

Live working — Guidelines for the installation of distribution line conductors — Stringing equipment and accessory items

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/78, Tools for live working, which has the responsibility to:

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Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

Summary of pages

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TECHNIQUE
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TR 61911

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2003-02

**Travaux sous tension –
Lignes directrices pour l'installation des
conducteurs des lignes de distribution –
Equipement de déroulage et accessoires**

**Live working –
Guidelines for the installation of distribution
line conductors –
Stringing equipment and accessory items**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**LIVE WORKING –
GUIDELINES FOR THE INSTALLATION
OF DISTRIBUTION LINE CONDUCTORS –
STRINGING EQUIPMENT AND ACCESSORY ITEMS**

FOREWORD

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IEC 61911, which is a technical report, has been prepared by IEC technical committee 78: Live working.

This second edition cancels and replaces the first edition published in 1998. It incorporates some technical changes to update work methods and procedures. It also expands the information on the use of earth rods. It comments on the use of conductor earths when a synthetic pulling rope is used.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
78/440/DTS	78/485/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2010.
At this date, the publication will be

- transformed into an International Standard;
- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

With the increased difficulty of de-energizing existing overhead lines, installing or removing conductors nearby, or crossing these existing circuits, creates hazards requiring special considerations, particularly with regard to earthing and bonding. Hazardous work conditions can also arise from induction, lightning strikes or electrostatic charging.

These potential electrical hazards demand that certain requirements be observed when choosing equipment and work methods for the protection of personnel or equipment.

This technical report has been prepared in accordance with the requirements of IEC 61477, where applicable.

LIVE WORKING – GUIDELINES FOR THE INSTALLATION OF DISTRIBUTION LINE CONDUCTORS – STRINGING EQUIPMENT AND ACCESSORY ITEMS

1 Scope

The present Technical Report provides recommendations for the selection and testing, where necessary, of conductor stringing equipment and accessory items used for the installation of bare and insulated overhead distribution conductors.

Procedures are recommended for proper earthing in order to protect equipment, components and personnel from currents which can result from accidental contact with nearby energized conductors, or induced voltage from adjacent energized lines, lightning strikes, switching errors or electrostatic charging.

The equipment under consideration in this Technical Report is used for distribution voltages, usually considered to be below 50 kV.

However, for voltages of 50 kV and above, use of IEC 61328 may be more appropriate. The choice of whether IEC 61328 or this Technical Report applies to the work being considered will usually depend on the physical size of the conductors, the size of the structures and the average span between supports.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60050(466):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 466: Overhead lines*

IEC 60050(651):1999, *International Electrotechnical Vocabulary (IEV) – Chapter 651: Live working*

IEC 60743:2001, *Live working – Terminology for tools, equipment and devices*

IEC 61230, *Live working – Portable equipment for earthing or earthing and short-circuiting*

IEC 61328, *Live working – Guidelines for the installation of transmission line conductors and earthwires – Stringing equipment and accessory items*

IEC 61477:2001, *Live working – Minimum requirements for the utilization of tools, devices and equipment*

3 Terms and definitions

Terminology for equipment and procedures associated with the installation of overhead conductors varies widely throughout the utility industry. See also IEC 60050(466), IEC 60050(651), and IEC 60743 for supplementary definitions.

For the purposes of this Technical Report, the following definitions apply.

3.1

anchor site

location along the distribution line where anchors are placed to temporarily hold the conductors in order to facilitate splicing, pulling or tensioning work

3.2

birdcaging

opening up of the outer layers of a conductor to form a bulge in the conductor

NOTE This usually occurs with multilayer large diameter conductors as they are passed through the tensioner bullwheels. Birdcaging may be controlled by increasing the tension in the conductor as it leaves the reel stand.

3.3

bond

equipotential connection, connection

electrical connection putting various exposed conductive parts at an equal potential

NOTE Bonding is used to bring all personnel and objects in the work area to the same potential.

3.4

bucket

basket

device designed to be attached to the boom tip of a line truck, crane or aerial lift to support workmen in an elevated working position

NOTE It is normally constructed of fibreglass to reduce its physical weight, maintain strength and obtain good dielectric characteristics.

3.5

bullwheel

wheel incorporated as an integral part of a puller or tensioner to generate pulling or braking tension on conductors or pulling ropes, through friction

NOTE A puller or tensioner normally has one or more bullwheels incorporated in its design. The physical size of the bullwheels will vary depending on the diameter of conductor or rope to be used. The wheels are power driven or retarded. Tensioner bullwheels are usually lined with polychloroprene or polyurethane. Puller bullwheels usually have hardened steel grooves.

3.6

circuit (of an overhead line)

conductor or system of conductors through which an electric current is intended to flow

[IEV 466-01-07]

NOTE In transmission and distribution lines, a circuit usually consists of three phases for a.c. lines, and two phases for d.c. lines.

3.7

clearance

minimum separation between two conductors operating at different voltages, between conductors and supports or other objects, or between conductors and the earth

3.8

clipping-in

clamping-in, clipping

transferring of sagged conductors from the stringing blocks to their permanent suspension positions and the installing of the permanent suspension clamps

3.9

clipping offset

calculated distance, measured along the conductor from the plumb mark to a point on the conductor at which the centre of the suspension clamp is to be placed

NOTE When stringing in rough terrain, clipping offsets may be required to balance the horizontal forces on each suspension structure.

3.10

compression joint

conductor splice, sleeve, splice

tubular compression fitting designed and fabricated from aluminium, copper or steel to join or terminate conductors

NOTE It is usually applied through the use of hydraulic or mechanical presses. However, in some cases explosive type joints are utilized.

3.11

conductor

cable, wire

component intended to carry electric current. A wire, usually bare, or combination of wires not insulated from one another, suitable for carrying an electric current. A conductor may be bare or insulated

3.12

conductor cover

line hose, line guard

protective cover used to shroud the conductor

NOTE It may be flexible or rigid, according to the insulating material used.

[Definition 5.1.3 of IEC 60743, note modified]

3.13

conductor grip

Chicago grip, conductor clamp, come-along, come-along clamp, Klein

device designed to permit the pulling or temporary holding of the conductor without splicing on fittings, eyes, etc.

NOTE The conductor grip permits attachment to a continuous conductor where threading is not possible. The design of these grips varies considerably. Most common grips are those which utilize an open sided rigid body with opposing mobile jaws and a swing latch. In addition to pulling or temporary holding of conductors, this type is commonly used to tension guys and, in some cases, pull or temporarily hold wire rope.

3.14

conductor thermometer

accurate thermometer permanently attached to a short sample of conductor and used to determine ambient temperature for correcting sag charts to actual conditions during the sagging operation

3.15

conductor trimmer

tool used to trim the aluminium wires from around the core of ACSR (aluminium conductor steel reinforced) conductors in preparation for the splicing process

3.16**connector link**

pulling rope connector, link, peanut

rigid link designed to connect pulling ropes and usually designed to pass through the grooves of bullwheels on the puller when under load

NOTE It will not spin to relieve torsional forces.

3.17**crossing structure**

guard structure, H-frame, rider pole structure, scaffolding, temporary structure

structure built of poles, tubes, or other specialized equipment such as a crane, sometimes using rope nets

NOTE Crossing structures are used whenever conductors are strung over roads, power lines, communications circuits, highways or railroads and normally constructed in such a way as to prevent the conductor from falling onto or into any of these facilities in the event of equipment failure, broken pulling ropes, loss of tension, etc.

3.18**dead-ending**

procedure which results in the termination of conductors at an anchor structure

3.19**de-energized**

dead

at a potential equal to or not significantly different from that of the earth at the worksite

[IEV 651-01-15, modified]

3.20**dynamometer**

load cell

device designed to measure mechanical loads or tension on conductors

NOTE Various models are used to tension guys or sag conductors.

3.21**earth**

ground

conducting connection by which an electric circuit or equipment is connected to the earth, or to some conduction body of relatively large extent that serves in place of the earth

3.22**earth cable**

ground cable

flexible conductor usually of stranded copper with a transparent cable protective sheath, and attached at both ends to clamps, designed to connect conductors or equipment to earth or to an earth mat

[Definition 15.1 of IEC 60743, modified]

3.23**earth clamp**

ground clamp

component for connecting an earthing cable, short-circuiting cable or connecting cluster to an earthing conductor or an earth electrode

[IEV 651-14-07 and definition 15.6 of IEC 60743]

NOTE The earth clamp is used for making connections between the conductors, stringing equipment, pulling/pilot ropes and the earth.

3.24

earth mat

counterpoise, earth grid, ground gradient mat, ground mat
system of interconnected bare conductors arranged in a pattern over a specified area on, or buried below, the surface of the earth

NOTE Normally, an earth mat is bonded to earth rods driven around and within its perimeter to increase its earthing capabilities and provide convenient connection points for earthing devices. The primary purpose of the mat is to provide safety for workmen by limiting potential differences within its perimeter to safe levels in case of high currents which may flow if the circuit or conductor being worked became energized for any reason. Metallic surface mats and gratings are sometimes utilized for this same purpose. When used, these mats are employed at pull, tension and midspan splice sites.

3.25

earth rod

earth electrode, ground electrode
rod driven into the earth to serve as an earthing terminal, such as a copper-clad steel rod, solid copper rod or galvanized steel rod

NOTE Copper-clad steel rods are commonly used during conductor stringing operations to provide a means of obtaining an electrical earth using portable earthing devices.

3.26

earthing stick

earthing pole, ground stick
device comprising an insulating stick equipped with a permanent or detachable coupling for installing line clamps, short-circuiting bars, or conductive extension components

[IEV 651-14-10 and definition 15.8 of IEC 60743]

NOTE The earthing stick is made of fibreglass, reinforced plastic or similar, with a particular, highly resistant connection and is of sufficient length to allow safe gripping and installation of earth clamps.

3.27

earthing system

ground system
system consisting of all interconnected earthing connections in a specific area, such as a pull section

3.28

electromagnetic field induction

electromagnetic coupling
phenomenon that produces both an induced voltage and current

NOTE 1 When the predominant effect is due to voltage, this is known as **electric field induction**.

NOTE 2 When the predominant effect is due to current, this is known as **magnetic field induction**.

3.29

electric field induction

capacitive coupling
process of generating voltages and/or currents in a conductive object or electrical circuit by means of time-varying electric fields

3.30

energized

alive, current-carrying, hot, live
at a potential significantly different from that of the earth at the worksite and which presents an electrical hazard

NOTE A part is energized when it is electrically connected to a source of electric energy. It can also be energized when it is electrically charged under the influence of an electric or magnetic field.

[IEV 651-01-14]

3.31**equipotential**

set of points all of which have the same potential

3.32**equipotential work zone area/site**

work zone where all equipment is interconnected or bonded by jumpers, earths, earth rods and/or mats that will minimize voltage differences between all parts of the zone under worst case conditions of energization

3.33**factor of safety, mechanical**

ratio of breaking strength or yield strength to the maximum allowable applied force or load

3.34**fault**

any undesired change that impairs normal operation. A physical condition that causes a device, a component, or an element to fail to perform in a required manner

NOTE An example of a fault might be a short circuit, a broken wire or an intermittent connection.

3.35**fault current**

current flowing at a given point of a network resulting from a fault at another point of this network

NOTE A fault current flowing to earth may be called an earth fault current.

3.36**finger rope**

finger line

lightweight rope, normally natural fibre or synthetic fibre rope, placed over the stringing block when it is hung

NOTE The finger rope usually extends from the ground, passes through the stringing block and back to the ground. It is used to thread the end of the pilot rope or pulling rope over the stringing block and eliminates the need for workmen on the structure. These ropes are not required if pilot ropes are installed when the stringing blocks are hung.

3.37**hoist**

chain, cable, coffering hoist, ratchet hoist, pull lift, tirfor

device normally designed using roller or link chain or wire rope and having built-in leverage to enable heavy loads to be lifted or pulled

NOTE The hoist is often used to dead-end a conductor during sagging and clipping-in operations and when tensioning guys.

3.38**hold down block**

hold down roller, splice release block

device designed with one or more single groove sheaves to be placed on the conductor and used as a means of holding it down

NOTE The hold down block functions essentially as a stringing block used in an inverted position. It is normally used in midspan to control pilot rope, pulling rope or conductor uplift caused by stringing tensions, or at splicing locations to control the conductor as it is allowed to rise after splicing is completed.

3.39

isolate

to disconnect completely a device or circuit from other devices or circuits, separating it physically, electrically and mechanically from all sources of electrical energy

NOTE Such separation may not eliminate all effects of electromagnetic induction.

3.40

Jumper

dead-end loop

a) conductor that connects the conductors on opposite sides of a dead-end structure

b) conductor placed across the clear space between the ends of two conductors or metal pulling ropes which are being spliced together

NOTE Its purpose is to act as a shunt to prevent workmen from accidentally placing themselves in series between the two conductors.

3.41

magnetic field induction

inductive coupling

process of generating voltages and/or currents in an electrical circuit by means of time-varying magnetic fields

3.42

outage

condition where a circuit has been isolated to enable work to be performed which usually cannot be performed with the circuit energized

NOTE Such isolation may not eliminate all effects of electromagnetic induction.

3.43

pilot rope

lead line/rope, leader, P-line/rope, straw line/rope

lightweight rope, normally a synthetic fibre rope, used to pull heavier pulling ropes which in turn are used to pull the conductor

NOTE 1 Pilot ropes may be installed with the aid of finger ropes or by helicopter when the insulators and stringing blocks are hung.

NOTE 2 In some countries this rope is called a pre-pilot rope.

3.44

pilot rope puller

device designed to payout and rewind pilot ropes during stringing operations

NOTE A pilot rope puller can be either a bullwheel type design, usually with the take-up winder as an integral part of the machine, or a multiple drum type machine. It is usually located at the tensioner site.

3.45

portable earth interrupter tool

portable switching device designed to break high circulating currents, and which prevents an unmanageable large arc from occurring in the removal of the last earth in an earthing system

3.46**pulling rope**

bull line/rope, hard line/rope, sock line/rope

high strength rope, normally synthetic fibre rope or wire rope, used to pull the conductor

NOTE 1 On reconstruction jobs where a conductor is being replaced, the old conductor often serves as the pulling rope for the new conductor. In such cases, the old conductor should be closely examined for any damage prior to the pulling operations.

NOTE 2 In some countries this rope is called a pilot rope.

3.47**pull section**

pull setting, stringing section

section of line where the conductor is pulled into place by the puller and tensioner

3.48**pull site**

puller set-up, tugger set-up

location in a pull section where the puller, reel winder and anchors (snubs) are located

NOTE This site may also serve as the pull site for the next pull section.

3.49**puller/bullwheel**

equipment designed to pull pulling ropes and conductor(s) during stringing operations. The pulling rope is wound up under low mechanical tension on the drum in a take-up winder after passing through the puller bullwheels

NOTE The take-up winder may be incorporated as part of the bullwheel puller or may be a separate equipment.

[Definition 14.5 of IEC 60743]

3.50**puller/drum**

hoist, tugger

equipment designed to pull pulling ropes and conductor(s) during stringing operations. The pulling rope is wound directly on the drum of the puller at high mechanical tension

NOTE It may have more than one drum, one for each phase.

[Definition 14.6 of IEC 60743, note modified]

3.51**puller tensioner**

equipment which can be used either as a puller or tensioner

NOTE 1 The puller tensioner is usually designed for a single conductor only, but equipment exists that performs either the pulling or tensioning functions on bundle conductors.

NOTE 2 This equipment is desirable particularly for reconductoring work or where work flexibility is important. It may be of either the bullwheel or drum type, with the drum type used mainly for distribution work.

3.52**pulling vehicle**

pulling tractor

any piece of mobile ground equipment capable of pulling pilot ropes, pulling ropes or conductors

NOTE Helicopters may be considered as a pulling vehicle when utilized for the same purpose.

3.53

reel stand

reel elevator, reel trailer, reel truck

device designed to support one or more reels and having the possibility of being skid, trailer or truck mounted

NOTE Usually located behind the tensioner, this device pays out the conductor from the reel under low tension to the bullwheels of a tensioner for transmission line work, or directly to the stringing blocks for distribution line work. This device can accommodate rope or conductor reels of varying sizes and is usually equipped with reel brakes to prevent the reels from turning when pulling is stopped. It is used for either the slack or tension stringing method.

3.54

reel winder

take-up reel winder, take-up stand, take-up winder

machine designed to work in conjunction with a bullwheel puller and serve as a recovery unit for a pulling rope

NOTE It is normally powered hydraulically from the puller, but is sometimes equipped with its own engine. It can be skid, trailer or truck mounted.

3.55

ruling span

equivalent span

fictitious single span in which tension variations due to load or temperature changes are nearly the same as in the actual spans in a section

NOTE The approximate value a_c of the equivalent span is calculated from :

$$a_c \equiv \frac{\sqrt{\sum a_i^3}}{\sqrt{\sum a_i}}$$

where a_i is the length of the span i in the section.

[IEV 466-03-12]

3.56

running board

headboard

pulling device designed to permit stringing several conductors simultaneously with a single pulling rope

NOTE 1 The device is shaped to pass smoothly through the stringing block during the stringing process. The running board usually has a flexible pendulum tail suspended from the rear to prevent the conductors from twisting together during the pulling process.

NOTE 2 The conductors and pulling rope are normally connected to the running board with swivels to prevent twisting loads being transferred to the running board.

[IEV 651-13-04 and definition 14.4 of IEC 60743]

3.57

running earth

ground roller, moving ground, rolling ground, travelling ground, running ground

portable device designed to connect a moving conductor or a pulling/pilot rope to an electrical earth

NOTE These devices are normally placed on the conductor or pulling/pilot rope adjacent to the pulling and tensioning equipment located at either end of a pull section. They are primarily used to provide safety for personnel during construction or reconstruction operations.

[Definition 14.2 of IEC 60743]

3.58

sagging

process of pulling conductors up to their final tension or sag

3.59**sag section**

section of line between snub or dead-end structures

NOTE More than one sag section in a pull section may be required in order to sag properly the actual length of conductor which has been strung.

3.60**sag span**

control span

span selected within a sag section and used as a control to determine the proper sag of the conductor, thus establishing the proper conductor level and tension

NOTE A minimum of two, but normally three, sag spans are required within a sag section in order to sag properly. In mountainous terrain or where span lengths vary radically, more than three sag spans may be required within a sag section.

3.61**sag target**

sag board, target

device used as a reference point to sag conductors and placed on one structure of the sag span

NOTE The person, on the other structure of the sag span, can use it as a reference to determine the proper conductor sag.

3.62**slack stringing**

method of stringing conductor(s) slack without the use of a tensioner, but some minimal braking may be applied to the conductor reel

NOTE This usually means the conductor touches the ground between support structures. The conductor is pulled off the reel by a pulling vehicle and dragged along the ground, or the reel is carried along the line on a vehicle and the conductor deposited on the ground. As the conductor is dragged to, or past, each supporting structure, the conductor is placed in the stringing blocks, normally with the aid of finger ropes.

3.63**splicing**

jointing

process of joining the ends of conductor lengths to form a continuous mechanical and electrical connection

NOTE This is usually done by pressing aluminium or aluminium and steel sleeves over the ends of both conductors.

3.64**stringing**

process of pulling pilot ropes, pulling ropes and conductors over stringing blocks supported on structures of overhead lines

NOTE Quite often, the entire job of stringing conductors is referred to as a stringing operation, beginning with the installation of insulators and stringing blocks on the erected structures, and terminating after the conductors have been put in the suspension clamps and spacers or spacer dampers installed.

3.65**stringing block**

block, conductor running block, dolly, running out block, sheave, stringing sheave, stringing traveller, traveller

sheave, or sheaves, complete with a frame used separately or in groups and suspended from structures to permit the stringing of conductors

NOTE These devices are sometimes bundled with a centre sheave for the pulling rope and two or more conductor sheaves, and used to string more than one conductor simultaneously. For protection of conductors that should not be mechanically damaged, the conductor sheaves are often lined with non-conductive or semiconductive polychloroprene or polyurethane.

[Definition 14.3 of IEC 60743,]

3.66

stringing block earth

block ground, conductor running block earth, sheave ground, stringing block ground, traveller ground
portable device attached to a stringing block and designed to connect a moving conductor or
pulling/pilot rope to an electrical earth

NOTE A stringing block earth is primarily used to provide safety for personnel during construction or reconstruction operations. This device is placed on the stringing block at a strategic location where an electrical earth is required.

3.67

structure

pole, tower

wood, metal, synthetic, or concrete tower or pole which supports the conductors on insulators

3.68

structure base earth

butt ground, ground chain, portable earthing device, structure base ground, tower ground
portable device designed to connect (bond) a metal structure to an electrical earth and
primarily used to provide safety for personnel during construction, reconstruction or
maintenance operations

3.69

switching surge

transient overvoltage in an electrical circuit caused by a switching operation

NOTE When this occurs, a momentary voltage surge may be induced in a circuit adjacent and parallel to the switched circuit in excess of the voltage induced normally during steady-state conditions.

3.70

swivel

bullet, swivel joint

device designed to connect the conductors' ends or connect one pulling rope to a conductor or
conductors to a running board

NOTE 1 It is not designed to pass through the bullwheels of a puller or a tensioner under any significant load.

NOTE 2 The device will spin and help relieve the torsional forces which build up in the rope or conductor during the stringing process.

3.71

tension site

conductor payout station, payout site, reel set-up, tensioner set-up

location on a pull section where the tensioner, reel stands, conductor reels and anchors
(snubs) are located

NOTE The site may also serve as the tension site for the next pull section.

3.72

tension stringing

process of using pullers and tensioners to give the conductor sufficient tension and positive
control during the stringing operation, to keep it clear of the ground surface and other
obstacles which could cause damage to the surface of the conductor

3.73

tensioner, bullwheel

brake, retarder

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

NOTE Normally, it consists of one or more pairs of polyurethane or polychloroprene lined bullwheels with single or multiple grooves. Tension is accomplished by friction generated against the conductor which is reeved around the groove(s) of the bullwheel(s). Tensioners are available for single conductor stringing or multiconductor bundle stringing.

[Definition 14.1 of IEC 60743]

3.74**threading rope**

reeving rope, thread line

lightweight flexible rope, normally natural fibre or synthetic fibre rope, used to lead a conductor through the bullwheels of a tensioner or pulling rope through the bullwheels of a puller

3.75**touch voltage**

touch potential

potential difference between an earthed metallic structure and a point on the earth's surface separated by a distance equal to the normal maximum horizontal reach, approximately 1 m

NOTE This potential difference may be dangerous and may result from induction or fault conditions, or both.

3.76**ultimate strength, mechanical**

strength of a member, or part of an assembly at which failure of that member or part of the assembly occurs, and as a result it can no longer support a load or perform its intended function

3.77**uplift roller**

small single-grooved wheel designed to fit above the throat of the stringing block to keep the pulling rope or pilot rope in its sheave groove when uplift occurs due to stringing tensions

3.78**working load limit**

allowable load, maximum load, safe working load

limit of load that can be imposed safely on a member or assembly

NOTE This is usually calculated by dividing either the yield strength or the ultimate strength of the member or assembly by the accepted factor of safety. In the case of ropes, the working load is usually calculated by dividing the ultimate or breaking strength by the accepted factor of safety.

3.79**woven wire grip**

Kellem, mesh sock, sock, stocking, wire mesh grip

device designed to allow the temporary joining or pulling of conductors without the need of special eyes, links or grips

3.80**yield strength, mechanical**

strength of a member or part of an assembly at which permanent deformation of that member or part of the assembly occurs, and as a result it can no longer perform its intended function

4 Understanding the hazard – Basic theory

The protection of personnel from injury during the process of installing conductors on distribution lines is most important. The personnel at the work site installing these new conductors shall be protected against induced voltages and currents caused by energized adjacent lines. The personnel shall also be protected from the hazards which can result from accidental line energization. Personnel protection can be achieved by properly applying adequate protective earthing systems at the work area, by the use of correct work methods and specialized training, and by the use of equipment, which incorporates devices to protect against these types of hazards.