INCH-POUND

MIL-HDBK-522A
10 February 2016
Superseding
MIL-HDBK-522
26 October 2010

DEPARTMENT OF DEFENSE HANDBOOK

GUIDELINES FOR INSPECTION OF AIRCRAFT ELECTRICAL WIRING INTERCONNECT SYSTEMS

This handbook is for guidance only. Do not cite this document as a requirement.

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FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense (DoD).

2. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

3. This handbook is a guide for aircraft Electrical Wiring Interconnect System (EWIS) inspection. In case of conflict between the aircraft/platform-specific maintenance manual and this handbook, the platform specific manual will take precedence. Not all possible wire systems factors have been addressed. This handbook captures in one document, under suitable subject heading, fundamental installation criteria guidelines. The opportunity to focus on a single document results in substantial savings to the Government.

4. All aircraft are filled with miles of wiring and hundreds of wiring devices that connect and transfer power and signals to and from electrical components. Virtually all aircraft systems rely heavily on some type of wiring for safe operation. Much like the structural components of an aircraft, the health and integrity of the EWIS can be significantly compromised due to premature aging, damage, and failure of wiring insulation. It is integral to the overall maintenance and sustainment of all aircraft that the EWIS be treated as a system and as a system be afforded the same level of importance as the aircraft structure and other critical flight control systems.

5. The majority of aircraft wiring in military service is of a thin-walled construction, and by its very nature, is susceptible to mechanical damage. However, there are several factors that may contribute to premature aging, damage, and failure of wiring insulation, including but not limited to:

a. Wire/Bundle location (Severe Wind and Moisture Problem (SWAMP) Areas)
b. Temperature cycling
c. Contamination
d. Improper installation
e. Mishandling
f. Poor maintenance practices
g. Lack of effective inspection and maintenance training
h. Battle damage

6. This handbook was prepared by, and is regularly updated through, the cooperative efforts of Government and industry. Applicable documents are listed in each individual guideline. Additional information regarding aerospace vehicle wiring requirements is found in SAE-AS50881 “Aerospace Vehicle Wiring.” Copies of SAE AS50881 are available from the Society of Automotive Engineers at the website specified in section 2 of this handbook.

7. When a Joint Service manual is referenced throughout this document, the Navy equivalent is listed in each guideline. For other services’ technical manual numbers, refer to table I. See 2.2 for information on how to obtain copies of maintenance manuals referenced in this handbook.

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TABLE I. Topic and tri-service maintenance manual cross reference.

Manual Topic	Navy	Air Force	Army	USMC
General Wiring	01-1A-505-1	1-1A-14	1-1500-323-24-1	01-1A-505-1
Circular Connectors	01-1A-505-2	1-1A-14-2	1-1500-323-24-2	01-1A-505-2
Rectangular Connectors	01-1A-505-3	1-1A-14-3	1-1500-323-24-3	01-1A-505-3
Fiber Optics	01-1A-505-4	1-1A-14-4	1-1500-323-24-4	01-1A-505-4
Soldering/ESD	01-1A-23	00-25-259	5895-45/1C	5895-45/1D
Corrosion Program and Corrosion Theory	01-1A-509-1	1-1-689-1	1-1500-344-23-1	01-1A-509-1
Avionics and Electronics Cleaning and Corrosion Prevention/Control	01-1A-509-3	1-1-689-3	1-1500-344-23-3	01-1A-509-3

8. Comments, suggestions, questions or additional information on this document should be addressed to: Naval Air Systems Command (Naval Air Warfare Center Aircraft Division Lakehurst, Route 547, Mail Stop 120-3, Joint Base MDL, NJ 08733-5100 or by email to michael.sikora@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST online database at https://assist.dla.mil. The technical content contained in this handbook has been provided by NAVAIR Wiring Systems Branch AIR 4.4.5.3 (48298 Shaw Road Bldg. 1461, Patuxent River, MD 20670-1161) and through the Joint Service Wiring Action Group (JSWAG) email: jswag@navy.mil; web site: http://www.navair.navy.mil/jswag.

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1. SCOPE

1.1 Guidelines applicable to aircraft Electrical Wiring Interconnect Systems (EWIS). This handbook provides guidance and lessons learned in the inspection of EWIS. This handbook is for guidance only and cannot be cited as a requirement. If it is, the contractor does not have to comply.

1.2 Method of reference. Guidelines contained herein should be referenced by specifying this handbook and the guideline number for guidance only.

1.3 Interrelationship of guidelines. Each guideline is intended to cover some discipline in the inspection of EWIS, such as a procedure, a process, or the selection and application of parts and materials. Many of these disciplines, however, cannot retain a clear-cut separation or isolation from others so that when guidelines of MIL-HDBK-522 are referenced in a specification some guidelines will undoubtedly have a direct interrelationship with other guidelines. This interrelationship should be taken into consideration when referencing these guidelines.

2. APPLICABLE DOCUMENTS

2.1 Individual guidelines. See section 2 of each individual guideline for a listing of applicable documents. Documents referenced in the individual documents apply to the extent specified herein. (Copies of military documents are available online at http://quicksearch.dla.mil/.)

2.2 Copies of maintenance manuals. Copies of maintenance manuals NA 01-1A-505-1 through -4, may be obtained by DoD employees and uniformed users by going to the NATEC site https://mynatec.navair.navy.mil/ using their Common Access Card (CAC) to access the documents. Commercial entities requesting copies of these documents should reference this site for maintenance manual access via the Freedom of Information Act requests.

2.3 Industry addresses. Addresses for obtaining documents referenced in the guidelines but not obtainable from the Government are as follows:

National Electrical Manufacturers Association (NEMA)
1300 North 17th Street Suite 1752
Roslyn, Virginia 22209
Online: http://www.nema.org

Society of Automotive Engineers (SAE)
400 Commonwealth Drive
Warrendale, PA 15096-0001 USA
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3. ACRONYMS AND DEFINITIONS

3.1 Acronyms. The following acronyms are applicable to this handbook.

AIR	Denotes aviation for terminal lugs
AS	Aerospace Standard
AWG	American Wire Gauge
°C	Degrees Celsius
CAC	Common Access Card
CAGE	Commercial and Government Entity
CEA	Cognizant Engineering Authority
CPC	Corrosion Prevention (or Preventive) Compound
DoD	Department of Defense
DVI	Detailed Visual Inspection
EMI	Electromagnetic Interference
EN	Electroless Nickel
ESD	Electrostatic Discharge
EWIS	Electrical Wiring Interconnect (or Interconnection) System
°F	Degrees Fahrenheit
FOD	Foreign Object Damage.
GVI	General Visual Inspection
JSWAG	Joint Services Wiring Action Group
MDL	McGuire-Dix-Lakehurst
MIL-DTL	Military Detail Specification
MIL-HDBK	Military Handbook
MIL-PRF	Military Performance Specification
NASM	National Aerospace Standard (Metric)
NATEC	Naval Air Technical Data and Engineering Service Center
NAVAIR	Naval Air Systems Command
NEMA	National Electrical Manufacturers Association
NSN	National Stock Number
QPL	Qualified Products List
PTFE	Polytetrafluoroethylene
RF	Radio Frequency
RFI	Radio Frequency Interference.
RoHS	Restriction of Hazardous Substances
SAE	Society of Automotive Engineers
SWAMP	Severe Wind and Moisture Problem
USMC	United States Marine Corps
WP	Work Package
WRA	Wire Wrapped Assembly

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3.2 Definitions.

3.2.1 Airborne, space, aerospace. "Airborne" denotes those applications peculiar to aircraft and missile or other systems designed for operation primarily within the earth's atmosphere; "space" denotes application peculiar to spacecraft and systems designed for operation near or beyond the upper reaches of the earth's atmosphere; and "aerospace" includes both airborne and space applications.

3.2.2 Bend radius. Maximum amount a wire, cable, fiber, or fiber cable can be bent without causing damage. Usually called minimum safe bending radius.

3.2.3 Bird cage. Defect in stranded wire where the strands in the stripped portion between the covering of an insulated wire and a soldered connection (or an end-tinned lead) have separated from the normal lay of the strands.

3.2.4 Bonded assembly. Connector assembly in which the components are bonded together using an electrically appropriate adhesive in a sandwich type structure. Provides sealing against moisture and other environmental conditions that weaken electrical insulating properties.

3.2.5 Chamfer. Funnel type angle on the inside edge of the barrel entrance of a connecter insert and/or socket contact, which permits easier insertion of a pin contact into the barrel.

3.2.6 Coaxial cable. Cable consisting of two cylindrical conductors with a common axis. The two conductors are separated by a dielectric. The outer conductor or shield, normally at ground potential, acts as a return path for current flowing through the center conductor and prevents energy radiation from the cable. The outer conductor is commonly used to prevent external radiation from affecting the current flowing in the inner conductor. The outer conductor consists of woven strands of wire or is a metal sheath.

3.2.7 Conduit. Tube or trough in which insulated wires and cables are run.

3.2.8 Connector. Describes all interface devices, either plug or receptacle, used to provide rapid connect/disconnect service for electrical cable and wire interconnections. A fixed connector is used for attachment to a rigid surface, while a free connector mates with the wire or cable. Connectors used in military applications generally fall into three broad categories: single contact coaxial connectors, circular multi-contact connectors, and rectangular multi-contact connectors.

3.2.9 Discrepancy. A clearly identifiable deviation from the original design of the system as identified in the source data.

3.2.10 Dust Cover. Item that is specifically designed to cover the mating end of a connector for mechanical and/or environmental protection.

3.2.11 Electrical Wiring Interconnect System (EWIS). Known as aircraft wiring, is defined as any wire, fiber optic link, wiring or fiber device, or a combination of these items (including

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terminations) installed in any area of the aircraft for the purpose of transmitting electrical energy, signals, or data between two or more electrical end points.

3.2.12 Electromagnetic Interference (EMI). The disruption of operation of an electronic device when it is in the vicinity of an electromagnetic field that is caused by another electrical or electronic device. There is a wide range of frequencies at which EMI can occur. Shielding materials for the entire EMI spectrum are not readily available.

3.2.13 Environmentally sealed. Device that is provided with gaskets, seals, grommets, potting, or other means to keep out moisture, dirt, air, or dust which might reduce performance. Does not include non-physical environments such as Radio Frequency (RF) and radiation.

3.2.14 Grommet. A rubber ring or tube through which wires pass. Grommets can be used to provide sealing around wires where they enter a connector, or to provide mechanical protection for wires where they pass through a hole in a structure.

3.2.15 Harness. Assembly of wires and/or cables arranged so they may be installed or removed as a unit.

3.2.16 Heat shrinkable. Term describing tubes, sleeves, caps, boots, films, or other forms of plastic which shrink to encapsulate, protect, or insulate connections, splices, terminations, and other configurations with the application of heat. Heat shrinkable sleeves are typically defined in SAE AMS-DTL-23053.

3.2.17 Lacing tape. Flexible, flat fabric tape for tying harnesses and wire bundles, securing of sleeves and other items, and general lacing and tying applications. Available in various materials and impregnates.

3.2.18 Lay. Lay of any helical element of a cable is the axial length of a turn of the helix of that element. Among the helical elements of a cable may be each strand in a concentric-lay cable or each insulated conductor in a multi-conductor cable. Lay is often referred to as pitch.

3.2.19 Lay, direction of. Direction in which the strands or a conductor or components in a cable pass over the top of the bundle as they recede from an observer looking along the axis of the conductor or cable. Termed right hand or left hand (see lay).

3.2.20 Marker tape. Tape laid parallel to the conductors under the sheath in a cable, imprinted with the manufacturer’s name and the specification to which the cable is made.

3.2.21 Plating. Overlaying of a thin coating of metal on metallic components to improve conductivity, provide for easy soldering, or prevent rusting or corrosion.

3.2.22 Polyimide. A trademark of the DuPont Company for their polyimide resin film used as wire insulation. Polyimide (Kapton®) was a popular aircraft wiring insulation from the 1960's through the early 1990's because of its excellent mechanical properties at high temperatures, light weight, low smoke generation and low flammability. However, weathered polyimide was found

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to have a high risk of arcing due to hydrolysis (degradation caused by water absorption) and carbon arc tracking (self-propagation of arc faults along the surface of the insulation). Polyimide is now used almost exclusively in hybrid wiring insulation where it is sandwiched between layers of Teflon® for safety. Kapton® polyimide film is transparent and is amber in color. An opaque top coat is applied to provide different colors of wire and a surface for wire printing. Kapton® wire configurations are defined in Revision B of MIL-DTL-81381. Kapton® wire has poor life characteristics and is no longer recommended for Navy aircraft.

3.2.23 Potting. Process of completely enclosing an article in an envelope of liquid dielectric material which then changes to a solid. Potting is performed to improve and protect the electrical functions of the unit. The compound acts as a dielectric and provides strain relief and protection to the unit from the environment.

3.2.24 Routing. Path followed by a cable or conductor.

3.2.25 Safety wire. Securing wire used to prevent the loosening or vibrating free of the attached part.

3.2.26 Severe Wind and Moisture Problem (SWAMP) areas. Areas such as wheel wells, wing folds, areas near wing flaps, and areas directly exposed to extended weather conditions are considered SWAMP areas on aerospace vehicles.

3.2.27 Spiral wrap. Term used to describe the helical wrap of a tape or thread over a core.

3.2.28 Strand. One of the wires or groups of wires of any stranded conductor.

3.2.29 Strand lay. Distance of advance of one strand of a spirally stranded conductor, in one turn measured axially (see lay).

3.2.30 Stranded conductor. Conductor composed of a group of wires or of any combination of groups of wires. The wires in a stranded conductor are usually twisted or braided together.

3.2.31 Stress relief chamfer. The tapering or rounding of an interior or exterior corner of a mechanical part, incorporated in the design to eliminate areas of high stress concentration.

3.2.32 Stripping wire. Removal of a predetermined portion of insulation without affecting the mechanical or electrical characteristics of the conductor or the remaining insulation.

3.2.33 Tape, pressure sensitive. Pressure sensitive tapes contain an adhesive coating applied to the backing material which allows the backing to be positioned with application of pressure only. The use of an activator such as heat, solvent, or water is not required. The two primary functions of electrical pressure sensitive tapes are holding and insulating. These tapes are commonly adhered to conductors or other insulating devices and serve the purpose of holding or anchoring them in a desired manner.

3.2.34 Tape wrap. Term denoting a spirally or longitudinally applied tape material wrapped

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around the wire, either insulated or uninsulated, and used as an insulation or mechanical barrier.

3.2.35 Terminal. Metal wire termination devices designed to handle one or more conductors to be attached to a board, bus, or block with mechanical fasteners, or clipped on. Types include ring, tongue, spade, flag, hook, blade, quick-connect, off-set, and flanged. Special types include taper pin, taper tab, and others, either insulated or non-insulated.

3.2.36 Terminal lug. Device designed to be affixed, usually at one end, to a post, stud, chassis, or similar device, and with provision for attachment of an electrical conductor(s) in order to establish an electrical connection.

4. GENERAL GUIDELINES

4.1 Application. The guidelines contained herein are intended to provide guidance applicable to EWIS, unless otherwise indicated in the guideline.

4.2 Use of selection and application standards. When a selection and application standard is referenced in a guideline, the devices or parts selected should conform to the applicable military or commercial specifications referenced in the standard.

5. DETAIL GUIDELINES

5.1 Individual guidelines for EWIS inspection. The individual guidelines for EWIS are located after section 6.

6. NOTES

6.1 Intended use. The guidelines in this document are intended to provide information on the proper tools and procedures for repairing and maintaining the EWIS.

6.2 Subject term (key word) listing.

Circular connectors
Pressure sensitive tape
Corrosion prevention
Rectangular connectors
Electronics cleaning
Severe Wind and Moisture Problem Areas
Fiber Optics
Soldering
Maintenance procedures
Stress relief chamfer

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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GUIDELINE 1

INTRODUCTION AND INSPECTION TECHNIQUES

1. Purpose. This guideline demonstrates proper inspection techniques used when working with the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual.
Work Package 004 01	Aircraft Wiring System Inspection.
Work Package 026 00	Connector Cleaning and Preservation.

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. The following tools and techniques should be used when performing inspections on EWIS:

WARNING

Ensure aircraft external electrical power and battery, or batteries, are disconnected before proceeding with any of the following instructions or routine maintenance. Failure to do so can result in severe injury or death to personnel, and/or damage to equipment.

a. EWIS Inspection should be performed using a bright light and mirror. For difficult to access locations, a borescope may be employed (see figure 1-1).

NOTE

A bright white light (not red or night vision green) with an incandescent (conventional) bulb has been shown to be the most effective in identifying discrepancies. LED light bulbs are not recommended for inspections.

b. Dirt, grease or other contaminants might hide unsatisfactory conditions. The area to be inspected should be clean enough to perform a complete inspection. The cleaning process itself should not compromise the integrity of EWIS. Additional information regarding cleaning practices and techniques is given in NA 01-1A-505-1, Work Package (WP) 026 00.

c. When inspecting the EWIS, it is important to inspect the areas behind, under, and on top of all EWIS components. Hidden areas should be inspected using a bright light and mirror.

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4. (continued).

d. Determine the level of inspection required to accurately complete the assessment (i.e., General Visual Inspection (GVI), Detailed Visual Inspection (DVI), Zonal Inspection) based on the applicable requirements document (e.g., inspection work cards or technical publications).

e. Use a consistent approach for each zone/area (e.g., left to right, top to bottom) and repeat for subsequent zones/areas to be inspected. Focus on all the accessible EWIS components in the applicable zone/area. Inspect entire wiring system within the required zone, panel, or opening.

f. Identify and document/record each discrepancy in the zone/area being inspected.

g. Correct all discrepancies immediately beginning with any/all flight safety/critical discrepancies.

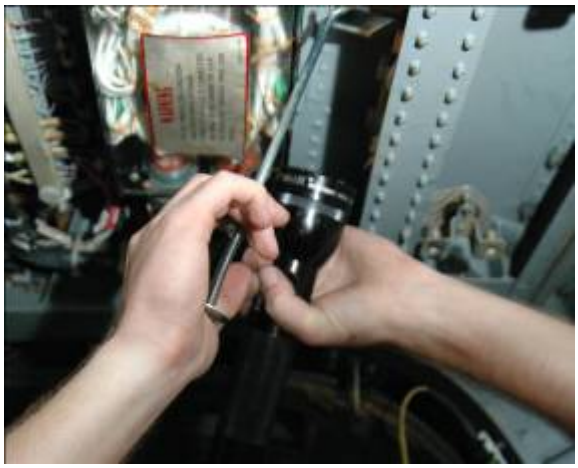
h. Deficiencies not corrected should be documented in the applicable aircraft/end item records/forms/logbooks for correction at the next scheduled maintenance opportunity. Until discrepancies are corrected, they must be re-inspected at each available opportunity to ensure deficiencies have not worsened.

i. Additional information regarding inspection practices and techniques is specified in NA 01-1A-505-1, Work Package 004 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

Acceptable
Proper tools for inspecting EWIS: Bright light and mirror.



Acceptable
Proper use of a mirror and flashlight inspecting a wiring harness.

FIGURE 1-1. EWIS inspection tools.

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GUIDELINE 2

INCOMING WIRE INSPECTION FROM THE SUPPLY SYSTEM

1. Purpose. This guideline demonstrates incoming wire inspection criteria for wire used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 00	Wire Characteristics, Replacement and Inspection Techniques.
Work Package 007 00	Connectors, Wiring and Harness Stowage

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. The following steps should be followed when inspecting incoming wire received from the supply system:

a. Ensure wire/cable is received from the supply system on a spool (see figure 2-1) and wire is legibly marked with part number and CAGE code every twelve inches (see figure 2-2).

b. Only wire/cable from qualified sources may be installed on aircraft. Refer to the applicable Qualified Products List (QPL) for approved manufacturing sources. Copies of QPLs are available from NAVAIR QPL at: http://www.navair.navy.mil/qpl/ and from the ASSIST database at http://quicksearch.dla.mil/

c. Visually inspect exposed wire while wrapped on the spool for physical damage, nicks, cuts, burrs, abrasion, etc. (see figure 2-3). Unwind the first 3-4 feet and check for general condition, insulation smoothness, kinks, insulation discontinuity, discoloration, or bleaching. Remove damaged sections. If damage is throughout the length of the wire, it is unserviceable.

CAUTION

Silver plated conductors are prone to cuprous oxide (red plague) due to improper processing during manufacture (see figure 2-3). Thoroughly inspect the stripped wire for evidence of red corrosion on the conductor. This is an unserviceable condition; submit deficiency report.

NOTE

If wire end is not capped, trim off one to two inches of the wire from the loose end. This ensures any corroded/contaminated section is removed.

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4. (continued).

d. Visually inspect both ends of wire by stripping insulation from the last one inch of wire, untwist strands and closely examine conductor for any signs of corrosion. For silver plated conductors, thoroughly inspect stripped wire for evidence of red/reddish brown discoloration (corrosion) on the conductor. Any sign of corrosion is cause for rejection (see figure 2-3).

e. Gain access to both ends of spooled wire and check wire for continuity. Continuity value should match the value on the label of the spool. If no label or missing value, refer to NA 01-1A-505-1 WP 004 00 table 1. Upon completion of continuity check, cap the exposed ends of the wire or cable to prevent wicking of moisture and potential corrosion. Additional information regarding wire capping is given in the NA 01-1A-505-1, Work Package 007 00.

f. Additional information regarding incoming wire inspection is given in the NA 01-1A-505-1, Work Package 004 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

Acceptable
Wire is received from supply on a spool.

Unacceptable
Wire received from supply in an unusable condition. Wire is not on a spool.

Unacceptable
Wire received from supply in an unusable condition. Wire is in several small pieces.

FIGURE 2-1. Examples of acceptable and unacceptable wire received from supply system.

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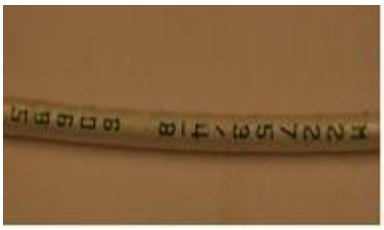
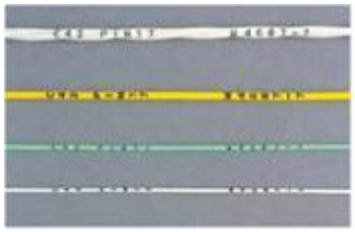


Acceptable
QPL wire with proper CAGE and part number markings from the manufacturer.

Unacceptable
No wire marking on wire.

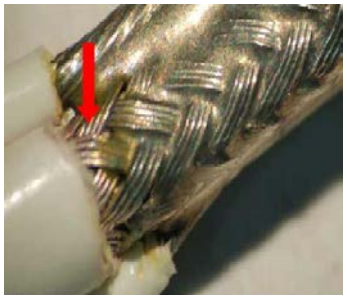


Unacceptable
Incorrect wire marking. Does not have required CAGE and part number every 12 inches.

FIGURE 2-2. Examples of acceptable and unacceptable wire marking.

Acceptable
Typical wire conductor without any corrosion.

Unacceptable
Broken strands and signs of corrosion on conductor/shielding.



Unacceptable
Severe corrosion on wire conductor/shielding.

FIGURE 2-3. Examples of acceptable and unacceptable conductors.

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GUIDELINE 3

WIRE INSULATION INSPECTION (EXCLUDING POLYIMIDE/KAPTON™ WIRE)

1. Purpose. This guideline demonstrates inspection criteria for wire or cable insulation (other than polyimide type) used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 01	Aircraft Wiring System Inspection
Work Package 014 01	Fault Diagnosis and Fault Location
NA 01-1A-505-4	Aircraft Fiber Optic Cabling Manual

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. The following steps should be followed when inspecting and repairing wire insulation.

a. Examine insulation for physical damage using the classifications below:

1. Class I. Major (catastrophic) damage to cable assemblies/bundles/wires consisting of extensive wiring damage where 6 or more wires are damaged, or where evidence of arcing is present (burnt insulation, burnt conductor strands, flash over marks on structure). Cannot be categorized as Class II or III damage, requires an engineering disposition. Coordinate with Cognizant Engineering Authority (see figure 3-1).

2. Class II. Intermediate damage to cable assemblies/bundles/wires consisting of wiring damage where 5 or fewer wires are damaged including: cut, torn or separated braid/shield/insulation material, abraded or severed conductors, abrasion against fluid carrying lines, or abrasion of size 8 and larger power cables against grounded structure.

3. Class III. Minor damage to cable assembly/ bundle/wire exterior (no damaged or abraded internal conductor), consisting of chafed or torn protective braid or insulation material.

4. Class IV. Superficial damage to multi-layer insulated wire (such as composite) applying to M22759/80-92, M22759/180-192, M27500-XXDB-DR, and M27500-XXWB-WR wire/cable types. Superficial damage to composite wire/cable outer layer consists of damage to only the PTFE (white outer tape exposing inner, tan insulator layer).

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4. (continued).

b. Cracking, chafing, flaking, or peeling of the insulation of any wire or cable (excluding polyimide topcoat, see guideline 4) is a discrepancy.

c. Radial cracking (circumferential to axis of wire or cable) is a discrepancy (see figure 3-2). Some insulation may be more susceptible to cracking within 1/2 inch of clamps.

d. Heat damage: melting, scorching, charring and blistering is a discrepancy (see figure 3-3).

e. Fluid/moisture effects: swelling, blistering or cracking is a discrepancy.

f. Mechanical damage that is caused by the installation or removal of equipment, crew movement, shifting cargo etc. is a discrepancy.

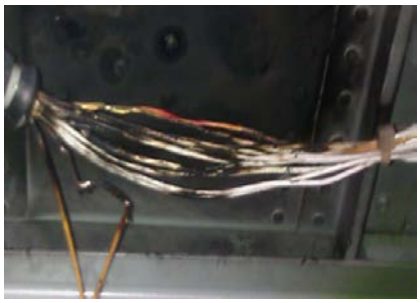
g. Wiring that bears evidence of having been crushed is a discrepancy.

h. Additional information regarding insulation inspection is given in the NA 01-1A-505-1, Work Package 004 01. Information regarding the inspection of fiber optic cables and insulation is given in NA 01-1A-505-4, Work Package 014 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

Acceptable
Insulation is not damaged



Unacceptable
Wire bundle with more than 6 wires showing insulation overheat damage

FIGURE 3-1. Examples of wire in acceptable condition and with Class I wire damage.

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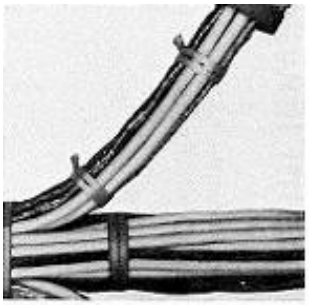
Acceptable
Insulation is not damaged, chafed or flaking.

Unacceptable
Radial crack in the insulation.

FIGURE 3-2. Examples of insulation in acceptable and unacceptable condition.



Acceptable
Serviceable wire harness with no signs of damage.

Unacceptable
Arc tracking

Unacceptable
Overheating seen as a discoloration of the insulation (brown) compared to the white insulated wire.

Unacceptable
Overheating seen at the splice termination.

FIGURE 3-3. Examples of an undamaged wiring harness and wire damaged due to arc tracking and overheating.

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GUIDELINE 4

POLYIMIDE (KAPTON™) WIRE INSULATION INSPECTION

1. Purpose. This guideline demonstrates EWIS inspection criteria for wire or cable which employs polyimide type insulation, outer jacket, or topcoat.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 01	Aircraft Wiring System Inspection

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4 General inspection guidelines. Inspecting and repairing polyimide wire insulation are classified as follows.

a. Examine polyimide insulation for damage using the classifications below:

1. **Class I.** Major (catastrophic) damage to cable assemblies/bundles/wires consisting of extensive wiring damage where 6 or more wires are damaged to include wire flash-over/arc tracking, burned/brittle insulation, or burned/broken conductor strands. This type of damage cannot be categorized as Class II or III damage and requires an engineering disposition (see figure 4-1).

2. **Class II.** Intermediate (severe) damage to cable assemblies/bundles/wires consisting of wiring damage where 5 or fewer wires are damaged including: cut, torn or separated braid/shield/insulation material, abraded or severed conductors, abrasion against fluid carrying lines, or abrasion of size 8 and larger power cables against grounded structure, or wire flash-over/arc tracking, burned/brittle insulation (see figure 4-2).

3. **Class III.** Minor damage to cable assembly/ bundle/wire exterior (no damaged or abraded internal conductor), consisting of chafed or torn protective braid or insulation material (see figure 4-3).

4. **Class IV.** Superficial damage to Kapton™ insulated wire (such as flaking) applies to all M81381/7, M81381/9, M27500-XXMR, and M27500- XXMT wire/cable types. Superficial damage to Kapton™ wire/cable exterior consists of damage only to the outer jacket (known as topcoat flaking). It is usually found at connector/boot area or termination points and is due to repetitive bending or flexing of cable assembly/bundle/wire where the conductor is not exposed and there are no insulation breaches/cracks (see figure 4-4).

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4. (continued).

b. Repair of Classes II, III, and IV is performed at Organizational Level Maintenance. Class I damage requires an engineering disposition to determine the maintenance repair level and method of repair. Class I also requires a submission of a deficiency report at http://www.jdrs.mil/jdrs.html.

c. Superficial damage to Kapton™ wire/cable exterior consists of damage only to the outer jacket (known as topcoat flaking) and does not require repair/maintenance. When there are cuts or breaches in the inner (brownish) insulation layer exposing the conductor repair/maintenance is required. See class IV above (see figures 4-3 and 4-4).

d. Radial cracking (circumferential to axis of wire or cable) is a discrepancy (see figure 4-5); maintenance/repair is required. This type of damage is susceptible to cracking within ½ inch of clamps or at areas of relative motion. See Class III above.

e. Wiring that bears evidence of having been crushed is a discrepancy. Classification of damage is dependent on severity.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

Acceptable
Insulation is not damaged, chafed or flaking.

Unacceptable
Wire and insulation is damaged, overheated, on more than 6 wires in bundle.

FIGURE 4-1. Examples of polyimide insulated wire in acceptable condition and polyimide insulated wire with class I wire damage.

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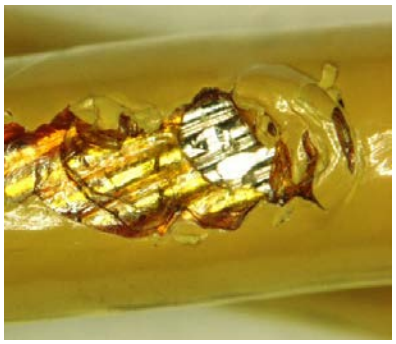
Acceptable
No wire insulation damage

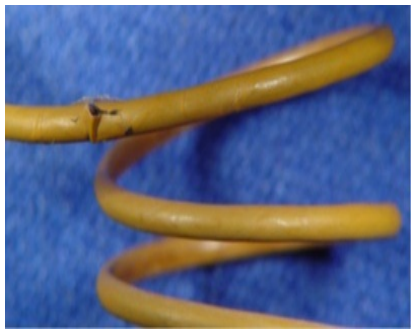
Unacceptable
5 wires with insulation damage; conductor exposed



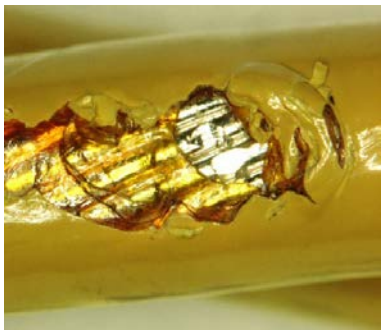
Unacceptable
Wire damage thru insulation; conductor is nicked and exposed

FIGURE 4-2. Examples of polyimide insulated wire in acceptable condition and polyimide insulated wire damage with class II damage.

Acceptable
No wire insulation damage



Acceptable
Only outer topcoat damage. No inner polyimide insulation (brown) damage; conductor not exposed



Unacceptable
Both outer topcoat, and inner polyimide insulation (brown) damaged; conductor nicked

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FIGURE 4-3. Examples of polyimide insulated wire in acceptable condition and polyimide insulated wire with class III damage.

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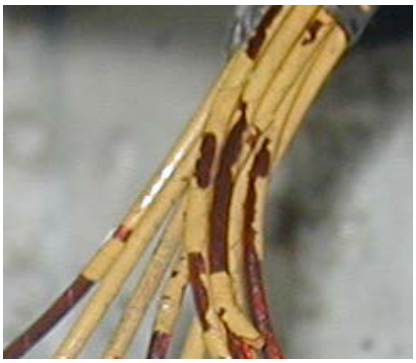


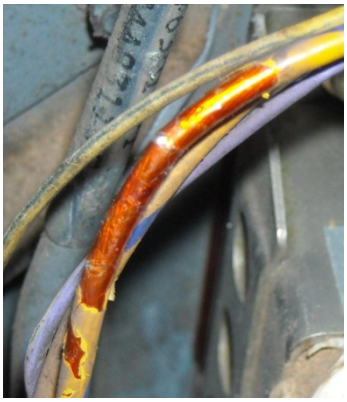
Acceptable
Polyimide insulation topcoat flaking; no damaged polyimide insulation (brown); no repair required

Acceptable
Polyimide insulation topcoat flaking; no damaged polyimide insulation (brown); no repair required

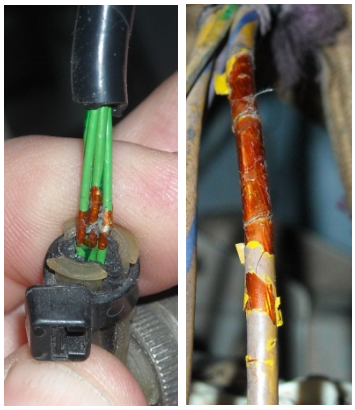
Unacceptable
One wire shows exposed conductor; repair required

FIGURE 4-4. Examples of polyimide insulated wire in acceptable condition and polyimide insulated wire with class IV damage.

Acceptable
No wire insulation damage.



Unacceptable
Polyimide insulation cracked; conductor exposed.



Unacceptable
Polyimide insulation cracked; conductor exposed.

FIGURE 4-5. Examples of polyimide insulated wire in acceptable condition and polyimide with radial cracking damage.

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GUIDELINE 5

CONNECTOR MATING INSPECTION

1. Purpose. This guideline gives criteria for inspecting connectors used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

MIL-DTL-38999	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant with, Crimp Removable Contacts or Hermetically Sealed with Fixed, Solderable Contacts, General Specification for.
MS27488	Plug, End Seal, Electrical Connector
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 01	Aircraft Wiring System Inspection.
Work Package 010 00	Harness Installation.

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. The following steps should be followed when inspecting connectors used in the EWIS:

a. Before coupling the connector, examine the mating halves for properly seated contacts and:

1. Confirm that all cavities are filled with contacts (except unused cavities for coaxial contacts).

2. Verify that there are no bent contacts.

3. Confirm that unwired cavities are fitted with the proper sealing plugs in accordance with MS27488.

4. Verify that the applicable backshell, if required, is tightened on connector, and where cable clamp is used, saddle bars are tightened.

***WARNING*:**
Unless otherwise required by specific equipment technical data, power should be removed from the affected circuit to avoid shock hazard and possible arcing of connector.

b. After examination and mating, verify connector has locked, or is tight, depending on type. When a threaded connector has no indicator line, make certain that it has been sufficiently

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4.b. (continued).

tightened. If the connector has a mating indicator line/band, then the following procedure should be followed:

1. Check for proper location of the red, locked indicator band on MIL-DTL-38999, series 3 connectors. If the red band is properly located and the connector is fully mated, the red band will not be visible. If the connector is fully mated and the red band is visible, two conditions may apply (see figure 5-1):

a. The red band has been mislocated on the receptacle but the connection system otherwise functions as designed.

b. The red band is correctly located on the receptacle or plug but red band is mis-located on mating connector half due to allowable tolerances defined in MIL-DTL-38999, Revision K. This condition has been corrected in Revision L of MIL-DTL-38999, but these the connectors may be installed in various systems/aircraft. If this condition exists, use steps given in this guideline to confirm that the connector is properly mated and mark the connector as shown in figure 5-2.

c. If the connector has a bayonet system, then the following procedure should be followed:

1. The bayonet system employs three locking pins spaced 120 degrees apart on the outside perimeter of the receptacle.

2. Make sure that all locking pins of the coupling are engaged.

3. When connected, verify that the locking pins are visible through the inspection holes. The locking pins are usually colored white or blue.

c. Additional information regarding connector mating inspection is specified in NA 01-1A-505-1, Work Packages 004 01 and 010 00.

5 Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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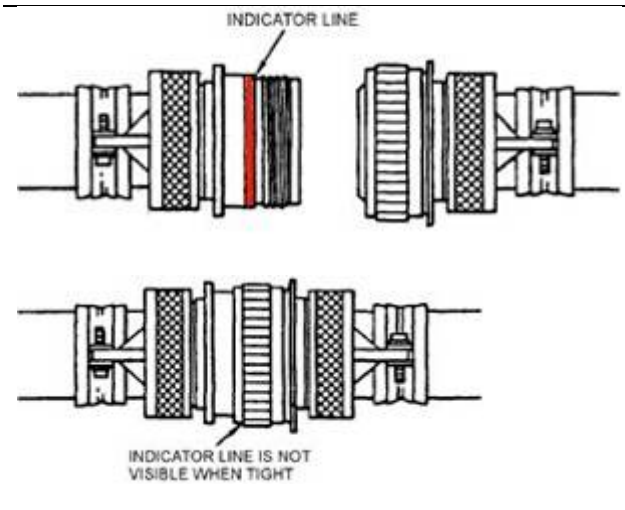
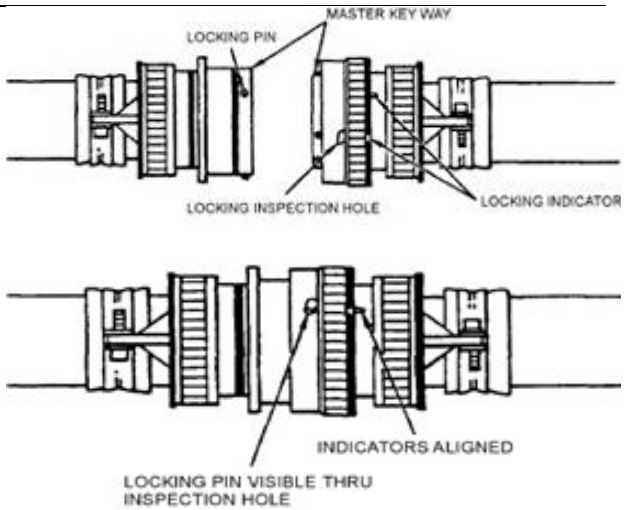


Acceptable

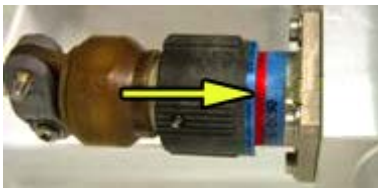


Acceptable

FIGURE 5-1. Example of correctly mated connectors using an indicator line and locking pin with inspection hole.

Acceptable
Upon successful system functional test (all applicable systems pass) a yellow stripe is marked on the receptacle.

Acceptable
Plug indicating a known mis-located red band on an otherwise functional receptacle.



Unacceptable
The red band is visible and has no yellow marking stripe.

FIGURE 5-2. Examples marking yellow stripes on connectors.

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GUIDELINE 6

COAXIAL CABLE INSTALLATION INSPECTION

1. Purpose. This guideline gives criteria for the inspection of coaxial cable installed in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 006 00	Radio Frequency (RF) Cable Chracteristics and Replacements

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting cable harnesses that include coaxial cables the following items should be checked:

a. Cable clamps and spot ties used on coaxial cables should be examined to confirm that they are not excessively tight. Only A-A-52083 or A-A-52084 lacing tape/tie string should be used for tying wire and cable bundles containing coaxial cables. Figure 6-1 shows the proper use of lacing tape/tie string.

b. Confirm that coaxial cable is routed as directly as possible.

c. Verify that the minimum bend radius requirements are not violated; if none noted, use 10 times the diameter of the largest cable in the harness (see figures 6-2, 6-3, and 6-4).

d. Confirm that unnecessary or sharp bends are avoided to preserve the cable's dielectric integrity.

e. Additional information regarding coaxial cable inspection is specified in NA 01-1A-505-1, Work Package 006 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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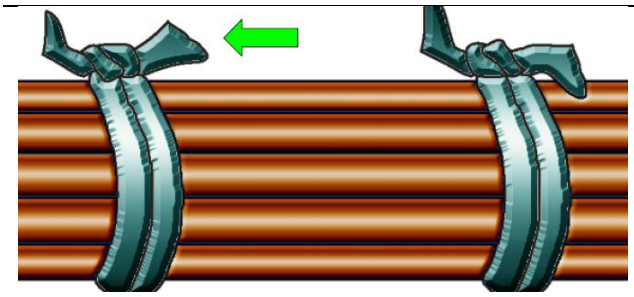

Acceptable
A-A-52083 or A-A-52084
lacing tape, ties are neat and properly spaced.

Unacceptable
A-A-52083 or A-A-52084
lacing tape that is too loose or too tight.

FIGURE 6-1. Examples of acceptable and unacceptable use of lacing tape.

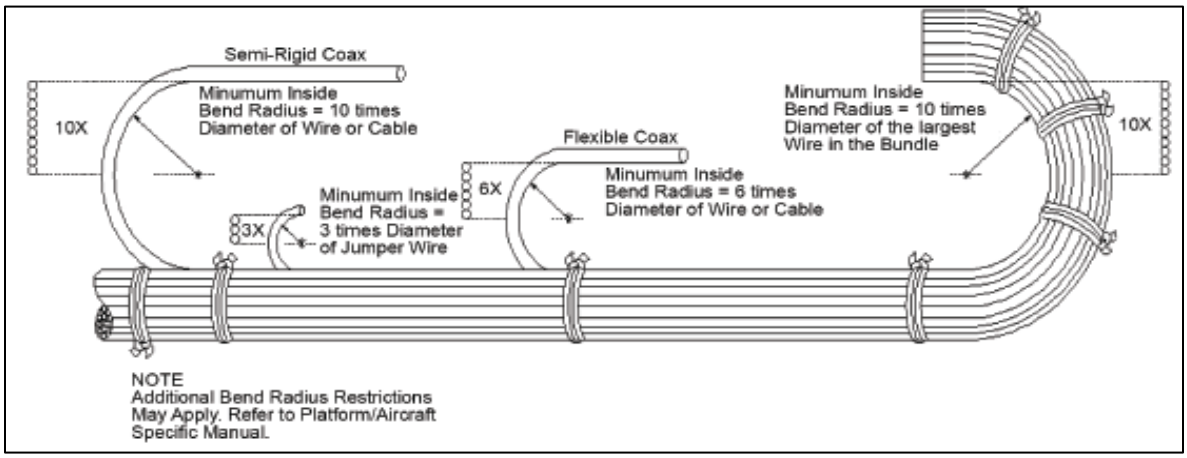

FIGURE 6-2. Acceptable bend radius.

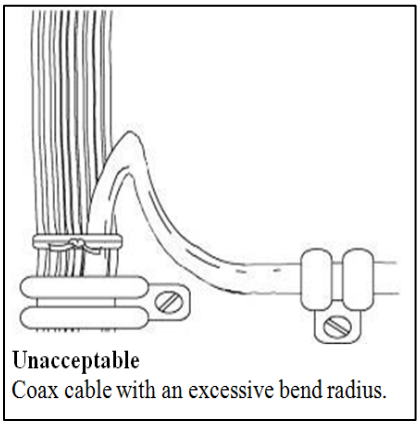

FIGURE 6-3. Example of unacceptable coaxial bend radius.

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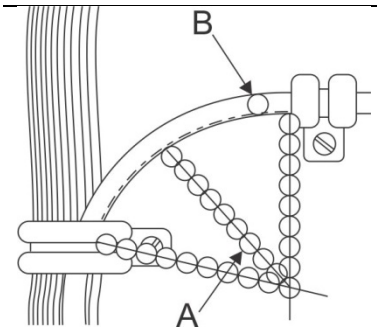	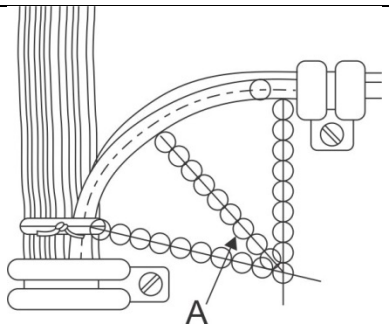	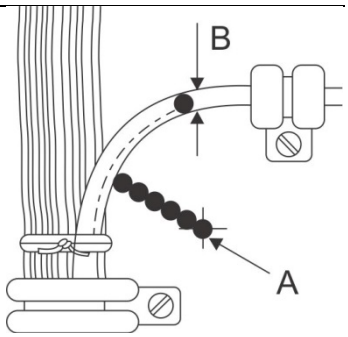
Acceptable Wires and cables should have a minimum bend radius (A) of ten times the diameter of the largest wire insulation (B) contained in the bundle.	**Acceptable** The bend radius shown (A) measures slightly more than 10 times the diameter of the largest wire in the harness breakout.	**Unacceptable** The radius (A) of the wire breakout measures only 6 times the wire diameter (B). Excessive stress is exerted on wires installed with sharp bends.

FIGURE 6-4. Acceptable and unacceptable bend radius.

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GUIDELINE 7

PROPER MARKING OF WIRE/FIBER OPTIC AND CABLE HARNESSES

1. Purpose. This guideline gives inspection criteria on the proper marking of wire and cable used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 008 00	Wire, Cable, and Harness Marking
NA 01-1A-505-4	Aircraft Fiber Optic Cabling Manual
Work Package 003 03	Marking Methods and Labels

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. The following procedures should be followed when inspecting wire and fiber optic cable and harnesses.

a. There are two methods of marking wire and cables: direct and indirect marking. Inspect marked wire/cable as follows:

WARNING

Hot stamp marking directly on the wire or cable is not authorized for any aircraft EWIS application. Hot stamping degrades wire insulation, resulting in system failure and potential injury to personnel.

1. Direct marking is printed on the wire or cable outer covering. Inspect cable assembly/harness marker as follows:

a. Ensure the marking can be identified at intervals not longer than 3 inches along the entire length of wire or cable.

b. Verify that direct marking is legible and contains the applicable identifier for system, sub-system, reference designator, or item identification.

2. Indirect wire or cable marking is performed using tags or labels attached to the wire or cable. Inspect cable assembly/harness marker as follows:

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4.a.2. (continued).

a. Verify that the indirect marked wire or cable is identified with printed heat shrinkable sleeves or labels after the last clamp and within 12 inches of the cable termination and at intervals of 3 feet throughout the length of wire or cable or harness.

b. Verify that the marking labels are installed after the last clamp and within 12 inches of the termination point.

c. Individual wire not in a cable should be identified with a marking label in the same fashion as if it were a harness.

d. Individual wires less than 6 inches in length need not be marked.

e. Ensure that the heat shrinkable marking labels have been shrunk/recovered onto harness.

f. If after examining the harness, labels are missing, print and affix new marking labels.

g. Verify that marking is legible and contains the applicable identifier for system, sub-system, reference designator, or item identification.

h. If labels or tape (B637-1-500 YELLOW) are used, ensure they are secured with lacing tape in accordance with A-A-52083 or A-A-52084 (see figure 7-1).

WARNING

Continuous printing methods such as Inkjet, Laser, and Hot stamp marking are not authorized for any fiber optic application.

b. Marking of fiber optic cables can only be performed using indirect marking methods. Indirectly marked cable bundle or cable harness should be identified with printed sleeves at the following locations unless otherwise superseded in the platform maintenance manual. Inspect fiber optic cables as follows:

1. After the last clamp.

2. Within 12 inches of the cable termination.

3. At intervals of 3 feet throughout the length of the individual cables, cable bundle or cable harness.

4. Within 6 inches of the cable assembly entering or exiting conduit for routing through a fuel tank or used as protection in a severe environment.

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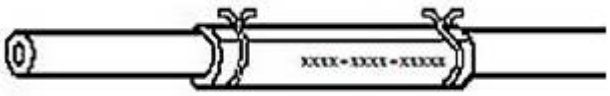
4.b. (continued).

5. The recommended fiber optic cable marking should contain applicable text and border. The border or the band should be violet and the background color yellow (see figure 7-2).

c. Additional information regarding the proper marking of wire and fiber optic and cable harnesses is provided in the NA 01-1A-505-1, Volume 1, Work Package 008 00 and NA 01-1A-505-4, Work Package 003 03.

5. Detail guidelines. This section is not applicable to this guideline.

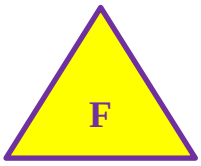
6. Notes. This section is not applicable to this guideline.



Acceptable
Wire marking example using lacing tape.

Unacceptable
Non-heat shrinkable wire marking tape is not secured with lacing tape/tie string.

FIGURE 7-1. Examples of acceptable and unacceptable wire marking with and without lacing tape.



Acceptable
Weapon Repairable Assembly (WRA) Label. This label is usually found within 6 inches from the fiber optic connection port. Text and border color is violet and the background color is yellow.

Acceptable
Cable that is marked within 12 inches of the termination point.

FIGURE 7-2. Examples of acceptable fiber optic label and cable marking.

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GUIDELINE 8

CAPPING AND STOWAGE OF ON-AIRCRAFT CONNECTORS INSPECTION

1. Purpose. This guideline gives inspection criteria and procedure for the proper capping and stowing of connectors used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass.
A-A-52084	Tape, Lacing and Tying, Aramid.
A-A-59163	Insulation Tape, Electrical, Self-Adhering Unsupported Silicone Rubber.
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices
ANSI/ESD S20.20	ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
Air Force Technical Order 00-25-234	General Shop Practice Requirements for the Repair, Maintenance, and Test of Electrical Equipment
SAE AS21919	Clamp, Loop Type, Cushioned Support. (DoD adopted)
SAE AS23190/4	Mounting Hardware, Cushion Clamp, Metal for Cable Harness Tying and Support, Type V, Class 1
SAE AS81765/4	Insulating Components, Molded, Electrical, Heat Shrinkable Fluoroelastomer, Flexible, Crosslinked. (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual.
Work Package 007 00	Connectors, Wiring and Harness Stowage for operational and Non-operational Aircraft.
Work Package 026 00	Connector Cleaning and Preservation.
NA 01-1A-505-4	Aircraft Fiber Optic Cabling Manual
Work Package 012 02	Dust Cover Preparation and Capping Methods.

(See 2. APPLICABLE DOCUMENTS of this handbook for source web site.)
(ANSI/ESD S20.20 is available from the Electrostatic Discharge Association www.esda.org.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When fiber optic and electrical connectors are capped or stowed in the EWIS, the following procedures should be followed:

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4. (continued).

a. If fiber optic termini are installed in the connectors used in the EWIS, refer to NA 01-1A-505-4 for identification and follow-on maintenance procedures.

b. If electrical connectors are being examined for proper capping or covering, the following actions should be taken:

1. Ensure that the connector is clean and the exterior (external metal surfaces) has corrosion preventative compound sparingly applied. See NA 01-1A-505-1, Work Package 026 00 for further information.

2. Ensure that an approved capping method is employed based on application (operational/non-operational) and duration (short/long term).

a. Metal cap/plug. When inspecting a connector using a metal cap or plug, verify that the connector is clean and that a military standard protective metal cover is used (see figure 8-1).

CAUTION:

Plastic caps are not authorized for use at any time on ready for flight aircraft, as they are a FOD hazard. Only military standard metal covers, heat shrinkable caps or pressure sensitive tape are authorized.

b. Plastic connector covers are only to be in aircraft undergoing depot maintenance, off aircraft maintenance and for shipping (see figure 8-1).

c. When inspecting heat shrinkable end caps (101A083-XX-X, conforming to SAE AS81765/4), ensure they fit snuggly and conform to the connector being capped.

WARNING

Do not use Conductive Shielding Tape that meets MIL-STD-1686 (ESD Grid Tape, such as NSN 5999-01-378-8454) to cap aircraft connectors. It is a FOD hazard; when removed, it can leave a residue and is conductive, which may short out circuits when power is applied to the aircraft. Application of this tape to on-aircraft connectors can cause damage to aircraft and injury to personnel. For Air Force Applications refer to ANSI/ESD S20.20 and Technical Order 00-25-234, Section VII.

NOTE

Plastic bags are not authorized for use to cap and stow connectors.

d. When examining connectors wrapped with pressure sensitive, self-fusing silicone tape verify that the connectors have been cleaned and preserved. Also, confirm that, type II tape in accordance with A-A-59163 is being used and it is secured with lacing tape/tie string in accordance with A-A-52083 or A-A-52084 (see figure 8-1).

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3. When inspecting connectors secured to adjacent structure or harnesses, confirm they are secured using cushion clamps in accordance with SAE AS21919/AS23190/4 or tie string/lacing tape in accordance with A-A-52083 or A-A-52084.

e. Additional information regarding connector capping and stowage is provided in the NA 01-1A-505-1, Work Packages 007 00 and 026 00. Information on the capping and stowage of fiber optic connectors is provided in NA 01-1A-505-4, Work Package 012 02.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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Acceptable Typical protective cover.	**Acceptable** Pressure sensitive tape wrapped connector.	**Acceptable** 101A083-XX-X heat shrinkable end cap installed over connector.	**Unacceptable** Plastic bag or ESD Grid Tape used to cap and stow connector.	**Unacceptable** Plastic Dust Cap; not for operational aircraft; only authorized for aircraft in depot maintenance, or off aircraft for shipping and storage.

FIGURE 8-1. Examples of acceptable and unacceptable connector capping and stowage methods.

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GUIDELINE 9

MECHANICAL STRIPPING WIRE INSPECTION

1. Purpose. This guideline gives criteria on inspecting wire used in the EWIS after using a mechanical stripping device.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual.
Work Package 009 00	Wire and Cable Stripping.

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting or repairing wire stripped using a mechanical stripping device, the following procedures should be followed:

a. Visually inspect the wire and determine if any of the following unacceptable conditions exist (see figures 9-1 and 9-2):

1. Nicked or cut strands

2. Frayed insulation

3. Broken wire strands (see table 9-1)

WARNING:
Care should be exercised when smoothing insulation or twisting conductors as nicked, frayed, or broken strands can cause injury.

4. Un-stranded, splayed or bird cage strands (see figure 9-1). If un-twisting or bird-caging occurs, correct and reshape conductor strands by twisting the strands in the same direction as the normal lay of the wire. The conductor is recommended only to be twisted by hand. If pliers are required due to the size of the strands, caution should be taken to prevent damage to the conductor. The conductor should not be over-twisted.

b. Visually inspect the wire insulation to determine if it has been damaged during wire stripping. When examined, the wire insulation (see figure 9-3):

1. Should not be punctured, crushed, or cut by the tool.

2. Should not have deformation exceeding 20 percent of the insulation thickness.

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4.b. (continued).

3. Should not have gouges, ragged edges, be loose, nor frayed.

4. The end of the insulation should be cut as squarely and cleanly as required to meet any soldering or crimping requirements.

5. Insulation damage should not exceed 1/32 inch or 50 percent of the insulation's outside diameter, whichever is greater.

c. Additional information regarding the inspection of wire stripped using mechanical wire strippers is provided in NA 01-1A-505-1, Work Package 009 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

Acceptable
Wire insulation removed without disturbing the normal lay of the wire, as shown. Wire strands are free of nicks or cuts.

Unacceptable
Strands, re-twisted and overlapping each other, as shown, will result in increased stress and difficulty in forming a mechanical joint.

Unacceptable
Wire strands that are re-twisted in excess of their normal lay exert increased stress and may break.

FIGURE 9-1. Examples of acceptable and unacceptable wire stripping.

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Unacceptable
Wire strands are nicked, due to misalignment of wire and stripping blades. Nicked strands reveal base metal, and may break.

Unacceptable
Wire strands show evidence of a ringed condition (arrow) caused by stripper blades. Outer strands are weakened and may break.

Unacceptable
Several wire strands are cut (arrow). This condition may be the result of placing the wire in the wrong hole size of the mechanical stripper.

Unacceptable
Wire strands are bird-caged, due to misalignment of wire and stripping blades.

FIGURE 9-2. Examples of wire strands in an unacceptable condition after wire stripping.

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	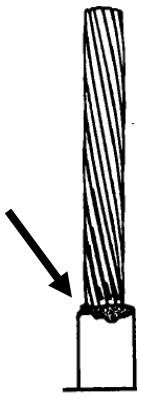	
Acceptable Wire stripped with mechanical strippers that show no evidence of damage to either the insulation or the wire strands.	**Acceptable** Although wire insulation appears to be cut or split, close examination shows that only the outer coating is damaged and does not exceed 1/32 inch, or 50 percent of insulation's thickness (whichever is greater).	**Unacceptable** The insulation has been pinched by the mechanical strippers. This condition was caused by using too small hole/setting of the mechanical stripper.

FIGURE 9-3. Examples of wire insulation in acceptable and unacceptable condition after wire stripping.

TABLE 9-1. Allowable nicked or broken strands.

Number of Strands per Conductor*	Total Allowable Nicked or Broken Strands
1 and 7	None Nicked, Broken or Severed
19	2 Nicked, None Broken or Severed
37	4 Nicked, None Broken or Severed
More than 37	6 Nicked, None Broken or Severed
*No nicked or broken strands are permitted for aluminum conductor regardless of the number of conductor strands.	

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GUIDELINE 10

MECHANICAL STRIPPING/SHIELDING REMOVAL INSPECTION

1. Purpose. This guideline gives criteria for inspecting cables with shielding after they have been stripped using a mechanical stripping device.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual.
Work Package 009 00	Wire and Cable Stripping

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When mechanicallystripped shielded cable is inspected, the following procedure should be followed (see figure 10-1):

a. Verify that there are no nicks or cuts on the shielding or inner wire insulation or the conductor.

b. Verify that the shielding is uniformly trimmed and shows no evidence of unraveling.

c. Verify the dielectric insulator is uniformly cut (flush/squared) and no nicks are present.

d. Additional information regarding the inspection of shielded cables stripped using mechanical strippers is provided in the NA 01-1A-505-1, Work Package 009 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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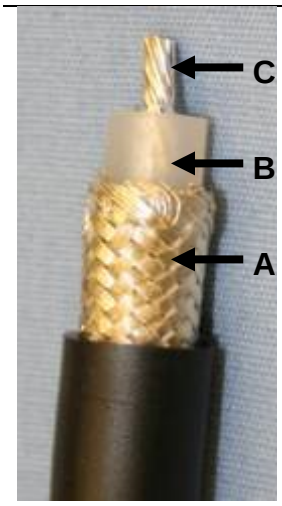			
Acceptable After stripping there should be no nicks or cuts on the shielding (A) or inner wire insulation (B) or the conductor (C).	**Unacceptable** Shielding has been cut unevenly, indicating poor trimming technique. Shielding strands have spread apart, making installation of solder sleeve difficult. Strands may puncture solder sleeve during shrinking.	**Unacceptable** Cut shielding strands, as shown, are caused during outer insulation removal.	**Unacceptable** Nicked dielectric insulator is caused during shielding removal.

FIGURE 10-1. Examples of acceptable and unacceptable mechanical stripping of shielded cable.

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GUIDELINE 11

THERMAL/LASER STRIPPING CABLE JACKET INSPECTION

1. Purpose. This guideline gives criteria for inspecting wire after using a thermal/laser stripping device.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 009 00	Wire and Cable Stripping

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Figure 11-1 shows cable in acceptable and unacceptable condition after stripping using a thermal or laser stripper. When inspecting cable jackets that have been stripped using a thermal or laser stripper, the following procedure should be followed:

WARNING

Thermal strippers can cause serious burns. Keep flammables away from thermal strippers. Do not leave thermal strippers unattended during operating or cool down. Thermal strippers are not for use on fueled aircraft as they are not explosion proof.

a. Allow wire to cool before handling, then verify there are no nicks or cuts on the shielding or inner wire insulation or the conductor.

b. Verify that there has been no contact made by the wire with thermal stripper beyond the stripping area.

c. Verify insulation is not charred or blistered.

d. Verify insulation is not pulled in strings adhering to the conductor.

e. Verify that all insulation is removed from the conductor.

f. Verify conductor is not damaged.

g. Additional information regarding the inspection of wires stripped using thermal/laser strippers is provided in the NA 01-1A-505-1, Work Package 009 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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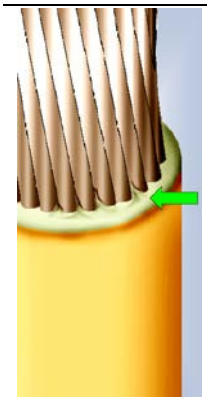	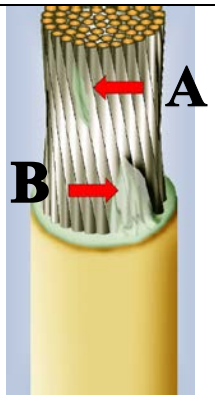		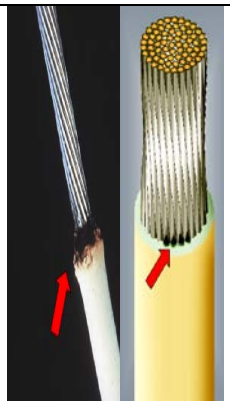
Acceptable Jacket should have a minimum of edge flash, as shown, with no damage to the jacket. Slight charring and discoloration of jacket is acceptable.	**Unacceptable** (A) Insulation flash has not been removed. (B) Peeling of topcoat further than 1/16 inch from strip point is unacceptable.	**Unacceptable** Contact with thermal stripper beyond the stripping area has caused the jacket to melt (arrow), exposing shielding strands.	**Unacceptable** Burned or charred jacket or strands, as shown, is the result of excessive heat application.

FIGURE 11-1. Examples of acceptable and unacceptable stripping of shielded cable by thermal/laser strippers.

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GUIDELINE 12

HARNESS ROUTING INSPECTION

1. Purpose. This guideline gives criteria for inspecting proper harness routing of wires and cables that make up the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 010 00	Harness Installation
NA 01-1A-505-4	Aircraft Fiber Optic Cabling Manual
Work Package 012 01	General Practices for Cable Harness Installation

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting harness routing in aircraft, the following procedures should be followed.

a. Confirm that individual wires in a bundle are uniformly arranged and of the same length (see figure 12-1).

b. Confirm that the wire length is short enough so that there are no wire loops where individual wires can be easily damaged (see figure 12-1).

c. Ensure that cabling is routed so that relative motion does not result in abrasion between wires with dissimilar insulation.

d. Confirm that any wiring of dissimilar insulation that crosses over or under other wires are secured using lacing tape in accordance with A-A-52083 or string in accordance with A-A-52084 tie to prevent chafing before and after the cross over, but not on the cross over point. This is especially important in the case of polyimide insulation when it is in contact with other insulation types.

e. Ensure that sufficient slack exists for full extension of shock mounts or vibration isolators on cabling affixed or connected to shock/vibration protected equipment.

f. Confirm that sufficient slack exists to permit maintenance access.

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4. (continued).

g. Ensure that bundles are secured to exhibit a smooth appearance, without protruding wires which can be snagged or damaged.

h. Confirm that there are no twisted wires under lacing string (see figure 12-2).

i. When fiber optic cabling is routed with electrical cable/wire:

1. Ensure that fiber optical cable does not support electrical cables.

2. Verify that fiber optic cables are located on top of electrical cables.

j. Additional information regarding the inspection of cable harness routing is provided in NA 01-1A-505-1, Work Package 010 00 and NA 01-1A-505-4, Work Package 012 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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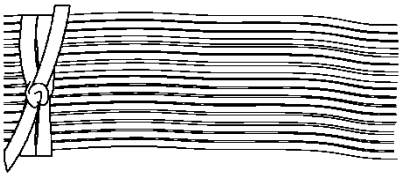
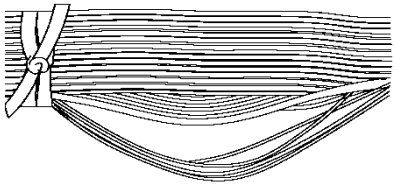
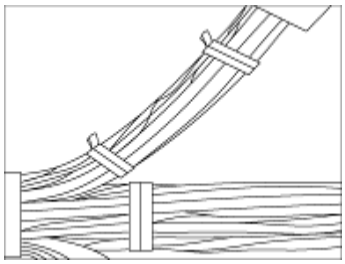


Acceptable
Individual wires in a wire bundle should be uniformly arranged and of the same length. Varying lengths of wire will increase the bundle diameter.

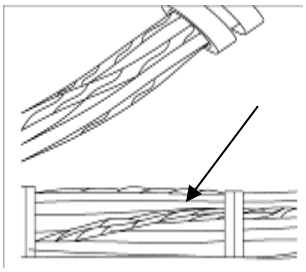


Unacceptable
Excessive wire length has formed loops that can easily be damaged and has increased the bundle diameter.

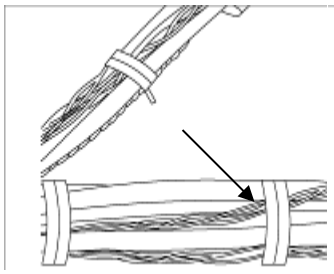
FIGURE 12-1. Examples of acceptable and unacceptable wires in a wire bundle.



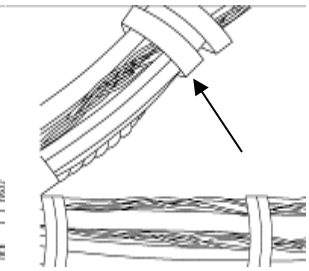
Acceptable
Wires in a harness should run straight and parallel to each other, as shown. Although some minor wire crossing is permitted, wires should never cross each other under a spot tie or clamp.



Acceptable
Wires (arrow) are shown crossing over the top of other wires. However, the crossover does not occur under a spot tie or clamp.



Unacceptable
The twisted wires (arrow) are shown crossing another wire underneath a spot tie. Damage to insulation may result.



Unacceptable
The twisted wires (arrows) have crossed over the top of the other wires, under the clamp. Damage to individual wires may occur.

FIGURE 12-2. Examples of acceptable and unacceptable wires in a wiring harness that are straight and twisted.

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GUIDELINE 13

CABLE HARNESS COVERING OR PROTECTION INSPECTION

1. Purpose. This guideline gives criteria for inspecting cable harness coverings and abrasion protection.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass.
A-A-52084	Tape, Lacing and Tying, Aramid.
MS35489	Grommets, Synthetic and Silicone Rubber, Hot-Oil and Coolant Resistant
SAE AS21919	Clamp, Loop Type, Cushioned Support. (DoD adopted)
SAE AS23190	Wiring, Positioning, and Support Accessories (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual.
Work Package 010 00	Harness Installation.

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting and repairing cable harness covering and protection, the following procedures should be followed:

a. Examine cable harness covering (convoluted tubing or cable wrap) for:

1. Loosening or fraying.

2. Proper support using rigid conduit or SAE-AS21919/AS23190 cable clamps (see figure 13-1).

3. Proper installation of spot tie on convoluted tube wrapped harness and spiral wrap (see figures 13-1 and 13-2).

4. Secured wrap ends are spot tied using lacing tape (A-A-52083 or A-A-52084) (see figure 13-2).

5. Twisting of harness covering, a minimum of one revolution per foot. This accommodates for uniform coverage around bends or twists around the harness being protected (see figure 13-2).

b. Examine cable harness for chafing where wire or cable is routed near structural members and equipment (see figure 13-3).

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4.b. (continued).

2. Crosses over/under other wiring.

3. Passes through lightening holes. If found, cover all feed throughs with an edge grommet (see figure 13-6) and wire bundle or harness in lightening hole (see figure 13-4).

4. Moves/flexes when door(s) are opened/closed.

5. Passes over or near hinged areas.

6. Turns or bends near components and at connector backshells and is flexed during removal and installation of components.

7 Around generator power wiring routing areas.

8. At conduit exit points (see figure 13-1).

c. Clearance from structure, surfaces, and equipment should be a minimum of 1/2 inch. Where physical separation of at least 1/2 inch cannot be maintained, the edges should be covered with suitable protection, or the harness should have secondary protection. For wire or bundles containing polyimide (Kapton®) insulated wire (e.g. M81381), if the separation is 1/2 inch or less, use secondary protection over the wire bundle. Examples of secondary protection for wiring harness are: heat wrap, spiral chafe wrap, chafe pad, Expando sleeving, or wrap-around sleeving. All harness wraps and sleeving should be secured with lacing tape/tie string within an inch of the ends. Refer to NA 01-1A-505-1, WP 010 00 for additional requirements.

d. Examine places where wire bundles come into contact with sharp edges. If found, sharp edges should be covered using with Teflon sheet (see figure 13-5), or MS35489 grommet (see figure 13-6).

e. Examine locations where wiring may come into contact with bolts. If found, apply polysulfide sealant to bolt head or install domed nut cover over applicable nut (see figure 13-5).

f. Examine places where wiring harnesses come into contact with abrasive surfaces. If found, teflon tape with a minimum 50 percent overlap should be used on these wiring harnesses. Spot ties should be used on each end of the tape to prevent unraveling. Teflon sheet or other chafe protection may also be used (see figures 13-4 through 13-6).

g. Additional information regarding the inspection of cable harness covering or protection is provided in NA 01-1A-505-1, Work Package 010 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline

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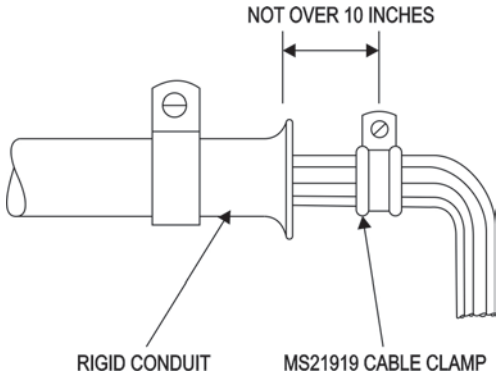
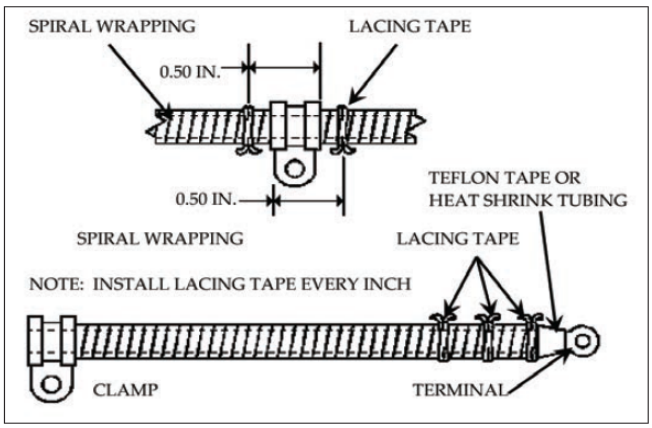


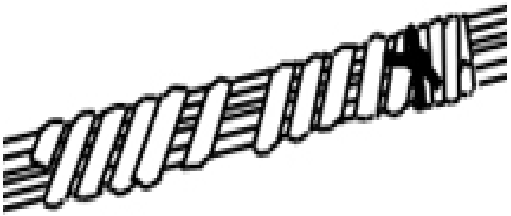
Acceptable
This is an example of how a wire harness should be supported after exiting a rigid conduit.

Acceptable
Correct installation of spot tie on a convoluted tube wrapped harness with a clamp.

FIGURE 13-1. Examples of acceptable cable harness support and protection.



Acceptable
Correct installation of spot tie on a spiral wrapped harness with a clamp.



Unacceptable
Spot tie not installed on spiral wrap. The spiral wrap is loosened and unraveling.

FIGURE 13-2. Examples of acceptable and unacceptable spiral wrapped cable harness.

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Acceptable Proper installation of harness covering.	**Unacceptable** Improper twisting of harness covering.	**Unacceptable** No spot tie on harness covering.

FIGURE 13-3. Examples of acceptable and unacceptable wires in a wiring harness that are straight and twisted.

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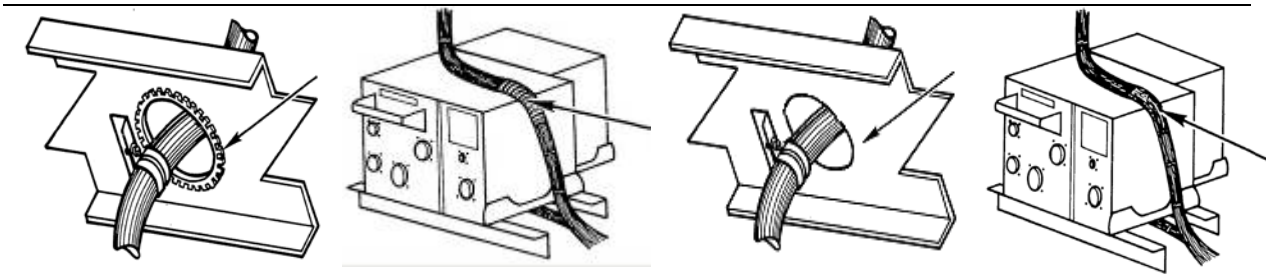
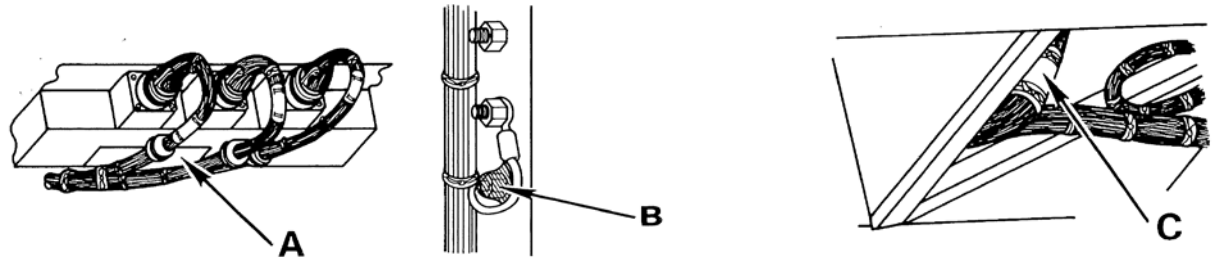


Acceptable Feed through with edge grommet (arrow). Center bundle/harness in lightening hole.	**Acceptable** Wire harnesses wrapped with Teflon spiral chafe wrap, or chafe pad and secured with lacing tape/tie string.	**Unacceptable** Missing edge grommet.	**Unacceptable** Harness is routed on sharp edge of structure. Cable insulation will be damaged due to aircraft vibration.

FIGURE 13-4. Examples of acceptable and unacceptable routing of cables in feed throughs and aircraft structures.



Acceptable (A) Positive clearance maintained and sharp edges covered with Teflon sheet.	**Acceptable** (B) Polysulfide sealant applied to bolt head.	**Acceptable** (C) Teflon tape with a minimum 50 percent overlap.

FIGURE 13-5. Examples of acceptable use of Teflon sheet and polysulfide sealant.

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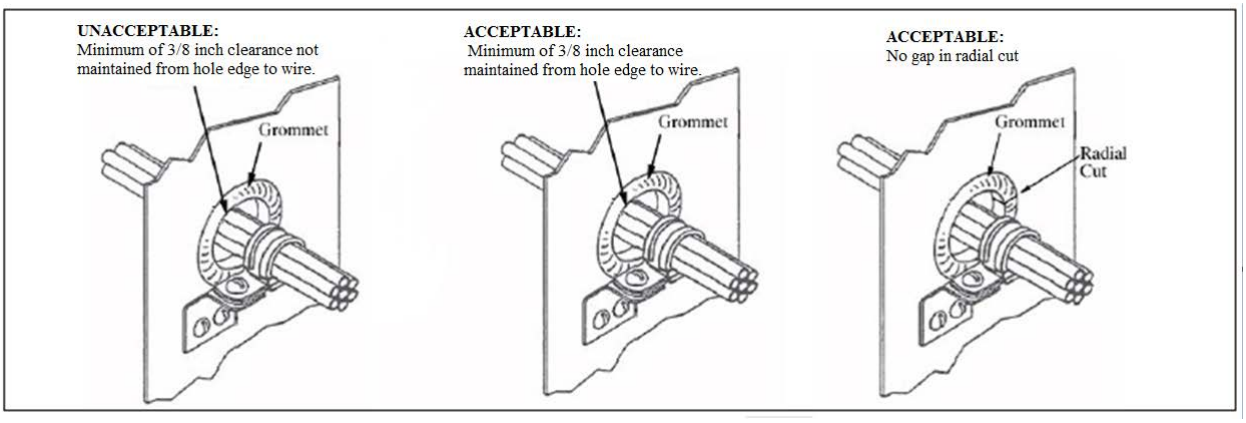

FIGURE 13-6. Unacceptable and acceptable MS35489 donut grommet installation.

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GUIDELINE 14

CRITICAL CLAMP MARKER INSPECTION

1. Purpose. This guideline gives inspection criteria on critical clamp markers used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 008 00	Wire, Cable, and Harness Marking
Work Package 010 00	Harness Installation

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General guidelines. The following criteria for critical clamp marker installation are as follows:

WARNING

Critical clamp marker labels may not be moved from their design drawing-required location. If moved beyond allowable limits, the harness may be damaged, or cut, resulting in aircraft system failure or injury to personnel.

NOTE

Critical clamp markers installed on designated wire harnesses provide a means of ensuring installation clearance requirements are met. Typically, installed on very long/ branched harnesses (landing gear, flight controls) subjected to motion.

a. Ensure markers are permanent and may not be moved to facilitate maintenance.

b. Verify critical routing points are indicated by colored markers (typically one to two inches wide, white or yellow, marked by paint, tape or label) on the bundle which are located under cable clamp such that the colored marker is exposed on both sides of the clamp (see figure 14-1).

c. Verify correct cable assembly routing and clamping of specific cables or harnesses. Refer to the applicable aircraft electrical wiring installation drawings, or Illustrated Parts Breakdown. If not available, contact the Cognizant Engineering Authority for direction.

d. Additional information regarding critical clamp markers is provided in NA 01-1A-505-1, Volume 1, Work Package 008 00 and 010 00.

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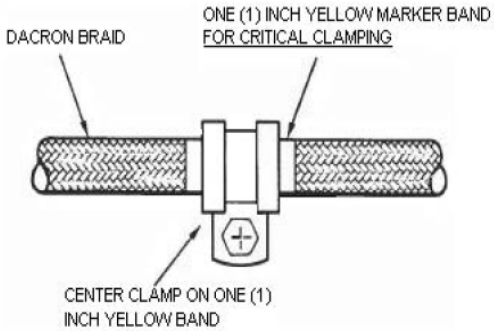

Acceptable
Correct marker type; centered on clamp, with both sides shown

Acceptable
Ideal clamp marker installation

Unacceptable
Markers are not under the clamps or only partially

FIGURE 14-1. Acceptable and unacceptable critical clamp marker installation.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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GUIDELINE 15

WIRE/HARNESS CLEARANCE INSPECTION

1. Purpose. This guideline gives criteria for inspecting wire or harness clearances.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 010 00	Harness Installation
NA 01-1A-505-4	Aircraft Fiber Optic Cabling Manual
Work Package 012 01	General Practices for Cable Harness Installation.

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting installed wire/harness and fiber optic cable clearance, the following guidance should be followed:

a. Clearance from structure, surfaces, and equipment should be a minimum of 1/2 inch. Where physical separation of at least 1/2 inch cannot be maintained, the edges should be covered with suitable protection, or the harness should have secondary protection (e.g., heat shrink, chafe wrap, etc.). Examples of where these minimum clearances can exist include the distance between:

1. Wire/harness and linkages, throttle controls, boxes, covers, structures, control cables and component mounting hardware (see figure 15-1).

2. Terminal lugs between other lugs, adjacent components and nearby structures at contactors, circuit breakers, relays, power control relays and terminal boards.

b. Clearance from flammable fluid carrying lines and tubes. The following should be considered when inspecting wire/harness routed near fluid carrying lines.

1. There should be a minimum 2-inch clearance between wire/harness and fluid carrying lines, tubes and equipment. Separation between wire/harness and fluid carrying lines is not required when a conduit, bulkhead or other continuous structure separates cabling from fluid lines (see figure 15-2).

2. Wire/harness should be routed level with or above all fluid lines.

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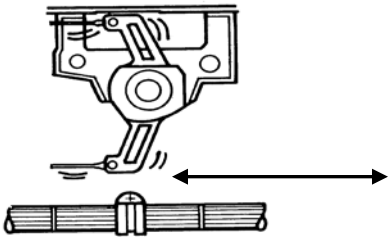
4. (continued).

3. Wire/harness should not be attached to fluid carrying lines, tubes, and equipment unless they require electrical connections (unless specifically authorized so as to maintain positive separation). If not, then a minimum ½-inch clearance is acceptable if a clamp (or other positive means) and secondary protection (e.g., heat shrink or wrap-around sleeve) is used to separate the wire or harness from the flammable fluid line.

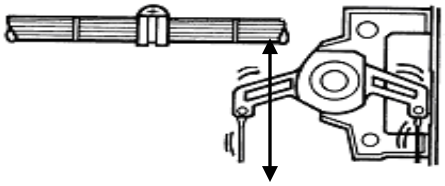
c. Information regarding the inspection of wire/harness and fiber optic cable clearances is provided in NA 01-1A-505-1, Work Package 010 00 and NA 01-1A-505-4, Work Package 012 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.



Acceptable
Secure wire harness to avoid moving parts and high temperature ducts or equipment.



Unacceptable
Reposition wire harness to prevent harness from being damaged by mechanical linkage during travel.

FIGURE 15-1. Examples of acceptable and unacceptable placement of wire harnesses near equipment and linkage.

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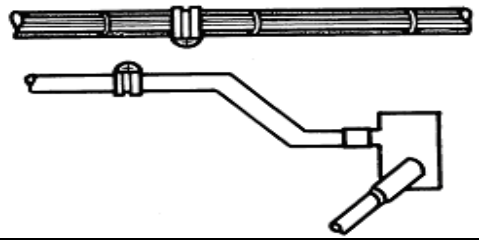	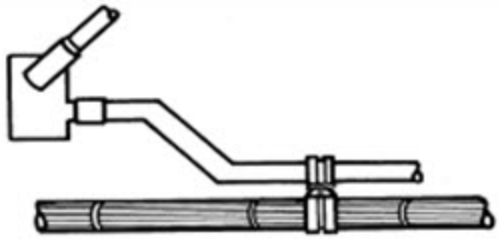
Acceptable Cables, wires and harnesses should maintain a separation of not less than 2 inches from lines carrying flammable fluids (fuels, hydraulic fluid, and coolant). Where drawing requirements are less than 2 inches, the cable should be rigidly supported and covered with suitable secondary protection material.	**Unacceptable** Cables, wires and harnesses should not be clamped or tied to fluid lines. Cable harness should be routed above fluid lines.

FIGURE 15-2. Examples of acceptable and unacceptable placement of wires, cables, and harnesses near fuel lines.

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GUIDELINE 16

CABLE HARNESS BEND RADIUS INSPECTION

1. Purpose. This guideline gives criteria for inspecting cable harness bend radius in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 010 00	Harness Installation

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. The following procedures should be followed when inspecting the bend radius of electrical cables and harnesses. The maintenance of minimum bend radius requirements ensures optimum system performance.

a. For wiring system applications:

1. Confirm that wiring groups, bundles or harnesses and cables individually routed and supported, meet the minimum bend radius. At the point individual wiring breaks out from a group, harness or bundle, the minimum bend radius should be ten times the outside diameter of the largest included wire or cable, provided the wire is suitably supported at the breakout point (see figure 16-1).

2. Verify that wires used as shield terminators or jumpers, when required to reverse direction, have a minimum bend radius three times the wire diameter at the reversal point, provided the wire is adequately supported.

3. Flexible coaxial cables should have a bend radius of minimum of six times the cable diameter and semi-rigid coaxial cable should have a minimum bend radius of 10 times the cable diameter (see figure 16-2).

4. Ensure the minimum bend radius, as measured on the inside radius of the harness/cable is no more than 10 times the outside diameter of the largest wire/cable in the harness (see figures 16-1 and 16-2).

b. Information regarding cable harness bend radius inspection is provided in NA 01-1A-505-1, Volume 1, Work Package 010 00.

5. Detail guidelines. This section is not applicable to this guideline.

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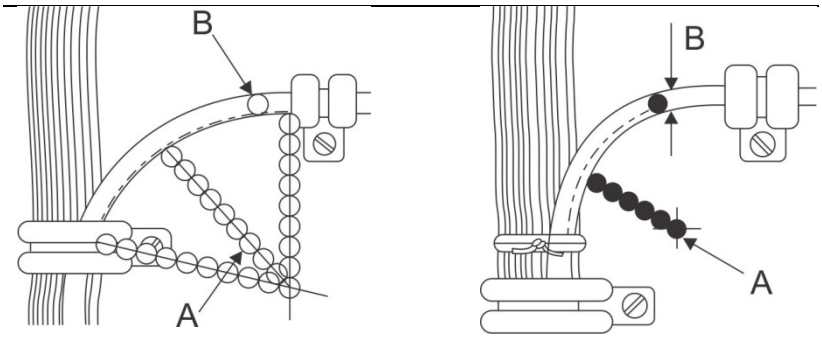
6. Notes. This section is not applicable to this guideline.



Acceptable	**Unacceptable**
Wires and cables should have a minimum bend radius (A) of ten times the diameter of the largest wire insulation (B) contained in the bundle.	The radius (A) of the wire breakout measures only 6 times the wire diameter (B). Excessive stress is exerted on wires installed with sharp bends.

FIGURE 16-1. Examples of wires and cables with acceptable and unacceptable bend radius.

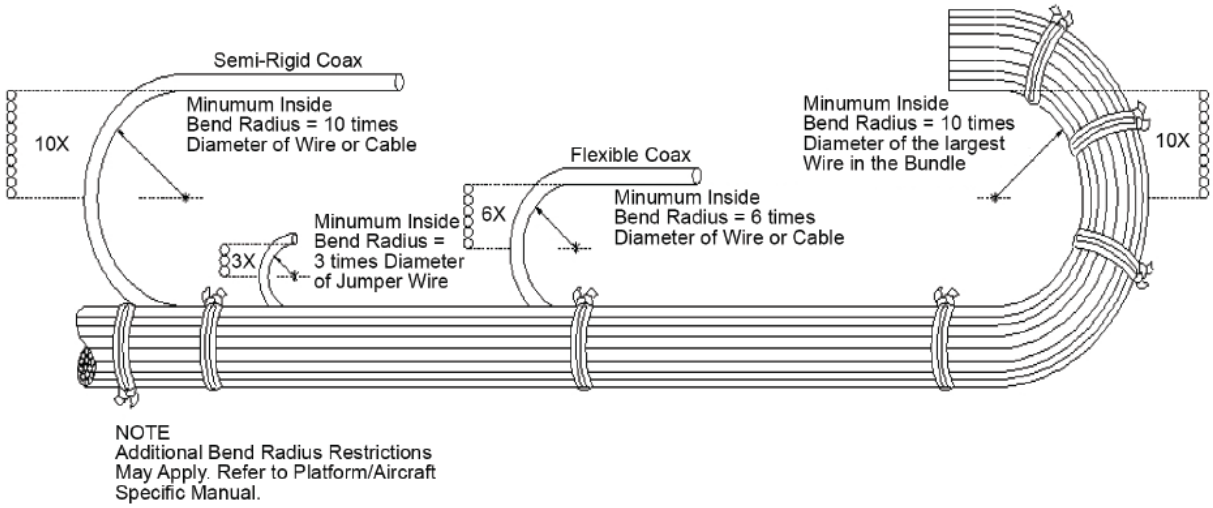


FIGURE 16-2. EWIS minimum bend radius.

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GUIDELINE 17

SPOT TIE/LACING TAPE/TIE STRING INSPECTION

1. Purpose. This guideline gives criteria for using or inspecting secondary support spot tie / lacing tape used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 010 00	Harness Installation
NA 01-1A-505-4	Aircraft Fiber Optic Cabling Manual
Work Package 012 01	General Practices for Cable Harness Installation

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Use the following installation procedures when inspecting lacing tape or tie string:

a. Wire bundle is secured using lacing tape/tie string (part number A-A-52083 or A-A-52084), where A-A-52084 is used for all general applications and A-A-52083 is only used for high temperature applications. Ensure only A-A-52084 or A-A-52083 finish C, size 2 or 3 is employed (e.g., A-A-52084-C-2).

b. Verify that a clove hitch and square knot has been used and trim off excess squarely to 3/8″ ±1/8″ length (see figures 17-1 and 17-2).

c. Verify wire/cable bundles have been tied tightly enough to prevent slipping, but not so tightly that the lacing tape/tie string cuts into or deforms the insulation. Care must be taken when lacing or tying coaxial cable, which has a soft dielectric insulation. If the dielectric is deformed, signal integrity will be degraded.

d. Lacing tape/tie string should be uniformly spaced and located every 3″ to 6″ throughout the length of the harness. The spacing of spot ties used should be as indicated in table 17-1 (see figure 17-3).

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4. (continued).

TABLE. 17-1. Lacing tape/ tie string spacing on open/closed architecture harnesses.

Wire bundle diameter	Spot Tie Spacing	
	Max	Not less than
up to ½″	4″	3″
½″ to 3″	5″	3″
3″ & larger	6″	3″

e. Lacing tape/tie string installed inside electronic assembly/panel wiring/circuit breaker panel should be uniformly spaced in accordance with table 17-2 throughout the length of the harness. The spacing of spot ties used should be as indicated in table 17-1 (see figure 17-4).

TABLE. 17-2. Lacing tape/tie string spacing for inside electronic assembly and panel harnesses.

Bundle Diameter	Preferred Mimimum Spot Tie Spacing	Maximum Spot Tie Spacing
1/2 inch and less	Approx. 1/2 inch	1 - 1/2 inch
Over 1/2 inch up thru 1 inch	Approx. bundle diameter	1 - 1/2 inch
Over 1 inch	Approx. bundle diameter	Bundle diameter + 1/2 inch

f. Lacing string/tie string should not be closer to the clamp than a distance equal to the width of the clamp (see figure 17-5).

g. When lacing string/tie string are used at breakouts, they should be located as shown on figure 17-6.

CAUTION

Applying lacing ties too tightly can lead to degraded optical performance or fiber breakage. Use extreme caution when applying lacing tape to ensure that the ties do not deform the cable, cable bundles, or cable harness.

h. When inspecting lacing string/tie string installed on fiber optic harnesses, the following should be considered:

1. Ties should not be used on the part of a cable group or bundle located inside a conduit.

2. Continuous lacing may not be used for secondary support of fiber optic cable, cable bundles, or cable harness.

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4. (continued).

3. Plastic cable straps (zip ties) are prohibited for use as secondary support. Refer to guideline 21 for information regarding plastic cable straps.

i. Additional information regarding the inspection of lacing tapes and spot ties used with electrical cables is provided in NA 01-1A-505-1, Work Package 010 00 and for fiber optic cables in NA 01-1A-505-4, Work Package 012 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

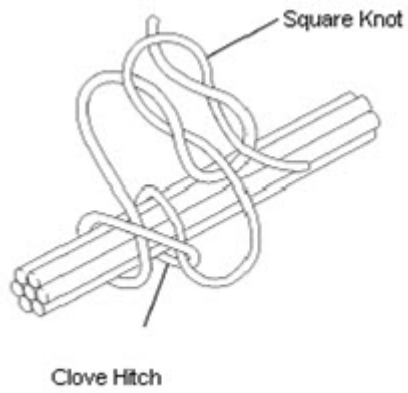	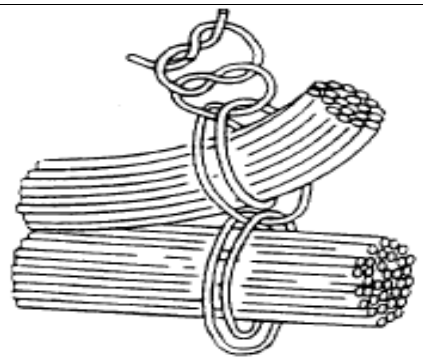
Acceptable Clove hitch, followed by a square knot.	**Acceptable** Breakout of bundle into two separate bundles. Wrap cord around wire group or bundle, as shown. Make a clove hitch, followed by a square knot with an extra loop. Trim free ends of cord 3/8″ +/- 1/8″.

FIGURE 17-1. Examples of acceptable use of lacing tape.

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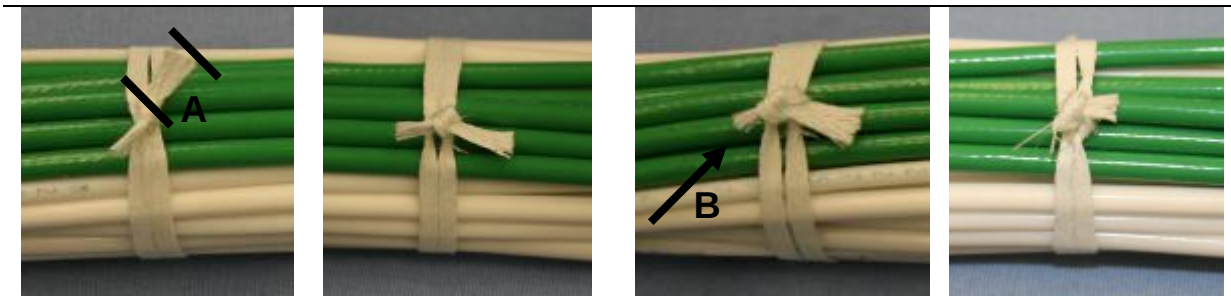

Acceptable
The ends of the tying material should be approximately even in length, cut square at the ends and measure 3/8″ +/-1/8″ from the knot as shown (A).

Acceptable
The cut ends of the knot are uneven in length indicating poor trimming technique. However, the length of both ends are within the allowable limits.

Unacceptable
The tying material is trimmed short of the required 1/4″ (B) minimum length.

Unacceptable
The loose ends of the spot tie knot have been trimmed closer than the 1/4″ minimum requirement.

FIGURE 17-2. Examples of acceptable and unacceptable tying of lacing tape.

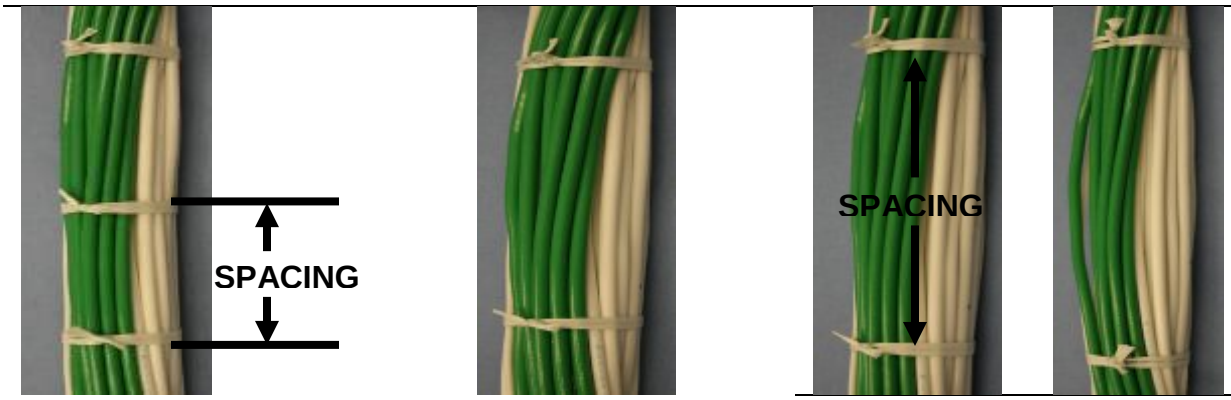

Illustration of spacing of of spot ties (see table 17-1).

Acceptable

Unacceptable **Unacceptable**

The maximum allowable spot tie spacing has been exceeded. Wires cannot be contained neatly. Loose wires may be damaged.

FIGURE 17-3. Examples of acceptable an unacceptable lacing tape/ tie string spacing.

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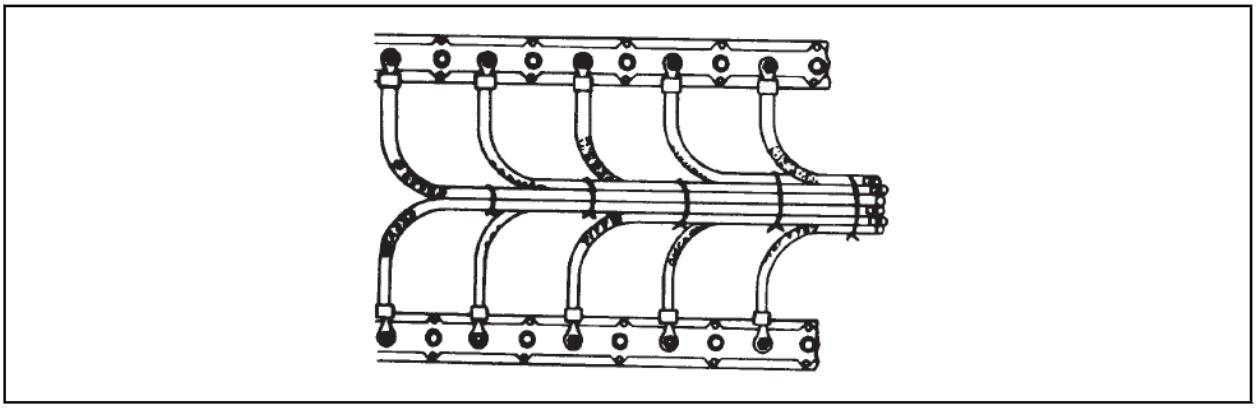

FIGURE 17-4. Lacing tape/tie string at termination inside electronic assembly and panel harnesses.

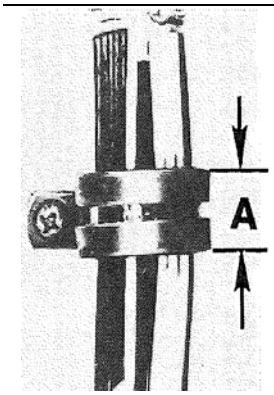			
Acceptable Spot ties are no closer to the clamp than a distance equal to the width of the clamp (A). This will allow the wire bundle to be supported by the clamp, as shown.	**Acceptable** Spot tie wrap is located at a distance, from the clamp, equal to the clamp width. Bundle is able to conform to the shape of the clamp.	**Unacceptable** Spot tie has been positioned too close to clamp, resulting in the cut end of the spot tie being pinched by the clamp.	**Unacceptable** The clamp has been placed over the spot tie. When tightened, the clamp will press the tie down into the wire insulation causing serious damage.

FIGURE 17-5. Examples of lacing tape/tie string correctly located and located too close to a cable clamp.

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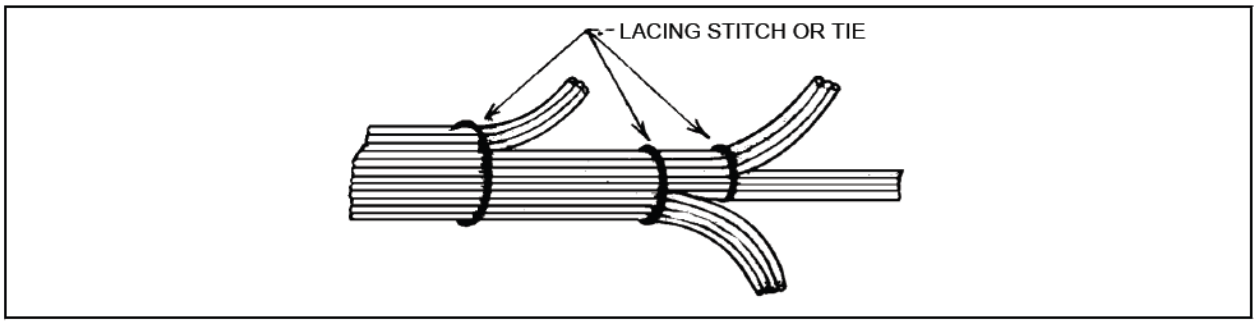

FIGURE 17-6. Spot ties at breakouts should be located as shown.

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GUIDELINE 18

PRIMARY SUPPORT CABLE CLAMP INSPECTION

1. Purpose. This guideline gives criteria for inspecting cable harness primary support cable clamps used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying Glass
A-A-52084	Tape, Lacing and Tying, Aramid
A-A-59163	Insulation Tape, Electrical, Self-Adhering Unsupported Silicone Rubber
SAE AS21919	Clamp, Loop Type, Cushioned Support. (DoD adopted)
SAE AS23190	Clamp, Loop Type, Cushioned Support. (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 010 00	Harness Installation
NA 01-1A-505-4	Aircraft Fiber Optic Cabling Manual
Work Package 012 01	General Practices for Cable Harness Installation

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting clamps used in the EWIS, the following procedure should be used:

a. Primary support clamps:

1. Confirm SAE AS21919 or SAE AS23190 primary support clamp part number includes a “W” in the part number if it is a wedge type clamp; does not apply to plastic, or specialty clamp configurations (see figure 18-1).

2. Inspect the base or wedge of cushion material to ensure wires are not pinched in metal band (see figure 18-1).

3. Ensure clamps are not too large or too small for wire bundle on which they are installed (see figure 18-2). If the wire bundle is smaller than the nearest clamp size, or if a clamp of the proper size is not available, wrap the wire bundle with the necessary number of turns of non-adhesive insulating tape in accordance with A-A-59163 Type 2, so the bundle will be held securely in the clamp.

4. Confirm no plastic clamps are used where ambient temperature may exceed 185 °F. Plastic cable clamps are not permitted for use as primary support of fiber optic cable. Where

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4.a (continued).

plastic clamps are used to support electrical wiring at least every fourth clamp should be a rubber cushion type clamp.

5. Confirm there are no loose, broken, or deteriorated cushion clamps.

6. Verify all clamps used are able to withstand the environment to which they are exposed.

7. Confirm there are no deformed clamps and that there are no cracks in the metal portion, particularly at the bolt location (see figure 18-3).

8. Verify metal cushion clamps are used as primary means to support fiber optic cabling.

9. Ensure lacing tape/tie string (A-A-52084 or A-A-52083) is used only for secondary support.

10. Verify that wire harnesses are held firmly and fill the clamp completely (see figures 18-4 and 18-5).

11. Confirm clamps are secure enough to prevent harness movement and chafing.

12. Verify the clamp does not compress the wire while maintaining continuous contact throughout the clamp (see figure 18-4).

13. Confirm proper clamp tightness by following all wire/harness runs and lightly shaking at all clamp or support devices. Inspect for proper torque by attempting to rotate clamp around bolt/screw axis. If not tight, length may be improper or bolt bottomed out.

14 Examine clamp for proper thread protrusion from the back of the clamp. Three to five threads are optimum (2 minimum).

15. Ensure airframe clips, nut plates, and brackets do not have loose rivets or fasteners.

16. Verify the space between clamps is not greater than 24 inches (see figures 18-5 and 18-6).

17. Confirm fuel lines have not been used to support wire harnesses (see figure 18-5).

b. Other support clamps.

1. Figure 18-7 illustrates the different parts of clamps used for single, double harness clamping, and multi-harness wiring.

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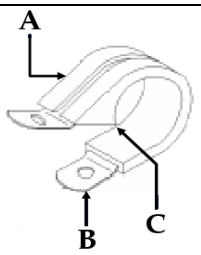
4. (continued).

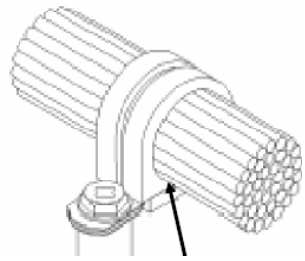
c. Additional information regarding the correct usage of clamps to support electrical and fiber optic cables is provided in NA 01-1A-505-1, Work Package 010 00 and NA 01-1A-505-4, Work Package 012 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

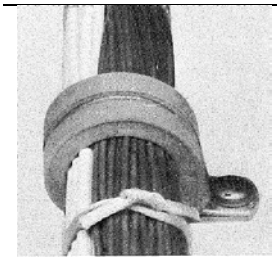


Acceptable
(A) Rubber cushion. (B) Clamp tabs. (C) Wedge.

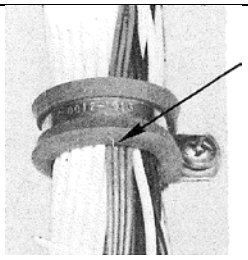


Acceptable
Verify no pinched wires at the wedge.

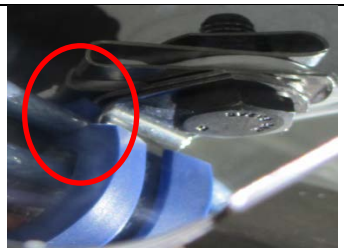
FIGURE 18-1. Examples of acceptable clamps and clamp installation.



Acceptable
Wire harness that is held firmly and fills the clamp completely. Clamp does not distort the clamp or crush the wires. Clamp is secure enough so that the harness does not move and there is no chafing.



Unacceptable
Wires are compressed tightly into clamp, decreasing bundle below normal diameter. Visible evidence of tight clamping may be a curved contour of the rubber cushion (arrow).



Unacceptable
The clamp shown with wire pinched under wedge.

FIGURE 18-2. Examples of clamps that are properly and improperly installed on wire bundles.

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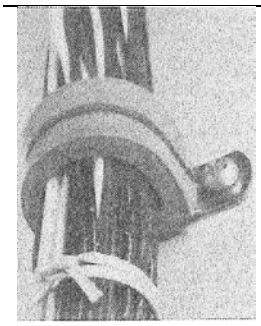
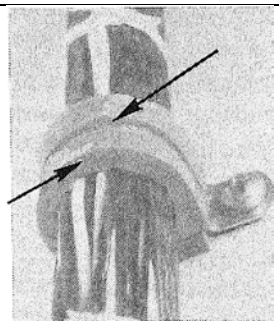
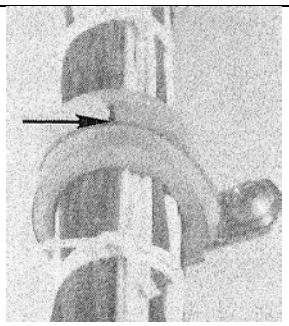


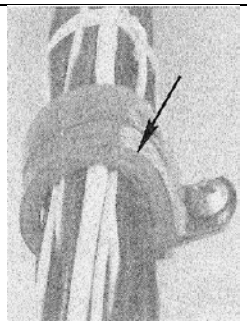
Acceptable
The rubber cushion should be free from gouges that expose the metal clamp, and from cuts or cracks.



Acceptable
Slight abrasions and minor imperfections (arrows) are acceptable provided there is no exposed metal or sharp indentation which may develop into cracks.

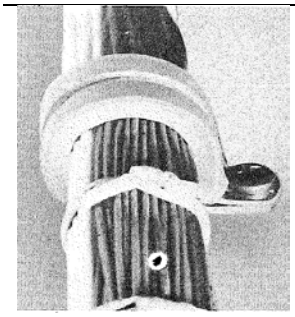


Unacceptable
Cushion is weakened by cut (arrow). Cut will tend to propagate and increase cushion separation.

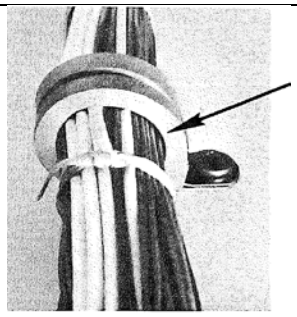


Unacceptable
The metal clamp has been exposed by a gouge (arrow).

FIGURE 18-3. Examples of clamps in acceptable and unacceptable condition.



Acceptable
Wire harness should be held firmly within the clamp to prevent excessive wire movement.



Acceptable
Although wire clamp is not completely tight (arrow), it contacts enough of the wire bundle to assure firm grip and prevent harness movement.

Unacceptable
Wire bundle is not held tightly by the clamp. Too large a clamp, used as shown, will not provide a snug grip. Chafing of the wires may occur.

FIGURE 18-4. Examples of acceptable and unacceptable installation of clamps to prevent wire chafing.

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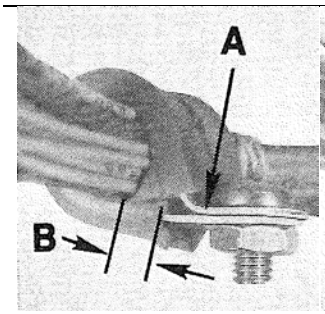	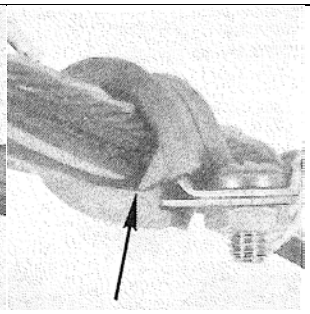	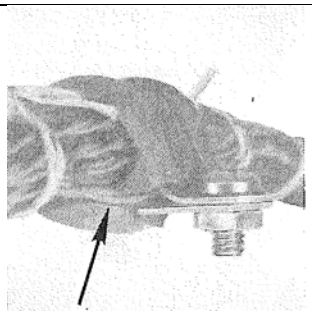	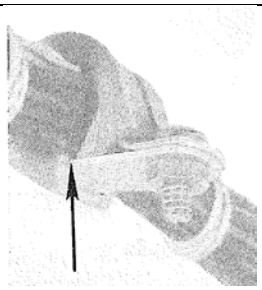
Acceptable Cable clamps should fit the wire bundle snugly when completely tightened. The mounting flanges should close together (A) and the cushion wedge (B) should overlap the cushion, as shown.	**Acceptable** Although clamp appears loose, it is snug enough to hold bundle securely. Mounting flanges are closed tight and cushion wedge is contacting lower cushion (arrow) preventing contact of wire with bare clamp.	**Unacceptable** Clamp fits snugly and flanges are closed properly. However when clamp was being closed, wires were trapped between wedge and lower cushion (arrow) and could contact bare clamp.	**Unacceptable** Clamp appears to be loose which may allow movement of wire bundle. Also, the rubber cushion has slipped and wires are in contact with bare clamp (arrow).

FIGURE 18-5. Examples of acceptable and unacceptable clamp tightening.

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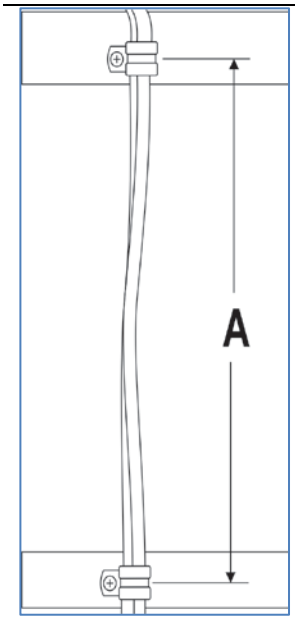
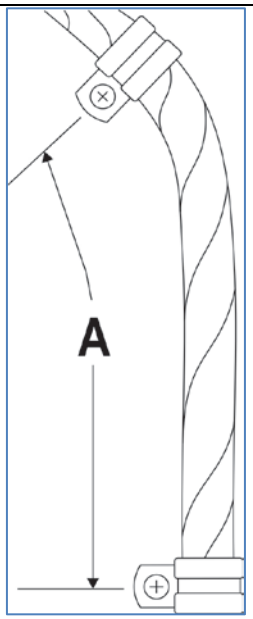
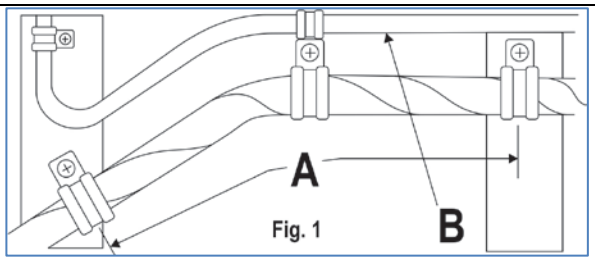
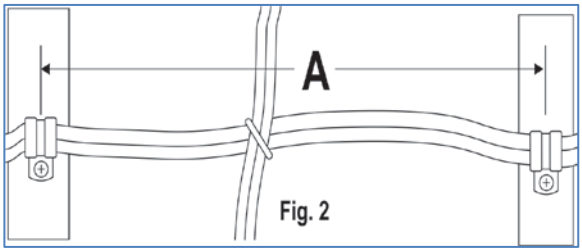


Acceptable
Where dictated by design, cable support clamps may be a maximum of 24 inches apart (A). Wire harnesses should not be supported by other harness assemblies or by fuel lines or other nonstructural members.



Acceptable
Cable clamps are within the maximum spacing. Clamp spacing (A) is measured along the contour of the harness, as shown.





Unacceptable
Fig. 1 - Harness is supported by fuel lines (B). Structurally supported clamps are located more than 24 inch maximum clamp spacing allowable (A).
Fig. 2 - Harness is spot tied to another harness (arrow) for support because of the excess spacing (A) between clamps. This is not adequate support.

FIGURE 18-6. Examples of acceptable clamp spacing and unacceptable use of fuel lines and spot ties as a means of support.

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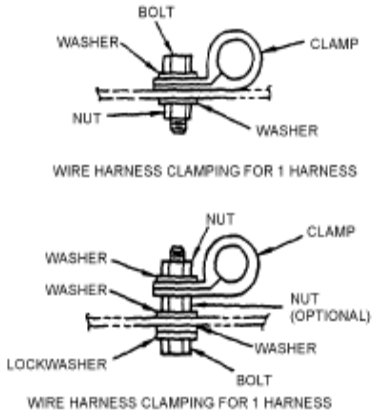
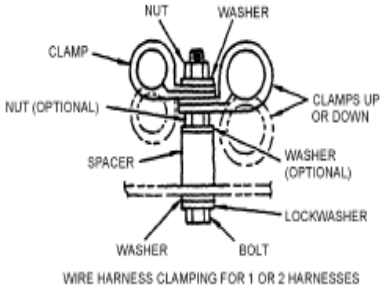
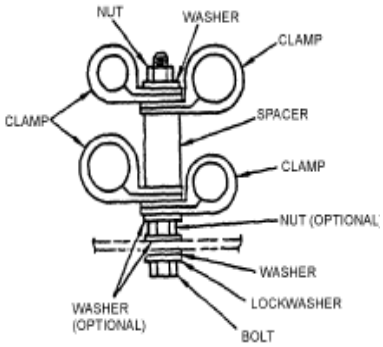


Typical single harness clamping



Typical two harness clamping
(Top and bottom clamping commonly referred to as marriage clamping.)



Typical multi harness wiring
(Side by side clamping commonly referred to as butterfly clamping.)

FIGURE 18-7. Acceptable hardware mounting configurations for clamps.

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GUIDELINE 19

HARNESS DRIP LOOP INSPECTION

1. Purpose. This guideline gives criteria on inspecting cable harness drip loop.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 010 00	Harness Installation

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See section 3 of this handbook.

4. General inspection guidelines. When inspecting drip loops used in EWIS wiring the following should be examined:

a. Wiring should be examined for proper drip loop installation. Wiring dressed down to a connector should have a drip loop/trap to prevent fluids or condensation from running down the wiring into the connector. A drip loop should also be installed between the connector and the first primary support. Figure 19-1 gives examples of acceptable and unacceptable drip loops. If a drip loop is present, it should be inspected as follows:

1. Verify drainage hole in tape or tubing (if installed) is at the lowest point. If none exists, create drainage hole.

2. Ensure hole is not clogged or covered, and that no fluids are present.

NOTE
Potted connectors do not require a drip loop.

b. Additional information regarding the inspection of drip loops provided in NA 01-1A-505-1, Work Package 010 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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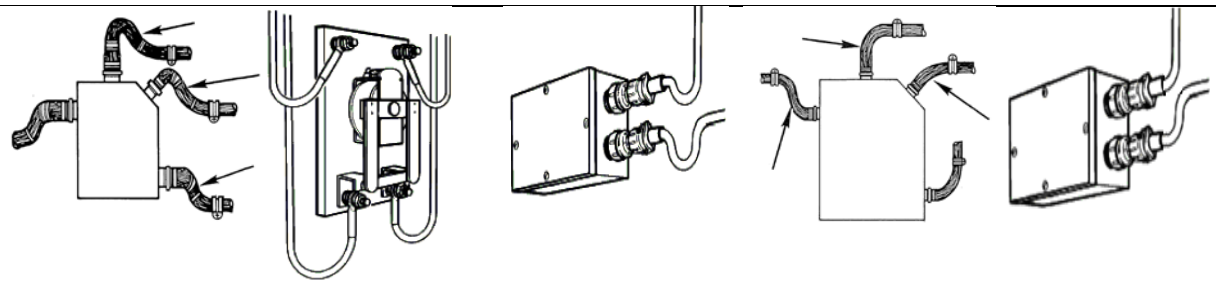

Acceptable **Acceptable** **Acceptable** **Unacceptable** **Unacceptable**

Draining, in both on-ground and in-flight conditions, should be provided in wires and cables at electrical and electronic components.

No drip loop provided. Any moisture collected will run straight into the connector and/or components.

FIGURE 19-1. Examples of acceptable and unacceptable drip loops.

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GUIDELINE 20

SHIELD TERMINATION FERRULE INSPECTION

1. Purpose. This guideline gives criteria for inspecting a shield crimp ring after installation in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 015 00	Shield Terminations
SAE AS21980	Ferrule, Outer, Uninsulated, Shield Terminating, Type I, Two Piece, Class 1, for Shielded Cables. (DoD adopted)
SAE AS21981	Ferrule, Inner, Uninsulated, Shield Terminating, Type I Two Piece, Class 1, for Shielded Cables. (DoD adopted)

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Crimped on shield termination ferrule is designed to contain and terminate the cable shielding, allowing up to 1/16 inch of shielding material to protrude past outer ring. The SAE AS21980 or SAE AS21981 shield ferrule assembly uses an inner and outer ring. The outer terminates the shield over the inner ring. Figure 20-1 shows proper and improper installation of shield termination ferrules.

a. Ensure inner and outer crimp rings overlap and align on top of each other. No more than 1/32 of an inch of the inner crimp ring should be visible

b. Ensure cable shield is trimmed to 1/32 to 1/16 of an inch past the outer ring around cable circumference.

c. If ground wire is installed under the outer crimp ring, ensure metal conductor is visible next to the outer crimp ring. This validates that no wire insulation is under the crimp ring and optimal continuity is achieved.

d. Additional information regarding the inspection of shield crimp rings are provided in NA 01-1A-505-1, Work Package 015 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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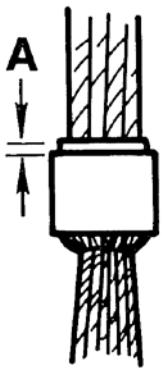			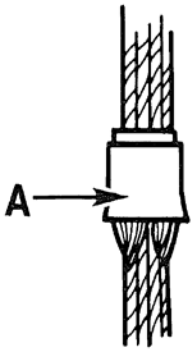
Acceptable (A) Inner ring aligned with outer ring, or may extend past outer ring by 1/32 inch. Shielding protrudes 1/16 to 1/32 inch past outer ring.	**Unacceptable** No shielding protrudes beyond outer ring. There is not enough shielding in contact surface between inner and outer ring.	**Unacceptable** Inner ring extends beyond maximum allowed, resulting in reduction of crimp contact surface and insufficient crimp.	**Unacceptable** (A) Outer ring is not completely formed because of improper positioning in crimp tool.

FIGURE 20-1. Examples of shield termination ferrules in acceptable and unacceptable condition.

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GUIDELINE 21

SECONDARY SUPPORT DEVICES INSPECTION

1. Purpose. This guideline gives criteria on inspecting secondary support devices used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
SAE AS50881	Wiring Aerospace Vehicle (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 010 00	Harness Installation

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting secondary support devices used in the EWIS, they should be examined for the following:

a. Installation: The use of plastic cable straps is strictly prohibited in all instances. When maintenance is to be performed on a wire bundle secured with plastic cable straps, only remove enough straps to affect the applicable repair. Upon restoration, install lacing tape/tie string in accordance with A-A-52084 or A-A-52083 (see figure 21-1). Refer to guideline 17 for additional inspection of lacing tape.

b. Additional information regarding the inspection of plastic, self-clinching cable straps and lacing tape is provided in NA 01-1A-505-1, Work Package 010 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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	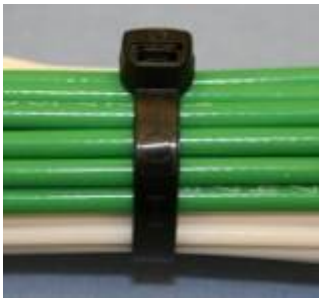
Acceptable Proper installation of lacing tape installed on a harness.	**Unacceptable** Plastic strap is installed after repair performed. Only remove enough straps to affect applicable repair. Lacing tape should be installed after restoration.

FIGURE 21-1. Examples of acceptable and unacceptable secondary support installation.

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GUIDELINE 22

EMI SHIELDED WRAP-AROUND REPAIR INSPECTION

1. Purpose. This guideline gives criteria on inspecting EMI shield wrap-around repair when this repair is present in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
A-A-59163	Insulation Tape, Electrical, Self-Fusing, Unsupported Silicone Rubber
SAE AS85049/93	Connector Accessories, Electrical, Termination, Shield Split Support Ring, Composite, Nonenvironmental, Straight, Category 7. (DoD adopted)
SAE AS85049/128	Connector Accessories, Electrical Backshell, Shield Band, Category 7 (For AS85049/82-/90, /93, /109-/117 Accessories). (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 011 00	Open and Overbraided Harness Repair

(See 2.1 through 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting EMI shield wrap used in the EWIS, the following should be considered:

NOTE

a. Ensure the EMI type of wrap is installed. Round-it 2000NXEMI-B is the EMI shielded wrap configuration. It is identified by a visible blue tracer, stitched longitudinally on the wrap. This blue tracer will be continuously visible.

NOTE

All wrap around protective sleeving material incorporates a white colored tracer as a means to ensure minimum coverage/overlap. The white tracer is applied longitudinally along the length of the wrap and should not be visible if properly installed.

b. Ensure a minimum 90° overlap exists in the EMI two layer sleeving material (see figure 22-1). The white tracer line on the overlap direction should not be visible if the correct size sleeving was employed with the required overlap.

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c. Ensure that a minimum twist of 1 to 2 turns per yard of the wire bundle is maintained (see figure 22-1).

d. Ensure the Round-it 2000NXEMI-B is terminated with metallic EMI shield termination bands (AS85049/128) at each end. This will ensure shield continuity and EMI coverage for the harness.

e. Verify that the sleeving on the bundle is tight. There should be no folds or gaps.

f. Ensure sleeving has been secured with lacing and tying tape (A-A-52084 or A-A-52083) every 2 +/- 0.5 inch.

g. Additional information regarding the inspection of EMI shield wrap provided in NA 01-1A-505-1, Work Package 011 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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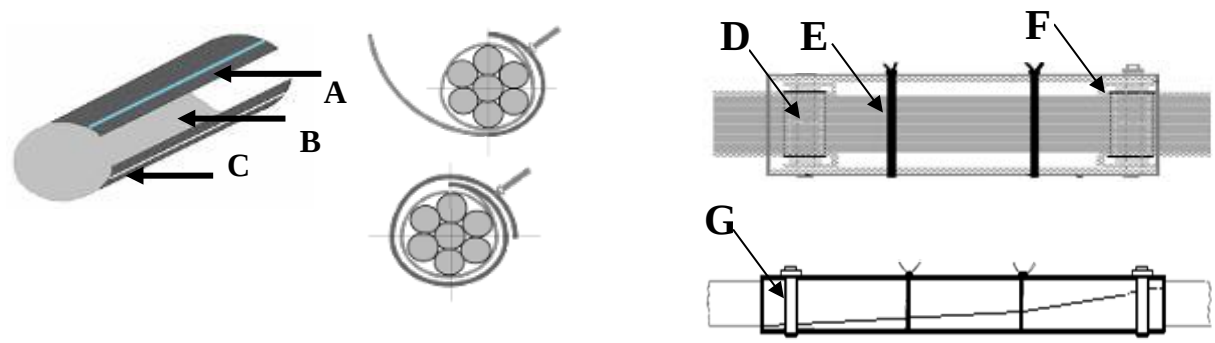

(A) External layer: Nomex for mechanical Protection. (B) Internal layer: Flat braid in nickel plated copper for EMI Protection. (C) White tracer indicating the maximum operating diameter. If the required overlap is applied, the tracer should not be exposed.	Ensure 90° overlap of both the metal braid layer and the Nomex layer.	Wrap around repair using EMI metal bands with the required sleeve twist and overlap requirements. (D) Split Ring (M85049/93-XX) (E) Spot Tie (A-A-52084). (F) Self-Fusing Silicone tape A-A-59163, Type II. (G) EMI metal band (Part No. M85049/128-1 or -2).

FIGURE 22-1. Illustration of EMI wrap around braid and examples of proper installation.

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GUIDELINE 23

CONTACT CRIMP INSPECTION

1. Purpose. This guideline gives criteria for inspecting contact crimps.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 013 00	Contacts and Terminals

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting crimped contacts used in the EWIS ensure the following minimum requirements:

a. Ensure metal conductor is visible in the contact inspection hole. It is possible to have the crimp indents deform the inspection hole of a crimp contact (see figure 23-1).

b. Verify the four double (8 total) indents are visible on the crimped contact (see figure 23-2).

c. Confirm conductor is visible around the contact crimp barrel. Ensure metallic conductor is visible (insulation gap) and not greater than 1/32″. Re-terminate the contact as required to meet the insulation gap limit.

d. Confirm that the contact crimp barrel is not cracked next to/parallel to the crimp indents. Replace contact if cracked.

e. Gently pull/tug on contact in direction parallel to the wire length to ensure adequate crimp.

5. Additional information regarding the inspection of contact crimps is provided in NA 01-1A-505-1, Work Package 013 00.

6. Detail guidelines. This section is not applicable to this guideline.

7. Notes. This section is not applicable to this guideline.

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Acceptable Crimp indents deform the inspection hole boundary but do not inhibit the visibility of the conductor.	**Acceptable** Crimp indent enters the inspection hole. Conductor is visible through the deformed hole.	**Unacceptable** Crimp indents have deformed the inspection hole such that the conductor is not visible.

FIGURE 23-1. Examples of acceptable crimp indents and their location with the inspection hole.

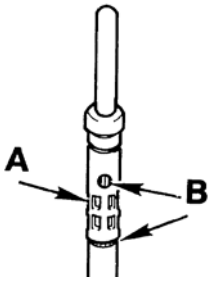	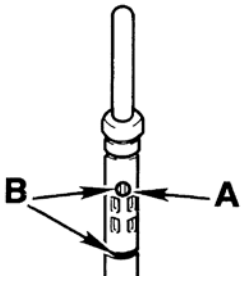	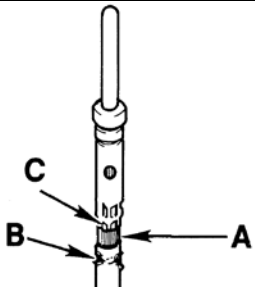	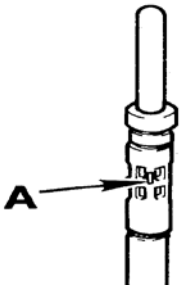
Acceptable (A) Proper contact crimp. Crimp indents are uniform. (B) The conductor is just visible around the barrel and in the inspection hole.	**Acceptable** (A) The crimp borders the inspection hole but does not intrude into the hole. (B) The conductor is visible in the inspection hole and around the end of the barrel.	**Unacceptable** (A) Gap between the wire insulation and the crimp barrel exceeds 1/32″ maximum allowable. Strip length too long. (B) Wire insulation damage from the stripping tool. (C) The contact was improperly positioned in the tool. The crimp has occurred on the end of the barrel.	**Unacceptable** (A) The contact was improperly positioned in the tool. The crimp has occurred over the inspection hole. The conductor is not visible in the inspection hole.

FIGURE 23-2. Examples of acceptable and unacceptable contact crimps.

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GUIDELINE 24

CONTACT FRETTING CORROSION INSPECTION

1. Purpose. This guideline provides criteria on inspecting Contact Fretting Corrosion in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 01	Aircraft Wiring System Inspection
Work package 013 00	Contacts and Terminals
Work Package 014 02	Basic Fault Isolation Methods
NA 01-1A-509-1	Corrosion Program and Corrosion Theory

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Contact fretting corrosion should be examined as follows:

NOTE

Fretting is a condition where slight movement between mated surfaces occurs, which continually exposes fresh metal to corrosion.

a. Verify connector plugs and receptacles do not have evidence of gold flaking on interfaces. Evidence of gold flakes in bottom of connector plug/receptacle requires cleaning and re-inspecting (see figure 24-1).

b. Ensure connector pin does not show any signs of cracking or surface plating damage (see figure 24-2).

c. Examine connector for damaged threads (mating or accessory threads), bayonet pins and keyways.

d. Repair and replace any contact that shows evidence of fretting corrosion. See NA 01-1A-505-1, Work package 013 00 for Contacts and Terminals.

e. Additional information regarding contact fretting corrosion inspection is given in NA 01-1A-505-1, Work Packages 004 01 and 014 02.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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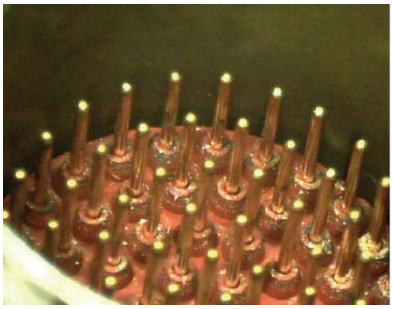
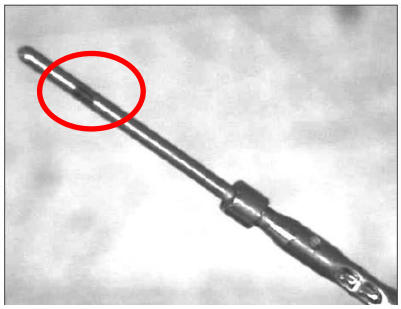


Acceptable
Connector is clean, no signs of corrosion or gold flaking on interfacial seal or o-ring.

Unacceptable
Gold flaking on interfacial seal; evidence of fretting.

FIGURE 24-1. Evidence of fretting corrosion on connector.



Acceptable
Contact is clean, no signs of corrosion, and gold plating intact.

Unacceptable
Gold plating chipped off; Copper exposed and corroded; evidence of fretting corrosion.

FIGURE 24-2. Evidence of fretting corrosion on typical M39029 contact.

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GUIDELINE 25

COPPER TERMINAL LUG INSPECTION

1. Purpose. This guideline gives criteria for inspecting copper terminal lugs (M7928) used in the EWIS. For cold applied terminal lugs (M7928/14) see guideline 26.

2. Applicable documents. The documents listed below are those applicable to this guideline.

SAE AS7928	Terminals, Lug: Splices, Conductor: Crimp Style, Copper, General Specification For. (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 013 00	Contacts and Terminals

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. In order to verify that the terminal lugs are crimped properly, when used in the EWIS, they should be examined as follows:

a. Check that the wire insulation is inserted in the support area of the terminal barrel (see figure 25-1).

b. Confirm that the conductor is extended through the terminal barrel.

c. Verify that stripped wire ends are flush to terminal stop with not more than 1/32 inch is protruding (see figure 25-2).

d. Confirm that the crimp indent is applied on the surface of the terminal wire barrel.

CAUTION

In cases where the wire insulation diameter is small enough to enter the conductor crimp barrel area of the terminal lug, care should be used to prevent crimping over insulation.

e. Verify that no wire insulation is present in the wire crimp barrel.

f. Confirm that conductor insulation has been inserted into the insulation support area of the terminal lug barrel (see detail A of figure 25-2).

g. Verify that the amount of insulation stripped from the wire is not excessive, such that conductors extend into the hardware mounting area (see detail A of figure 25-2).

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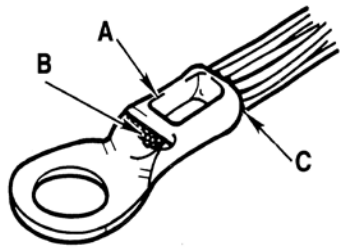
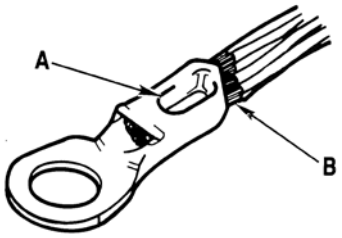
h. Additional information regarding the inspection of terminal lug crimps is provided in NA 01-1A-505-1, Work Package 013 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.



Acceptable
(A) Lug has been properly positioned in tool.
(B) Stripped wire ends are flush to terminal stop (Not more than 1/32″ inch protruding).
(C) No insulation is in barrel.



Unacceptable
(A) Lug improperly positioned in tool resulted in deformation of terminal with crimp indent not centered on barrel.
(B) Excessive wire strip length.

FIGURE 25-1. Examples of acceptable and unacceptable crimping of terminal lugs.

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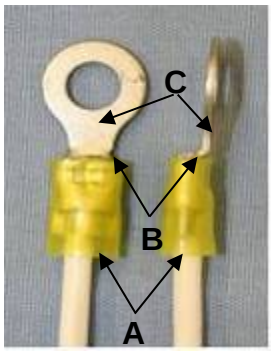	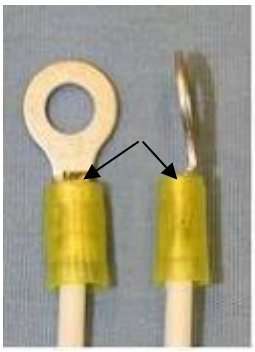	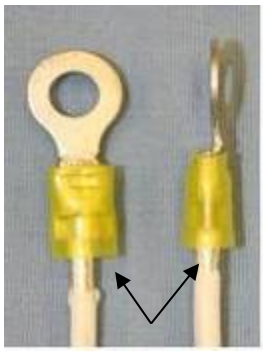	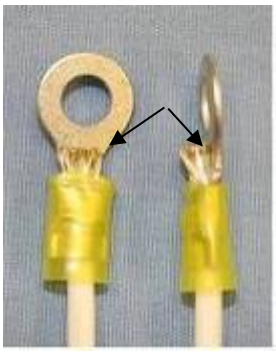
Acceptable (A) Conductor insulation should be inserted within support area of the terminal barrel. (B) Stripped conductor extends fully through the terminal barrel, as shown, with no more than 1/32 inch protruding. (C) No conductors extend into hardware mounting area.	**Unacceptable** Terminal lug and wire were not completely inserted into the crimping tool. Front end of barrel has been pinched (arrows), causing insufficient crimp on conductor.	**Unacceptable** Conductor insulation (arrows) has not been inserted into the insulation support area of the terminal lug barrel. Excessive strip length.	**Unacceptable** Conductor (arrows) extends into hardware mounting area. Excessive strip length.

FIGURE 25-2. Examples of acceptable and unacceptable wire installation in terminal lugs.

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GUIDELINE 26

COLD-APPLIED TERMINAL LUG INSPECTION

1. Purpose. This guideline provides criteria on inspecting cold applied terminal lugs used in EWIS. For conventional, copper terminal lugs (i.e., M7928/4) (see guideline 25).

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 013 00	Contacts and Terminals
SAE AS7928/14	Terminal, Electric, Permanent, Crimp Style, Tin-coated Copper, Insulated, environment Resistant, Class 1, 150 Degrees C, Heatless Sealing (DoD adopted)

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. In order to verify that the cold-applied terminal lugs (SAE AS7928/14) are crimped properly, when used in the EWIS, they should be examined as follows (see figures 26-1 and 26-2):

a. Verify crimp indent of barrel is visible and parallel to terminal ring.

b. Ensure wire strands are visible at ring end of the lug.

c. Ensure crimp barrel and insulation sleeve are not cracked.

d. Check for adequate crimp of terminal lug by tugging on wire end. Verify wire cannot be pulled out of lug with average hand pull force.

e. Ensure all conductor strands are inserted in the crimp barrel.

f. Verify no bubbles are visible in gel.

g. Ensure gel overlaps wire insulation by at least 3/16″.

h. Verify a visible gap of 1/32″ exists between crimp barrel and wire insulation.

i. Additional information regarding cold applied terminal lug inspection is given in NA 01-1A-505-1, Work Package 13 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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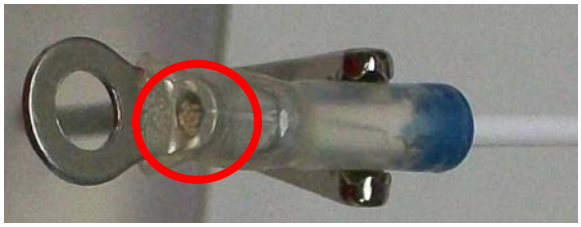
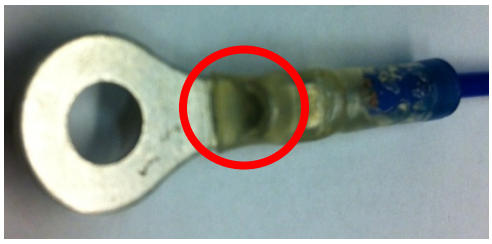
Acceptable
Crimp placement is centered and parallel to terminal tongue; no air bubbles in gel; no cracks in sleeve, adequate gel coverage on wire in excess of 3/16″.



Acceptable
Stripped wire is visible in inspection window.

FIGURE 26-1. Examples of acceptable cold-applied terminal lugs.

Unacceptable
Air bubbles visible inside insulating gel. Excess of 1/32″ insulation exposed.



Unacceptable
Wire strands not visible in end of terminal lug crimp barrel.

FIGURE 26-2. Examples of unacceptable cold-applied terminal lugs.

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GUIDELINE 27

SOLDER SLEEVE/SHIELDING TERMINATION INSPECTION

1. Purpose. This guideline gives criteria for inspecting solder sleeve/shielding terminations (M83519/1 through /5) used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

SAE AS83519	Shield Termination, Solder Style, Insulated, Heat-Shrinkable. (DoD adopted)
SAE AS83519/2	Shield Termination, Solder Style, Insulated, Heat-Shrinkable, Environment Resistant With Pre Installed Leads For Cables Having Tin Or Silver Plated Shields (Class I). (DoD adopted)
SAE AS83519/3	Shield Termination, Solder Style, Insulated, Heat-Shrinkable Environment Resistant With Preinstalled Braid, Class 1, Non-ROHS
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 015 00	Shield Terminations

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting solder sleeves and shielding terminals the minimum and maximum solder flow should be verified (see figure 27-1):

NOTE

The ground lead configuration may be a 22 AWG insulated wire (M83519/2), or shield braid lead (M83519/3).

a. For acceptable minimum solder flow, the following should be present:

1. Slight traces of dull red color (thermal indicator).

2. Solder has lost all original shape.

3. Sealant inserts have melted and flowed along wires.

4. Shield and lead contours are visible.

5. A definite fillet is visible between lead and shield.

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4a. (continued).

b. For acceptable maximum solder flow, the following should be present.

1. Dull red color has disappeared.

2. Slight traces of dull red color (thermal indicator) in sealant insert area are acceptable.

3. Sealant inserts have melted and flowed out along wires.

4. A definite fillet is clearly visible between lead and shield.

5. Joint area is visible despite browning of sleeve.

c. When there is insufficient heat during the soldering process, unacceptable solder flow results. In this situation, the following can be observed when inspecting the solder flow:

1. Dull red color (thermal indicator) is clearly visible.

2. Original shape of solder preform is clearly visible.

3. Melt-able sealing inserts have not flowed.

4. Contour of braid and/or lead is blocked by solder.

d. When there is too much heat used during the soldering process, unacceptable solder flow results. In this situation, the following can be observed when inspecting the solder flow:

1. Joint area is not visible because of severe darkening of the outer sleeve.

2. Solder fillet is not visible along lead and shield interface.

3. Wire insulation damaged outside of sleeve.

e. Additional information regarding inspection of solder sleeves and shield terminations is provided in NA 01-1A-505-1, Work Package 015 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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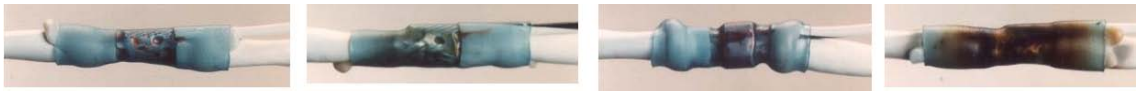

Acceptable Minimum Solder Flow	**Acceptable** Maximum Solder Flow	**Unacceptable** Insufficient heat. Solder band not melted.	**Unacceptable** Overheated

FIGURE 27-1. Examples of solder sleeves that have acceptable and unacceptable solder flow.

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GUIDELINE 28

BONDING STRAP / JUMPER INSPECTION

1. Purpose. This guideline gives criteria for inspecting bonding/jumper straps used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 017 00	Bonding and Grounding

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting bonding straps and jumpers used in the EWIS, the following should be examined (see figure 28-1):

a. If there is evidence of electrical arcing, check for intermittent electrical contact between conducting surfaces that may become a part of a ground plane or a current path.

b. Confirm that bond connections are secure and free from corrosion.

c. Verify that bonding jumpers are installed in such a manner as not to interfere in any way with the operation of movable components of the aircraft.

d. Inspect bonding jumper condition and verify that jumpers are not frayed or kinked. Replace if more than one third of the jumper wire strands are broken.

e. Confirm that self-tapping screws are not being used for bonding purposes. Only standard threaded screws or bolts of appropriate size should be used.

f. Confirm that bonds are attached directly to the basic aircraft structure rather than through other bonded parts.

g. Verify that the resistance across a bonding or grounding jumper is 0.1 ohm or less. This test is made after the mechanical connection is completed and consists of a milliohm-meter reading of the resistance between the cleaned areas of the object and the structure. Refer to the platform/aircraft manual for specific installation and test requirements (see figure 28-2).

h. Additional information regarding the bonding straps, jumpers, and multiple grounds is provided in NA 01-1A-505-1, Work Package 017 00.

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5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

Acceptable

Proper bonding strap applied.

Unacceptable
Frayed and broken bonding strap.

Unacceptable
Wrong orientation and frayed bonding strap.

FIGURE 28-1. Examples of bonding straps in acceptable and unacceptable condition.

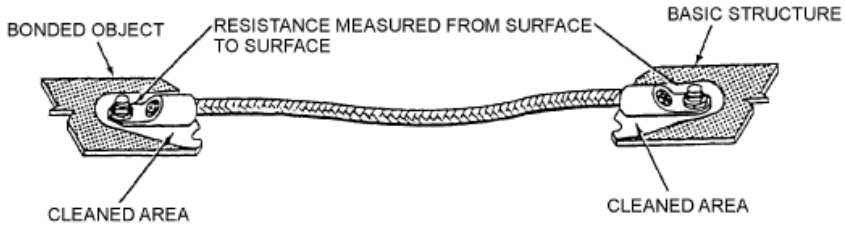

FIGURE 28-2. Bonding resistance test setup.

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GUIDELINE 29

HEAT-APPLIED SPLICE INSPECTION

1. Purpose. This guideline gives criteria for inspecting heat-applied splices (Environmental M81824/1 splices, Multi-splice /6 thru /11), and M81824/13 stub splices used in the EWIS. For cold-applied splices, see guideline 30 (M81824/12) and 31 (M81824/14).

2. Applicable documents. The documents listed below are those applicable to this guideline.

SAE AS81824	Splices, Electric, Permanent, Crimp Style, Copper, Insulated, Environment Resistant (DoD adopted)
SAE AS81824/1	Splice, Electric, Permanent, Crimp Style Copper, Insulated, Environment Resistant, Class 1 (DoD adopted)
SAE AS81824/12	Splice, Electric, Permanent, Crimp Style, Tin-Coated Copper, Insulated, Environment Resistant, Class 1, 150 ºC, Heatless Sealing. (DoD adopted)
SAE AS81824/13	Splice, Stub, Electric, Permanent, Crimp Style, Nickel/Copper, Insulated, Environment Resistant, 175 ºC Max. (DoD adopted)
SAE AS81824/14	Splice, Electric, Permanent, Crimp Style, Nickel-Coated Copper, Insulated, Environment Resistant, Class 1, 175 °C, Heatless Sealing
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual Work Package 014 00 Wire and Cable Splicing and Repair

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting splices used in the EWIS, the following should be verified:

NOTE

This guideline applies to environmentally sealed splices other than cold-applied splices meeting M81824/12; see guideline 30 and for M81824/14 see guideline 31.

a. If multiple splices are installed in a single harness, verify that splices are staggered. If wires are shielded, stagger shield ferrules. See guideline 27 for shield termination inspection.

b. Confirm that splices are not installed in a fuel tank or within 12 inches entering or exiting a fuel tank.

c. Verify that no splices have been installed under support clamps.

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4. (continued).

d. Confirm that splices are not installed in an area of high flexibility in the harness.

e. Verify the in-line splice and stub splices are crimped properly:

NOTE

For a splice to be environmentally sealed, the hot melt sealant must flow out past the ends of the sleeve. In order for an in-line splice to be properly crimped, the following should exist (see figures 29-1 and 29-2):

1. Conductor should be centered in the crimp nest.

2. Ensure that the crimp indent is on the side containing the inspection hole.

3. Verify that no wire strands are protruding from the end of the crimp barrel.

4. Ensure that the wire insulation gap is of 1/32″ maximum against the end of the crimp barrel. This ensures that no insulation is inside the crimp barrel.

5. Verify that the stripped conductors are butted up flush against the wire stop inside each end of the crimp barrel. Verify conductors are visible in the crimp barrel inspection window.

6. For stub splices (M81824/13), ensure that the conductors are visible and trimmed flush with the end of the crimp barrel (see figure 29-2).

f. Ensure that splices are not installed inside a conduit or within 3 inches of the conduit openings.

g. Confirm that individual in-line splices and stub splices have been completely insulated.

h. Splices may not be used within 12 inches of a termination device except for:

1. When attaching to the pig-tail spare lead of a potted termination device.

2. To splice multiple wires to a single wire.

3. To adjust the wire sizes so that they are compatible with the contact crimp barrel sizes (this is not applicable for power distribution circuits).

4. When the original harness design configuration requires it. In that instance, these additional requirements apply: splices should not be located within the backshell area under a strain relief or clamp and should be secured using secondary support (lacing tape).

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4. (continued).

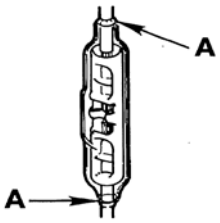
i. Additional information regarding splice inspection is given in NA 01-1A-505-1, Work Package 014 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

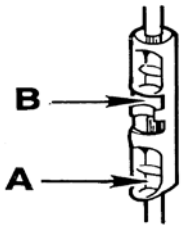
Acceptable

Wire insulation should have 1/32 inch maximum gap at each end. The conductor should be butted against the splice center stop. Crimp indent of both wires is on the side containing the inspection hole. (Insulation sleeve is not shown for clarity.)



Acceptable

Wire conductor must be visible through insulation sleeving. (A) Melted sealing bands flowed out of both ends of the sleeve



Unacceptable

(A) Crimp not centered on splice barrel.
(B) Top wire conductor is not visible or butted against splice center stop. (Insulation sleeve is not shown for clarity).

FIGURE 29-1. Examples of acceptable and unacceptable in-line splices.

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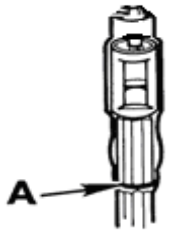
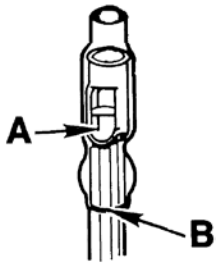


Acceptable

Crimp is centered on barrel and the bare wire is visible and cut flush at the end of the barrel.
(A) Sealant flowed out of end of sleeve.



Not Acceptable

(A) Crimp is not centered on barrel because of improper positioning in tool. (B) Sealant did not flow out of end of sleeve.

FIGURE 29-2. Examples of acceptable and unacceptable stub splices.

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GUIDELINE 30

COLD-APPLIED SPLICE (M81824/12) INSPECTION

1. Purpose. This guideline provides criteria for inspecting repairs using the cold splice (M81824/12) when used in EWIS. For the M81824/1 heat applied splice, see guideline 29. For the M81824/14 heatless splice, see guideline 31.

2. Applicable documents. The documents listed below are those applicable to this guideline.

SAE AS81824	Splices, Electric, Permanent, Crimp Style, Copper, Insulated, Environment Resistant. (DoD adopted)
SAE AS81824/1	Splice, Electric, Permanent, Crimp Style Copper, Insulated, Environment Resistant, Class 1 (DoD adopted)
SAE AS81824/12	Splice, Electric, Permanent, Crimp Style, Tin-Coated Copper, Insulated, Environment Resistant, Class 1, 150 ºC, Heatless Sealing. (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 014 00	Wire and Cable Splicing and Repair

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting cold applied splices meeting SAE AS81824/12 used in the EWIS, the following should be verified. Examples of acceptable and unacceptable cold splices are depicted in figures 30-1 and 30-2 respectively.

a. If multiple splices are installed in a single harness, verify that splices are staggered. If wires are shielded, stagger shield ferrules. See guideline 27 for shield termination inspection.

b. Confirm that splices are not installed in a fuel tank or within 12 inches entering or exiting a fuel tank.

c. Verify that no splices have been installed under support clamps.

d. Confirm that splices are not installed in an area of high flexibility in the harness.

e. Verify the cold applied splice is installed as follows:

1. Confirm the crimp indent is on both sides of barrel and is parallel with the inspection window (see figure 30-1).

2. Ensure the crimp barrel and insulation are not cracked.

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4.e (continued).

3. Check for adequate crimp of splice by tugging on wire ends. Verify wire cannot be pulled out of splice with average hand pull force.

4. Verify all conductor strands are inserted in the crimp barrel.

5. Ensure no bubbles are visible in gel (both sides) (see figure 30-2).

NOTE

The red size splice has a larger inspection window than the blue and yellow size splices. This feature was required to ensure the best mechanical and electrical properties for each splice size.

6. Verify that both wire ends are visible in the inspection window.

7. Ensure that only one wire is inserted in each end of the cold applied splice.

8. Verify that gel overlaps the wire insulation at least 3/16 inch.

9. Ensure that visible gap of up to 1/32 inch exists between the crimp barrel and the wire insulation.

f. Additional information regarding cold splice inspection is provided in NA 01-1A-505-1, Work Package 014 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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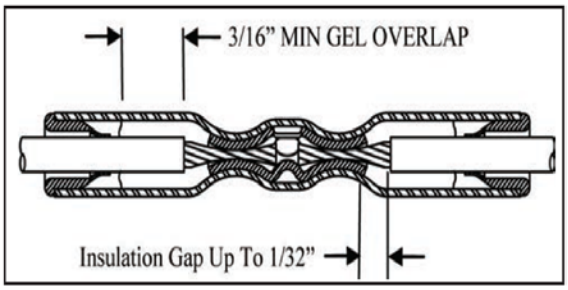
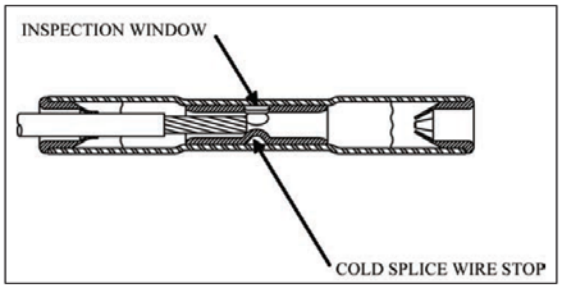


Acceptable

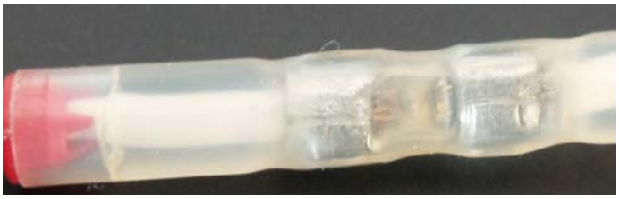
Before crimping, crimp placement is centered and parallel inspection window; no air bubbles in gel; no cracks in sleeve, adequate gel coverage on wire in excess of 3/16″; there is 1/32″ insulation gap visible.



Acceptable

Conductors are butted up against the splice wire stop and visible in inspection window.

FIGURE 30-1. Examples of acceptable cold-applied splice (M81824/12).



Acceptable
No Air bubbles visible in gel

Unacceptable
Air bubbles visible in gel

FIGURE 30-2. Example of an acceptable and an unacceptable cold-applied splice (M81824/12).

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GUIDELINE 31

HEATLESS SPLICE (M81824/14) INSPECTION

1. Purpose. This guideline provides criteria for inspecting repairs using the heatless splice (M81824/14) when used in EWIS. For the M81824/1 heat applied splice, see guideline 29. For the M81824/12 cold applied splice, see guideline 30.

2. Applicable documents. The documents listed below are those applicable to this guideline.

SAE AS81824	Splices, Electric, Permanent, Crimp Style, Copper, Insulated, Environment Resistant. (DoD adopted)
SAE AS81824/1	Splice, Electric, Permanent, Crimp Style Copper, Insulated, Environment Resistant, Class 1. (DoD adopted)
SAE AS81824/14	Splice, Electric, Permanent, Crimp Style, Nickel-Coated Copper, Insulated, Environment Resistant, Class 1, 175 °C, Heatless Sealing
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 014 00	Wire and Cable Splicing and Repair

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting heatless splices meeting SAE AS81824/14 used in the EWIS, the following should be verified. Examples of acceptable and unacceptable heatless splices are depicted in figures 31-1 and 31-2, respectively.

a. If multiple splices are installed in a single harness, verify that splices are staggered. If wires are shielded, stagger shield ferrules. See guideline 27 for shield termination inspection.

b. Confirm that splices are not installed in a fuel tank or within 12 inches entering or exiting a fuel tank.

c. Verify that no splices have been installed under support clamps.

d. Confirm that splices are not installed in an area of high flexibility in the harness.

e. Verify that the heatless splice is installed as follows:

1. Ensure the insulation sleeve is locked and will not slide off with average hand pull force

2. Ensure that the insulation sealing sleeve is not cracked.

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4.e (continued)

3. Rotate the insulation sleeve to view the inspect window. Verify that both conductor ends are visible in the inspection window.

4. Ensure only one wire is inserted in each end of the heatless splice.

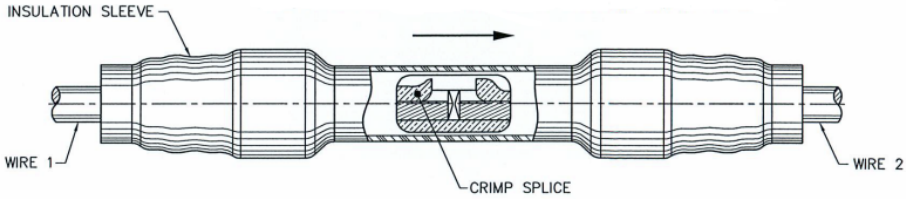
5. Ensure that the ends of the sealing sleeve contact the outside diameter of the wire insulation to form a seal.

6. Ensure that the inspection window doesn't show evidence of fluids or corrosion inside the splice.

f. Additional information regarding heatless splice inspection is provided in NA 01-1A-505-1, Work Package 014 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

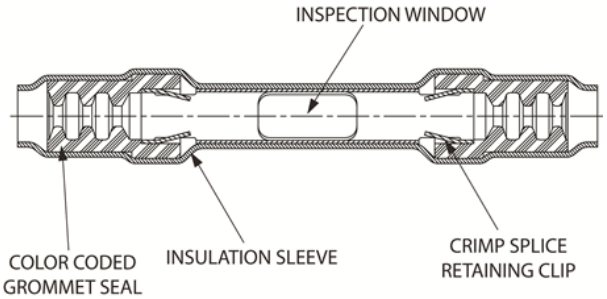


Acceptable

Conductors are butted up against the splice wire stop and visible in inspection window.

Acceptable

Insulation sleeve is not cracked and will not slide off.



Acceptable

No fluids or corrosion inside the inspection window.

FIGURE 31-1. Examples of acceptable heatless splice (M81824/14).

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Unacceptable
Conductor not visible in inspection window.

Unacceptable
Evidence of corrosion inside sleeve. Multiple wires installed, both ends.

FIGURE 31-2. Examples of unacceptable heatless splices (M81824/14).

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GUIDELINE 32

WRAP-AROUND/SIDE-ENTRY WIRE INSULATION REPAIR (C-WRAP) INSPECTION

1 Purpose. This guideline provides criteria for inspecting insulation repairs using the C-Wrap insulation sleeve when used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 014 00	Wire and Cable Splicing and Repair

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When using C-Wrap wire insulation repair sleeves (D-150-C-XX, D-200-C-XX) in the EWIS, the following should be followed:

a. Inspect for the following:

1. Ensure there is no loose/damaged/protruding portion of the insulation, or wire strands. The damaged wire jacket is completely covered by the repair sleeve.

2. Confirm that the installed sleeve is fully shrunk onto the wire (see figure 32-1).

3. Verify that the adhesive is melted, flowed and filled the slit of the insulation sleeve.

4. Ensure the installed repair sleeve, or wire outer jacket, does not show any evidence of overheating, (burning, browning or severe darkening) or damage (see figure 32-2).

5. Up to three C-Wrap sleeve repairs can be installed per foot of wire.

6. No more than 10 sleeve repairs on a wire segment or section.

b. Additional information regarding splice inspection is given in NA 01-1A-505-1, Work Package 014 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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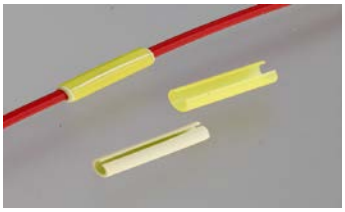
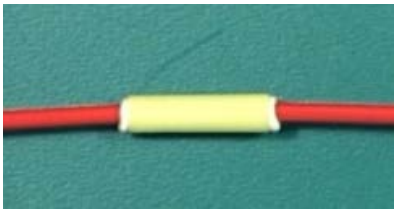
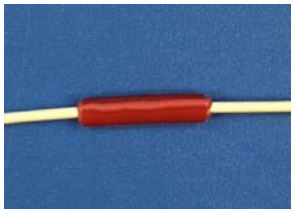


Acceptable
Two piece construction; before and after installation.



Acceptable
Fully melted inner adhesive; no overheat/damage to wire insulation.



Acceptable
Seam fully closed; no exposed conductor.

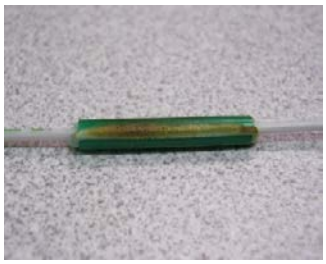
FIGURE 32-1. Acceptable wrap-around/side-entry wire insulation (C-wrap) repair.

Unacceptable
Exposed conductor; under-heated or under-sized.

Unacceptable
Misalignment adhesive and outer sleeve.

Unacceptable
Adhesive/insulation mismatch.

Unacceptable
Over-heated installation.



Unacceptable
Mis-matched adhesive and sleeve as well as over-heated installation.

Unacceptable
Under-heated/not melted.

FIGURE 32-2. Unacceptable wrap-around/side-entry wire insulation (C-wrap).

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GUIDELINE 33

CIRCULAR CONNECTOR AND TERMINAL BLOCK INSPECTION

1. Purpose. This guideline gives criteria on inspecting connectors used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

SAE AMS-DTL-23053	Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for. (DoD adopted)
MS27488	Plug, End Seal, Electrical Connector
SAE AS85049	Connector Accessories, Electrical, General Specification for. (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 014 00	Wire and Cable Splicing and Repair
Work Package 020 00	Military Standard Circular Connectors
Work Package 027 00	Terminal Junction System

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Figure 33-1 shows the different parts that make up typical electrical connectors. When inspecting connectors used in the EWIS, the following items should be examined:

a. Inspect the insulator insert for damage and to ensure there are no bent or splayed/expanded contacts. Contacts should be properly seated and locked and not pushed back (recessed or uneven) into the insert (see figure 33-1).

b. Ensure all un-wired contact cavities on the grommet surface are populated with environmental sealing plug (MS27488); (see figure 33-2).

CAUTION

Do not install the knob end of the sealing plug into connector cavities without having first inserted un-wired contacts. Failure to follow this procedure damages the connector, as the sealing plug is trapped inside the connector by the contact locking mechanism.

c. Ensure that all installed sealing plugs are installed with the large end (head) inside the connector grommet (see figure 33-2).

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4. (continued).

d. Inspect the connector shell plating and finish for corrosion or flaking. No corrosion is acceptable. Flaking of plating is acceptable only on the nose (front shell outer diameter) of the plug or around the keyways.

e. Inspect for serviceable condition of attaching mechanism:

1. For threaded connectors inspect thread surfaces for wear and condition.

2. For bayonet connectors inspect locking pins and mating surface and holes for wear and condition. Ensure all three locking pins are present and secure.

f. Confirm that connector receptacles with mounting flanges contain proper mounting hardware.

g. Verify that every connector has a strain relief or backshell installed. For circular connectors they must meet SAE AS85049 and application requirement (i.e., EMI, environmental).

h. When inspecting connectors with grommet seals the following should be examined (see figures 33-3 and 33-4):

1. Verify that there are no chips, gouges or other damage in or extending from chamfered area to the base of the chamfer.

2. Confirm that wire outside diameter is within tolerances defined in the applicable connector specification. If the wire outside diameter is undersized, wire may be built up with heat shrinkable sleeving (SAE AMS-DTL-23053) to the correct diameter to obtain proper environmental seal. Cut to length necessary to extend ½-¾ inch beyond grommet. Do not apply so as to cover crimp contact (see figure 33-6).

3. Verify grommet seals are not distorted so as to create a gap between the wire and the seal where wires enter connectors and terminal blocks. All wires should extend straight out from the connector, as shown, so that a gap is not created (see figure 33-5).

CAUTION

Fiber optic connectors should not be unmated for inspection. Disassemble fiber optic connectors only for maintenance or troubleshooting.

i. Fiber optic connector inspections should always be done before mating. Existing pollutants and damage of an unmated connector (plug or receptacle) can easily be transferred to the mating connector. Prior to mating verify fiber optic ferrule end faces are clean and free of damage.

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j. Additional information regarding inspection of connectors and terminal junctions is provided in NA 01-1A-505-1, Work Package 020 00, and 027 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

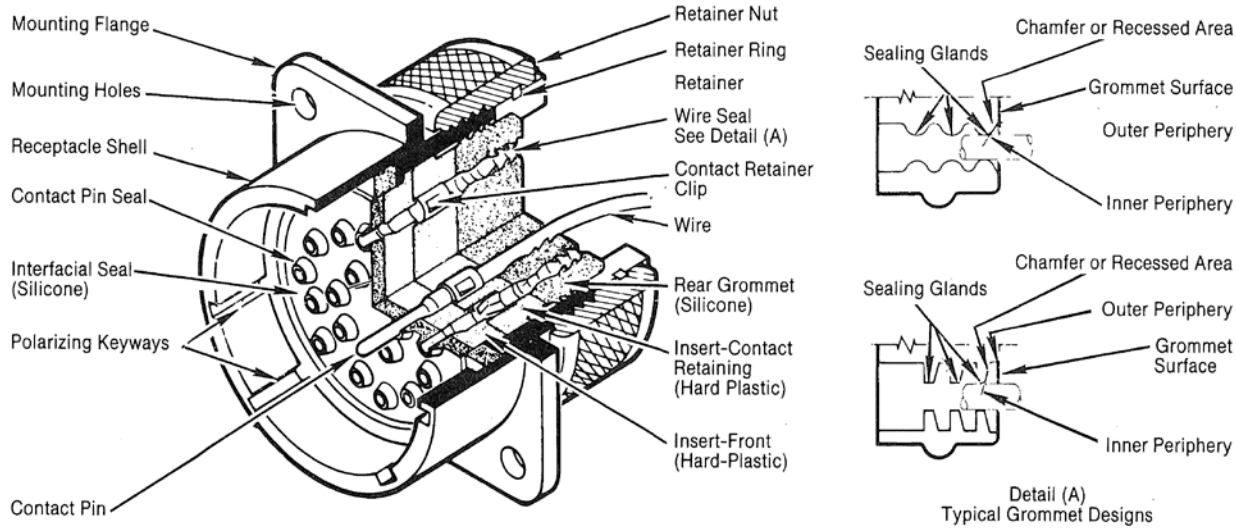

FIGURE 33-1. Illustration of typical connector components.

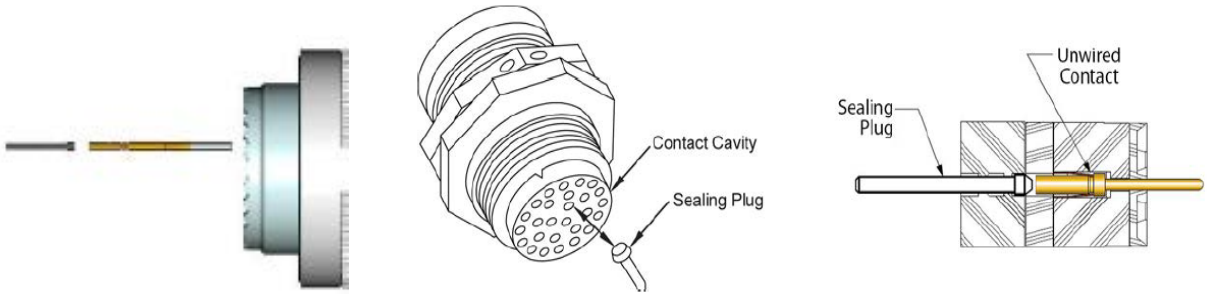

FIGURE 33-2. Sealing plug and contact installation for required connector sealing.

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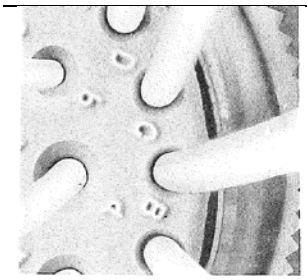
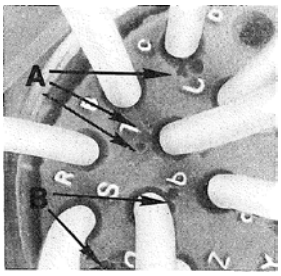
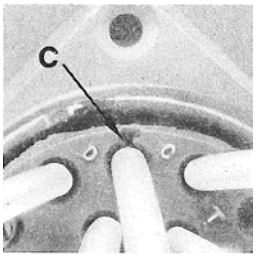


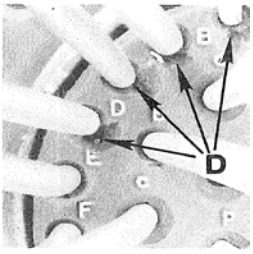
Acceptable
The connector grommet has no surface gouges that extend to the wire, or below the bottom of the chamfer (first sealing gland).



Acceptable
Although gouges appear on the grommet surface (A) and in the chamfer area (B), none extend to the base of the chamfer.

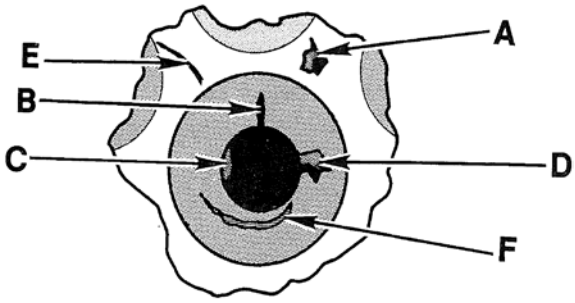


Unacceptable
The gouge (C) extends through the chamfered area and comes in contact with the wire. The sealing ability of the grommet is reduced.

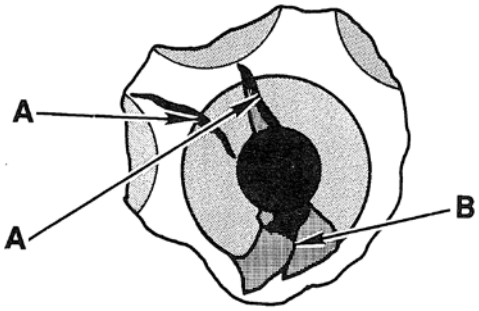


Unacceptable
The large deep gouges (D) extend below bottom of the chamfer, and destroy the sealing capability of the grommet.

FIGURE 33-3. Examples of connector grommets in acceptable and unacceptable condition.



Acceptable
Any ONE imperfection: (A) Chip, nick or gouge, (B) Split crack through the sealing gland but not extending out of the recessed or chamfered area, (C) Mold Flash, (D) Chip, nick or gouge through the sealing gland but not out of the recessed or chamfered area, (E) Split or crack, (F) Chip , nick or gouge not through the sealing gland.



Unacceptable
(A) Split or crack extending out of the recessed or chamfered area, (B) Chip, nick or gouge extending out of the recessed or chamfered area. May be repairable using standard repair procedures.

FIGURE 33-4. Examples of sealing grommet with different levels of damage.

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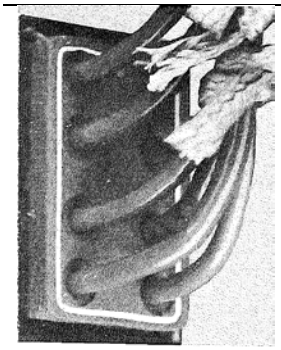	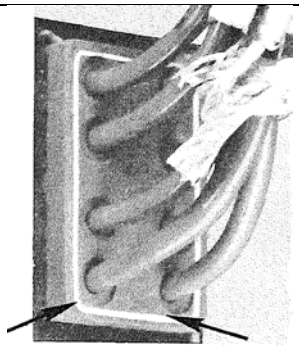	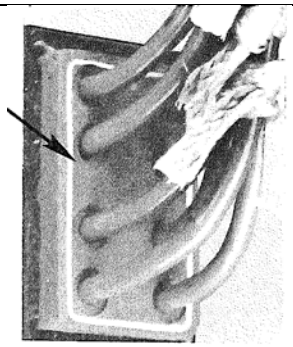	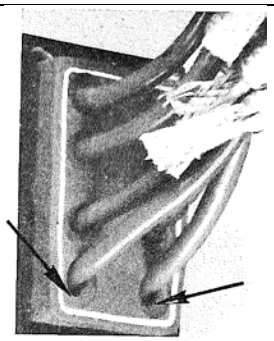
Acceptable Wires entering connectors and terminal blocks; grommet seals do not distort the seal. All wires extend straight out from the connector.	**Acceptable** Normal flexing of wires may exert pressure against the grommet (arrows), but slight distortion of the seal is not enough to create a gap between the seal and wire.	**Unacceptable** Although the wires are routed at a proper angle, one wire has been pulled back sharply during spot tie installation. A very large gap (arrow) is the result.	**Unacceptable** Wires do not come straight out of the grommet and have distorted the seal. The result is large gaps (arrows). Contaminants and moisture can enter the terminal block.

FIGURE 33-5. Examples of acceptable wire installation in connector and terminal blocks.

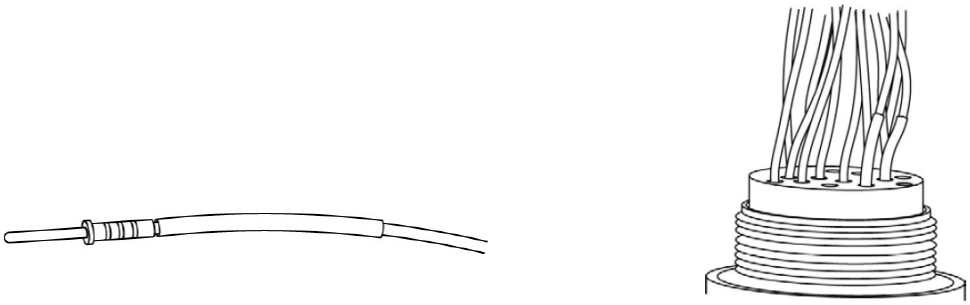

FIGURE 33-6. Wire insulation built up with heat shrink installed in connector.

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GUIDELINE 34

COMPOSITE CONNECTOR INSPECTION

1. Purpose. This guideline provides criteria for inspecting composite connectors in the EWIS. Refer to Guideline 33 for all other circular connector inspection criteria.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 01	Aircraft Wiring System Inspection
Work Package 020 00	Military Standard Circular Connectors

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Electrical connectors are manufactured from various metallic and non-metallic (composite) materials. The following guideline applies to only the inspection of composite (non-metallic) connectors (plug and receptacle). Inspect as follows:

NOTE

Plating on composite connectors provides electrical conductivity and EMI protection. Excessive degradation of the plating affects system EMI performance.

a. On Electroless Nickel (EN) plated composite connectors; inspect for any flaking of nickel plating on the nose of the plug and/or around the keyways. Limited nickel flaking is acceptable. Replace the connector if there is excessive plating wear (large sections missing EN plating inside or out).

CAUTION

Damage to composite connectors adversely affects their structural and electrical properties. Failure to replace damaged composite connectors may lead to system degradation or failure.

b. Inspect composite connector for any chipped composite material (usually tan or black in color). Chipped composite material anywhere on the plug or receptacle is not acceptable and the connector requires replacement.

c. Additional information regarding composite connector damage is given in NA 01-1A-505-1, Work Package 004 01 and Work Package 020 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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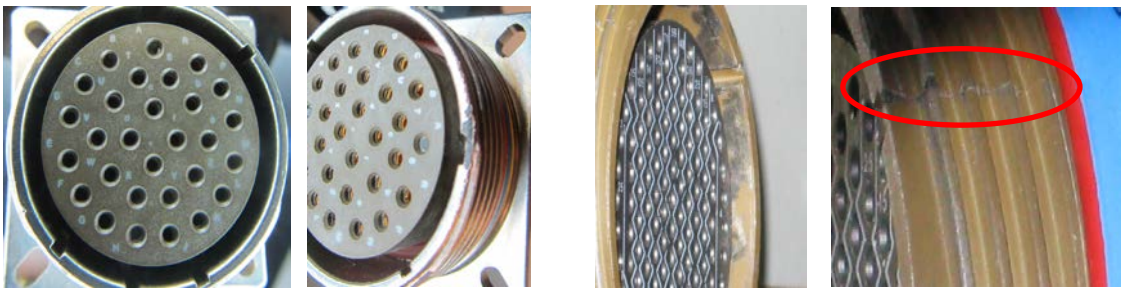

Acceptable	**Acceptable**	**Unacceptable**	**Unacceptable**
Serviceable	Limited	Excessive wear/ Connector nickel flaking	Cracked connector, flaking

FIGURE 34-1. Acceptable and unacceptable composite connector damage.

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GUIDELINE 35

CONNECTOR EMI GROUNDING RING INSPECTION

1. Purpose. This guideline provides criteria for inspecting connector EMI grounding rings (finger seals) in EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 01	Aircraft Wiring System Inspection
Work Package 020 00	Military Standard Circular Connectors

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. The following guidelines should be used to perform an inspection on connectors containing EMI grounding ring (finger seal). EMI connectors should be inspected as follows:

Warning

Ensure that any broken pieces of EMI finger seal are removed. Failure to remove the loose pieces may cause FOD and/or electrical shock hazard and degrade system performance.

Note

The metallic EMI seal is made of spring fingers in the connector to allow shell-to-shell grounding, before contacts mate and after they separate. They provide the required EMI protection and help meet the shield effectiveness requirements of the application (see figure 35-1).

a. If any broken fingers (segments) on the EMI spring finger seal are found on the plugs/receptacles, remove all loose segments from inside of plug and/or mating receptacle (see figure 35-2). Contact Cognizant Engineering Authority for further guidance on EMI system level requirements for the particular damaged connector.

b. For MIL-DTL-38999 circular connectors, series II plugs with EMI spring finger seal only, spring fingers are allowed to be missing at bayonet pins, provided that the spring continues to be retained about the shell periphery (see figure 35-3).

c. Additional information regarding EMI grounding ring connector damage is given in NA 01-1A-505-1, Work Package 020 00 and 004 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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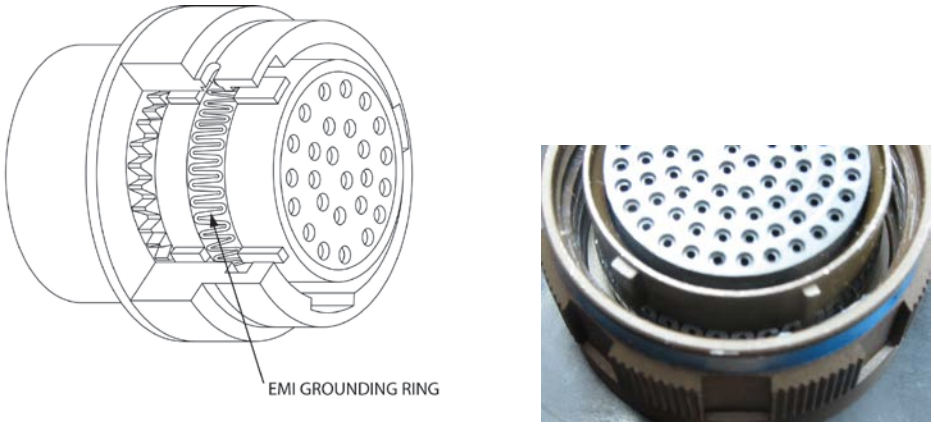
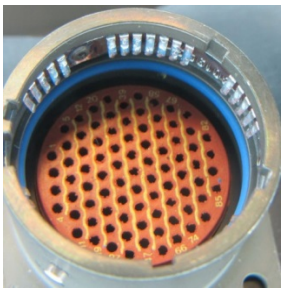


FIGURE 35-1. Connector plug with EMI finger seal.

Unacceptable
Multiple broken EMI seal fingers

Unacceptable
Missing and broken EMI seal fingers

FIGURE 35-2. Unacceptable EMI finger damage.



Acceptable
MIL-DTL-38999 Series II connector with
EMI fingers missing at bayonet pins

FIGURE 35-3. Acceptable EMI connector finger damage.

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GUIDELINE 36

CONNECTOR BACKSHELL INSPECTION

1. Purpose. This guideline gives criteria for inspecting the electrical connector backshells used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

MIL-I-22444	Insulation Tape, Electrical, Self-Bonding Silicone Rubber Treated Bias Weave Or Sinusoidal Weave Glass, Cable Splicing, Naval Shipboard. (Inactive for New Design)
NA 01-1A-505-1	Joint General Series Wire Maintenance
Work Package 024 00	Connector accessories

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Figure 31-1 illustrates components associated with non-environmental, environmental and EMI backshells. When inspecting backshells used in the EWIS, the following steps should be taken:

a. Confirm that all components are present, and installed in the correct order. Ensure harness orientation meets minimum bend radius requirements. See guideline 16.

b. Verify that the backshell is tightened by applying a clockwise force as viewed from the connector rear. Refer to NA 01-1A-505-1 WP 024 00 for backshell torque values.

c. Confirm that silicone tape (MIL-I-22444) or a reusable side entry bushing (CS949X-000) to build cable diameter is applied under strain relief if the harness is smaller than the strain relief opening where the rubber grommet is not installed. See NA 01-1A-505-1, WP 024 00.

d. Additional information regarding inspection of connector backshells is given in NA 01-1A-505-1, Work Package 024 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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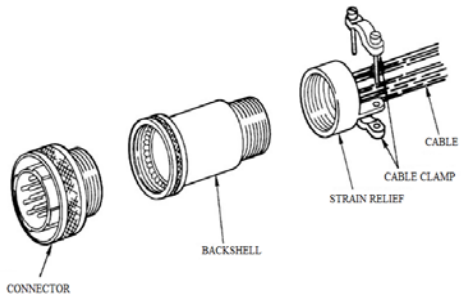
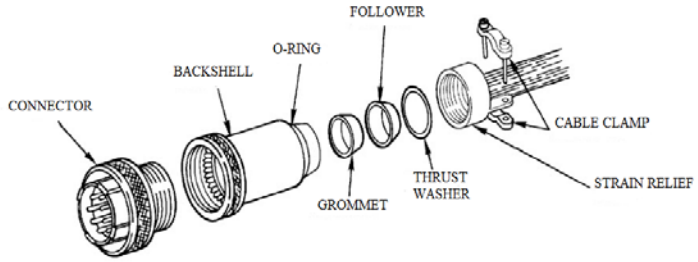
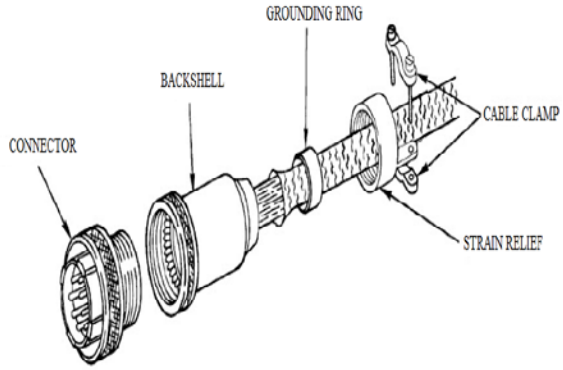


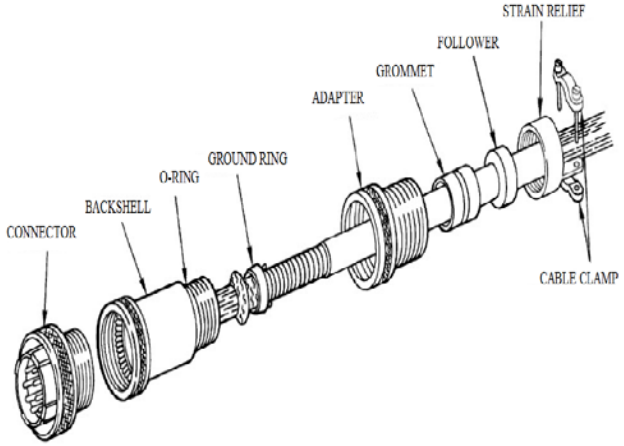
Typical non-environmental backshell



Typical environmental backshell



Typical non-environmental EMI/RFI backshell



Typical environmental EMI/RFI backshell

Figure 36-1. Illustrations of components associated with non-environmental, environmental and EMI/RFI backshells.

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GUIDELINE 37

CONNECTOR STRAIN RELIEF INSPECTION

1. Purpose. This guideline gives criteria for inspecting the connector stress relief in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

MIL-I-22444	Insulation Tape, Electrical, Self-Bonding Silicone Rubber Treated Bias Weave Or Sinusoidal Weave Glass, Cable Splicing, Naval Shipboard. (Inactive for New Design)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 024 00	Connector Accessories

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Figure 37-1 gives examples of acceptable and unacceptable connector strain relief. When inspecting connector strain relief the following steps should be used:

a. For angled applications (90 or 45 degree strain reliefs), ensure wire exits the connector sealing glands perpendicular to the grommet for 3/8″ prior to any wire bend.

b. Check wire for proper contour and that it is not being pulled tight, inducing stress on sealing glands, distorting the grommet, and prohibiting an environmental seal.

c. Ensure that there is a minimum of two wraps of silicone rubber tape cushion (MIL-I-22444) centered securely under the cable clamp, or a reusable side entry bushing (CS949X-000) to build cable diameter where necessary. See NA 01-1A-505-1, WP 024 00.

d. Confirm that cable clamp and attaching hardware are installed.

e. Ensure bending of cabling exiting a backshell occurs at the strain relief.

f. Additional information regarding inspection of connector strain relief is given in NA 01-1A-505-1, Work Package 024 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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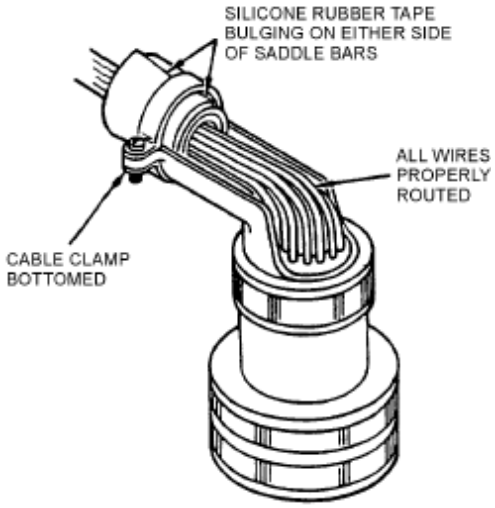
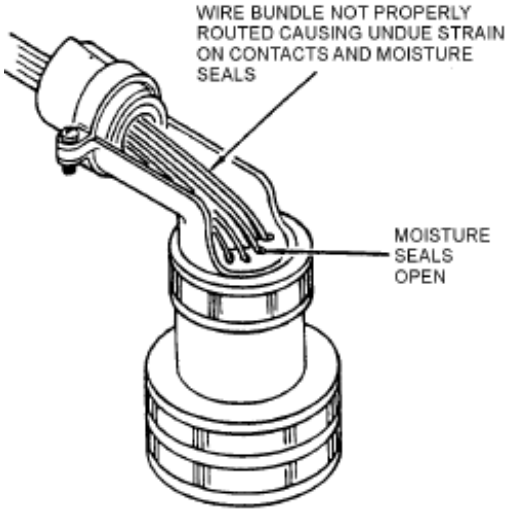


Acceptable
Wire exits sealing glands perpendicular to the grommet for 3/8″ prior to any wire bend. Does not induce stress on sealing glands. Provides environmental seal around wire.



Unacceptable
The short wires in back of connector (arrow) produce excess stress on contact crimp joint and sealing glands. Distorts sealing gland, prohibiting environmental seal.

FIGURE 37-1. Examples of acceptable and unacceptable connector strain relief.

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GUIDELINE 38

LOCKWIRE/SAFETY CABLE INSPECTION

1. Purpose. This guideline gives criteria for inspecting lockwire (AS4536) and safety cable (AS3617) connectors used in the EWIS. For shearwire inspection, see guideline 39.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NASM20995	Wire, Safety or Lock. (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 018 00	Lockwiring, Shear Wiring, and Safety Cables

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)
(Copies of NASM20995 are available from www.aia-aerospace.org.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When lockwire and safety cable used in the EWIS are inspected, the following should be examined:

NOTE

Always refer to the platform/weapon system specific manual governing maintenance practices to ensure that the use of safety cable is not limited or prohibited from use.

a. Lockwire inspection:

1. Verify that lockwire is not used for any shear or breakaway applications (see guideline 39 for shearwire applications).

2. Verify lockwire is twisted in a clockwise direction, with approximately 8 to 10 twists per inch. The cut end (pigtail) of the lockwire should have 4 to 6 complete turns (1/4 to ½ inches long), bent under or back to prevent injury. Lockwire or safety cable should be installed so that the applicable shell of the connector being secured is pulled toward the tightening direction (see figure 38-1).

3. Confirm that lockwire, in accordance with NASM20995-NC20, N32, N20, N40 (or equivalent), is routed in the most direct way to the tightening position, is taut, and shows no evidence of nicks, kinks or breaks (see figure 38-2).

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4.a (continued)

4. Confirm that the lockwire has not been over twisted and that there are no broken wires (see figure 38-2).

b. Safety Cable Installation

1. Verify that safety cable is not used for any shear or breakaway applications (see guideline 39 for shearwire applications).

2. Ensure the safety cable crimping ferrule is securely installed and cable is tensioned (see figure 38-3). For flex limits of safety cable refer to NA-01-505-1, WP 018 00.

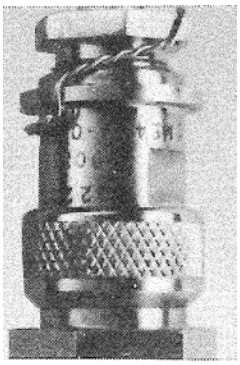
3. Ensure safety cable routing is to the tightening position of the device being secured.

4. Ensure safety cable diameter meets application requirements.

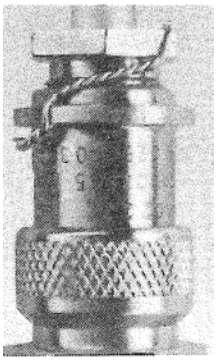
c. Additional information regarding lockwire and safety cable inspection is provided in NA 01-1A-505-1, Work Package 018 00.

5. Detail guidelines. This section is not applicable to this guideline.

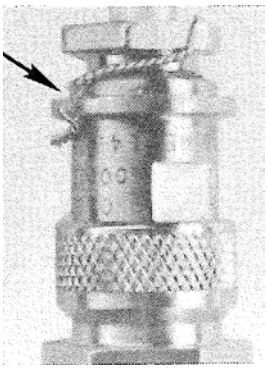
6. Notes. This section is not applicable to this guideline.



Acceptable
Lockwire is twisted clockwise, as shown. A pigtail of 4 to 6 twists is left after completion of safety wiring.



Unacceptable
Lockwire has been over twisted. Excessive twists may cause a wire break.



Unacceptable
Excessive twists have resulted in a broken wire (arrow). This is caused by the extreme stress of over twisting wires.

FIGURE 38-1. Examples of acceptable and unacceptable installation of lockwire.

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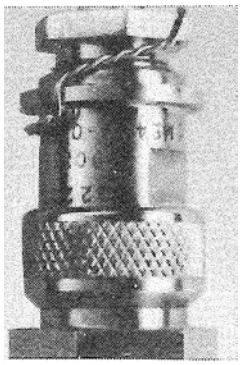
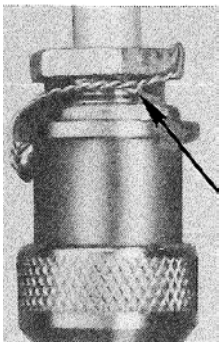
Check the source to verify that this is the current version before use.



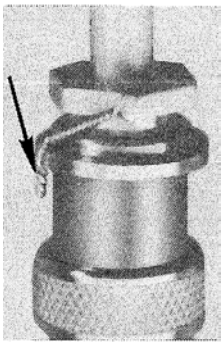
Acceptable

Lockwire is routed in the most direct way to the tightening position, is taut and shows no evidence of nicks, kinks or breaks



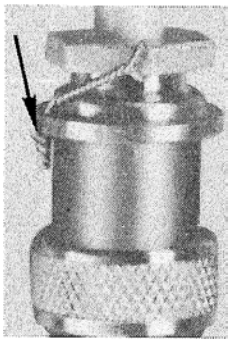
Unacceptable

Kinked lockwire (arrow) should be removed and replaced. A kinked strand transfers the stress load to the remaining strand and may result in lock wire failure.



Unacceptable

Wire is over twisted and shows evidence of nicks (arrow) which may fracture and result in loss of lock wire tension.



Unacceptable

The broken wire (arrow) is the result of over twisting during application.

FIGURE 38-2. Examples acceptable use of lockwire, lockwire that is directly routed and unacceptable installation of lockwire due to kinks and over twisting.

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Check the source to verify that this is the current version before use.

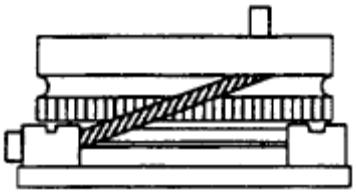	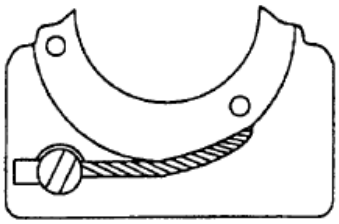	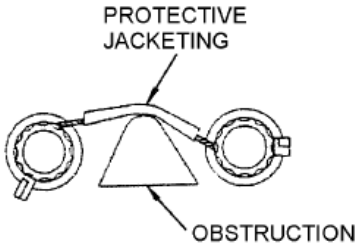
Acceptable Safety cable may be used as a substitute for lock wire on electrical equipment and connectors in aircraft to prevent accidental loosening caused by vibration. Safety cable may be used on threaded parts, such as connector coupling mechanisms, backshells, strain relief components, relays, other electrical components, and equipment covers/panels.	**Acceptable** Safety cable installed on a single jam nut receptacle. Safety cable may be installed from a fastener as shown above or it may require the use of a self-looping safety cable.	**Acceptable** A tubular jacket is installed where it may come into contact with other surfaces that may damage the safety cable or may be damaged by the safety cable.

FIGURE 38-3. Examples of acceptable safety cable installations.

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GUIDELINE 39

SHEARWIRE INSPECTION

1. Purpose. This guideline provides criteria for inspecting shearwire used in EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 018 00	Lockwiring, Shearwiring and Safety Cables

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Shearwire should be examined as follows:

WARNING

Loss of life may occur when lockwire is used instead of shearwire.

CAUTION

Shear wire is intended to secure emergency equipment to prevent accidental actuation. Inadvertent actuation of switch is possible if switch guard is shear wired to the switch toggle lever.

NOTE

MS20995-CY20 shearwire may be yellow or reddish (copper) colored.

a. Verify emergency devices are shearwired with only copper wire, part number MS20995-CY20.

b. All applications are single wire method so that it may be easily broken in an emergency (see figure 39-1).

c. Ensure wire ends are terminated (twisted) in a pigtail and out of the way to protect against injury (see figure 39-2).

d. Additional information regarding shearwire inspection is given in NA 01-1A-505-1, Work Package 018 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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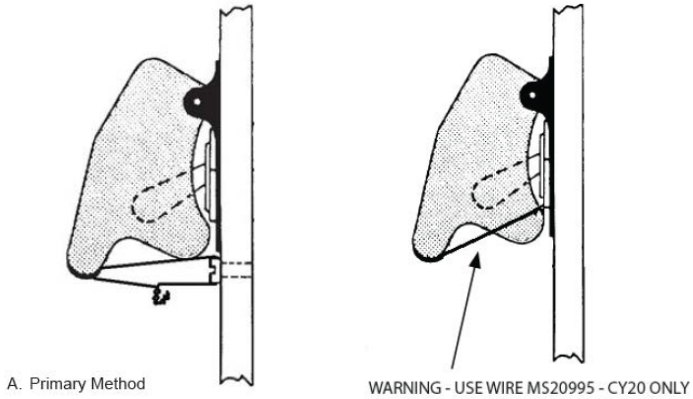
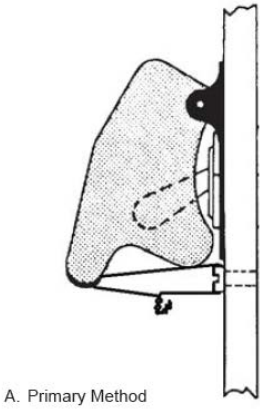


B. Alternate Method

FIGURE 39-1. Shearwiring emergency devices.

Unacceptable
Shearwire not installed (right) and broken (left)



Acceptable
Shearwire installed using primary method

FIGURE 39-2. Unacceptable and acceptable shearwiring of emergency devices.

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Check the source to verify that this is the current version before use.

GUIDELINE 40

PRESERVATION OF CONNECTOR/COMPONENT INSPECTION

1. Purpose. This guideline gives criteria on inspecting connector/component preservations used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
MIL-PRF-8516	Sealing Compound, Synthetic Rubber, Electric Connectors and Electric Systems, Chemically Cured
MIL-A-46146	Adhesives-Sealants, Silicone, RTV, Noncorrosive (For Use With Sensitive Metals And Equipment)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 025 00	Potting and Sealing Connectors, Electrical Cable Assemblies, and Electrical Components
Work Package 026 00	Connector Cleaning and Preservation
NA 01-1A-509-1	Corrosion Program and Corrosion Theory
NA 01-1A-509-3	Avionic Cleaning and Corrosion Prevention/Control

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Figure 40-1 gives examples of connections in acceptable and unacceptable conditions. When inspecting for connector corrosion, connector sealing methods, and electrical connection potting, the following apply:

NOTE

Ensure connectors or components to be inspected are first cleaned of contaminants or debris to facilitate inspection.

a. Metallic or plated connectors and backshells should be inspected for signs of corrosion (see figure 40-1). If severe corrosion is found, replace damaged component:

1. Corrosion deposits/powder, flaking or loosening of outer plating material. Refer to NA 01-1A-505-1 WP 026 00 Table 1 for identification of various corrosion types and their appearance.

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Check the source to verify that this is the current version before use.

4.a. (continued).

2. Pitting, erosion, or cracking that can interfere with connector mating or compromise environmental sealing.

NOTE

If connector was sealed using a dual wrap kit (AD28500-36-36-8), inspect for the following:

b. Connector sealed using the dual wrap kit AD28500-36-36-8 (contains the pink colored Stretch Seal (inner layer), the gray colored Self-Fusing Silicone tape (outer layer), and HT3326-5FR50 sealing compound (see figure 40-2) should be inspected as follows:

1. Ensure no voids and 50 percent overlap of gray self-fusing outer layer tape is uniformly applied.

2. Ensure the outer layer is secured with lacing and tying tape in accordance with A-A-52084 or A-A-52083.

3. Ensure that none of the inner, pink stretch seal tape is exposed. Only the gray outer layer tape should be exposed.

NOTE

If connector was sealed/potted using MIL-PRF-8516, MIL-A-46146, or TG2010FR-50, inspect for the following:

c. Connector sealing/potting using compounds such as MIL-PRF-8516, MIL-A-46146 and TG2010FR-50 (figures 40-3 and 40-4) should be inspected as follows:

1. Ensure potting boot or ring is firmly seated against back of connector.

2. Ensure potting boot or ring is completely filled with potting compound.

d. Electrical connection potting, as may apply to exposed relays, contactors, and ground terminals (figures 40-3 and 40-4) should be inspected as follows:

1. Ensure all exposed metallic surfaces are uniformly potted with sealing compound.

e. Additional information regarding the preservation of connectors and their components is given in NA 01-1A-505-1, Work Package 025 00, Work Package 026 00, NA 01-1A-509-1 and NA 01-1A-509-3.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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Check the source to verify that this is the current version before use.

Acceptable
Serviceable connector.

Unacceptable
Connector corrosion with connector degraded until broken.

Unacceptable
Another example of corrosion on a connector.

FIGURE 40-1. Examples of connectors that are in acceptable and unacceptable condition.

Acceptable

Dual wrap kit installed properly using self-leveling green, stretch seal (inner, pink layer) and self-fusing silicone tape (outer, gray layer), secured with lacing tape.

Unacceptable

Self-fusing silicone tape not applied and not secured with authorized lacing tape.

FIGURE 40-2. Examples of the acceptable and unacceptable usage of dual wrap and polyurethane removable sealant.

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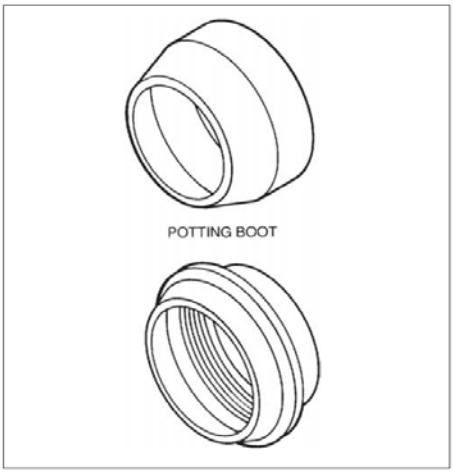
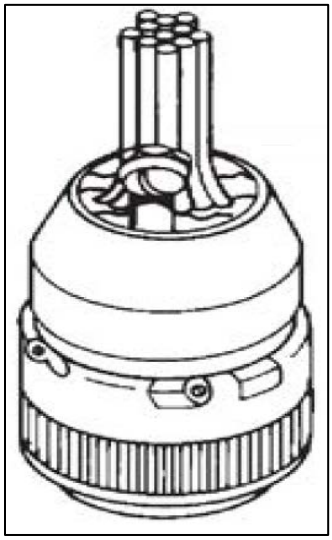


FIGURE 40-3. Potting boot and potting boot ring.



Acceptable
Potting ring and sealant correctly installed.

Acceptable
Sealant uniformly installed and exposed metallic surfaces covered.

FIGURE 40-4. Acceptable potting compound/sealant applied to connector or electrical components.

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GUIDELINE 41

CORROSION PREVENTION COMPOUND (CPC) APPLICATION INSPECTION

1. Purpose. This guideline provides criteria on inspecting corrosion prevention compound used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

MIL-PRF-81309	Corrosion Preventive Compounds, Water Displacing, Ultra-Thin Film
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 026 00	Connector Cleaning and Preservation
NA 01-1A-509-3	Avionic Cleaning and Prevention/Control
NA 01-1A-509-1	Corrosion Program and Corrosion Theory

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. CPC (such as MIL-PRF-81309, Type III) application should be examined as follows:

WARNING

Internal connector surface CPC application can result in serious damage to equipment, possibly resulting in system failure or fire, and personnel injury may occur.

a. Verify there is no evidence of CPC build-up on internal sections of connectors and receptacles (see figure 41-1).

b. Verify there is no evidence of CPC build-up on multiple termini/contact connectors containing fiber optic termini or on fiber optic single ferrule connectors. Any seepage ingress into the connector housing is considered a contaminant and may degrade the system transmission performance or cause failure.

c. Verify CPC is only applied to the external sections of the plugs and receptacles.

d. Verify there is no evidence of CPC build up on the insulation of any wire. This includes all types and grades of CPC's (e.g. structural or avionics grade).

e. Additional information regarding corrosion prevention compound inspection is given in NA 01-1A-505-1, Work Package 026 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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Unacceptable
Evidence of CPC build-up in connector and on contacts.

FIGURE 41-1 Unacceptable CPC build-up examples.

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GUIDELINE 42

TERMINAL BOARD AND GROUND STUD INSPECTION

1. Purpose. This guideline gives criteria for terminal board and ground stud inspections.

2. Applicable documents. The documents listed below are those applicable to this guideline.

MIL-PRF-8516	Sealing Compound, Synthetic Rubber, Electric Connectors and Electric Systems, Chemically Cured
MIL-A-46146	Adhesives-Sealants, Silicone, RTV, Noncorrosive (For Use With Sensitive Metals And Equipment)
NAS1149	Washer, Flat (DoD adopted)
SAE AS7928	Terminals, Lug: Splices, Conductor: Crimp Style, Copper, General Specification for (DoD adopted)
NASM21042	Nut, Self-Locking, 450 °F, Reduced Hexagon, Reduced Height, Ring Base, Non-Corrosion Resistant Steel (DoD adopted)
SAE AS21919	Clamp, Loop Type, Cushioned Support (DoD adopted)
SAE AS23190	Straps, Clamps, and Mounting Hardware, Plastic and Metal for Cable Harness Tying and Support (DoD adopted)
NASM25440	Washers For Use With Aircraft Aluminum Terminals. (DoD adopted)
SAE AS27212	Terminal Board Assembly, Molded-In-Stud, Electric (DoD adopted)
NASM35338	Washer, Lock-Spring, Helical, Regular (Medium) Series (DoD adopted)
NASM35649	Nut, Plain, Hexagon, Machine Screw, UNC-2B (DoD adopted)
NASM35650	Nut, Plain, Hexagon, Machine Screw, UNF-2B (DoD adopted)
SAE AS70991	Terminals: Lug and Splice, Crimp Style, Aluminum, for Aluminum Aircraft Wire (DoD adopted)
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 004 01	Aircraft Wiring System Inspection
Work Package 013 00	Contacts and Terminals
Work Package 017 00	Bonding and Grounding
Work Package 019 00	Bus Bar and Terminal Board

(See 2.1 through 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)
(Copies of NAS documents are available at www.aia-aerospace.org.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting terminal board and ground stud used in the EWIS, the following items should be examined:

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4. (continued).

a. Terminal board mounting and connections should be inspected as follows:

1. Confirm that no more than four terminal lugs, or three terminal lugs and one bus are connected to one terminal stud. Verify that no more than four wires in a terminal lug, resulting in a maximum sixteen wires per stud.

2. Verify that terminal lugs with various diameters are stacked with the largest outer diameter on the bottom and the smallest on top.

3. Verify that terminal lugs are not over tightened or worn so that the terminal lug or stud is not deformed or damaged.

4. Check the wires connected to the terminal board to confirm that the wires have a minimum of 3/4″ ±¼″ wire length plus required bend radius allowance (see figure 42-1).

5. Confirm that all wires exit straight from terminal lugs (see figure 42-1).

6. Confirm that a marking sleeve is installed.

7. Verify that terminal lugs are positioned so that bending is not required to remove fastening screw or nut (see figure 42-2).

8. Confirm that terminal lugs are positioned so that movement will tend to tighten the nut.

9. Verify that copper terminal lugs do not have spacers or washers between the tongues of terminal lugs (see figure 42-3).

10. Confirm that aluminum terminal lugs have the tongue or total number of tongues sandwiched between two NASM25440 flat washers. Spacers or other washers are not permitted between the tongues (see figure 42-4).

11. When two lugs are attached to one side of a stud, verify that the lugs are installed back-to-back (see figure 42-5).

12. When the maximum of three lugs is installed on one side, confirm that a space washer is placed between back-to-back lugs and the third lug (see figure 42-5).

13. Verify that stud hardware is stacked as shown on figure 42-3 or figure 42-4 depending on application requirements.

WARNING

Ensure cover is securely installed over terminal boards. Failure to install cover is an electrical shock hazard. May cause injury or death to personnel.

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4.a. (continued).

14. Verify terminal board cover is securely installed on the terminal board.

b. Ground stud mounting and connections should be as follows:

1. Confirm that no more than four terminal lugs, or three terminal lugs and one bus are connected to one terminal stud. Verify no more than four wires in a terminal lug, resulting in a maximum sixteen wires per stud.

2. Verify that terminal lugs with various diameters are stacked with the largest outer diameter on the bottom and the smallest on top.

3. Verify that terminal lugs are not over tightened or worn so that the terminal lug or stud is not deformed or damaged.

4. Confirm that all wires exit straight from terminal lugs.

5. Verify that terminal lugs are positioned so that bending is not required to remove fastening screw or nut (see figure 42-2).

6. Confirm total number of aluminum terminal lugs is sandwiched (enclosed) between two NASM25440 flat washers. Additional spacers or other types of washers are not permitted between the terminal lugs (see figure 42-4).

7. When two terminal lugs are attached to one side of a stud, verify that the lugs are installed back-to-back (see figure 42-5).

8. When the maximum of three terminal lugs is installed on one side, confirm that a space washer is placed between back-to-back lugs and the third lug (see figure 42-5).

9. Verify that stud hardware is stacked in accordance with figure 42-3 or figure 42-4 depending on application requirements.

10. Examine ground stud and attaching hardware for corrosion. Refer to NA 01-1A-505-1 WP 026 00 Table 1 for appearance of specific corrosion types. Clean or replace as required.

11. Verify mounting hardware of terminal strip is potted or sealed with suitable potting compound (i.e., MIL-A-46146, Thixoflex Part No. TG2010FR-50 or Polysulfide Sealant in accordance with MIL-PRF-8516).

12. Verify cushioned clamps (e.g., SAE AS21919 or SAE AS23190) employed as primary support and are not used for any bonding or grounding connection.

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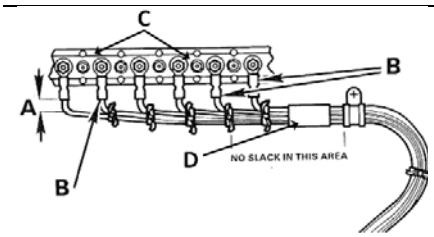
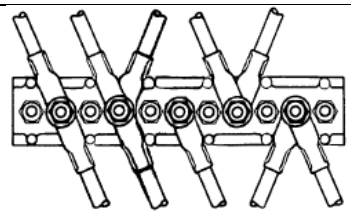
c. Additional information regarding inspection of bus bars, terminal boards and ground studs is provided in NA 01-1A-505-1, Work Packages 004 01, 013 00, 017 00 and 019 00.

5. Detail guidelines. This section is not applicable to this guideline.

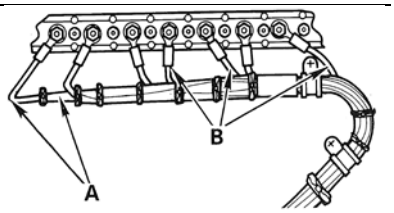
6. Notes. This section is not applicable to this guideline.



Acceptable
(A) Wire length should be ¾″ ±¼″ maximum plus bend radius. (B) All wires exit straight from terminal lug.
(C) Exposed mounting hardware of terminal strip is potted or sealed with suitable potting compound.
(D) Marking sleeve is attached after bundle is formed



Acceptable
All terminals should be placed so that movement will tighten nut as shown.



Unacceptable
(A) Excessive wire length, and bend radius.
(B) No stress relief at termination, insufficient wire length.

FIGURE 42-1. Examples of acceptable and unacceptable wire length, bend radius, and terminal placement.

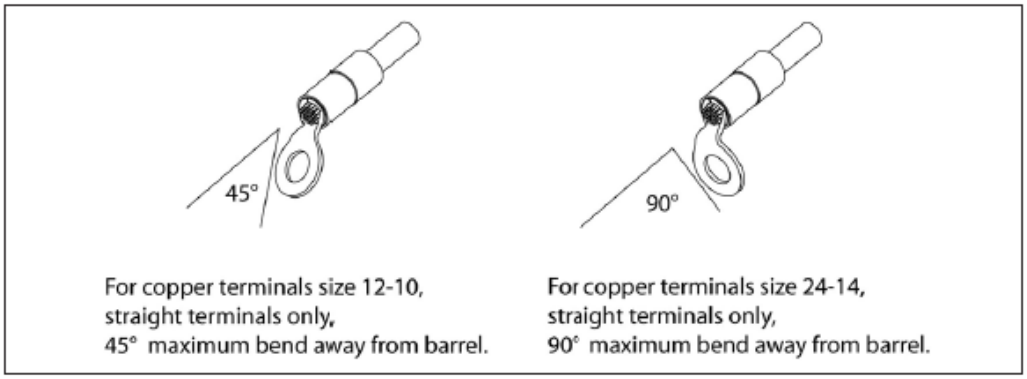


FIGURE 42-2. Maximum allowable copper terminal lug bend.

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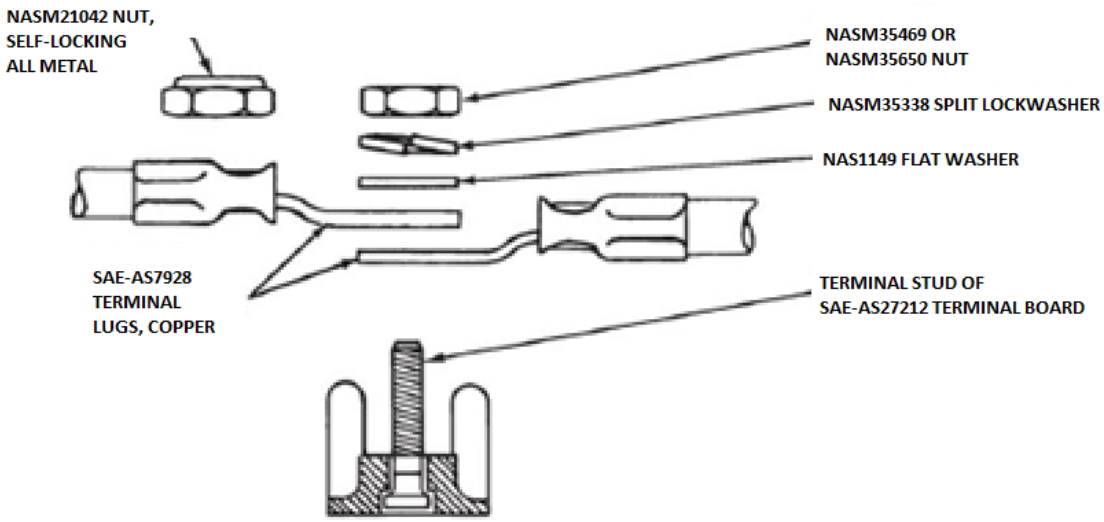

FIGURE 42-3. Hardware for wiring terminal boards with copper terminals

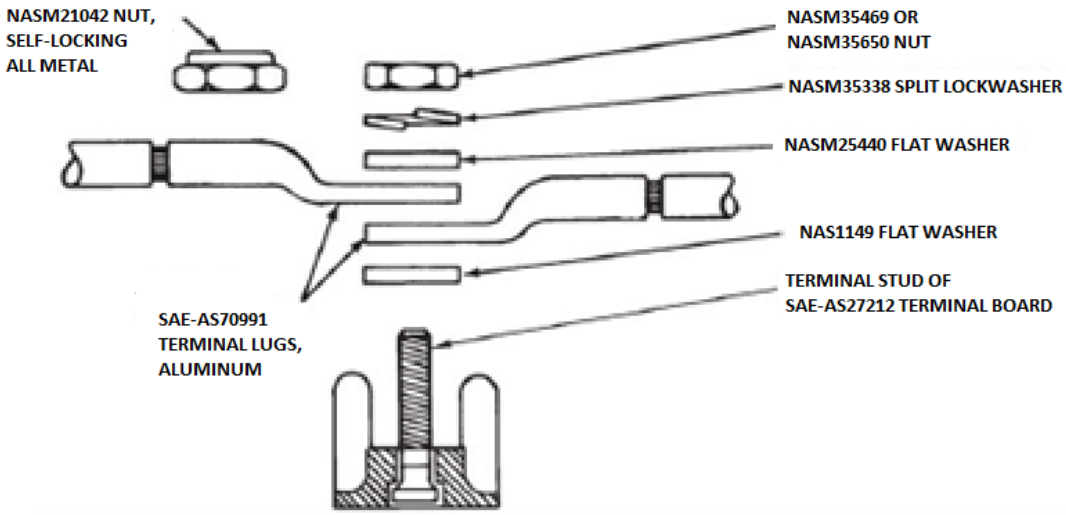

FIGURE 42-4. Hardware for wiring terminal boards with aluminum terminals

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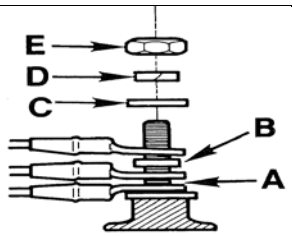	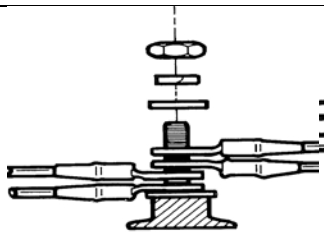	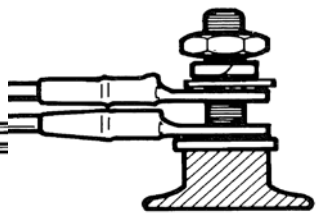	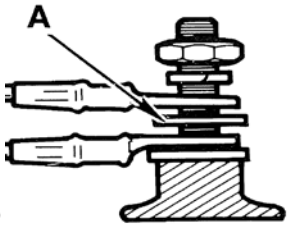
Acceptable (A) Two lugs are attached to one side of a stud, the lugs are installed back-to-back. Three lugs are on one side, a space washer is placed between (A) back-to-back lugs and (B) the third lug. Stud hardware is stacked in the following order (C) flat washer, (D) lock washer, (E) nut.	**Acceptable** When four lugs are installed, they will be grouped in pairs, back-to-back, on opposite sides of the studs.	**Unacceptable** The lugs are not back-to-back as required. This places stress on the ring tongue creating cracks and fractures.	**Unacceptable** Improper hardware stackup. (A) Flat washer should be on top of the top lug. No washer required between just two back-to-back lugs.

FIGURE 42-5. Examples of acceptable and unacceptable installation of terminal lugs and associated hardware.

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GUIDELINE 43

CIRCUIT BREAKER INSPECTION

1. Purpose. This guideline gives criteria for inspecting circuit breakers used in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual.
Work Package 028 00	Protective Devices Installation.
Work Package 004 01	Aircraft Wiring System Inspection.

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Perform the following inspection on thermal and arc-fault circuit breakers of single or multi-phase configurations (see figure 43-1):

WARNING

Verify that installed circuit breakers are in the OFF position and aircraft external electrical power and battery or batteries are disconnected before proceeding with any of the following instructions or routine maintenance. Failure to do so can result in damage to the equipment and severe injury or death to personnel.

a. Inspect push-button for cracks or deterioration and inspect case for cracks, deterioration, discoloration and burn marks.

b. Verify that there are no foreign objects present that could cause physical damage or electrical shorts.

c. Check leads of wires for burn marks and physical damage. Also, check for broken wire strands at wire terminations.

d. Examine the circuit breakers for burn marks on the insulating barrier material of three phase circuit breakers.

e. Inspect circuit breakers and around the circuit breaker for corrosion, discoloration and hot spots on all metal parts, including buss bars.

f. Ensure all circuit breaker connecting hardware is tight and secure and verify correct line and load connection.

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4. (continued).

g. Confirm that the circuit breaker does not have a history of tripping. A tripped breaker may be faulty, may be in a faulty circuit, or may be improperly applied. Fault isolate affected circuit and/or replace circuit breaker as necessary.

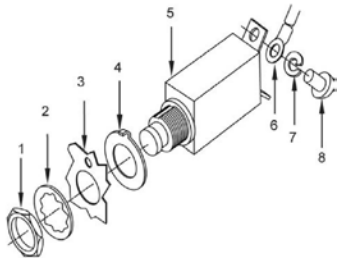
h. Inspect the circuit breaker boot for splits or deterioration. Do not remove the boot except for inspection.

i. For deactivated (pulled) circuit breakers, ensure that only approved circuit breaker collars/devices are employed (plastic zip ties, string tie, etc., are NOT approved).

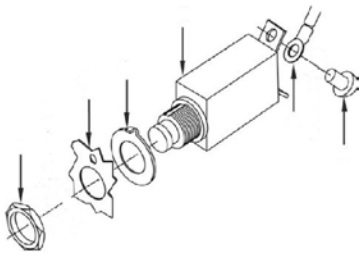
j. Additional information regarding the inspection of circuit breakers is given in NA 01-1A-505-1, Work Package 028 00 and 004 01.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.



Acceptable
1. Nut
2. Lock washer
3. Panel
4. Key washer
5. Circuit breaker
6. Terminal
7. Lock washer
8. Screw



Unacceptable
Missing 2 lock washers (item 2 and 7)

Unacceptable
Screw too long and is causing damage to circuit breaker housing.

FIGURE 43-1. Examples of circuit breakers in acceptable and unacceptable condition.

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GUIDELINE 44

SOLDER INSPECTION

1. Purpose. This guideline gives criteria on inspecting solder contacts and joints in the EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 016 00	Soldering
NA 01-1A-23	Standard Maintenance Practices Miniature/Microminiature (2M) Electronic Assembly Repair
Work Package 020 00	Introduction to Lead-Free Solder

(See 2.2 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines.

NOTE
The following guideline applies to conventional, tin-lead solder applications. For lead-free solder applications, refer to NA 01-1A-23, Work Package 020 00.

a. When inspecting solder joints within the EWIS, a good solder joint has the following characteristics (see figure 44-1):

1. A bright silvery appearance, with smooth fillets and feathered, not sharp, edges.

2. The entire joint will be covered with a smooth even coat of solder, and the contour of the joint will be visible.

3. The insulation is properly cut and free of solder.

b. When inspecting solder joints within the EWIS, any of the following indicate a poor solder joint and are cause for rejection (see figure 44-1):

1. Dull gray, chalky, or granular appearance (evidence of a cold joint).

2. Hair line cracks or irregular surface (evidence of a disturbed joint).

3. Grayish, wrinkled appearance (evidence of excessive heat).

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4.b. (continued).

4. Partially exposed joint (evidence of insufficient solder).

5. Scorched wire insulation or burned connector inserts are present.

6. Globules, drips, or tails of solder are present.

c. When inspecting wire insulation at solder joints, if any of these conditions are present, they are cause for rejection:

1. Insulation is charred, burned or blistered (evidence of overheating).

2. Insulation has frayed or uneven appearance.

3. Solder present on insulation.

4. Ensure minimum insulation clearance equal to the diameter of the insulated wire (see figure 44-2).

d. Additional information regarding the inspection of soldering is given in NA 01-1A-505-1, Work Package 016 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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Acceptable Good solder quantity with no spillage.	**Unacceptable** Insufficient solder quantity with uncovered wire stands.	**Unacceptable** Excess solder flow with protrusions.

FIGURE 44-1. Examples of acceptable and unacceptable soldering.

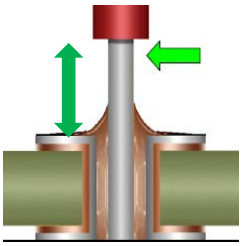	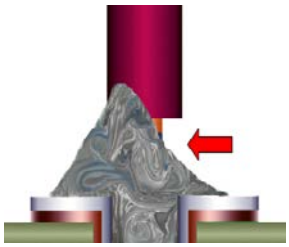	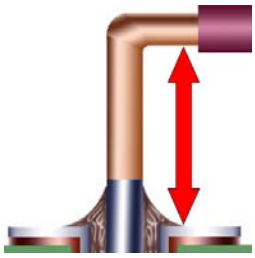
Acceptable	**Unacceptable**	**Unacceptable**
The insulation gap should be a minimum of one wire insulations over insulation of wire.	The insulation is imbedded into the solder joint.	The insulation gap exceeds minimum of one wire insulation of wire. May present a shorting potential.

FIGURE 44-2. Acceptable and unacceptable insulation gap.

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GUIDELINE 45

GROMMET INSPECTION

1. Purpose. This guideline provides criteria on inspecting grommets on airframes and structures used with EWIS.

2. Applicable documents. The documents listed below are those applicable to this guideline.

MS35489	Grommets, Synthetic and Silicone Rubber, Hot-Oil and Coolant ... Resistant
SAE AS21919	Clamp, Loop Type, Cushioned Support
NASM22529/1	Grommet, Composite, Edging
NA 01-1A-505-1	Joint General Series Wire Maintenance Manual.
Work Package 010 00	Harness Installation

(See 2.1 through 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)
(Copies of NASM22529/1 are available at www.aia-aerospace.org.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. When inspecting donut (MS35489) or caterpillar grommets (NASM22529/1), the following should be followed:

CAUTION

Grommets are designed for incidental contact only and should not be used as a primary or secondary means of chafe protection.

a. Ensure grommets are used when physical separation between wiring and equipment or structure edges where a minimum of ½-inch clearance cannot be maintained. A minimum 3/8-inch clearance is acceptable for lightening hole applications (see figure 45-1).

b. Verify grommet is not damaged. If damaged, replace as necessary.

c. Verify grommet installation is secured and is not a potential Foreign Object Damage (FOD) hazard.

d. For flat edge grommet (NASM22529/1), if the width of the gap is greater than 0.3 inch, replace the grommet. Ensure wire bundle is on the farthest side of the gap (see figures 45-2 and 45-3).

e. Additional information regarding donut or caterpillar grommets is given in NA 01-1A-505-1, Work Package 010 00.

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5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

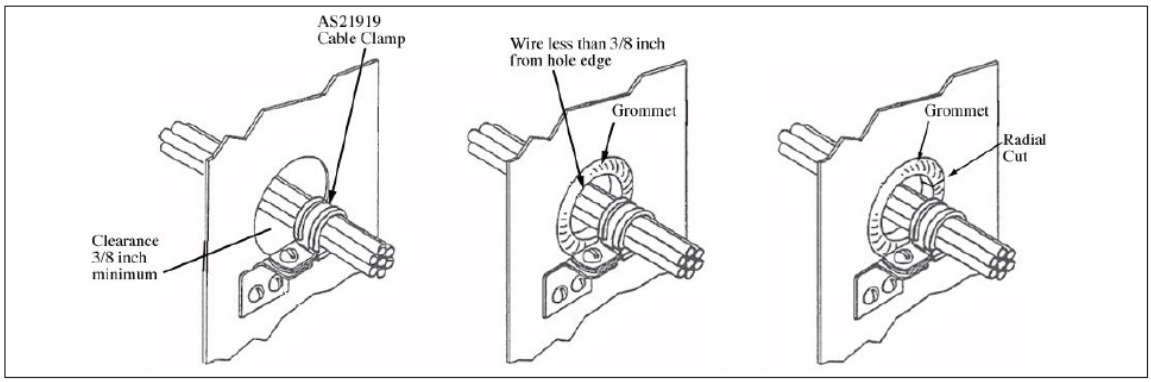
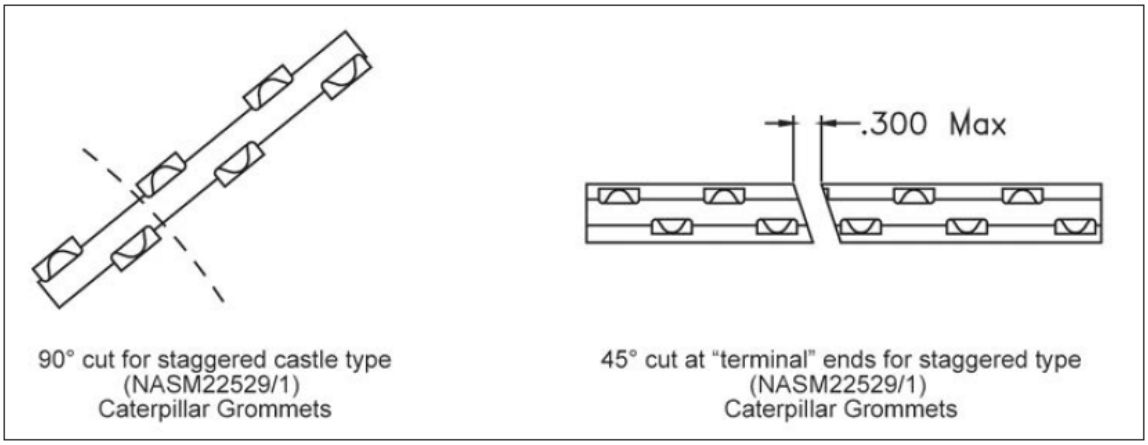


FIGURE 45-1. Acceptable grommet installation.



Acceptable
Staggered grommet cut at 90 degrees

Acceptable
Staggered grommet with less than .30 inch gap.

FIGURE 45-2. Grommet gap.

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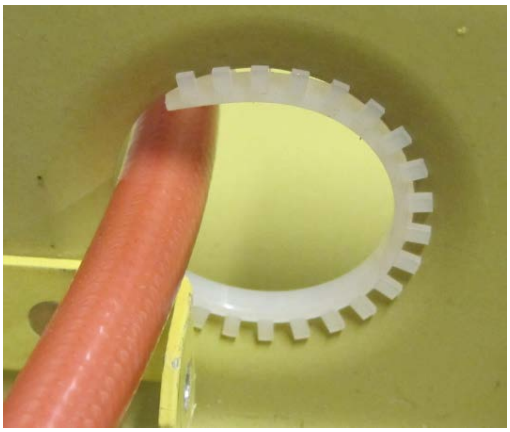

Unacceptable
Grommet does not cover the full circumference of lightening hole. Minimum clearance not maintained.

Unacceptable
Cable pinched in grommet gap.

FIGURE 45-3. Unacceptable grommet installation.

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GUIDELINE 46

LARGE GAUGE TERMINAL LUG INSPECTION

1. Purpose. This guideline gives criteria for inspecting large gauge terminal lugs.

2. Applicable documents. The documents listed below are those applicable to this guideline.

NA 01-1A-505-1	Joint General Series Wire Maintenance Manual
Work Package 013 00	Contacts and Terminals
SAE AS5259	Tool and Accessories, Electrical, Size 8 to 700 KCMIL, General Purpose Use, Die and Dieless, Crimping (DoD adopted).
SAE AS7928	Terminals, Lug: Splices, Conductor: Crimp Style, Copper, General Specification For (DoD adopted)

(See 2.2 and 2.3 under 2. APPLICABLE DOCUMENTS for source web site.)

3. Acronyms and definitions.

3.1 See sections 3.1 and 3.2 of this handbook.

4. General inspection guidelines. Improper crimping techniques may degrade the mechanical (tensile strength) and electrical performance of large gauge terminal lugs. Large terminal lugs are regarded as those that can accommodate wire/cable bigger than 12 AWG. To verify large terminal lugs are crimped properly, they should be examined as follows:

WARNING

Ensure terminal lug is longitudinally centered in the crimp die or against the die stop (if available). If crimp indent is located at either end, it may result in a joint with high electrical resistance and low mechanical pull strength. Overheat and fire may result.

a. Verify the crimp indent is positioned in the center of the terminal.

NOTE

Large gauge terminal lug crimp dies meeting SAE AS5259 incorporate the marking of the wire size and terminal lug type, such that after crimping, it leaves the mark embossed on the terminal lug. Not all in-service approved and qualified crimp tools and dies have this feature.

b. Verify that the crimp die wire gauge number (i.e., “2/0” is for 2/0 wire) and type (i.e., “CU” means Copper terminal lug) is embossed on completed crimp. These markings need to align with the “AIR AWG/size” rating of the terminal lug wire AWG rating (see figure 46-1).

c. Check that the wire insulation is inserted in the support area of the terminal barrel (see figure 46-2).

d. Confirm that the stripped wire conductor is pushed fully into the lug.

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4. (continued).

e. Verify that the stripped wire ends are flush to terminal stop with not more than 1/32 inch protruding (see figure 46-2).

f. Verify that no wire insulation is present in the wire crimp barrel.

g. Confirm that conductor insulation has been inserted into the insulation support area of the terminal lug barrel (see figure 46-2).

h. Verify that the amount of insulation stripped from the wire is not excessive, such that conductors extend into the hardware mounting area (see figure 46-2).

NOTE

Not all terminal lug configurations employ the "AIR AWG" marking convention. This marking signifies that the wire employed is for aviation applications and employs smaller wire strand, thus a different crimp setting. Refer to the terminal lug specification for requirements, or the Cognizant Engineering Authority.

i. Verify correct "AIR AWG" rating (if so marked) on terminal lug matches the appropriate wire AWG and type (i.e. Copper or Aluminum) (see detail B of figure 46-1)

j. Additional information regarding the inspection of terminal lug crimps is provided in NA 01-1A-505-1, Work Package 013 00.

5. Detail guidelines. This section is not applicable to this guideline.

6. Notes. This section is not applicable to this guideline.

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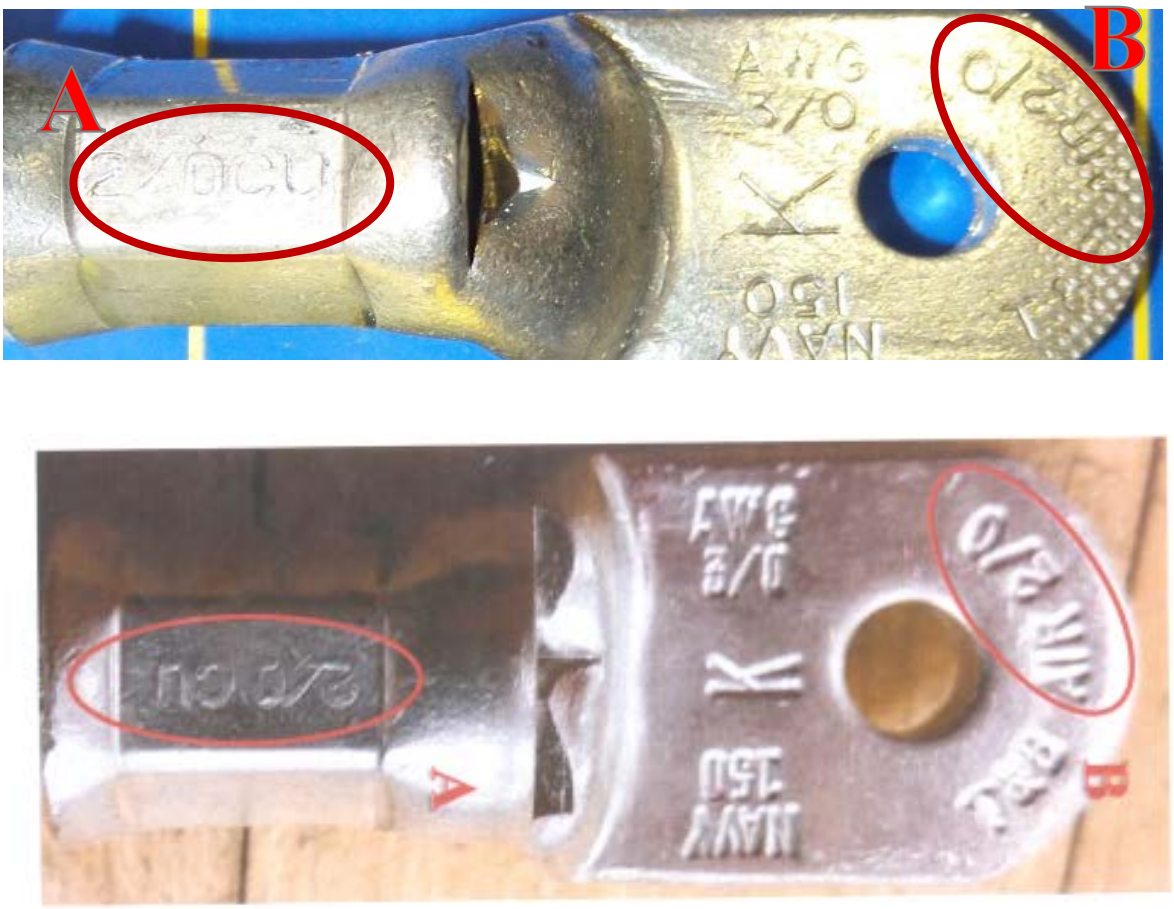

(A) Die index number embossment on completed crimp. (B) AIR AWG marking.

FIGURE 46-1. Terminal lug markings.

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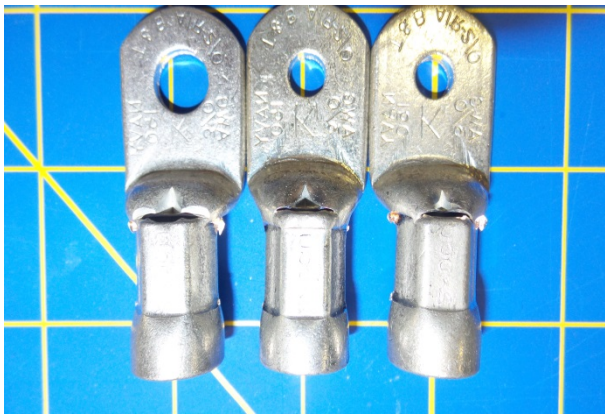
Acceptable
Lug has been properly positioned in tool. Stripped wire ends are flush to terminal stop (not more than 1/32 inch protruding). No insulation is in barrel.



Unacceptable
Lug improperly positioned in tool resulted in crimp indent not centered on barrel.

FIGURE 46-2. Examples of acceptable and unacceptable crimping of terminal lugs.

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CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - AS
Air Force - 85
DLA - CC

Review activities:
Air Force - 11, 19, 84

Preparing activity:
Navy - AS

(Project 6145-2015-031)

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