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IEEE Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities

STANDARDS

IEEE Power and Energy Society

Developed by the
Insulated Conductors Committee

IEEE Std 1185™-2019
(Revision of IEEE Std 1185-2010)

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Abstract: Guidance for the proper installation of cable in generating stations and industrial facilities is provided in this recommended practice.

Keywords: American wire gauge, AWG, basket grip, bend radius, cable, cable cleats, cable jamming, cable testing, cable ties, cable tray, cmil, conduit, duct bank, ducts, English units, figure 8, galloping, IEEE 1185™, installation, jam ratio, kcmil, luff, metric units, OD, outside diameter, overall diameter, pull back, pull tension, pullby, pulling bend radius, ropes, sidewall bearing pressure, sidewall pressure, slack puller, sleeve, swivel, training bend radius, trench, wire, wire way

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Introduction

This introduction is not part of IEEE Std 1185-2019, IEEE Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities.

Construction of generating stations and industrial facilities involve the installation of a large number of cables in various raceway types such as conduits, trays, duct banks, trenches, wire ways, direct burial, etc. Cable failures can lead to power outages and equipment downtime, resulting in inconvenience at best, lost production, or worse, a safety issue. This document provides information to help engineers, technicians, and trades/crafts people avoid potential wire or cable damage during installation, testing, and modification of cable systems at generating stations and industrial facilities. The majority of these cables are unshielded, and except in duct banks or direct burial, where water may be present, there is usually no uniform continuous ground plane on the outside of the cable to allow effective post-installation voltage testing of the cable. Without a continuous ground plane, effective cable post-installation testing, as well as the ability to detect cable damage prior to placing the cable in service, is limited. Therefore, greater emphasis needs to be placed on wire and cable installation methods and practices to assure proper cable installation and long life.

It should be noted that other documents such as cable manufacturer's cable installation manuals, IEEE/IEC/AEIC standards, National Electrical Code® (NEC®) (NFPA 70), Canadian Electrical Code (CEC) Parts I, II, and III, or other local codes, are available that provide cable system design and installation information. It is not the intent of this recommended practice to replace or supersede the other information but to compliment it and, as needed, provide more detail, or alternate methods and techniques for proper cable installation. It is also not the intent of this document to override the installation requirements outlined in governing documents such as NEC, CEC, cable manufacturer's installation manuals or permitting documents, etc. Even though utilities in certain situations may be exempt from requirements of NEC, the utility is not exempt from following good cable installation practices in an effort to help maximize cable life and help minimize in-service cable failures.

This revision is a complete rewrite to re-organize the information into a more logical sequence. An attempt has been made to not delete any technical data from the previous edition.

Selected sections have been combined into a comprehensive section (8.2, Securing cable to raceway) that classifies the forces acting on cables, addresses cable design considerations, and provides in-depth information on cable supports and restraints, including a discussion on thermal expansion, a list of cable restraint devices and new calculations. While prior revisions were primarily based on securing vertical cables, this revision greatly expands on protecting cables from the electrodynamic forces that occur during short circuits.

Improved installation methods are also expected to increase confidence in the ability of the installed cable to function in the accident environments for nuclear power generating stations, and increase confidence in cables that improve safety and reliable operation of industrial facilities and cogeneration/fossil plants.

Monitoring pulling tensions is an effective approach to ensuring that the cable pulling limits, such as minimum bend radius, sidewall bearing pressure (SWBP), and conductor strength, is not exceeded. Since most cable pulls are manual pulls and the setup time to monitor pulling tension is significant, pulling tensions are typically only quantitatively monitored when performing long, high tension pulls requiring the use of motorized pulling equipment. When a cable pull into conduit is made manually, the dynamometer reading has to be adjusted after measuring various angles. Due to the complexity of this process, manual cable pulls are seldom quantitatively monitored. This document introduces the use of conduit-cable pulling charts and other methods as alternatives to direct monitoring of the pulling tensions. This document also provides cable lubrication methods, pull rope selection criteria, pulling attachment methods, and alternative methods to traditional cable pull tension monitoring, etc.

Cable pullbys (i.e., pulling cables into conduits that already contain cables) are a common practice in the utility industry and often not thoroughly addressed in either cable manufacturer literature or existing industry standards. Some utilities have reported damage to the existing cables in the conduits when executing pullbys. Measuring the pulling tensions may help but may not prevent cable damage due to pullbys, because the damage can occur from the pull rope or pulled by cable as the pull rope or cable passes over or under existing cables. Instead of prohibiting the practice of cable pullbys, the cable installation process should be more carefully controlled by evaluating the pullby conditions prior to starting the pullby and by placing restrictions on the process to avoid cable damage. However, it should be recognized that this is a risky procedure, and damaged cables or questionable conditions can result from cable pullby practices.

AEIC CG5 [B3] compliments this document for long power cable pulls through duct bank systems and should be considered as additional reference source. Cable installation information can also be found in IEEE Std 576™-2000 [B67] and may also be consulted as an additional reference source.

Due to the IEEE Policy 9.18 requirement to show metric units as the primary measurement unit, the English units are shown for convenience in parentheses after the metric units. The user of this document is cautioned to pay close attention to the units of the equations (metric versus English) and select units accordingly. Conformance to this standard can be achieved using either metric or English units provided the user is consistent when selecting and applying the units. The user is strongly cautioned not to mix units as mixing units can and will result in installation issues. The user is encouraged to select units that are most familiar to the installers so as to reduce the potential for creating installation problems that could go undetected until wire and cable failures occur, which is often years after installation. An attempt was made to keep the significant figures of the metric and English units comparable. However, due the application of rounding principles, the mathematical conversion from English numbers to metric numbers may not be exact.

Acknowledgments

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Figure G.1, Short circuit current waveform, is reprinted with permission from Talon Products LLC.

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1. Overview

1.1 Scope

This recommended practice provides guidance for wire and cable installation practices in generating stations and industrial facilities. It covers installation of cable in trays, conduit, duct banks, wire ways, gutters, and other raceway systems. It covers medium voltage power cable, low voltage power cable, control cable, instrumentation cable, coax/triax cable, fiber optic cable, data communications cable, and other specialty cables used in power plant and industrial environments. This document may also be of benefit for the proper installation of wire and cable systems in commercial, governmental, and public facilities when the same or similar wire or cable types and raceways are used.

1.2 Purpose

The purpose of this recommended practice is to provide guidance on how to help prevent installation damage, which is the single greatest cause of wire and cable failures. Cable failures can lead to power outages and equipment downtime, resulting in inconvenience at best, lost production, or worse, a safety issue. This document provides information for engineers, technicians, and trades/crafts people to avoid potential wire or cable damage during installation, testing, and modification of cable systems at generating stations and industrial facilities.

1.3 Units of measure

The requirement to show metric units first and, if desired, English units second in parentheses after the metric units is dictated by IEEE Policy 9.18, and has been implemented in this document even though the customary practice when installing American Wire Gauge (AWG) wire and cable is to use the English units. The user of this document may choose to use the English units, since cables made to AWG sizes are typically installed using English units of measure, even though the metric units are shown first and English units second in parentheses. Conformance to this recommended practice can be achieved using either metric or English units provided the user is consistent when selecting and applying the units. The user is strongly cautioned not to mix units as mixing units can and will result in installation issues. The user is encouraged to select units that are most familiar to the installers so as to reduce the potential for creating installation problems that could go undetected until wire and cable failures occur, which is often years after installation. It should also be noted that due to the reversal of the order of metric and English units, an attempt was made to keep the significant