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Enamelled winding wires

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Descriptors : enamelled wires, electric wires

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law:

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Enamelled winding wires

1 Scope This Japanese Industrial Standard specifies enamelled winding wires which are used for windings and wirings of electrical equipments, hereafter referred to as "wires". Requirements other than those covered by this Standard shall be as given in JIS C 3053.

Remarks 1 The normative references to this Standard are as follows.

JIS C 2351 *Varnishes for enameled wires*

JIS C 3003 *Methods of test for enamelled copper and enamelled aluminium wires*

JIS C 3053 *General rules for winding wires*

JIS C 3102 *Annealed copper wires for electrical purposes*

JIS C 3103 *Annealed copper wires for winding wires*

JIS C 3104 *Rectangular copper wires for electrical purposes*

JIS H 2110 *Virgin aluminium ingots for electrical purposes*

2 The International Standards corresponding to this Standard are as follows.

IEC 317-0 *Specifications for particular types of winding wires
Part 0 : General requirements*

IEC 317-1 *Specifications for particular types of winding wires
Part 1 : Polyvinyl acetal enamelled round copper wire, class 105*

IEC 317-2 *Specifications for particular types of winding wires
Part 2 : Solderable polyurethane enamelled round copper wire, class 130, with a bonding layer*

IEC 317-3 *Specifications for particular types of winding wires
Part 3 : Polyester enamelled round copper wire, class 155*

IEC 317-4 *Specifications for particular types of winding wires
Part 4 : Solderable polyurethane enamelled round copper wire, class 130*

IEC 317-8 *Specifications for particular types of winding wires
Part 8 : Polyesterimide enamelled round copper wire, class 180*

IEC 317-14 *Specifications for particular types of winding wires
Part 14 : Polyvinyl acetal enamelled round aluminium wire, class 105*

IEC 317-17 *Specifications for particular types of winding wires
Part 17 : Polyvinyl acetal enamelled rectangular copper wire, class 105*

3 The units and numerical values shown in { } in this Standard are based on the traditional units, and are appended for reference.

2 Classification and symbols Wires are classified and symbolized according to the conductor and the kind and thickness of coated film as shown in Table 1.

Table 1 Classification and symbols

Classification	Symbol	Shape of sectional area of conductor		Annex No.
		Round	Rectangular	
Oleo-resinous enamelled round copper winding wires of class 1 Oleo-resinous enamelled round copper winding wires of class 2	1EW 2EW	○	—	1
Polyvinyl formal enamelled round copper winding wires of class 0 Polyvinyl formal enamelled round copper winding wires of class 1 Polyvinyl formal enamelled round copper winding wires of class 2	0PVF 1PVF 2PVF	○	—	2
Polyvinyl formal enamelled round aluminium winding wires of class 0 Polyvinyl formal enamelled round aluminium winding wires of class 1	Al-0PVF Al-1PVF	○	—	3
Polyvinyl formal enamelled rectangular copper winding wires	PVF	—	○	4
Polyester enamelled round copper winding wires of class 0 Polyester enamelled round copper winding wires of class 1 Polyester enamelled round copper winding wires of class 2	0PEW 1PEW 2PEW	○	—	5
Polyurethane enamelled round copper winding wires of class 1 Polyurethane enamelled round copper winding wires of class 2 Polyurethane enamelled round copper winding wires of class 3	1UEW 2UEW 3UEW	○	—	6
Self-bonding polyurethane enamelled round copper winding wires of class 0 Self-bonding polyurethane enamelled round copper winding wires of class 1 Self-bonding polyurethane enamelled round copper winding wires of class 2	0SBUEW 1SBUEW 2SBUEW	○	—	7
Polyesterimide enamelled round copper winding wires of class 0 Polyesterimide enamelled round copper winding wires of class 1 Polyesterimide enamelled round copper winding wires of class 2	0EIW 1EIW 2EIW	○	—	8

3 Temperature index, insulation covering and characteristics The temperature index, insulation covering and characteristics shall be as given in Annexes 1 to 8.

4 Conductor

4.1 Copper wire The copper wire shall be the annealed copper wire specified in JIS C 3102 or its equivalent for class 0 or class 1 wires, and be the annealed copper wire specified in JIS C 3103 for class 2 or class 3 wires.

4.2 Rectangular copper wire The rectangular copper wire shall be the number 3 or 4 wire specified in JIS C 3104.

4.3 Aluminium wire The aluminium wire shall be the annealed aluminium wire finished by drawing the aluminium ingot specified in JIS H 2110.

5 Test methods The test methods shall be as given in the appropriate one of Annexes 1 to 8 and JIS C 3003.

6 Inspection The inspection is divided into the type inspection and the delivery inspection, and shall be carried out, using the test methods referred to 5 above, on the items specified in Annexes 1 to 8. The inspection results shall conform to the requirements of 3 and 4 above. However, part of the delivery inspection may be omitted by the agreement between the parties concerned with the acceptance.

7 Packaging and net mass of one coil

7.1 Packaging The wire shall be wound on a reel of suitable size for the conductor diameter or its dimensions without loosening and tangle, or in a container of suitable size without causing tangle, and shall be adequately packaged to avoid scratch or tangle during the transportation.

7.2 Net mass of one coil The net mass of one coil shall be as given in Table 2 and Table 3. However, if agreed between the parties concerned with the acceptance, such a case is excepted.

The tolerances on net mass of one coil (including the mass specified in the agreement between the parties concerned with the acceptance other than the mass given in Table 2 and Table 3) shall be $\pm 30\%$.

7.3 Coiling in sections If wires are wound on a reel or in a container, the reel or container shall contain not more than two lengths of wire, and the mass of one length shall be not less than 20 % of the said net mass of one coil (the mass specified in Tables 2 and 3 or the mass based on the agreement between the parties concerned with acceptance).

In this case a slip of white paper shall be inserted between the layers to indicate the position where two lengths of wire are facing each other.

Table 2 Round wires

Conductor diameter mm	Net mass of one coil kg	
	Copper wires	Aluminium wires
0.02 to 0.025	0.1	—
0.03	0.3	
0.04 to 0.07	1	
0.08 to 0.16	4	
0.17 to 0.29	10	
0.30 to 0.37	15	
0.40 to 0.70	25	7
0.75 to 1.5	30	8
1.6 to 3.2	40	10

Table 3 Rectangular copper wires

Conductor sectional area mm ²	Net mass of one coil kg
Under 10	10
10 and over	45

8 Designation of product The product shall be designated by the class, colour (if coloured) and conductor diameter or by the symbol, colour (if coloured) and conductor diameter for round wires, and by the class and conductor size (thickness × width) or by the symbol and conductor size (thickness × width) for rectangular wires.

Example 1 : “Polyvinyl formal enamelled round copper winding wire of class 1 0.85 mm” or “1PVF 0.85 mm”

Example 2 : “Polyvinyl formal enamelled round aluminium winding wire of class 1 1.6 mm” or “Al-1PVF 1.6 mm”

Example 3 : “Polyvinyl formal enamelled rectangular copper winding wire 2.0 × 4.0 mm” or “PVF 2.0 × 4.0 mm”

Example 4 : “Self-bonding polyurethane enamelled round copper winding wire of class 0 0.85 mm” or “0SBUEW 0.85 mm”

Example 5 : “Polyurethane enamelled round copper winding wire of class 1 (red) 0.85 mm” or “1UEW (red) 0.85 mm”

9 Marking The following items shall be marked on each reel or container at an appropriate position:

- (1) Class or symbol
- (2) Colour (if coloured)

- (3) Conductor diameter or conductor size (thickness $\times$ width)
- (4) Serial number
- (5) Net mass
- (6) Number of lengths of wire (if coiled in sections)
- (7) Manufacturer's name or abbreviation
- (8) Year and month of manufacture or their abbreviation

Annex 1

Oleo-resinous enamelled round copper winding wires

1 Scope This Annex specifies oleo-resinous enamelled round copper winding wires.

2 Temperature index 105 °C

3 Insulation covering The insulation covering shall consist of the varnish for oleo-resinous enamelled wire specified in **JIS C 2351**, or any other similar varnishes which are at least equivalent thereto in quality, baked on the surface of the conductor uniformly. The insulation covering so applied shall have no detrimental effect to the conductor, and shall show no flaws or dirt.

4 Characteristics The characteristics shall be as given in Annex 1 Table 1, and Annex 1 Tables 2-1 and 2-2.

Annex 1 Table 1 Characteristics

Item	Characteristics	Test methods		Inspection	
		Test conditions	Applicable subclause of JIS C 3003	Type inspection	Delivery inspection
Dimension	Shall meet the values specified in Annex 1 Tables 2-1 and 2-2.	—		5 (1)	○
Pin-hole	5 holes max. for class 1 wires, 12 holes max. for class 2 wires of 0.04 mm or smaller diameter, and 8 holes max. for class 2 wires of 0.05 mm or larger diameter. Both of two specimens shall satisfy the above values in retest.	If the number of pinholes does not satisfy the specified value, retest may be made by sampling further two specimens from the same reel.		6	
Flexibility	Film shall show no crack through which conductor is visible.	Conductor diameter	Elongation or diameter of mandrel	8.1	
		mm			
		0.08 to 0.35	10 %		
		0.37 to 0.50	4 <i>d</i>		
		0.55 to 0.75	5 <i>d</i>		
		0.80 to 1.0	6 <i>d</i>		
Dielectric breakdown	Shall meet the values specified in Annex 1 Tables 2-1 and 2-2.	—		11	—
Resistance to softening	140 °C and over			12 (2)	
Conductor resistance	Shall meet the values specified in Annex 1 Tables 2-1 and 2-2.			19	
Elongation				20	

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Annex 1 Table 2-1 Oleo-resinous enamelled round copper winding wires
of class 1 (1EW)

Dimensions				Minimum dielectric breakdown voltage V	Maximum conductor resistance per unit length Ω/km (20 °C)	Minimum elongation %	
Conductor		Minimum film thickness mm	Maximum overall diameter mm				
Diameter mm	Tolerance mm						
0.30	±0.01	0.014	0.352	2 800	262.9	20.0	
0.32			0.372		230.0		
0.35			0.402		191.2		
0.37			0.424		170.6		
0.40		0.015	0.456		145.3		
0.45			0.016		0.508		114.2
0.50		0.017	0.560	3 050	91.43		
0.55	±0.02		0.620		78.15		
0.60			0.672		65.26		
0.65			0.018	0.724	55.31		
0.70	0.019	0.776		47.47			
0.75	0.020	0.830		3 400	41.19		
0.80	0.021	0.882			36.08		
0.85	0.022	0.934			31.87		
0.90	0.023	0.986			28.35		
0.95	0.024	1.038	25.38				
1.0	±0.03	0.025	1.102		23.33		

Annex 1 Table 2-2 Oleo-resinous enamelled round copper winding wires
of class 2 (2EW)

Conductor		Dimensions		Minimum dielectric breakdown voltage V	Maximum conductor resistance per unit length Ω/km (20 °C)	Minimum elongation %	
Diameter mm	Tolerance mm	Minimum film thickness mm	Maximum overall diameter mm				
0.025	±0.002	0.003	0.037	120	42 780	5.0	
0.03			0.044	150	28 870	7.0	
0.04			0.056	200	15 670		
0.05	±0.003	0.004	0.069	950	10 240		10.0
0.06			0.081		6 966	15.0	
0.07			0.091		4 990		
0.08		0.005	0.103	1 100	3 778		
0.09			0.113		2 959		
0.10			0.125		2 381		
0.11		0.135		1 957	15.0		
0.12		0.006	0.147	1 300			1 636
0.13			0.157				1 389
0.14			0.167				1 193
0.15		0.177		1 037			
0.16		0.007	0.189			908.8	15.0
0.17			0.199			803.2	
0.18			0.211	1 600		715.0	
0.19		0.221		640.6			
0.20		0.231		577.2			
0.21		0.241		522.8			
0.22	±0.004	0.252		480.1	20.0		
0.23		0.009	0.264			438.6	
0.24			0.274			402.2	
0.25			0.284			370.2	
0.26		0.294		341.8			
0.27		0.304		316.6			
0.28		0.314		294.1			
0.29	0.324		273.9				
0.30	±0.005	0.010	0.337	2 000		254.0	20.0
0.32			0.357			222.8	
0.35			0.387		185.7		
0.37		0.407		165.9			
0.40		0.011	0.439		141.7		
0.45	0.490			112.1			
0.50	±0.006	0.012	0.542	2 150	89.95	25.0	
0.55			0.592		74.18		
0.60		±0.008	0.644		62.64		
0.65	0.694			53.26			
0.70	0.746			45.84			
0.75	±0.010	0.013	0.798	2 400	39.87		25.0
0.80		0.015	0.852		35.17		
0.85			0.904		31.11		
0.90			0.956		27.71		
0.95		0.016	1.008		24.84		
1.0	±0.012	0.017	1.062		22.49		

Annex 2

Polyvinyl formal enamelled round copper winding wires

1 Scope This Annex specifies polyvinyl formal enamelled round copper winding wires.

2 Temperature index 105 °C

3 Insulation covering The insulation covering shall consist of the varnish for formal enamelled wire specified in **JIS C 2351**, or any other similar varnishes which are at least equivalent thereto in quality, baked on the surface of the conductor uniformly. The insulation covering so applied shall have no detrimental effect to the conductor, and shall show no flaws or dirt.

4 Characteristics The characteristics shall be as given in Annex 2 Table 1 and Annex 2 Tables 2-1 to 2-3.

Annex 2 Table 1 Characteristics

Item	Characteristics	Test methods		Inspection	
		Test conditions	Applicable subclause of JIS C 3003	Type inspection	Delivery inspection
Dimension	Shall satisfy the values specified in Annex 2 Tables 2-1 to 2-3.	—	5 (1)	○	○
Pin-hole	2 holes max. for class 0 wires, 3 holes max. for class 1 wires, and 5 holes max. for class 2 wires. Both of two specimens shall satisfy the above values in retest.	If the number of pinholes does not satisfy the specified value, retest may be made by sampling further two specimens from the same reel.	6	○	○
Flexibility	Film shall show no crack through which conductor is visible.	Stretch wire until it fractures. The diameter of mandrel shall be 1 <i>d</i> .	8.1	○	○
Adherence		—	9	○	○
Resistance to abrasion	Shall satisfy the values specified in Annex 2 Tables 2-1 to 2-3. In retest, both of two sets of specimens shall satisfy the values specified in Annex 2 Tables 2-1 to 2-3.	If the mechanical failing load does not satisfy the specified values, retest may be made on further two sets of specimens, two specimens being a set.	10	○	—
Dielectric breakdown	Shall satisfy the values specified in Annex 2 Tables 2-1 to 2-3.	—	11	○	○
Resistance to softening	170 °C and over		12 (2)	○	—
Resistance to solvent	Film shall show no bubbles or blisters. Film shall show no peeling through which conductor is visible.	In pencil hardness test, the hardness of pencil lead shall be 2 H.	14.1	○	—
Conductor resistance	Shall satisfy the values specified in Annex 2 Tables 2-1 to 2-3.	—	19	○	—
Elongation			20	○	—

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Annex 2 Table 2-1 Polyvinyl formal enamelled round copper winding wires
of class 0 (0PVF)

Dimensions			Maximum overall diameter mm	Minimum dielectric breakdown voltage V	Failing load in resistance-to-abrasion test N [gf]		Maximum conductor resistance per unit length Ω/km (20 °C)	Minimum elongation %			
Conductor		Minimum film thickness mm			Average value (min.)	Lowest value (min.)					
Diameter mm	Tolerance mm										
0.10	±0.008	0.016	0.156	3 500	—	—	2 647	15.0			
0.11			0.166				3 750		2 153		
0.12			0.017						0.180	1 786	
0.13									0.190	1 505	
0.14									0.200	1 286	
0.15									0.210	1 111	
0.16		0.018		0.222	969.5						
0.17			0.232	853.5							
0.18			0.019	0.246	757.2						
0.19		0.256		676.2							
0.20		0.266		607.6							
0.21		0.276		549.0							
0.22		0.286		498.4							
0.23		0.020	0.298	3 800	—	—	454.5		20.0		
0.24			0.308				416.2				
0.25			0.318				382.5				
0.26	±0.01		0.330				5.4 { 551 }			4.7 { 479 }	358.4
0.27			0.340				5.5 { 561 }			—	331.4
0.28			0.350								307.3
0.29		0.360	4.8 { 490 }	285.7							
0.30	0.021	0.374	4 200	5.8 { 592 }	5.0 { 510 }	262.9					
0.32		0.394		5.9 { 602 }	5.1 { 520 }	230.0					
0.35		0.424		6.0 { 612 }		191.2					
0.37		0.022		0.446		6.3 { 643 }	5.4 { 551 }	170.6			
0.40		0.023		0.480		6.7 { 683 }	5.7 { 581 }	145.3			
0.45		0.024		0.532	7.1 { 724 }	6.1 { 622 }	114.2				
0.50	±0.02	0.025	0.586	4 500	7.5 { 765 }	6.4 { 653 }	91.43				
0.55		0.026	0.646		7.6 { 775 }	6.5 { 663 }	78.15				
0.60			0.698		8.0 { 816 }	6.8 { 694 }	65.26				
0.65		0.027	0.752		8.4 { 857 }	7.2 { 734 }	55.31				
0.70		0.028	0.804		8.8 { 898 }	7.5 { 765 }	47.47				
0.75		0.030	0.860	5 100	9.6 { 979 }	8.1 { 826 }	41.19				
0.80		0.031	0.914		9.9 { 1.010 }	8.5 { 867 }	36.08				
0.85		0.032	0.966		10 { 1.020 }	8.8 { 898 }	31.87				
0.90		0.033	1.020		11 { 1.120 }	9.1 { 928 }	28.35				
0.95		0.034	1.072		5 900	9.5 { 969 }	25.38				
1.0	±0.03	0.036	1.138	12 { 1.220 }		10 { 1.020 }	23.33				
1.1		0.037	1.242	13 { 1.330 }		11 { 1.120 }	19.17				
1.2			1.342				16.04				
1.3			1.448				13.61				
1.4		1.548	11.70								
1.5		0.041	1.654	14 { 1.430 }	12 { 1.220 }	10.16					
1.6		1.754	8.906								
1.7		0.042	1.856			7.871					
1.8			1.956	16 { 1.630 }	—	7.007					
1.9			2.062			6.278					
2.0		0.044	2.162			5.656					
2.1			2.266	17 { 1.730 }	14 { 1.430 }	5.123					
2.2			2.368			4.662					
2.3		2.468	4.260								
2.4		0.048	2.574	18 { 1.840 }	15 { 1.530 }	3.908					
2.5		0.049	2.678			3.598					
2.6	2.778		3.324								
2.7	2.878		3.079								
2.8	2.978		2.861								
2.9	3.078		2.665								
3.0	3.178		2.489								
3.2	3.388		2.198								
	±0.04										

Annex 2 Table 2-2 Polyvinyl formal enamelled round copper winding wires
of class 1 (1PVF)

Dimensions		Minimum film thickness mm	Maximum overall diameter mm	Minimum dielectric breakdown voltage V	Failing load in resistance-to- abrasion test N (gf)		Maximum conductor resistance per unit length Ω/km (20 °C)	Minimum elongation %			
Conductor					Average value (min.)	Lowest value (min.)					
Diameter mm	Tolerance mm										
0.10	±0.008	0.009	0.140	2 000	—	—	2 647	15.0			
0.11		0.010	0.150	2 200	—	—	2 153				
0.12			0.162				1 786				
0.13			0.172				1 505				
0.14			0.182				1 286				
0.15			0.192				1 111				
0.16		0.011	0.204	2 400			—		—	969.5	
0.17			0.214							853.5	
0.18			0.226							757.2	
0.19		0.012	0.236							676.2	
0.20			0.246							607.6	
0.21			0.256							549.0	
0.22			0.266							498.4	
0.23			0.013							0.278	454.5
0.24										0.288	416.2
0.25										0.298	382.5
0.26	±0.01	0.310		3.5 { 357 }				3.0 { 306 }		358.4	
0.27		0.320		3.6 { 367 }	3.1 { 316 }	331.4					
0.28		0.330	307.3								
0.29		0.340	285.7								
0.30		0.014	0.352	3.9 { 398 }	3.3 { 337 }	262.9					
0.32			0.372	2 800	—	—		230.0			
0.35			0.402				4.0 { 408 }	3.4 { 347 }	191.2		
0.37			0.424				4.4 { 449 }	3.7 { 377 }	170.6		
0.40		0.015	0.456						4.7 { 479 }	4.0 { 408 }	145.3
0.45			0.508						4.7 { 479 }	4.0 { 408 }	114.2
0.50	±0.02	0.017	0.560	3 050	5.1 { 520 }	4.4 { 449 }	91.43				
0.55		0.018	0.620	—	—	—	78.15				
0.60			0.672				5.2 { 530 }	4.5 { 459 }	65.26		
0.65			0.724				5.6 { 571 }	4.8 { 490 }	55.31		
0.70			0.776				6.0 { 612 }	5.1 { 520 }	47.47		
0.75		0.020	0.830	3 400	6.4 { 653 }	5.4 { 551 }	41.19				
0.80		0.021	0.882		6.7 { 683 }	5.7 { 581 }	36.08				
0.85		0.022	0.934		7.1 { 724 }	6.0 { 612 }	31.87				
0.90		0.023	0.986		7.5 { 765 }	6.4 { 653 }	28.35				
0.95		0.024	1.038		7.9 { 806 }	6.7 { 683 }	25.38				
1.0	±0.03	0.025	1.102	—	8.3 { 847 }	7.0 { 714 }	23.33				
1.1		0.026	1.204	4 150	—	—	7.4 { 755 }	19.17			
1.2			1.304				8.7 { 887 }	7.8 { 796 }	16.04		
1.3			0.027				1.408	9.2 { 938 }	7.9 { 806 }	13.61	
1.4							1.508	9.3 { 949 }	8.2 { 836 }	11.70	
1.5		0.028	1.612	—	—	—	8.3 { 847 }	10.16			
1.6			1.712				8.7 { 887 }	8.906			
1.7			1.814				10 { 1 020 }	7.871			
1.8		0.029	1.914	4 350	—	—	7.007				
1.9			0.030				2.018	11 { 1 120 }	9.1 { 928 }	6.278	
2.0							2.118	9.2 { 938 }	5.656		
2.1							2.220		9.5 { 969 }	5.123	
2.2			0.032				2.322		9.8 { 1 000 }	4.662	
2.3							2.422	9.9 { 1 010 }	4.260		
2.4							0.033	2.526	10 { 1 020 }	3.908	
2.5			0.034					2.628	13 { 1 330 }	11 { 1 120 }	3.598
2.6	2.728							—	—	3.324	
2.7	2.828						3.079				
2.8	2.928	2.861									
2.9	3.028	2.665									
3.0	±0.04	3.128	—	—	—	2.489					
3.2		3.338				2.198					