iterated in order to evaluate the forces through the duration of the short circuit, beginning with the initiation of the fault and considering an adequate sampling of data points.

To calculate the maximum mechanical force applied to a cable-retaining device, multiply the resultant distributed force by the lineal cable-retaining device spacing. For example, given a maximum distributed repulsive force between two conductors of 20 000 N/m and a cable-retaining device lineal spacing of 0.305 m, the force transmitted to the cable-retaining device calculates to 6100 N. For additional guidance on calculating the maximum mechanical force on a cable-retaining device, reference IEEE Std 1185™.

7.4 Cable-bending radius

The bend radius of a cable shall not be less than the minimum as defined by IEEE Std 45.8 (for Type P marine shipboard cable), ICEA S-75-381 (for mining and portable power feeder cables), or NFPA 70 (for NEC cable types and wiring methods), as applicable.

7.5 DC conductor insulation

Conductors used for dc service above approximately 40 V dc in wet locations shall have a thermosetting insulation material such as ethylene propylene rubber (EPR), crosslinked polyethylene (XLPE), crosslinked polyolefin (XLPO), or other insulation suitable for the application. In wet locations, thermoplastic insulation such as polyvinyl chloride (PVC) can be adversely affected by dc voltages. This deleterious effect is caused by a phenomenon known as *electro-osmosis, electroendosmosis,* or *electrical endosmosis*.

8. AC and DC top drive power service loops

An ac or dc top drive power service loop is either a special type of umbilical or drag chain assembly that operates in a rigorous and physically abusive environment and yet fits into a very limited envelope of space. The power service loop connects between the top drive and the derrick and hangs freely in the air between these two mounting points in a pronounced U-shaped catenary configuration. It feeds electrical power to the top drive drill motor as the top drive is hoisted up and lowered down along a track in the derrick during drilling operations. The uniqueness of the application, due to the environment on a drilling rig that the power service loop operates in, dictates that special considerations shall be made relative to its mechanical and electrical design criteria.

The power service loop cable size shall have a continuous current-carrying capacity determined by multiplying the 0.80 duty factor times the continuous current rating of the top drive drill motor. The power service loop cable size shall be selected such that the cable temperature does not exceed the emergency overload temperature rating of the cable (reference ANSI/NEMA WC 70/ICEA S-95-658, Appendix C; interpolation between published temperatures in the table is allowed) when the motor is operating at maximum continuous current rating of the top drive drill motor.

The top drive is a drilling machine that is constantly manned by an operator when in use. The top drive control system that the operator interfaces with monitors the temperature of the top drive drilling motor and the operational status of its external cooling system. The top drive control system also limits the amount of continuous and intermittent current that can be applied to the top drive drilling motor based on its continuous full load amp current rating during drilling, makeup, and breakout operations. Therefore, the practice of sizing motor branch circuit power cables based on 125% of the motor's full load amps for direct across the line (DOL) motor starter circuits and adjustable speed drive applications is not applicable to sizing the ampacity of the ac and dc top drive power service loop.

The cable bundle used to build the power service loop should be uniformly twisted and have a lay-length suitable for the application. The ampacity of a hose type umbilical service loop can be determined as follows:

a) When a power service loop design consists of a uniformly twisted cable bundle pulled into a hose and filled along its entire length with potting compound, the power service loop ampacity is determined using Table 1 values divided by 0.85 as the assembly is considered as a cable in free air. Reference Example 1 in Annex B for example calculations.

b) When it is desired to consider the specific thermal properties of the materials and components used to manufacture the power service loop as well as other parameters relative to the specific top drive application, the use of equations from IEC 60287-1-1 in conjunction with cable selected from Table 1 shall be allowed as an alternative method for calculating the cable size and ampacity.

c) When a power service loop design consists of a uniformly twisted cable bundle pulled into a hose with a short section (e.g., 2 ft to 4 ft) at each end of the hose potted so as to support and hold the twisted cable bundle in place within the hose and the remaining mid-section of the hose is not potted, the ampacity of the power service loop should be calculated by multiplying the free air ampacity of the cable selected from Table 1 by a factor of 0.80. Reference Example 3 in Annex B for an example calculation.

d) When multiple power service loops are installed on a top drive, a space of one service loop diameter between each service loop at both hang-off points is required to consider each power service loop assembly as cable in free air, otherwise the appropriate ampacity derating factor for conductors operating is parallel is required. See Example 2 in Annex B for example calculations.

When a power service loop consists of an assembly manufactured as a complete cable under one jacket in lieu of a cable bundle pulled into a hose, the power service loop ampacity is determined using Table 1 values divided by 0.85 as the assembly is considered as a cable in free air. Reference Example 1 and Example 2 in Annex B for example calculations.

A drag chain assembly is typically an articulated cable tray containing power cables which allows the equipment to be repositioned without disconnection of the cables. When a drag chain assembly in lieu of an umbilical-type power service loop is used to power the top drive drill motor, the power cables in the drag chain should be considered as cables in a cable tray using Table 1. See B.4 for an example of an ampacity calculation for this application.

The flying power leads that exit the top drive end of the power service loop should be mechanically protected by a non-magnetic metallic braided armor that is suitably grounded.

In variable frequency drive (VFD) applications, power service loops should be provided with enough shielding to minimize the potential for electromagnetic interference (EMI) and its impact on systems surrounding the power service loop performance. Braided bronze is not considered an adequate shield in this case due to its low conductivity (~ 20% or less) as compared to copper.

9. Cable glands Class I, Division 1 and Division 2

9.1 Overview

Cable seals are designed to withstand the potential internal pressures of the explosionproof enclosure by creating a seal to minimize the passage of vapors and gasses and to prevent flame propagation into the cable. Explosionproof cable glands that are NRTL approved to comply with ANSI/UL 2225 or UL 1203