuits:** Electrical circuits supplying equipment and systems for voice, sound, or data transmission, such as telephone, data communication, interior communication, paging systems, wired music systems, fire and general alarm systems, smoke and fire detection systems, closed circuit television, and microprocessor-based automated alarm and control systems.

**double-banked:** The arrangement of cables in a cable tray or raceway wherein the cables are stacked in two layers.

**drag chain:** A reciprocating cable-management system that can contain cables and/or hoses that are allowed free movement within the drag chain. Cables and/or hoses can be in single or multiple layers.

**explosionproof cable seal:** A cable gland filled with compound and designed to contain an explosion in the enclosure to which it is attached or to minimize passage of flammable gases or vapors from one location to another. An explosionproof conduit seal may also be used in combination with a cable termination fitting as an explosionproof cable seal.


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**explosive atmosphere:** A mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapor, mist, or dust in which, after ignition, combustion spreads throughout the unconsumed mixture.

**festoon:** A mechanical non-motorized trolley or trolleys capable of carrying single or multiple cable and/or hoses on a manufactured steel rail or steel I-beam.

**flammable:** Capable of igniting easily, burning intensely, or having a rapid rate of flame spread.

**intrinsically safe circuit:** A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

**jacket/sheath:** A nonmetallic protective covering over the cable core is considered a jacket. When it is applied over the armor, it is considered a sheath.

**marine shipboard Type P cable:** Impervious sheathed armored or unarmored cable addressed in the National Electrical Code, constructed in accordance with IEEE Std 1580™ and UL 1309, except that an overall impervious sheath is required over the armored construction, and approved as "Shipboard Cable, Marine" by a Nationally Recognized Testing Laboratory (NRTL).

**Nationally Recognized Testing Laboratory (NRTL):** A U.S. Occupational Safety and Health Administration (OSHA) designation given to testing facilities that provide product safety testing and certification services to manufacturers. OSHA publishes a current list of NRTL on its website. The means for identifying approved equipment can vary for each organization concerned with product evaluation, some of which do not recognize equipment as approved unless it is also labeled. The authority having jurisdiction normally utilizes the system employed by the certifying organization to identify an approved product.

**single-banked:** The arrangement of cables in a cable tray or raceway wherein the cables are installed in a single layer.

**sunlight resistant:** Ability to withstand exposure to direct sunlight as defined by UL 2556.

**TC-ER-HL cable:** Power and control tray cable that is suitable for Class I, Division 1 locations as specified in the National Electrical Code.

**umbilical:** Single or group of functional components, such as electrical cables, optical fiber cables, hoses, and tubes, laid up or bundled together, that generally includes an unsupported, suspended section.

**unclassified location:** An unclassified location is a location not classified as Division 1 or Division 2, or Zone 0, Zone 1, or Zone 2. The term *unclassified location* is used synonymously with the term *nonclassified location*.

**variable frequency drive (VFD):** A type of adjustable speed drive where a converter, using controlled rectifier or transistor devices having the capability of adjusting the frequency and proportional voltage of the output waveform, provides speed control of an ac motor.

**zone:** A method of specifying the probability that a location is made hazardous by the presence, or potential presence, of flammable concentrations of gases and vapors, or combustible mixtures of dusts.


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