VDE SPEC

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Requirements for tensioners and pullers for the installation of conductors and earth wires in the construction of overhead lines

VDE SPEC 90014 V1.0 (en)

VDE

FOREWORD

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No draft version of this VDE SPEC has been published.

This document has been prepared by the VDE SPEC 90014 V1.0 project group of VDE Association for Electrical, Electronic & Information Technologies (www.vde.com).

This VDE SPEC was developed in coordination with DKE working group 421.0.2, Montage und Werkzeuge, [Installation and tools], and DKE working group 214.5, Ausrüstungen und Geräte zum Arbeiten unter Spannung; Arbeitsgeräte und starre Schutzvorrichtungen [Equipment for live working; tools and rigid protection devices].

This VDE SPEC has been prepared in accordance with the VDE SPEC method. VDE SPECs are drawn up in project groups in a process that does not necessarily involve all groups with an interest.

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In technical terms, the preparation of this document has been based on an excerpt from a planned prestandard currently being drafted by the aforementioned working groups. The document has been produced as part of the work of working groups 421.02 and 214.5 on the basis of an adjustment to IEC/TR 61328:2017-04 to meet the requirements of the participants in the working group. Participants in the working group are as follows:

- Representatives of the transmission system operators.
- Representatives of the manufacturers of stringing equipment.
- Representatives of construction companies involved in the construction of overhead lines.
- Representatives of the manufacturers of fittings for overhead lines.

Because IEC/TR 61328 is established at international level as one of the few standards on the market, DKE working groups 421.0.2 and 214.5 have decided to publish a VDE SPEC in advance of the prestandard to provide the market with a non-manufacturer-specific specification for stringing equipment (pullers, tensioners, drum stands and reel stands) and methods.

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Contents

Figures

1 Scope

This document provides non-manufacturer-specific recommendations for selecting and, if necessary, inspecting stringing equipment and accessories for installing bare and insulated conductors. This applies to drum stands, tensioners, pullers and reel stands. The conventional stringing methods are described.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC

Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility

Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors

EN ISO 12100:2010, Safety of machinery - General principles for design, risk assessment and risk reduction

EN 14492-1:2006+A1:2009, Cranes - Power driven winches and hoists - Part 1: Power driven winches

3 Terms and definitions

The terminology used within the utility industry for equipment and methods for installing conductors and earth wires in overhead lines is highly variable. See also IEC 60050-466, IEC 60050-651 and IEC 60743 for additional definitions.

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

– ISO Online browsing platform: available at http://www.iso.org/obp

– IEC Electropedia: available at http://www.electropedia.org/

3.1
dead-ending
procedure that results in the termination of conductors at an anchor structure

3.2
anchor
a device, usually buried in the ground, so installed as to provide a firm point of attachment for resisting uplift

[SOURCE: IEV 466-09-22]

3.3
sling
lanyard for absorbing tension between the mounting attachments

3.4
mounting attachment
component capable of absorbing the expected tension

3.5
working coefficient
ratio of minimum breaking load to safe working load

3.6
tensioner
equipment designed to hold mechanical tension against a pulling rope or conductor(s) during the stringing operation

Note 1 to entry: Commonly known as a brake.

[SOURCE: DIN EN 60743:2014-05, 14.1.2, modified – *Seilbremse* ['rope brake'] replaced by *Bremsmaschine* ['tensioner'] and *Seilzugspannung* ['stringing tension'] by *Seilzugkraft* ['stringing force']; in addition, Note 1 to entry replaced by new Note 1 to entry]

3.7
conductor bundle
set of individual conductors connected in parallel and disposed in a uniform geometrical configuration, that constitutes one phase or pole of a line

[SOURCE: IEV 466-10-20]

3.8
guide roller
roller, preferably made of plastic, for guiding the conductor at the inlet/outlet of the puller/brake

3.9
reel
steel drum for holding ropes

3.10
reel stand
device for operation in conjunction with a double-capstan puller or puller-tensioner used to hold the pulling rope

3.11
birdcaging
short section of a conductor in which the outer wires are significantly longer than the inner wires and thus protrude from the rest of the rope

3.12
conductor
a wire or combination of wires not insulated from one another, suitable for carrying an electric current

Note 1 to entry: One or more aluminium, aluminium alloy, copper, zinc-coated or aluminium clad steel wires, or combinations thereof, wrapped together, which collectively have the function of conducting an electrical current.

[SOURCE: IEV 466-01-15 – modified. For this definition, the addition '(of an overhead line)' has been deleted and Note 1 to entry added.]

3.13
minimum breaking load
maximum force at which the component will not fail

3.14
conductor regulation
method of pulling conductors to their defined tension or sag

3.15
stringing
method by which pulling ropes and conductors are pulled over stringing blocks fastened to supports of overhead lines

3.16
tension stringing
method of using pullers and tensioners to give conductors sufficient tension and positive control during the stringing operation to keep them clear of the ground surface and other obstacles

3.17
slack stringing
method of stringing ropes without the use of a tensioner, albeit with some minimal braking applied to the conductor reel

3.18
safe working load
maximum load that the component can bear given the working coefficient

3.19
bullwheel
wheel or wheels incorporated as an integral part of a puller or tensioner with multiple offset grooves allowing the continuous winding of a conductor or a rope to generate pulling or braking force, through friction

3.20
double-capstan puller
style of puller that uses two successive bullwheels with multiple grooves and the pretensioning force exerted by the rope magazine to feed or brake the rope through friction

3.21
drum site
location of tensioner, drum stands and their stays

3.22
stay
device for holding an object securely in place, comprising anchors, mounting attachments and slings

3.23
pulling rope
rope used for pulling additional ropes or conductors

3.24
puller site
location of puller, reel stand and their stays

3.25
swivel
fastener for a friction-fitting and torsion-free transfer of tension between two linked ropes/conductors during stringing

[SOURCE: DIN 48207-3:2005-06, 3.1]

3.26
running board
device designed to allow several conductors to be pulled simultaneously with a single pulling rope

[SOURCE: IEC 60743:2013, 14.2.3, modified – 'stringing device' replaced by 'device' and 'conductor ropes' replaced by 'conductors'; in addition, notes to entry and figures not carried over.]

3.27
pulling vehicle
piece of mobile ground or airborne equipment capable of pulling ropes or conductors

4 Mechanical hazards

To prevent any unexpected failure of the stringing elements, depending on the design and topography of the line, the fact that the maximum tension usually differs from the force that can occur at the tensioner or the puller shall be taken into account. The maximum value for the applied tension can possibly be greater, particularly if there are significant variations in the heights of attachment points. The inclination of the suspension insulator set in the case of conductors in a stringing block as opposed to the clamped state serves as a measure of the difference in tension.

In the case of stringing operations in crossing areas, increased installation tensions can possibly be required in order to comply with the minimum distance requirements.

In each case, it shall be ensured that the maximum installation tension of the conductors and the permissible load values for the stringing elements are not exceeded.

It shall be ensured that the machinery (puller/tensioner) does not move uncontrollably under load. As a rule, the weight of the machinery is not sufficient to guarantee stability under load, which means that it is necessary to anchor the devices in place.

5 Conductor stringing methods and equipment

5.1 General

The methods of installing conductors currently employed in overhead systems are many and varied. The basic methods currently in use are outlined below. The methods depend somewhat on the type and size of the overhead line to be installed and the ground over which the overhead line is to be installed.

Installing conductors (one conductor or several subconductors in a bundle) involves stringing with the aid of a puller and a tensioner.

A running board can be used for stringing conductor bundles. The conductors and the pulling rope are connected via swivels to prevent torque being transferred to the rope to be strung. The conductors and pulling rope shall be designed and shaped such as to ensure minimal torsion during stringing.

Stringing blocks are generally mounted at the downstream attachment points of the conductors on the pylon and are used to guide the strung ropes between the puller and tensioner while remaining clear of the ground.

Any necessary anchors are used during stringing to transfer the applicable forces into the ground. Machine anchors are used to fasten the machinery used during stringing. Pylon anchors absorb the forces exerted on the pylon structure at the drum and puller sites during stringing. Head anchors are used to improve the internal stability of the pylons and pylon crossbars against the forces exerted during stringing.

There are some mechanical and electrical characteristics that are important in the selection of stringing equipment. They are detailed below.

5.2 Stringing methods

5.2.1 Pulling ropes

Slack stringing (dragging) is generally used to install the first pulling rope (see Figure 1). In isolated cases, the first pulling rope can also be pulled in with tension (no dragging) (see Figure 2).

If necessary, several pulling ropes with consistent tensile strength shall be pulled in one after the other until the working load of the pulling rope is sufficient for the expected installation tension of the conductor (see Figure 2 and Figure 3).

A number of factors can cause torsion during stringing. The effects of torsional forces shall be minimized to protect ropes and connectors.

Causes of torsional forces can include:

- The design and structure of the ropes
- The inherent rotation of the ropes during as they are unwound
- All winding angles at roller and groove sides along the rope being strung

Torsional forces can be reduced by means of decoupling using swivels and the arrangement of stringing elements to optimize winding angles.

When conductors are replaced, the existing conductor can also be used as a pulling rope if it possesses adequate loading capacity. If the mechanical strength of the conductor to be replaced is not adequate, it is possible to pull in a pulling rope when the old conductor is pulled out. The tension in the conductor to be replaced can thereby be reduced. The pulling rope that has been pulled in may then be used to install the new conductor.

Because the status of the connector is not always known, particular caution is required when the old conductor is pulled out.

Connectors shall not run around the bullwheels of a puller unless the manufacturer has approved them for that purpose, as they can be deformed numerous times in that case. This can result in the sudden failure of the connector.

One commonly used procedure is to cut the connector out when it reaches the puller and connect the ends of the severed conductor with cable grips. The cable grips are passed through the bullwheels of the puller and can be removed before the conductor is wound on the reel.

5.2.2 Conductors

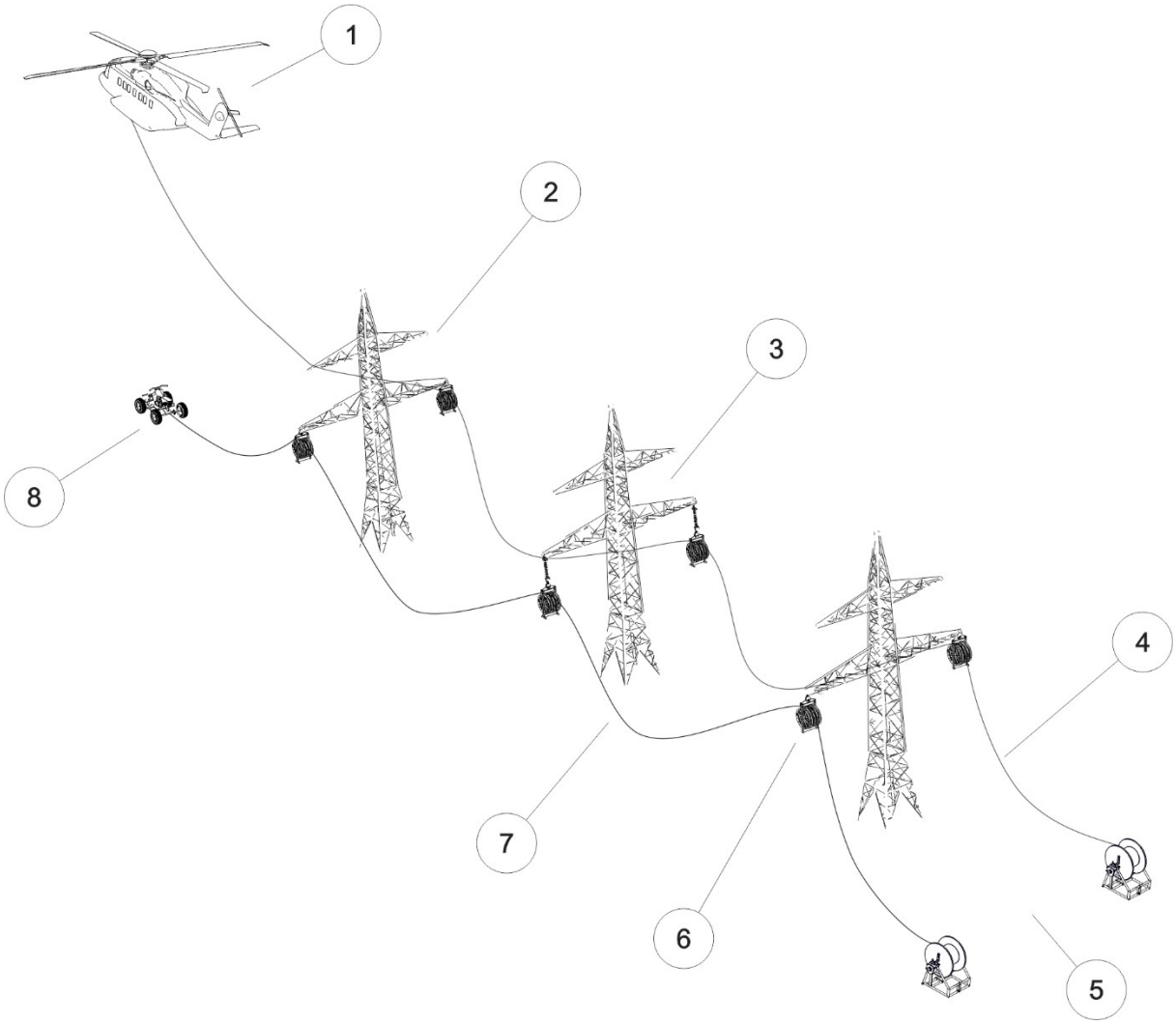
The conductor and the pulling rope are held under tension during stringing to prevent them from coming into contact with the ground or any other obstacles between the pylons. Selecting the correct installation tension can allow the conductor to be passed over objects and structures at an adequate distance.

In the process of stringing single conductors, the pulling rope is connected to the conductor rope by means of a cable grip and swivel and pulled in without dragging (see Figure 3).

In the case of bundle conductor stringing, the subconductors in each bundle are pulled simultaneously and with the same tension applied. For this purpose, the pulling rope is connected to the subconductors by means of a running board, swivels and cable grips and pulled in without dragging (see Figure 4).

The most common method of tension stringing is to use one or more tensioners (depending on the number of subconductors in a bundle) and one double-capstan puller.

5.2.3 Slack stringing

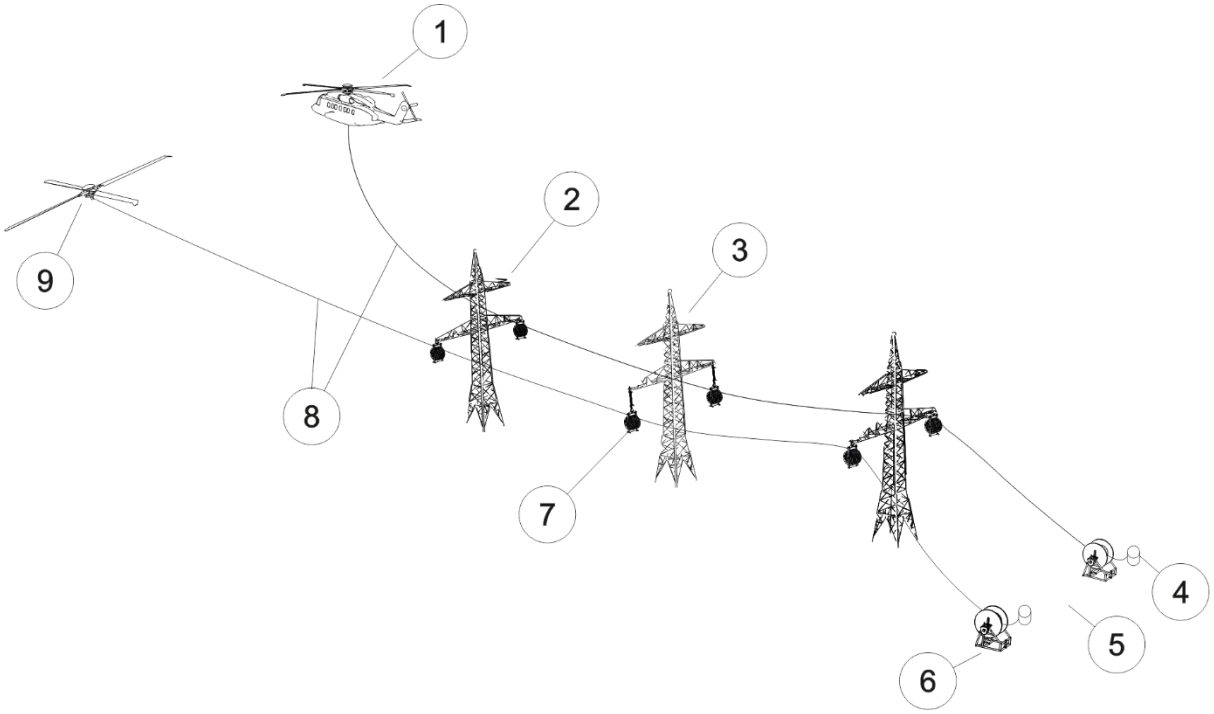


Key

1	Pulling vehicle (helicopter)	2	Anchor pylon
3	Suspension pylon	4	Pulling rope
5	Drum site	6	Stringing block
7	Pulling rope	8	Pulling vehicle (quad bike/ATV)

Figure 1 – Slack stringing (installing pulling ropes via dragging)

5.2.4 Tension stringing

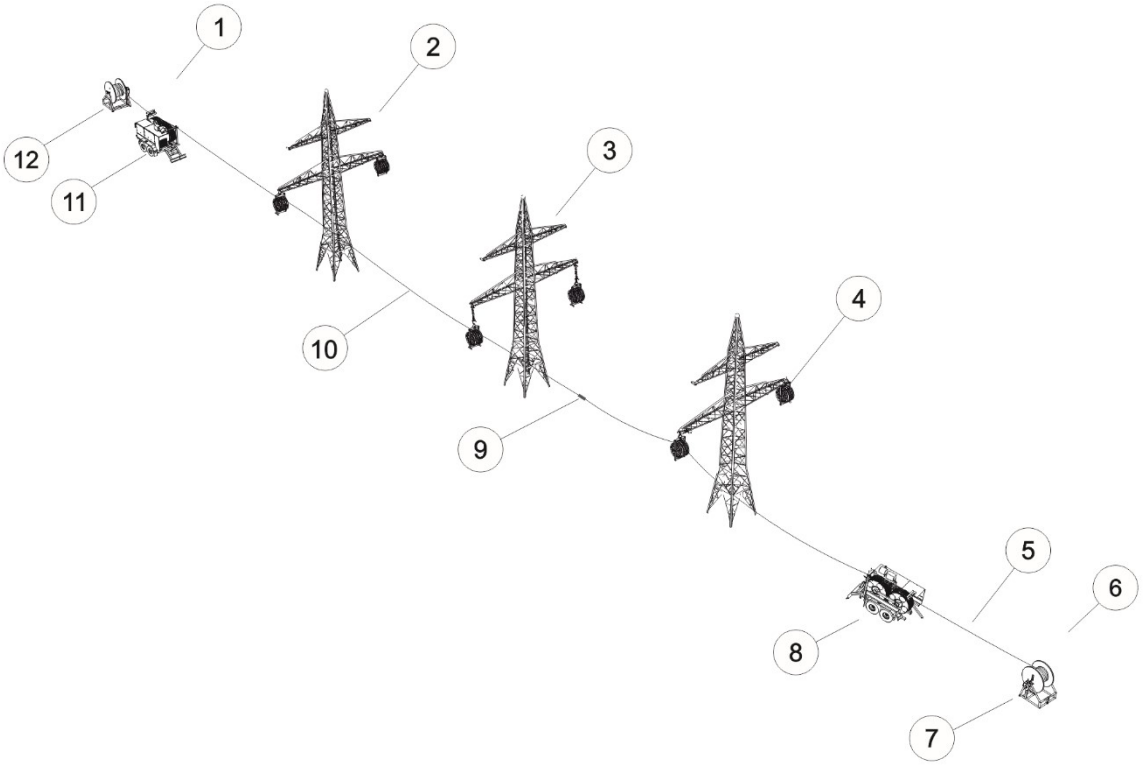


Key

1	Pulling vehicle (helicopter)	2	Anchor pylon
3	Suspension pylon	4	Hydraulic power unit
5	Drum site	6	Drum stand
7	Stringing block	8	Pulling rope
9	Pulling vehicle (drone)		

Figure 2 – Tension stringing (installing pulling ropes without dragging)

5.2.5 Stringing for single rope

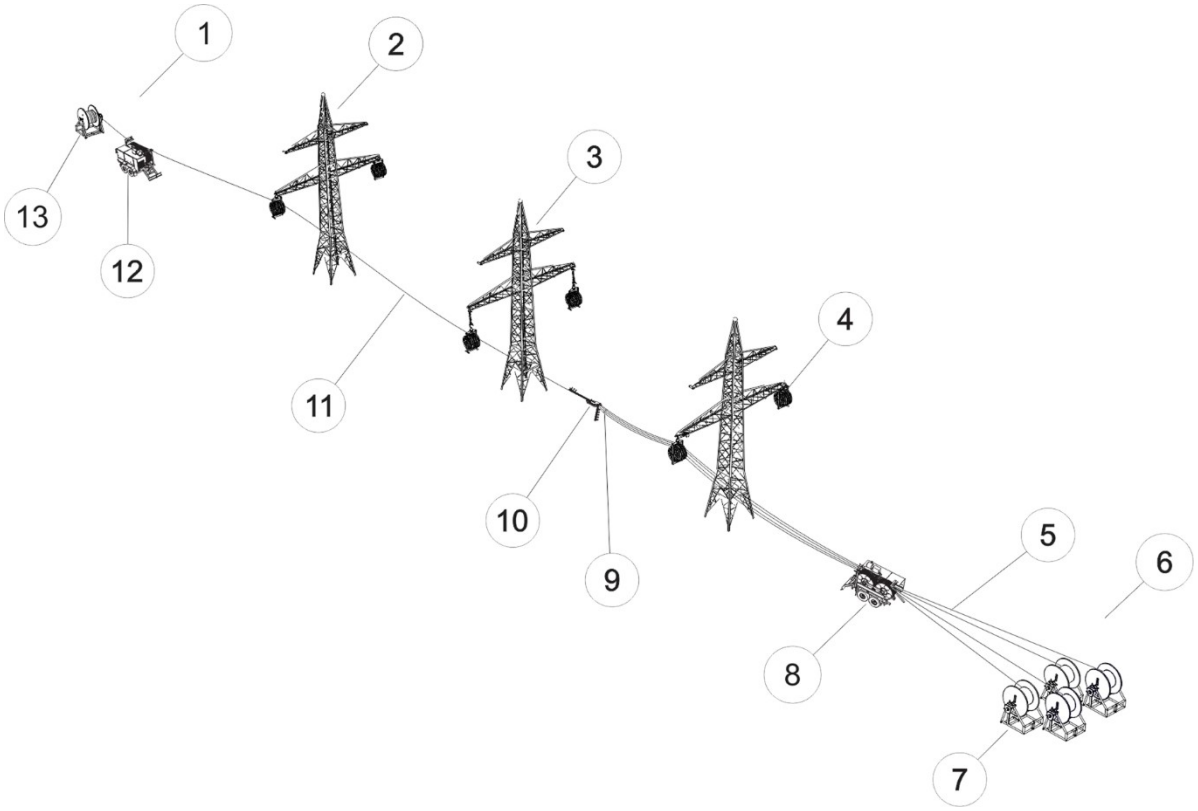


Key

1	Puller site	2	Anchor pylon
3	Suspension pylon	4	Stringing block
5	Conductor	6	Drum site
7	Drum stand	8	Puller-tensioner/tensioner
9	Swivel/connector	10	Pulling rope
11	Puller-tensioner/puller	12	Reel stand

Figure 3 – Stringing for single rope

5.2.6 Stringing for conductor bundle



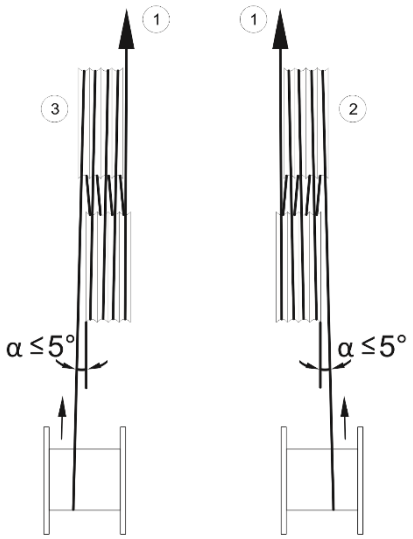
Key

1	Puller site	2	Anchor pylon
3	Suspension pylon	4	Stringing block
5	Conductor	6	Drum site
7	Drum stand	8	Puller-tensioner/tensioner
9	Cable grip/swivel	10	Running board
11	Pulling rope	12	Puller-tensioner/puller
13	Reel stand		

Figure 4 – Stringing for bundle of four

5.3 Requirements for drum and puller sites

Drum and puller sites shall be designed to suit the location, size, intended function and working method. Means of preventing electrical hazards shall be incorporated in planning at the drum and puller sites. To ensure that installation can take place easily, the conductor for standard right-hand-lay conductors, as viewed from the perspective of the operator looking in the direction of stringing from behind the tensioner, shall be placed on the left-hand sides of the bullwheels of the tensioner (see Figure 5, left).



Key

1 Tension in direction of puller

2 Left-hand-lay conductor

3 Right-hand-lay conductor

Figure 5 – Arrangement of coil holder and tensioner

5.4 Stringing equipment

5.4.1 General

This clause deals with the equipment used for stringing and general criteria for the selection of machinery, including safety precautions for protecting installation personnel from electrical hazards.

5.4.2 Stringing machinery

5.4.2.1 General

Tensioners, pullers or puller-tensioners can be used.

The machinery shall comply with the applicable safety regulations.

These include:

2006/42/EC – Machinery Directive

2014/30/EU – EMC Directive

2014/35/EU – Low Voltage Directive

2000/14/EC – Outdoor Noise Directive

EN ISO 12100:2010, Safety of machinery - General principles for design - Risk assessment and risk reduction

EN 14492-1:2006+A1:2009, Cranes - Power driven winches and hoists - Part 1: Power driven winches

5.4.2.2 Tensioners

5.4.2.2.1 General

Tensioners with at least two bullwheels are used, with three or more grooves for every subconductor on each wheel. Each subconductor shall have an adequate number of grooves (at least three) to prevent the outer layers of wires slipping over the layers underneath in the case of multi-layered conductors.

This involves increasing the tension applied to the bullwheel grooves one groove at a time. Requirements for special conductor types shall be agreed upon between the client, conductor manufacturer, machinery manufacturer and installer.

5.4.2.2.2 General criteria

Generally applicable and desirable characteristics of tensioners are as follows.

It is important that the conductor be installed smoothly and without jerking or bouncing to avoid any sudden overload on machinery and equipment and ensure safe and high-quality stringing. The tensioning system should provide for a constant tension in the conductor at all stringing speeds and should hold this tension even when stringing is stopped.

NOTE It is possible to use tensioners with independently controlled bullwheels for each conductor or rigid bullwheels for multiple conductors. The use of machinery with independently controlled bullwheels makes it easier to regulate the tension of each conductor than the use of bullwheel machinery with a single controller.

5.4.2.2.3 Definition of rope braking force

The following aspects shall be taken into account:

- Stringing force per conductor and the number of subconductors to be strung at the same time
- Reserve of at least 20 % of the calculated installation tension
- If necessary, reserve of 20 % of tension as per the sag table for regulation

5.4.2.2.4 Other criteria for the selection of tensioners

The following specific criteria should be considered in the selection of a suitable tensioner to be used for a particular project.

a) The bullwheel grooves shall be lined with a material that will prevent damage to the surface of the conductor and allow the conductor to insert itself into the groove. The material used for the groove surfaces shall be chosen to ensure that conductors can reliably be installed with the friction necessary to transfer the requisite forces.

b) The minimum diameter of the bullwheel, measured at the bottom of the groove, is 40 times the conductor diameter.

c) The minimum bullwheel groove diameter is 1,1 times the conductor diameter to allow the cable grip joints installed at the end of the conductor to pass through the groove.

d) The conductors running from the rope drum shall be guided into the correct groove of the bullwheel with the aid of guide rollers below and on both sides of the conductor. The guide rollers shall be designed such that the angle of the conductor ends between the drum stand and the tensioner is reduced (see Figure 5, left). The angle of the guide on the individual rollers shall not exceed 5° in the horizontal or vertical direction.

e) There shall be a holding brake as per Clause 5.4 of EN 14492-1:2006+A1:2009, usually a hydraulic spring-loaded brake, incorporated into the drive unit of each bullwheel pair. This is necessary to enable the tension of the conductor to be maintained in the event of failure of the drive unit or hydraulics. In certain applications, such as when the pulling rope or conductor is strung by helicopter, a suitable logic device shall be provided to ensure safe operation of the holding brake and thus avoid any critical situations involving the brake engaging during stringing.

f) The control panel for the tensioner shall be equipped with at least one measuring instrument for displaying braking force and one device that the operator can set to a particular braking force value.

g) The control panel for the tensioner should be positioned such that the operator has a clear view of the working area. Remote control systems can be used for this.

h) The tensioner frame shall incorporate anchor lugs of suitable sizes for fastening anchors to hold the machinery in place on site.

i) The tensioner frame shall be equipped with an earthing point. Its surface shall ensure a sufficiently conductive electrical connection.

j) If the tensioner is fitted with electrically isolated and conductive components, an earthing strap shall be installed between the isolated component and the frame of the machinery.

k) The tensioners shall have a hydraulic controller to ensure that there is always pretension in place on the rope between the rope drum and the tensioner.

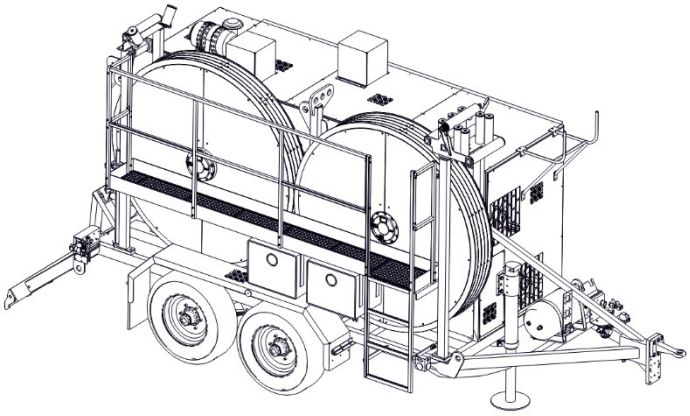


Figure 6 – Example of a tensioner with a pair of bullwheels with multiple grooves

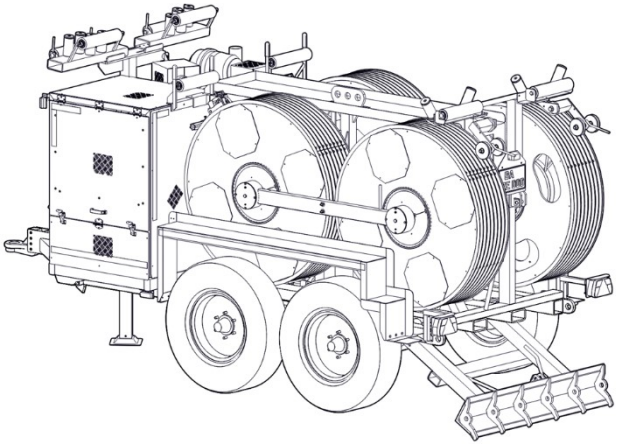


Figure 7 – Example of a tensioner with several pairs of bullwheels with multiple grooves

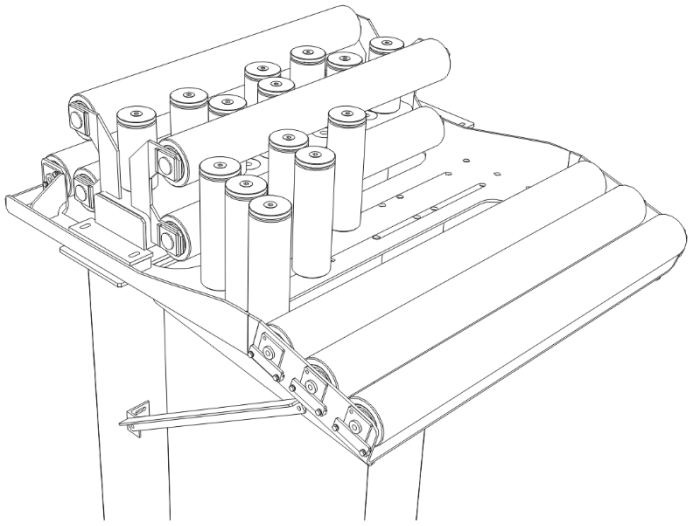


Figure 8 – Example of a rope inlet

5.4.2.3 Pullers

5.4.2.3.1 General

There are three main puller designs:

a) drum pullers, either with a single drum or with one drum for each rope to be pulled;

b) double-capstan pullers with in-built conductor reel (see Figure 10);

c) double-capstan pullers with separate conductor reel (see Figure 9).

The first two designs are intended primarily as pullers for pulling ropes.

5.4.2.3.2 General criteria

Generally applicable and desirable characteristics of pullers are as follows.

a) It is important that the conductor/pulling rope be pulled in smoothly and without jerking or bouncing. Consequently, it should be possible to change the speed of the puller gradually rather than in increments.

b) The puller shall have sufficient pulling power to start the conductor moving at full stringing force after a stop.

5.4.2.3.3 Definition of puller force

The following aspects shall be taken into account:

- Stringing force per conductor and the number of subconductors to be strung at the same time
- Length and route of stringing section
- Reserve of at least 20 % of the calculated installation tension at the puller

NOTE For stringing, the tension in the puller shall intentionally be greater than the calculated force of the tensioner, as this is required to overcome the friction forces, inertia and any height differences in the section being installed. As a rule, during regulation at the drum site, greater forces are exerted on the tensioner, which acts as a puller in that case.

5.4.2.3.4 Other criteria for the selection of pullers

Other criteria for the selection of pullers are as follows.

a) The bullwheels should have hardened steel grooves to prevent wear if the double-capstan pullers are to be used for steel pulling ropes (Figure 9 and Figure 10).

b) Suitable groove surfaces shall be chosen for the bullwheels of pullers that can be used both for pulling ropes and for conductors.

c) Sufficient current-carrying capacity shall be ensured between the bullwheel and the conductor or pulling rope so that current caused by electromagnetic interference can reliably be transferred.

d) The diameter of puller bullwheels shall be greater than 25 times the diameter of the rope, as a smaller diameter will reduce the lifetime of the pulling rope.

e) There shall be a holding brake as per Clause 5.4 of EN 14492-1:2006+A1:2009, usually a hydraulic spring-loaded brake, incorporated into the drive unit of each bullwheel pair. This is necessary to enable the tension of the conductor to be maintained in the event of failure of the drive unit or hydraulics.

f) The control panel for the puller shall have a measuring instrument with a tension indicator and an overload device that the operator can set to a maximum tension. The overload device shall automatically stop the puller when the tension reaches the set value. This will prevent the puller from continuing to pull up to dangerous levels if the conductor, rope or running board becomes snagged and held somewhere along the stringing section.

g) In the case of pullers with bullwheels, the conductor reel controller shall ensure that there is always pretension in place on the rope between the conductor reel and the tensioner.

h) The pulling rope should be guided into the correct groove of the bullwheel from the conductor reel with guide rollers placed below and on each side of the rope.

i) In the case of drum pullers, suitable equipment shall be used to ensure that the pulling rope is guided from the pylon to the pulling rope drum and evenly wound across the width of the drum. This makes for smooth pulling and prevents the rope from becoming tangled on the drum.

j) In the case of bullwheel pullers, suitable equipment shall be used to ensure that the pulling rope is guided from the puller to the pulling rope drum or wheel and evenly wound across the width of the drum. This makes for smooth pulling and prevents the rope from becoming tangled on the drum.

k) The control panel for the puller should be positioned such that the operator has a clear view of the working area. Remote control systems can be used for this.

l) The puller frame shall incorporate anchor lugs of suitable sizes to hold the machinery in place on site.

m) The puller frame shall be equipped with an earthing point. Its surface shall ensure a sufficiently conductive electrical connection.

n) If the puller is fitted with electrically isolated and conductive components, an earthing strap shall be installed between the isolated component and the frame of the machinery.

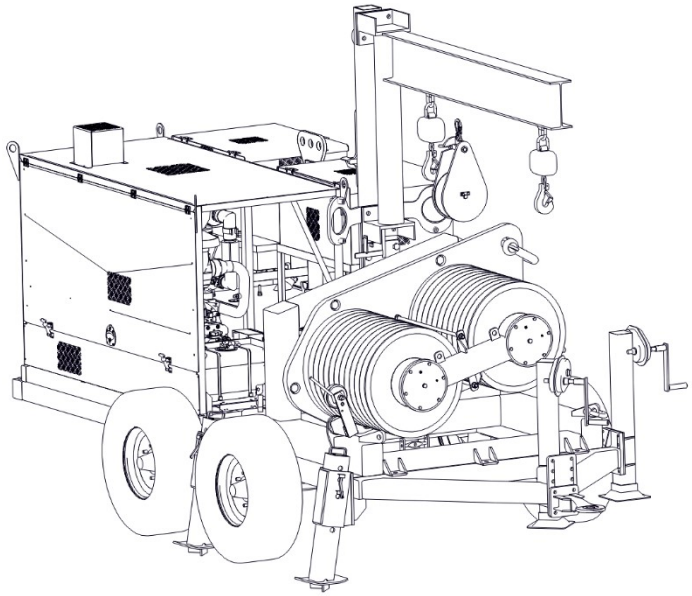


Figure 9 – Example of a bullwheel puller with a separate conductor reel

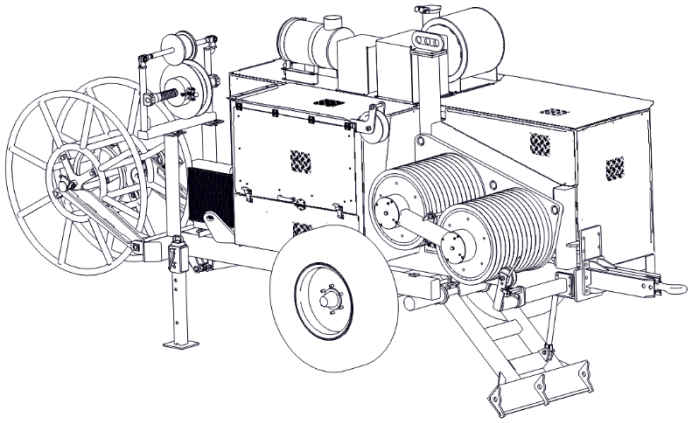


Figure 10 – Example of a bullwheel puller with an integrated conductor reel

5.4.2.4 Puller-tensioners

5.4.2.4.1 General

These are items of stringing machinery that can be used as both tensioners and pullers (see Figures 11 to 13).

Puller-tensioners with at least two bullwheels are used, with three or more grooves for every subconductor on each wheel (see Figure 11). Each subconductor shall have an adequate number of grooves (at least three) to prevent the outer layers of wires slipping over the layers underneath in the case of multi-layered conductors.

This involves increasing the tension applied to the bullwheel grooves one groove at a time. Requirements for special conductor types shall be agreed upon between the client, conductor manufacturer, machinery manufacturer and installer.

5.4.2.4.2 General criteria

Generally applicable and desirable characteristics of puller-tensioners are as follows.

It is important that the conductor be installed smoothly and without jerking or bouncing to avoid any sudden overload on machinery and equipment and ensure safe and high-quality stringing. The tensioning system should provide for a constant tension in the conductor at all stringing speeds and should hold this tension even when stringing is stopped.

NOTE It is possible to use puller-tensioners with independently controlled bullwheels for each conductor or rigid bullwheels for multiple conductors. The use of machinery with independently controlled bullwheels makes it easier to regulate the tension of each conductor than the use of bullwheel machinery with a single controller.

Generally applicable and desirable characteristics of the operation of a puller-tensioner as a puller are as follows.

a) It is important that the conductor/pulling rope be pulled in smoothly and without jerking or bouncing. Consequently, it should be possible to change the speed of the puller gradually rather than in increments.

b) The puller shall have sufficient pulling power to start the conductor moving at full stringing force after a stop.

5.4.2.4.3 Definition of puller force / tensioner force

The following aspects shall be taken into account for puller operation:

- stringing force per conductor and the number of subconductors to be strung at the same time;
- reserve of at least 20 % of the calculated stringing force;
- if necessary, reserve of 20 % of tension as per the sag table for regulation.

NOTE For stringing, the tension in the puller shall intentionally be greater than the calculated force of the tensioner, as this is required to overcome the friction losses from the section being installed. As a rule, during regulation at the drum site, greater forces are exerted on the tensioner, which acts as a puller in that case.

The following aspects shall be taken into account for tensioner operation:

- stringing force per conductor and the number of subconductors to be strung at the same time;
- length and route of stringing section;
- reserve of at least 20 % of the calculated stringing force at the puller.

5.4.2.4.4 Other criteria

The following specific criteria concerning the puller-tensioner when used as a tensioner should be considered in the selection of a suitable puller-tensioner to be used for a particular project:

a) The bullwheel grooves shall be lined with a material that will prevent damage to the surface of the conductor and allow the conductor to insert itself into the groove.

b) The minimum diameter of the bullwheel, measured at the bottom of the groove, is 40 times the conductor diameter.

c) The minimum bullwheel groove diameter is 1,1 times the conductor diameter to allow the cable grip joints installed at the end of the conductor to pass through the groove.

d) The conductors from the rope drum shall be guided into the correct groove of the bullwheel with the aid of guide rollers below and on both sides of the conductor. The guide rollers shall be designed such that the angle of the conductor ends between the drum stand and the tensioner is reduced (see Figure 5, left). The angle of the guide on the individual rollers shall not exceed 5° in the horizontal or vertical direction.

e) There shall be a holding brake as per Clause 5.4 of EN 14492-1:2006+A1:2009, usually a hydraulic spring-loaded brake, incorporated into the drive unit of each bullwheel pair. This is necessary to enable the tension of the conductor to be maintained in the event of failure of the drive unit or hydraulics. In certain applications, such as when the pulling rope or conductor is strung by helicopter, a suitable logic device shall be provided to ensure safe operation of the holding brake and thus avoid any critical situations involving the brake engaging during stringing.

f) The control panel for the puller-tensioner shall be equipped with at least one measuring instrument for displaying braking force and one device that the operator can set to a particular braking force value.

g) The control panel for the puller-tensioner should be positioned such that the operator has a clear view of the working area. Remote control systems can be used for this.

h) The puller-tensioner frame shall incorporate anchor lugs of suitable sizes for fastening anchors to hold the machinery in place on site.

i) The puller-tensioner frame shall be equipped with an earthing point. Its surface shall ensure a sufficiently conductive electrical connection.

j) If the puller-tensioner is fitted with electrically isolated and conductive components, an earthing strap shall be installed between the isolated component and the frame of the machinery.

k) A puller-tensioner to be used in restringing work for directly pulling out the conductor to be replaced that is used as a pulling rope to pull in the new conductor should, like a tensioner, have a bullwheel diameter of at least 40 times the conductor diameter, as the state and behaviour of the conductor to be replaced are difficult to predict.

l) The puller-tensioner shall have a hydraulic controller to ensure that there is always pretension in place on the rope between the rope drum and the tensioner.

The following also applies if the puller-tensioner is used as a puller:

a) The control panel for the puller shall have a measuring instrument with a tension indicator and an overload device that the operator can set to a maximum tension. The overload device shall automatically stop the puller when the tension reaches the set value. This will prevent the puller from continuing to pull up to dangerous levels if the conductor, rope or running board becomes snagged and held somewhere along the stringing section.

b) The pulling rope should be guided into the correct groove of the bullwheel from the conductor reel with deflection rollers placed below and on each side of the rope.

c) In the case of puller-tensioners, suitable equipment shall be used to ensure that the pulling rope is guided from the puller-tensioner to the pulling rope drum or wheel and evenly wound across the width of the drum. This makes for smooth pulling and prevents the rope from becoming tangled on the drum.

d) The control panel for the puller-tensioner should be positioned such that the operator has a clear view of the working area. Remote control systems can be used for this.

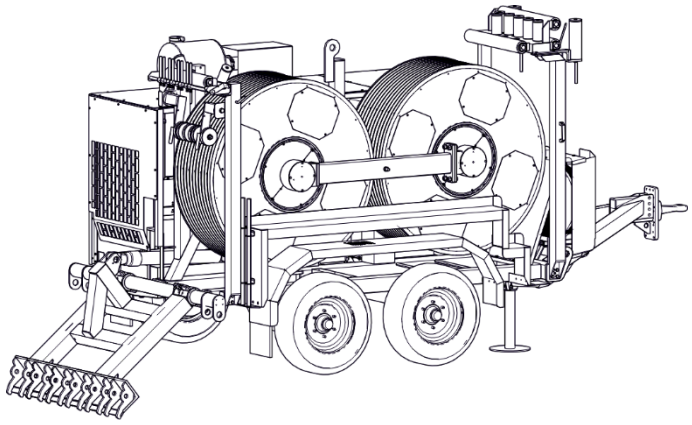


Figure 11 – Example of a puller-tensioner with a pair of bullwheels with multiple grooves

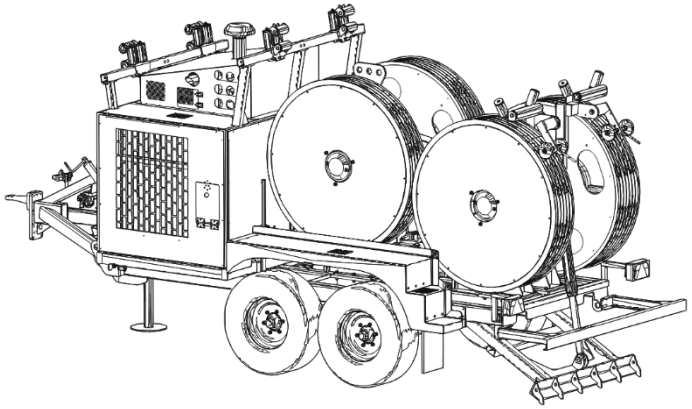


Figure 12 – Example of a puller-tensioner with several pairs of bullwheels with multiple grooves

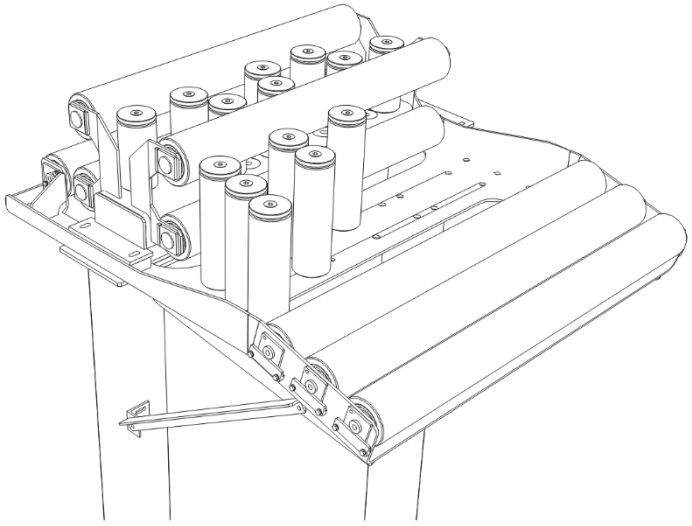


Figure 13 – Example of a rope inlet

5.4.3 Reel stands

5.4.3.1 General

Unpowered reel stands can be used to pull out thin pulling ropes, and such a reel stand can have a tensioner. Further pulling rope stringing shall require tension stringing, with reel stands with power drive and tensioner systems used.

A reel stand (see Figure 14, for example) can have its own power source for driving the reel; however, they are more often powered by a hydraulic drive system on the puller via hydraulic hose connections.

In any case, reels are driven such that they wind up the pulling rope with pretension. This ensures that the pulling rope always remains taut between the puller and the conductor reel during stringing so that the rope does not loosen on the puller bullwheels.

5.4.3.2 Criteria for the selection of reel stands

The criteria for the selection of reel stands are as follows:

a) Each reel stand has a winding system to help to wind the pulling rope evenly across the reel and prevent uneven build-up that could cause snarling of the rope on the reel.

b) The reel stand shall be able to accommodate the size and weight of the reel to be used on the project.

c) The reel stand shall incorporate anchor lugs of suitable sizes to hold them in place on site.

d) The reel frame shall be equipped with an earthing point. Its surface finish shall be free of any paint or other coatings or surface contamination so as to ensure a sufficiently conductive electrical connection.

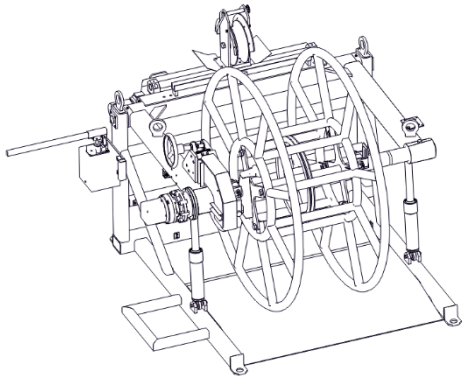


Figure 14 – Example of a reel stand

5.4.4 Drum stands

5.4.4.1 General

Drum stands (see Figure 15 for example) are used to hold the conductor drums. They are usually positioned behind the tensioner and used to wind off the conductor from the rope drum. Drum stands can be self-loading, but the drums are usually loaded into the drum stand by crane or other lifting equipment.

One drum stand is required for each subconductor of a conductor bundle.

Drum stands or mobile trailer drum stands are used to hold the conductor drums.

The drum stand shall be equipped with a brake mechanism to maintain tension in the conductor between the drum stand and the tensioner during the stringing process. The use of hydraulic braking systems is preferred to ensure that the conductor is pulled out from the drum as smoothly as possible. The drive system is usually powered directly via the rope tensioner.

In exceptional cases, use of drum stands without puller-tensioners or a tensioner can be agreed upon for the direct installation of conductors during stringing at very low tensions when there is no possibility of coming into contact with existing live conductors or any risk of crossing. Installation shall take place without dragging in any case.

5.4.4.2 Criteria for the selection of drum stands

The criteria for the selection of drum stands are as follows.

a) The drum stand shall be able to accommodate the size and weight of the conductor drum to be used on the project.

b) The drum stand shall be positioned in such a way that it remains in place on site during stringing. If stays are required for this, the drum stand frame shall possess suitable mounting attachments.

c) The drum stand shall be equipped with an earthing point. Its surface finish shall be free of any paint or other coatings or surface contamination so as to ensure a sufficiently conductive electrical connection.

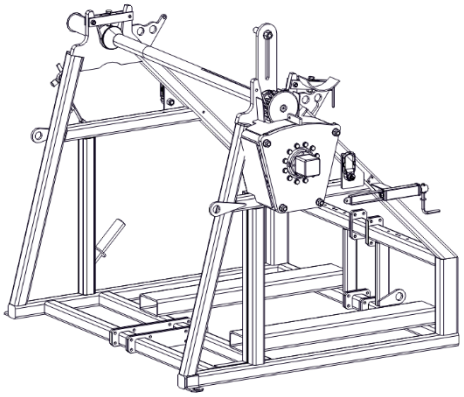


Figure 15 – Example of a drum stand

Bibliography

IEV 466 - *International Electrotechnical Vocabulary - Chapter 466: Overhead lines; identical with IEC 60050-466:1990*

IEV 651 - *International Electrotechnical Vocabulary - Part 651: Live working; identical with IEC 60050-651:1999-07*

IEC/TR 61328:2017, *Live working - Guidelines for the installation of transmission and distribution line conductors and earth wires - Stringing equipment and accessory items*

IEC 60743:2013-07, *Live working - Terminology for tools, devices and equipment*

National edition:

DIN EN 60743:2014-05, *Arbeiten unter Spannung - Terminologie für Werkzeuge, Geräte und Ausrüstungen (IEC 60743:2013); Deutsche Fassung EN 60743:2013*

DIN 48207-3:2005-06, *Freileitungen mit Nennspannungen über 1 kV - Verfahren und Ausrüstung zum Verlegen von Leitern - Teil 3: Wirbelverbinder*

EN 50341-1:2012, *Overhead electrical lines exceeding AC 1 kV - Part 1: General requirements - Common specifications*

National edition:

DIN EN 50341-1:2013-11 (VDE 0210-1:2013-11), *Freileitungen über AC 1 kV - Teil 1: Allgemeine Anforderungen - Gemeinsame Festlegungen; Deutsche Fassung EN 50341-1:2012*

EN 50182:2001, *Conductors for overhead lines - Round wire concentric lay stranded conductors*
EN 50182/AC:2005
EN 50182/AC:2013

National edition:

DIN EN 50182:2001-12, *Leiter für Freileitungen - Leiter aus konzentrisch verseilten runden Drähten*;
Deutsche Fassung EN 50182:2001
DIN EN 50182 Berichtigung 2:2016

EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction*

National edition:

DIN EN ISO 12100:2011-03, *Sicherheit von Maschinen - Allgemeine Gestaltungsleitsätze - Risikobeurteilung und Risikominderung (ISO 12100:2010); Deutsche Fassung EN ISO 12100:2010*
DIN EN ISO 12100 Berichtigung 1:2013

EN 14492-1:2006+A1:2009, *Cranes - Power driven winches and hoists - Part 1: Power driven winches*

National edition:

DIN EN 14492-1:2010-06, *Krane - Kraftgetriebene Winden und Hubwerke - Teil 1: Kraftgetriebene Winden; Deutsche Fassung EN 14492-1:2006+A1:2009*

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