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British Standard Specification for **Rubber-insulated cables for electric power and lighting**

Conducteurs et câbles isolés au caoutchouc pour installations

Starkstromleitungen mit einer Isolierung aus Gummi

BS 6007 : 1983

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Foreword

This British Standard has been prepared under the direction of the General Electrotechnical Engineering Standards Committee. It is a revision of BS 6007 : 1975, but does not come into effect until 1 July 1984 (see back cover). In the meantime, BS 6007 : 1975 remains as the current standard until its withdrawal in July 1984 when this revision will supersede it.

This revision takes into account the second edition of CENELEC* Harmonization Document HD 22† issue dated October 1982, and is published in advance of the date on which it is anticipated that cables manufactured to comply with this revision will become available to enable manufacturers and users to be forewarned of the impending changes. The cable industry intends that cables complying with this standard will be available from 1 July 1984. However, it is understood that in the intervening period, cables complying with the 1975 edition of this standard will continue to be supplied.

Where Harmonized Code Designations are given, the requirements are in conformity with those of all countries which accept the basic principles of harmonization in accordance with the requirements of CENELEC. Designs shown as

recognized national types are not harmonized but are regarded as representing a particular requirement in the UK which is not reflected in other countries.

Colours for core identification as agreed within CENELEC have been included in tables 1 to 6, as appropriate.

NOTE. BSI Sales Department will respond to purchase orders for BS 6007 by supplying copies of the 1983 edition. Copies of the 1975 edition may be obtained by quoting the number 'BS 6007/75'.

Certification. Attention is drawn to the certification services (see inside back cover) of the British Approvals Service for Electric Cables (BASEC)‡. These services include licensing manufacturers to use BASEC certification trade marks as independent assurance that cables or cords have been designed and manufactured to appropriate British Standards. BASEC is a subscriber to an agreement in CENELEC whereby cables or cords coming within Harmonized Code Designations and manufactured under a BASEC licence, can carry marks acceptable to other signatory countries (CENELEC 'Common Marking').

Compliance with a British Standard does not of itself confer immunity from legal obligations.

*European Committee for Electrotechnical Standardization.

†The second edition is in four Parts, HD 22.1.S2, HD 22.2.S2, HD 22.3.S2 and HD 22.4.S2.

‡British Approvals Service for Electric Cables, Maylands Avenue, Hemel Hempstead, Hertfordshire HP2 4SQ.

British Standard for

Rubber-insulated cables for electric power and lighting

1. Scope

This British Standard specifies requirements for the construction, electrical properties, mechanical properties and dimensions of non-armoured rubber-insulated cables and flexible cables for operation at voltages up to and including 450 V a.c. to earth and 750 V a.c. between conductors.

The types of cables included in the standard are:

- (a) Table 1. Rubber-insulated, textile-braided and compounded cable, single core 450/750 V;
- (b) Table 2. Rubber-insulated and sheathed cable, flat twin 300/500 V;
- (c) Table 3. Rubber-insulated and sheathed flexible cable, 3-core and 4-core 300/500 V;
- (d) Table 4. Rubber-insulated and sheathed flexible cable, single core, circular twin, 3-core, 4-core and 5-core 450/750 V;
- (e) Table 5. Rubber-insulated, HOFR-sheathed flexible cable, single core, circular twin, 3-core, 4-core and 5-core 450/750 V;
- (f) Table 6. Rubber-insulated, braided, heat-resistant flexible cable, single core and twisted twin 300/500 V.

A guide to the use of rubber-insulated cables is given in appendix A. Guidance to manufacturers on procedures for routine testing is given in appendix B.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2. Definitions

For the purposes of this British Standard, the definitions given in BS 4727 apply together with the following.

2.1 rated voltage U_0 . The power-frequency voltage to earth for which the cable is designed.

2.2 rated voltage U . The power-frequency voltage between conductors for which the cable is designed.

3. Voltage designation

The rated voltage of a cable is the reference voltage for which the cable is designed and which serves to define the electrical tests and shall be expressed, in volts, by the following expression:

$$U_0/U$$

where

U_0 is the r.m.s. value between any insulated conductor and earth, i.e. the metal covering of the cable or the surrounding medium;

U is the r.m.s. value between any two phase-conductors of a multicore cable or of a system of single-core cables.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended and this applies both to the value U_0 and to the value U .

In a direct current system, the nominal voltage of the system shall be not higher than 1.5 times the rated voltage of the cable.

NOTE. The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %. A cable can be used at 10 % higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

The rated voltages recognized for the purpose of this standard shall be 300/500 V and 450/750 V.

4. Conductors

4.1 Construction. The conductors shall be annealed copper conductors complying with BS 6360. Unless otherwise given in tables 1 to 6, as appropriate, the individual wires of conductors shall be plain or covered with an effective layer of commercial tin.

Where the wires are plain, a separator tape made of suitable material shall be placed between the conductor and the insulation.

NOTE. Where the wires are tinned and for cables whose properties are given in table 6, the application of a separator is left to the discretion of the manufacturer.

The solderability of plain conductors, except for the cables whose properties are given in table 6, shall be tested as described in appendix C. The part of the conductor that has been immersed in the solder bath shall be adequately tinned.

4.2 Class. The class of the conductor shall be as given in tables 1 to 6, inclusive.

5. Insulation

5.1 Type of insulation. The insulation shall be one of the following types complying with BS 6899 as given in tables 1 to 6, as appropriate:

- (a) type EI1 rubber insulation;
- (b) type GP1 rubber insulation;
- (c) type EI2 rubber insulation;

Compliance shall be checked by carrying out the appropriate tests listed in table 8.



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5.2 Application. The insulation shall be closely applied to the conductor or separator as follows:

- (a) types EI1 and GP1: unless applied by the extrusion process, the insulation shall consist of at least two layers;
- (b) type EI2: the insulation shall be extruded in a single layer.

It shall be possible to remove the insulation easily, without damage to the insulation itself, the conductor or the tin coating, if any.

Compliance shall be checked by examination and by a manual test.

5.3 Thickness. The mean value of the thickness of the insulation shall be not less than the value given for each type and cross section of cable in tables 1 to 6, as appropriate. However, it shall be permissible for the thickness at any one place to be less than the value specified provided that the difference does not exceed 0.1 mm +10 % of the value specified.

Compliance shall be checked by the measurements described in 2.1.1 of BS 6469 : 1984.

From each core to be tested, one sample of core shall be taken from each of three places separated by at least 1 m.

The mean of all the values obtained on the three pieces of insulation shall be calculated to two decimal places and then rounded off to obtain the mean value of insulation thickness. If the calculation gives 5 or more for the second decimal figure, the first figure shall be raised to the next number: thus, for example, 1.75 shall be rounded to 1.8 and 1.74 to 1.7.

The smallest of all the values obtained shall be taken as the minimum thickness of insulation at any place.

5.4 Addition of tape. Where stated in tables 1 to 6, it shall be permissible for a proofed textile tape to be applied over the insulation. The tape shall be applied helically with a minimum overlap of 1 mm. In the completed cable, it shall be possible to remove the proofed tape without damage to the insulation.

6. Core identification

6.1 General. Each core shall be identified by its colour. The colour shall be either throughout the whole of the insulation or on its surface, or, where it is given in tables 1 to 6 that it is permitted, on a proofed tape or textile braid which may be applied over the insulation. In the latter case, the identifying colour shall be visible on the external surface.

6.2 Colours. The colours of the cores according to the number of cores in the cable and also the sequence of these colours shall be as given in tables 1 to 6, as appropriate.

6.3 Harmonized code designations. A harmonized code designation is given in table 6 for single core non-sheathed cables. These cables shall be permitted to bear the Common Marking in accordance with 10.2, provided the colours comply with the following:

- (a) the colours available shall include the combination green/yellow and the colour blue;
- (b) combinations of colours other than green/yellow shall not be considered harmonized.

Single-core non-sheathed cables complying with the properties given in tables 1 to 6 where harmonized code designations are given, but having core colours not in accordance with the requirements of this subclause, are not harmonized types and shall not bear the Common Marking.

NOTE. Attention is drawn to the fact that, according to the use to which the cables are put, it may be necessary to comply with core colour requirements specified in the 'Regulations for Electrical Installations' published by the Institution of Electrical Engineers, any British or other standard applicable, or any appropriate regulations or statutory requirements.

6.4 Bi-colour combination. On the core marked with the bi-colour combination green/yellow, the distribution of these colours shall be such that for every 15 mm length of core, one of these colours shall cover at least 30 % and at most 70 % of the surface of the core, while the other colour covers the remainder of the surface.

NOTE 1. In case of dispute and where appropriate to the method of colour marking of the insulation, see 2.7 of BS 6469 : 1984 for a test method to check compliance.

NOTE 2. Information on the use of the colours green/yellow and blue. It is understood that the colours green and yellow when they are combined as specified above are recognized exclusively as a means of identification of the core intended for use at earth connection or similar protection and that the colour blue is intended for the identification of the core intended to be connected to neutral. If, however, there is no neutral, blue can be used to identify any core except for earthing or protective conductor.

6.5 Clarity and durability. The colours shall be clearly identifiable and durable.

Compliance shall be checked by trying to remove the colour of the cores by rubbing the core 10 times with a piece of cotton wool or cloth soaked in water.

7. Filler

7.1 Material. Unless otherwise specified, the filler shall be composed of one of the following or of any combination of the following:

- (a) a compound of rubber or equivalent synthetic elastomers, vulcanized or unvulcanized; or
- (b) natural or synthetic textiles; or
- (c) paper.

There shall be no harmful interactions between the constituents of the filler and the insulation and/or the sheath.

7.2 Application. Whether the cable includes fillers or whether the sheath may penetrate between the cores thus forming a filling, shall be as given in tables 1 to 6, as appropriate, for each type of cable. The fillers, if any, shall fill the spaces between the cores, giving the assembly a practically circular shape, and shall not adhere to the cores.

NOTE. The assembly of cores and fillers may be held together by a film or tape.

A centre filler, if used, shall comply with 7.1

8. Braid

8.1 Fibre. The yarns forming the braid shall be one of the following:

- (a) based on natural material, e.g. cotton or treated cotton;
- (b) based on synthetic material, e.g. rayon or polyamide;
- (c) fibre made of glass or equivalent material.

8.2 Construction. The braid shall have a uniform texture, without knots or gaps. Braids made of glass fibres shall be treated with a suitable substance in order to resist fraying.

9. Sheath

9.1 Type of sheath. The sheath shall be one of the following types complying with BS 6899 as given in tables 1 to 6, as appropriate:

- (a) type EM1 ordinary duty rubber sheath;
- (b) type EM2 ordinary duty oil-resisting and flame-retardant sheath;

*Available from the Institution of Electrical Engineers, 2 Savoy Place, London WC2 0BL.

(c) type RS4* heavy duty oil-resisting and flame-retardant sheath.

Compliance shall be checked by carrying out the appropriate tests given in table 8.

9.2 Construction

9.2.1 General. The protective sheath shall consist of a single layer or of two layers, as given in tables 1 to 6, as appropriate, complying with 9.2.2 or 9.2.3.

9.2.2 Single layer. The sheath shall be applied in a single layer:

- (a) to the core, in single-core cables;
- (b) to the assembly of cores and any filler, in multicore cables.

The sheath shall be capable of being removed without damage to the cores. Where taped cores are employed, some transfer of proofing from the tape to the sheath shall be permissible.

NOTE. A tape or film may be applied under the sheath.

Where given in tables 1 to 6, the sheath shall penetrate into the space between the cores, thus forming a filler.

9.2.3 Two layers. The two layers shall be as follows.

(a) *Inner layer.* The inner sheath shall be applied as specified in 9.2.2.

NOTE. A proofed tape or equivalent separator may be applied over the inner layer.

If the tape or separator, if any, adheres to the inner sheath, it shall be permitted for its thickness for values not exceeding 0.5 mm to be included in the measurement of thickness of the inner sheath.

(b) *Outer layer.* The outer sheath shall be applied over the inner sheath or over the tape or separator, if any.

NOTE. The outer sheath may or may not be bonded to the inner layer or to the tape or separator.

If the outer layer is bonded to the inner layer, it shall be visibly distinguishable from the inner layer; if it is not bonded, it shall be easily separable from the inner layer.

9.3 Thickness. The mean value of the sheath thickness shall be not less than the value given for each type and cross section of cable in tables 2, 3, 4 and 5, as appropriate. However, it shall be permissible for the thickness at any place to be less than the value specified, provided that the difference does not exceed 0.1 mm +15 % of the value specified.

Compliance shall be checked by the measurements described in 2.1.2 of BS 6469 : 1984.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

The mean of all the values obtained on the three pieces of sheath shall be calculated to two decimal places and rounded off as detailed in 5.3 to obtain the mean value of sheath thickness.

The smallest of all the values obtained shall be taken as the minimum thickness of sheath at any place.

9.4 Colour. The colour of the sheath is specified only for the cable whose properties are given in table 5 and shall be as given in table 5.

10. Marking

10.1 Indication of origin. All cables shall be provided with an indication of origin consisting either of an identification thread or threads or the continuous marking of the manufacturer's name or trademark.

*Previously known as 'Heavy duty HOFR' in BS 6899.

If coloured threads are used, the colours shall comply with those registered in PD 2379, where applicable. The colours shall be easy to recognize or shall become recognizable by cleaning with petrol or other suitable solvent, if necessary.

The marking of the manufacturer's name or trademark, if used, shall be by one of the three following alternative methods:

- (a) printed tape within the cable;
- (b) printing, indenting or embossing on the insulation of at least one core, the core coloured blue, if any;
- (c) printing, indenting or embossing on the sheath, if any.

The marking shall be legible and regarded as continuous if the gap between the end of one complete inscription and the beginning of the next does not exceed:

- (1) 500 mm if the marking is on the sheath;
- (2) 200 mm in all other cases.

10.2 CENELEC 'Common Marking'. It shall be permitted for a cable for which a Harmonized Code Designation is given in tables 1 to 6 to carry an indication that it has been manufactured under a licence issued by one of the Approvals organizations subscribing to the CENELEC Agreement on the use of a commonly agreed marking for cables and cords. If it does carry such an indication, this shall be one of the following.

(a) The mark of the Approvals Organization, followed by the Common Marking <HAR> applied by one of the three alternative methods specified in 10.1.

(b) An identification thread extending throughout the length of the cable indicating the Approvals Organization. The base colour shall be yellow and this shall be serially dyed or printed red and black. The lengths of the coloured section shall comply with dimensions laid down by CENELEC for that Approvals Organization (see PD 2379).

Neither of these indications shall be used for a cable shown in tables 1 to 6 as a national type.

The name CENELEC, in full or abbreviated, shall not be directly marked on, or in, the cable.

10.3 Heat-resisting cables. Cables having type GP1 rubber insulation shall be identified throughout their length by the legend 'HEAT RESISTING 85', either printed on a tape within the cable or printed on the core, or printed, indented or embossed on the external surface of the cable. The gap between the end of one legend and the beginning of the next shall be not greater than 300 mm.

10.4 Outer marking. Type EM2 sheathed cables, whose properties are given in table 4, shall be distinguished from other rubber-sheathed cables having the same cross-sectional area and number of cores by means of the marking RN printed or embossed on or indented into the sheath.

The marking shall be continuous as specified in 10.1.

10.5 Durability. Any marking by printing shall be durable. Compliance shall be checked by tightly rubbing the marking 10 times with a piece of cotton wool or cloth soaked in water.



11. Construction and overall dimensions

11.1 Construction. The construction of the cables shall be as given in tables 1 to 6, as appropriate.

Compliance shall be checked by examination and measurement.

11.2 Mean overall dimensions. The mean overall dimensions of the cables shall be within the limits given in tables 1 to 6, as appropriate.

Compliance shall be checked by the measurements described in 2.1.3 of BS 6469 : 1984.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

For flat cable the mean of the three determinations of each of the major and minor axes shall be taken as the mean overall dimensions.

For other cable, the mean of the six values obtained shall be taken as the mean overall diameter.

11.3 Ovality. The difference between any two values of the overall diameter of circular sheathed cables at the same cross section (ovality) shall not exceed 15 % of the upper limit given in tables 1 to 6, as appropriate, for the mean overall diameter.

Compliance shall be checked by the measurements described in 2.1.3 of BS 6469 : 1984.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

Two measurements shall be taken at the same cross section of the cable covering the maximum and minimum values.

12. Electrical requirements

12.1 Conductor resistance. When the d.c. resistance of each conductor is measured on a sample of cable at least 1 m in length it shall comply with BS 6360.

12.2 Voltage test on complete cable. When the cable is tested as described in E.1 and E.2 no breakdown of insulation shall occur.

12.3 Voltage test on core. When the core is tested as described in E.1 and E.3 no breakdown of insulation shall occur.

12.4 Test to check the absence of faults in insulation.

When cable is tested as described in E.1 and E.4 no failure of insulation shall occur.

12.5 Surface resistance of sheath. When cable is tested as described in E.1 and E.5 the surface resistance of the sheath shall be not less than $1 \times 10^9 \Omega$.

13. Test under fire conditions

The cables whose properties are given in tables 4 and 5 shall comply with BS 4066 : Part 1. The test shall be carried out on a sample of the complete cable.

14. Flexing test

When the 4 mm² flexible cables whose properties are given in tables 3, 4 and 5 are subjected to the flexing test described in BS 6500, except that the load on the cable shall be 2.0 kg, the pulley diameter 200 mm and the current loading 32 A, they shall comply with BS 6500.

Flexible cables having conductors with a nominal cross section exceeding 4 mm² shall not be subjected to the flexing test.

Table 1. Rubber-insulated, textile-braided and compound cable, 450/750 V single core

National type

Construction

Tinned annealed copper conductor. Class 1 solid conductor and class 2 stranded conductor, as shown in the table.

Optional tape separator.

Rubber insulation type GP1.

Optional proofed tape.

Textile braid.

Preservative compound.

Colours for core identification. Black, red or other colours (see clause 6).

Nominal cross-sectional area of conductor	Class of conductor	Radial thickness of insulation	Mean overall diameter (upper limit)
mm ²		mm	mm
1	1	0.8	4.3
1.5	1 or 2	0.8	4.6
2.5	1 or 2	0.8	5.0
4	2	1.0	6.4
6	2	1.0	7.0
10	2	1.2	8.6
16	2	1.2	9.6
25	2	1.4	11.5
35	2	1.4	13.0
50	2	1.6	14.5
70	2	1.6	16.5
95	2	1.8	19.0

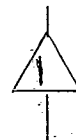


Table 2. Rubber-insulated and sheathed cable, 300/500 V flat twin

National type

Construction

Tinned annealed copper conductor. Class 2 stranded conductor.

Rubber insulation type EI1.

Two cores laid parallel and sheathed with type EM2.

Colours for core identification. Black and red.

Colour of sheath. Not specified.

Nominal cross-sectional area of conductor	Radial thickness of insulation	Radial thickness of sheath	Mean overall dimensions	
			Lower limit	Upper limit
mm ²	mm	mm	mm	mm
2.5	0.8	1.1	5.4 × 8.8	6.8 × 11.0

Table 3. Rubber-insulated and sheathed flexible cable, 300/500 V 3-core and 4-core

NOTE. Sheathed flexible cords having conductor sizes smaller than 4 mm² are covered by BS 6500.

Harmonized code designation. HO5RR-F.

Construction

Plain or tinned annealed copper conductor. Class 5 flexible conductor.

Separator required for plain conductor, optional for tinned.

Rubber insulation type EI1.

Optional proofed tape.

The cores twisted together with optional fillers to form a practically circular assembly, a centre filler may be used.

Rubber sheath type EM1.

The sheath shall be extruded in a single layer and applied in such a way that it fills the spaces between the cores.

Colours for core identification

3-core: green/yellow, blue and brown.

4-core: green/yellow, black, blue and brown.

Colour of sheath. Not specified.

Number and nominal cross-sectional area of conductors	Radial thickness of insulation	Radial thickness of sheath	Mean overall diameter	
			Lower limit	Upper limit
mm ²	mm	mm	mm	mm
3 × 4	1.0	1.2	11.5	14.5
3 × 6	1.0	1.4	13.5	18.5
4 × 4	1.0	1.3	13.0	16.5
4 × 6	1.0	1.5	15.0	20.5

Table 4. Rubber-insulated and sheathed flexible cable, 450/750 V single core, circular twin, 3-core, 4-core and 5-core

NOTE. Sheathed flexible cords having conductor sizes smaller than 4 mm² are covered by BS 6500.

Harmonized code designation. HO7RN-F.

Construction

Plain or tinned annealed copper conductor. Class 5 flexible conductor.

Separator required for plain conductor, optional for tinned.

Rubber insulation type EI1.

A proofed textile tape may be applied on each core.

Unless applied by extrusion, the insulation of conductors having a nominal cross section in excess of 4 mm² shall be covered with a proofed textile tape, helically wound with an overlap of at least 1 mm.

If the insulation is extruded, the proofed tape is optional.

The cores twisted together without fillers to form a practically circular assembly, a centre filler may be used.

In the case of cores having conductors of large cross section a textile tape may be applied around the core assembly before application of the sheath, provided that the finished cables shall not have any substantial cavity in outer interstices between the cores.

Rubber sheath, as follows.

(a) Single-core cable: a single layer type EM2.

(b) Multicore cables:

(i) sizes up to 10 mm²: a single layer type EM2;

(ii) sizes above 10 mm², either a single layer type EM2 or two layers, with the inner layer type EM1 and the outer layer type EM2.

The sheath in a single layer or the inner layer of the sheath in two layers shall fill the outer interstices between the cores and be capable of being removed without damage to the cores. Where taped cores are employed, some transfer of proofing from the tapes to the sheath is permissible.

Colours for core identification

Single core: black.

Twin: blue and brown.

3-core: green/yellow, blue and brown.

4-core: green/yellow, black, blue and brown.

5-core: green/yellow, black, blue, brown and black.

Colour of sheath. Not specified.

Table 4. (continued)

Nominal cross-sectional area of conductor	Radial thickness of insulation	Radial thickness of sheath												
		Single core. Single layer	2-core. Single layer	Two layers		3-core. Single layer	Two layers		4-core. Single layer	Two layers		5-core. Single layer	Two layers	
				Inner	Outer		Inner	Outer		Inner	Outer		Inner	Outer
mm ²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
4	1.0	1.5	1.8	—	—	1.9	—	—	2.0	—	—	2.2	—	—
6	1.0	1.6	2.0	—	—	2.1	—	—	2.3	—	—	2.5	—	—
10	1.2	1.8	3.1	—	—	3.3	—	—	3.4	—	—	3.6	—	—
16	1.2	1.9	3.3	1.3	2.0	3.5	1.4	2.1	3.6	1.4	2.2	3.9	1.5	2.4
25	1.4	2.0	3.6	1.4	2.2	3.8	1.5	2.3	4.1	1.6	2.5	4.4	1.7	2.7
35	1.4	2.2	—	—	—	4.1	1.6	2.5	4.4	1.7	2.7	—	—	—
50	1.6	2.4	—	—	—	4.5	1.8	2.7	4.8	1.9	2.9	—	—	—
70	1.6	2.6	—	—	—	4.8	1.9	2.9	5.2	2.0	3.2	—	—	—
95	1.8	2.8	—	—	—	5.3	2.1	3.2	5.9	2.3	3.6	—	—	—
120	1.8	3.0	—	—	—	5.6	2.2	3.4	6.0	2.4	3.6	—	—	—
150	2.0	3.2	—	—	—	6.0	2.4	3.6	6.5	2.6	3.9	—	—	—
185	2.2	3.4	—	—	—	6.4	2.5	3.9	7.0	2.8	4.2	—	—	—
240	2.4	3.5	—	—	—	7.1	2.8	4.3	7.7	3.1	4.6	—	—	—
300	2.6	3.6	—	—	—	7.7	3.1	4.6	8.4	3.3	5.1	—	—	—
400	2.8	3.8	—	—	—	—	—	—	—	—	—	—	—	—
500	3.0	4.0	—	—	—	—	—	—	—	—	—	—	—	—
630	3.0	4.1	—	—	—	—	—	—	—	—	—	—	—	—

*National type.



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