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GOVERNMENT OF INDIA MINISTRY OF RAILWAYS



TECHNICAL SPECIFICATION FOR CURRENT CARRYING FLEXIBLE DROPPER ("A" Dropper) FOR 25kV AC ELECTRIC TRACTION

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SPECIFICATION FOR CURRENT CARRYING
FLEXIBLE DROPPER ("A" Dropper)
SPECIFICATION NO.TI/SPC/OHE/CCFD/0160(02/2020)

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SPECIFICATION FOR CURRENT CARRYING FLEXIBLE DROPPER ("A" Dropper) FOR OVERHEAD LINES OF 25 KV AC ELECTRIC TRACTION SYSTEM.

1 SCOPE

In existing system of OHE, the dropper Wires of 5/7 mm diameter are used to hold the Contact Wire from Catenary Wire and are not the current carriers. During the passage of pantographs of 'High Speed' Trains, the dropper (either side of Bracket Assembly) gets compressed and quickly goes back to the original position, acting like whip.

For increasing the speed potential of existing OHE, Railway Board vide letter no. 2001/Elect(G)/170/1 dated 19.10.2016 has issued guideline that 'A' droppers shall be 'Current carrying Flexible Dropper'.

Keeping the requirement of stability of Contact Wire & carrying of current during passing of Pantographs of high speed Trains, this Specification has been prepared.

This Specification covers the requirement of Current Carrying Flexible Dropper("A" Dropper) for Overhead lines (OHE) of 25 kV AC Electric Traction System. Herein after, throughout the Specification, it will be referred as Flexible Dropper Wire. Nomenclature for 0.5 mm wire is "Wire", 7*0.5mm conductor is "Concentric Stranded Member" and 19*7*0.5 conductor is "Flexible Dropper Wire". Presently, in India, current carrying flexible dropper is being used in Metros and DFFCIL.

This Specification of Current Carrying Flexible Dropper has been drafted for development purpose and keeping the requirement of Indian Railways in view. The properties have been taken from the International & National Standards for development of it; final Specification shall be frozen on the basis of results of validation of prototype.

The "Make in India" Policy of Government of India shall be applicable.

2 GOVERNING SPECIFICATIONS

2.1 In the preparation of this specification assistance has been taken from the following standards and specifications.

Clause No.	Standard	Title
2.1.1	IS : 191-2007 or latest	Specification for Copper
2.1.2	IS: 14214:1994 or latest	Annealed Stranded Copper Conductor for jumper wires-specification
2.1.3	DIN 43138 or latest	Flexible cables for overhead equipment and return current.
2.1.4	DIN 48200 Part 2	Bronze wires for stranded conductors

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	or latest	
2.1.5	DIN 48203 Part 2 or latest	Wrought copper alloy (Bz) wires and conductors; technical delivery conditions

2.2 In case of any conflict or disparity between the contents of the above specifications and this specification, the latter shall prevail.

2.3 Any deviation from this specification proposed by the manufacturer to improve upon the performance of Flexible Dropper Wire shall be considered only on its merits provided full particulars with justification and financial implication are furnished by the manufacturer.

3 ENVIRONMENTAL CONDITIONS

The Flexible Dropper shall be suitable for outdoor use in moist tropical climate and in areas subject to heavy rainfall, polluted due to industry and marine atmosphere and severe lightning. The limiting weather conditions which the Dropper has to withstand in service are indicated in TABLE - 1.

TABLE - 1
ENVIRONMENTAL CONDITIONS

SN	Environmental Condition	Limits
i.	Ambient air Temperature.	0 ^o C to +50 ^o C
ii.	Maximum temperature of metallic object under sun.	70 ^o C
iii.	Minimum temperature.	-10 ^o C
iv.	Maximum relative humidity	100%
v.	Annual rainfall	Dry Arid regions and also heavy monsoon affected regions with rainfall ranging from 1750mm to 6250mm.
vi.	Maximum number of thunder storm days per annum.	85
vii.	Maximum number of dust storm days per annum.	35
viii.	Number of rainy days per annum	120
ix.	Basic wind pressure	216 kgf/m ²
x.	Altitude	Altitude: 1000m above mean sea level. Altitude: 2000m in Hill area.

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4 CONDUCTOR

4.1 Material:

Flexible Dropper wire having enhanced vibration property shall be made rope lay construction. The flexible dropper shall be made of bronze BzII (CuMg). The diameter of Flexible Dropper Wire shall be 7.5 mm. Copper used for fabrication of Bz II Flexible Dropper Wire should be **Electrolytic grade 'A' Copper cathodes conforming to ~~LME Grade 'A' copper as listed in the London Metal Exchange~~ chemical composition of Cu-Cath 1 of IS 191-2007 or latest/its equivalent.** The chemical composition of the Flexible Dropper wire shall be as given in table 2.

TABLE - 2
CHEMICAL COMPOSITION

Element	%ppm
Cu	Remaining %
Mg	0.3-0.5 %
Other impurities	0.1 % (max)
Oxygen	20 ppm (max)

* copper percentage is defined as remaining. Means 100% minus magnesium percentage minus 0.1% impurities minus 20 ppm oxygen content.

4.2 PHYSICAL CONSTANTS OF FLEXIBLE DROPPER WIRE

4.2.1 Volume Resistivity:

The maximum resistivity at 20°C is taken as 0.02778 ohm mm²/m. The values of the resistance per unit length at 20°C are calculated from the following formula:

$$R/L = \rho / A$$

where

R is the resistance at 20 °C, in Ω;
 ρ is the resistivity of the metal at 20 °C, in Ωm;
 A is the cross section of the wire, in m²;
 L equal to 1000 m.

4.2.2 Density:

At a temperature of 20°C the density shall be taken as 8.9 g/cm³.

4.2.3 Coefficient of Linear Expansion:

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At a temperature of 20°C the coefficient of linear expansion shall be taken as 0.000017 per Centigrade degree. This coefficient may be used over a temperature range of 0°C to 150°C.

4.2.4 Constant Mass Temperature Coefficient of Resistance:

At a temperature of 20°C the coefficient of variation of the resistance with temperature has been taken as 0.0027 per centigrade degree.

4.2.5 FREEDOM FROM DEFECTS:

The Flexible Dropper Wires shall be clean, smooth and free from harmful defects, such as scales, peeling, sharp edge and other defects.

5 STANDARD SIZES, DIMENSIONS, RESISTANCE, WEIGHTS AND OTHER PROPERTIES OF FLEXIBLE DROPPER WIRE

5.1 The Various Sizes, Dimensions, Resistance, Weight and other properties of Flexible Dropper Wire shall be in accordance with the value given in Table-3,4 & 5.

TABLE-3
PROPERTIES OF WIRE (0.5 mm)

Diameter			Standard weight per m	Resistance at 20°C per m		Minimum Breaking Load On standard diameter	Minimum Tensile Strength	Minimum Elongation on 200 mm	Calculated area on standard diameter
Stn.	Max.	Min.		Stn.	Max.				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(11)
mm	mm	mm	gm	Ohm	Ohm	KN	Kgf/mm ²	%	mm ²
0.5	0.53	0.47	1.744	0.141	0.143	122	618	*	0.196
*Shall be incorporated on validation of prototype tests results									

Note 1- The standard weight given in column 4 is based on standard diameter and for information only.

5.2 CONCENTRIC STRANDED MEMBER (7 x 0.5mm)

TABLE-4

Diameter	Calculated area on standard diameter	Standard weight per meter	Resistance at 20°C per Km	Minimum Breaking Load	Minimum Tensile Strength
Stn.			Stn.	On standard diameter	
(1)	(2)	(3)	(4)	(7)	(9)
mm	mm ²	gm	Ohm	KN	KN/mm ²
1.5	1.374	12.37	20.40	116	589
*Shall be incorporated on validation of type test results					

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5.3 FLEXIBLE DROPPER WIRE [19x7X0.5 mm]

TABLE-5

Nominal Cross section (mm ²)	Calculated Cross section (mm ²)	Number of Wires	Diameter (mm)		Resistance ohm/km		Weight (Kg/Km)	Tensile Strength Of wires after stranding (N/mm ²) (Minimum)
			Wire	Conductor	Stn.	Max.		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
25	26.1	133	0.50	7.5	1.124	1.145	246	589

6 Lay

Ordinary-lay stranding, outer layer regular twist.

Length of Lay :

Concentric Stranded Member:11 to 14 times its diameter.

Flexible dropper wire : Outer layer 8 to 11 times its diameter. The lay length of the other layers shall be at the option of the manufacturer unless specifically agreed upon.

Flexible dropper wire shall be stranded with minimum stress.

7 JOINTS IN THE FLEXIBLE DROPPER WIRE :

The wire shall be drawn in continuous lengths, without joints except those made in the rod.

Normally joints in concentric stranded member during stranding are not permitted. However, Any welding or soldering on wires shall be carried out with the greatest of care. These joints shall be annealed after the welding or soldering process over a distance of at least 200 mm on each side of the joint. Distance between two joints in concentric stranded member shall not be less than 15m. Not more than two joints in one kilometre length is permitted.

No joint are allowed during twisting in flexible dropper wire.

8 TESTS

8.1 The internal test results for all the tests specified in clauses-9 shall be furnished by the manufacturer to the Purchaser/Director General (TI)/RDSO prior to take up the prototype testing.

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- 8.2 Any changes required to be done in the prototype as required by the Purchaser/Director General (TI)/RDSO shall be carried out expeditiously by the manufacturer.
- 8.3 TYPE-TESTING SCHEDULE: Prior to giving a call to the Purchaser/Director General (Traction Installation)/ RDSO for inspection and testing of the prototype, the successful manufacturer shall submit a detailed test schedule consisting of schematic circuit diagrams/layout for each of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the test shall invariably be done accordingly. However during the process of type testing or even later, the purchaser reserves the right to conduct any additional test(s) besides those specified herein, on Flexible Dropper Wire so as to test Flexible Dropper Wire to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement arises between the manufacturer and representative of the Director General (TI)/RDSO during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type test, it shall be brought to the notice of the Director General (TI)/RDSO, whose decision shall be final and binding.
- 8.4 All the tests specified, unless otherwise mentioned elsewhere, in the specification shall be carried out at the manufacturer works. The manufacturer shall arrange all the necessary machinery, apparatus, labour and assistance required for conducting the tests without any extra cost.
- 8.5 In the event of the tests not being carried through to completion at one stretch for any reasons attributable to the manufacturer and it is required for the representative of the Purchaser/Director General (TI)/RDSO to go again or more number of times to the works of the manufacturer or other place(s) for continuing and/or completing the tests on the prototype(s) of the Flexible Dropper, the manufacturer shall reimburse to the Director General (TI)/RDSO the cost for the representative's visits to works or other place(s) for the tests more than once. The costs as claimed by the Purchaser/Director General (Traction Installation), Research Designs & Standards Organisation, Lucknow shall be paid through a demand draft as advised to the manufacturer.
- 8.6 BULK MANUFACTURING: Only after clear written approval of the results of the tests on the prototype is communicated by the Purchaser/Director General (TI)/RDSO to the manufacturer, manufacturer shall take up bulk manufacture of the Flexible Dropper Wire which shall be strictly with the same material and process as adopted for the prototype.

9 TESTS ON FLEXIBLEDROPPER WIRE

9.1 TYPE TESTS:

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Three wires before stranding and nine wires (3 wires from each layer and 3 from core) from flexible dropper wire shall be taken at random for each type test except Chemical composition test. Three wires before stranding and three wires from flexible dropper wire shall be taken for Chemical composition test **by Spectrometer. One sample of wire shall be subjected to Electrolysis Test (IS: 440-1964 or latest) for determination of copper content.**

9.1.1 Test on Wire(0.5 mm):

- i) Visual Examination.
- ii) Measurement of Dimensions.
- iii) Measurement of Weight.
- iv) Chemical Composition.
- v) Tensile Strength.
- vi) Elongation.
- vii) Electrical Resistance.

9.1.2 Test on Flexible dropper wire:

- i) Visual Examination.
- ii) Measurement of Dimensions.
- iii) Measurement of Weight.
- iv) Electrical Resistance.
- v) Lay length

9.2 ACCEPTANCE TESTS:

Same as Type Tests, in addition, weighment of 3 or 1/5th of offered Flexible Dropper Wire coils for acceptance tests, whichever is higher, for gross weight. Samples of flexible dropper wire for acceptance tests shall be cut from each coil. The tests specified in Clause no. 9.1.2 shall be conducted on flexible dropper wire. Then nine wires(3 wire from each layer and 3 wires from core) from flexible dropper wires shall be taken at random and subjected to the test specified in Clause 9.1.1 except chemical composition test. One wire from each coil shall be taken for Chemical composition test **by Spectrometer. Chemical composition shall be as per Table 2. After chemical composition analysis by Spectrometer, one sample(one wire) per 10 coils or minimum one sample for less than 10 coils, shall be subjected to Electrolysis Test (IS: 440-1964 or latest) for determination of copper content.** The Inspector shall verify the results of manufacturer's tests.

The samples of wire and flexible dropper wire taken from each coil shall be subjected to all the tests prescribe in clause 9.1. The wire and flexible dropper wire in the coil shall be deemed to have passed the tests if the samples pass all the tests. If a sample fails in more than one test, the coil shall be rejected. Should the sample fail in any one of the tests, two more sample shall be taken from the coil and subjected to all the tests. Should any sample fail in any test, the coil shall be rejected.

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9.3 MANUFACTURER TESTS

Sampling shall be as per Acceptance Test.

- i) Visual Examination.
- ii) Measurement of Dimensions.
- iii) Measurement of Weight.
- iv) Chemical Composition.
- v) Tensile Strength.
- vi) Elongation.
- vii) Electrical Resistance.

10 TEST METHODS

10.1 VISUAL EXAMINATION

When examined visually, the wires and flexible dropper wire shall be smooth, free from harmful defects such as abrasions, peelings, rough surface and bird caging. The Flexible Dropper Wire shall have no twists or kinks.

10.2 VERIFICATION OF DIMENSIONS

The diameter of the Wire/Flexible dropper wire shall be measured by means of a ratchet micrometer or a digital micrometer/ vernier caliper . The value of the diameter shall be the mean of two readings made in two directions perpendicular to each other and situated approximately at the same cross section.

10.3 MEASUREMENT OF WEIGHT

The weight of the Flexible Dropper Wire per km shall be calculated by weighing a piece of 50 Cm length by a digital balance. The weight of the Wire per km shall be calculated by weighing a piece of 1 m length by Precision digital electronic weighing balance.

10.4 CHEMICAL ANALYSIS

The Samples of wire taken from the Flexible Dropper Wire coil shall be tested for Chemical Composition. The material shall have the Chemical Composition as given in table-2. The magnesium content and trace Elements shall be determined by Spectrometric method. Determination of Copper content shall be performed by 'Electrolysis Method'(IS:440-1964 or latest).

10.5 TENSILE TEST

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The sample of Wire which is straight and of length such that when it is held in the jaws of the Tensile Testing Machine the distance between the jaws is not less than 250mm shall be taken. A gauge length of 200mm shall be marked on the test piece for the purpose of measuring the elongation. The load shall be applied gradually until the test piece breaks. The tensile strength of the Flexible Dropper Wire shall be not less than values specified in TABLE-3.

10.6 ELONGATION TEST

The elongation shall be measured on the same test piece which was subjected to tensile test up to its fracture as specified in Clause- 10.5. The elongation of the sample after tensile test shall be measured with reference to the gauge length after the fractured ends have been fitted together provided fracture occurs within the gauge length. The values of percent elongation measured shall be not less than the values specified in TABLE-3. If the fracture occurs outside the gauge length and the required elongation is not achieved, another sample shall be tested. If this sample also fails, the lot shall be rejected.

10.7 MEASUREMENT OF LAY LENGTH

The lay lengths measured should be as per clause 6.

10.8 ELECTRICAL RESISTANCE TEST

The electrical resistance of three samples shall be measured by means of a double Kelvin Bridge or Micro Ohm Meter. The current terminals shall be sufficiently away from the voltage terminals. The electrical resistance of test sample multiplied by $W \times C/K$ shall not exceed the appropriate values indicated in TABLE-3 for single wire & Table-5 for Flexible Dropper Wire.

Where

W = weight per km of test sample in kg

K = standard weight of Dropper Wire per km in kg

C = multiplying constant for temperature variation indicated in TABLE-6.

Note : The Inspector shall check the accuracy and calibration of the measuring equipment by resistance of known value.

11 PACKING AND MARKING

11.1 PACKING OF FLEXIBLE DROPPER WIRE

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The material shall be supplied in Coils strapped with loops or as required by the Purchaser.

11.2 PACKING AND MARKING OF DROPPER WIRE

11.2.1 The Flexible Dropper Wire shall be supplied properly wound in Coils, in specified weight as required by the purchaser, the turns of the wire being close and continuous without any over-riding except on the first and last turns of each layer. A Coil shall carry only one continuous length of Dropper Wire. The plastic sheet covering over the last layer of the Flexible Dropper Wire shall be provided to avoid any damage to Flexible Dropper Wire. Loss/damage due to entanglement of Wire, if any shall be on supplier's account.

11.2.2 The Weight of the Flexible Dropper Wire for each coil shall be specified by the purchaser. The specified weight shall not be more than 150 kg.

11.2.3 The weight of the Flexible Dropper Wire in a coil, after the test pieces required for the various tests have been cut and taken out shall be not less than values specified by the purchaser.

11.2.4 Suitable tag for identification having details mentioned below shall be provided on each coil:

- i) Purchaser's order number.
- ii) Size of Flexible Dropper Wire.
- iii) Gross and net weights.
- iv) Coil Number/ Drum number
- v) Name of Manufacturer
- vi) Consignee and other particulars as required by the purchaser.

11.3 DISPOSAL OF REJECTED FLEXIBLE DROPPER WIRE

Flexible Dropper Wire which is rejected shall be cut into small pieces of length. This shall be done in the presence of the Inspector.

12 MULTIPLIER CONSTANT FOR FLEXIBLE DROPPER WIRE

Multiplying constant and its reciprocal for converting resistance of Flexible Dropper Wire various temperatures to that at standard temperature of 20° C and to that and for converting resistance at 20°C to that at any other temperature respectively:

TABLE – 6

Temperature °C	Multiplier Constant	Reciprocal of constant
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(1)	(2)	(3)
5.0	1.0422	0.9595
5.5	1.0407	0.9608
Temperature °C	Multiplier Constant	Reciprocal of constant
6.0	1.0392	0.9622
6.5	1.0378	0.9635
7.0	1.0363	0.9649
7.5	1.0349	0.9662
8.0	1.0334	0.9676
8.5	1.0320	0.9689
9.0	1.0306	0.9703
9.5	1.0291	0.9716
10.0	1.0277	0.9730
10.5	1.0263	0.9743
11.0	1.0249	0.9757
11.5	1.0234	0.9770
12.0	1.0220	0.9784
12.5	1.0206	0.9797
13.0	1.0192	0.9811
13.5	1.0178	0.9824
14.0	1.0164	0.9838
14.5	1.0150	0.9851
15.0	1.0136	0.9865
15.5	1.0123	0.9878
16.0	1.0109	0.9892
16.5	1.0095	0.9905
17.0	1.008	0.9919
17.5	1.0068	0.9932
18.0	1.0054	0.9946
18.5	1.0040	0.9959
19.0	1.0027	0.9973
19.5	1.0013	0.9986
20.0	1	1
20.5	0.9986	1.00135
21.0	0.9973	1.0027
21.5	0.9959	1.0040
22.0	0.9946	1.0054
22.5	0.9932	1.0067
23.0	0.9919	1.0081
23.5	0.9906	1.0094
24.0	0.98931	1.0108
24.5	0.9879	1.0121
25.0	0.9866	1.0135

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25.5	0.9853	1.0148
26.0	0.9840	1.0162
26.5	0.9827	1.0175
27.0	0.9814	1.0189
27.5	0.9801	1.0202
28.0	0.9788	1.0216
28.5	0.9775	1.0229
29.0	0.9762	1.0243
29.5	0.9749	1.0256
30.0	0.9737	1.0270

NOTE - 1: If the resistance of Flexible Dropper Wire at T°C is measured, the resistance at 20°C is obtained by multiplying the resistance at T°C by the multiplying constant against the value of T°C given in column 2. If the resistance at 20°C is known, the resistance at T°C is obtained by multiplying the resistance at 20°C by reciprocal indicated against T°C given in column 3.

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