



Installation

PULLING TENSION

The maximum tension applied to a cable during installation is limited in order to prevent damage or distortion of cable components which could reduce the life or reliability of the cable.

The method of pulling is significant in that different methods will result in different stresses on critical cable components for the same overall tension.

Nexans recommends that, wherever possible, the cable be pulled by means of the conductor, aided where feasible by a grip over the outer jacket.

The tension developed in any straight section of a duct is calculated as follows:

$$T = 9.81 * L * W * f$$

where:

T = pulling force, Newtons

L = section length, metres

W = cable weight, kg/m

f = coefficient of dynamic friction

The tension developed in a bend is calculated as follows:

$$T = T1 e^{(fa)}$$

T = tension leaving bend

T1 = tension at bend entrance

e = base of natural logarithms (2.71828)

f = coefficient of dynamic friction

a = angle of bend, radians

The parameter $e^{(fa)}$ is evaluated for some common conditions.

| Bend Angle (degrees) | $e^{(fa)}$ | | |
|----------------------|------------|--------|--------|
| | f=0.25 | f=0.30 | f=0.40 |
| 30 | 1.14 | 1.17 | 1.23 |
| 45 | 1.22 | 1.27 | 1.37 |
| 60 | 1.30 | 1.37 | 1.52 |
| 90 | 1.48 | 1.6 | 1.88 |

At any bend the tension should not exceed 29.2kN per metre of radius of the bend.

When designing the duct layout, it is recommended that the bends be concentrated near the end from which the cable is to be pulled. This practice will result in lower tensions. In some cases, the tensions resulting from alternative directions should be calculated.

Both the cable and pulling rope should be well lubricated with a good commercial cable lubricant following the lubricant supplier's instructions.

The recommendations given above are intended to cover a wide range of pulling conditions. It is

possible, under ideal conditions, and with experienced supervision, to exceed these limits. For further guidance, see IEEE Paper 84 T&D 365-3, or contact Nexans.

| Coefficients of Dynamic Friction with Lubricant (Low Sidewall Pressure) | | | |
|--|--------------|--------------------|-----------------------|
| Duct Type | Cable Jacket | One Cable per Duct | Three Cables per Duct |
| PVC | PVC | 0.50 | 0.60 |
| | PE | 0.40 | 0.45 |
| PE | PVC | 0.30 | 0.45 |
| | PE | 0.25 | 0.85 |
| Fibre | PVC | 0.25 | 0.60 |
| | PE | 0.40 | 0.45 |
| Asbestos cement | PVC | 0.70 | 0.70 |
| | PE | 0.70 | ---- |

| Maximum Pulling Tension* for ENERGEX Power Cables (Newtons) | | | | | |
|--|--------------------|----------|----------|-------------------|-------------------|
| Size (AWG/kcmil) | Single - conductor | | | Three - conductor | |
| | Copper | Aluminum | | Copper | Aluminum Stranded |
| | | Solid | Stranded | | |
| 8 | 805 | | 590 | 1610 | 1175 |
| 6 | 1285 | | 930 | 2570 | 1870 |
| 4 | 2040 | | 1485 | 4080 | 2970 |
| 3 | 2575 | | 1870 | 5150 | 3745 |
| 2 | 3245 | 1770 | 2360 | 6490 | 4720 |
| 1 | 4095 | 2230 | 2980 | 8190 | 5960 |
| 1/0 | 5160 | 2820 | 3760 | 10320 | 7515 |
| 2/0 | 6510 | 3550 | 4740 | 13020 | 9470 |
| 3/0 | 8210 | | 5970 | 16420 | 11940 |
| 4/0 | 10350 | | 7530 | 20700 | 15060 |
| 250 | 12230 | | 8900 | 24460 | 17790 |
| 350 | 17120 | | 12455 | 34240 | 24910 |
| 500 | 24460 | | 17790 | 48920 | 35580 |
| 750 | 36690 | | 26690 | 73380 | 53380 |
| 1000 | 48920 | | 35585 | 97840 | 71170 |

- Notes: 1. Maximum allowable tension when pulling directly on the conductor(s).
- 2. For more information consult the AEIC CG5 Pulling Guide.

The minimum bending radius to which a concentric neutral cable may be bent for permanent training during installation is eight times the overall diameter for a single conductor cable and twelve times the overall diameter for a single conductor tape shielded cable. For multiplexed single conductor cables, the minimum bending radius is eight times the diameter of the individual conductors or five times the overall diameter, whichever is greater. These limits do not apply to conduit bends, the sheaves, or other curved surfaces around which the cable may be pulled under tension while being installed. In all cases, the minimum bending radii specified refers to the inner surface of the cable and not to the axis of the cable.

When pulling the cable, the minimum bending radius should be at least 1.5 times the above recommended value in order to limit the sidewall bearing pressure (SWBP) to 29.2 kN per metre. This limit should be reduced 21.9kN per metre when the jacket is not applied tightly to the cable core.

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While these concentric neutral cables meet the CSA cold bend and impact tests at -40°C, Nexans does not recommend installing these cables below -10°C without taking special precautions.

Special precautions may include :

- Expose the cable to a temperature of at least 15°C for 24 hours immediately prior to installation.
- Pull cable more slowly than normal.
- Take extra care during installation to prevent excessive bending close to the minimum bending radius or sudden impacts to cable.

Contact Nexans for additional information on recommended practices for low temperature installations.