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In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the Standards to which they refer.

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*Central Electricity Board
*Electricity Commissioners
*General Post Office
*Ministry of Fuel and Power
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† The Electrical Industry Committee is the British National Committee of the International Electrotechnical Commission

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BRITISH STANDARD SPECIFICATION FOR

HIGH-VOLTAGE OVERHEAD LINES

FOR LINE VOLTAGES UP TO AND INCLUDING 11 kV WITH CONDUCTORS NOT EXCEEDING 0·05 SQ. IN.

FOREWORD

The purpose of this specification is to standardise both three-phase and single-phase light high-voltage overhead lines for working voltages up to and including 11 kV by a type of construction to give improved performance by a reduction of some of the troubles associated with types of construction hitherto used. Its general adoption and the standardisation of components should effect considerable economies in first cost and subsequent maintenance, thereby facilitating the provision of supplies to remote and isolated premises and the development of the few remaining sparsely populated areas of Great Britain that are at present without electricity supplies.

The aim has been to keep the design as simple as possible compatible with reliable operation, and the factors governing the design are based on extensive experience on overhead lines in conjunction with recent research. The loading on conductors and poles is based on the effect of a wind of a recorded velocity of 70 miles per hour acting on the bare conductors.

This specification is based on an original design supplied by the British Electrical and Allied Industries Research Association.

Only copper conductors and only two sizes, i.e., 0·025 sq. in. and 0·05 sq. in. stranded are recommended, and the details of design given are based on the use of these particular conductors. This, however, does not preclude the use of solid conductors or of conductors of other metals. Where such other conductors are used, the general principles of the design given in this specification shall apply, except where minor modifications thereto are made necessary because of the use of such conductors.

If use is made of composite metal or other conductors of higher tensile strength than copper, it may be advisable, depending on the span length employed and the breaking stress of the stronger metal, to increase the overall factor of safety of such conductors so as to avoid the risk of vibration trouble which may be experienced if the tension of such conductors, in still air at 60°F., is greater than, say, one fifth of the breaking load.

This specification is confined as regards poles to the use of imported red fir, home-grown red fir and larch. If approval is obtained for the use of other timbers the appropriate modulus of rupture must be taken into account.

The practice of erecting lines with unearthed insulator steelwork has proved most satisfactory from an operational point of view, particularly with regard to the reduction of trouble due to lightning. To obtain the maximum benefit of this practice, an insulator is inserted in each stay, except at cable terminating poles, transformer poles and switchgear poles, on which all steelwork is earthed. On transformer poles the electrode used for earthing the steelwork should be situated outside the resistance area of the earthed electrode connected to the low-voltage system neutral (see Appendix C).

The Postmaster-General has modified his requirements for guarding when his line is crossed by a line erected to this specification. These requirements, together with approved drawings, are set out in Appendix A.

This specification is entirely suitable for lines to be erected in most parts of the British Isles. Consideration, however, should be given to altitude and climatic and other conditions of the locality in which the line has to be erected by providing for specially severe conditions, such as an increase in pole strength and/or reduction in span lengths and the like, as may be desirable.

This specification is intended for the use of authorised undertakers and is a statutory alternative to the Overhead Line Regulations, either of which may be adopted. This has been brought about by the making by the Electricity Commissioners of two amending Regulations. The first (set out in Appendix B(1) hereto) amends the Overhead Line Regulations by giving statutory effect to the Specification, in permissive form; and the second (set out in Appendix B(2) hereto) introduces into Regulation 12 of the Electricity Supply Regulations, 1937, the words 'other than overhead lines,' which places it beyond doubt that Regulation 12 extends only to underground mains, and consequently has no effect in relation to this specification.

Authorised undertakers are reminded, however, that the Overhead Line Regulations El.C.53 (Revised) and the Electricity Supply Regulations, 1937, extend to matters not dealt with in this Specification (e.g., Regulation 4 (Inaccessibility of line conductors) El.C.53 (Revised); and that adoption of the specification does not relieve them of their continuing statutory obligation to comply with both of those codes of Regulations so far as applicable and except in-so-far as they are inconsistent with or are superseded by the requirements of the specification.

This specification may be used by non-statutory bodies or persons who may erect and use electric lines for the supply of electricity. Such bodies and persons may, in the circumstances laid down in Section 4 of the Electric Lighting Act, 1888, be served by the Electricity Commissioners with notice requiring them to comply with regulations; and the regulations usually prescribed by the Commissioners in such cases conform generally with those applicable to Authorised Undertakers and are directed to ensure the safety of the public.

EMERGENCY CONDITIONS

As stated in their circular letter dated 16th September, 1942 (Reference A. 950/820), the Electricity Commissioners permit, as an emergency measure, the use of home-grown poles with a factor of safety of 2·5 for lines erected for purely temporary wartime purposes. The columns for 'imported red fir' poles in table 4 are therefore applicable in such cases for ascertaining the maximum permissible loading span for home-grown poles.

SPECIFICATION

SCOPE

1. This specification applies to both three-phase and single-phase high-voltage distribution lines where the normal working pressure between any conductor and earth does not exceed 6·6 kV, the maximum size of conductor being as set out in clause 4.

Where a line is intended initially for single-phase and later for three-phase operation, the poles and crossarms required for a three-phase line shall be installed. The sizes of poles and crossarms specified for a single-phase line shall only be used where permanent single-phase operation is intended.

DEFINITIONS

2. The following definitions have been adopted for the purposes of this specification only:

a. Span. The span is the horizontal distance between two adjacent supports.

b. The wind-loading span is half the sum of the two adjacent spans.

c. Equivalent span. The equivalent span of a line (or section of line between rigid points) on which the conductors are free to move longitudinally at the supports (and in which the tension for any condition of load and temperature is therefore the same in all spans) is the span in which tension variations are identical with those in the line or section of line. Its length is obtained by dividing the sum of the cubes of the individual spans by the length of the line or section, and taking the square root of the whole,

i.e., equivalent span =

$$\sqrt{\frac{L_1^3 + L_2^3 + L_3^3 \ldots\ldots}{L_1 + L_2 + L_3 \ldots\ldots}}$$

where L_1, L_2 and L_3 are the individual span lengths of the section.

d. Sag. The sag under any system of conductor loading is the distance, measured in the direction of the resultant load, between the conductor and the mid-point of the straight line joining the adjacent supports.

e. An intermediate pole is a pole on which the conductors are supported on pin insulators.

f. A section pole is a pole on which the conductors are made-off on each side on tension insulators.

g. A terminal pole is a pole on which the conductors are erected on one side only and are made-off on tension insulators.

h. Factor of safety. The factor of safety of any component is the ratio of its ultimate strength to the maximum working load for which it is designed.

i. Bonding wire. A conductor connecting together metal components.

j. Earthing wire. A conductor connecting metal components or a bonding wire to an earth electrode.

k. A road. A surfaced way used by vehicular traffic.

DESIGN DATA

3. *a. Conductors.* The tension of a line conductor at a temperature of 22°F. and subjected to a wind exerting a transverse pressure equivalent to 16 lb. per sq. ft. calculated on the whole of the projected area of the conductor shall not exceed its breaking load divided by 2·5.

b. Poles. Poles in conjunction with stays, if any, shall withstand the longitudinal, transverse and vertical loads resulting from the loading condition stated in *a.* above, ignoring the effect of wind pressure on the pole itself, with a factor of safety of 2·5 in the case of imported red fir and 3·5 in the case of larch or home-grown red fir poles.

The pole dimensions given in table 4 are calculated on the following basis:

Loading point	6 in. above pole top.
Wind pressure	16 lb. per sq. ft. on the bare conductor only.

Modulus of rupture 7800 lb. per sq. in.

c. Wooden crossarms, crossarm struts and stay insulators. Wooden crossarms, crossarm struts and stay insulators shall have a factor of safety of not less than 3·0.

d. Steelwork. The maximum working load of all steel components including stay wires, but excluding insulator pins, shall not exceed the ultimate tensile strength of the component divided by 2·5.

Insulator pins and other insulator fittings shall comply with B.S. 137.

CONDUCTORS

4. *a. Types and sizes.* The conductors recommended in this specification are 0·025 sq. in. (3/·104 in. diameter) and 0·05 sq. in. (3/·147 in. diameter) hard drawn copper, which shall comply with B.S. 125, the latter size being the maximum permissible.

The maximum size of any copper alloy or composite metal conductor shall be 0·04 sq. in. copper equivalent, and not larger than 7/14 S.W.G., in the case of a steel conductor or a composite conductor in which steel is the chief component.

b. Erection of conductors. It is recommended that the stringing of the conductors shall conform to the conductor stringing, tables 1 and 2.

It is recommended that before making off to the appropriate sag, the conductors be over-tensioned by 60 per cent of their breaking tension, and kept at this tension for at least twenty minutes.

c. Midspan joints. Midspan joints are permissible and where they are used they shall be of the torsion sleeve or of the mechanical cone type and shall develop not less than 95 per cent of the ultimate strength of the conductor and shall have at least the same conductivity.

d. Line connectors. When conductors are joined together at points where they are not under tension, a line connector in accordance with fig. 19 should preferably be used.

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e. Conductor termination and binding-in.

(i) *Terminal and section poles.* The conductor shall be made-off on a gunmetal or galvanised malleable cast-iron terminating thimble, conforming to fig. 16, with a single-wire type binder of soft copper, 0·080 in. diameter (14 S.W.G.), the binder extending for a length of 4 in. as shown on fig. 16.

(ii) *Intermediate poles (angle positions).* The conductor shall be secured to the side groove of the pin insulator by a single stirrup and binding, as shown on fig. 17, consisting of a chafer of soft copper tape 0·028 in. (22 S.W.G.) × 3/16 in., wrapped on the conductor over the length in contact with the insulator, with a single stirrup of hard-drawn copper wire 0·212 in. diameter (5 S.W.G.) and a binding of soft copper wire 0·080 in. diameter (14 S.W.G.) to the dimensions shown on fig. 17.

(iii) *Intermediate poles (straight line positions).* The conductor shall be secured to the top groove of the pin insulator by twin stirrups and binding, as shown on fig. 18, consisting of a chafer of soft copper tape 0·028 in. (22 S.W.G.) × 3/16 in., wrapped on the conductor over the length in contact with the insulator, with twin stirrups of hard-drawn copper wire, 0·212 in. diameter (5 S.W.G.) and a binding of soft copper wire 0·080 in. diameter (14 S.W.G.) to the dimensions shown on fig. 18.

To prevent movement of the stirrups on deep-headed insulators, the binding wire shall be bound around the bent-up portion of the stirrups before commencing the binding over the conductor.

MINIMUM HEIGHT OF CONDUCTORS

5. The height from the ground of any line conductor at any point of the span at a temperature of 122°F. shall be not less than 17 ft. The minimum height of conductors at crossings shall be as set out in clauses 14 to 16.

LENGTH OF SPAN

6. Table 3 shows the lengths of span and conductor spacings recommended for use over flat or ordinary undulating country where conditions are suitable. Shorter spans should be employed where local considerations render them desirable. This table also shows the maximum lengths of span which can be used with the two standard conductor spacings, when an occasional longer span is necessary.

SUPPORTS

7. Wood poles shall be used and the construction shall be generally in accordance with figs. 1, 2, 3, 4 and 5.

They shall be of red fir or European larch and shall comply with the following specifications respectively:

B.S. 139. Red fir poles for telegraph and telephone lines.

B.S. 513. European larch poles for transmission lines.

In no case shall poles of diameter less than 6½ in. at a point 5 ft. from the butt be used.

A template shall be used for marking off the holes required for securing the crossarm and its tie-straps or struts and, in order that the crossarm shall be level when the pole is erected, the centre line of the template shall be placed parallel to the effective centre line of the pole.

Each pole shall be drilled, scarfed and marked as shown on fig. 13. This marking shall indicate the overall length, diameter, species of wood, year of creosoting, together with a horizontal gouge mark which must be cut at 10 ft. from the butt. This marking shall be carried out on the same side of the pole as that on which the drilling templates have been used.

As far as is practicable, all cutting, scarfing and drilling of poles shall be done before creosoting. Where this is not practicable, all cut, scarfed or drilled surfaces shall be coated with a mixture of creosote and tar.

The poles shall be planted to the depths given in table 4.

A kicking-block as shown in fig. 1, or other means, shall be provided where the ground or local conditions call for additional strength in the foundations.

The maximum loading spans that can be carried on poles erected to factors of safety of 2·5 and 3·5 respectively are given in table 4. It should, however, be noted that in many cases the span lengths shown are in excess of the maximum specified in table 3 for 3 ft. 6 in. conductor spacing. Where such longer span is necessary, special consideration should be given to the conductor spacing.

In practice there are many other determining factors which may require shorter span lengths to be employed; shorter even than those indicated for the minimum diameter of a pole of any given length. In such cases, the actual factor of safety of the pole may be considerably in excess of either 2·5 or 3·5.

Where the indicated length of span for the minimum diameter of pole of any given length exceeds those shown in table 3, no further span lengths are indicated for larger pole diameters.

CROSSARMS

8. Crossarms may be of steel or wood. Bolts and nuts shall be used for securing the crossarms, tie-straps and crossarm struts; curved washers to fig. 38 shall be fitted between the head of the bolt and the pole.

a. Steel crossarms. Steel crossarms shall be angle section of steel complying with B.S. 15. They shall have dimensions as shown on figs. 26, 27, 28, 29, 30, 31 and 32, and shall be used in the positions indicated in table 5.

b. Tie-straps. Tie-straps shall be of steel complying with B.S. 15 and shall be as shown on fig. 34.

c. Wooden crossarms. Wooden crossarms shall be cut from the heartwood of fully-seasoned karri, jarrah, gurjun or oak, free from knots, shakes or splits and shall be straight in grain. They shall be of the dimensions shown on figs. 35 and 36 and shall be used in the positions indicated in table 5. A 2½ in. flat washer to fig. 39 shall be fitted between the crossarm and the collar of the insulator pin and between the crossarm and the nut of the pin.

d. Crossarm struts. Crossarm struts shall be of wood of the same species and quality as specified for wooden crossarms. They shall be as shown on fig. 37 and shall be fitted to the crossarm in metal sockets as shown on fig. 40 and to the pole in box washers as shown on fig. 41.

INSULATORS AND FITTINGS

9. *a. Insulators.* All insulators shall comply with B.S. 137 and in the case of pin insulators the ratings shown in table 6 shall be used.

One 10 in. diameter disc with standard ball and socket fittings to B.S. 137 shall be used on terminal and section poles.

An increase in the size of pin insulators or the number of discs per string is recommended where such increase is necessitated by local climatic or other conditions.

b. Insulator pins. Line insulator pins shall comply with refs. 28 or 29 of B.S. 137 and pilot insulator pins shall comply with ref. 45 of B.S. 137. The maximum line deviation on pins shall be as shown in table 7.

c. Insulator hooks. Insulator hooks with dimensions shown on fig. 22 shall be made from mild steel rod of not less than 28/33 ton quality, with a forged ball in accordance with B.S. 137.

d. Terminating straps. Terminating straps for both terminal and section poles shall be made of mild steel of not less than 28/33 ton quality, the dimensions being as shown on fig. 23.

STAYS

10. Stay wires shall be of galvanised mild steel of 45 ton quality and shall comply with B.S. 183.

Stay rods shall be of galvanised mild steel of 28/33 ton quality and shall be of circular section with tubular type turnbuckles as shown in fig. 46.

A wooden insulator shall be inserted in any stay wire attached to a pole on which the steelwork is not earthed. These insulators shall be cut from the heartwood of fully-seasoned karri, jarrah or gurjun, free from knots, shakes or splits and shall be straight in grain. They shall conform, after planing, to the dimensions shown on fig. 47.

Oak is not permitted for stay insulators.

The combined use of stay wires and stay rods shall be as specified in table 8, the stay wire being made-off and spliced in the manner shown on fig. 14.

Alternatively, reinforced concrete stay blocks of suitable design may be used.

Table 9 sets out the minimum angle between pole and wire for single stays for various angles of line deviation. Local conditions will determine the actual angle between stay and pole, the number and size of stays and the size of baulk required.

EARTHING AND BONDING

11. Steelwork on poles shall *not be earthed* except at poles fitted with transformers, remote mechanically-operated switchgear or cable or other apparatus which impairs the impulse flashover value of the additional insulation provided by the wooden pole. At such poles all steelwork shall be bonded and earthed and stays left uninsulated, subject to, and in accordance with, the following requirements:

(i) The earth electrode resistance shall comply with clause 17 of the Electricity Commissioners' Overhead Line Regulations El. C. 53 (Revised).

(ii) Where rods are used for earthing, they shall be of galvanised wrought iron of the type shown on fig. 45.

(iii) Where any special equipment on a pole includes metalwork accessible from ground level which normally has to be handled by an operator when the line is alive (i.e., a switch-operating handle), such metalwork shall be connected to an earth mat, so situated as to include within its area the whole of the ground on which the operator would normally stand. It is recommended that this should be carried out in accordance with the arrangement shown on fig. 15 (see also Appendix C).

Insulator steelwork on a wooden crossarm need not be bonded, but in such cases care shall be taken to ensure efficient contact between the crossarm and the insulator pins and between the pole and the crossarm. The metal washers shown on figs. 38 and 39 are intended for this purpose.

Earthing and bonding wires shall be of copper of a minimum diameter of 0·16 in. (8 S.W.G.) and they shall be stapled to the pole at intervals of not less than 12 in. Where atmospheric conditions are likely to cause galvanic action staples shall be of non-ferrous metal and the wire should be tinned and an earth clip to fig. 42 used where possible.

NOTE. In view of the fact that, except at certain poles referred to above, no permanent earthing electrodes will be provided along the route of these overhead lines, it is recommended that provision be made either in the form of additional electrodes fixed at reasonable intervals or, alternatively, suitable portable earthing equipment be provided to facilitate the earthing of lines for maintenance purposes.

DANGER NOTICES

12. Danger notices shall conform to fig. 43 and shall be fixed to the pole at a height of approximately 10 ft. above ground level.

ANTI-CLIMBING DEVICES

13. Anti-climbing devices shall be fitted to all poles other than single poles and to all single poles carrying transformers or remote mechanically-operated fuses or switchgear. They shall also be fitted to all stays where two or more are arranged in such proximity to one another as to facilitate climbing.

Anti-climbing devices (where required) shall be of galvanised barbed wire as shown on fig. 14.

ROAD CROSSINGS

14. At road crossings, the height from the road surface of any line conductor or cradle wire at a temperature of 122°F. shall not be less than 20 feet and no additional precautionary measures are necessary.

RAILWAY, CANAL AND OTHER OVERHEAD LINE CROSSINGS

15. Where an overhead line to this specification is erected along or across a railway or canal (including a navigable river) or crosses over any other overhead wire, it shall comply with the general requirements of the Electricity Commissioners' Overhead Line Regulations for such crossings and with such other arrangements (if any) as may be agreed with the authorities concerned to meet local or special conditions.

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POST OFFICE LINES

16. Where an overhead line to this specification crosses or is in proximity to an overhead telephone or telegraph line of the Postmaster-General, it must comply with the special requirements of the Postmaster-General as set out in Appendix A.

TRANSFORMER POLES

17. Where pole-mounted transformers are installed, the horizontal formation and spacing of the conductors shall be maintained.

SWITCHGEAR POLES

18. Where line sectionalising is required, horizontal remote-operated switchgear, generally to fig. 6, is recommended where the line deviation does not exceed 35° and generally to fig. 7 where the line deviation exceeds 35°.

TEE-OFF POLES

19. It is recommended that tee-off poles shall conform to fig. 8, and that any necessary switch or fuse gear be mounted on adjacent poles.

MATERIALS, WORKMANSHIP AND FINISH

20. *a. Materials.* The material of all component parts shall be as stated on the appropriate drawings.

b. Drilling. All poles, crossarms, tie-straps and crossarm struts shall be drilled to templates.

c. Galvanising. All ironwork and steelwork shall be galvanised after all mechanical operations, e.g. drilling, filing, etc., and after all exter.al threading have been completed. Internal threading shall be carried out after galvanising, the threads being well oiled.

Galvanising shall be applied by the hot process and for all parts, other than stay wires and barbed wire, it shall consist of a coating of at least 2 oz. of zinc per sq. ft. of surface and shall not adversely affect the mechanical properties of the coated metalwork.

The quality of the galvanising on all metalwork, other than stay wires and barbed wire, shall be determined by the tests given in B.S. 729.

The quality of the galvanising on stay wires and barbed wire shall be determined by the tests given in B.S. 443.

d. Creosoting. Kicking blocks and stay baulks shall be pressure creosoted in accordance with B.S. 139.

TABLES

TABLE 1

0·025 SQ. IN. (3/·104 IN.) COPPER CONDUCTOR

(A) CONDUCTOR SAGS AND TENSIONS

Maximum vertical sags (at 122°F. in still air, i.e. worst condition for ground clearance)

Equivalent span ft.	150	200	250	300	350
Tension lb.	189	189	190	191	192
Sag	1 ft. 6 in.	2 ft. 8 in.	4 ft. 2 in.	6 ft. 0 in.	8 ft. 0 in.

(B) MINIMUM VERTICAL SAGS

(Vertical component of deflected sag at 22°F. with wind, i.e. worst condition for conductor tension, uplift and downward load)

Equivalent span f	150	200	250	300	350
Tension lb.	607	607	607	607	607
Sag	6 in.	10 in.	1 ft. 3 in.	1 ft. 10 in.	2 ft. 6 in.

(C) ERECTION SAGS

Table 1 (continued). (Based on 250 ft. equivalent span)

Erection temperature °F.	Erection tension lb.	Sag in still air for various span lengths										
		100 ft.	125 ft.	150 ft.	175 ft.	200 ft.	225 ft.	250 ft.	275 ft.	300 ft.	325 ft.	350 ft.
		in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
30	350	4	7	10	1 1	1 5	1 10	2 3	2 8	3 3	3 9	4 5
40	324	5	7	10	1 2	1 7	2 0	2 5	2 11	3 6	4 1	4 9
50	300	5	8	11	1 3	1 8	2 1	2 7	3 2	3 9	4 5	5 1
60	279	5	8	1 0	1 5	1 10	2 3	2 10	3 5	4 0	4 9	5 6
70	260	6	9	1 1	1 6	1 11	2 5	3 0	3 8	4 4	5 1	5 11
80	243	6	10	1 2	1 7	2 1	2 7	3 3	3 11	4 8	5 5	6 4
90	228	7	10	1 3	1 8	2 2	2 9	3 5	4 2	4 11	5 10	6 9
100	215	7	11	1 4	1 9	2 4	2 11	3 9	4 5	5 3	6 2	7 2
110	203	7	1 0	1 5	1 11	2 6	3 2	3 10	4 8	5 7	6 6	7 7

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(D) ERECTION TENSIONS

(At various temperatures in still air)

Erection temperature °F.	Tensions for various equivalent spans (lb.)						
	150 ft.	200 ft.	225 ft.	250 ft.	275 ft.	300 ft.	350 ft.
30	476	412	379	350	323	301	269
40	438	378	349	324	301	264	257
50	399	346	321	300	281	267	246
60	362	316	296	279	264	253	237
70	328	290	273	260	248	241	228
80	294	265	252	243	234	229	220
90	264	243	234	228	223	219	212
100	237	224	219	215	211	209	205
110	213	207	205	203	201	201	199

NOTES.

1. *Basis.*

Wind at 22°F.	16 lb. per sq. ft. of projected area.
Temperature range	22°—122°F.
Breaking load	1518 lb.
Maximum working tension in conductor	Breaking load ÷ 2·5.

2. *Flexibility of poles.* All poles are assumed to be perfectly flexible in the direction of the line, except those fitted with longitudinal stays which are regarded as rigid. On this assumption the conductor tension for any condition of load and temperature would be the same in all spans in a line or section of line, its value being that appropriate to the equivalent span.

see Amdt. No. 1.

3. *Maximum sags.* As the tension under maximum sag conditions varies with equivalent span, it is recommended that the maximum sag templet to be used for setting out should be constructed on the assumption that the equivalent span will be approximately equal to the span to which the line is designed. If the tension corresponding to the actual equivalent span differs appreciably from such span, the effect of the resulting variation in maximum sags should be ascertained.

4. *Minimum vertical sags.* The tension under conditions of maximum loading and minimum temperature is the same for all equivalent spans, and cases of possible uplift or excessive downward load may therefore be investigated on the profile by using a single parabolic templet, the shape of which is correct for all equivalent spans.

5. *Erection sags.* The erection sags given for various spans are correct only for lines or sections having an equivalent span of 250 ft., and for any other equivalent span they must be adjusted in inverse proportion to the appropriate tension given in table 1 (A).

TABLE 2

FOR 0·05 SQ. IN. (3/·147 IN.) COPPER CONDUCTOR

(A) CONDUCTOR SAGS AND TENSIONS

Maximum vertical sags (at 122°F. in still air, i.e. worst condition for ground clearance)

Equivalent span ft.	200	250	300	350	400	450	500
Tension lb.	427	442	454	461	468	473	477
Sag	2 ft. 4 in.	3 ft. 6 in.	5 ft. 0 in.	6 ft. 8 in.	8 ft. 6 in.	10 ft. 9 in.	13 ft. 1 in.

(B) MINIMUM VERTICAL SAGS

(Vertical component of deflected sag at 22°F. with wind, i.e. worst condition for conductor tension, uplift and downward load)

Equivalent span ft.	200	250	300	350	400	450	500
Tension lb.	1168	1168	1168	1168	1168	1168	1168
Sag	10 in.	1 ft. 4 in.	1 ft. 11 in.	2 ft. 8 in.	3 ft. 5 in.	4 ft. 4 in.	5 ft. 4 in.

(C) ERECTION SAGS

(Based on 350 ft. equivalent span)

Erection temperature °F.	Erection tension lb.	Sag in still air for various span lengths												
		200 ft.	225 ft.	250 ft.	275 ft.	300 ft.	325 ft.	350 ft.	375 ft.	400 ft.	425 ft.	450 ft.	475 ft.	500 ft.
		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
30	711	1 5	1 9	2 2	2 8	3 2	3 9	4 4	4 11	5 7	6 4	7 1	7 11	8 9
40	673	1 6	1 11	2 4	2 10	3 4	3 11	4 7	5 3	5 11	6 9	7 6	8 5	9 3
50	637	1 7	2 0	2 5	3 0	3 6	4 2	4 10	5 6	6 3	7 1	7 11	8 10	9 10
60	605	1 8	2 1	2 7	3 2	3 9	4 4	5 1	5 10	6 7	7 6	8 4	9 4	10 4
70	576	1 9	2 2	2 9	3 3	3 11	4 7	5 4	6 1	6 11	7 10	8 10	9 9	10 10
80	549	1 10	2 4	2 10	3 5	4 1	4 10	5 7	6 5	7 3	8 3	9 3	10 3	11 5
90	525	1 11	2 5	3 0	3 7	4 3	5 0	5 10	6 8	7 7	8 7	9 8	10 9	11 11
100	503	2 0	2 6	3 1	3 9	4 6	5 3	6 1	7 0	7 11	9 0	10 1	11 2	12 5
110	483	2 1	2 7	3 3	3 11	4 8	5 6	6 4	7 3	8 3	9 4	10 6	11 8	12 11

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(D) ERECTION TENSIONS

Table 2 (continued). (At various temperatures in still air)

Erection temperature °F.	Tensions for various equivalent spans (lb.)								
	200 ft.	250 ft.	300 ft.	325 ft.	350 ft.	375 ft.	400 ft.	450 ft.	500 ft.
30	924	846	774	741	711	687	664	629	605
40	854	786	725	697	673	653	635	607	587
50	786	728	678	657	637	622	608	586	570
60	722	675	636	620	605	593	583	566	555
70	662	626	598	586	576	567	560	548	540
80	606	583	564	556	549	544	539	531	526
90	555	543	533	529	525	523	520	515	513
100	510	507	505	504	503	503	502	502	501
110	469	476	480	482	483	485	486	488	490

NOTES.

1. *Basis.*

Wind at 22°F.	16 lb. per sq. ft. of projected area.
Temperature range	22°—122°F.
Breaking load	2920 lb.
Maximum working tension in conductor	Breaking load ÷ 2·5.

2. *Flexibility of poles.* All poles are assumed to be perfectly flexible in the direction of the line, except those fitted with longitudinal stays which are regarded as rigid. On this assumption the conductor tension for any condition of load and temperature would be the same in all spans in a line or section of line, its value being that appropriate to the equivalent span.

See Amdt. No. 1.

3. *Maximum sags.* As the tension under maximum sag conditions varies with equivalent span, it is recommended that the maximum sag templet to be used for setting out should be constructed on the assumption that the equivalent span will be approximately equal to the span to which the line is designed. If the tension corresponding to the actual equivalent span differs appreciably from such span, the effect of the resulting variation in maximum sags should be ascertained.

4. *Minimum vertical sags.* The tension under conditions of maximum loading and minimum temperature is the same for all equivalent spans, and cases of possible uplift or excessive downward load may therefore be investigated on the profile by using a single parabolic templet, the shape of which is correct for all equivalent spans.

5. *Erection sags.* The erection sags given for various spans are correct only for lines or sections having an equivalent span of 350 ft., and for any other equivalent span they must be adjusted in inverse proportion to the appropriate tension given in table 2 (D).

TABLE 3

SPAN LENGTHS AND CONDUCTOR SPACINGS

Conductor size	Recommended span	Maximum permissible single span	
	2 ft. 6 in. conductor spacing	2 ft. 6 in. conductor spacing	3 ft. 6 in. conductor spacing
0·025 sq. in. copper	250 ft.	300 ft.	350 ft.
0·05 sq. in. copper	350 ft.	400 ft.	500 ft.

TABLE 4

MAXIMUM WIND LOADING SPANS FOR INTERMEDIATE AND SECTION POLES

Pole dimensions			Depth in ground	Maximum wind loading spans							
				Three-phase lines				Single-phase lines			
				0·025 sq. in. copper conductors		0·05 sq. in. copper conductors		0·025 sq. in. copper conductors		0·05 sq. in. copper conductors	
				F.S. 2·5	F.S. 3·5	F.S. 2·5	F.S. 3·5	F.S. 2·5	F.S. 3·5	F.S. 2·5	F.S. 3·5
Height above ground	Diameter at 5 ft. from butt	Overall length		*Imported red fir	Larch or home-grown red fir	*Imported red fir	Larch or home-grown red fir	*Imported red fir	Larch or home-grown red fir	*Imported red fir	Larch or home-grown red fir
ft.	in.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
19	6½	24	5	404	289	285	204	606	432	428	306
	7			—	359	354	253	—	—	531	379
	7½			—	—	433	310	—	—	—	455
	8			—	—	527	375	—	—	—	562
21	7	26	5	455	325	321	229	683	488	486	343
	7½			—	400	395	282	—	—	592	423
	8			—	—	480	343	—	—	—	514
	8½			—	—	575	410	—	—	—	—
23	7	28	5	417	298	294	210	626	447	441	315
	7½			—	366	361	259	—	—	541	388
	8			—	—	438	314	—	—	—	471
	8½			—	—	526	375	—	—	—	562
25	7	30	5	379	271	268	192	569	406	402	288
	7½			—	335	333	236	—	—	499	354
	8			—	407	403	288	—	—	—	432
	8½			—	—	485	346	—	—	—	519
27	7½	32	5	435	310	307	219	652	465	460	328
	8			—	380	375	268	—	—	562	402
	8½			—	—	450	322	—	—	—	483
	9			—	—	533	381	—	—	—	—
29	7½	34	5	395	285	279	201	593	427	418	301
	8			—	369	365	261	—	—	547	391
	8½			—	—	419	300	—	—	—	450
	9			—	—	497	355	—	—	—	532
30	8	36	6	478	342	337	241	717	513	505	361
	8½			—	410	405	289	—	—	—	433
	9			—	—	481	344	—	—	—	516
	9½			—	—	566	404	—	—	—	—
32	10†	38	6	877	627	619	442	1315	940	928	663
34	10†	40	6	826	590	583	417	1239	885	874	625

* Pinus sylvestris.

† Any pole with an overall length in excess of 36 ft. to have a diameter at least equal to a 'MEDIUM' pole as specified in B.S. 139.

Basis. Loading point 6 in. above pole top.
Wind pressure 16 lb. per sq. ft. on the bare conductor only.
Modulus of rupture Taken as 7800 lb. per sq. in. for all species of timber.

NOTE. This table indicates the maximum lengths of loading span that would be permissible on various sizes and species of poles for the respective factors of safety and sizes of conductor for single and three-phase lines, *if the pole strength were the only factor to be taken into account.* See also Clause 7.

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TABLE 5. CROSSARMS

THREE-PHASE LINES

Type of pole	Condition of use	Steel crossarms: Size (angle section)	Steel crossarms: B.S. drawing No.	Wooden crossarms: Size	Wooden crossarms: B.S. drawing No.
Intermediate (2 ft. 6 in. conductor spacing)	(i) At straight line positions (ii) At line deviations up to 35°	5 ft. 4 in. × 2¾ in. × 2¾ in. × ⅜ in.	Fig. 26	5 ft. 6 in. × 3 in. × 3 in.	Fig. 35
Intermediate (3 ft. 6 in. conductor spacing)	(i) At straight line positions (ii) At line deviations up to 60° (0·025 sq. in. conductor) (iii) At line deviations up to 35° (0·05 sq. in. conductor) (iv) Where duplicate pin insulators are required.	7 ft. 4 in. × 4 in. × 3 in. × ⅜ in.	Fig. 27	Steel crossarms to be used	
Section	At all positions where strain insulators are required.	7 ft. 4 in. × 4 in. × 3 in. × ⅜ in.	Fig. 28		
Terminal	All line terminations	5 ft. 4 in. × 5 in. × 3 in. × ⅜ in.	Fig. 29		
	SINGLE-PHASE LINES				
Intermediate (3 ft. 0 in. conductor spacing)	(i) At straight line positions (ii) At line deviations up to 35°	3 ft. 4 in. × 2¾ in. × 2¾ in. × ⅜ in.	Fig. 30	3 ft. 6 in. × 3 in. × 3 in.	Fig. 36
Intermediate (3 ft. 6 in. conductor spacing)	(i) At straight line positions (ii) At line deviations up to 60° (0·025 sq. in. conductor) (iii) At line deviations up to 35° (0·05 sq. in. conductor). (iv) Where duplicate pin insulators are required.	3 ft. 10 in. × 2¾ in. × 2¾ in. × ⅜ in.	Fig. 31	Steel crossarms to be used	
Section (3 ft. 0 in. conductor spacing)	(i) At straight line positions	3 ft. 4 in. × 2¾ in. × 2¾ in. × ⅜ in.	Fig. 30		
	(ii) At line deviations up to 35°	3 ft. 4 in. × 2¾ in. × 2¾ in. × ⅜ in.	Fig. 30		
	(iii) At line deviations of 35° and over conductor spacing 3 ft. 6 in.	3 ft. 10 in. × 2¾ in. × 2¾ in. ~~× 2¾ in.~~ × ⅜ in.	Fig. 31		
Terminal	(i) At line terminations (0·025 sq. in. conductor)	3 ft. 4 in. × 2¾ in. × 2¾ in. × ⅜ in.	Fig. 30		
	(ii) At line terminations (0·05 sq. in. conductor)	3 ft. 4 in. × 4 in. × 3 in. × ⅜ in.	Fig. 32		

See Amdt. No. 1.

NOTE. Table 5 applies to lines in which the spans do not exceed those given in table 3. Special arrangements will be required to meet exceptional cases such as a long span adjacent to a very acute line deviation.

TABLE 6
INSULATOR RATINGS

Line voltage	Insulator rating No.
Up to 6·6 kV.	30
Up to 11 kV.	50

TABLE 7
MAXIMUM LINE DEVIATIONS ON PIN INSULATORS

Copper conductors	Maximum line deviation: 400 lb. pins	Maximum line deviation: 800 lb. pins
0·025 sq. in.	35°	60°
0·05 sq. in.	15°	35°

TABLE 8
SIZES OF STAY WIRE AND STAY RODS

For use with stay wire	Breaking load of stay wire	Diameter of rod see 'X' on fig. 46	Ultimate tensile strength of complete rod	Standard sizes of wood baulks to be used according to ground conditions
7/·160 in. dia. (7/8 S.W.G.)	~~12 750 lb.~~ 14,158 lb.	11/16 in.	15 680 lb.	4 ft. 3 in. × 10 in. × 5 in. or 4 ft. × 8 in. × 4 in. or 2 ft. × 8 in. × 4 in.
4/·160 in. dia. (4/8 S.W.G.)	~~7 900 lb.~~ 8,104 lb.	½ in. or 11/16 in.	8 064 lb.	

See Amdt. No. 1.

TABLE 9
SLOPE OF STAY WIRES

For line deviation (degrees)	Minimum angle between stay wire and pole (degrees): Three-phase lines, 0·025 sq. in. copper: 4/·160 in. diameter stay wire	Three-phase lines, 0·025 sq. in. copper: 7/·160 in. diameter stay wire	Three-phase lines, 0·05 sq. in. copper: 4/·160 in. diameter stay wire	Three-phase lines, 0·05 sq. in. copper: 7/·160 in. diameter stay wire	Single-phase lines, 0·025 sq. in. copper: 4/·160 in. diameter stay wire	Single-phase lines, 0·05 sq. in. copper: 4/·160 in. diameter stay wire	Single-phase lines, 0·05 sq. in. copper: 7/·160 in. diameter stay wire
Up to 15°	20	—	20	—	20	20	—
20	20	—	23	—	20	20	—
25	20	—	29	—	20	20	—
30	20	—	35	21	20	23	—
35	20	—	42	24	20	26	—
40	23	—	49	28	20	30	—
45	26	—	—	32	20	35	21
50	29	—	—	36	20	39	23
55	32	—	—	39	21	43	25
60 or terminal	35	21	—	43	23	48	27
70	41	24	—	52	26	—	32
80	48	27	—	62	30	—	36

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