INCH-POUND
MIL-DTL-32180
17 November 2004
SUPERSEDING
MIL-DTL-915/1F
22 August 2002

DETAIL SPECIFICATION

CABLE ASSEMBLY, AIRCRAFT ELECTRICAL SERVICE

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification establishes the design for an aircraft electrical service cable assembly used to connect shipboard 400Hz power from Aircraft Electrical Servicing System (AESS) stations to onboard aircraft.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	-	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment (Type 1 - Environmental and Type II - Internally Excited)

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to commandstandards@navsea.navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

DEPARTMENT OF DEFENSE DRAWINGS

MS90362	-	Connector, Receptacle, External Electric Power, Aircraft, 115/200 Volt, 400 Hertz

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specification exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Materials. The contractor shall select materials capable of meeting all of the operational and environmental requirements specified herein.

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Cable assembly electrical characteristics.

3.3.1 Rating. The power conductors of the aircraft servicing cable assembly shall be rated at 600 Volts and shall have a minimum current carrying capacity of 175 Amperes. When operating with the minimum current carrying capacity of 175 Amperes, the conductor temperature rise shall not exceed 50 °C. The control conductors shall be rated at 300 Volts and shall have a minimum current carrying capacity of 5 Amperes.

3.3.2 Voltage drop. The application of a load of 175 Amperes per phase, 0.8 power factor, to the aircraft servicing cable assembly shall result in a maximum voltage drop of 0.04 Volts per foot per phase, when tested at 400Hz, with a 20 °C ambient temperature.

3.3.3 Voltage unbalance. The application of a balanced load of 175 Amperes per phase, 0.8 power factor, to the aircraft servicing cable assembly shall result in a maximum voltage unbalance phase-to-phase of 0.5 Volts, when tested at 400Hz, with a 20 °C ambient temperature.

3.3.4 Dielectric strength. The dielectric strength between conductors shall not exhibit a leakage current that exceeds 70 micro-amps.

3.3.5 Insulation resistance. The insulation resistance between the conductors shall be a minimum of 100 megohms.

3.4 Cable assembly design.

3.4.1 Cable assembly length. Each aircraft servicing cable assembly shall be 90 ± 1.5 feet in length. Certain applications may call for shorter lengths in which case the same tolerance applies (see 6.2).

3.4.2 Conductor material. The current carrying conductors of the aircraft servicing cable assembly shall be made from annealed copper wire in accordance with A-A-59551, Temper 1 and coating B or T.

3.4.3 Number and size of conductors. The aircraft servicing cable assembly shall contain six AWG 5 conductors, two per phase, helically laid around one AWG 2 center neutral conductor. There shall be a minimum of six control conductors with a minimum size of AWG 18.

3.4.4 Conductor termination. Each phase conductor (A, B, C, and N) shall be separately lugged to fit 0.375 inch studs. All control conductors shall be lugged to fit #8 size screws. The outer jacket shall be stripped back to reveal 12 ± 0.5 inches of each conductor except the neutral shall be 14 ± 0.5 inches long. Heat shrink tubing shall be applied to cover the bundle of 12-inch long leads, leaving 2 inches of the neutral uncovered.

3.4.5 Cable jacket. The outer jacket of the aircraft servicing cable shall be made of reinforced neoprene and shall be capable of withstanding severe abrasion (see 4.5.6).

3.4.6 Cable diameter. The outer diameter of the aircraft servicing cable shall not exceed 1.55 ± 0.05 inches.

3.4.7 Bend radius. The aircraft servicing cable shall have a minimum bend radius of 9 inches and shall be able to sustain a minimum of 750 consecutive bends without conductor strand breakage in excess of the allowable limits (see 4.5.6) and 2500 consecutive bends without jacket rupture.

3.4.8 Cable impact. The aircraft servicing cable shall be capable of withstanding the impact of a 6 lb. weight dropped repeatedly for 1000 times from a height of 1 foot without experiencing any splits, tears, cracks, or ruptures in the jacketing, short circuits, or loss of continuity in the conductors.

3.4.9 Cable weight. The aircraft servicing cable shall weigh no more than 1.8 + 0.1 lbs. per ft. (excluding the aircraft servicing connector).

3.4.10 Cable marking. The aircraft servicing cable shall be marked along the exterior jacket and shall include:

a. Manufacturer's name and part number

b. "Aircraft Power Cable"

3.4.11 Helical deformation. The aircraft servicing cable shall be capable of withstanding up to 2000 deformation cycles (see 4.5.10). These deformation cycles produce severe mechanical stresses, which cause the internal cable elements to move with respect to each other. Failure of cable elements to return to their original positions results in progressive helical deformation of the cable.

3.4.12 Aircraft servicing connector.

3.4.12.1 Connector. The aircraft servicing connector shall be integrally molded to one end of the cable and shall be watertight. The connector shall provide the interface with shipboard aircraft and shall engage with receptacles conforming to MS90362 and MS90362-1. The aircraft servicing connector shall have six socket contacts marked A, B, C, E, F, and N, arranged as shown on Figure 1. Socket contacts A, B, C, and N shall be connected to phase conductors A, B, C, and Neutral, respectively.

3.4.12.2 Connector flexing. The molded aircraft servicing cable connector shall be capable of withstanding 10,000 flexing cycles when installed in a mating receptacle without visual evidence of cable and connector damage (see 4.5.11).

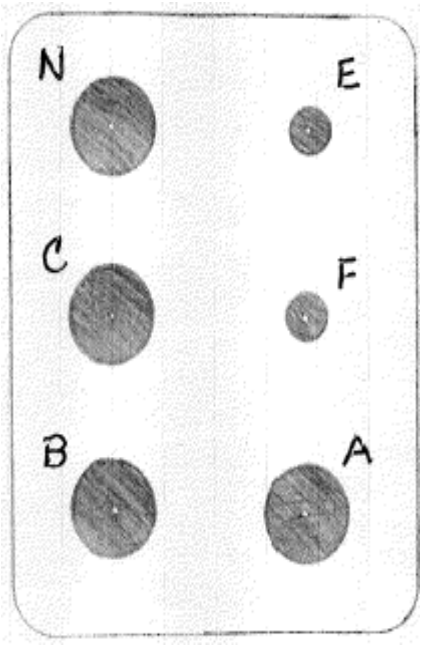


FIGURE 1. Connector socket arrangement (as viewed from the face which mates with the aircraft receptacle).

3.4.12.3 Contact section. The contact section of the molded aircraft servicing connector shall be capable of being repaired in the field by installing a one-piece, molded, replacement contact section. Installation of the contact section shall restore watertight integrity to the molded aircraft servicing connector. Repair shall not include replacement of the entire aircraft servicing connector.

3.4.12.4 Engagement force. The aircraft servicing connector shall be capable of being engaged and disengaged from the aircraft receptacle 1000 times with a force of 80 ± 20 lbs. throughout the operating temperature range of -30 °C to +55 °C.

3.4.12.5 Pushbutton switches. The molded aircraft servicing connector shall include an integral ON/OFF pushbutton switch module that is capable of connecting and disconnecting power to the aircraft receptacle. The ON switch shall be normally OPEN and the OFF switch shall be normally CLOSED. Both switches shall have a minimum continuous AC rating of 115 Volts, 1 Amperes, at 60-400Hz , and a minimum continuous DC rating of 28 Volts, 2 Amperes. The pushbutton switches shall be housed in a single, replaceable, watertight module that is keyed to guard against improper installation. Replacement shall not include any wiring. Installation shall restore watertight integrity to the aircraft servicing connector.

3.4.12.6 Insertion interlock. The F-socket of the molded aircraft servicing connector shall be constructed of three distinct parts: conductor, insulator, and conductor. The two isolated contacts of the F-socket shall be used as part of a safety interlock circuit to prevent power from being applied to the aircraft servicing connector when not installed into the aircraft receptacle. Removal of the aircraft servicing connector from the aircraft receptacle shall disconnect power with no amperage level dependency. The F-socket contacts shall be part of the replaceable, molded, contact section (see 3.4.12.3).

3.4.12.7 Insertion interlock controller. The insertion interlock shall include a controller that accepts a 115 Volt, 400Hz, input signal and provides a 24 Volt DC signal that is fully isolated from neutral and ground. This controller module shall also include two isolated sets of normally OPEN relay contacts, rated for 115 Volts, 1 Ampere AC, or 28 Volts, 2 Amperes DC. This controller module shall not exceed 3 inches x 3 inches x 3 inches in size. The controller module shall be watertight. The controller module shall meet Grade A, Class I shock of MIL-S-901 and Type I vibration of MIL-STD-167-1. The controller module shall be supplied separately.

3.4.12.8 Control wiring. The control wires shall be connected to socket contacts E and F, and the pushbutton switches as shown in Figure 2.

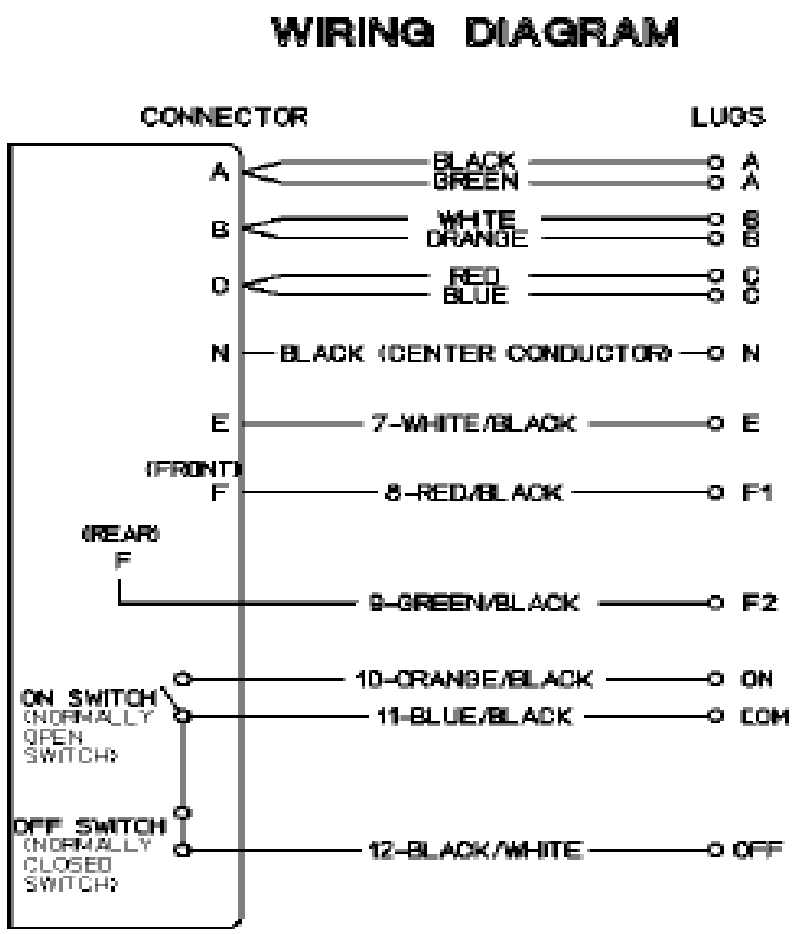


FIGURE 2. Wiring diagram.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall be performed on one complete aircraft servicing cable assembly when a first article sample is required (see 6.1). First article inspection shall include the examination and inspections in accordance with Table I.

4.3 Conformance inspection. Conformance inspection shall include the examination and inspections in accordance with Table I.

TABLE I. Examination and inspections.

Test requirement	Requirement paragraph	Inspection paragraph	First article inspection	Conformance inspection
Rating	3.3.1	4.5.1	X	
Voltage drop	3.3.2	4.5.2	X	
Voltage unbalance	3.3.3	4.5.3	X	
Dielectric strength	3.3.4	4.5.4	X	
Insulation resistance	3.3.5	4.5.5	X	X
Cable assembly length	3.4.1	4.4	X	X
Conductor material	3.4.2	4.4	X	
Conductor number & size	3.4.3	4.4	X	
Conductor termination	3.4.4	4.4	X	X
Cable abrasion	3.4.5	4.5.6	X	
Cable diameter	3.4.6	4.4	X	X
Bend radius	3.4.7	4.5.7	X	
Cable impact	3.4.8	4.5.8	X	
Cable weight	3.4.9	4.5.9	X	
Cable marking	3.4.10	4.4	X	X
Helical deformation	3.4.11	4.5.10	X	
Connector	3.4.12.1	4.4	X	X
Connector flexing	3.4.12.2	4.5.11	X	
Contact section	3.4.12.3	4.4	X	X
Engagement force	3.4.12.4	4.5.12	X	
Pushbutton switch	3.4.12.5	4.4	X	X
Insertion interlock	3.4.12.6	4.5.13	X	
Interlock controller shock	3.4.12.7	4.5.14	X	
Interlock controller vibration	3.4.12.7	4.5.15	X	

4.4 Examination. Each aircraft servicing cable assembly shall be examined for compliance with the requirements specified in 3.2 through 3.4.12.7. This element of inspection shall encompass all visual examinations and dimensional measurements. Noncompliance with any specified requirements or presence of one or more defects preventing the assembly from performing its intended function shall constitute cause for rejection.

4.5 Methods of inspection.

4.5.1 Conductor rating. Connect power conductors A, B, C, and N in series, and apply a DC current of 175 ± 0.5 Amperes for 30 minutes. The temperature rise of the conductors, as measured directly on the copper, shall comply with 3.3.1.

4.5.2 Voltage drop. With the aircraft servicing cable assembly supplying a load of 175 Amperes, 0.8 power factor per phase, the voltage drop across the cable assembly shall comply with 3.3.2.

4.5.3 Voltage unbalance. With the aircraft servicing cable assembly supplying a load of 175 Amperes, 0.8 power factor, 400Hz, per phase, the voltage unbalance shall comply with 3.3.3.

4.5.4 Dielectric strength. The dielectric strength between the conductors shall be tested at 1500 Volts DC. The test voltage shall be applied for a period of 60 seconds. The leakage current shall comply with 3.3.4.

4.5.5 Insulation resistance. The insulation resistance between the conductors when measured with a 500 Volt megger shall comply with 3.3.5.

4.5.6 Cable abrasion. Two samples of cable, each 2.5 ft. in length, are required for this inspection. Each sample shall be mounted securely at one end, and a 10 lb. weight shall be freely suspended from the other. The samples shall be placed over the squirrel cage abrasion apparatus shown in Figure 3. 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. The specimen shall be subjected to 1000 oscillations at a rate of 20 ± 2 oscillations per minute. An oscillation shall consist of 5 bars travel forward and backward from a given point.

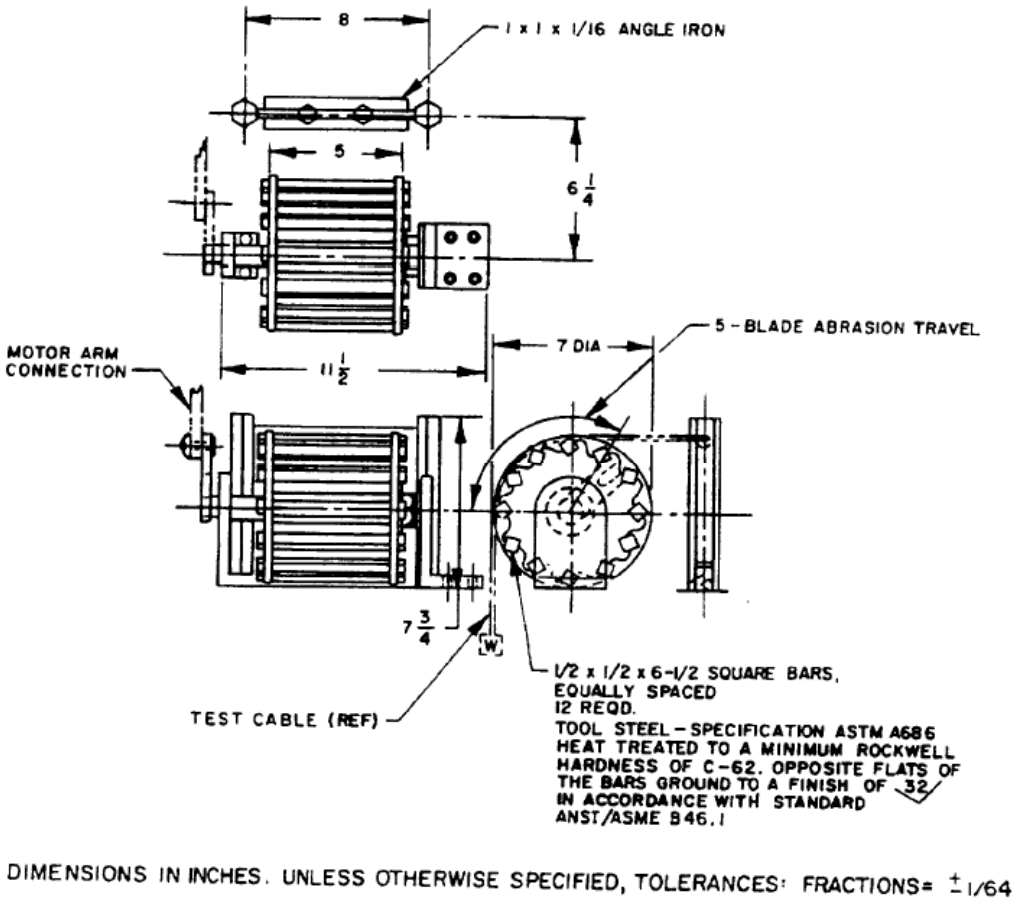


FIGURE 3. Cable abrasion test apparatus.

4.5.7 Bending endurance. This inspection determines the effects of repeated reversing bending motion on the cable and its component conductors.

4.5.7.1 Specimen description. Two sample cable assemblies shall be subjected to the following bending endurance inspection. The specimen samples shall be 84-inches long, including aircraft servicing connector.

4.5.7.2 Test apparatus. The test apparatus (see Figure 4) shall include a means for suspending the cable assembly vertically and for automatically bending the upper portion of the sample to the left and to the right by 150 degrees as measured from vertical, as shown. The test apparatus shall not have a mandrel that restricts the severity of bending of the cable.

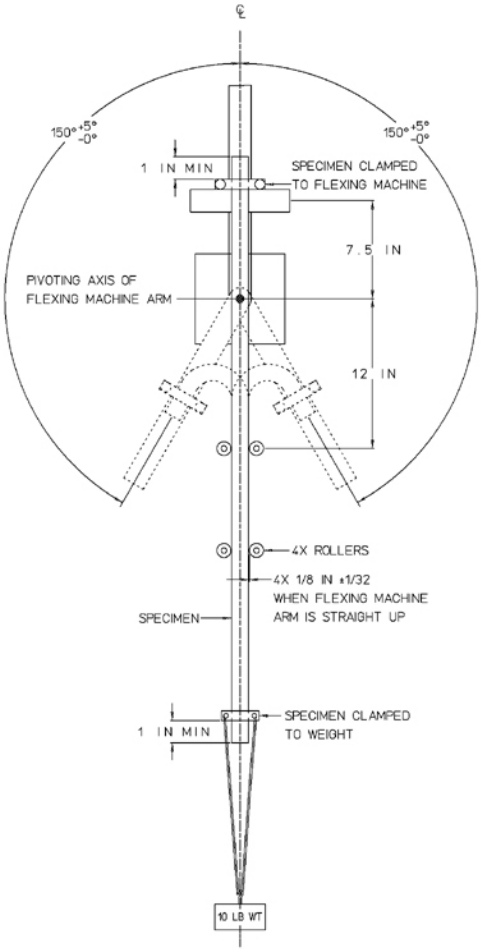


FIGURE 4. Bending endurance test apparatus.

4.5.7.3 Mounting. The specimen sample shall be suspended and bent by means of a rigid motor driven arm, which shall initially be vertical and shall be pivoted about its lower end, which shall have a clamp to secure the cable. The distance between the entry of the cable and the nearest edge of the clamp shall be about one inch. The flexing speed shall be 12 to 14 cycles per minute. A cycle is defined as a 150-degree flex clockwise from vertical, followed by 300 degrees counterclockwise, followed by 150 degrees clockwise back to vertical. The connector end of the cable traverses a 300-degree arc. Cable clamps shall be positioned such that when the arm is vertical (straight up), the longitudinal axis of the specimen shall intersect the pivoting axis, and the center of the lower clamp shall be 20 inches above a horizontal line drawn through the centerline of the upper guide rollers. The lower guide rollers shall be about 30 inches from the centerline of the lower clamp. The guide rollers shall be spaced about ⅛ inch from the cable to restrain lateral motion. Rollers shall be capable of free rotation at all time. The 10 lb. mass shall be attached to the lower end of the sample to provide vertical tension.

4.5.7.4 Inspection procedure – part 1. The first sample cable assembly shall be installed in the apparatus, and the apparatus shall operate for 750 cycles. At the end of 750 cycles, the sample shall be removed and examined.

4.5.7.5 Visual examination. The jacket shall be examined. Any jacket rupture shall constitute failure.

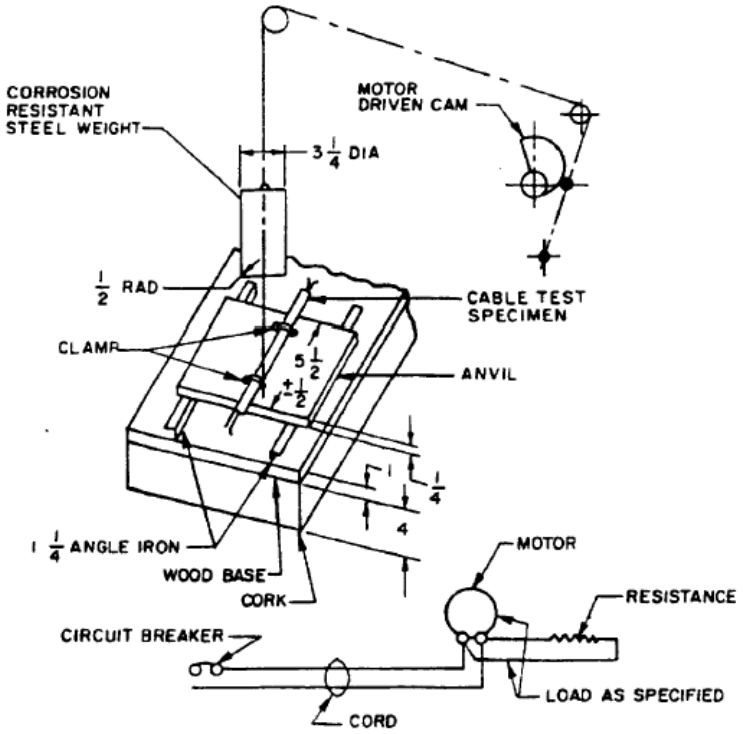
4.5.7.6 Dissection. The cable shall be dissected to allow inspection of each conductor along the flexed portion. The following criteria shall constitute failure: (a) breakage of the stranding of the neutral conductor in excess of 1% (b) breakage of the stranding in any of the control conductors in excess of 1% (c) breakage of the stranding in any of the six power conductors in excess of 10%.

4.5.7.7 Inspection procedure – part 2. The second sample cable assembly shall be installed in the apparatus, and the apparatus shall operate for 2000 cycles. At the end of 2000 cycles, the sample shall be removed and examined.

4.5.7.8 Visual examination. The jacket shall be examined. Any jacket rupture shall constitute failure.

4.5.7.9 Dissection. The cable shall be dissected to allow inspection of the neutral conductor along the flexed portion. Breakage of the stranding of the neutral conductor in excess of 1% shall constitute failure.

4.5.8 Cable impact. Three samples of cable (each 18 inches long) are required for this inspection. Each sample shall be clamped flat as shown in Figure 5. The center portion of each sample of cable shall be subjected to the impact of dropping a 10 ± 0.5 lb. weight from a height of 1 foot. This action shall be repeated 1000 times at a rate of 25 ± 2 drops per minute. To verify the continuity of the cable, there shall be a continuous current of 1 ± 0.5 amperes through each conductors, while undergoing this inspection. To detect interior short circuit or failure, ⅓ to ½ of the conductors shall be permanently connected in series with adjacent conductors connected into the load circuit. Any splits, tears, cracks, or ruptures in the jacketing, short circuits, or loss of continuity in the conductors of the samples shall constitute failure.



WIRING DIAGRAM

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS= ±1/64

FIGURE 5. Cable impact test apparatus.

4.5.9 Cable weight. The weight per foot of the aircraft servicing cable (excluding the aircraft servicing connector) shall be determined. The weight shall comply with 3.4.9.

4.5.10 Helical deformation. This inspection exposes the cable to severe stresses under mechanical load, which will cause the internal cable elements to move with respect to each other. Failure of cable elements to return to their original positions will result in progressive helical deformation of the cable, also referred to as “corkscrewing”.

4.5.10.1 Specimen description. Two specimen samples, without the aircraft servicing connector, 30 feet in length, are required for this inspection.

4.5.10.2 Test apparatus. Each of the four sheaves on the moving part of the apparatus (see Figure 6) shall be not more than 12 ± 0.125 inches in diameter, mounted on 16-inch centers. The horizontal distance between sheaves shall be 24 ± 0.125 inches. The apparatus shall provide a means to apply a 50 lb. force to the cable. This may be done by applying a weight to the cable, or by applying a force by pneumatic or hydraulic means. The total travel distance of the sheaves shall be not less than 10 ± 0.5 feet. The rate of travel shall be 6 ± 1 cycles per minute. A cycle is defined as the back and forth movement.

4.5.10.3 Mounting. One end of the cable sample shall be attached to the stationary clamp located at one end of the apparatus. The cable shall be wrapped around the sheaves in two S-configurations, as shown. A 50-lb. force shall be applied to the other end of the cable.

4.5.10.4 Inspection procedure – part 1. The first cable sample shall be installed in the apparatus and the device shall operate for 250 cycles. After 250 cycles, the cable shall be removed and examined. Any deformation of the cable shall constitute failure. Check continuity. Any continuity failure shall constitute failure. Remove the jacket from a 48-inch section in the middle of the cable length and visually inspect conductors. Any distortion of the conductors shall constitute failure.

4.5.10.5 Inspection procedure – part 2. The second cable sample shall be installed in the apparatus and the device shall operate for 2000 cycles. After 2000 cycles, the cable shall be removed and examined for evidence of helical deformation. If deformation occurs, measure and record the amount of variation from peak to valley along the central axis of the cable. Any variation of more than 0.25 ± 0.05 inches shall constitute failure.

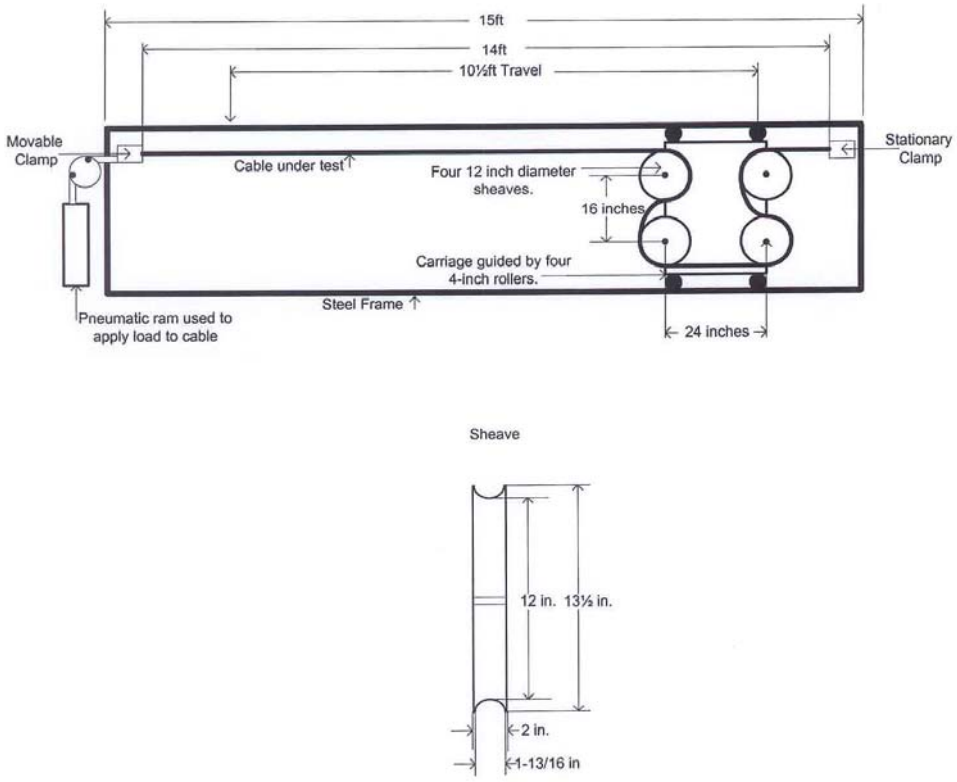


FIGURE 6. Helical deformation test apparatus.

4.5.11 Connector flexing. This test requires one sample cable assembly. Insert the aircraft servicing connector fully into a test receptacle. The connector shall be flexed, using a maximum force of 20 ± 2 lbs., for a total of 10,000 cycles. The rate of flexing shall be 3 to 5 cycles per minute. A cycle is defined as the application of the specified force to the one side of the connector, release, force applied to the other side of the connector and release. Any evidence of damage of the connector or cable, exterior or interior, apparent at the conclusion of the test shall constitute failure.

4.5.12 Engagement force. A pretest measurement of the engagement force of the aircraft servicing connector shall be made using a receptacle in accordance with MS90362. Pretest measurements shall be made with the aircraft servicing connector and receptacle at three distinct temperatures; -30 °C, ambient and 55 °C. The force required to remove the aircraft servicing connector form the receptacle shall comply with 3.4.12.4. At ambient temperature only, the aircraft servicing connector shall be inserted into, and removed from, the mating receptacle 1000 times. The rate of insertion shall be 2 to 5 cycles per minute. A cycle is defined as one insertion and one removal. A suitable electrical contact lubricant may be used to prevent galling of the contacts. After 1000 cycles, posttest measurements of the engagement force of the aircraft servicing connector shall be made at –30 °C, ambient and 55 °C. The engagement force shall be within the range of 80 ± 20 lbs.

4.5.13 Insertion interlock. The F-socket safety interlock circuit of the molded aircraft servicing connector shall be checked to determine that continuity is established upon insertion of the aircraft servicing cable connector into its mating receptacle. Continuity shall be disrupted when the connector is removed from the receptacle. Operation other than specified shall constitute failure.

4.5.14 Insertion interlock controller shock. The insertion interlock controller shall be subjected to shock using a light weight shock apparatus in accordance with MIL-S-901. The controller module shall be operated at the conclusion of the shock test to determine that it is fully functional. Less than full operational capability shall constitute failure.

4.5.15 Insertion interlock controller vibration. The insertion interlock controller shall be subjected to vibration in accordance with MIL-STD-167-1. The controller module shall be operated at the conclusion of the vibration test to determine that it is fully functional. Less than full operational capability shall constitute failure.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Aircraft electrical service cable assemblies include the portable aircraft servicing cable and the aircraft servicing connector. The assembly is used to connect shipboard 400Hz power from Aircraft Electrical Servicing System (AESS) stations to onboard aircraft. Aircraft electrical service cable assemblies are intended for shipboard flight deck and aircraft hangar applications only

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.
b. When first article is required (see 3.1).
c. Total number of cables required.
d. Manufacturer's part number.
e. Manufacturer's part number of interlock controller (see 3.4.12.7).
f. Total quantity of interlock controllers.
g. Packaging requirements (see 5.1).
h. Length of each cable.

6.3 Subject term (key word) listing.

Aircraft Electrical Servicing System (AESS)

aircraft service cable

connector

interlock

Custodians:
Army – CR
Navy – SH
Air Force – 99

Preparing Activity:
Navy – SH
(Project 6145-N366-000)

Review Activities:
Navy – AS, BC, CG, EC
Air Force – 84
DLA – CC
CIV - NA

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.