

INCH-POUND

J-W-1177/15B

June 10, 1988

SUPERSEDING

J-W-1177/15A

September 27, 1976

FEDERAL SPECIFICATION SHEET

WIRE, MAGNET, ELECTRICAL, CLASS 220, TYPE M,
POLYIMIDE-COATED, ROUND

This specification is approved by the Commissioner, Federal Supply Service,
General Services Administration, for the use of all Federal agencies.

The requirements for acquiring the wire described herein shall consist of this
specification and the latest issue of J-W-1177.

Classification: Class 220; type M (single), type M2 (heavy),
type M3 (triple), type M4 (quadruple); round.
Insulating materials: The film shall be based on polyimide resin.
NEMA/ANSI equivalent: M, M2, and M3 test requirements, except for
thermal endurance and certain wire sizes required
for stock standardization, are equivalent to
MW-16 of NEMA MW 1000. M4 is not specified in
NEMA MW 1000.
General requirements: See J-W-1177 for general requirements, quality
assurance provisions, and packaging.

Requirements:

| Characteristics | Test procedure, see J-W-1177 | Wire sizes, AWG | Requirements |
|------------------------------|---------------------------------|--------------------|---------------------------------------------------------------------------------|
| Dimensions | 4.7.1.2 | 4-50 | See tables I and II. |
| Adherence and flexibility | 4.7.2.1 | 4-50 | No cracks visible in the coating. |
| Elongation | 4.7.5 | 4-50 | Not less than the value in table III. |
| Heat shock | 4.7.4 | 4-44 | No cracks visible in the coating after conditioning as shown in table IV. |

AMSC N/A

FSC 6145

DISTRIBUTION STATEMENT A Approved for public release; distribution unlimited

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Requirements: (Continued)

| Characteristics | Test procedure, see J-W-1177 | Wire sizes, AWG | Requirements |
|---------------------------------------|---------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Scrape resistance | 4.7.6 | 10-30 | Lowest grams-to-fail load for any of the three tests and the average of the three tests shall be not less than the values in table V. |
| Springback | 4.7.7 | 14-30 | Not greater than the value in table VI. |
| Dielectric strength | 4.7.9 | 4-44 | Not less than the value in table VII. |
| Continuity | 4.7.10 4.7.11 | 31-50 14-30 | The number of discontinuities shall be not greater than the number listed in table VIII. |
| Completeness of cure | 4.7.16.2 | 4-50 | Dissipation factor shall be not greater than 0.60 percent. |
| Thermoplastic flow | 4.7.8 | 18, 36 | Median shall be not less than 400°C with heavy film coated wire. |
| Solubility | 4.7.12 | 18, 36 | Heavy film coated wire shall not soften sufficiently to expose bare conductor when immersed in xylene or 50/50 parts by volume xylene/ethyl Cellosolve. |
| Dielectric strength at temperature | 4.7.14 | 18, 36 | Heavy film coated wire shall average not less than 4275 volts for 18 AWG or 1900 volts for 36 AWG. |
| Thermal endurance | 4.7.15.1 | 18 | 220°C minimum with heavy film coated wire. |
| | 4.7.15.2 | 4-44 | 2000 volts/mil minimum after 168 hours at 275°C. |
| | 4.7.15.3 | 4-44 | 240°C minimum as shown in table IV. |

TABLE I. Dimensions, sizes 4 to 44 AWG.

| AWG size | Bare wire diameter, inch | | | Type M, single | | Type M2, heavy | | Type M3, triple | | Type M4, quadruple | |
|----------|--------------------------|---------|---------|------------------------------------|--------------------------------|------------------------------------|--------------------------------|------------------------------------|--------------------------------|------------------------------------|--------------------------------|
| | Minimum | Nominal | Maximum | Minimum increase in diameter, inch | Maximum overall diameter, inch | Minimum increase in diameter, inch | Maximum overall diameter, inch | Minimum increase in diameter, inch | Maximum overall diameter, inch | Minimum increase in diameter, inch | Maximum overall diameter, inch |
| | | | | | | | | | | | |
| 1/4 | 0.2023 | 0.2043 | 0.2053 | 0.0018 | 0.2079 | 0.0037 | 0.2098 | 0.0056 | 0.2117 | 0.0074 | 0.2135 |
| 1/5 | .1801 | .1819 | .1828 | .0018 | .1854 | .0036 | .1872 | .0054 | .1890 | .0072 | .1908 |
| 1/6 | .1604 | .1620 | .1628 | .0017 | .1653 | .0035 | .1671 | .0052 | .1688 | .0070 | .1706 |
| 1/7 | .1429 | .1443 | .1450 | .0017 | .1474 | .0034 | .1491 | .0051 | .1508 | .0068 | .1525 |
| 1/8 | .1272 | .1285 | .1292 | .0016 | .1315 | .0033 | .1332 | .0049 | .1348 | .0066 | .1365 |
| 1/9 | .1133 | .1144 | .1150 | .0016 | .1173 | .0032 | .1189 | .0048 | .1205 | .0064 | .1221 |
| 1/10 | .1009 | .1019 | .1024 | .0015 | .1045 | .0031 | .1061 | .0046 | .1076 | .0062 | .1092 |
| 1/11 | .0898 | .0907 | .0912 | .0015 | .0933 | .0030 | .0948 | .0045 | .0963 | .0060 | .0978 |
| 1/12 | .0800 | .0808 | .0812 | .0014 | .0832 | .0029 | .0847 | .0043 | .0861 | .0058 | .0876 |
| 1/13 | .0713 | .0720 | .0724 | .0014 | .0743 | .0028 | .0757 | .0042 | .0771 | .0056 | .0785 |
| 1/14 | .0635 | .0641 | .0644 | .0016 | .0666 | .0032 | .0682 | .0048 | .0700 | .0064 | .0715 |
| 1/15 | .0565 | .0571 | .0574 | .0015 | .0594 | .0030 | .0609 | .0045 | .0627 | .0060 | .0644 |
| 1/16 | .0503 | .0508 | .0511 | .0014 | .0531 | .0029 | .0545 | .0043 | .0562 | .0057 | .0577 |
| 1/17 | .0448 | .0453 | .0455 | .0014 | .0475 | .0028 | .0488 | .0041 | .0504 | .0055 | .0520 |
| 1/18 | .0399 | .0403 | .0405 | .0013 | .0424 | .0026 | .0437 | .0039 | .0452 | .0052 | .0468 |
| 1/19 | .0355 | .0359 | .0361 | .0012 | .0379 | .0025 | .0391 | .0037 | .0406 | .0049 | .0422 |
| 1/20 | .0317 | .0320 | .0322 | .0012 | .0339 | .0023 | .0351 | .0035 | .0364 | .0047 | .0379 |
| 1/21 | .0282 | .0285 | .0286 | .0011 | .0303 | .0022 | .0314 | .0033 | .0326 | .0044 | .0342 |
| 1/22 | .0250 | .0253 | .0254 | .0011 | .0270 | .0021 | .0281 | .0032 | .0293 | .0043 | .0308 |
| 1/23 | .0224 | .0226 | .0227 | .0010 | .0243 | .0020 | .0253 | .0030 | .0264 | .0040 | .0279 |
| 1/24 | .0199 | .0201 | .0202 | .0010 | .0217 | .0019 | .0227 | .0029 | .0238 | .0039 | .0252 |
| 1/25 | .0177 | .0179 | .0180 | .0009 | .0194 | .0018 | .0203 | .0027 | .0214 | .0036 | .0228 |
| 1/26 | .0157 | .0159 | .0160 | .0009 | .0173 | .0017 | .0182 | .0026 | .0193 | .0035 | .0206 |
| 1/27 | .0141 | .0142 | .0143 | .0008 | .0156 | .0016 | .0164 | .0024 | .0173 | .0032 | .0185 |
| 1/28 | .0125 | .0126 | .0127 | .0008 | .0140 | .0016 | .0147 | .0023 | .0156 | .0031 | .0166 |
| 1/29 | .0112 | .0113 | .0114 | .0007 | .0126 | .0015 | .0133 | .0022 | .0142 | .0029 | .0152 |
| 1/30 | .0099 | .0100 | .0101 | .0007 | .0112 | .0014 | .0119 | .0021 | .0128 | .0028 | .0137 |

See footnote at end of table.

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TABLE I. Dimensions, sizes 4 to 44 AWG. - Continued

| AWG size | Bare wire diameter, inch | | | Type M, single | | Type M2, heavy | | Type M3, triple | | Type M4, quadruple | |
|----------|--------------------------|---------|---------|------------------------------------|--------------------------------|------------------------------------|--------------------------------|------------------------------------|--------------------------------|------------------------------------|--------------------------------|
| | Minimum | | Maximum | Minimum increase in diameter, inch | Maximum overall diameter, inch | Minimum increase in diameter, inch | Maximum overall diameter, inch | Minimum increase in diameter, inch | Maximum overall diameter, inch | Minimum increase in diameter, inch | Maximum overall diameter, inch |
| | Minimum | Nominal | | | | | | | | | |
| 31 | 0.0088 | 0.0089 | 0.0090 | 0.0006 | 0.0100 | 0.0013 | 0.0108 | 0.0019 | 0.0114 | 0.0026 | 0.0121 |
| 32 | .0079 | .0080 | .0081 | .0006 | .0091 | .0012 | .0098 | .0018 | .0104 | .0024 | .0110 |
| 33 | .0070 | .0071 | .0072 | .0005 | .0081 | .0011 | .0088 | .0016 | .0093 | .0022 | .0099 |
| 34 | .0062 | .0063 | .0064 | .0005 | .0072 | .0010 | .0078 | .0015 | .0083 | .0020 | .0088 |
| 35 | .0055 | .0056 | .0057 | .0004 | .0064 | .0009 | .0070 | .0013 | .0074 | .0018 | .0079 |
| 36 | .0049 | .0050 | .0051 | .0004 | .0058 | .0008 | .0063 | .0012 | .0067 | .0016 | .0071 |
| 37 | .0044 | .0045 | .0046 | .0003 | .0052 | .0008 | .0057 | .0012 | .0061 | .0016 | .0065 |
| 38 | .0039 | .0040 | .0041 | .0003 | .0047 | .0007 | .0051 | .0010 | .0054 | .0014 | .0058 |
| 39 | .0034 | .0035 | .0036 | .0002 | .0041 | .0006 | .0045 | .0009 | .0048 | .0012 | .0051 |
| 40 | .0030 | .0031 | .0032 | .0002 | .0037 | .0006 | .0040 | .0009 | .0043 | .0012 | .0046 |
| 41 | .0027 | .0028 | .0029 | .0002 | .0033 | .0005 | .0036 | .0007 | .0038 | .0010 | .0041 |
| 42 | .0024 | .0025 | .0026 | .0002 | .0030 | .0004 | .0032 | .0006 | .0034 | .0008 | .0036 |
| 43 | .0021 | .0022 | .0023 | .0002 | .0026 | .0004 | .0029 | .0006 | .0031 | .0008 | .0033 |
| 44 | .0019 | .0020 | .0021 | .0001 | .0024 | .0004 | .0027 | .0006 | .0029 | .0008 | .0031 |

1/ These bare wire diameters may be exceeded, provided:

- (a) The maximum diameters specified by QQ-W-343 are not exceeded,
- (b) The minimum increases in diameter shown in table I are maintained, and
- (c) The maximum overall diameters shown in table I are not exceeded.

TABLE II. Characteristics of wire, sizes 45 to 50 AWG.

| AWG size | Theoretical ^{1/} nominal bare wire diameter, inch | Conductor resistance at 20°C ohms per foot | | | Type M, single | | Type M2, heavy | |
|-------------|------------------------------------------------------------------------|-----------------------------------------------|---------|---------|------------------------------------------------|-----------------------------------------|------------------------------------------------|-----------------------------------------|
| | | | | | Minimum increase in diameter, inch | Maximum overall diameter, inch | Minimum increase in diameter, inch | Maximum overall diameter, inch |
| | | Minimum | Nominal | Maximum | | | | |
| 45 | 0.00176 | 3.080 | 3.348 | 3.616 | 0.00010 | 0.00205 | 0.00030 | 0.00230 |
| 46 | .00157 | 3.870 | 4.207 | 4.544 | .00010 | .00185 | .00030 | .00210 |
| 47 | .00140 | 4.868 | 5.291 | 5.714 | .00010 | .00170 | .00030 | .00190 |
| 48 | .00124 | 6.205 | 6.745 | 7.285 | .00010 | .00150 | .00020 | .00170 |
| 49 | .00111 | 7.744 | 8.417 | 9.090 | .00010 | .00130 | .00020 | .00150 |
| 50 | .00099 | 9.734 | 10.58 | 11.43 | .00010 | .00120 | .00020 | .00140 |

^{1/} Theoretical nominal bare wire diameters are in accordance with NBS Handbook 100. Conductor diameter tolerances are shown as resistance values and shall be determined by measuring the resistance of the wire in accordance with ASTM B 193, where applicable. A specimen at least 5 feet long shall be used.

TABLE III. Elongation of finished wire.

| AWG size | Minimum elongation, percent | AWG size | Minimum elongation, percent | AWG size | Minimum elongation, percent | AWG size | Minimum elongation, percent | AWG size | Minimum elongation, percent |
|----------|-----------------------------|----------|-----------------------------|----------|-----------------------------|----------|-----------------------------|----------|-----------------------------|
| 4 | 38 | 14 | 33 | 24 | 28 | 33 | 23 | 42 | 16 |
| 5 | 37 | 15 | 33 | 25 | 28 | 34 | 22 | 43 | 15 |
| 6 | 37 | 16 | 33 | 26 | 27 | 35 | 21 | 44 | 14 |
| 7 | 36 | 17 | 32 | 27 | 27 | 36 | 20 | 45 | 11 |
| 8 | 36 | 18 | 32 | 28 | 26 | 37 | 20 | 46 | 10 |
| 9 | 36 | 19 | 31 | 29 | 26 | 38 | 19 | 47 | 8 |
| 10 | 35 | 20 | 30 | 30 | 25 | 39 | 18 | 48 | 7 |
| 11 | 35 | 21 | 30 | 31 | 24 | 40 | 17 | 49 | 6 |
| 12 | 34 | 22 | 29 | 32 | 24 | 41 | 17 | 50 | 5 |
| 13 | 34 | 23 | 29 | | | | | | |

TABLE IV. Heat shock.

| AWG size | Minimum elongation, percent | Mandrel diameter | Minimum temperature, °C |
|----------|-----------------------------|------------------|-------------------------|
| 4-9 | 30 | None | 240 |
| 10-13 | 25 | 5X | 240 |
| 14-30 | 20 | 3X | 240 |
| 31-44 | 1/20 | 3X | 240 |

^{1/} Or to the breaking point, whichever is less.

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TABLE V. Scrape resistance.

| AWG size | Type M | | Type M2 | | Type M3 | | Type M4 | |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | Average grams-to-fail | Minimum grams-to-fail | Average grams-to-fail | Minimum grams-to-fail | Average grams-to-fail | Minimum grams-to-fail | Average grams-to-fail | Minimum grams-to-fail |
| 10 | 545 | 465 | 1090 | 925 | 1360 | 1150 | 1635 | 1385 |
| 11 | 545 | 465 | 1090 | 925 | 1360 | 1150 | 1635 | 1385 |
| 12 | 545 | 465 | 1090 | 925 | 1360 | 1150 | 1635 | 1385 |
| 13 | 545 | 465 | 1090 | 925 | 1360 | 1150 | 1635 | 1385 |
| 14 | 545 | 465 | 1090 | 925 | 1360 | 1150 | 1635 | 1385 |
| 15 | 510 | 430 | 1015 | 865 | 1270 | 1080 | 1520 | 1295 |
| 16 | 475 | 405 | 955 | 810 | 1190 | 1010 | 1430 | 1215 |
| 17 | 445 | 380 | 890 | 755 | 1115 | 945 | 1335 | 1130 |
| 18 | 420 | 355 | 835 | 710 | 1045 | 890 | 1250 | 1065 |
| 19 | 390 | 335 | 785 | 665 | 980 | 830 | 1175 | 995 |
| 20 | 370 | 315 | 740 | 630 | 920 | 785 | 1110 | 945 |
| 21 | 345 | 295 | 695 | 595 | 865 | 735 | 1040 | 890 |
| 22 | 325 | 275 | 650 | 550 | 810 | 690 | 975 | 825 |
| 23 | 300 | 255 | 605 | 515 | 755 | 645 | 905 | 770 |
| 24 | 285 | 245 | 565 | 485 | 710 | 605 | 845 | 725 |
| 25 | 265 | 225 | 530 | 450 | 665 | 565 | 795 | 675 |
| 26 | 245 | 210 | 495 | 425 | 620 | 530 | 740 | 635 |
| 27 | 230 | 200 | 460 | 395 | 575 | 490 | 860 | 590 |
| 28 | 215 | 185 | 435 | 370 | 540 | 460 | 650 | 555 |
| 29 | 200 | 170 | 405 | 340 | 505 | 425 | 605 | 510 |
| 30 | 190 | 160 | 380 | 325 | 470 | 395 | 570 | 485 |

TABLE VI. Springback of finished wire.

| AWG size | Maximum springback, degrees | | AWG size | Maximum springback, degrees | |
|----------|-----------------------------|-----------------|----------|-----------------------------|-----------------|
| | Types M and M2 | Types M3 and M4 | | Types M and M2 | Types M3 and M4 |
| 14 | 42 | 46 | 23 | 62 | 64 |
| 15 | 46 | 49 | 24 | 67 | 69 |
| 16 | 50 | 53 | 25 | 72 | 74 |
| 17 | 54 | 58 | 26 | 76 | 80 |
| 18 | 58 | 62 | 27 | 50 | 55 |
| 19 | 62 | 66 | 28 | 55 | 60 |
| 20 | 66 | 70 | 29 | 61 | 65 |
| 21 | 53 | 53 | 30 | 66 | 70 |
| 22 | 58 | 58 | | | |

TABLE VII. Minimum breakdown voltages.^{1/}

| AWG size | Volts | | | AWG size | Volts | | |
|-------------|--------|---------|---------|-------------|--------|---------|---------|
| | Type M | Type M2 | Type M3 | | Type M | Type M2 | Type M3 |
| 4 | 2055 | 3700 | 4930 | 25 | 2625 | 4725 | 6325 |
| 5 | 2000 | 3600 | 4800 | 26 | 2550 | 4600 | 6150 |
| 6 | 1945 | 3500 | 4670 | 27 | 2500 | 4500 | 6000 |
| 7 | 1885 | 3400 | 4525 | 28 | 2425 | 4375 | 5850 |
| 8 | 1835 | 3300 | 4405 | 29 | 2375 | 4250 | 5700 |
| 9 | 1775 | 3200 | 4260 | 30 | 2300 | 4150 | 5550 |
| 10 | 3445 | 6200 | 8268 | 31 | 2075 | 3825 | 4850 |
| 11 | 3335 | 6000 | 8005 | 32 | 1850 | 3525 | 4725 |
| 12 | 3220 | 5800 | 7730 | 33 | 1675 | 3250 | 4500 |
| 13 | 3110 | 5600 | 7465 | 34 | 1500 | 2975 | 4250 |
| 14 | 3525 | 6325 | 8450 | 35 | 1325 | 2750 | 3825 |
| 15 | 3425 | 6175 | 8225 | 36 | 1200 | 2525 | 3525 |
| 16 | 3325 | 6000 | 8000 | 37 | 1075 | 2325 | 3525 |
| 17 | 3250 | 5850 | 7800 | 38 | 950 | 2150 | 2975 |
| 18 | 3175 | 5700 | 7600 | 39 | 850 | 1975 | 2750 |
| 19 | 3075 | 5550 | 7400 | 40 | 775 | 1800 | 2750 |
| 20 | 3000 | 5400 | 7200 | 41 | 700 | 1675 | 2150 |
| 21 | 2925 | 5250 | 7025 | 42 | 625 | 1525 | 1975 |
| 22 | 2850 | 5125 | 6850 | 43 | 550 | 1400 | 1975 |
| 23 | 2775 | 5000 | 6675 | 44 | 500 | 1300 | 1975 |
| 24 | 2700 | 4850 | 6500 | | | | |

^{1/} All sizes of type M4 shall be not less than 2000 volts/mil.

TABLE VIII. Continuity.

| AWG size | Maximum number of discontinuities | | | |
|----------|-----------------------------------|---------|---------|---------|
| | Type M | Type M2 | Type M3 | Type M4 |
| 14-24 | 25 | 5 | 3 | 1 |
| 25-30 | 25 | 7 | 5 | 3 |
| 31-46 | 25 | 5 | 3 | 1 |
| 47-50 | 25 | 10 | 7 | 5 |

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Part number: Magnet wire covered by this specification shall be defined by the following part numbering system. Example:
M1177/15-02C029

| | | | |
|-----------------------------------------------------------------|------------------------------------------|--------------------------------------------------|-------------------------------------------------|
| <u>M1177/15-</u> Federal specification identifier | <u>02</u> Two digit type code | <u>C</u> Single letter conductor code | <u>029</u> Three character size code |
|-----------------------------------------------------------------|------------------------------------------|--------------------------------------------------|-------------------------------------------------|

The following codes shall apply:

| Type | Type code | Conductor | Conductor code |
|------|-----------|----------------------|----------------|
| M | 01 | Copper | C |
| M2 | 02 | Aluminum | A |
| M3 | 03 | Nickel-coated copper | N |
| M4 | 04 | Silver-coated copper | S |

The size code shall be the bare wire dimension. AWG wire size shall be used.

Intended use: Type M magnet wire is intended for use in 220°C applications similar to those for which type T is used. Type M magnet wire has been standardized for the repair of shipboard power equipment.

Revision letters are not used to denote changes due to the extensiveness of the changes.

MILITARY INTERESTS:

Custodians:

Army - CR
Navy - SH
Air Force - 85

Review activities:

Army - AR, ER, MI
DLA - IS

User activities:

Army - ME
Navy - AS, CG, MC, OS

CIVIL AGENCY COORDINATING ACTIVITIES:

GSA - FSS, PBO, PCD

INTERIOR - BLM

HHS - FDA

DCGOVT - DCG

NASA - JFK

COMMERCE - NBS

TRANSPORTATION - APM, FAA

Preparing activity:

Navy - SH

(Project 6145-1111-12)