

Cable, Power, Electrical, Portable
General Specification For

RATIONALE

Incorporate AS5756-A2 and update references.

1. SCOPE

1.1 Scope

This specification covers 600-volt heavy duty, portable, power, single and multiconductor, electrical cable for severe flexing service (see detail specifications for voltage limitations).

1.2 Classification

Cable of this specification shall be in accordance with the applicable specification sheet (see 3.1).

1.3 Part Number

Part numbers defined in this specification are coded as in the following example:

M5756	/2	-001
Basic Specification	Applicable Specification Sheet	Dash Number

Example: M5756/2-001. The cable is produced in accordance with part number M5756/2-001 from AS5756.

1.3.1 Basic specification: The basic specification shall describe the performance requirements of components and finished cable.

1.3.2 Applicable specification sheet: The specification sheet shall describe the material and construction details of finished cable and components.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2011 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

**SAE values your input. To provide feedback
on this Technical Report, please visit
<http://www.sae.org/technical/standards/AS5756A>**

SAE WEB ADDRESS:

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of the other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE International Publications

Application for copies should be addressed to SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS5756/1*	Cable, Power, Electrical, 600 Volts, Portable, Single Conductor, Non-Ozone Resistant
AS5756/2*	Cable, Power, Electrical, 600 Volts, Portable, Single Conductor, Ozone Resistant
AS5756/3*	Cable, Power, Electrical, 600 Volts, Portable, Multiconductor
AS5756/4*	Cable, Electrical, 600 Volts, Portable, Multiconductor, Ozone Resistant
AS5756/5*	Cable, 3-Phase Power, Electric, Portable, Multiconductor, 90 Degrees C, 600V, Ozone Resistant, Split Neutral
AS5756/6*	Cable, 3-Phase Power, Electric, Portable, Multiconductor, 90 Degrees C, 600V, Ozone Resistant, Split Phase
AS5756/7*	Cable, Low Inductance, 270 Volt Dc
J1966	Oils, Lubricating, Aircraft Piston Engine (Nondispersant Mineral Oil)

* SAE AS5756 detail specification

2.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI/ASME B46.1 Surface Texture

2.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A686	Tool Steel, Carbon and Carbon-Vanadium
ASTM D1149	Accelerated Ozone Cracking of Vulcanized Rubber, Test for
ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B33	Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B172	Rope-Lay-Stranded Copper Conductors Having Bunched Members, for Electrical Conductors
ASTM B174	Bunch-Stranded Copper Conductors for Electrical Conductors

ASTM D471 Standard Test Method for Rubber Property-Effect of Liquids

ASTM D3599 Kerosene

ASTM D6880 Standard Specification for Wood Boxes

2.4 NATIONAL CONFERENCE OF STANDARDS LABORATORIES (NCSL)

Application for copies should be addressed to National Conference of Standards Laboratories, 2995 Wilderness Place, Suite 107, Boulder, CO 80301-5404, www.ncsli.org

NCSL Z540-1 General Requirements for Calibration Laboratories and Measuring and Test Equipment

2.5 U.S. Government Documents

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

H4/H8 Catalog of Commercial and Government Entities (CAGE)

MIL-STD-104 Limits for Electrical Insulation Color

MIL-STD-129 Military Marking for Shipment and Storage

FED-STD-228 Cable and Wire, Insulated, Methods of Testing

TT-I-735 Isopropyl Alcohol

MIL-STD-2073-1 Standard Practice for Military Packaging

A-A-55057 Panels, Wood/Wood Based; Construction and Decorative

A-A-59282 Chemicals, Analytical; General Specification For

A-A-59551 Wire, Electrical, Copper (Uninsulated)

3. REQUIREMENTS

3.1 Specification Sheets

The requirements for the component wire and finished cable furnished under this specification shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern (see 6.2).

3.2 Qualification

The finished cables furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.3).

3.3 Materials

Materials used in the manufacture of the cable shall be of high quality suitable for the purpose and conforming with Government specifications cited.

- 3.3.1 Conductor materials: All strands used in fabricating the conductors of this specification shall be annealed copper strands 0.0063 nominal inch in diameter (AWG 34) conforming to ASTM B3 or ASTM B33 and shall be uncoated or tin-coated as specified in 4.3.1.1 or 4.3.1.2. Strands shall be free of lumps, kinks, splits, scraped or corroded surfaces and skin impurities.
- 3.3.1.1 Bare copper strands: Bare (uncoated) copper strands shall be used for conductors of size 8 and larger. The bare copper strands shall be in accordance with ASTM B3.
- 3.3.1.2 Tin coated copper strands: Individual copper strands shall be uniformly coated with commercially pure tin for conductor size 10 and smaller. The tin coated copper strands shall be in accordance with ASTM B33.
- 3.3.2 Insulation and jacket materials: Materials for wires and cables shall be in accordance with the applicable specification sheet and shall be capable of meeting all requirements of this specification. Materials shall be designed to be resistant to degradation by ozone and weathering through use of ozone and weathering resistant materials or protectants unless otherwise specified in the specification sheet.
- 3.4 Design and Construction

Wire and cable shall be of the design, construction and physical dimensions specified herein and in the applicable specification sheet.

- 3.4.1 Conductors: Stranded conductors shall be annealed copper wire in accordance with A-A-59551, Temper 1 and coating B or T as specified. Conductors of size 18-14 shall be Type B, Class M, of A-A-59551. Conductors of size 10-250 kcmil shall be Type R, Class M, of A-A-59551. All conductors shall conform to the requirements of Table 1 of this specification unless otherwise required by the specification sheet.

TABLE 1 - REQUIREMENTS FOR CONDUCTORS

Wire size (AWG)	Minimum no. of AWG 34 strands	Lay-Up of strands 2/	Minimum conductor diameter (inches)	Nominal conductor diameter (inches 1/)	Maximum conductor diameter (inches)
18	41	1 x 41	0.046	0.048	0.050
16	65	1 x 65	0.057	0.060	0.063
14	104	1 x 104	0.074	0.078	0.082
12	165	1 x 165	0.095	0.101	0.106
10	259	7 x 37	0.120	0.126	0.132
8	420	7 x 60	0.154	0.162	0.170
6	665	19 x 35	0.204	0.215	0.226
4	1064	19 x 56	0.256	0.269	0.282
2	1666	7 x 7 x 34	0.320	0.337	0.354
1	2107	7 x 7 x 43	0.357	0.376	0.395
1/0	2646	7 x 7 x 54	0.402	0.423	0.444
2/0	3325	19 x 7 x 25	0.483	0.508	0.533
3/0	4256	19 x 7 x 32	0.547	0.576	0.605
4/0	5320	19 x 7 x 40	0.613	0.645	0.677
250 kcmil	6384	19 x 7 x 48	0.655	0.690	0.725

1/ Nominal values are given for information only.

2/ Other stranding constructions may be used provided they contain the minimum number of strands, and are of equivalent flexibility

- 3.4.1.1 Conductor splices: Splices of individual strands or of individual rope lay members are permitted and shall be a butt joint. No more than one joint shall be at the same conductor cross-section and in no case shall an entire conductor be spliced at one point.

- 3.4.1.2 Lay length of stranded conductors: The lay length of bunch stranded conductors (size 12-18) shall be in accordance with ASTM B174. The lay length of rope-lay stranded conductors having bunched stranded members (size 10-250) shall be in accordance with ASTM B172.
- 3.4.2 Separator: When bare (uncoated) conductors are used, a separator of suitable material shall be applied between the conductor and the insulation. When tin-coated conductors are used, application of such separator is optional with the manufacturer. The inner wrap of suitable threads or tapes shall form a close fit over the conductor in such manner that when stripped the conductor is clean and in condition for electrical contact.
- 3.4.3 Insulation thickness: The minimum thickness of insulation over each stranded conductor shall be as specified in the applicable specification sheet (see 4.5.10).
- 3.4.4 Cabling and application of filler: For cables consisting of more than one insulated conductor, the separately insulated conductors shall be cabled together with a left-hand lay and, where necessary, the interstices filled to give the cable a substantially circular cross section. The length of the lay of the conductors shall not exceed 16 times the calculated diameter under the jacket based on specified nominal dimensions. Material used for filler shall be compatible with the requirements of the finished cable.
- 3.4.5 Jacket thickness: The minimum jacket thickness shall be in accordance with Table 2 unless otherwise specified in the applicable specification sheet (see 4.5.11).

TABLE 2 - JACKET THICKNESS, SHOCK AND ABRASION REQUIREMENTS

Diameter under jacket (inches)	Minimum jacket thickness (inches)	Nominal jacket thickness ^{1/} (inches)	Abrasion test weight (pounds)	Impact (shock) test (min. no. of impacts) and abrasion test (min. no. of oscillations)
0.325 and less	0.056	0.0625	2	600
0.326 to 0.430	0.070	0.078	2	800
0.431 to 0.540	0.085	0.094	2	900
0.541 to 0.640	0.098	0.109	3	1000
0.641 to 0.740	0.113	0.125	3	1200
0.741 to 0.850	0.127	0.141	3	1400
0.851 to 1.100	0.140	0.156	6	1550
1.101 to 1.320	0.155	0.172	6	1700
1.321 to 1.550	0.168	0.187	6	1850
1.551 to 1.820	0.182	0.203	6	2000

^{1/} Nominal values are given for information only.

- 3.4.6 Color coding: Cable consisting of two or more conductors shall have the insulation of individual conductors colored as specified herein unless otherwise specified in the applicable specification sheet. The color limits shall be in accordance with MIL-STD-104, Class 2. The conductors shall be cabled together in the color sequence shown below. Unless otherwise specified the insulation of the center conductor shall be colored black.

Conductor number	Conductor insulation color
1	Black
2	White
3	Red
4	Green
5	Orange
6	Brown
7	Blue

Example: A 3-conductor cable will contain 1 black, 1 white and 1 red colored insulated wire.

3.5 Performance

The cables shall be capable of meeting all the requirements of this specification when tested using the test methods of Section 4.

- 3.5.1 Spark (insulation flaws): Prior to assembling into the finished cable, each insulated conductor shall withstand a 3000 ±100 volt spark test to assure there are no electrical defects in the insulation. Any portions of the insulated conductor failing to withstand the voltage shall be removed (see 4.5.2.1).
- 3.5.2 High potential (wet dielectric): All finished cable shall withstand a minimum 3000 ±100 volt AC dielectric voltage between each conductor and the water. Rupture or puncture of the insulation shall constitute failure (see 4.5.2.2).
- 3.5.3 High temperature: The cable shall withstand the dielectric requirement of 3.5.7 and 70 percent of the minimum number of abrasion resistance oscillations of Table 2 after the high-temperature test (see 4.5.3).
- 3.5.4 Impact (shock): The cable shall withstand a minimum number of impact shocks listed in Table 2 after the heat conditioning portion of the test. Failure of a specimen shall be when current ceases to flow or when the specimen shorts out or grounds (see 4.5.4).
- 3.5.5 Abrasion: Cable shall withstand the minimum number of oscillations listed in Table 2 using the applicable weights from Table 2 (see 4.5.5).
- 3.5.6 Fluid immersion: The cable shall not increase in diameter more than 15 percent, shall meet the dielectric requirement of 3.5.7, and shall meet 70 percent of the minimum number of abrasion resistance oscillations of Table 2 after the fluid immersions (see 4.5.6).
- 3.5.7 Dielectric: The cable shall withstand the applicable test voltage while immersed in water. There shall be no rupture or puncture of the insulation (see 4.5.7).
- 3.5.8 Insulation resistance: The cable shall have an insulation resistance of not less than the value of R calculated from the following formula:

$$R = k \log D/d$$

where:

D = diameter over the insulation (inches)

d = diameter under the insulation (inches)

R = insulation resistance (megohms per 100 ft at 60 °F)

k = 2000 unless otherwise specified (see 4.5.8)

3.5.9 Low Temperature

- 3.5.9.1 Cold bend: The insulation or cable jacket shall not crack during the test and must meet the dielectric requirement of 3.5.7 after the test (see 4.5.9.1).
- 3.5.9.2 Cold impact: The insulation or cable jacket shall not fracture during the test and must meet the dielectric requirement of 3.5.7 after the test (see 4.5.9.2).
- 3.5.10 Ozone resistance: Heat aged and un-aged specimens of the cable jacket and the wire insulation of each color shall exhibit no cracks when examined under a seven power optical magnifier after ozone exposure (see 4.5.12).
- 3.5.11 Conductor resistance: The maximum direct current conductor resistance shall not exceed that shown in the applicable specification sheet (see 4.5.13).

3.5.12 Bending endurance: Finished cable shall exhibit no electrical breakdowns or cracking of the outer jacket during or after the test. There shall be no conductor breakage or a short circuit due to shorts between the insulated conductors (see 4.5.14).

3.6 Identification of Product

All cables shall be identified by surface printing on the outside of the jacket or combined insulation and jacket in addition to any marker tape which may be used. Single conductor cables size 8 and larger and all multiconductor cables shall have a marker tape approximately 1/8 inch wide placed under the jacket or insulation in addition to the surface printing. Printing on the surface and the marker tape, when applicable, shall be at intervals of less than 18 inches, as measured from the start of one complete marking to the beginning of the next. The following information shall appear on the cable surface and the marker tape, when applicable:

“SAE specification part number of the cable” (see 1.3) 1/

1/ The dash number is not required to be printed on the surface of the cable

“The manufacturer’s Commercial and Government Entity (CAGE) designation in accordance with publication H4/H8”

“The year of manufacture of the cable”

An example would be:

M5756/2-001123451988

At the manufacturer’s option, the company name or logo may also be printed on the jacket, insulation or the marker tape of the cable.

3.6.1 Use of SAE designations: SAE designations shall not be applied to a product, except for Qualification test samples, nor referred to in correspondence until notice of approval has been received from the qualifying activity.

3.7 Workmanship

Cables shall be constructed and finished in a thoroughly workmanlike manner in accordance with accepted high grade production techniques. The cables shall be a uniform and consistent product and shall be free from any defects which will adversely affect the serviceability of the product, such as lumps, kinks, splits, abrasions, scrapes, corroded surfaces, skin impurities and faulty extruded surfaces.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all contract inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the supplier may use any qualifying activity approved facilities suitable for the performance of the inspection requirements specified herein. The purchaser and qualifying activity has the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for Compliance

All items must meet all technical requirements of the product specification. The inspection set forth in this specification shall become a part of the supplier’s overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the supplier of the responsibility of assuring that all products comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the purchaser to acceptance of defective material.

4.1.2 Test Equipment and Inspection Facilities

Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspection shall be established and maintained by the supplier. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with NCSL Z540-1 or equivalent standards approved by the qualifying activity.

4.1.3 Classification of Inspections

The inspections conditions specified herein are classified as follows:

- a. Initial Qualification Inspection (see 4.3)
- b. Retention of Qualification Inspection (see 4.3.2)
- c. Quality Conformance Inspection (see 4.4)

4.2 Inspection Conditions

The conditions for the inspections are specified as applicable and all test data shall be compiled in accordance with qualifying activity authorization letter.

4.3 Initial Qualification Inspections (see 6.3)

Initial qualification inspection shall be in accordance with Tables 3 and 3A. Sequential testing is not required except as specified. A request for initial qualification shall be made to the qualifying activity prior to initiating testing. Testing cannot begin until the supplier has received an authorization letter. The supplier is recommended to provide the qualifying activity a test plan based on the authorization letter to ensure the supplier and qualifying activity maintain communication and document changes as needed. The qualifying activity has the authority to modify the specification test requirements to resolve test failures/discrepancies and to wave testing to verify specific product manufacturing changes or qualifications by similarity. For each component tested, the supplier shall use the same materials, manufacturing procedures, and methods of inspection as would be used to provide the component to a purchaser. Any material, design or significant change in the supplier's process control inspections, quality conformance inspections, or manufacturing control drawings (editorial changes are acceptable) without the express approval of the qualifying activity may result in loss of qualification for that product. The qualifying activity shall perform the tests specified in Table 3 and supplier shall perform the tests specified in Table 3A in a laboratory of their choice. All test laboratories requires qualifying activity approval.

TABLE 3 - QUALIFYING ACTIVITY TEST REQUIREMENTS

Examination or test	Requirement Paragraph	Examination or Test Paragraph
Conductor stranding <u>1/</u>	3.4.1	4.5.1
Dimensions	3.1	4.5.1
Weight	3.1	4.5.1
Marking	3.6	4.5.1
Length of lay <u>2/</u>	3.4.1.2	4.5.1
Color coding <u>2/</u>	3.4.6	4.5.1
Insulation thickness	3.4.3	4.5.10
Jacket thickness <u>2/</u>	3.4.5	4.5.11
Spark test	3.5.1	4.5.2.1
High potential	3.5.2	4.5.22
Insulation resistance	3.5.8	4.5.8
Cold bend	3.5.9.1	4.5.9.1
Cold impact	3.5.9.2	4.5.9.2
Conductor resistance <u>1/</u>	3.5.11	4.5.13

1/ Not required for multi-conductor cable

2/ Not required for single conductor cable

TABLE 3A - SUPPLIER TEST REQUIREMENTS

Examination or test	Requirement Paragraph	Examination or Test Paragraph
High temperature test	3.5.3	4.5.3
Impact shock	3.5.4	4.5.4
Abrasion resistance	3.5.5	4.5.5
Fluid immersion	3.5.6	4.5.6
Ozone resistance <u>1/</u>	3.5.10	4.5.12
Bending endurance	3.5.12	4.5.14

1/ When required by the detail specification

4.3.1 Initial Qualification Test Report

The supplier shall furnish the qualifying activity one certified test report containing the following information:

- a. The quantitative results for tests specified in Table 3A and the authorization letter. Upon request from the supplier, the qualifying activity will provide certified Table 3 test results for the test report.
- b. A tabulated comparison of the dimensions specified herein and each manufacturing control drawing for components qualified by similarity.

4.3.2 Retention of Qualification Inspection

At 36-month intervals, the qualifying activity shall authorize the supplier to begin Retention of Qualification. The qualifying activity may establish an alternate due date to accommodate testing schedules. The supplier shall provide a retention of qualification test report (see 4.3.3). The qualifying activity shall perform the Table 3 tests on samples, which have passed the quality conformance inspection (see 4.4). The qualifying activity will provide certified data to the supplier upon request. Failure to submit to Retention of Qualification shall result in loss of qualification for that product.

4.3.3 Retention of Qualification Test Report

The supplier shall furnish the qualifying activity one certified test report containing the following information:

- a. A summary of the results of quality conformance tests, including corrective actions performed during the retention period indicating as a minimum, the number of lots that passed and the number that failed.
- b. A tabulated comparison of the dimensions specified herein and each manufacturing control drawing for components qualified by similarity.

4.3.4 Initial and Retention Qualification Similarity Sample Lot

The test sample lot size for initial and retention of qualification tests shall be a 200 minimum foot specimen of each type or size indicated below:

- a. Single conductor cable: Qualification of size 14 shall qualify sizes 18, 16, 14, 12 and 10. Qualification of size 6 shall qualify sizes 8, 6, 4 and 2. Qualification of size 1/0 shall qualify sizes 1, 1/0, 2/0, 3/0, 4/0 and 250 kcmil.
- b. Multi-conductor cable: Qualification of a 3-conductor cable shall cover all multi-conductor cables in the sizes specified in (a. above). Unless otherwise specified by the qualifying activity, a separate multi-conductor cable for each size of construction shall be used to qualify cables containing wire of different sizes.

Additional qualification by similarity may be authorized by the qualifying activity when justified by the supplier. The supplier and qualifying activity shall perform all tests on samples from the same lots.

4.3.5 Qualification Non-compliance

Failure to pass all qualification requirements shall result in disapproval of the components that failed and the family of components represented by the failed components.

4.3.6 Forwarding of qualification test report and specimens

Unless otherwise specified by the qualifying activity, fifty feet of untested cable for each size range and type to be qualified, and the manufacturer's certified test report shall be forwarded to the qualifying activity (see 6.4). The specimens shall be stamped by the Government inspector as representative sample lot of the manufacturer's normal production capability. Specimens submitted without the stamp will not be accepted. Tags shall be attached to specimens with the following information:

- a. Manufacturer's name or CAGE number
- b. Specification part number for each construction
- c. Description of insulating and jacketing materials
- d. Thickness of insulation and jacket
- e. Description of fillers, separator, etc. (if used)

4.4 Quality Conformance Inspection

Quality conformance inspection shall consist of the following tests performed on every lot of wire or cable procured under this specification:

- a. Individual inspection.
- b. Sampling inspection.

4.4.1 Inspection of packaging: Except when commercial packaging is specified, the sampling and inspection of the preservation and interior package marking shall be in accordance with quality conformance inspection requirements of MIL-STD-2073-1. The sampling and inspection of the packing for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification shown in Section 5. The inspection of marking for shipment and storage shall be in accordance with MIL-STD-129. The inspection of commercial packaging shall be as specified in the contract (see 6.2).

4.4.2 Individual tests: All cable and wire produced in accordance with this specification shall be subjected to the following tests as described under "Test methods" (see 4.5).

- a. Examination of product (see 4.5.1).
- b. Spark test (see 4.5.2.1).
- c. High potential (wet dielectric) (see 4.5.2.2).

4.4.3 Sampling tests: Three samples shall be selected at random from each lot of 50 000 feet and one sample for each additional 10 000 feet of finished cable for each test listed below. The sample size shall not exceed one sample for each continuous length of finished cable. Specimen lengths shall be as specified in the individual test paragraphs. An inspection lot shall consist of all cable of the same military part number produced under essentially the same conditions and offered for inspection at the same time. Sampling tests shall consist of the following:

- a. Low temperature (see 4.5.9).
- b. High potential (wet dielectric) (see 4.5.2.2).
- c. Insulation resistance (see 4.5.8).
- d. Insulation thickness (see 4.5.10).
- e. Jacket thickness (see 4.5.11).
- f. Conductor resistance (4.5.13).

4.4.4 Rejection and retest: When sampling tests are specified on a number of samples that are selected as representative of a certain lot, and one or more of this number fails to meet the specified test(s), acceptance of all items shall be withheld until the extent and cause of failure is determined. Individual tests may be continued pending investigation of a Sampling test failure, but the final acceptance of the product is contingent upon the Inspector's decision regarding the overall performance of the product to specification requirements. If investigation indicates that the defects may exist on items previously accepted, full particulars concerning the defect(s) found, including recommendations for correction shall be furnished to the contracting activity.

4.5 Test Methods

4.5.1 Examination of product: Cable and wire shall be examined to ascertain compliance with this specification and the applicable specification sheet with respect to material, workmanship, construction, dimensions, stranding, identification and color coding.

4.5.2 Potential Test

4.5.2.1 Spark test: The insulation of each individual wire, prior to final assembly into the finished cable, shall be subjected to the test of Method 6211 of FED-STD-228. The test voltage shall be 3000 ± 100 volts AC and all wire sizes shall be tested. Any flaws detected in the insulation shall be removed.

4.5.2.2 High-potential (wet dielectric) test: Each reel or spool of finished cable shall be immersed in tap water for a period of 6 hours after which a minimum 3000 ± 100 volts shall be impressed in the following manner for a minimum period of one minute:

Single conductor cable - Between the conductor and water.

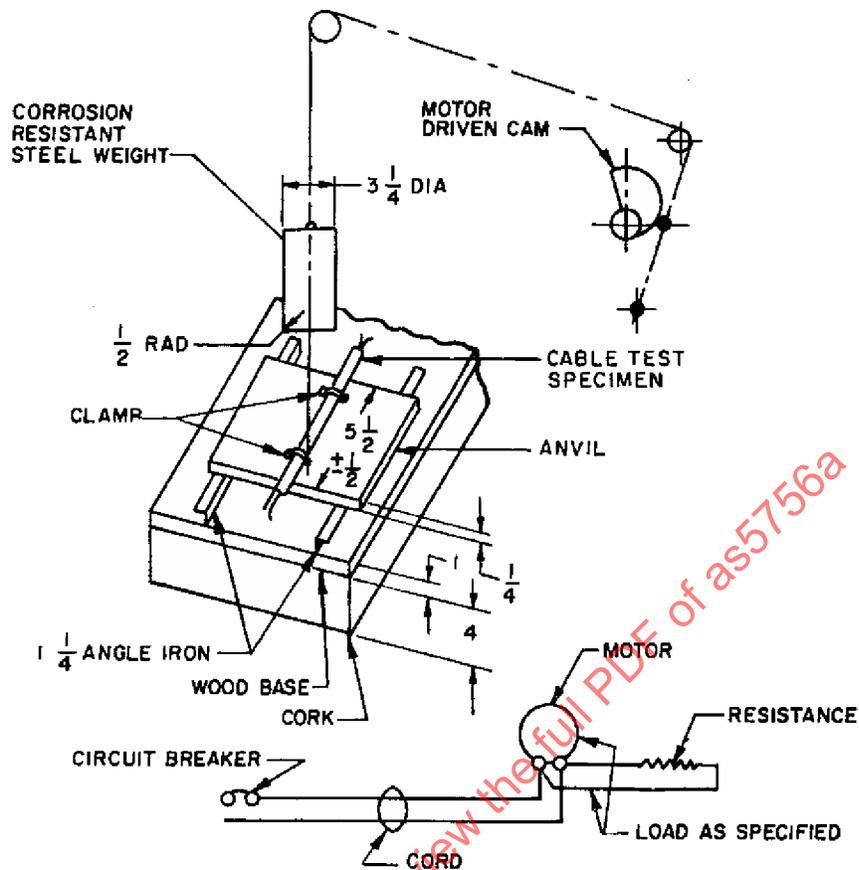
Multi-conductor cable - Between each conductor and all other conductors connected together and to the water.

4.5.3 High-temperature tests: A minimum 2 feet ± 3 inches specimen stripped to the bare conductor or conductors, 1 to 1-1/2 inches from each end, shall be suspended around a mandrel $5 \pm 1/2$ times the outside diameter of the cable. A weight, as shown in Table 2 for the applicable size of the cable shall be attached to the exposed conductor at each end. The specimen on the mandrel with the weights freely suspended shall be placed in a circulating air oven maintained at a temperature of 100 ± 2 °C for a minimum period of 120 ± 1 hours. The weight shall be removed from the specimen when the specimen has been allowed to cool to room temperature. The bent portion of the specimen shall then be bent not less than 180 degrees around the mandrel in the opposite direction with the opposite side of the cable in contact with the mandrel at a uniform rate for a minimum 180-degree bend within 30 seconds. The specimen shall then be subjected to the dielectric test of 4.5.7. Following the dielectric test, and within 24 hours, the specimen shall be subjected to the abrasion test of 4.5.5, using 70 percent of the minimum number of oscillations specified in Table 2.

4.5.4 Impact (shock): Three 18-inch (minimum) specimens of completed cable shall be used for this test.

4.5.4.1 Heat conditioning: The specimens shall be freely suspended in an air oven at a temperature of $+71^\circ \pm 1$ °C for a minimum period of 72 ± 1 hours. At the expiration of the 72-hour period, the specimens shall be removed from the oven and allowed to remain at room temperature for a minimum of 24 hours, after which they shall be subjected to the following test.

4.5.4.1.1 Procedure: The impact shall consist of dropping a 23 ± 1 -0 pound weight a distance of $6.5 \pm 1/2$ inch, minus the outside diameter of the test sample, on the center portion of the sample while it is clamped flat on a smooth metal plate as shown on Figure 1. The drops shall be made at the rate of 25 ± 2 per minute. There shall be a continuous current of $3 \pm 1/2$ amperes through size 18 and smaller conductors, $5 \pm 1/2$ amperes through size 16, and $15 \pm 1/2$ amperes for size 14 and larger, while undergoing this test. To detect interior short circuit or failure, 1/3 to 1/2 of the conductors of a multi-conductor cable shall be permanently connected in a series with adjacent conductors connected into the load circuit. The minimum number of shocks shall be not less than specified in Table 2 based on the average for three samples.

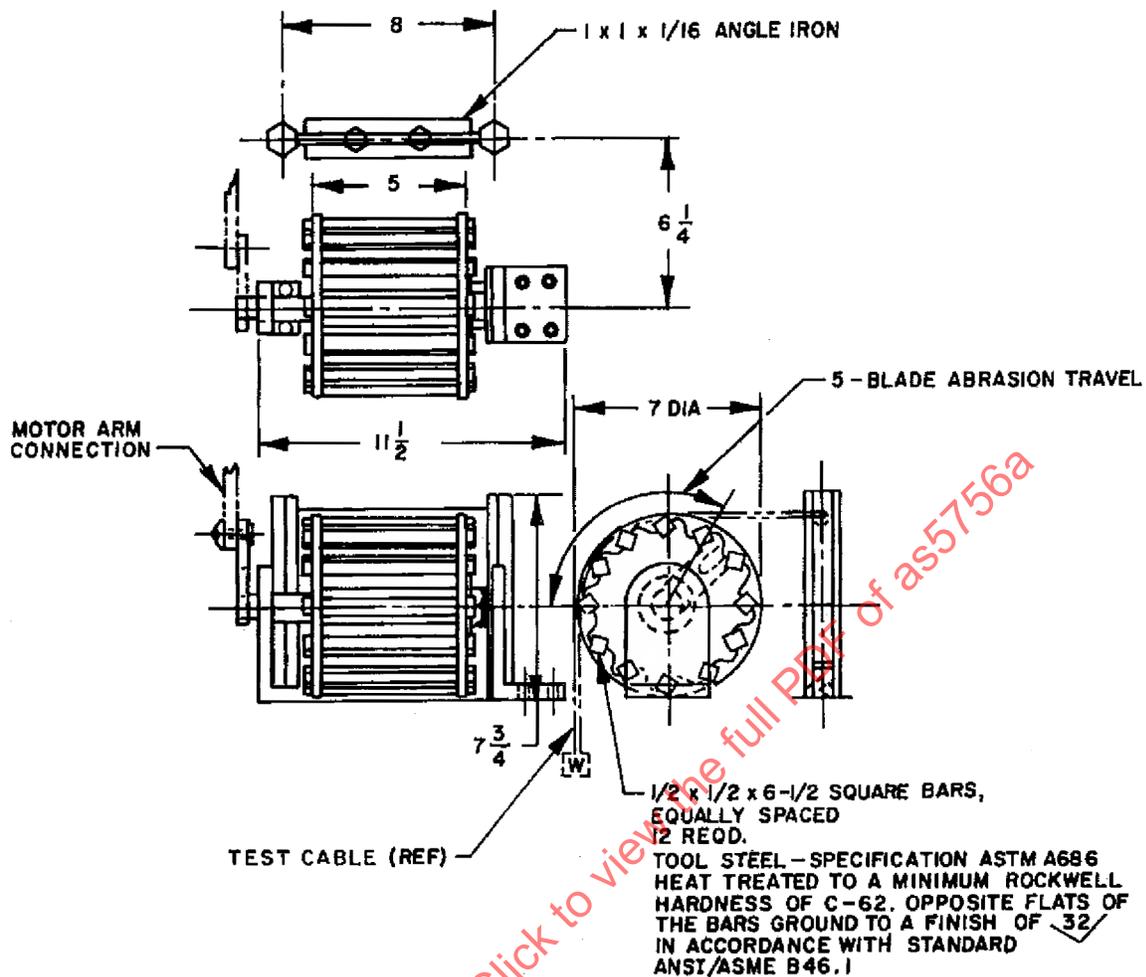


WIRING DIAGRAM

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS = $\pm 1/64$

FIGURE 1 - IMPACT (SHOCK)

- 4.5.5 Abrasion test: Two untested samples 2.5 feet minimum in length shall be mounted securely at one end and weights as specified in Table 2 freely suspended to the other end with the cable placed over a squirrel cage abrasion tested as shown on Figure 2. A suitable tripping circuit shall be arranged to denote failure by stopping the machine when any bar of the squirrel cage comes in contact with the bare conductor of the cable or wire. The specimen shall be subjected to 20 ± 2 oscillations per minute. The minimum number of oscillations to failure shall be as specified in Table 2. An oscillation shall consist of 5 bars travel forward and backward from a given point.



DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS $\pm 1/64$

FIGURE 2 - ABRASION TEST APPARATUS

- 4.5.6 Fluid immersion: Four individual samples 2.5 feet minimum in length shall be stripped to the bare conductor on either end for 1 inch and formed in a loop not less than 5 times the diameter of the cable. A minimum of 18 inches of the cable shall then be placed in each of the fluids specified in Table 4 for the time specified. Within 15 minutes after completion of the soaking and air drying, the increase in diameter shall be measured. Samples shall be subjected to the Dielectric test of 4.5.7 and the Abrasion test of 4.5.5 using 70 percent of the minimum number of oscillations in Table 2.

TABLE 4 - FLUIDS

Fluid	Soak time (hours)	Air-drying time (hours)
Hydrocarbon fluid (Specification ASTM D471, Type III)	4	2
Isopropyl alcohol (Specification TT-I-735)	4	2
Chemical, analytical		
Kerosene and aircraft lubricating oil, 50% each at 48° to 50°c (Specifications ASTM D3599 and SAE-J1966, grade 1100, respectively)	16	3

4.5.7 Dielectric test: This method applies to specimens previously conditioned in the tests of 4.5.3, 4.5.6 and 4.5.9. Unless otherwise specified, the test sample shall consist of approximately 2-foot lengths of cable with the insulation, filler and outer protective jacket, as applicable, removed for a distance of 1 inch from the ends of each specimen or each conductor in multi-conductor cable. Filler and outer jacket shall be removed from the stripped conductors of multi-conductor cable a minimum of 3 inches on each end.

4.5.7.1 Procedure: The specimen shall be formed into a loop, and the ends of the conductor or conductors shall be twisted or clamped together. The loop thus formed shall be immersed in tap water in order that not more than 1-1/2 inches of each end of the insulation will protrude above the surface of the water for a period of four hours. At the conclusion of the four-hour period of immersion and while the specimen is still immersed, the applicable voltage below shall be applied between each conductor and all other conductors and the water for a period of 1 minute.

Conductor Size (AWG)	Test Voltage (at 60 Hertz)
18-16	1500
14-8	3000
6-2	3500
1-4/0	4000
250 kcmil	5000

4.5.8 Insulation resistance: The insulation resistance shall be determined using Test Method 6031 of FED-STD-228, except the time of water immersion shall be 4 hours minimum. A direct-current potential of 100-500 volts shall be used. If a temperature correction factor is used to convert the insulation resistance value to 60 °F, it shall be furnished by the cable manufacturer.

4.5.9 Low Temperature

4.5.9.1 Cold bend: A specimen of sufficient length of cable or wire shall be placed in a cold chamber and conditioned at $-54^{\circ} \pm 2^{\circ} \text{C}$ for 4 hours minimum. Upon the completion of the conditioning period and while still at -54°C , the specimen shall be bent twice around a mandrel of a diameter 5 to 7 times the outer diameter of the specimen within 24 ± 6 seconds at a uniform rate of five turns per minute for two complete turns. The specimen shall remain in contact with the mandrel during the test. The mandrel shall be rotated by a handle or other control located outside the cold chamber. Upon completion of this test and within 15 minutes the specimen shall be subjected to the dielectric test of 4.5.7.

- 4.5.9.2 Cold impact test: A specimen of sufficient length of cable, whose outer jacket has been removed for approximately 1 foot on one end, shall be placed in a cold chamber and conditioned at $-54^{\circ} \pm 2^{\circ} \text{C}$ for 4 hours minimum. Upon completion of the conditioning period and while still at -54°C , the cable shall be placed on an anvil consisting of 3/8-inch steel plate and subjected to a 3 to 3-1/2 foot-pound impact by dropping a weight having a ball-shaped end with a $1/2 \pm 1/64$ inch radius through a tube at right angles to the specimen. Individual insulated conductors shall be subjected to a .25 to .31 foot-pound impact. Three drops shall be made at the same spot on the specimen. Upon completion of this test, the specimens shall be subjected to the Dielectric test of 4.5.7.
- 4.5.10 Insulation thickness: Measurement of thickness shall be made in accordance with Method 1011 or 1014 of FED-STD-228.
- 4.5.11 Jacket thickness: Measurement of thickness shall be made in accordance with Method 1011 or 1014 of FED-STD-228.
- 4.5.12 Ozone resistance: The test samples shall consist of at least four specimens of the finished cable and at least six specimens of each color of insulated wire removed from the finished cable. The length of each specimen shall be sufficient to allow cable of 1 inch or less diameter to be wrapped a minimum of 5 turns on the appropriate mandrel listed below and over 1.00 inch diameter cable to be wrapped a minimum of 3 turns on the appropriate mandrel listed below. Mandrel sizes are:

Specimen Diameter (Inches)	Mandrel Diameter
0.0 to 0.500	3-1/2 to $4 \pm 1/2$ x specified diameter
0.501 to 0.750	4-1/2 to $5 \pm 1/2$ x specified diameter
0.751 to 1.250	5-1/2 to $6 \pm 1/2$ x specified diameter
1.251 to 1.750	7-1/2 to $8 \pm 1/2$ x specified diameter
1.751 and larger	9-1/2 to $10 \pm 1/2$ x specified diameter

The specimens must be at room temperature for at least one week before sample preparation. One half of the test specimens shall be tested for ozone resistance after heat aging and one half shall be tested unaged. The heat aging shall be at $158^{\circ} \text{F} \pm 5^{\circ} \text{F}$ (70°C) for 70 ± 5 hours and the specimens shall then be kept at room ambient for at least four days after removal from the aging oven and before the ozone test. The ozone test shall be conducted per ANSI/ASTM D1149 except for the chamber temperature shall be $100^{\circ} \text{F} \pm 5^{\circ} \text{F}$, the ozone concentration shall be 50 ± 3 parts ozone per 100 000 000 parts of air, and the exposure time shall be 168 ± 1 hour. At the end of the exposure, the mounted specimens shall be removed from the chamber and allowed to cool to room temperature. The specimens shall be examined for cracks in the jacket or insulating materials under a seven power optical magnifier.

- 4.5.13 Conductor resistance: The direct current resistance of each conductor shall be measured on the finished wire or cable as specified in Method 6021 of FED-STD-228, except that immersion is not required and a Kelvin bridge or other suitable instrument may be used. The increase in conductor resistance per foot due to cabling in multi-conductor cables is incorporated into the conductor resistance values of the specification sheets.
- 4.5.14 Bending endurance: Three samples of the completed cable shall be prepared in accordance with Figure 3 and the conductors connected in series as shown in Figure 4. These samples shall be subjected to 2000 (minimum) flexural cycles using the fixture shown in Figure 5. A 110 V, 60 Hz AC potential with a load current of not less than 0.5 amperes shall be impressed on each conductor and shown on an ammeter.