ISBN 978-0-626-27392-7

SANS 754:2012

Edition 4.7

SOUTH AFRICAN NATIONAL STANDARD

Eucalyptus poles, cross-arms and spacers for power distribution and communications systems

Amdt 6

Published by SABS Standards Division
1 Dr Lategan Road Groenkloof ✉ Private Bag X191 Pretoria 0001
Tel: +27 12 428 7911 Fax: +27 12 344 1568
www.sabs.co.za

Table of changes

Change No.	Date	Scope
Amdt 1	1996	Amended to change a strength value in a table, to change the method of taper measurement and the requirements for spirality.
Amdt 2	1998	Amended to – replace the standardization mark with the new certification mark; – change the requirements for the strength testing and inspection of poles and cross-arms; – change the requirements for crook, sweep, taper and binding; – change the method of measurement for crook and sweep, the value for the average modulus of elasticity and the marking information; – add notes on preservative treatment; – change the minimum diameter at the theoretical ground line (TGL) of poles and cross-arms to provide the true values; – add the minimum diameter at midpoint of poles and cross-arms; and – correct the titles of referenced standards.
Amdt 3	2001	Amended to increase the retention requirement for hazard class H4 poles, to change the definition for solid penetration, and to change the position of determination of moisture content and penetration.
Amdt 4	2003	Amended to change the definitions of “acceptable” and “approved”, to update references to align with international standards, to delete reference to SABS 02, to change the method to determine penetration and to change the requirements and methods for marking.
Amdt 5	2007	Amended to delete references to the certification mark, to include a requirement regarding cross-fractures in poles (4.4.13), to update cross references, and to correct the sequence of annexes.
Amdt 6	2010	Amended to update the title and the scope, to update referenced standards, to remove reference to the South African Bureau of Standards, to update the table on retention and penetration requirements, to delete a note on the availability of figures for the calibration of electric moisture-meters, and to delete reference to the obtainability of the correction factor.
Amdt 7	2012	Amended to update the introduction, the scope, referenced standards, cross-references and the table on species of timber, to change the minimum allowable fibre stress, to add process and penetration test requirements, to change marking requirements, to change the title of, and to insert characteristic strength values for poles and cross-arms in, the annex on strength tests and values for poles and cross-arms, and to renumber the remaining clauses accordingly, to insert a new annex on mean bending strength values, and to delete the numbering of the bibliography.

Foreword

This South African standard was approved by National Committee SABS TC 218, *Timber preservation*, in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was published in xxxx 2012.

This document supersedes SANS 754:2010 (edition 4.6).

A vertical line in the margin shows where the text has been technically modified by amendment No. 7.

Annexes A, B, C, D, E and H form an integral part of this document. Annexes F, G, I, J and K are for information only. **Amdt 4; amdt 5**

Introduction

Creosotes used for treating timber vary in colour; the blackness of creosote is no indication of its quality. Some very good wood-preserving creosotes either do not blacken wood at all or do so only very slightly.

The results of standard service tests and research have shown that creosotes that comply with the requirements of SANS 616 perform equally under South African conditions, which range from semi-desert to subtropical. Correctly applied, these creosotes should give timber in contact with the ground an expected service life of more than 40 years. **Amdt 6, amdt 7**

Timber treated with creosote or with a mixture of creosote and coal tar suffers less damage from grass fires than does untreated wood (which presents a serious fire hazard). After re-drying, timber treated with a mixture of copper-chromium-arsenic compounds is, owing to "afterglow", more susceptible to damage by fire than is timber treated with creosote or with a mixture of creosote and coal tar. **Amdt 7**

The grading in the standard is based on the assumption that the poles, cross-arms and spacers are to be used in the dimensions in which they are graded. Conversion of any kind after treatment will reduce the expected service life. Where notching or drilling of timber is necessary after it has been treated with a preservative, the exposed wood should be liberally coated with the same type of preservative at the recommended treating temperature, a post-hole treater being used where relevant.

The species allowed in terms of the standard were selected because of their known strength and long-term service records. **Amdt 6**

The standard applies to the condition of the timber at the time of despatch and does not cover deterioration brought about during transportation and storage.

Contents

Eucalyptus poles, cross-arms and spacers for power distribution and telephone systems **Amdt 6**

1 Scope

This standard specifies requirements for eucalyptus poles, grown in Southern Africa, that are treated with creosote, a mixture of creosote and waxy oil, a mixture of copper-chromium-arsenic compounds (CCA), a mixture of copper azole compounds (CuAz), or a mixture of alkaline-copper-quaternary compounds (ACQ), and that are intended to be used as upright supports for communications systems, and as upright supports, cross-arms and spacers (in five-pole structures) for power distribution lines. **Amdt 6; amdt 7**

NOTE Assessment of compliance with the requirements of 4.2, 4.3, 4.7.1, and 4.8.1 (in the case of poles, cross-arms and spacers that are treated with a mixture of copper-chromium-arsenic compounds) to 4.8.4 (inclusive), requires special agreement between the supplier and the purchaser. **Amdt 5**

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

SABS 02, Deleted by amendment No. 4.

SANS 616, *Wood-preserving creosote mixtures and coal-tar mixtures.* **Amdt 6**

SANS 673, *Mixtures of copper-chromium-arsenic compounds for timber preservation*.

~~SANS 1290, *Wood preserving mixtures of creosote and waxy oil*.~~ **Amdt 6**

SANS 3575/ISO 3575, *Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities.* **Amdt 4**

SANS 5967, *Retention of preservative in timber (volume method)*.

SANS 5984, *Moisture content of timber and timber products (oven dry method)*.

SANS 5985, *Moisture content of timber (extraction method)*.

SANS 5986, *Moisture content of timber (electric moisture-meter method)*.

SANS 5987, *Depth of penetration of preservative and detection and depth of sapwood in timber*.

SANS 5988, *Retention of preservative in timber (sample method)*.

SANS 5989, *Retention of preservative in timber (weighbridge method)*.

SANS 6000, *Heartwood detection in timber of the Eucalyptus species*.

SANS 10005:2011, *The preservative treatment of timber*. **Amdt 7**

3 Names of species, and definitions

3.1 Deleted by amendment No. 4.

3.2 Definitions

For the purposes of this standard, the following definitions apply:

3.2.1
acceptable
acceptable to the authority administering this standard, or to the parties concluding the purchase contract, as relevant **Amdt 4**

3.2.2
approved
approved by the authority administering this standard **Amdt 4**

3.2.3
butt
thick end of a pole or cross-arm

3.2.4
centre
part of a pole, cross-arm or spacer that consists of the first year's growth

3.2.5
core
cylindrical piece of wood extracted by means of an increment borer

3.2.6
crook
natural curvature that extends over not more than 2 m of the length of a pole, cross-arm or spacer

3.2.7
cross-arm
pole that is used in a horizontal or near-horizontal position in a structure for the support of power distribution lines, but that is not intended to be used in contact with the ground

3.2.8
diameter class
for a given nominal top diameter, in millimetres, the set of all integral diameter values that exceed or are equal to the given top diameter but are less than the next higher value

EXAMPLE In table C.2 (see annex C), which gives tabulated top diameters of 80 mm, 100 mm, etc., the 80 mm (diameter) class includes all integral diameter values from 80 mm to 99 mm. **Amdt 7**

3.2.9
diameter tape
graduated tape by means of which the effective diameter can be read direct when the tape is placed round a pole, cross-arm or spacer

3.2.10
end check
separation along the grain of the wood and across the annual rings, and that occurs at the end of a pole, cross-arm or spacer

3.2.11
eucalyptus
timber derived from trees of the genus *Eucalyptus* grown in Southern Africa

3.2.12
gum pocket
cavity that contains or has contained an accumulation of gum

3.2.13
gum vein
ribbon of gum between growth rings

3.2.14
increment borer
auger-like instrument with a hollow bit, used to extract cores from wood

3.2.15
kino
gum usually found in eucalyptus and leguminous trees

3.2.16
knot cluster
three (or more) knots so close together that the deflected wood layers envelop the entire group

3.2.17
mechanical damage
defect caused by mechanical means and that has an adverse effect on the aesthetic appearance, the treated sapwood, or the inherent strength of the pole, cross-arm or spacer

3.2.18
post-treatment defect
defect that has developed after treatment and that results in the exposure of untreated wood, but is not classified as mechanical damage

3.2.19
Deleted by amendment No. 3.

3.2.20
Deleted by amendment No. 3.

3.2.21
ring shake
complete separation of the wood fibres that appears as an arc or as a complete circle, that occurs between the annual rings, and that is a natural defect that could be present in some trees

3.2.22
slab-gaining
gaining
removal of timber to a specified depth (measured radially) from the top end of a pole, resulting in a planar area on the surface of the pole that extends from the top end of the pole for a specified length, is parallel to the general longitudinal axis, is free from unacceptable undulations, and terminates, at the bottom, in a bevel

3.2.23
solid penetration
presence of preservative (when relevant, as evidenced by an acceptable chemical test) in all or in a specified portion (as relevant) of the sapwood to an extent that causes complete coloration of that area of the sapwood, except that one band of untreated timber to a maximum of 2 mm in depth will be allowed within the area **Amdt 3**

3.2.24
sound knot
knot that is solid across the face in spite of having surface checks, and of which the fibres are so completely intergrown with the surrounding wood that it can be relied upon to retain its position in the wood

3.2.25
spacer block
piece of timber that is used as a spacer between poles and cross-arms in five-pole structures, but that is not intended to be used in contact with the ground

3.2.26
spirality
spiral grain
natural deviation of the grain from straightness along the longitudinal axis of the pole

3.2.27
splinter-pulling
formation of hollows in normal wood at the butt of a pole, caused by long needle-like splinters, during felling

3.2.28
surface check
separation along the grain of the wood and across the annual rings but not extending to the end of a pole, cross-arm or spacer

3.2.29
sweep
natural curvature that extends over more that 2 m of the length of a pole or cross-arm

3.2.30
theoretical ground line
TGL
point at the given ground line, 1 500 mm ± 25 mm (if not given) above the nearest point of the butt of a pole

3.2.31
treated
treatment
impregnated/impregnation with an acceptable preservative

3.2.32
volume
actual
mean of the cross-sectional areas, in square metres, of the two ends of a pole, cross-arm or spacer, multiplied by its length, in metres

4 Requirements

4.1 Type of product

The product shall be poles, cross-arms or spacers, as required (see annex A.1(a)).

4.2 Species of timber

Unless other acceptable species are required and approved (see annex A.2(a)), eucalyptus poles, cross-arms and spacers shall be of one of the species given in table 1.

Table 1 — Species of timber

1	2
Species of timber	
Botanical name	**Standard name**
Eucalyptus cloeziana[a]	Cloeziana[a]
Eucalyptus grandis	Saligna
Eucalyptus grandis/saligna hybrids	Saligna
Eucalyptus maculata	Maculata
Eucalyptus maideni	Maideni
Eucalyptus microcorys	Microcorys
Eucalyptus paniculata[a]	Paniculata[a]
Eucalyptus saligna	Saligna
[a] Poles of this species shall be strength tested in accordance with 4.3 before being classified as able to withstand a maximum fibre stress (in bending) of 75 MPa, based on the required minimum top diameter of the pole or cross-arm and on a taper of 5 mm per metre of length.	

Amdt 3, amdt 7

4.3 Strength

4.3.1 Poles (except streetlight poles) and cross-arms

When so required (see annex A.1(b),and after all machining has been completed, poles and cross arms shall be tested in accordance with either annex C.2 or annex C.3. Each pole and cross-arm shall be capable of withstanding, without showing any signs of failure, a force *F* calculated in accordance with the appropriate formula given in annex C. The force *F* corresponds to a minimum fibre stress (in bending) of 50 MPa or, if so required, 75 MPa (see table 1). Each pole or cross-arm that is tested shall be marked by the supplier with an additional tag that displays the individual test number of each pole or cross-arm. The tag shall be applied to the butt of the pole or cross-arm.
Amdt 2; amdt 3; amdt 7

NOTE 1 The calculated minimum fibre stress of 50 MPa is based on the minimum top diameter in the class.
Amdt 7

NOTE 2 Pole species that have a minimum fibre stress (in bending) that exceeds 75 MPa are of exceptional strength, and should be specified in exceptional cases only. **Amdt 7**

NOTE 3 Spacers need not be strength tested.

4.4 Freedom from defects

4.4.1 Sapwood

When determined in accordance with 5.3.1, the minimum radial width of the sapwood in a pole, cross-arm or spacer shall be at least the minimum radial penetration of preservative as given in column 7 of table 3. Sapwood shall not have been removed to such an extent that the remaining width of sapwood is less than the specified minimum radial penetration of preservative.

4.4.2 Decay

Before poles, cross-arms and spacers are preservative treated, they shall have been found to be free from decay and from live fungal fruiting bodies.

NOTE At cross-over contact points, surface softening of depth not exceeding 5 mm is not regarded as decay.

4.4.3 Gum (kino) veins

Gum veins shall be permitted, provided that

a) the relevant requirements for depth of penetration of preservative are complied with, and

b) the poles and cross-arms are tested and found to comply with the requirements of 4.3.

4.4.4 Gum pockets

Gum pockets shall be permitted, provided that

a) the depth of a pocket, measured radially, does not exceed 15 mm,

b) the required penetration of preservative is achieved,

c) in the basal 2 m length of a pole, the distance or sum of the distances that the gum pocket(s) extends around the circumference of the pole, does not exceed 20 % of the circumference of the pole at the position of the lowest pocket, and

d) the penetration of preservative below the gum pocket complies with the relevant requirements of 4.8.5. The surface may be drilled to improve penetration of the preservative beyond permissible gum pockets, provided that the diameter of the drilled holes does not exceed 3 mm, and the distance between centres is at least 25 mm. Plugging of the holes is not necessary.

4.4.5 Insect damage

Poles, cross-arms and spacers shall be generally free from insect damage, but the following shall be permitted:

a) scoring or channelling (or both), of depth not exceeding 3 mm, on the surface of a pole, cross-arm or spacer;

b) not more than five barkborer (*Cerambicidae*) holes in any 1 m length of a pole or cross-arm, provided that the holes are tightly plugged (after treatment) with an acceptable treated wooden dowel; and

c) not more than 20 pinhole borer (*Ambrosia*) holes, identified in accordance with annex E, in any 1 m length of a pole or cross-arm.

Damage caused by *Lyctus* borer, identified in accordance with annex E, shall not be permitted.

4.4.6 Ring shakes

There shall be no ring shakes in spacers. Poles and cross-arms may have ring shakes (identified in accordance with 5.3.7), provided that there are no more than one at the butt and one at the top end, and not within 50 mm of the periphery.

4.4.7 Spirality; spiral grain

Spiral grain shall be permitted, provided that, in the case of poles and cross-arms, it does not exceed 1,0 turn in any 3,0 m of the length of a pole or cross-arm, and pro rata for poles and cross-arms of length less than 3,0 m. **Amdt 1**

4.4.8 Post-treatment defects

There shall be no post-treatment defects in any pole, cross-arm or spacer.

4.4.9 Mechanical damage

Any deleterious effect of mechanical damage shall not exceed that of a permissible defect.

4.4.10 Crook and sweep

4.4.10.1 General

There shall be no combination of crook and sweep, or more than one crook or sweep in a pole or cross-arm. These restrictions do not apply to spacers. **Amdt 2; amdt 3**

4.4.10.2 Cross-arms of length less than 6,0 m

When measured in accordance with 5.3.6, crook and sweep, expressed in millimetres, shall not exceed 15 times the numerical value, in metres, of the length L of the cross-arm. (See also figure 2(a).) **Amdt 2**

4.4.10.3 Cross-arms of length at least 6,0 m

Crook or sweep shall be such that a straight line connecting the midpoint at the top of a cross-arm with the midpoint at the butt of the cross-arm does not lie outside the surface of the cross-arm at any intermediate point. (See also figure 2(b).) **Amdt 2**

4.4.10.4 Poles of length at least 6,0 m

Crook or sweep shall be such that a straight line connecting the midpoint at the top of a pole with

a) the midpoint at the TGL, or

b) the midpoint at the butt (see annex A.1(n)),

does not lie outside the surface of the pole at any intermediate point.

(See also figure 2(b) or 2(c), as relevant.) **Amdt 2**

4.4.11 Taper

The taper in a pole or cross-arm from top to butt shall not exceed 10 mm/m of length of the pole or cross-arm.

NOTE This requirement represents an upper limit and should not be confused with the tapers of 3 mm/m assumed in 4.5.3, 5 mm/m assumed in annex C.2 and annex C.3, or 7 mm/m in table F.1 of annex F.
Amdt 2, amdt 7

Spacers shall be evenly tapered.

4.4.12 Maximum permissible defects

Unless higher maxima are required and approved (see annex A.2(b)), the defects in poles, cross-arms and spacers, measured in accordance with 5.3 after binding (see annex D), shall not exceed the permissible maxima given in table 2.

4.4.13 Cross-fractures

All poles shall be free from cross-fracture. **Amdt 5**

4.5 Dimensions

4.5.1 Spacers

The dimensions of spacers shall be as required (see annex A.1(c)).

4.5.2 Length of poles and cross-arms

The length of a pole or cross-arm, measured in accordance with 5.4.1, shall be as required, subject to a tolerance of ± 75 mm. Required lengths (see annex A.1(d)) should preferably be selected from column 1 of table C.1 of annex C.

NOTE All distances (e.g. holes, binding) should be measured from the level of the lowest part of the top or from the level of the highest part of the butt (see 5.4.1), whichever is applicable.

4.5.3 Diameter of poles and cross-arms

When measured in accordance with 5.4.2,

a) the top diameter of a pole or cross-arm, which could vary between the minimum and the maximum of any particular diameter class (see column 2 of table C.1 of annex C), shall be at least equal to the minimum required value (see annex A.1(e)), which shall preferably be one of the values given in column 2 of table C.1 of annex C, appropriate to the required length, and **Amdt 5**
b) the diameter of a pole at the TGL shall be at least that calculated from the minimum top diameter of the class, based on a taper of 3 mm per metre of length of the pole. **Amdt 1; amdt 2**

Table 2 — Maximum permissible defects

1	2	3
Description of defect	**Permissible maximum**	
	Poles	**Cross-arms**
Checks		
a) End checks[a]		
1) Number[b]		
Top	4	3
Butt	4	3
2) Length (as it appears on the surface)		
Top	2 × top dia.	2 × top dia.
Butt	5 × butt dia.	2 × butt dia.
3) Width		
i) Top		
If top dia. does not exceed 180 mm:	1/10 dia. or 15 mm (whichever is less)	6 mm
If top dia. exceeds 180 mm:	1/10 dia. or 15 mm (whichever is less)	10 mm
ii) Butt		
If top dia. does not exceed 180 mm:		
Individual width	1/10 dia. or 25 mm (whichever is less)	1/10 dia. or 10 mm (whichever is less)
Sum of widths	50 mm	–
If top dia. exceeds 180 mm:		
Individual width	1/10 dia. or 25 mm (whichever is less)	1/10 dia. or 15 mm (whichever is less)
Sum of widths	50 mm	–
b) Surface checks		
1) Number[c]	3 at any cross-section	3 at any cross-section
2) Individual length	8 × dia.[d]	8 × dia.[d]
3) Individual width	15 mm	10 mm
4) Sum of widths	40 mm	25 mm
Knots and knot-holes larger than 10 mm (not applicable to a pole or cross-arm tested and found to comply with 4.3)		
a) Size of individual knots and knot-holes	1/6 circumference	1/6 circumference
b) Sum of sizes of knots in clusters in worst 150 mm of length	1/3 circumference	1/3 circumference

[a] The number of end checks in spacers shall be limited to three per end, their length shall be a maximum of 1/4 of the length of the spacer, and their width shall be a maximum of 10 mm.

[b] End checks that extend through the centre of an end and appear in two opposite positions of the periphery are regarded as two checks.

[c] Provided that where three checks occur together at any cross-section, the sum of their lengths shall not exceed half the length of the pole or cross-arm.

[d] The diameter of the pole or cross-arm midway along the length of the check.

4.5.4 Ovality of poles and cross-arms

When measured in accordance with 5.4.2, the ovality of poles and cross-arms shall not exceed the following limits:

a) in the case of poles, the difference between the largest and the smallest diameter at the top of a pole shall not exceed 20 mm in the case of a pole of nominal top diameter not exceeding 140 mm, and 25 mm in other cases; and

b) in the case of cross-arms, the difference between the largest and the smallest diameter at the top and between the largest and the smallest diameter at the butt shall not exceed 20 mm in the case of a cross-arm of nominal top diameter not exceeding 140 mm, and 25 mm in other cases, except that in cross-arms of nominal length exceeding 9 m, the difference between the largest and the smallest diameter at the butt shall not exceed 50 mm.

4.6 Cut of ends

4.6.1 Poles

The ends of poles shall be free from steps and, when measured in accordance with 5.4.3, shall comply with the relevant requirements of 4.6.1.1 and 4.6.1.2. (See also figure 1.)

4.6.1.1 Tops

The cut at the top of poles shall be one of the following, as required (see 5.4.3 and annex A.1(f)):

a) flat top cut : 90° ± 5° to the longitudinal axis;

b) slant top cut : 60° ± 5° to the longitudinal axis; and

c) gable top cut : 60° ± 5° to the longitudinal axis.

4.6.1.2 Butts

The butt shall be cut square (to within 15°) to the longitudinal axis of the pole, and the total area of any hollows caused by splinter-pulling, when measured in accordance with 5.3.5, shall not exceed 10 % of the cross-sectional area of the butt.

4.6.2 Cross-arms and spacers

Both ends of cross-arms and spacers shall be free from steps and, when measured in accordance with 5.4.3, shall have an angle of cut of 90° ± 5°.

4.6.3 Binding and nail-plating

Poles and cross-arms shall be bound or nail-plated, as required (see A.1(g)), in accordance with the requirements of annex D. **Amdt 2**

4.7 Trimming and shaping

4.7.1 General

Shaping and cutting to size of poles, cross-arms and spacers shall have been carried out prior to preservative treatment.

4.7.2 Bark

Poles, cross-arms and spacers shall be free from bark (outer and inner) that inhibits the penetration of the preservative.

4.7.3 Branches

Branches shall have been cut off neatly and flush with the bole prior to preservative treatment. (See also 4.4.1, 4.7.1 and 4.7.4.)

4.7.4 Swellings

Swellings damaged during the removal of bark or during the trimming of branches shall not be regarded as a defect, provided that the requirements of 4.4.1 are complied with.

4.7.5 Gaining of poles

4.7.5.1 Gaining shall be as required (see annex A.1(h)).

4.7.5.2 When end checks are present, the plane of the gain shall be such that the holes required in terms of 4.7.6 have the maximum support from adjacent solid timber.

4.7.6 Holes in poles

Holes in poles shall be as required (see annex A.1(i)) but should not be within 150 mm of an end.

4.8 Preservative treatment

4.8.1 Moisture content

Unless a higher value is required and approved (see annex A.2(c)), the average moisture content of poles, cross-arms and spacers at the time of treatment and determined in accordance with 5.5, shall not exceed 250 g/kg in the case of treatment with a class C[1)] or a class W[1)] preservative (but no individual pole, cross-arm or spacer shall have a moisture content that exceeds 280 g/kg).

4.8.2 Process

Preservative treatment shall be carried out in accordance with SANS 10005, except that in the case of creosote treatment the poles shall be kept in the creosote filled treatment vessel at the minimum temperature specified in SANS 616, and maintained for at least 1 h. **Amdt 7**

Each treatment plant shall be equipped with an electronic data recording unit that registers time, pressure, temperature and vacuum during each cycle of treatment. **Amdt 7**

4.8.3 Preservatives

The preservative used shall be one of the following types, as required (see annex A.1(j)):

a) creosote or creosote mixtures that comply with the requirements of SANS 616; or
Amdt 6; amdt 7

1) See classification in SANS 10005.

b) a solution of copper-chromium-arsenic compounds that complies with the requirements of SANS 673 and that has a total element concentration of not less than 14,6 g/L.

NOTE 1 Poles treated with copper-chromium-arsenic preservatives are normally not used for lines in rural areas since veld fires could cause afterglow. This does not apply to cross-arms.

NOTE 2 It is recommended that poles, cross-arms and spacer blocks freshly treated with copper-chromium-arsenic preservatives be open-air stacked for at least five days, to facilitate fixation.

Amdt 2

4.8.4 Retention of preservative

When determined in accordance with 5.6, unless higher net retention values are required and approved (see annex A.2(d)), the average net retention of a charge shall be at least equal to the value given in column 6 of table 3, appropriate to the hazard class required (see annex A.1(k)). (See also SANS 10005.)

4.8.5 Penetration

Each pole treated in accordance with this standard shall be tested to determine compliance with the penetration requirements. **Amdt 7**

The depth of solid penetration of preservative, measured in accordance with 5.7, shall be at least equal to the value given in column 7 of table 3, appropriate to the hazard class required (see annex A.1(k)). Should a band of untreated timber (see 3.2.23) fall within the required penetration area, the required depth of penetration shall be increased by the depth of the untreated band.

Amdt 3

Table 3 — Retention and penetration requirements

1	2	3	4	5	6	7	8
Hazard class (see SANS 10005)	**Exposure class**	**Timber application**	**End use**	**Preservative type**	**Average net retention (assay zone)**[a] Mass fraction	**Minimum average net retention** kg/m³	**Minimum preservative penetration** mm
H4	Exterior ground contact	Timber in direct contact with the ground	Distribution and communications poles	CCA or creosote or CuAz[b] or ACQ[b]	– – 0,83 1,69	16 or 115 or 5,4[c] or 10,9[c]	15
H3	Exterior above ground	Timber not in direct contact with the ground but exposed to leaching and weathering	Cross-arms and spacers	CCA or creosote or CuAz[b] or ACQ[b]	– – 0,50 0,98	12 or 100 or 3,2[c] or 6,3[c]	15

[a] Average net retention (assay zone) levels expressed in a mass fraction of Cu + biocide.
[b] Timber treated with CuAz or ACQ preservatives: If the actual timber density or sapwood content (or both) are less than those in (c), then a suitable sampling plan (see annex C of SANS 10005:2011) may be used to determine the actual net retention, using the following formula: *ANR* = mass fraction (column 6) × oven dry timber density × sapwood content.
[c] In the case of hardwoods treated with CuAz or ACQ preservatives, the average net retention expressed in kg/m³ (total volume) is calculated by converting from the mass fraction active ingredients using an oven dry timber density of 800 kg/m³, and a sapwood content of 80 % for large poles.

Amdt 3; amdt 6; amdt 7

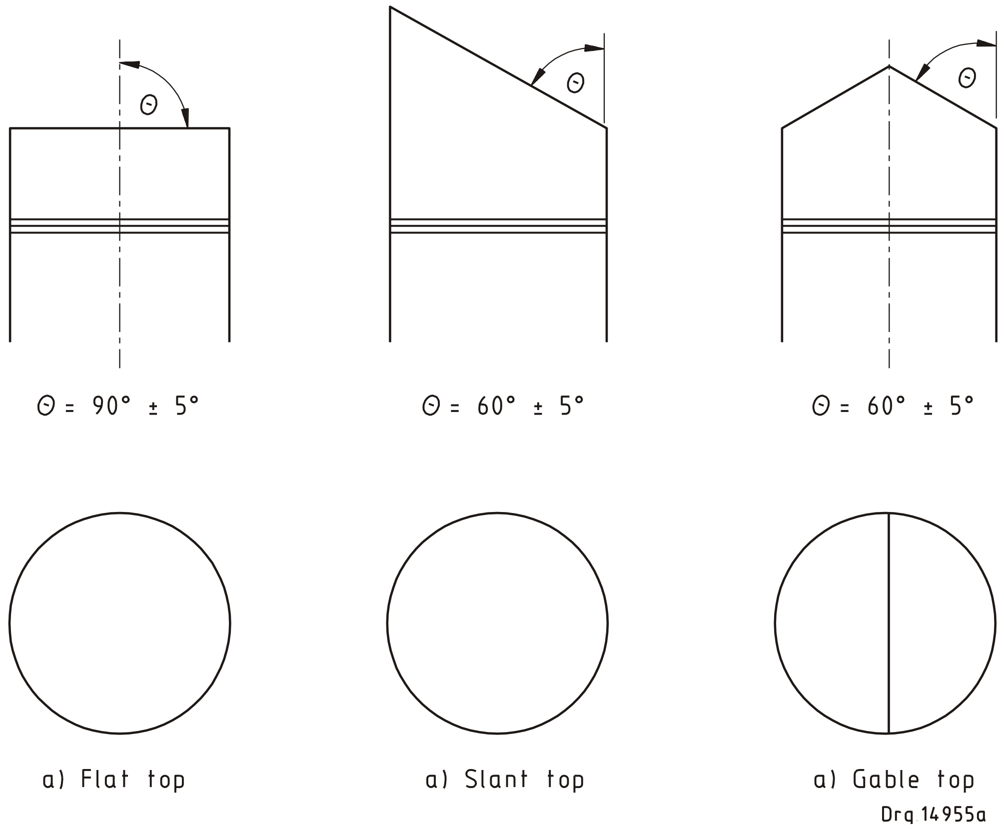


Figure 1(a) — Top cuts

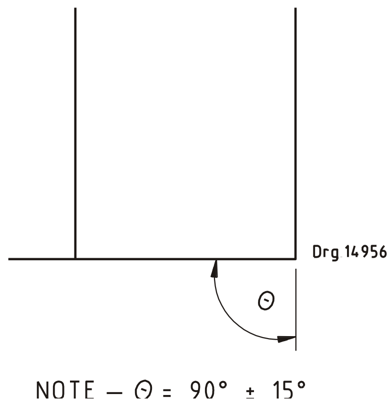


Figure 1(b) — Butt finish **Amdt 2**

Figure 1 — The different top cuts and the butt finish

5 Inspection and methods of test

5.1 General

5.1.1 Using one of the methods given in annex C.2 or annex C.3 as relevant, determine the strength of each pole or cross-arm in the sample (see annex B.2.2 for sampling) before subjecting it to the other appropriate tests. **Amdt 7**

5.1.2 If holes have been drilled in order to assess compliance of the timber (see annex B.2.3), poles and cross-arms may be returned to the lot after testing, provided that, immediately after the holes have been drilled and the timber inspected, the holes are filled with preservative at the recommended treating temperature and tightly plugged to their full depth with a completely penetrated preservative-treated pine dowel. **Amdt 2; amdt 3**

5.1.3 Measure the location of the holes on the gained surface.

5.2 Inspection

Visually examine and then measure (using the relevant methods given in 5.3 and 5.4) each pole, cross-arm or spacer, selected in accordance with annex B.2.2, for compliance with the relevant requirements of 4.4 to 4.7 (inclusive).

5.3 Measurement of defects

5.3.1 Radial width of sapwood

Use SANS 5987, but, in the case of cross-arms and spacers, extract the test specimen(s) at the approximate midlength. Measure, to the nearest 1 mm, the radial width of sapwood in each test specimen and record the minimum of the results. When differentiation between sapwood and heartwood is not possible by visible colour difference, use an acceptable chemical test (see SANS 6000).

5.3.2 Gum pockets

Measure, to the nearest 1 mm, the maximum depth of a gum pocket as the deviation from the surface that the pole, cross-arm or spacer would have presented had it not been interrupted by the defect.

5.3.3 Surface and end checks

Measure the length of a check to the nearest 10 mm and the width (at its widest point) to the nearest 1 mm. Take the length of the check as being the distance over which its width exceeds 3 mm, but in the bottom third of the length of a pole or cross-arm, take the length of the check as being the distance over which its width exceeds 5 mm. When checks run lengthways into each other but are broken by cross-bands of solid wood of width (measured across the grain) exceeding 5 mm and of depth such that there is no visible opening between the two checks, regard them as individual checks.

5.3.4 Knots, knot clusters, knot-holes and cavities

Take as the size of a knot its maximum dimension, measured to the nearest 5 mm and transverse to the length of the pole or cross-arm. If a knot is difficult to define or to outline, take as its limits those of the outer growth ring obviously belonging to the branch. Measure knot clusters, knot-holes and cavities resulting from knot-hole surrounds in the same way.

5.3.5 Splinter-pulling hollows

Take as the size of a splinter-pulling hollow the mean of its largest and smallest diameters (each measured to the nearest 5 mm and at right angles to the general grain direction) on its exposed face.

5.3.6 Crook and sweep

5.3.6.1 In the case of cross-arms of length less than 6,0 m, measure (to the nearest 5 mm) crook and sweep as the maximum distance between a straight line and the inner curve. Ensure that the straight line is between two points not more than 2 m apart in the case of crook and not less than 2 m apart in the case of sweep (see figure 2(a)). **Amdt 2**

5.3.6.2 In the case of cross-arms of length at least 6,0 m, observe whether any part of a cross-arm crosses an imaginary straight line that connects the midpoint at the top with the midpoint at the butt (see figure 2(b)). **Amdt 2**

5.3.6.3 In the case of poles of length at least 6,0 m, measure crook and sweep in accordance with one of the following methods, as required (see annex A.1(n)), by observing whether any part of the surface of a pole crosses an imaginary straight line that connects the midpoint at the top with

a) the midpoint at the butt (see figure 2(b)), or

b) the midpoint at the TGL (see figure 2(c)). **Amdt 2**

5.3.7 Ring shakes

Insert a feeler of thickness 2 mm (or a circular wire of diameter 2 mm) to its maximum extent into the separation. If the depth of insertion exceeds 500 mm, consider the separation to be a ring shake.

5.4 Dimensions and end cuts

Measure the length, diameter and squareness of ends of poles, cross-arms and spacers as given in 5.4.1 to 5.4.3.

5.4.1 Length

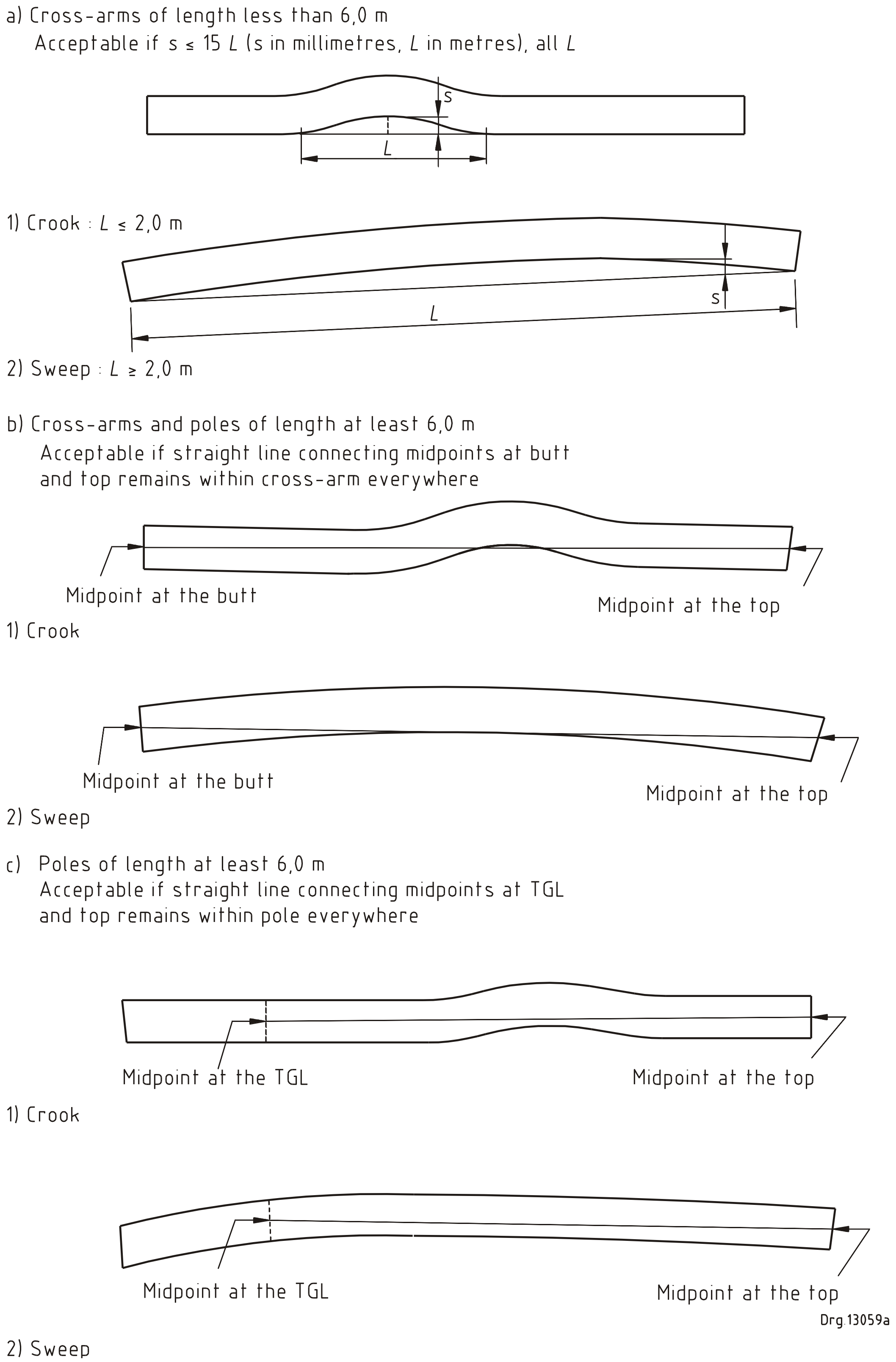
Take as the length of a pole or cross-arm the shortest distance (measured to the nearest 10 mm) between the level of the lowest part of the top and the level of the highest part of the butt.

5.4.2 Diameter

Measure diameters to the nearest 1 mm, using (except when measuring ovality of ends (see 4.5.4)) a diameter tape. In the case of oval cross-sections, measure the smallest diameter through the geometrical midpoint of the largest diameter.

5.4.3 End cuts

Measure the angle of cut of ends to the nearest degree.



Amdt 2

Figure 2 — Measurement of crook and sweep

5.5 Average moisture content at the time of preservative treatment

5.5.1 Position of testing

When moisture content is determined in accordance with 5.5.2 and 5.5.3, take the reading or sample at the approximate midlength of the pole, cross-arm or spacer with a tolerance of 10 % of the length of the unit in either longitudinal direction to a maximum of 500 mm, and above any knots or gum pockets that could influence the result. **Amdt 3**

5.5.2 Untreated poles and cross-arms

Determine the moisture content to the nearest 10 g/kg, using the electric moisture-meter method given in SANS 5986 or the oven-dry method given in SANS 5984. In cases of dispute, the oven-dry method shall be used.

NOTE 1 In the case of poles, moisture content readings taken with an electric moisture meter and that exceed 280 g/kg should not be considered as accurate; the oven-dry method should be used in such cases.

NOTE 2 Deleted by amendment No.6.

5.5.3 Poles and cross-arms treated with a class C[2)] preservative

Use the extraction method given in SANS 5985 to determine the moisture content to the nearest 10 g/kg.

5.6 Net retention

Use SANS 5988 or SANS 5989 or, provided that the volume of preservative required to treat the charge in terms of this standard can be gauged to within 1 %, use SANS 5967.

NOTE Each load in a charge may be considered a separate charge, provided that the average net retention of each load is determined.

5.7 Depth of penetration of preservative

Use the relevant method given in SANS 5987 to assess compliance with the requirements of 4.8.5 but, in the case of cross-arms and spacers, assess penetration at the approximate midlength and in the case of poles, assess penetration at a point 2 m from the butt. **Amdt 3**

In cases where the penetration is less than the minimum value given in column 7 of table 3, but not less than 10 mm, an additional sample shall be taken on the opposite side of the pole or cross-arm. The pole shall be deemed to comply if the average of the two measurements is at least equal to the value given in column 7 of table 3. **Amdt 4**

When assessing for compliance with 4.4.1, 4.4.3, 4.4.4(d) or 4.7.2, use the same method, but test

a) where sapwood is at its minimum,

b) at gum veins,

c) at gum pockets, or

d) where bark is at its maximum,

respectively.

---

2) See classification in SANS 10005.

6 Marking

6.1 Method

Each pole, cross-arm and spacer shall be marked in a legible, indelible and permanent way by using one of the acceptable methods given in annex H, as required by the purchaser (see annex A.1(o)). **Amdt 4**

6.2 Position

Each pole, cross-arm and spacer shall be marked at a position as follows:

a) poles of length exceeding 5 m: on the face 3,5 m ± 50 mm from the butt; and **Amdt 4**

b) cross-arms and spacers: preferably on the thin end.

Paragraph deleted by amendment No. 4.

When strength testing is required (see 4.3), an additional round tag (see annex H), which displays the individual test number, shall be applied to the butt of each pole or cross-arm tested. **Amdt 2; amdt 4**

6.3 Information

Each pole, cross-arm and spacer shall bear the following minimum information (in the case of spacers, (a) to (c) shall apply). Include additional information as required (see annex A.1(l)):

a) the identification mark of the plant at which the pole, cross-arm or spacer was treated;

b) the month and year during which the pole, cross-arm or spacer was treated (e.g. 4/12 for April 2012); **Amdt 7**

c) the hazard class, in accordance with table 3;

d) the species, e.g. E for eucalyptus poles; **Amdt 7**

e) the length of the pole, in metres; and

f) the minimum top diameter of the class. **Amdt 2**

Annex A
(normative)

Notes to purchasers

A.1 The following requirements shall be specified in tender invitations and in each order or contract:

a) the type of product (see 4.1);

b) whether proof-testing of the strength of poles or cross-arms (as appropriate) is required, and whether the poles or cross-arms (as appropriate) are to withstand a fibre stress (in bending) of 50 MPa or 75 MPa (see 4.3); **Amdt 2; amdt 7**

c) the dimensions of spacers (see 4.5.1);

d) the length of poles and cross-arms (see 4.5.2);

e) the minimum top diameter of poles and cross-arms (see 4.5.3);

f) the cut of the top ends of poles (see 4.6.1.1);

g) whether poles, cross-arms and spacers are to be bound or nail-plated (see 4.6.3), and the method of binding or nail-plating (see annex D); **Amdt 2**

h) details of gaining of poles (see 4.7.5.1);

i) details of holes in poles (see 4.7.6);

j) the type of preservative (see 4.8.3); **Amdt 2**

k) the hazard class (see 4.8.4 or 4.8.5);

l) whether additional information is required (see clause 6);

m) whether it is required that a lot of the product be inspected by an approved inspection body in accordance with the client's requirements; **Amdt 2**

n) whether, in poles of length at least 6,0 m, crook and sweep should be measured by using the imaginary straight line from the midpoint at the top to the midpoint at the butt, or to the midpoint at the TGL (see 5.3.6.3); and **Amdt 2**

o) the method of marking to be used (see 6.1 and annex H). **Amdt 4**

A.2 The following requirements may be specified by the purchaser but shall be approved by the authority administering this standard: **Amdt 4**

a) the species of timber, if other than one of those given in table 1 (see 4.2);

b) the maximum permissible defects, if less stringent than those given in table 2 (see 4.4.12);

c) the moisture content at the time of preservative treatment, if higher than as specified (see 4.8.1); and

d) the net retention values, if higher than as specified (see 4.8.4).

Annex B
(normative)

Quality verification of eucalyptus poles, cross-arms and spacers

B.1 Quality verification

B.1.1 When a purchaser requires ongoing verification of the quality of eucalyptus poles, cross-arms and spacers, it is suggested that, instead of concentrating solely on evaluation of the final product, he also direct his attention to the manufacturer's quality system. In this connection it should be noted that SANS 9001 covers the provisions of an integrated quality system. **Amdt 4**

B.1.2 If no information about the implementation of quality control or testing during manufacture is available to help in assessing the quality of a lot, and a purchaser wishes to establish, by inspection and testing of samples of the final product, whether a lot of the product complies with this standard, use the sampling plan given in B.2.2. It must be noted that such a sampling plan applies to the final product only. **Amdt 5**

B.2 Assessment of compliance with this standard

B.2.1 Definitions

B.2.1.1
acceptable quality level
AQL
maximum percentage defective product units that, for purposes of sampling inspection, can be considered satisfactory as a process average

B.2.1.2
defective
eucalyptus pole, cross-arm or spacer that fails in one or more respects to comply with the relevant requirements of this standard

B.2.1.3
lot
not less than 50 and not more than 3 200 poles or cross-arms that have the same type of binding, are of the same nominal dimensions, and have been treated to the same retention with the same class of preservative, from one manufacturer, and submitted at any one time for inspection and testing

B.2.2 Sampling

The following sampling procedures, based on an AQL of 4, shall be applied in determining whether a lot complies with the requirements of this standard. The samples so taken shall be deemed to represent the lot for the respective properties.

B.2.2.1 Sample for inspection

After checking the lot for compliance with clause 6 and annex C (see annex A.1(c)), take at random from the lot the number of poles, cross-arms and spacers given in column 2 of table B.1, relative to the appropriate lot size given in column 1.

B.2.2.2 Sample for testing

From the sample taken in accordance with B.2.2.1, take at random the appropriate number of poles, cross-arms or spacers given in column 4 of table B.1.

Table B.1 — Sample sizes

1	2	3	4	5
Lot size, poles, cross-arms or spacers	**Sample for inspection**		**Sample for testing**	
	Sample size, poles, cross-arms or spacers	**Acceptance number**	**Sample size, poles, cross-arms or spacers**	**Acceptance number**[a]
50 – 150	20	2	8	0
151 – 500	50	5	13	1
501 – 1 200	80	7	20	1
1 201 – 3 200	125	10	32	2
[a] Applicable only to penetration, to the moisture content of poles and to the moisture content of cross-arms and spacers not treated with a mixture of copper-chromium-arsenic compounds.				

B.2.3 Criteria for compliance

After establishing compliance with the relevant requirements given in 4.2, 4.7.1 and 4.8.2 to 4.8.4 (inclusive) and, in the case of units treated with a mixture of copper-chromium-arsenic compounds (see 4.8.3 (b)), the lot shall be deemed to comply with the requirements of this standard if **Amdt 5**

a) on inspection of the sample taken in accordance with B.2.2.1 for compliance with the requirements for freedom from defects (see 4.4), dimensions (see 4.5), cut of ends (see 4.6), and trimming and shaping (see 4.7), the number of defectives found does not exceed the relevant acceptance number given in column 3 of table B.1, and

b) on testing of the sample taken in accordance with B.2.2.2,

1) for compliance with the requirements for penetration (see 4.8.5), and moisture content (see 4.8.1), the number of defectives found does not exceed the relevant acceptance number given in column 5 of table B.1, and

2) the moisture content of the permissible defective(s) is in no case more than 280 g/kg, and

3) no defective is found in respect of strength (see 4.3).

Annex C
(normative)

Bending strength (MOR) for poles and cross-arms

Amdt 7

C.1 Characteristic strength values for poles and cross-arms

The 5th percentile characteristic bending strength of eucalyptus can be taken as 50 MPa. The higher 75 MPa characteristic bending strength is only applicable to the specific species as specified in table 1.

NOTE The mean characteristic bending strength of eucalyptus can be taken as 63 MPa. Table J.1 gives the force in newtons required to cause a mean fibre stress of 63 MPa.

Amdt 7

C.2 Cantilever loading test for poles 6 m and longer **Amdt 7**

C.2.1 Apparatus **Amdt 7**

C.2.1.1 Crib, capable of securing the pole under test from the butt end to the TGL, and that will **Amdt 7**

a) ensure no significant movement of the clamped butt during a test, and

b) prevent any rotational movement of the pole. **Amdt 7**

C.2.1.2 Wooden saddles, or similar suitable clamping devices (to secure the pole in the crib), of curvature that suits the diameter of the pole under test, and that will not damage the pole during the test. **Amdt 7**

C.2.1.3 Winch, or similar device, of suitable capacity and preferably motor-driven, that is capable of applying force to the pole under test, the force being applied horizontally and at an average angle of approximately 90° to the pole, through a cable of such a length that, during a test, the angle varies between slightly less than and slightly more than 90°.

Amdt 7

NOTE The position of the crib relative to the winch has to be altered for varying lengths of poles under test.

Amdt 7

C.2.1.4 Force indicator or recorder, calibrated to indicate or record (as relevant), to within 2,5 %, the actual force applied to the pole. **Amdt 7**

C.2.2 Procedure **Amdt 7**

C.2.2.1 Using the wooden saddles, securely clamp the butt of the pole in the crib, over a distance of 1,5 m ± 25 mm from the butt end. If the pole displays crook or sweep, ensure that the concave side of the crook or sweep faces towards the winch. Secure the cable to the pole at a position 600 mm ± 25 mm or 100 mm ± 25 mm, as relevant (see C.2.3), from the top end, and so position and secure the crib or winch (or both), that the angle between the axis of the pole and the cable is slightly less than 90°. **Amdt 7**

C.2.2.2 Take up the slack and, without jerking the pole, apply force (gradually and at as uniform a rate as possible) until the force reaches the appropriate value of F, calculated using the formula given in C.1.3. Then stop the test and release the force. **Amdt 7**

C.2.2.3 Consider the pole to be defective if any visible sign of failure was noted during the test.

Amdt 7

C.2.3 Calculation **Amdt 7**

Calculate the value of *F* as follows:

$$F = \frac{\sigma \times D^3}{10,2 \times L_1}$$

where

F is the force, in newtons, required to cause a minimum fibre stress in cantilever loading of 50 MPa or when required 75 MPa (see table 1); **Amdt 7**

σ is the relevant minimum fibre stress, i.e. 50 MPa or when required 75 MPa (see table 1); **Amdt 7**

D is the minimum diameter, in millimetres, of the pole or cross-arm at the TGL (i.e. 1 500 mm from the butt end), based on the specified minimum top diameter and a taper of 5 mm per metre of length (see table C.2); **Amdt 7**

L_1 is the distance, in millimetres, between the TGL and 600 mm from the top end in the case of poles and cross-arms of length at least 6,0 m, and between the TGL and 100 mm from the top end in other cases.

C.3 Midpoint loading test for poles and cross-arms shorter than 6 m **Amdt 7**

C.3.1 Apparatus **Amdt 7**

C.3.1.1 Two suitable anchorages, that **Amdt 7**

a) will not damage the pole/cross-arm during the test, and

b) are such that the distance between them can be adjusted to the appropriate test span, i.e. the length of the pole/cross-arm under test, minus 600 mm or minus 200 mm, as relevant (see C.3.3). **Amdt 7**

C.3.1.2 Suitable force applicator, that is positioned centrally between the anchorages, for example **Amdt 7**

a) either a hydraulic or a pneumatic ram of adequate capacity and stroke, that has a pressure foot of radius such as to fit the diameter at midlength of the pole/cross-arm under test and that will not damage the pole/cross-arm during the test, or

b) a suitable winch and cable.

C.3.1.3 Force indicator or recorder, calibrated to indicate or record (as relevant), to within 2,5 %, the actual force applied to the pole/cross-arm. **Amdt 7**

C.3.2 Procedure **Amdt 7**

C.3.2.1 So position the pole/cross-arm under test in the apparatus that the anchorages secure the pole/cross-arm at positions 300 mm ± 25 mm or 100 mm ± 25 mm (as relevant) from its ends and that, if the pole/cross-arm displays crook or sweep, the concave side of the crook/sweep faces towards the ram or the convex side of the crook/sweep faces towards the winch, as appropriate. **Amdt 7**

C.3.2.2 If a winch and cable is used, take up the slack and, without jerking the pole/cross-arm, apply force to the midlength point of the pole/cross-arm. If a ram is used, extend the ram (without impacting the pole/cross-arm) until it touches the midlength point of the pole/cross-arm. In each case, increase the force (gradually and at as uniform a rate as possible) until it reaches the appropriate value of *F*, calculated using the formula given in C.3.3. Then stop the test and release the force. **Amdt 7**

C.3.2.3 Consider the pole/cross-arm to be defective if any visible sign of failure was noted during the test. **Amdt 7**

NOTE If the force is applied in any plane other than the horizontal and vertical plane upward, a correction factor has to be applied to force *F*. **Amdt 3; amdt 6**

C.3.3 Calculation **Amdt 7**

Calculate the value of *F* as follows:

$$F = \frac{\sigma \times \pi \times D^3}{8 \times L_2}$$

where

F is the force, in newtons, required to cause a fibre stress in midpoint loading of 50 MPa or when required 75 MPa (see table 1); **Amdt 7**

σ is the relevant fibre stress, i.e. 50 MPa or when required 75 MPa (see table 1); **Amdt 7**

D is the diameter of the pole or cross-arm at midlength point, in millimetres, based on the specified minimum top diameter and a taper of 5 mm per metre of length (see table C.1);

L_2 is the distance, in millimetres, between 300 mm from the top end and 300 mm from the butt end in the case of poles and cross-arms of length at least 6,0 m, and between 100 mm from the top end and 100 mm from the butt end in other cases.

Table C.1 — Dimensions and strength values for poles and cross-arms

1	2	3	4	5	6	7	8
Length	**Minimum top diameter**	**Minimum diameter at theoretical ground line**[a]	**Minimum diameter at midpoint**[a]	**Force required to cause a fibre stress of 50 MPa**		**Force required to cause a fibre stress of 75 MPa**[d]	
				Cantilever loading[b]	**Midpoint loading**[c]	**Cantilever loading**[b]	**Midpoint loading**[c]
m	mm	mm	mm	kN	kN	kN	kN
1,5	80	–	83,75	–	8,87	–	13,31
1,5	100	–	103,75	–	16,87	–	25,30
1,5	120	–	123,75	–	28,62	–	42,94
1,5	140	–	143,75	–	44,87	–	67,30
1,5	160	–	163,75	–	66,32	–	99,48
2,0	80	–	85	–	6,70	–	10,05
2,0	100	–	105	–	12,63	–	18,94
2,0	120	–	125	–	21,31	–	31,96
2,0	140	–	145	–	33,26	–	49,88
2,0	160	–	165	–	49,00	–	73,50
2,5	80	–	86,25	–	5,48	–	8,22
2,5	100	–	106,25	–	10,24	–	15,36
2,5	120	–	126,25	–	17,18	–	25,77
2,5	140	–	146,25	–	26,70	–	40,06
2,5	160	–	166,25	–	39,23	–	58,84
3,0	100	–	107,5	–	8,71	–	13,07
3,0	120	–	127,5	–	14,53	–	21,80
3,0	140	–	147,5	–	22,50	–	33,76
3,0	160	–	167,5	–	32,95	–	49,43
3,0	180	–	187,5	–	46,22	–	69,34
3,5	100	–	108,75	–	7,65	–	11,48
3,5	120	–	128,75	–	12,70	–	19,05
3,5	140	–	148,75	–	19,58	–	29,38
3,5	160	–	168,75	–	28,59	–	42,89
4,5	100	–	111,25	–	6,29	–	9,43
4,5	120	–	131,25	–	10,32	–	15,49
4,5	140	–	151,25	–	15,80	–	23,70
4,5	160	–	171,25	–	22,93	–	34,40
4,5	180	–	191,25	–	31,94	–	47,91
6,0	80	102,5	95	1,35	3,12	2,03	4,68
6,0	100	122,5	115	2,31	5,53	3,47	8,30
6,0	120	142,5	135	3,64	8,95	5,46	13,42
6,0	140	162,5	155	5,39	13,54	8,09	20,31
6,0	160	182,5	175	7,64	19,49	11,46	29,23
6,0	180	202,5	195	10,44	26,96	15,66	40,44

Amdt 2; amdt 7

Table C.1 (*continued*)

1	2	3	4	5	6	7	8
Length	**Minimum top diameter**	**Minimum diameter at theoretical ground line**[a]	**Minimum diameter at midpoint**[a]	**Force required to cause a fibre stress of 50 MPa**		**Force required to cause a fibre stress of 75 MPa**[d]	
				Cantilever loading[b]	**Midpoint loading**[c]	**Cantilever loading**[b]	**Midpoint loading**[c]
m	mm	mm	mm	kN	kN	kN	kN
7,0	80	107,5	97,5	1,24	2,84	1,86	4,27
7,0	100	127,5	117,5	2,07	4,98	3,11	7,47
7,0	120	147,5	137,5	3,21	7,98	4,82	11,96
7,0	140	167,5	157,5	4,70	11,99	7,05	17,98
7,0	160	187,5	177,5	6,59	17,16	9,89	25,74
7,0	180	207,5	197,5	8,94	23,63	13,41	35,45
8,0	80	112,5	100	1,18	2,65	1,77	3,98
8,0	100	132,5	120	1,93	4,59	2,90	6,88
8,0	120	152,5	140	2,95	7,28	4,42	10,92
8,0	140	172,5	160	4,26	10,87	6,40	16,30
8,0	160	192,5	180	5,93	15,47	8,89	23,21
8,0	180	212,5	200	7,97	21,23	11,96	31,84
9,0	120	157,5	142,5	2,78	6,76	4,16	10,15
9,0	140	177,5	162,5	3,97	10,03	5,96	15,05
9,0	160	197,5	182,5	5,47	14,21	8,21	21,31
9,0	180	217,5	202,5	7,31	19,41	10,96	29,12
10,0	140	182,5	165	3,77	9,38	5,66	14,08
10,0	160	202,5	185	5,15	13,23	7,73	19,84
10,0	180	222,5	205	6,83	18,00	10,25	26,99
10,0	200	242,5	225	8,85	23,79	13,27	36,69
11,0	140	187,5	167,5	3,63	8,87	5,46	13,31
11,0	160	207,5	187,5	4,92	12,45	7,38	18,67
11,0	180	227,5	207,5	6,49	16,87	9,73	25,30
11,0	200	247,5	227,5	8,35	22,23	12,53	33,35
11,0	220	267,5	247,5	10,54	28,62	15,81	42,94
12,0	140	192,5	170	3,53	8,46	5,30	12,70
12,0	160	212,5	190	4,75	11,81	7,13	17,72
12,0	180	232,5	210	6,22	15,95	9,33	23,93
12,0	200	252,5	230	7,97	20,96	11,96	31,43
12,0	220	272,5	250	10,02	26,91	15,03	40,37
13,0	140	197,5	172,5	3,46	8,13	5,20	12,19
13,0	160	217,5	192,5	4,63	11,30	6,94	16,94
13,0	180	237,5	212,5	6,02	15,19	9,04	22,79
13,0	200	257,5	232,5	7,68	19,90	11,52	29,85
13,0	220	277,5	252,5	9,61	25,49	14,42	38,24

Amdt 2; amdt 7

Table C.1 (*concluded*)

1	2	3	4	5	6	7	8
Length	**Minimum top diameter**	**Minimum diameter at theoretical ground line**[a]	**Minimum diameter at midpoint**[a]	**Force required to cause a fibre stress of 50 MPa**		**Force required to cause a fibre stress of 75 MPa**[d]	
				Cantilever loading[b]	**Midpoint loading**[c]	**Cantilever loading**[b]	**Midpoint loading**[c]
m	mm	mm	Mm	kN	kN	kN	kN
14,0	160	222,5	195	4,54	10,87	6,81	16,30
14,0	180	242,5	215	5,87	14,56	8,81	21,84
14,0	200	262,5	235	7,45	19,02	11,18	28,53
14,0	220	282,5	255	9,29	24,30	13,93	36,44
15,0	160	227,5	197,5	4,47	10,50	6,71	15,76
15,0	180	247,5	217,5	5,76	14,03	8,64	21,04
15,0	200	267,5	237,5	7,27	18,27	10,91	27,40
15,0	220	287,5	257,5	9,03	23,28	13,55	34,92
16,0	160	232,5	200	4,43	10,20	6,65	15,30
16,0	180	252,5	220	5,68	13,58	8,52	20,36
16,0	200	272,5	240	7,14	17,63	10,70	26,44
16,0	220	292,5	260	8,83	22,41	13,24	33,61
18,0	160	242,5	205	4,40	9,72	6,60	14,58
18,0	180	262,5	225	5,58	12,85	8,37	19,28
18,0	200	282,5	245	6,95	16,60	10,43	24,89

[a] Based on the minimum top diameter given in column 2 and a taper of 5 mm/m of length.
[b] Calculated using the formula given in C.2.3.
[c] Calculated using the formula given in C.3.3.
[d] Applicable only to the specific species as specified in table 1.

Amdt 1; amdt 2, amdt 7

Annex D
(normative)

Methods of binding and nail-plating

D.1 General

D.1.1 Both ends of a pole, cross-arm or spacer shall be bound or nail-plated (see annex A.1(g)). **Amdt 7**

D.1.2 The minimum coating thickness on the galvanized nails, staples and wire used for binding shall be as follows:

a) nails and wire: 25 µm; and

b) staples: 10 µm.

D.1.3 Binding shall be carried out prior to preservative treatment.

D.2 Methods of binding

D.2.1 Staples

Each staple shall be of length at least 38 mm, of galvanized mild steel wire of diameter at least 4 mm, and shall be so driven slantwise across the binding wires that there is an offset of at least 3 mm between the points of the staple, measured on the surface of the pole or cross-arm and at right angles to its longitudinal axis.

D.2.2 Nailing and stapling

Nailing-and-stapling binding at the end of a pole, cross-arm or spacer shall consist of 4,5 turns of galvanized mild steel wire, of diameter at least 2,5 mm, tightly wound and firmly secured at each of its ends, through closed loops, by galvanized wire nails of diameter at least 3 mm and of length at least 38 mm. Each band of wire shall also be stapled at two positions, one approximately diametrically opposite the other and at right angles to the wire nails. **Amdt 2**

D.2.3 "Farmer's knot"

"Farmer's knot" binding at the end of a pole, cross-arm or spacer shall consist of four turns of galvanized mild steel wire, of diameter at least 2,5 mm, wound, double-twisted into a tight knot that rests flush against the surface of the pole, cross-arm or spacer, and then stapled at two positions. The first staple shall be applied on the knot and the second staple approximately diametrically opposite the first staple. **Amdt 2**

D.2.4 Loop tensioning

Loop tensioning binding at the end of a pole, cross-arm or spacer shall consist of galvanized mild steel wire of diameter at least 2,5 mm, shaped in the form of a hairpin, wound twice (to give four strands) around the pole, cross-arm or spacer, the loose ends being drawn through the loop (head of the hairpin), tensioned, bent back through 180°, and stapled to the pole, cross-arm or spacer at a point as close as possible to the loop. Excess wire at the free ends shall be cut off and the cut ends doubled back neatly alongside the staple. The four strands of wire shall be stapled to the pole, cross-arm or spacer block at two positions: the first staple shall be applied on the loop and the second staple approximately diametrically opposite the first staple. **Amdt 2**

D.3 Position

Binding should be positioned at least 100 mm from the end of a pole, cross-arm or spacer, and at least 50 mm from the nearest hole.

D.4 Nail-plating

NOTE Nail plates can only be considered for flat or slant end cuts, either at the top end of a pole or at the ends of cross-arms and spacers.

D.4.1 Construction

A nail plate shall

a) be made of steel,

b) have a zinc coating that complies with the requirements for a coating of class Z275 of SANS 3575, **Amdt 4**

c) be of thickness at least 1,2 mm and have a punched nail length of at least 14 mm,

d) be of such a size that the area covered by the nail plate is at least 70 % of the area of the applicable pole end, and **Amdt 7**

e) be such as to be acceptable.

D.4.2 Securing of nail plates

A nail plate shall be secured as follows:

a) the method of securing a nail plate shall be such as to be acceptable;

b) each nail shall be fully embedded in the pole end and no nail shall be bent; and

c) a nail plate shall be so positioned in the middle of a cut end that its edges do not protrude over the round faces of the timber.

Annex E
(normative)

Insect damage

Discriminate between pinhole borer (*Ambrosia*) and powder-post (*Lyctus*) damage as follows:

E.1 Visual examination

In untreated poles and cross-arms, the periphery of pinhole borer (*Ambrosia*) entrance/exit holes will normally be black and the holes will not be filled with frass, whereas the periphery of exit holes of powder-post (*Lyctus*) will normally be white and the holes will be filled with frass.

E.2 Increment borer method

Take increment borings from the greater of two holes and 20 % of the holes present in the infested area. Then take a further two increment borings at a distance of 15 mm to 25 mm away from any two of the initial borings, in the longitudinal direction of the exit hole.

In the case of pinhole borer (*Ambrosia*) damage, the extracted core will be solid timber (except for the radial entrance/exit hole(s)) and will usually have several short galleries transverse to the grain. These holes will normally be black and without frass in poles and cross-arms that are untreated or that have been treated with creosote or a mixture of creosote and waxy oil, and dark green and without frass in poles and cross-arms that have been treated with a mixture of copper-chromium-arsenic compounds.

In the case of powder-post (*Lyctus*) damage, the extracted core will show absence of solid timber, and the radial exit hole and galleries in the direction of the grain will be white and filled with frass in poles and cross-arms that are untreated, but black and filled with frass in poles and cross-arms that with frass in poles and cross-arms that have been treated with a mixture of have been treated with creosote or a mixture of creosote and waxy oil, or dark green and filled copper-chromium-arsenic compounds.

If the attack is severe, the head of the extracted core (i.e. the part that extends approximately 3 mm inwards from the surface of the pole or cross-arm) will usually become detached from the rest of the core.

Annex F
(informative)

Average volumes of poles and cross-arms

F.1 The volumes of poles and cross-arms are given as information only.

F.2 Measure all the diameters at each end of the load and calculate the volume of poles/cross-arms by using the following approximate formula:

$$V = \frac{L\ [2\ n\left(\sum x^2\right) + \left(\sum x\right)^2]}{7{,}6409\ n \times 10^6}$$

where

V is the total volume, in cubic metres, of poles/cross-arms in the load;

L is the average length, in metres, of the poles/cross-arms in the load;

n is the total number of diameters measured at both thick and thin ends;

x is an individual diameter, in millimetres, measured in a random direction.

F.3 Table F.1 gives dimensions and corresponding volumes of poles and cross-arms.

Table F.1 — Dimensions and corresponding volumes for poles and cross-arms

1	2	3
Length m	**Minimum top diameter** mm	**Volume** m^3
1,5	80	0,0107
1,5	100	0,0156
1,5	120	0,0216
1,5	140	0,0284
1,5	160	0,0362
2,0	80	0,0148
2,0	100	0,0215
2,0	120	0,0295
2,0	140	0,0387
2,0	160	0,0492
2,5	80	0,0191
2,5	100	0,0277
2,5	120	0,0378
2,5	140	0,0495
2,5	160	0,0627
3,0	100	0,0342
3,0	120	0,0465
3,0	140	0,0607
3,0	160	0,0768
3,0	180	0,0947
3,5	100	0,0411
3,5	120	0,0566
3,5	140	0,0724
3,5	160	0,0913
4,5	100	0,0559
4,5	120	0,0751
4,5	140	0,0971
4,5	160	0,1219
4,5	180	0,1496
6,0	80	0,0581
6,0	100	0,0809
6,0	120	0,1075
6,0	140	0,1378
6,0	160	0,1719
6,0	180	0,2098

Amdt 2

Table F.1 (*continued*)

1	2	3
Length m	**Minimum top diameter** mm	**Volume** m^3
7,0	80	0,0721
7,0	100	0,0995
7,0	120	0,1312
7,0	140	0,1674
7,0	160	0,2080
7,0	180	0,2530
8,0	80	0,0875
8,0	100	0,1197
8,0	120	0,1569
8,0	140	0,1991
8,0	160	0,2463
8,0	180	0,2986
9,0	120	0,1844
9,0	140	0,2329
9,0	160	0,2870
9,0	180	0,3468
10,0	140	0,2688
10,0	160	0,3301
10,0	180	0,3976
10,0	200	0,4714
11,0	140	0,3070
11,0	160	0,3756
11,0	180	0,4511
11,0	200	0,5335
11,0	220	0,6228
12,0	140	0,3474
12,0	160	0,4236
12,0	180	0,5073
12,0	200	0,5985
12,0	220	0,6973
13,0	140	0,3902
13,0	160	0,4742
13,0	180	0,5663
13,0	200	0,6665
13,0	220	0,7750

Amdt 2

Table F.1 *(concluded)*

1	2	3
Length m	**Minimum top diameter** mm	**Volume** m^3
14,0	160	0,5274
14,0	180	0,6281
14,0	200	0,7376
14,0	220	0,8559
15,0	160	0,5832
15,0	180	0,6928
15,0	200	0,8119
15,0	220	0,9402
16,0	160	0,6418
16,0	180	0,7605
16,0	200	0,8891
16,0	220	1,0279
18,0	160	0,7675
18,0	180	0,9049
18,0	200	1,0536
NOTE To ensure compliance with retention requirements and to reduce the possibility of under treatment, a taper of 7 mm/m has been accepted as the norm for volume calculations.		

Amdt 2

Annex G
(informative)

Modulus of elasticity

G.1 General

Calculate the modulus of elasticity E for a pole or cross-arm tested in accordance with annex C, using the formula given in G.2 or G.3. In addition to the steps given in annex C the increment in deflection δ as well as the increment in load P must be measured and recorded. The average value for E for eucalyptus poles and cross-arms can be taken as 11 000 MPa. **Amdt 2; amdt 7**

G.2 For cantilever testing

Calculate the modulus of elasticity as follows:

$$E = \frac{k\ PL^3}{\delta\ D_A{}^4}$$

where

E is the modulus of elasticity (MOE), in megapascals;

k is a constant, derived from the ratio between diameters at the point of clamping, D_B, and the point of load application, D_A (see table G.1);

P is the force applied, in newtons;

L is the distance (the test span), in millimetres, between the point of clamping and the point of load application;

δ is the deflection, in millimetres.

G.3 For midpoint testing

Calculate the MOE as follows:

$$E = \frac{PL^3}{2{,}36\ D^4\ \delta}$$ **Amdt 7**

where

E is the modulus of elasticity, in megapascals;

P is the force applied, in newtons; **Amdt 7**

L is the distance (the test span), in millimetres, between supports;

D is the diameter at the midpoint, in millimetres;

δ is the deflection, in millimetres.

Table G.1 — Constant related to the ratio between diameters at the point of clamping and the point of load application

1	2
D_B/D_A	k
1,000	6,79
1,025	6,31
1,050	5,87
1,075	5,47
1,100	5,10
1,125	4,77
1,150	4,47
1,175	4,19
1,200	3,93
1,225	3,69
1,250	3,48
1,275	3,28
1,300	3,09
1,325	2,92
1,350	2,76
1,375	2,61
1,400	2,47
1,425	2,35
1,450	2,23
1,475	2,11
1,500	2,01
1,525	1,91
1,550	1,82
1,575	1,74
1,600	1,66
1,625	1,58
1,650	1,51
1,675	1,44
1,700	1,38
1,725	1,32
1,750	1,27
1,775	1,21
1,800	1,16
1,825	1,11
1,850	1,07
1,875	1,03
1,900	0,99
1,925	0,95
1,950	0,92
1,975	0,88
2,000	0,85

Annex H
(normative)
Amdt 4

Methods of marking

H.1 General

In addition to the requirements given in H.2 and H.3, the following requirements shall be complied with when using either round or square tags: **Amdt 4**

a) the tags shall be either galvanized mild steel or aluminium; **Amdt 4**

b) galvanized mild steel tags shall be at least 0,5 mm in thickness and aluminium tags shall be at least 0,9 mm in thickness; **Amdt 4**

c) the letters and figures shall be at least 3,5 mm in size; **Amdt 4**

d) the coatings on the galvanized mild steel tags shall comply with the requirements for class Z275 of SANS 3575; and **Amdt 4**

e) the coatings on the nails shall have a galvanizing thickness of at least 25 μm. **Amdt 4**

H.2 Round identification tags **Amdt 4**

H.2.1 Round identification tags shall be at least 25 mm in diameter. **Amdt 4**

H.2.2 Each tag shall be attached by means of a galvanized nail of at least 30 mm in length and at least 2,5 mm in diameter, and in the case of face marking, recessed in the face of the pole, cross-arm or spacer to be flush with the surface. **Amdt 4**

H.3 Rectangular identification tags **Amdt 4**

H.3.1 The dimensions of the rectangular identification tags shall be at least 75 mm × 55 mm. **Amdt 4**

H.3.2 Each tag shall be attached, at each corner, by means of a galvanized nail of at least 30 mm in length and at least 2,5 mm in diameter. **Amdt 4**

Annex I
Amdt 5

(informative)

Handling and storage of treated poles and cross-arms

I.1 Poles and cross-arms will generally only give the projected service life if a long period of storage before installation is avoided. **Amdt 5**

Adequate time should be allowed to attain the equilibrium moisture of the area where they are to be used.

I.2 Storage in a horizontal position combined with exposure to direct sunlight causes degradation of creosoted timber and, in addition, creosotes tend to migrate because of gravitational forces, thereby reducing the amount of creosote on the upper side of the pole or cross-arm. **Amdt 5**

In such conditions, temperatures of as high as 60 °C have been recorded on creosoted poles; poles and cross-arms will also tend to develop checks (surface checks) if left so exposed for long periods of time and should therefore be shaded with shade cloth or kept under a roof. If, however, they have been exposed for such long periods, it is good practice from an appearance point of view to rinse them in a treatment vessel.

I.3 Poles should be cross-stacked for a maximum period of six months, at least 300 mm above the ground. If they have to be stacked for longer, they should be close-stacked, under cover, in a north-south direction, and, after six months, rotated 180°. The area beneath the stack should be clear of grass and debris, to reduce the risk of fire. **Amdt 5**

Care should be taken not to drop poles and cross-arms, especially those that have been treated with a mixture of copper-chromium-arsenic compounds and are still wet, since cross-fractures, which might not be clearly visible, could be caused by careless handling.

Mechanical damage beyond the limits of 4.4.8 (cross-cut, sharpening, cross-fracture owing to off-loading practices, hammering, etc.) at any stage is not acceptable.

Handling equipment should be used in such a manner that the surface of the pole or cross-arm is not damaged. Damaged poles and cross-arms should not be used, since their service life will be reduced.

Annex J
(informative)

Mean bending strength values

The values given in table J.1 is calculated using the mean bending strength, which can be taken as 63 MPa and is for information only (see C.1.1).

Table J.1 — Dimension and mean force values for poles and cross-arms

1	2	3	4	5	6
Length	**Minimum top diameter**	**Minimum diameter at theoretical ground line**[a]	**Minimum diameter at midpoint**[a]	**Force required to cause a mean fibre stress of 63 MPa**	
				Cantilever loading[b]	**Midpoint loading**[c]
m	mm	mm	mm	kN	kN
1,5	80	–	83,75	–	11,18
1,5	100	–	103,75	–	21,25
1,5	120	–	123,75	–	36,07
1,5	140	–	143,75	–	56,53
1,5	160	–	163,75	–	83,56
2,0	80	–	85	–	8,44
2,0	100	–	105	–	15,91
2,0	120	–	125	–	26,84
2,0	140	–	145	–	41,90
2,0	160	–	165	–	61,74
2,5	80	–	86,25	–	6,90
2,5	100	–	106,25	–	12,90
2,5	120	–	126,25	–	21,65
2,5	140	–	146,25	–	33,65
2,5	160	–	166,25	–	49,43
3,0	100	–	107,5	–	10,98
3,0	120	–	127,5	–	18,31
3,0	140	–	147,5	–	28,35
3,0	160	–	167,5	–	41,52
3,0	180	–	187,5	–	58,24
3,5	100	–	108,75	–	9,64
3,5	120	–	128,75	–	16,00
3,5	140	–	148,75	–	24,68
3,5	160	–	168,75	–	36,03
4,5	100	–	111,25	–	7,92
4,5	120	–	131,25	–	13,01
4,5	140	–	151,25	–	19,91
4,5	160	–	171,25	–	28,90
4,5	180	–	191,25	–	40,25

Table J.1 (*continued*)

1	2	3	4	5	6
Length	**Minimum top diameter**	**Minimum diameter at theoretical ground line**[a]	**Minimum diameter at midpoint**[a]	**Force required to cause a mean fibre stress of 63 MPa**	
				Cantilever loading[b]	**Midpoint loading**[c]
m	mm	mm	mm	kN	kN
6,0	80	102,5	95	1,71	3,93
6,0	100	122,5	115	2,91	6,97
6,0	120	142,5	135	4,58	11,27
6,0	140	162,5	155	6,80	17,06
6,0	160	182,5	175	9,63	24,55
6,0	180	202,5	195	13,15	33,97
7,0	80	107,5	97,5	1,57	3,58
7,0	100	127,5	117,5	2,61	6,27
7,0	120	147,5	137,5	4,05	10,05
7,0	140	167,5	157,5	5,92	15,10
7,0	160	187,5	177,5	8,31	21,62
7,0	180	207,5	197,5	11,26	29,78
8,0	80	112,5	100	1,49	3,34
8,0	100	132,5	120	2,44	5,78
8,0	120	152,5	140	3,71	9,17
8,0	140	172,5	160	5,37	13,69
8,0	160	192,5	180	7,47	19,50
8,0	180	212,5	200	10,05	26,75
9,0	120	157,5	142,5	3,50	8,52
9,0	140	177,5	162,5	5,01	12,64
9,0	160	197,5	182,5	6,90	17,90
9,0	180	217,5	202,5	9,21	24,46
10,0	140	182,5	165	4,75	11,82
10,0	160	202,5	185	6,49	16,66
10,0	180	222,5	205	8,61	22,67
10,0	200	242,5	225	11,15	29,98
11,0	140	187,5	167,5	4,57	11,18
11,0	160	207,5	187,5	6,20	15,68
11,0	180	227,5	207,5	8,17	21,25
11,0	200	247,5	227,5	10,52	28,01
11,0	220	267,5	247,5	13,28	36,07
12,0	140	192,5	170	4,45	10,66
12,0	160	212,5	190	5,99	14,89
12,0	180	232,5	210	7,84	20,10
12,0	200	252,5	230	10,04	26,40
12,0	220	272,5	250	12,62	33,91

Table J.1 (*concluded*)

1	2	3	4	5	6
Length	**Minimum top diameter**	**Minimum diameter at theoretical ground line**[a]	**Minimum diameter at midpoint**[a]	**Force required to cause a mean fibre stress of 63 MPa**	
				Cantilever loading[b]	**Midpoint loading**[c]
m	mm	mm	mm	kN	kN
13,0	140	197,5	172,5	4,37	10,24
13,0	160	217,5	192,5	5,83	14,23
13,0	180	237,5	212,5	7,59	19,15
13,0	200	257,5	232,5	9,67	25,08
13,0	220	277,5	252,5	12,11	32,12
14,0	160	222,5	195	5,72	13,69
14,0	180	242,5	215	7,40	18,35
14,0	200	262,5	235	9,39	23,96
14,0	220	282,5	255	11,70	30,61
15,0	160	227,5	197,5	5,64	13,24
15,0	180	247,5	217,5	7,26	17,68
15,0	200	267,5	237,5	9,16	23,02
15,0	220	287,5	257,5	11,38	29,33
16,0	160	232,5	200	5,58	12,85
16,0	180	252,5	220	7,15	17,11
16,0	200	272,5	240	8,99	22,21
16,0	220	292,5	260	11,12	28,24
18,0	160	242,5	205	5,54	12,25
18,0	180	262,5	225	7,03	16,20
18,0	200	282,5	245	8,76	20,91

[a] Based on the minimum top diameter given in column 2 and a taper of 5 mm/m of length.
[b] Calculated using the formula given in C.2.3 but using a mean fibre stress of 63 MPa.
[c] Calculated using the formula given in C.3.3 but using a mean fibre stress of 63 MPa.

Amdt 7

Bibliography

Amdt 7

SABS 457-1, Deleted by amendment No. 4.

SANS 457-2, *Wooden poles, droppers, guardrail posts and spacer blocks – Part 2: Softwood species*. **Amdt 2**

SANS 457-3 (SABS 457-3), *Wooden poles, droppers, guardrail posts and spacer blocks – Part 3: Hardwood species*. **Amdt 2**

SANS 675, *Zinc-coated fencing wire*.

SANS 753, *Pine poles, cross-arms and spacers for power distribution, telephone systems and street lighting.*

~~SANS 1265, *Waxy oil obtained from the synthol process and from other petroleum sources*.~~ **Amdt 7**

SANS 1288, *Preservative-treated timber*.

SANS 9001/ISO 9001, *Quality management systems – Requirements*. **Amdt 2; amdt 4**

SANS 10163-1, *The structural use of timber – Part 1: Limit-states design*.

SANS 10163-2 (SABS 0163-2), *The structural use of timber – Part 2: Allowable stress design*.

SANS 10255, *Health, safety and environmental guidelines for the construction and operation of timber treatment plants.*