

Standard Specification for Round Wire for Winding Electron Tube Grid Laterals¹

This standard is issued under the fixed designation F 290; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers round wire up to 0.006 in. (0.15 mm) in diameter for use as electron tube grid lateral winding wire.

1.2 Five classes of wire are covered based on their tensile properties (see 5.2 and 5.3).

1.3 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

- E 39 Test Methods for Chemical Analysis of Nickel²
- E 107 Test Methods for Chemical Analysis of Electronic Nickel ³
- E 129 Test Method for Spectrographic Analysis of Thermionic Nickel Alloys by the Powder Techniques ³

F 16 Test Methods for Measuring Diameter or Thickness of Wire and Ribbon for Electronic Devices and Lamps ⁴

F 205 Test Method for Measuring Diameter of Fine Wire by Weighing ⁴

F 288 Specification for Tungsten Wire for Electronic Devices and Lamps ⁴

F 289 Specification for Molybdenum Wire and Rod for Electrical Applications ⁴

3. Terminology

3.1 Description of Terms:

3.1.1 The following description of terms shall apply to the requirements specified in Table 1:

3.1.1.1 *breaking strength*—The stress at which the specimen breaks.

3.1.1.2 *elongation*—The maximum percent of stretch in a specimen of 10-in. (250-mm) gage length.

3.1.1.3 *tensile strength*— The ultimate strength of the material expressed either as grams per milligram per 200 mm length of wire or pounds per square inch.

3.1.1.4 *ultimate strength*—The maximum stress developed in a specimen.

3.1.1.5 *work load*—The difference between the yield load and the ultimate load.

3.1.1.6 *yield strength*— The stress developed at 1 percent elongation when testing a specimen of 10-in. (250-mm) gage length.

4. Chemical Composition

4.1 The wire shall conform to the requirements as to chemical composition as prescribed in Table 2.

5. Tensile Properties

5.1 The wire shall conform to the requirements as to tensile strength, yield strength, working range, and elongation properties as prescribed in Table 1 for the class of wire designated.

5.2 The class designations for the nickel-titaniummagnesium alloy UNS N03300; the nickel-manganese alloy UNS N02211; molybdenum wire, and the nickel-molybdenumiron alloy UNS N10001; are based on their tensile properties as follows:

5.2.1 *Class I*—The wire shall conform to elongation properties as specified in ranges in Table 1.

5.2.2 *Class II*—The wire shall conform to the following tensile properties:

5.2.2.1 Yield strength with a spread of approximately \pm 15 %, as shown in grams-force, minimum and maximum, in Table 2,

5.2.2.2 Working range, as specified in Table 1, and

5.2.2.3 Elongation as specified in Table 1.

5.2.3 *Class III*—The wire shall conform to the following tensile properties:

5.2.3.1 Yield strength with a spread of approximately \pm 10%, as shown in grams-force, minimum and maximum, in Table 1.

5.2.3.2 A larger working range as specified in Table 1, and 5.2.3.3 Elongation as specified in Table 1.

5.3 The class designations for tungsten wire are as follows:

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² Discontinued; see 1994 Annual Book of ASTM Standards, Vol 03.05.

³ Annual Book of ASTM Standards, Vol 03.05.

⁴ Annual Book of ASTM Standards, Vol 10.04.

5.3.1 *Classes IV and V*— Tungsten wire UNS R07005 shall conform to the tensile properties for both classes as prescribed in Table 3.

TABLE 1 Tensile Properties for Nickel-Titanium-Magnesium Alloy (UNS N03300), Nickel-Manganese Alloy (UNS N02211), Molybdenum Wire, and Nickel-Molybdenum-Iron Alloy (UNS N10001) Wire

Note—Wire supplied as Class I shall conform to the following	CLASS I g elongation values as spec	sified by range:	
Material	Range	Wire Diameter, in. (mm)	Elongation, %
Nickel-titanium-magnesium alloy (UNS N03300)			
and nickel-manganese alloy (UNS N02211)	1	All	8 to 16
	2	All	14 to 22
	3	0.003 (0.08) and under	20 and over
	4	Above 0.003 (0.08)	22 and over
/lolybdenum	1	All	8 to 16
•	2	All	14 to 22
lickel-molybdenum-iron alloy (UNS N10001)	1	0.001 (0.025)	8 to 18
	2	0.0015 (0.038)	18 to 32
	3	0.002 (0.050) and above	25 and over

CLASS II

Note—Wire supplied as Class II shall conform to the following requirements as to yield strength (± 15 percent), working range, and elongation:

Material in. (mm) Stress psi (Mpa) min. gf max. gf Nickel-Itanium-magnesium alloy (UNS N03300) 0.0015 (0.038) 74 000 (510) 55 76 17 0.0016 (0.044) 74 000 (610) 55 76 17 0.0018 (0.048) 70 500 (486) 62 84 17 0.0019 (0.048) 70 500 (486) 65 134 20 0.0027 (0.069) 64 500 (445) 145 190 75 0.0033 (0.064) 65 500 (433) 175 235 90 0.0033 (0.064) 63 500 (434) 235 315 136 0.0035 (0.089) 63 000 (434) 230 400 190 0.0045 (0.114) 60 000 (414) 370 500 220 0.0056 (0.127) 60 000 (414) 450 610 30 0.0065<		Wire D	iameter		Yield St	rength			
Nickel-ttanium-magnesium alloy (UNS N03300) 0.0015 0.0038 74 000 (fs10) 51 67 17 Nickel-ttanium-magnesium alloy (UNS N03300) 0.0016 (0.041) 74 000 (fs10) 56 76 17 0.0016 (0.044) 70 500 (486) 69 93 20 0.0018 (0.046) 70 500 (486) 69 93 20 0.0020 (0.051) 70 000 (483) 85 115 35 0.0022 (0.064) 68 500 (472) 130 175 60 0.0023 (0.064) 63 500 (434) 210 280 115 0.0033 (0.084) 63 000 (434) 235 315 135 0.0040 (0.114) 60 0000 (414) 370 500 250 0.0055 (0.140) 60 0000 (414) 450 103 300 0.0055 (0.140) 60 0000 (414) 550 745	Material	in	(mm)	Approximate	e Center	Lo	bad	Working Load, min, gf	Elongation, min, %
alloy (UNS N03300) 0.0016 0.0411 74 000 (510) 56 76 17 0.0017 (0.043) 70 500 (486) 62 84 17 0.0018 (0.046) 70 500 (486) 69 93 20 0.0020 (0.051) 70 000 (483) 85 115 35 0.0027 (0.069) 64 500 (472) 130 175 60 0.0033 (0.076) 63 500 (434) 210 280 115 35 0.0035 (0.089) 63 500 (434) 210 280 115 0.0035 (0.089) 63 500 (434) 210 280 115 0.0035 (0.089) 63 000 (434) 235 315 135 0.0046 (0.112) 60 000 (414) 370 500 250 0.0055 (0.127) 60 000 (414) 450 610 330 0.0055 <t< th=""><th></th><th></th><th>(1111)</th><th>Stress psi</th><th>(Mpa)</th><th>min, gf</th><th>max, gf</th><th>, j.</th><th>, ,</th></t<>			(1111)	Stress psi	(Mpa)	min, gf	max, gf	, j.	, ,
0.0017 (0.043) 70 500 (486) 62 84 17 0.0018 (0.046) 70 500 (486) 76 104 20 0.0020 (0.051) 70 000 (486) 76 104 20 0.0025 (0.064) 68 500 (445) 145 190 75 0.0025 (0.069) 64 500 (438) 175 235 90 0.0033 (0.089) 63 000 (434) 210 280 115 0.0035 (0.089) 63 000 (414) 300 400 190 0.0040 (0.122) 61 500 (414) 370 500 250 0.0060 (0.152) 60 000 (414) 550 745 400 0.0060 (0.152) 60 000 (414) 655 885 475 0.0060 (0.152) 60 000 (414) 655 885 475 0.0060 (0.152) 60 000 (0.0015	(0.038)	74 000	(510)	51	67	17	8
0.0018 (0.046) 70 500 (486) 69 93 20 0.0019 (0.046) 70 500 (486) 76 104 20 0.0020 (0.051) 70 000 (483) 85 115 35 0.0027 (0.069) 64 500 (442) 130 175 600 0.0033 (0.084) 63 000 (443) 210 280 115 0.0033 (0.089) 63 000 (444) 230 400 190 0.0045 (0.141) 60 000 (414) 450 610 330 0.0050 (0.142) 61 000 (414) 450 610 330 0.0055 (0.140) 60 000 (414) 655 745 400 0.0027 (0.067) 58 800 (32) 125 170 100 alloy (UNS N02211) 0.0025 (0.064) 55 400 (347) 175 245 106 0.0033 (0.067)	,	0.0016	(0.041)	74 000	(510)	56	76	17	8
0.0019 (0.048) 70 76 104 20 0.0020 (0.051) 70 000 (483) 85 115 35 0.0025 (0.069) 64 500 (443) 145 190 75 0.0033 (0.076) 63 500 (434) 210 280 115 0.0033 (0.089) 63 500 (434) 210 280 115 0.0033 (0.040) (6.009) 64 500 (424) 300 400 190 0.0040 (0.102) 61 500 (424) 300 400 190 0.0055 (0.140) 60 000 (414) 450 610 330 0.0050 (0.127) 60 000 (414) 550 745 400 0.0027 (0.067) 56 600 (390) 150 210 80 alloy (UNS N0221) 0.0025 (0.064) 54<400		0.0017	(0.043)	70 500	(486)	62	84	17	8
0.0020 (0.051) 70 000 (483) 85 115 35 0.0025 (0.064) 68 500 (442) 130 175 60 0.0030 (0.076) 63 500 (433) 175 235 90 0.0033 (0.064) 63 000 (434) 235 315 135 0.0040 (0.102) 61 500 (424) 300 400 190 0.0045 (0.114) 60 000 (414) 370 500 250 0.0050 (0.127) 60 000 (414) 450 610 330 0.0055 (0.140) 60<000		0.0018	(0.046)	70 500	(486)	69	93	20	8
0.0025 (0.064) 66 500 (472) 130 175 60 0.0027 (0.069) 64 500 (443) 175 235 990 0.0033 (0.064) 63 000 (434) 210 280 115 0.0033 (0.064) 63 000 (434) 235 315 1335 0.0040 (0.102) 61 500 (424) 300 400 190 0.0050 (0.127) 60 000 (414) 450 610 330 0.0055 (0.140) 60 000 (414) 655 885 475 Nickel-manganese 0.0027 (0.067) 56 600 (390) 150 210 80 0.0033 (0.084) 50 400 (347) 700 200 80 0.0033 (0.084) 50 400 (347) 717 245 105 0.0033 (0.084) 50 400 (347) 200 270 120 0.0033		0.0019	(0.048)	70 500	(486)	76	104	20	10
0.0027 (0.069) 64 600 (445) 145 190 75 0.0030 (0.076) 63 500 (438) 175 235 90 0.0033 (0.084) 63 000 (434) 210 280 115 0.0045 (0.102) 61 500 (424) 300 400 190 0.0045 (0.114) 60 000 (414) 370 500 250 0.0055 (0.140) 60 000 (414) 450 610 330 0.0060 (0.152) 60 000 (414) 655 885 475 0.0051 (0.51) 56 600 (392) 125 170 60 0.0027 (0.067) 56 800 (392) 125 170 60 0.0033 (0.084) 50 400 (347) 175 245 105 0.004 (0.112) 46 000		0.0020	(0.051)	70 000	(483)	85	115	35	10
0.0030 (0.076) 63 500 (439) 175 235 90 0.0033 (0.084) 63 000 (434) 210 280 115 0.0035 (0.089) 63 000 (434) 235 315 135 0.0040 (0.102) 61 500 (424) 300 400 190 0.0055 (0.140) 60 000 (414) 370 500 250 0.0056 (0.152) 60 000 (414) 550 745 400 0.0066 (0.152) 60 000 (411) 70 100 30 alloy (UNS N02211) 0.0027 (0.067) 56 800 (392) 125 170 60 0.0033 (0.064) 58 400 (403) 110 150 210 80 0.0033 (0.064) 50 400 (347) 175 245 105 0.0033 <		0.0025	(0.064)	68 500	(472)	130	175	60	10
0.0033 (0.084) 63 000 (434) 210 280 115 0.0035 (0.089) 63 000 (434) 235 315 135 0.0040 (0.102) 61 500 (424) 300 400 190 0.0045 (0.114) 60 000 (414) 450 610 330 0.0055 (0.140) 60 000 (414) 555 845 400 0.0060 (0.152) 60 000 (414) 555 845 475 Nickel-manganese 0.0020 (0.051) 58 600 (392) 125 170 60 0.0027 (0.067) 56 800 (392) 125 170 60 0.0033 (0.076) 56 600 (390) 155 210 80 0.0035 (0.084) 50 400 (347) 175 245 105 0.0035 (0.020)		0.0027	(0.069)	64 500	(445)	145	190	75	10
0.0035 (0.089) 63 000 (434) 235 315 135 0.0040 (0.102) 61 500 (424) 300 400 190 0.0045 (0.114) 60 000 (414) 370 500 250 0.0050 (0.127) 60 000 (414) 450 610 330 0.0060 (0.152) 60 000 (414) 655 885 475 0.0060 (0.152) 60 000 (414) 655 885 475 1alloy (UNS N02211) 0.0027 (0.067) 56 800 (392) 125 170 60 0.0030 (0.076) 56 600 (390) 150 210 80 0.0033 (0.084) 50 400 (347) 175 245 105 0.0034 (0.162) 51 000 (352) 250 340 170 0.0045 (0.177)		0.0030	(0.076)	63 500	(438)	175	235	90	15
0.0040 (0.102) 61<500		0.0033	(0.084)	63 000	(434)	210	280	115	15
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0.0050 (0.127) 60 000 (414) 450 610 330 0.0055 (0.140) 60 000 (414) 550 745 400 Nickel-manganese 0.0020 (0.051) 59 600 (411) 70 100 30 alloy (UNS N02211) 0.0025 (0.064) 58 400 (403) 110 150 50 0.0027 (0.067) 56 600 (392) 125 170 60 0.0033 (0.076) 56 600 (390) 150 210 80 0.0033 (0.084) 50 400 (347) 200 270 120 0.004 (0.102) 51 000 (352) 250 340 170 0.004 (0.127) 46 000 (317) 350 470 305 0.005 (0.127) 46 000 (827) 24 34 1 0.0010		0.0040	(0.102)	61 500	(424)	300	400	190	20
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Nickel-manganese alloy (UNS N02211) 0.0020 (0.051) 59 600 (411) 70 100 30 alloy (UNS N02211) 0.0025 (0.064) 58 400 (403) 110 150 50 0.0027 (0.067) 56 600 (390) 150 210 80 0.0033 (0.076) 56 600 (390) 150 210 80 0.0033 (0.084) 50 400 (347) 175 245 105 0.0035 (0.089) 50 400 (347) 200 270 120 0.0045 (0.114) 47 000 (324) 295 395 230 0.005 (0.127) 46 000 (317) 350 470 305 0.0010 (0.020) 120 000 (827) 35 50 4 0.0010 (0.023) 118 500 (817) 65 85 8		0.0055	. ,	60 000	(414)	550	745	400	20
Nickel-manganese alloy (UNS N02211) 0.0020 (0.051) 59 600 (411) 70 100 30 alloy (UNS N02211) 0.0025 (0.064) 58 400 (403) 110 150 50 0.0027 (0.067) 56 600 (390) 150 210 80 0.0033 (0.076) 56 600 (390) 150 210 80 0.0033 (0.084) 50 400 (347) 175 245 105 0.0035 (0.089) 50 400 (347) 200 270 120 0.0045 (0.114) 47 000 (324) 295 395 230 0.005 (0.127) 46 000 (317) 350 470 305 0.0010 (0.020) 120 000 (827) 35 50 4 0.0010 (0.023) 118 500 (817) 65 85 8		0.0060	(0.152)	60 000	(414)	655	885	475	20
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CLASS IINote—Wire supplied as Class II shall conform to the following requirements as to yield strength (\pm 15 percent), working range, and elongation:

	Wire D	iameter		Yield Str	rength			
Material	in.	(mm)	Approximate	e Center	Lc	ad	Working Load, min, gf	Elongation, min, %
		(1111)	Stress psi	(Mpa)	min, gf	max, gf	, 3.	, , , .
Nickel-molybdenum-iron alloy (UNS N10001)	0.0016	(0.041)	92 000	(634)	70	95	40	10
,	0.0020	(0.051)	85 000	(586)	102	138	65	10
	0.0025	(0.064)	85 000	(586)	160	215	110	10
	0.0030	(0.076)	80 000	(552)	219	297	165	15
	0.0033	(0.084)	80 000	(552)	272	368	205	15
	0.0035	(0.089)	80 000	(552)	287	389	240	15
	0.0040	(0.102)	80 000	(552)	371	503	320	20
	0.0050	(0.127)	80 000	(552)	606	820	485	20

Class III

Note—Wire supplied as Class III shall conform to the following requirements as to yield strength (±10 %), working range, and elongation:

	Wire D	iameter		Yield Str	rength			
Material	in.	(22.22)	Approximate	e Center	Lc	ad	 Working Load, min. af 	Elongation, min, %
	m.	(mm)	Stress psi	(Mpa)	min, gf	max, gf		, ,
Nickel-titanium-magnesium alloy (UNS N03300)	0.0015	(0.038)	74 000	(510)	53	65	20	10
	0.0016	(0.041)	74 000	(510)	59	73	25	10
	0.0017	(0.043)	70 500	(486)	66	80	30	12
	0.0018	(0.046)	70 500	(486)	72	89	35	12
	0.0019	(0.048)	70 500	(486)	81	99	35	12
	0.0020	(0.051)	70 000	(483)	90	110	45	15
	0.0025	(0.064)	68 500	(472)	135	165	75	15
	0.0027	(0.069)	64 500	(445)	150	185	90	15

Class III

Note—Wire supplied as Class III shall conform to the following requirements as to yield strength (±10 %), working range, and elongation:

	Wire D	iameter		Yield St	rength			
Material	:	(mm)	Approximat	e Center	Lo	ad	Working Load, min, gf	Elongation, min, %
	in.	(11111)	Stress psi	(Mpa)	min, gf	max, gf	Loud, min, gr	
Nickel-titanium-magnesium alloy (UNS N03300)	0.0030	(0.076)	63 500	(438)	185	225	120	15
	0.0033	(0.084)	63 000	(434)	220	270	145	15
	0.0035	(0.089)	63 000	(434)	250	305	170	20
	0.0040	(0.102)	61 500	(424)	315	385	230	20
	0.0045	(0.114)	60 000	(414)	390	480	310	20
	0.0050	(0.127)	60 000	(414)	475	585	400	20
	0.0055	(0.140)	60 000	(414)	580	710	485	20
	0.0060	(0.152)	60 000	(414)	690	850	575	20
Nickel-manganese alloy (UNS N02211)	0.0020	(0.051)	59 600	(411)	75	95	40	14
-)()	0.0025	(0.064)	58 400	(403)	115	145	65	14
	0.0027	(0.069)	56 800	(392)	130	165	80	14
	0.0030	(0.076)	56 600	(390)	160	200	100	18
	0.0033	(0.084)	50 400	(347)	190	235	125	18
	0.0035	(0.090)	50 400	(347)	210	260	145	18
	0.0040	(0.102)	51 500	(355)	265	325	200	22
	0.0045	(0.114)	47 500	(328)	310	380	265	22
	0.0050	(0.127)	46 000	(317)	370	450	355	22
	0.006	(0.152)	54 000	(372)	495	605	560	22
lolybdenum	0.0008	(0.020)	120 000	(827)	25	33	1	8
holybaonam	0.0010	(0.025)	120 000	(827)	40	50	4	8
	0.0012	(0.030)	118 500	(817)	55	65	6	8
	0.0012	(0.033)	118 500	(817)	65	75	8	8
	0.00133	(0.034)	118 500	(817)	70	80	8	8
	0.0015	(0.038)	113 500	(782)	82	100	10	12
	0.0017	(0.043)	113 500	(782)	105	129	15	12
	0.0020	(0.051)	96 000	(662)	135	165	25	15
	0.0025	(0.064)	96 000	(662)	202	248	40	15
	0.0020	(0.076)	96 000	(662)	277	339	40 65	17
	0.0033	(0.084)	96 000	(662)	336	410	80	17
	0.0035	(0.084)	96 000	(662)	377	461	90	17
	0.0040	(0.102)	96 000	(662)	493	603	115	17
	0.0040	(0.102)	96 000 96 000	(662)	493 624	762	145	17
	0.0045	(0.114)	96 000 96 000	(662)	770	942	145	17
	0.0055	· · · ·	96 000 96 000	(662)	932	942 1139	220	17
	0.0055	(0.140)	90 000	(002)	932	1139	220	17

Class III Note—Wire supplied as Class III shall conform to the following requirements as to yield strength (\pm 10%), working range, and elongation:

	Wire D	iameter		Yield Str	rength			
Material	in.	(mm)	Approximate	e Center	Lc	ad	Working Load, min, gf	Elongation, min, %
		(mm)	Stress psi	(Mpa)	min, gf	max, gf		, ,
	0.0060	(0.152)	96 000	(662)	1109	1355	260	17
Nickel-molybdenum-iron alloy (UNS N10001)	0.0016	(0.041)	92 000	(634)	76	92	45	15
	0.0020	(0.051)	85 000	(586)	109	133	75	15
	0.0025	(0.064)	85 000	(586)	167	205	125	15
	0.0030	(0.076)	80 000	(552)	232	284	185	20
	0.0033	(0.084)	80 000	(552)	289	353	230	20
	0.0035	(0.089)	80 000	(552)	305	373	270	20
	0.0040	(0.102)	80 000	(552)	394	482	360	20
	0.0050	(0.127)	80 000	(552)	642	784	540	20

6. Dimensions and Permissible Variations

6.1 The wire shall not vary from the specified diameter as determined by weight, by more than the amounts prescribed in Table 4. Center weights of various types of wire are given in Table 5.

6.2 In the case of finished plated wires, the percentage of plating shall be calculated on the basis of the bare wire weight. In specifying rod plated and drawn plated wire, the plating weight will be based on finished wire weight. Orders shall specify the manner of plating.

7. Surface

7.1 *Bare Wire*—The surface of the wire shall be bright, and free from cracks, slivers, fissures, lubricants, or other detrimental defects as determined at a magnification of $10 \times$.

7.2 *Plated Wire*— The bare wire shall conform to the requirements specified in 7.1; the plating shall be free from bubbles, flakes, blisters, porosity, and plating salts, and shall not show peeled containing when tested in accordance with 9.2.

8. Chemical Analysis

8.1 Chemical analysis of the material shall be made in accordance with the methods described in the following paragraphs (8.1.1 to 8.1.3):

8.1.1 *Nickel Alloy Wire (UNS N03300; UNS N02211; UNS N10001)*—The chemical analysis shall be made in accordance with either or both Test Methods E 39 and Test Methods E 107. The material may alternatively be analyzed in accordance with Test Method E 129.

8.1.2 *Molybdenum Wire*— The molybdenum content shall be determined gravimetrically or by a combination of analyses for impurities by spectrochemical and chemical methods.

8.1.3 *Tungsten Wire (UNS R07005)*—The tungsten content shall be determined gravimetrically or by a combination of analyses for impurities by spectrochemical and chemical methods.

9. Test Methods

9.1 *Tensile Properties*—Determine the yield strength, working range, breaking strength, and elongation by using a constant rate of traverse tester calibrated in terms of constant rate of traverse. Rate of traverse should be approximately 1 in. (25 mm)/min with a gage length of 10 in. (250 mm).

9.2 *Plate Adherence*— Draw the wire over a 0.10-in. (2.5-mm) radius knife edge, holding the wire against the edge with the thumb. Pull the wire at a 45° angle to the plane of the blade. In addition, draw the wire through a razor slit in a 0.25-in. (6-mm) thick leather pad with the wire riding on the bottom of the slit with approximately 30° angle of approach

Element, percent	Nickel-Ti Magne Alloy (UNS	esium	sium Nickel-Mar		Molyb- denum	Tungsten (UNS R07005)	Nickel-Molybdenum Iron Alloy (UNS N10001)	
	Limit	Nominal	Limit	Nominal	Limit	Limit	Limit	Nominal
Nickel	97.0 min	98.5	93.7 min	95.2			remainder	66.5
Carbon	0.4 max	0.25	0.20 max	0.10			0.12 max	0.05
Copper	0.25 max	0.03	0.25 max	0.05				
Iron	0.60 max	0.10	0.75 max	0.15			6.00 max	5.00
Magnesium	0.20 min	0.35						
	0.50 max							
Manganese	0.50 max	0.20	4.25 min	4.5			1.00 max	0.45
			5.25 max					
Molybdenum					99.9 min		33.00 max	27.50
Silicon	0.35 max	0.15	0.15 max	0.05			1.00 max	0.45
Sulfur	0.01 max	0.005	0.015 max				0.030 max	0.012
Titanium	0.20 min	0.40						
	0.60 max							
Tungsten						99.95 min		
Vanadium							0.60 min	0.25
Phosphorus							0.040 max	
Chromium							1.00 max	
Cobalt							2.50 max	

TABLE 2 Chemical Composition

TABLE 3 Tensile Properties for Tungsten Wire

	Wire Diameter, in. (mm)	Approximate Center Tensile Strength, psi (MPa)	g/mg-2	Strength, 200 mm of wire
		psi (MFa)	min	max
Class IV	under 0.0005 (0.013)	straightened	65	
Class V	under 0.0005 (0.013)	unstraightened	90	
Class IV	0.0005 to 0.002 (0.013 to 0.05)	384 600 (2650)	65	75
Class V	0.0005 to 0.002 (0.013 to 0.05)	439 000 (3025)	75	85

TABLE 4 Permissible Variations in Dimensions

Material	Diameter, in. (mm)	Permissible Variation	Out of Roundness, max
Ductile wire (Classes I, II, III)	Up to 0.006 (0.15)	±4 % from center weight ^A	5 % of diameter
Tungsten wire (Classes IV, V)	Up to 0.002 (0.05)	\pm 3 % from center weight ^A	5 % of diameter

^A Centerweights of various types of wire are listed in.

TABLE 5 Center Weights^{A,B}

Wire Diameter			Cer	Center Weight, mg/200 mm			
in.	(mm)	Nickel-Titanium- Magnesium Alloy (UNS N03300)	Nickel- Manganese Alloy (UNS N02211)	Molybdenum	Tungsten (UNS R07005)	Nickel- Molybdenum-Iron Alloy (UNS N10001)	
0.0010	(0.025)	0.89	0.89	1.03	1.94	0.95	
0.0015	(0.038)	2.00	1.99	2.31	4.37	2.14	
0.0016	(0.041)	2.28	2.27	2.63	4.97	2.43	
0.0020	(0.051)	3.56	3.54	4.11	7.77	3.80	
0.0025	(0.064)	5.56	5.54	6.43	12.14	5.94	
0.0030	(0.076)	8.00	7.97	9.25	17.49	8.56	
0.0033	(0.084)	9.68	9.65	11.19	21.16	10.36	
0.0035	(0.089)	10.89	10.85	12.59	23.80	11.65	
0.0040	(0.102)	14.22	14.18	16.45	31.09	15.22	
0.0045	(0.114)	18.00	17.94	20.82	39.35	19.26	
0.0050	(0.127)	22.23	22.15	25.70	48.58	23.78	
0.0055	(0.140)	26.89	26.80	30.10	58.78	28.77	
0.0060	(0.152)	32.00	31.90	37.01	69.95	34.24	

^A Center weight = constant \times (diameter)², where the constant is for a specific alloy and diameter is in mils.

^B Densities and constants for the various alloys are as follows:

Alloy	UNS No.	Density gm/cm ³	"C" Constant
Nickel-titanium-magnesium-alloy	UNS N03300	8.77	0.889
Nickel-manganese alloy	UNS N02211	8.74	0.886
Molybdenum		10.14	1.028
Tungsten	UNS R07005	19.17	1.943
Nickel-molybdenum-iron alloy (HB)	UNS N10001	9.38	0.951

and a 30° angle of departure. Note the approach side of the leather belt and wire for flaking or peeling of plating.

9.3 Weight Tolerance— Determine size and uniformity in accordance with Test Method F 205.

9.4 *Diameter Tolerance*—If specified, measure diameter tolerance by equipment calibrated as described in Test Methods F 16.

9.5 *Ductility*—Determine the ductility of tungsten and molybdenum in accordance with Specification F 288 and Specification F 289.

9.6 *Straightness*— Specify straightened wire by the radius of curvature or camber of a given length of wire. The degree of curvature and the length of wire to be used shall be as agreed upon by the purchaser and the seller.

10. Spooling

10.1 The wire shall be spooled in such a manner that it can be unwound under reasonable tension without binding or otherwise becoming distorted. For testing purposes, samples shall be removed from the spool under a tension equivalent to approximately 50 % of its own yield point.

10.2 Each spool shall contain one continuous length of wire. The minimum length per spool shall be 500 m, for sizes up to 0.004 in. (0.10 mm) in diameter; above 0.004 in. (0.10 mm) in diameter the minimum length per spool shall be 200 m.

11. Rejection

11.1 Any spool not conforming to the specified requirements may be rejected. If 15 percent or more of the spools inany shipment do not conform to the specified requirements, the entire shipment may be rejected.

12. Packaging

12.1 The packaging shall be adequate to protect the spools and wire from contamination and physical injury during shipment.

12.2 No dusty or linty materials shall be used for padding.

12.3 The inside of the container shall be free of dust and lint.

13. Marking

13.1 Each spool shall be plainly marked with the following information:

13.1.1 Name of material and class designation (the specific range or the exact elongation must be indicated for Class I),

13.1.2 Diameter of wire in inches (or millimeters) or weight in milligrams per 200 mm, length of wire or both,

- 13.1.3 Date of manufacture or lot number, or both,
- 13.1.4 Length in meters, and
- 13.1.5 Name of manufacturer.

14. Keywords

14.1 electron tube grids; molybdenum wire; small diameter wire; UNS N02211; UNS N03300; UNS N10001; UNS R07005

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