S9300-A6-GYD-010

REVISION 2

TECHNICAL MANUAL

ELECTRICAL WORKMANSHIP INSPECTION GUIDE FOR SURFACE SHIPS AND SUBMARINES

SUPERSEDURE NOTICE: THIS MANUAL SUPERSEDES S9300-A6-GYD-010, REVISION 1, DATED 08 OCTOBER 2009 AND ALL CHANGES THERETO.

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15 SEP 2011

RECORD OF REVISIONS

REVISION NO.	TITLE AND/OR BRIEF DESCRIPTION/PREPARING ACTIVITY	DATE
1	CHANGE AUTHORIZED BY NSWCCD-SSES CODE 944. NUMEROUS CORRECTIONS TO ENHANCE THE MANUAL.	8 OCTOBER 2009
2	INCORPORATED TMDERS N39040-11-AB02 AND N39040-11-AB03 TO CORRECT THE USE OF THIMBLES IN NEW CONSTRUCTION AND THE USE OF A LOCKING DEVICE FOR LUG TERMINALS. CHANGE AUTHORIZED BY NSWCCD-SSES CODES 944 AND 934. THE FOLLOWING WAS CHANGED: PARAGRAPH(S) , 3-5 AND 5-2	15 SEPTEMBER 2011

NOTE

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FOREWORD

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SAFETY SUMMARY

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

GENERAL SAFETY NOTICES

The following general safety notices supplement the specifi warnings and cautions appearing elsewhere in this manual. They are recommended precautions that must be understood and applied during operation and maintenance of the equipment covered herein. Should situations arise that are not covered in the general or specifi safety precautions, the commanding officer or other authority will issue orders as deemed necessary to cover the situation. No work shall be undertaken on energized equipment or circuits until approval of the commanding officer is obtained, and then only in accordance with Naval Ships Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300.

DO NOT REPAIR OR ADJUST ALONE

Under no circumstances shall repair or adjustment of energized equipment be attempted alone. The immediate presence of someone capable of rendering firs aid is required. Before making adjustments, be sure to protect against grounding. If possible, adjustments should be made with one hand, with the other hand free and clear of equipment. Even when power has been removed from equipment circuits, dangerous potentials may still exist due to retention of charges by capacitors. Circuits must be grounded and all capacitors discharged prior to attempting repairs.

TEST EQUIPMENT

Make certain test equipment is in good condition. If a metal-cased test meter must be held, ground the case of the meter before starting measurement. Do not touch live equipment or personnel working on live equipment while holding a test meter. Some types of measuring devices should not be grounded; these devices should not be held when taking measurements.

INTERLOCKS

Interlocks are provided for safety of personnel and equipment and should be used only for the purpose intended. They should not be battle shorted or otherwise modifie except by authorized maintenance personnel. Do not depend solely upon interlocks for protection. Whenever possible, disconnect power at the power distribution source.

SAFETY SUMMARY - Continued

MOVING EQUIPMENT

Personnel shall remain clear of moving equipment. If equipment requires adjustment while in motion, a safety watch shall be posted. The safety watch shall have a full view of the operations being performed, and immediate access to controls capable of stopping equipment motion.

FIRST AID

An injury, no matter how slight, shall never go unattended. Always obtain firs aid or medical attention immediately, and fil an injury report in accordance with OPNAVINST 5102.1 series, subj: Mishap Investigation and Reporting.

RESUSCITATION

Personnel working with or near high voltage shall be familiar with approved methods of resuscitation. Should someone be injured and stop breathing, begin resuscitation immediately. A delay could cost the victim's life. Resuscitation procedures shall be posted in all electrically hazardous areas.

GENERAL PRECAUTIONS

The following general precautions are to be observed at all times.

1. Install and ground all electrical components associated with this system/equipment in accordance with applicable Navy regulations and approved shipboard practices.
2. Ensure that all maintenance operations comply with Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat OPNAVINST 5100.19 series.
3. Observe precautions set forth in NSTM S9086-KC-STM-010/Chapter 300 with respect to electrical equipment and circuits.
4. Ensure that protective guards and shutdown devices are properly installed and maintained around rotating parts of machinery and high voltage sources.
5. Do not wear loose clothing while working around rotating parts of machinery.
6. Ensure that special precautionary measures are employed to prevent applying power to the system/equipment any time maintenance work is in progress.
7. Do not make any unauthorized alterations to equipment or components.
8. Before working on electrical system/equipment, check with voltmeter to ensure that system is not energized.
9. Consider all circuits not known to be ″dead,″ ″live″ and dangerous at all times.
10. When working near electricity, do not use metal rules, flashlights metallic pencils, or any other objects having exposed conducting material.
11. Deenergize all equipment before connecting or disconnecting meters or test leads.
12. When connecting a meter to terminals for measurement, use range higher than expected voltage.
13. Before operating equipment or performing any tests or measurements, ensure that frames of all motors and starter panels are securely grounded.

SAFETY SUMMARY - Continued

14. Ensure that area is well-ventilated when using cleaning compound or solvent. Avoid prolonged breathing of fumes and compound or solvent contact with skin or eyes.

CHAPTER 1

INTRODUCTION

1-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

1-2. PURPOSE.

This manual disseminates up-to-date information for evaluating electrical workmanship for submarine and surface ship electrical equipment and systems and applies to both nuclear and non-nuclear work. This manual consists of one volume that includes eleven chapters as follows:

Chapter 1 - Introduction

Chapter 2 - Soldered Connections

Chapter 3 - Cable Lug Terminal Installation

Chapter 4 - Sleeving Identificatio

Chapter 5 - Locking Devices

Chapter 6 - Lacing, Seizing and Dressing of Conductors

Chapter 7 - Cleanliness and Corrosion

Chapter 8 - Bus Work

Chapter 9 - Instrumentation

Chapter 10 - Miscellaneous Electrical Components

Chapter 11 - Spraytight Integrity

This manual was developed for use by electrical and electronic shop mechanics, electrical inspectors, and cognizant technical code personnel. The criteria contained herein has been based on the data formerly contained in Portsmouth Naval Shipyard Standard 4855.

This manual applies to work on a specifi ship or ships only when invoked by the Ship Specification or similar contractual documents. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the require-

ments set forth in the invoked document for that equipment or system shall govern. This manual is applicable to new construction, old work, and conversion or alteration of existing ships.

This manual consists of a number of color photographs showing preferred, acceptable, and unacceptable conditions. It should be noted that details given in the color photographs of this document may not be observed in black and white reproductions.

1-3. DOCUMENTS AND PUBLICATIONS.

The following documents and publications are referenced in this document:

	Government Documents - Commercial Item Descriptions
A-A-52080	Tape, Lacing and Tying, Nylon
A-A-52081	Tape, Lacing and Tying, Polyester
A-A-52082	Tape, Lacing and Tying, TFE-Fluorocarbon
A-A-52083	Tape, Lacing and Tying, Glass
A-A-52084	Tape, Lacing and Tying, Aramid
	Government Documents - Specification
MIL-DTL-713	Twine, Fibrous: Impregnated, Lacing and Tying
MIL-E-917	Electric Power Equipment, Basic Requirements
MIL-Y-1140	Yarn, Cord, Sleeving, Cloth and Tape-Glass
MIL-I-3158	Insulation Tape, Electrical Glass-Fiber (Resin-Filled): and Cord, Fibrous-Glass
MIL-DTL-15659	Terminal, Lug: Solder, Copper and Phosphor Bronze
MIL-T-16366	Terminals, Electrical Lug and Conductor Splices, Crimp-Style
	Government Documents - Standards
MIL-STD-763	Locking Devices
MIL-STD-2003	Electrical Plant Installation Standard Methods for Surface Ships and Submarines
MIL-STD-2003-1	Electric Plant Installation Standard Methods for Surface Ships and Submarines (Cable)
MIL-STD-2003-2	Electric Plant Installation Standard Methods for Surface Ships and Submarines (Equipment)
MIL-STD-2003-5	Electric Plant Installation Standard Methods for Surface Ships and Submarines (Connectors)
	Other Government Documents and Drawings
NAVSEA 0989-031-4000	Reactor Plant Instrumentation and Control Equipment Maintenance
S9086–KC-STM-010	NSTM Chapter 300, Electric Plant-General
	Non-Government Publications
NASM33540	Safety Wiring and Cotter Pinning, General Practices For
NFPA 70E	Standard for Electrical Safety in the Workplace
OSHECM	Occupational, Safety, Health and Environment Control Manual
SAE-AS7928	Terminals, Lug: Splices, Conductors: Crimp Style, Copper, General Specificatio For

1-4. DEFINITIONS.

Birdcage. A 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.

Clinched-wire through connection. A connection made by a wire that is passed through a hole in a PC board, subsequently formed or clinched in contact with the conductive pattern on each side of the board and soldered.

Complete solder joint. A soldered connection between a wire lead and a terminal area where the solder wets and forms a void-free fille between the wire lead and the complete terminal area.

Corrosion. The destruction of the surface of a metal by chemical reaction.

Crimp. Final configuratio of a terminal barrel formed by the compression of terminal barrel and wire.

Crimp termination. Connection in which a metal sleeve is secured to a conductor by mechanically crimping the sleeve with compression in hand or hydraulic crimping tools. Splices, terminals, and multi-contact connectors are typical terminating devices attached by crimping.

Crimper. That part of the crimping die, usually the moving part, that indents or compresses the terminal barrels. Also called Indenter.

Crimping chamber. Area of a crimping tool, formed by mating the anvil (nest) and crimper (indentor), in which a contact or terminal is crimped.

Crimping die. Portion of the crimping tool that shapes the crimp.

Crimping tool. Mechanism used for crimping.

Insulated terminal. Solderless terminal with an insulated sleeve over the barrel to prevent a short circuit in certain installations.

Insulation crimp. Area of a terminal, splice, or contact that has been formed around the insulation of the wire.

Jacket. Outermost layer of insulating material of a cable or wire.

Lug terminal. A terminal designed to be affixed, usually at one end, to a post, stud, chassis, etc., and with provision for attachment of a wire(s) or similar electrical conductor(s) in order to establish an electrical connection.

MCM. Thousand circular mils.

Nonwetting. Condition whereby a surface has contacted molten solder, but has had none of the solder adhere to it.

Solder flux A substance that transforms a passive, contaminated metal surface into an active, clean, solderable surface.

Solder lugs. Device to which wire is secured by soldering. Solder lugs are attached to a PC board, termination strip, chassis, or electrical component.

Surface mounting. The electrical connection of components to the surface of a conductive pattern without utilizing component holes.

Wicking. Desoldering method utilizing prefluxe braid of stranded wire or braid used with flux The wick material is placed on the solder joint and a heated iron tip is applied to the wick. Capillary action draws the solder up into the wick material.

Wetting. The formation of a relatively uniform, smooth, unbroken and adherent fil of solder to a base material.

Wire wrapped connection. A wire wrapped connection is a solderless connection made by wrapping bare wire around a square or rectangular terminal with a power or hand tool.

CHAPTER 2

SOLDERED CONNECTIONS

2-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

2-2. GENERAL REQUIREMENTS FOR NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability of soldered connections. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable conditions.

2-2.1 Connector Cup Soldering - New Work. The following general criteria shall be used in conjunction with the acceptable/not acceptable criteria. This criteria is not shown in photos.

a. Insulation clearance. Clearance between the end of the insulation and the solder of the connection shall be as follows:
   1. Minimum clearance. The insulation shall not be embedded in the solder joint. The contour of the conductor shall not be obscured at the termination end of the insulation.
   2. Maximum clearance. Clearance shall be less than two wire diameters (including insulation) or 1/16 inch, whichever is larger, but shall not permit shorting between adjacent conductors.

b. Wire strands.
   1. Nuclear. There shall be no broken, cut, or nicked strands.
   2. Non-nuclear - preferred. There shall be no broken, cut, or nicked strands.
   3. Non-nuclear - acceptable. Nicked or broken strands that do not exceed the limits of Table 2-1.

Table 2-1. Leads, Broken Strand Limits

Number of Strands	Maximum Allowable Nicked or Broken Strands
less than 7	0
7 - 15	1
16 - 18	2
19 - 25	3
26 - 36	4
37 - 40	5
41 or more	6

c. Insulation. Insulation shall be clean and undamaged.

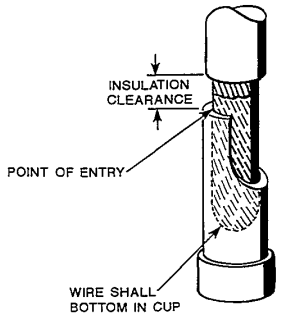
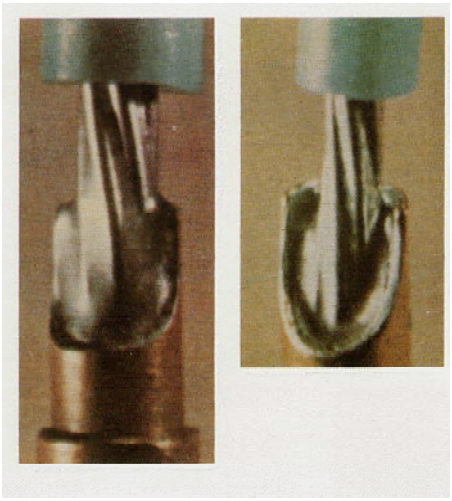


Figure 2-1. Typical Connector Cup Soldering



PREFERRED (LEFT PHOTO)

Conductor is correct size for cup application.

Solder completely fill the cup and follows the contour of the cup entry slot.

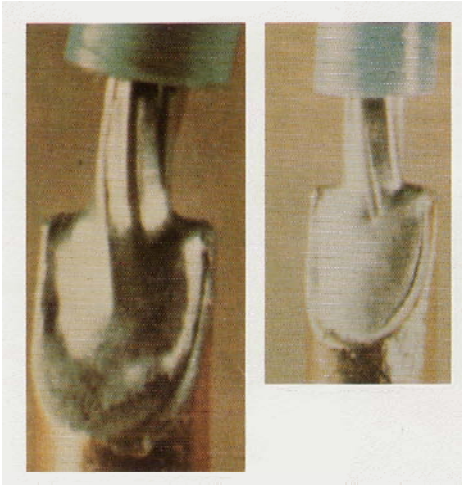
Strands are well define below the top surface of the cup.

PREFERRED (RIGHT PHOTO)

Only sufficient solder has been used to fil the cup.

Conductor shows no sign of wicking, individual strands are visible.

Solder has smooth, bright, metallic appearance.



ACCEPTABLE (LEFT PHOTO)

Solder has wicked up to, but not under the insulation. No evidence of scorching or enlarging of the insulation.

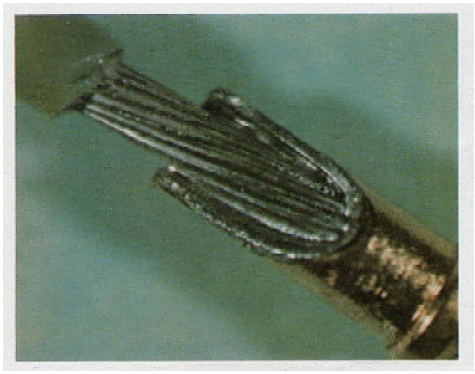
All strands are within cup and fully seated.

Maximum solder, however the solder does not extend beyond cup diameter.

ACCEPTABLE (RIGHT PHOTO)

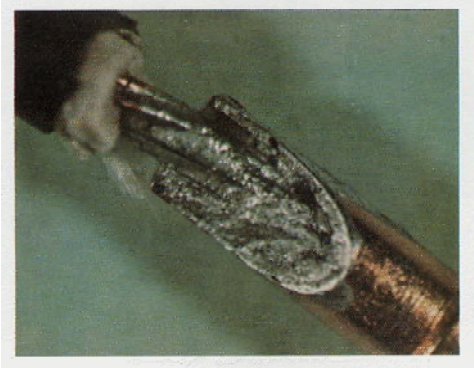
Cup has been “Spot Tinned” as a result of the soldering iron application.

Maximum amount of solder has been used but does not project beyond cup diameter.



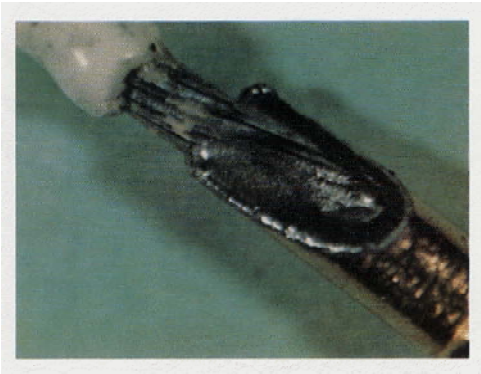
ACCEPTABLE
Minimum solder (wire well tinned - fille still visible between wire and cup).

NOT ACCEPTABLE
Cold solder joint.
Characterized by poor wetting and solder that either beads-up or has a rough piled-up appearance.



NOT ACCEPTABLE
Disturbed joint.
Relative motion between wire and terminal during solidificatio of solder that results in a joint with a frosty and granulated appearance.

NOT ACCEPTABLE
Birdcaging (separation of individual strands).



NOT ACCEPTABLE
Wicking is evident by solder extending to and under insulation as evidenced by enlarged insulation.

2-2.2 Bifurcated Terminal Soldering - New Work. The following general criteria for new work shall be used in conjunction with the acceptable/not acceptable criteria. This criteria is not shown in photos.

a. Insulation clearance. Clearance between the end of the insulation and the solder of the connection shall be as follows:

   1. Minimum clearance. The insulation shall not be embedded in the solder joint. The contour of the conductor shall not be obscured at the termination end of the insulation.
   2. Maximum clearance. Clearance shall be less than two wire diameters (including insulation) or 1/16 inch, whichever is larger, but shall not permit shorting between adjacent conductors.

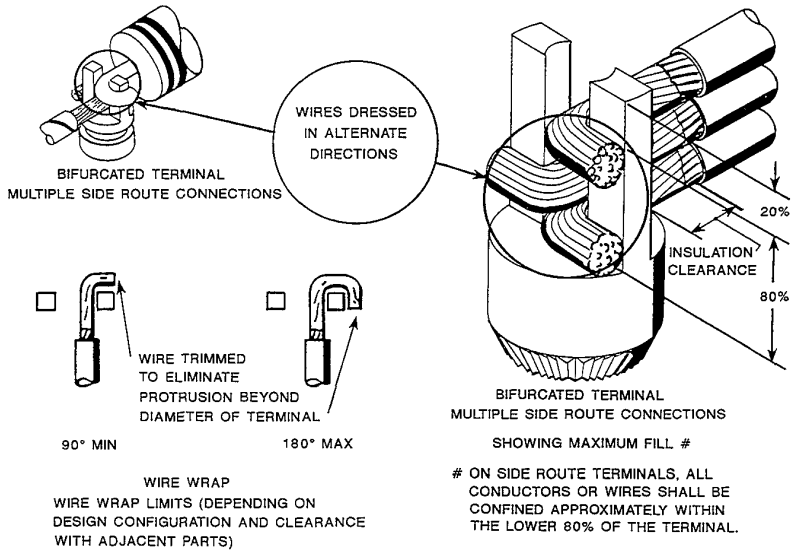


Figure 2-2. Bifurcated Terminal Connections

b. Wire strands.

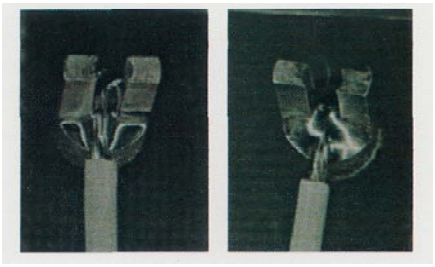
1. Nuclear. There shall be no broken, cut, or nicked strands.
2. Non-nuclear - preferred. There shall be no broken, cut, or nicked strands.
3. Non-nuclear - acceptable. Nicked or broken strands that do not exceed the limits of Table 2-1.

c. Insulation. Insulation shall be clean and undamaged.

d. Wire leads. The number of leads shall be limited to three per terminal post, six per terminal.

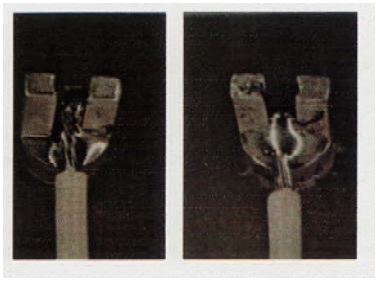
PREFERRED
Good wetting of terminal and wire.
Insulation trimmed neatly.
Solder is smooth, bright and shiny.

PREFERRED
Smooth, clean fille between conductor and terminal.
Sufficient amount of solder, conductor clearly visible and mounted at base of terminals.



ACCEPTABLE
One terminal has minimum solder, the other maximum solder.
Minimum solder: Just covers the wire or lead over the extent of the wrap. Solder shall wet the terminal and wire or lead and form a visible fillet
Maximum solder: Shall not completely obscure the extent of the wrap. Solder shall wet the terminal wire or lead. There shall be no spillage of solder over the sides of the terminal although a thin wetted area is acceptable.

ACCEPTABLE
Maximum amount of solder. Portion of contour of the conductor is still visible.



NOT ACCEPTABLE
One terminal has insufficient solder, the other has excessive solder.
Insufficient solder: Does not cover the wire or lead over extent of the wrap or filletin is incomplete.
Excessive solder: A buildup of solder that completely obscures the contour of the wire or lead or extent of the wrap.
Solder that overflow the confine of the connection area (not shown in photo).

NOT ACCEPTABLE
Contamination (such as flu or other impurities).

NOT ACCEPTABLE
Original lay or twist of wire not maintained.

2-2.3 Turret Post Soldering - Wire Termination - New Work. The following general criteria for new work shall be used in conjunction with the acceptable/not acceptable criteria. This criteria is not shown in photographs.

a. Insulation clearance. Clearance between the end of the insulation and the solder of the connection shall be as follows:

1. Minimum clearance. The insulation shall not be embedded in the solder joint. The contour of the conductor shall not be obscured at the termination end of the insulation.
2. Maximum clearance. Clearance shall be less than two wire diameters (including insulation) or 1/16 inch, whichever is larger, but shall not permit shorting between adjacent conductors.

b. Wire strands.

1. Nuclear. There shall be no broken, cut, or nicked strands.
2. Non-nuclear - preferred. There shall be no broken, cut, or nicked strands.
3. Non-nuclear - acceptable. Nicked or broken strands that do not exceed the limits of Table 2-1.

c. Insulation. Insulation shall be clean and undamaged.

d. Wire wrap.

1. Wire wraps are normally installed on turret terminals using the lower guide slots.
2. Wire wraps shall be installed in the same direction, i.e., clockwise or counterclockwise. Wires shall maintain contact with the post for the full curvature of the wrap.
3. The number of wires shall be limited to three per section and six per terminal.

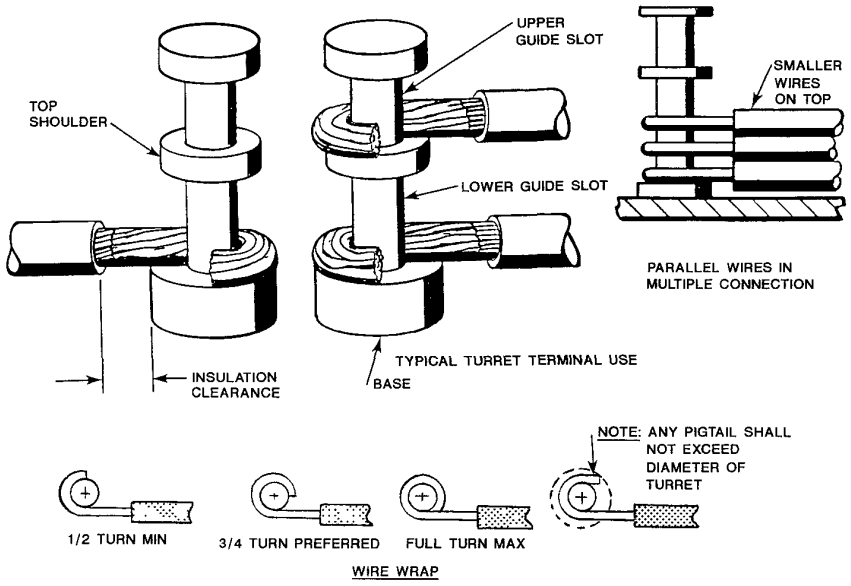


Figure 2-3. Turret Post Connections

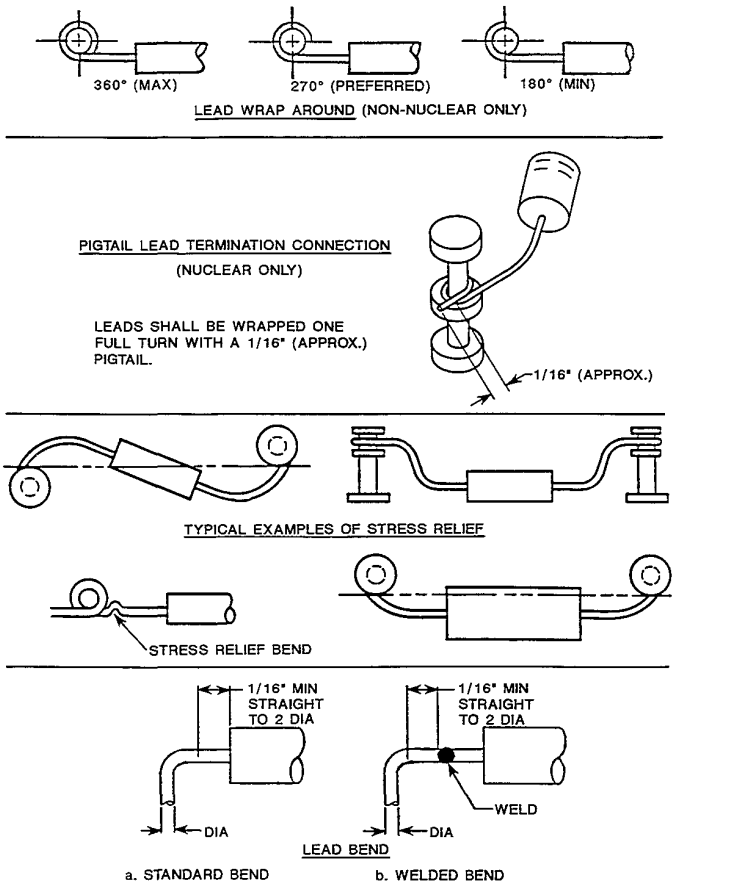
PREFERRED
Sufficient amount of solder.
Wire soldered to base in lower guide slot of post (preferred) or to top shoulder in upper guide slot of post.
Wire well defined
Solder is clean, bright and smooth. No contamination.
Original lay or twist of wire has been maintained.

ACCEPTABLE (LEFT PHOTO)
Minimum solder.
Solder that just covers the wire or lead over extent of the wrap. Solder shall wet the terminal and wire or lead and form a visible fillet
ACCEPTABLE (RIGHT PHOTO)
Maximum solder.
Solder shall not completely obscure the extent of the wrap. Solder shall wet the terminal and wire or lead. There shall be no spillage of solder over the sides of the terminal although a thin wetted area is acceptable.

NOT ACCEPTABLE
Insufficient solder.
Solder does not cover the wire or lead over extent of the wrap or filletin is incomplete.

NOT ACCEPTABLE
Excess solder.
A buildup of solder that completely obscures the contour of the wire or lead over extent of the wrap. Solder that overflow the confine of the connection area (not shown in photo).

2-2.4 Turret Post Soldering - Component Termination - New Work. Figure 2-4 illustrates the general criteria for new work that shall be used in conjunction with the acceptable/not acceptable criteria. This criteria is not shown in the photographs.

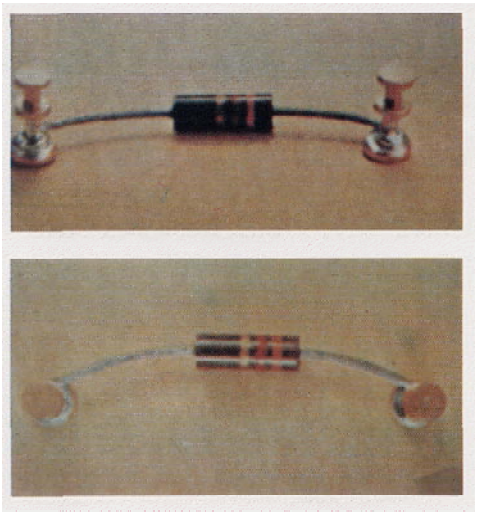


The distance between the body of the part or lead weld bead and the bent section of a lead shall be at least twice the diameter of the lead but not less than 1/16 inch.

Figure 2-4. Typical Component Terminations

a. Lead wrap.

1. Component leads are normally installed on turret terminals using the upper guide slots.
2. Lead wraps shall be installed in the same direction, i.e., clockwise or counterclockwise. Leads shall maintain contact with the post for the full curvature of the wrap.
3. The number of leads shall be limited to three per section and six per terminal.

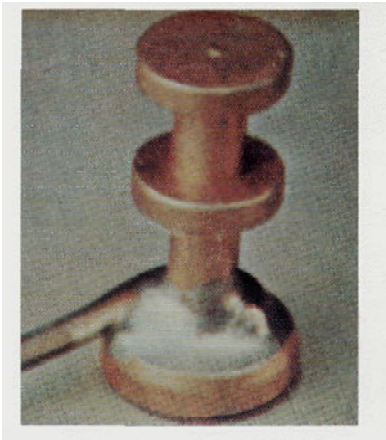


PREFERRED
Component lead soldered to base in lower guide slot of post or to top shoulder in upper guide slot of post.
Component centered between terminals and seated flus on boards.
Leads not under tension - component leads form a slight loop to offset component body from terminal centerline.
It may be impossible to include allowance for stress relief when mounting components because of equipment mechanical design. In these cases the component should be mounted in the same manner as the existing component.

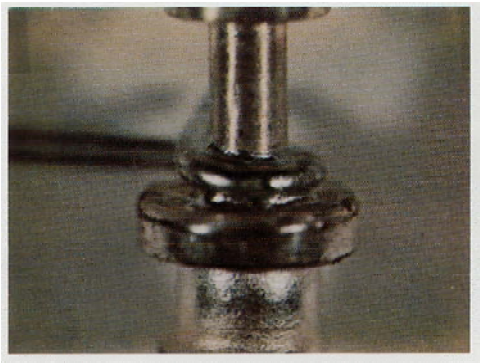
PREFERRED (NUCLEAR)
Solder is neat and bright, sufficient to cover lead and “feathers” out on terminal post. Fillet is complete.
Component lead is clean and well tinned.
Pigtail is mandatory for nuclear work.

PREFERRED (NON-NUCLEAR)
Solder is neat and bright, sufficient to cover lead and “feathers” out on terminal post. Fillet is complete.
Component lead is clean and well tinned.

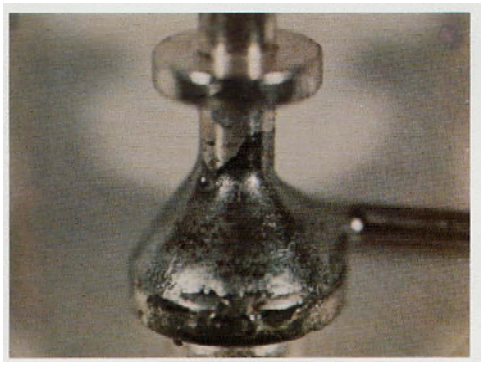
ACCEPTABLE
Minimum solder.
Solder that just covers the wire or lead over extent of the wrap. Solder shall wet the terminal and wire or lead and form a visible fillet



ACCEPTABLE
Maximum solder.
Solder shall not completely obscure the extent of the wrap. Solder shall wet the terminal and wire or lead. There shall be no spillage of solder over the sides of the terminal although a thin wetted area is acceptable.



NOT ACCEPTABLE
Insufficient solder.
Solder does not cover the wire or lead over extent of the wrap or filletin is incomplete.



NOT ACCEPTABLE
Excess solder.
A buildup of solder that completely obscures the contour of the wire or lead over extent of the wrap. Solder that overflow the confine of the connection area (not shown in photo).

2-2.5 Hook Terminal Soldering - New Work. The following general criteria shall be used in conjunction with the acceptable/not acceptable criteria. This criteria is not shown in photographs.

a. Insulation clearance. Clearance between the end of the insulation and the solder of the connection shall be as follows:
   1. Minimum clearance. The insulation shall not be embedded in the solder joint. The contour of the conductor shall not be obscured at the termination end of the insulation.
   2. Maximum clearance. Clearance shall be less than two wire diameters (including insulation) or 1/16 inch, whichever is larger, but shall not permit shorting between adjacent conductors.

b. Wire strands.
   1. Nuclear. There shall be no broken, cut, or nicked strands.
   2. Non-nuclear - preferred. There shall be no broken, cut, or nicked strands.
   3. Non-nuclear - acceptable. Nicked or broken strands that do not exceed the limits of Table 2-1.

c. Insulation. Insulation shall be clean and undamaged.

d. Wire leads. There shall be no more than three conductors for each terminal. Wires shall be wrapped directly to the terminal and not on prior wrapped wires.

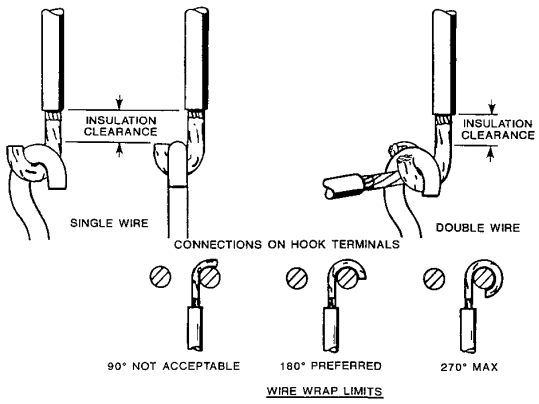
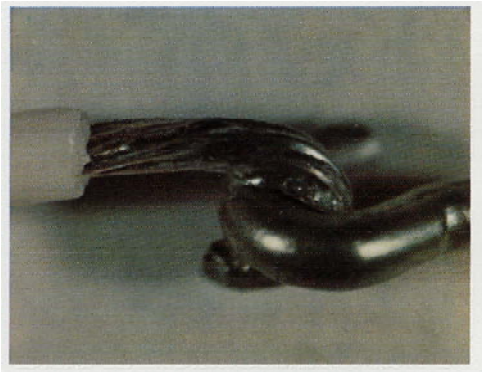


Figure 2-5. Hook Terminal - Wire Wrap Limitations

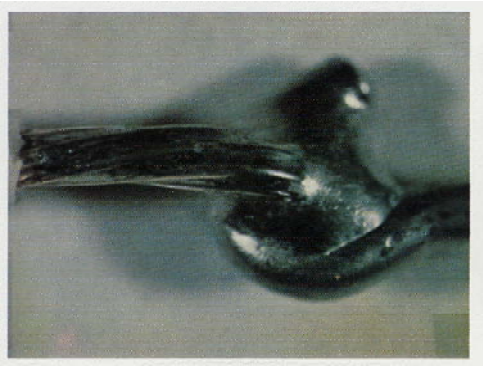
PREFERRED
Correct amount of solder used, wire is clearly defined
Solder is smooth, bright, and shiny.

ACCEPTABLE
Minimum solder.
Solder that just covers the wire or lead over the extent of the wrap. Solder shall wet the terminal wire or lead and form a visible fillet

ACCEPTABLE
Maximum solder.
Solder shall not completely obscure the extent of the wrap. Solder shall wet the terminal and wire or lead.



NOT ACCEPTABLE
Insufficient solder.
Solder does not cover the wire or lead over the extent of the wrap or filletin is incomplete.



NOT ACCEPTABLE
Excess solder.
A buildup of solder that completely obscures the contour of the wire or lead or extent of the wrap.
Solder that overflow the confine of the connection area (not shown in photos).

2-2.6 Pierced or Perforated Terminals - New Work. The following general criteria for new work shall be used in conjunction with the acceptable/not acceptable criteria. This criteria is not shown in photographs.

a. Insulation clearance. Clearance between the end of the insulation and the solder of the connection shall be as follows:

   1. Minimum clearance. The insulation shall not be embedded in the solder joint. The contour of the conductor shall not be obscured at the termination end of the insulation.

   2. Maximum clearance. Clearance shall be less than two wire diameters (including insulation) or 1/16 inch, whichever is larger, but shall not permit shorting between adjacent conductors.

b. Wire strands.

   1. Nuclear. There shall be no broken, cut, or nicked strands.

   2. Non-nuclear - preferred. There shall be no broken, cut, or nicked strands.

   3. Non-nuclear - acceptable. Nicked or broken strands that do not exceed the limits of Table 2-1.

c. Insulation. Insulation shall be clean and undamaged.

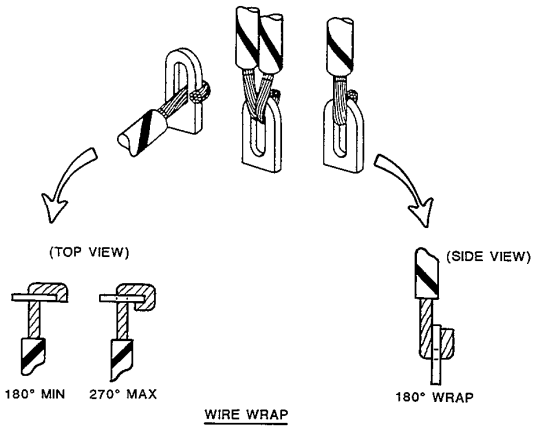
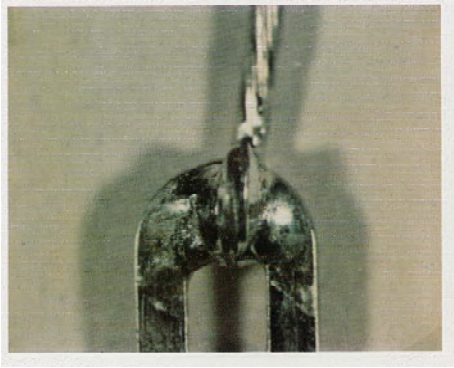
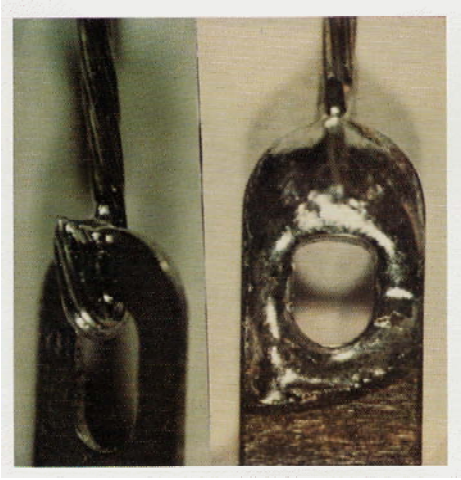


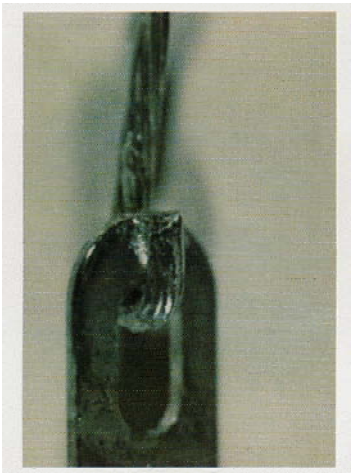
Figure 2-6. Pierced or Perforated Terminals - Wire Wrap Limits



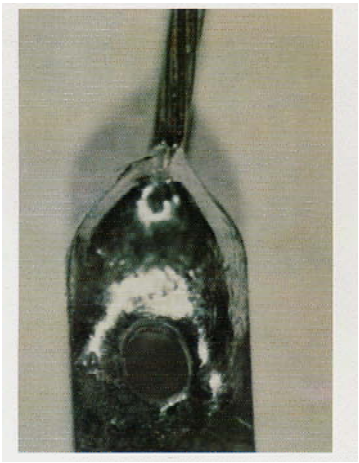
PREFERRED
Good wetting, solder "feathers" out to smooth edge.
Lead wire has good wetting to terminal.
Solder is smooth, bright, and shiny.
Wire lead is clearly outlined.



ACCEPTABLE (LEFT PHOTO)
Minimum solder.
Solder that just covers the wire or lead over the extent of the wrap. Solder shall wet the terminal wire or lead and forms a visible fillet
ACCEPTABLE (RIGHT PHOTO)
Maximum solder.
Solder shall not completely obscure the extent of the wrap. Solder shall wet the terminal and wire or lead.

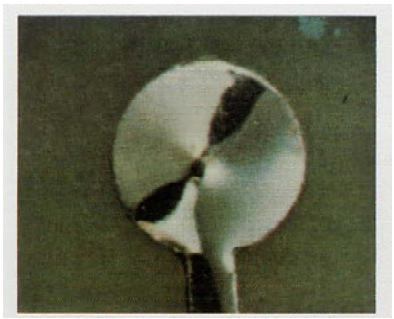


NOT ACCEPTABLE
Insufficient solder.
Solder does not cover the wire or lead over the extent of the wrap or filletin is incomplete.



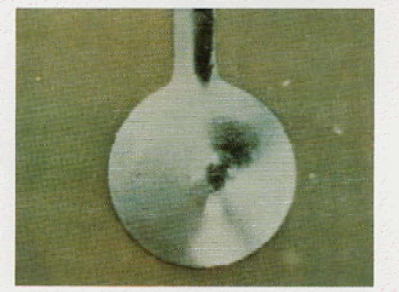
NOT ACCEPTABLE
Excess solder.
A buildup of solder that completely obscures the contour of the wire or lead or extent of the wrap.
Solder that overflow the confine of the connection area.

2-2.7 Printed Circuit Board Soldering - Straight Through Method - New Work.



PREFERRED
Solder fille around lead is 100 percent complete.
Solder has a smooth, bright metallic appearance.
No void areas or pinholes. Solder flo and wetting action is good.
Lead contour is well defined (Lead shall protrude through circuit board approximately 1/32 inch.)
ACCEPTABLE (Not Shown in Photos)
Minimum Solder - solder is minimum but still provides complete fille around lead and complete coverage of pad. No void areas or pinholes.

ACCEPTABLE
Maximum solder but lead is visible.

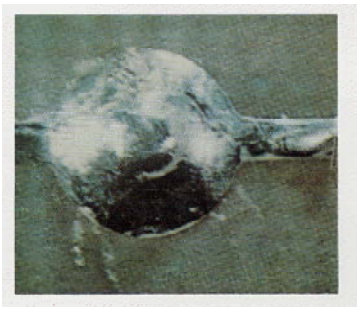


ACCEPTABLE
Small surface imperfections around periphery of circuit pad.

ACCEPTABLE
Minor surface imperfections.

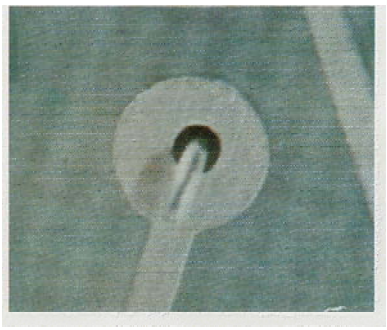
ACCEPTABLE
Component flus with board unless otherwise specifie by the design. Parts dissipating one watt or more should be mounted so that the body of the part is not in direct contact with the board.
Component centered between connection points (preferred). If component is off-center, ensure that lead bend criteria is not violated (refer to paragraph 2-2.4).
Lead wire straight from component and bent at 90–degree angle into board.

NOT ACCEPTABLE
Insufficient solder.
Incomplete fillet/voi areas.

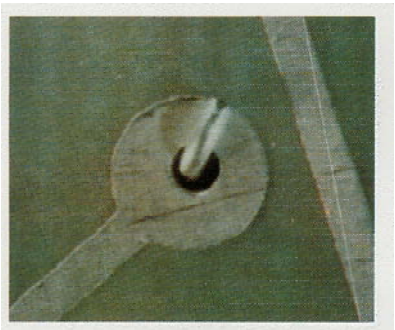


NOT ACCEPTABLE
Cold solder joint.
NOT ACCEPTABLE (Not Shown in Photos)
Excessive heat, as evidenced by conditions such as damage to plated through holes, scorched board, or flowin of epoxy binder material.

2-2.8 Printed Circuit Board Soldering - Clinched Type Method - New Work.

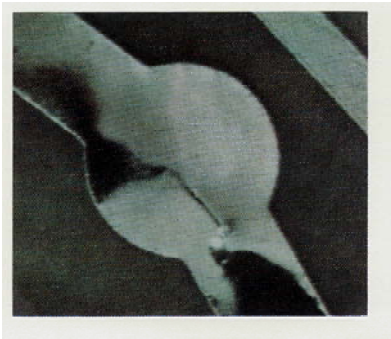


PREFERRED
Lead is clinched in line with the circuit path.
Lead is clinched flus to circuit.
Lead is approximately one radius long.

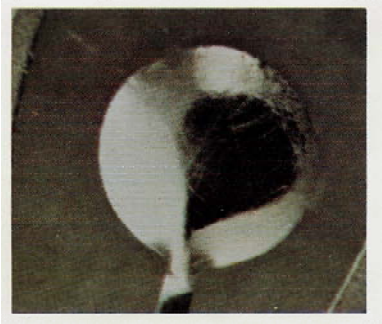


ACCEPTABLE
Lead is approximately one radius long.
Lead is clinched flus to circuit.

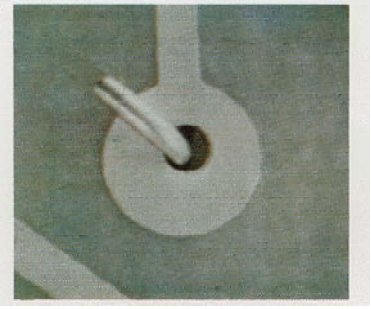
ACCEPTABLE
Lead clinched in line with circuit path.
Bent over portion of lead is not more than one pad diameter long.
Lead is clinched flus to circuit.



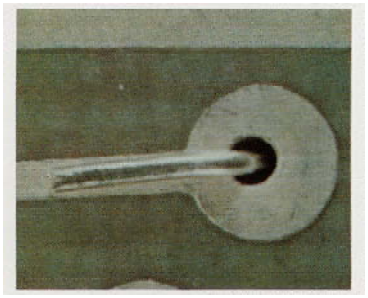
PREFERRED
No void areas or surface imperfections.
100 percent solder fille around lead.
Solder covers lead and feathers out to a thin edge on circuit path.
Solder has smooth, bright metallic appearance.
Contour of lead clearly defined
ACCEPTABLE (Not Shown in Photos)
Minimum solder - solder is minimum but still provides complete fille around lead and complete coverage of pad. No void areas or pinholes.



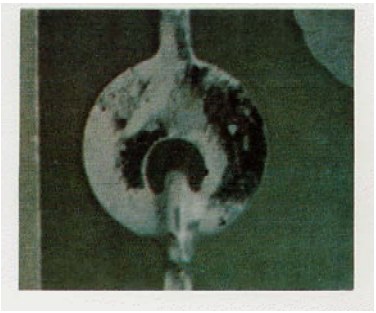
ACCEPTABLE
Maximum solder but lead is visible.



NOT ACCEPTABLE
Lead extends beyond edge of circuit pattern.



NOT ACCEPTABLE
Lead is more than one pad diameter long.



NOT ACCEPTABLE
Insufficient solder. Incomplete fillet/voi area.
NOT ACCEPTABLE (Not Shown in Photos)
Excessive heat, as evidenced by conditions such as damage to plated through holes, scorched board, or flowin of epoxy binder material.

2-3. SOLDERING - GENERAL REQUIREMENTS - OLD WORK.

Old work is not acceptable for any of following general conditions in addition to specifi conditions define in each section:

a. Nicked or broken strands that exceed the limits of Table 2-1.

b. Birdcaging (refer to paragraph 2-2.1).

c. Conditions that permit shorting between adjacent conductors or conductive material, such as:
   1. Excessive insulation clearance
   2. Damaged/burnt insulation

d. Cold solder joint (refer to paragraph 2-2.1).

e. Disturbed joint (refer to paragraph 2-2.1).

f. Contamination (refer to paragraph 2-2.1).

g. Excessive pigtail, which is define as follows:
   1. Nuclear. Any pigtail that permits shorting between adjacent conductors or conductive material.
   2. Non-nuclear - electrical. Any pigtail that permits shorting between adjacent conductors or conductive material.
   3. Non-nuclear - electronic. Any pigtail that exceeds new work criteria.

h. Excessive solder that permits shorting or grounding or that violates creepage and clearance requirements.

2-3.1 Bifurcated Terminal Soldering - Old Work. Old work shall be evaluated to the general criteria for old work and the following criteria:

ACCEPTABLE
Post slightly bent, no evidence of cracking.

NOT ACCEPTABLE
Post excessively bent.
Post cracked (not shown in photo).

NOT ACCEPTABLE
Insufficient solder. Incomplete fillet

2-3.2 Turret Post Soldering - Wire Termination and Component Termination - Old Work. Old work shall be evaluated to the general criteria for old work and the following criteria:

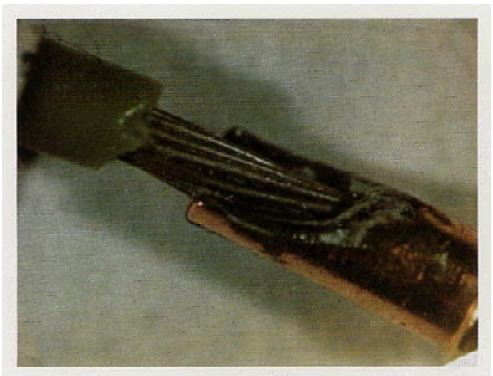
a. Criteria for unacceptability not shown in the following photographs includes:
   (1) Wire wrap less than 180-degree turn.
   (2) Cracked component lead.
   (3) Component offset from center to such a degree that component interferes with proper soldered connection to its terminal.

NOT ACCEPTABLE (WIRE TERMINATION)
Insufficient solder. Incomplete fillet

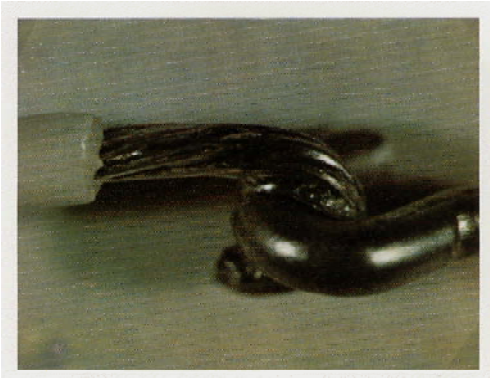
NOT ACCEPTABLE (COMPONENT TERMINATION)
Insufficient solder. Incomplete fillet

2-3.3 Connector Cup Soldering and Hook Terminal Soldering - Old Work.
Old work shall be evaluated to the general criteria for old work and the following criteria:

a. Criteria for unacceptability not shown in the following photographs includes:
   1. Conductor too big for cup application.
   2. All strands not in cup.
   3. Wire wrap that is less than 90 degrees.

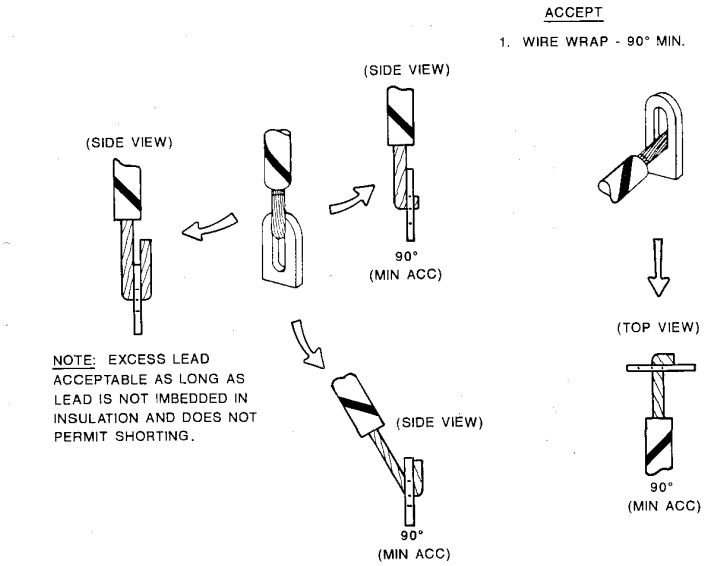


NOT ACCEPTABLE (CONNECTOR CUP)
Insufficient solder. Incomplete fillet



NOT ACCEPTABLE (HOOK TERMINAL)
Insufficient solder. Incomplete fillet

2-3.4 Pierced or Perforated Terminals - Old Work. Old work shall be evaluated to the general criteria for old work and the following criteria:



Wire wrap shown is acceptable if 90 degrees minimum.

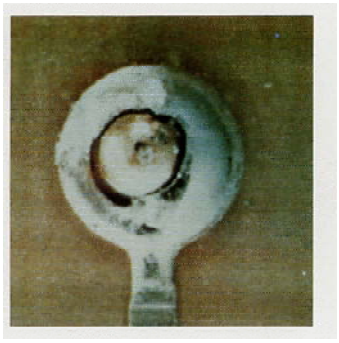
Figure 2-7. Examples of Acceptable Pierced or Perforated Terminations

NOT ACCEPTABLE
Insufficient solder. Incomplete fillet

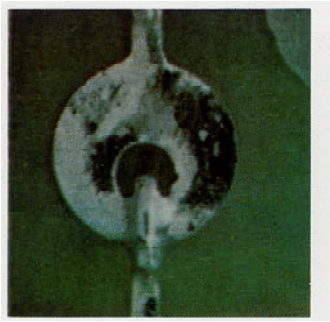
2-3.5 Printed Circuit Board Soldering - Straight Through Method and Clinched Type Method - Old Work. Old work shall be evaluated to the general criteria for old work and the following criteria:

a. Criteria for unacceptability not shown in the following photographs includes:

1. Excessive lead protrusion that may cause shorting.
2. Excessive heat, as evidenced by conditions such as damage to plated through holes, scorched board, or flowin of epoxy binder material.



NOT ACCEPTABLE
Insufficient solder. Incomplete fillet



NOT ACCEPTABLE
Insufficient solder. Incomplete fillet

CHAPTER 3

CABLE LUG TERMINAL INSTALLATION

3-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

3-2. CABLE LUG TERMINALS - GENERAL REQUIREMENTS - NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability of crimp type cable lug terminal installation for completing cable connections. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition. Cable lug terminals that are installed on new work or as replacements for cable terminations on existing work shall conform to MIL-T-16366 (solderless type), SAE-AS7928 (insulated barrel solderless type), and MIL-DTL-15659 (solder type). The use of mechanical connectors for cable terminations has been discontinued with the latest revision of MIL-T-16366 and the issuance of MIL-STD-2003. Problems experienced with mechanical connectors have resulted in the adoption of compression (crimp) type connectors as the preferred cable termination method.

To assure the compression connection for cable terminations, the crimping tool used for terminating shall have features that will prevent bad connections. Built-in inspection features for the crimping tool shall include the following:

a. One cycle (positive) mechanism that guarantees full compression before release.

b. Use of die code embossing so that a positive inspection feature provides visual indication that the correct installing die was used.

3-2.1 Uninsulated Lugs - New Work. The following inspection criteria for uninsulated lugs is PREFERRED:

a. Wire insulation butts against lug of barrel.

b. Crimp is in center of barrel. Unless specificall addressed by the lug manufacturer, lugs whose barrels have seams shall be crimped on the seam, and lugs whose barrels are seamless shall be crimped on the top.

c. Lug is proper size for conductor.

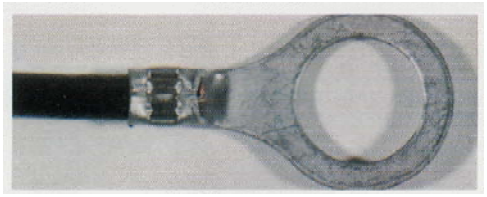
d. Conductor flus with end of barrel/butts against observation hole.

e. No broken or nicked strands.

g. Insulation is not cut or damaged.

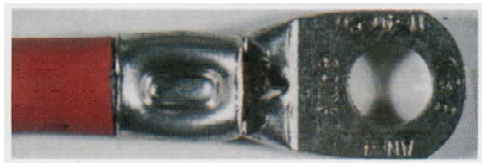
h. Flashing removed (die-press lugs).

i. Die Code No. embossed on lug (die-press lugs).

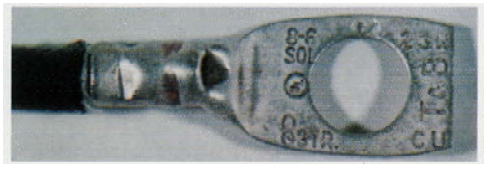


PREFERRED (CRIMP)
Tool Used: AMP 49935

PREFERRED
Tool Used: WT-110 (M)



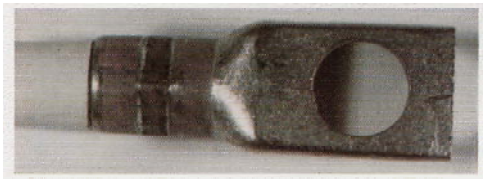
PREFERRED
Tool Used: WT-115



PREFERRED
Tool Used: TBM-2

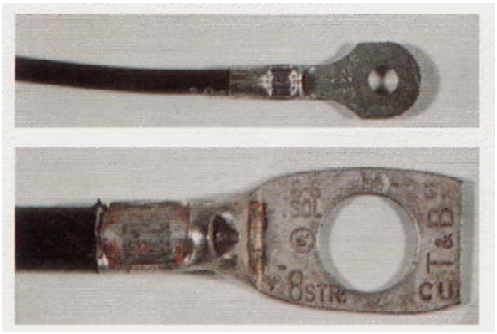
PREFERRED
Tool Used: TBM-5

PREFERRED
Tool Used: TBM-8
Tool Used: TBM-8 (Reverse Side)



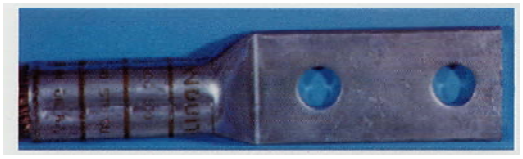
PREFERRED
Tool Used: TBM-8
Tool Used: TBM-8 (Reverse Side)

PREFERRED
Tool Used: 12 Ton Hydraulic
(Note that the embossed die code No-42-in this sample).



ACCEPTABLE
Crimp off-center but still totally on barrel.

PREFERRED
Tool used: Square D VC6-FT Wire size: 250 MCM



PREFERRED
Tool used: Square D VC6-FT Wire size: 500 MCM

PREFERRED
Tool used: Square D VC6-FT Wire size: 250 MCM

The following criteria are ACCEPTABLE for uninsulated lug installations.

a. Insulation clearance within the following limits:

1. Nuclear. Insulation is within 1/32″ of, but does not extend into barrel.
2. Non-nuclear. Insulation is within the limits of Table 3-1, but does not extend into the barrel.

Table 3-1. Maximum Insulation Clearance

Wire Size	Maximum Insulation Clearance
Below 1,400 cm	1/32 inches
1,400 - 7,500 cm	1/8 inches
Above 7,500 cm	1/4 inches

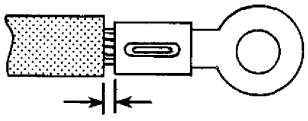


Figure 3-1. Uninsulated Lugs - Insulation Clearance

b. Nicked or broken strands:
   1. Nuclear. None.
   2. Non-nuclear. Within the limits of Table 2-1.
   3. Wires or cables carrying 600 Volts or more are allowed no broken strands.

c. Sharp edges of flashin rounded (die press lugs).

d. Conductor extends beyond end of barrel, but does not interfere with installation of fastener or other lugs (see Figure 3-2).
   1. Nuclear. The criteria is restricted to a maximum of 1/16″.

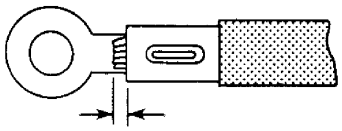
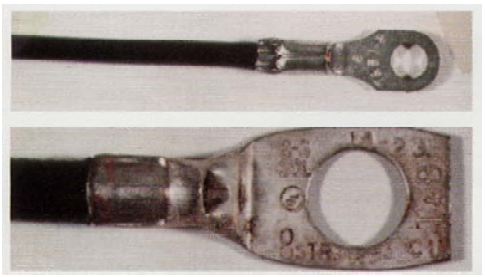
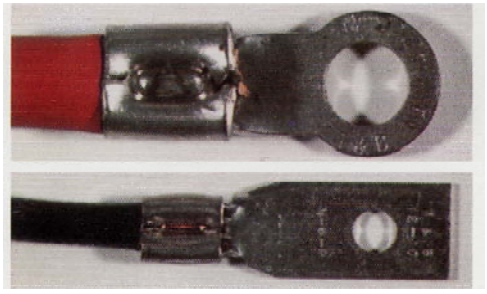


Figure 3-2. Uninsulated Lugs - Conductor Extends Beyond End of Barrel

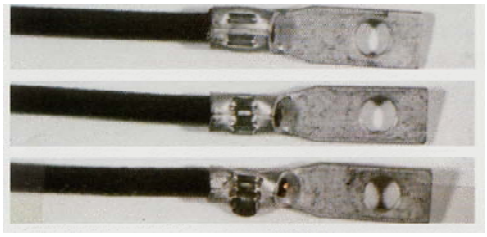


NOT ACCEPTABLE
Crimp not totally on barrel of lug.

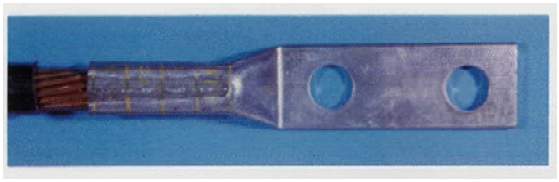


NOT ACCEPTABLE
Split in seam.

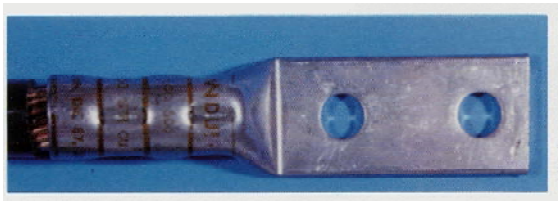
NOT ACCEPTABLE
Crimped with an insulated type crimper.



NOT ACCEPTABLE
Undercrimped - wrong setting used. (Compare with middle photo.)
(Acceptable - use for comparison purposes.)
Overcrimped - wrong setting used. (Compare with middle photo.)



NOT ACCEPTABLE
Insulation cut back too far.



NOT ACCEPTABLE
Not crimped correct number of times. (Should be crimped between each set of lines.)

3-2.2 Insulated Lugs - New Work. The following inspection criteria for insulated lugs is PREFERRED and shown in the following photos.

a. Insulation fully inserted (i.e., firml bottomed in insulation grip).

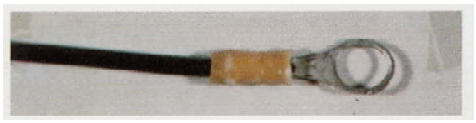
b. Lug is proper size for conductor.

c. Crimp is in proper part of barrel.

d. Conductor flus with end of barrel.

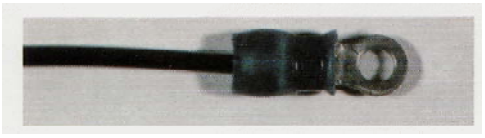
e. Insulation is not cut or damaged.

f. Insulation grip or wire insulation support is crimped. (Not applicable to WT-117 tool.)

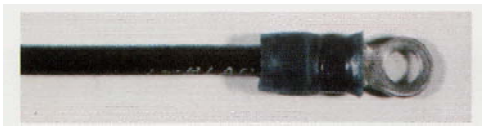


PREFERRED (CRIMP)
Tool Used: AMP 59275 (“T” Head)

PREFERRED
Tool Used: AMP 47386

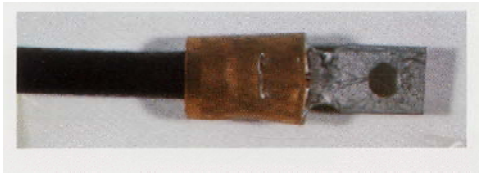


PREFERRED
Tool Used: AMP 47387

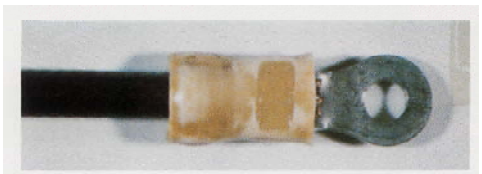


PREFERRED
Tool Used: AMP 59250 (“T” Head)

PREFERRED
Tool Used: AMP 59239-4

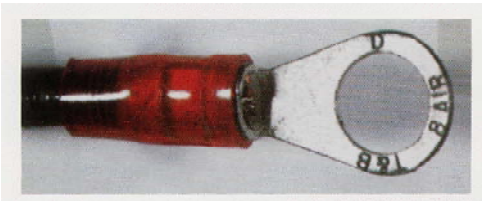


PREFERRED
Tool Used: WT-145A (Note that Clark Cable MS 25037-1A and WT-145 are the same tool with different names. Both produce the same crimp.)



PREFERRED
Tool Used: M 22520/5-01 (with-100 die).

PREFERRED
Tool Used: AMP 69061



PREFERRED
Tool Used: WT-117S

PREFERRED
Heavy duty lug (identifie by black line).
Tool Used: AMP 59239-4

ACCEPTABLE
Seam in barrel split open (separated) as a result of the crimping operation.

ACCEPTABLE (NOT SHOWN IN PHOTOS)

Conductor extends beyond end of barrel, but does not interfere with installation of fastener or other lugs. (Note that for nuclear work, the criteria is restricted to a maximum of 1/16″.

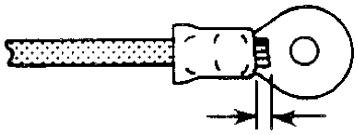


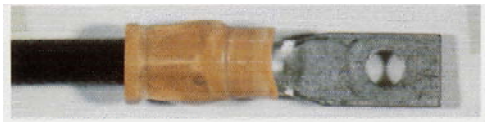
Figure 3-3. Insulated Lugs - Conductor Extends Beyond End of Barrel

NOT ACCEPTABLE
Crimped with uninsulated type crimping tool (WT-110 Tool used).

NOT ACCEPTABLE
Crimped with uninsulated type crimping tool (AMP 49935 Tool used).

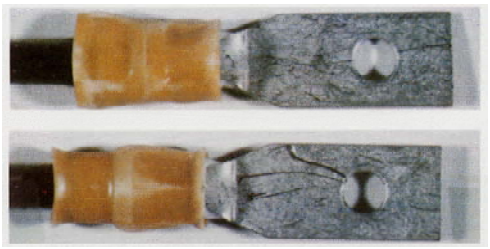
NOT ACCEPTABLE
Crimp not totally on barrel of lug (compare with photo below).

(ACCEPTABLE - Use for comparison purposes.)



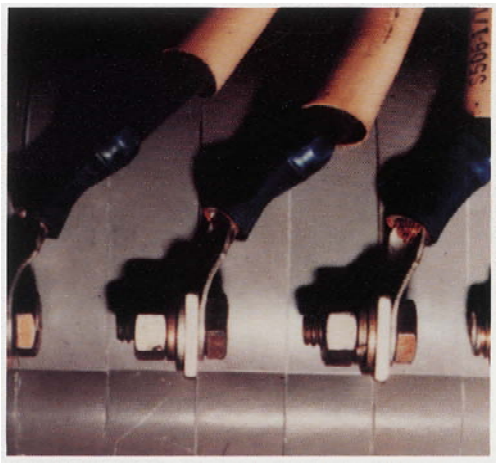
NOT ACCEPTABLE
Crimp not totally on barrel of lug. (Compare with photo below.)

(ACCEPTABLE - Use for comparison purposes).

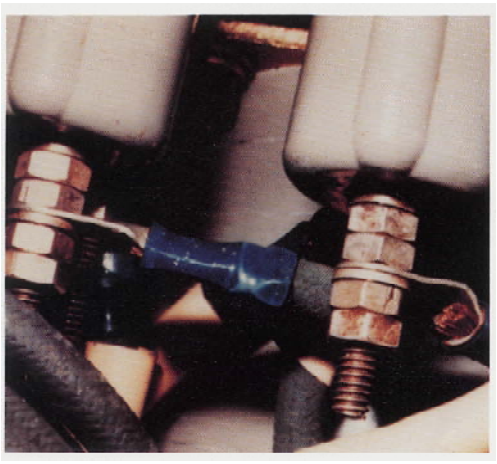


NOT ACCEPTABLE
Crimped backwards.

3-2.3 Terminal Lug Bending - New Work. This section applies only to lug sizes 1-2 (for AWG wire size 22 or larger) through 100 MCM (No. 1/0 AWG). Larger size lugs (over 100 MCM) may be bent up to 60 degrees once only unless otherwise authorized by the cognizant technical code. New work is define as when a new lug is installed on a new or existing lead.

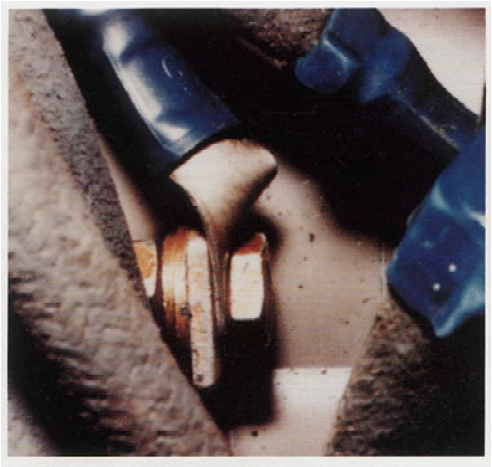


PREFERRED
Lug and lead installed so that bending of the lug is minimized. Bends are smooth and gentle. No creasing.

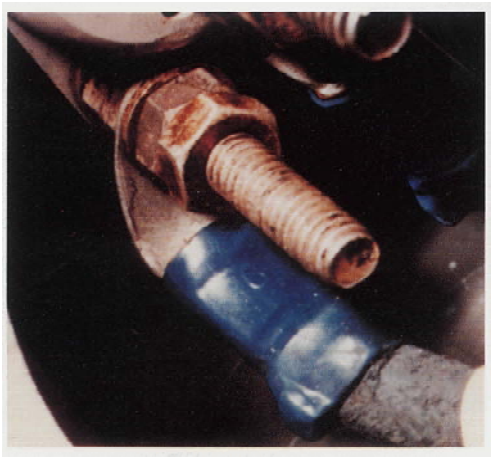


PREFERRED
Lug and lead installed so that bending of the lug is minimized. Bends are smooth and gentle. No creasing.

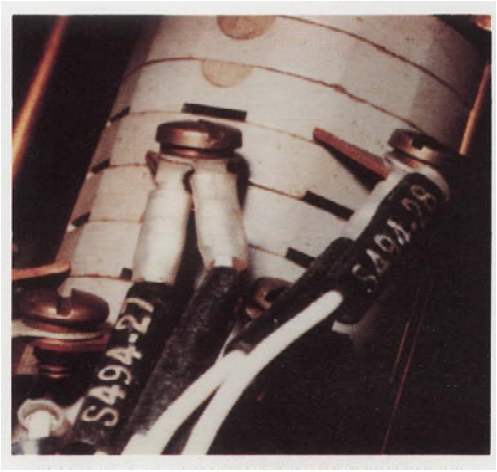
PREFERRED
Lug and lead installed so that bending of the lug is minimized. Bends are smooth and gentle. No creasing.



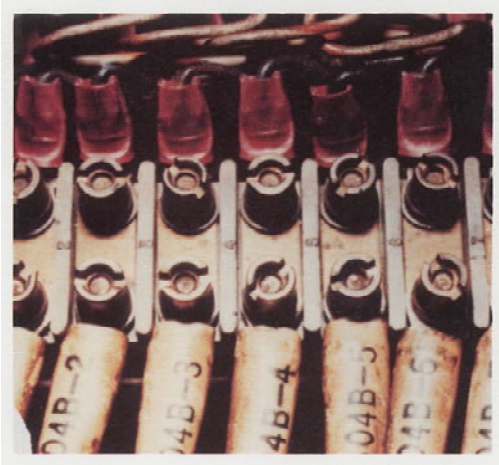
ACCEPTABLE
Lug may be bent to suit lead installation/dressing. Bending should be minimized. No lug should have multiple bends. A multiple bend is when a lug has been bent once, an attempt to straighten it out, and bent again leaving a ripple effect in the lug. Bending in more than one plane is not considered a multiple bend.



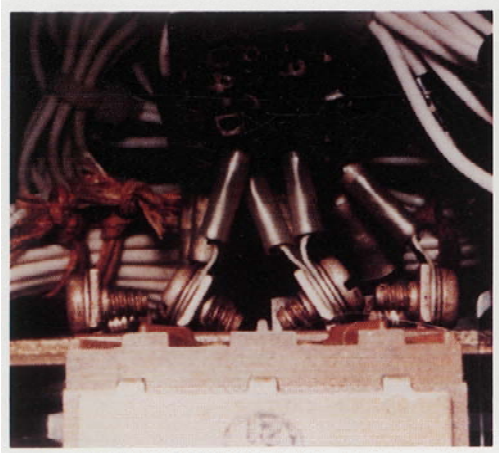
ACCEPTABLE
Lug may be bent to suit lead installation/dressing. Bending should be minimized. No lug should have multiple bends. A multiple bend is when a lug has been bent once, an attempt to straighten it out, and bent again leaving a ripple effect in the lug. Bending in more than one plane is not considered a multiple bend.
No cracks visible.



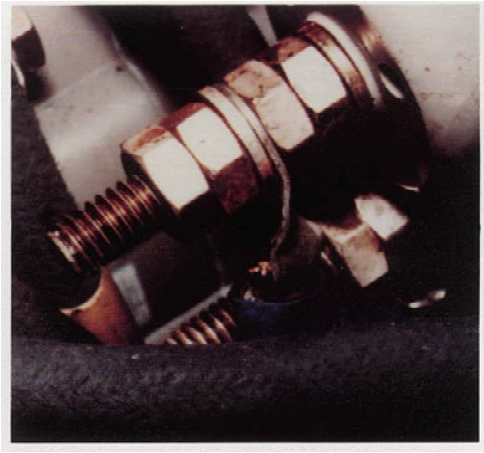
ACCEPTABLE
Lug may be bent to suit lead installation/dressing. Bending should be minimized. No lug should have multiple bends. No cracks visible.



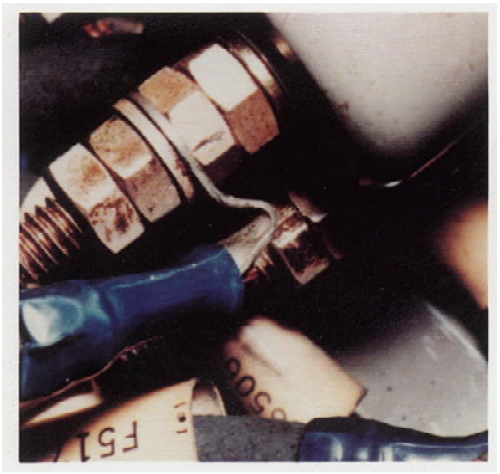
ACCEPTABLE
Lug may be bent to suit lead installation/dressing. Bending should be minimized. No lug should have multiple bends. No cracks visible.



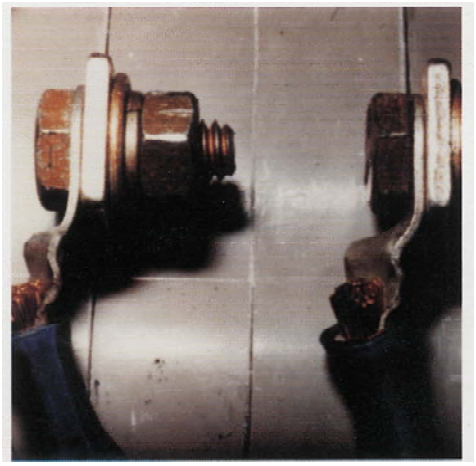
ACCEPTABLE
Lug may be bent to suit lead installation/dressing. Bending should be minimized. No lug should have multiple bends. No cracks visible.



NOT ACCEPTABLE
Multiple bends are unacceptable for new work.



NOT ACCEPTABLE
Multiple bends are unacceptable for new work.



NOT ACCEPTABLE
Multiple bends are unacceptable for new work.

NOT ACCEPTABLE
Any lugs with evidence of cracking should be replaced.

3-3. CABLE LUG TERMINALS - GENERAL REQUIREMENTS - OLD WORK.

3-3.1 Uninsulated Lugs - Old Work.
ACCEPTABLE (NOT SHOWN IN PHOTOS)

a. Insulation clearance that does not meet or exceeds new work criteria but does not permit shorting between conductors or conductive material.

b. Conductor extends beyond end of barrel, but does not interfere with installation of fastener or other lugs.

c. Broken or nicked strands within the limits of Table 2-1.

(1) Wires or cables carrying 600 V or more are allowed no broken strands.

d. Conductor less than flus with end of barrel, but still visible and extends through entire crimp.

e. Die press lugs - die code not visible on lug.

NOT ACCEPTABLE (NOT SHOWN IN PHOTOS)

a. Insulation clearance permits shorting between adjacent conductors or conductive material.

b. Conductor not visible through observation hole (not extending through entire crimp).

c. Nicked or broken strands that exceed limits of Table 2-1.

d. Improper size lug used.

e. Conductor extends under fastening device or interferes with installation of other lugs.

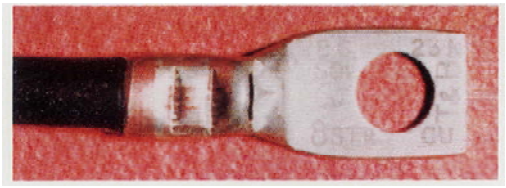
f. Wire insulation extends into barrel.

NOT ACCEPTABLE

a. Split in seam (refer to paragraph 3-2.1).

b. Crimped with insulated type crimping tool (refer to paragraph 3-2.1).

NOT ACCEPTABLE
Crimped with vice grips.



NOT ACCEPTABLE
Crimped with diagonal pliers.

3-3.2 Insulated Lugs - Old Work.
ACCEPTABLE (NOT SHOWN IN PHOTOS)

a. Conductor extends beyond end of barrel, but does not interfere with installation of fastener or other lugs.

b. Conductor less than flus with end of barrel, but still visible and extends through entire crimped portion of lug.

c. Insulation not gripped by lug on an insulation grip crimp type lug when the crimp is satisfactory and shorting to other leads or grounding is not a problem, provided that the lead is not subject to repeated flexin or strain.

NOT ACCEPTABLE (NOT SHOWN IN PHOTOS)

a. Conductor extends under fastening device or interferes with installation of other lugs.

b. Nicked or broken strands that exceed the limits of Table 2-1.

c. Conductor not extending through entire crimp.

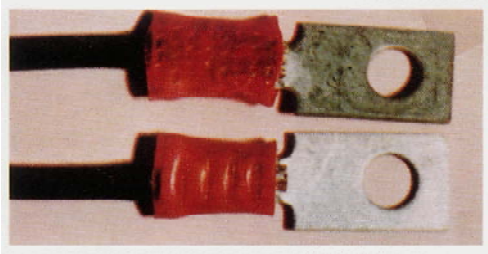
d. Improper size lug used.

e. Insulation clearance permits shorting to adjacent component or conductive material.

f. Not crimped using an insulated type crimping tool (refer to paragraph 3-2.2).

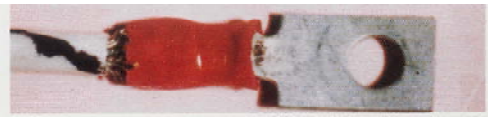
g. Crimp not totally on barrel on lug (refer to paragraph 3-2.2).

h. Crimped backwards (refer to paragraph 3-2.2).



NOT ACCEPTABLE
Lug is crimped with vice grips.
NOT ACCEPTABLE
Lug is crimped with diagonal pliers.

NOT ACCEPTABLE
Lug is soldered (for insulated lugs only).



NOT ACCEPTABLE
Conductor is too large and has been cut down.

3-3.3 Terminal Lug Bending - Old Work.

ACCEPTABLE
Lugs may be bent to suit lead installation/dressing. Bending should be minimized so long as there are no cracks.

ACCEPTABLE
Lugs may be bent to suit lead installation/dressing. Bending should be minimized so long as there are no cracks.

ACCEPTABLE (NOT SHOWN IN PHOTOS)

a. Slightly bent terminal posts, provided the terminal is not part of a mating connector and the termination can be tightened.

b. Green corrosion (oxidation) adhering to but not affecting operation of hardware (lugs wires).

NOT ACCEPTABLE (NOT SHOWN IN PHOTOS)

a. Loose, excessively bent, corroded, or broken terminal lugs.

b. Wiring connections showing signs of overheating, corrosion, or damage to the contact surface.

c. Lugs with cracks or split seams.

d. Terminal lug connections that are capable of rotating about the terminal or binding post so as to permit contact with other energized conductors or ground.

3-4. COMPRESSION CABLE LUGS (DOSSERT CONNECTOR) MAKE-UP TO CIRCUIT BREAKER/ FUSE CLIP CURRENT STUD.

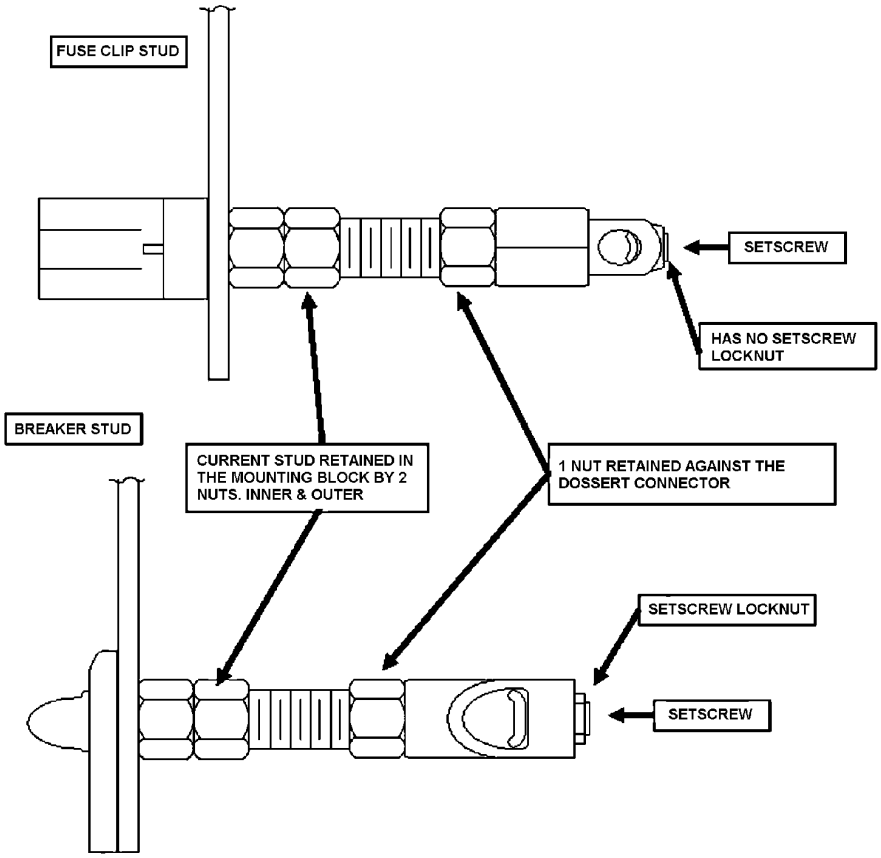
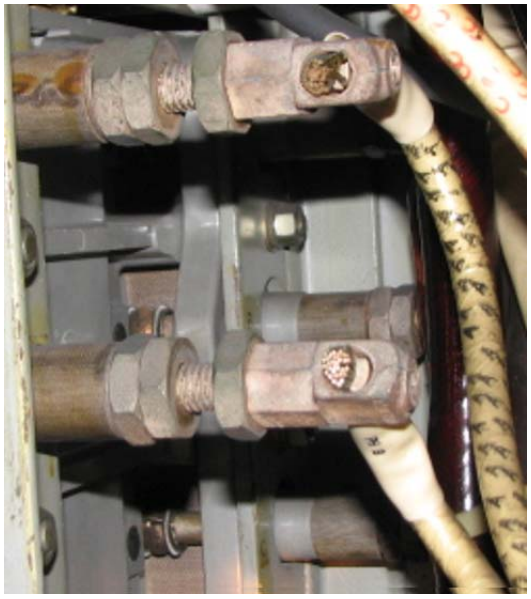


Figure 3-4. Two Possible Styles of Compression Type (DOSSERT) Cable Lug Connectors and Make-up to Circuit Breaker/Fuse Clip Current Stud



ACCEPTABLE
Current stud retained in the mounting block by two nuts, inner and outer (jam nut assembly).
Flat washers may be used as spacers where necessary. One nut retained against the Dossert connector.
Dossert setscrew has no locknut.

ACCEPTABLE (NOT SHOWN IN PHOTO)

a. Current stud may be retained in the mounting block with a washer and a single nut. Torque should be in accordance with the inner nut values of Table 3-2.

b. When current stud is retained in the mounting block by two nuts, inner and outer (jam nut assembly), torque values should be in accordance with Table 3-2.

c. Two nuts, inner and outer (jam nut assembly), may be found against the Dossert connector. Torque values should be in accordance with Table 3-2.

d. When one nut is retained against the Dossert connector, torque should be in accordance with the inner nut values of Table 3-2.

e. Followers in the Dossert connector must be of the non rotating type, where the compression plate does not rotate when it compresses the conductor.

f. Dossert setscrew locknut torque should be 6 to 8 ft-lbs (per Figure 3-4, not all Dossert connectors have set-screws).

NOT ACCEPTABLE (NOT SHOWN IN PHOTO)

a. Evidence of overheating.

b. Contact surface corrosion.

c. Loose connections.

d. Rotating compression followers in the Dossert connector.

Table 3-2. DOSSERT Connector Torque Values

Stud Size (in.)	Torque (ft-lbs)			
	Inner Nut		Outer Nut	
	Min.	Max.	Min.	Max.
3/8	7	8	8	9
1/2	15	17	17	19
3/4	25	28	28	31
1–1/8	40	44	45	49

3-5. FERRULES (THIMBLES).

The use of thimbles on power cable conductors where mechanical connections are made without lugs is prohibited for new construction. In existing non-nuclear applications, thimbles should be removed from equipment during overhaul or other extended maintenance period. For existing nuclear applications, NAVSEA 08 should be contacted prior to making any changes to electrical connections with thimbles.

Ferrules (thimbles) are connectors used to terminate stranded wires. This application is frequently used when the wires are to be inserted into a clamping device.

ACCEPTABLE
Wire strands are now one solid part available to conduct current.
Wires are protected and the ferrules eliminate the possibility of unwanted contact.
Easy wire insertion into a clamping device.

NOT ACCEPTABLE (NOT SHOWN IN PHOTOS)

a. Found to be loose.
b. Not mounted flus against the compression fitting
c. Heat damage is present on the cable.

CHAPTER 4

SLEEVING IDENTIFICATION

4-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

4-2. SLEEVING IDENTIFICATION - GENERAL REQUIREMENTS - NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability of sleeving identifica tion. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition. This chapter shows sleeving identificatio requirements for terminal ends of interconnecting ship's cables. It does not apply to terminal ends of wiring furnished with equipment (since marking requirements for that wiring will be in accordance with the applicable drawing or equipment specifica tion). However, general criteria in this chapter such as legibility and damaged sleeving could be applied to wiring furnished with equipment.

The following general criteria apply for new work:

a. When the cabling diagram/wiring table shows three designations (e.g., cable no., termination no., and wire no.), the sleeving shall be marked to show these three designations.

b. When the cabling diagram/wiring table shows two designations (e.g., cable no. and termination no.), the sleeving shall be marked to show these two designations.

c. Feeder cables may be identifie with color-coded sleeving.

d. When the notes on the cabling diagram or wiring table give specifi instructions on how to identify sleeving, those instructions shall be followed in lieu of the instructions in this chapter.

e. When space restrictions make it difficult or impossible to mark all designations on the sleeving, appropriate engineering code permission should be requested to determine the minimum marking. In these cases, the termination no. shall become the minimum designation required.

Inspection criteria: Sleeving requirements shall be as follows:

a. Lettering shall be clear and legible.

b. Lettering shall be visible under normal lighting conditions.

c. When uninsulated lugs are used, sleeving shall be installed down over the lug barrel. When insulated lugs are used, the installation of sleeving down over the lug barrel is optional.

d. Sleeving shall be intact and not cut, torn, or damaged.

e. Heat shrinkable sleeving does not have to be shrunk, provided that the fi of the sleeve on the conductor is secure enough to prevent inadvertent movement.

f. Two sleeves may be used for identificatio when all sleeving identificatio cannot fi on one sleeve.

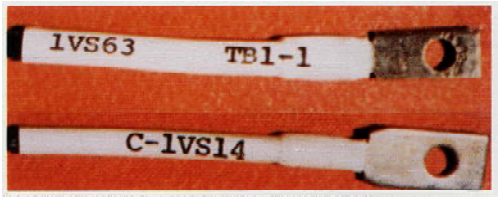
g. Inspection of identificatio sleeving should be non-intrusive; disconnecting leads to verify markers/sleeving is not required or desired.

h. The Indelible Ink Method (i.e., hand mark the sleeving with an indelible ink pen and spray with Data Coat) may be used on a case basis. Use this method only when the typewriter used to type the sleeving is not available, such as on an off shift or weekend. Do not use this method in high temperature areas (200° F and above).

i. Temporary wire markers (e.g., E-Z-Code markers) are not allowed unless covered and secured in place with a clear heat-shrink tubing properly applied.

4-2.1 IC Systems/Nuclear Systems, Motor/Controller. Distribution Panel (Load Center) - New Work.

a. Typical for IC Systems and Nuclear Systems:

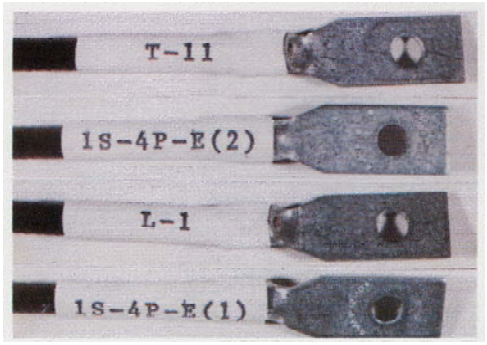


Wire no. and termination no.

Cable no. (reverse side)

b. Typical for Internal Motor/Controller Lead Connections:

1. For single speed motors, color-coded sleeving is acceptable in lieu of cable no. and termination no. (refer to paragraph 4-2.4).
2. For motor connections, ensure markings are placed on the conductor in an area where they will be visible after motor connection is assembled and taped.



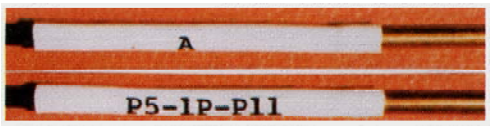
Termination no.

Cable no. (reverse side)

Termination no.

Cable no. (reverse side)

c. Typical Distribution Panel (Load Circuit):



Phase Designation

Cable no. (reverse side)

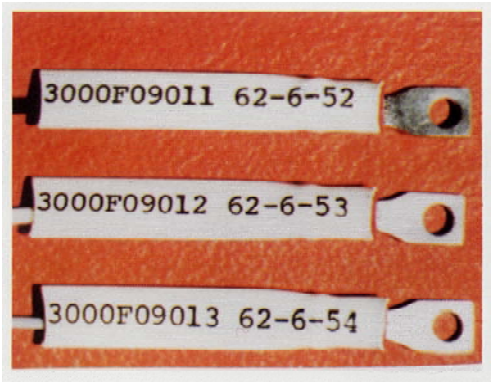
4-2.2 Torpedo Fire Control, Missile Fire Control/SINS (SSBN)/TI, Gyro/U-W LOG/DRAI/SINS (SSN), Sonar/Radar/Radio/ECM - New Work.

a. Typical for Torpedo Fire Control:

Wire no. and termination no.

Cable no. (reverse side)

b. Typical for Missile Fire Control, SINS (SSBN), and Test Inst (TI):

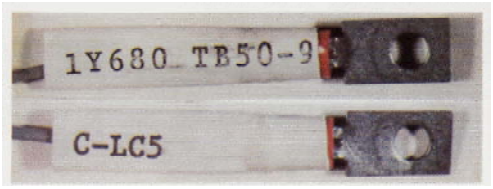


Wire no., cable no. and termination no.

(1) Cable no. (3000F09) is contained within the wire no. (3000F09011, 3000F09012, 3000F09013).
(2) Termination no. format is normally explained on the wiring table. Example (62-6-52):

6	1st digit - door assy
2	2nd digit - pnl assy
-	3rd digit - dash
6	4th digit - terminal board
-	5th digit - dash
52	last digits - connection no.

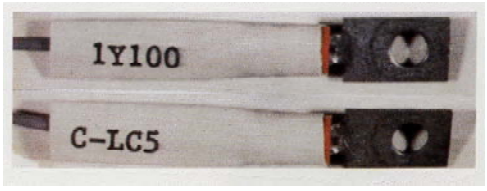
c. Typical for Gyro, U-W LOG, DRAI, and SINS(SSN):



Wire no. and termination no.

Cable no. (reverse side)

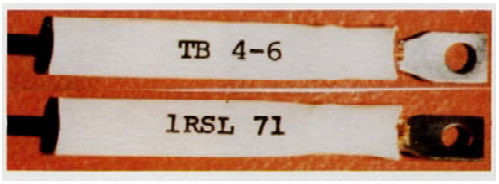
d. Example for Master Compass:



Termination no.

Cable no. (reverse side) Note that wire no. not required for master compass. (1Y100 is the terminal ID no. and not the wire no.)

e. Typical for Sonar/Radar, Radio, and ECM Systems:



Termination no.

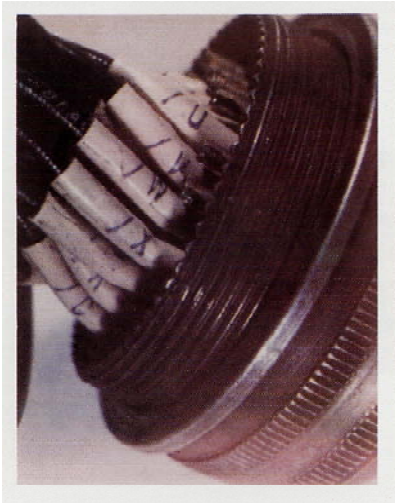
Cable no. (reverse side)

4-2.3 Leads in Cable Connectors - New Work. For leads in cable connectors, identify sleeving with the contact letter or number of the contact position to which the lead is connected.

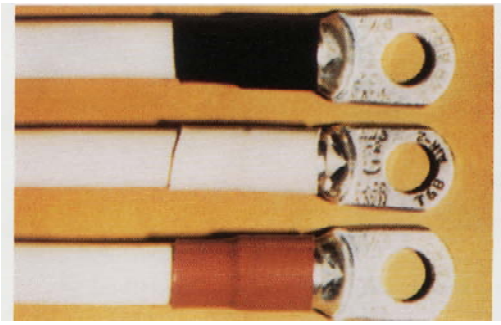
a. Identificatio sleeving is not required if conductor size and backshell size prevents installation.

b. Identificatio sleeving is not applicable to high density connectors.

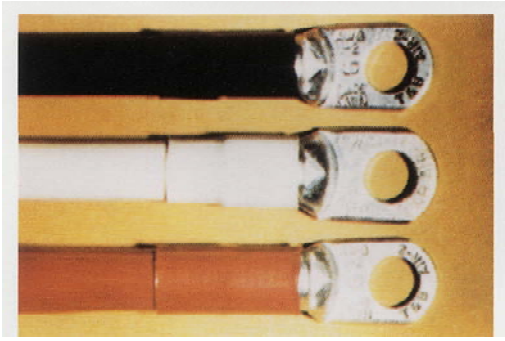
c. The slash (/) mark in the photo indicates that the letters are lower case vice capital letters.



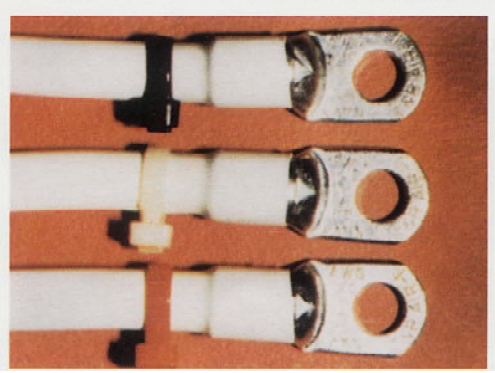
4-2.4 Feeder Cables - New Work. Feeder cables may be identifie as shown in this section or by marking phase designation and cable no. on white sleeving.



ACCEPTABLE
Typical phase markings - Feeder cables
Short lengths of color-coded sleeving over lengths of white sleeving. Short lengths of color-coded sleeving may also be installed over lengths of black sleeving (not shown in photo).



ACCEPTABLE
Typical phase markings - Feeder cables
Short lengths of color-coded sleeving over lengths of matching colored sleeving.



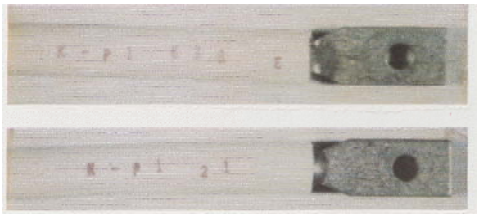
ACCEPTABLE
Typical phase markings - Feeder cables
Color-coded tie wraps over lengths of white sleeving. (100 MCM thru 800 MCM). Color-coded tie wraps may also be installed over lengths of black sleeving (not shown in photo).

NOTE

Do not use tie-wraps in high temperature areas (200° F or above).

4-2.5 High Temperature Sleeving, Split and Seized Sleeving, Spares - New Work.

a. Typical for high temperature applications (glass sleeving).



Wire no. and termination no.

Cable no. (reverse side)

NOTE

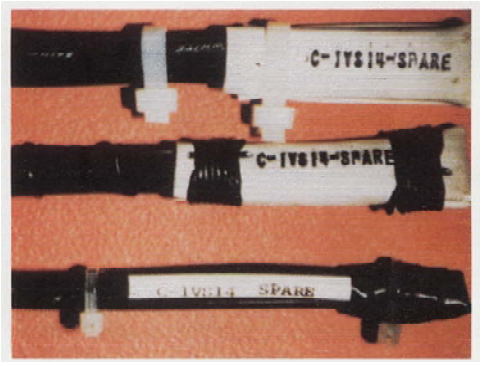
Above sample shown was marked using the hot printing method. Do not use T&B Marker WT-163M-1 (indelible ink marker) for marking silicone rubber coated fibe glass or Teflo sleeving.

b. Sleeving split and seized or tie wrapped in place: ACCEPTABLE but not preferred and used only on a case basis.

NOTE

Do not use tie-wraps in high temperature areas (200° F or above).

c. Typical bundle of spare leads with sleeving and bundle secured overall with tie wraps.

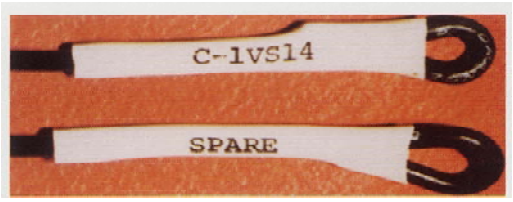


Cable no. and spare identificatio

Seizing vice tie wraps

Individual sleeve marker with plastic vinyl tape and bundle secured with tie wraps.

d. Typical for single spare leads.



Cable no.

Spare identificatio (reverse side)

4-3. SLEEVING IDENTIFICATION - GENERAL REQUIREMENTS - OLD WORK.

4-3.1 Identificatio Markings - Old Work. The following general criteria shall be used in inspecting old work:

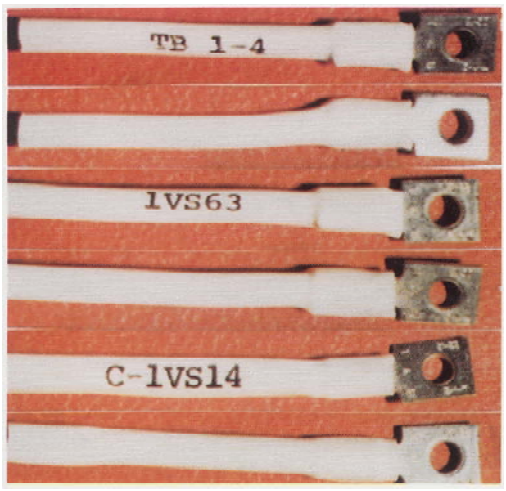
a. When uninsulated lugs are used, sleeving shall be installed down over the lug barrel. When insulated lugs are used, the installation of sleeving down over the lug barrel is optional.

b. Slight damage or discoloration is ACCEPTABLE if identificatio is not affected and sleeve is in no danger of falling off.

c. Sleeving shall be marked with at least the minimum information shown in this section.

d. Fiber tags used for identificatio are ACCEPTABLE.

e. Nuclear/non-nuclear electrical & electronic applications (except for motor/controller lead connections, distribution panel (load circuits), feeder cables, spares, lighting panels & cable connectors): The following examples are ACCEPTABLE.



Termination no. only (nuclear or non-nuclear)

Wire no. only (nuclear or non-nuclear)

Cable no. only (non-nuclear)

NOTE

For nuclear applications, termination no. or wire no. must be marked on sleeving.

ACCEPTABLE

Phase designation only.

f. Wire markers that do not meet the requirements of this inspection guide are not acceptable.

g. Damaged or obliterated wire markers/sleeving are not acceptable.

h. Disconnecting leads to verify wire marker/sleeving is not required or desired.

i. Replacement of wire markers that have information missing, provided either the wire number or lead termination point is identified is not necessary.

j. The use of black indelible ink marker covered by clear lacquer in low temperature applications is satisfactory.

k. Single wires not grouped together in a harness and not more than 12 inches in length which can be traced by hand, need not be marked for identification

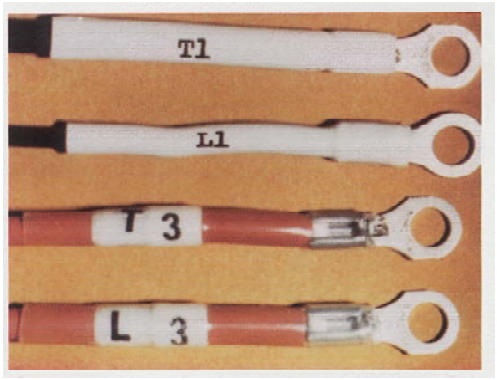
l. Discolored and/or hardened insulation sleeving that is not cracked or burnt is acceptable provided the sleeving is not installed in an area where bending and flexibilit are required.

NOTE

Color-coded sleeving is ACCEPTABLE in lieu of phase designation.

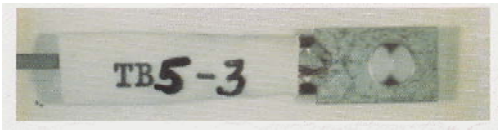
4-3.2 Identificatio Markings - Illegible Markings - Old Work.

a. Feeder cables and internal motor/controller lead connections.



ACCEPTABLE
Termination no. only.

ACCEPTABLE
Termination no. only (transparent shrinkable sleeving over easy markers - non-nuclear only).



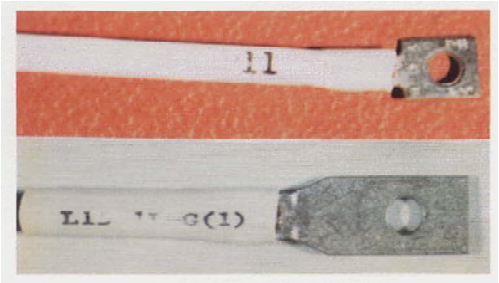
ACCEPTABLE
Missing/illegible letters/nos. restored with indelible ink and sprayed with Data Coat (non-high temperature areas only).

ACCEPTABLE (NOT SHOWN IN PHOTOS)

NOTE

For single speed motors, color-coded sleeving is ACCEPTABLE in lieu of termination number.

a. Leads in cable connectors - no identificatio sleeving required.
b. Nuclear old work same as paragraph 4-2.5. Non-nuclear old work same as paragraph 4-2.5 except unmarked sleeving is acceptable.



NOT ACCEPTABLE
Unable to distinguish without question what the letters or numbers are through normal vision (both samples).

CHAPTER 5

LOCKING DEVICES

5-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

5-2. LOCKING DEVICES - GENERAL REQUIREMENTS - NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability of locking devices. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition.

General requirements for locking devices include:

a. Locking devices on electrical connections and electrical installations on submarines shall be installed in accordance with the method for locking devices on electrical connections and installations on submarines of MIL-STD-2003-2.

b. Lockwiring techniques for electrical connectors shall be installed in accordance with the connector lockwiring techniques of MIL-STD-2003-5.

c. Per requirements of the method for locking devices on electrical connections and installations on submarines of MIL-STD-2003-2:

   1. Unless otherwise specifie in the individual equipment specification locking devices shall be provided on electrical connections in all equipment. All nuts, bolts, studs, and screws used for electrical connections shall be secured by means of a locking device in accordance with acceptable locking devices such as nut and locknut, self-locking nut, external tooth lockwashers, internal tooth lockwashers, and split-ring lockwashers (per requirements of MIL-STD-2003-2, Figure 2A20). An exception is allowed when the locking device need not be provided where lug terminals are used for conductors smaller than 14 AWG (4,000 circular mils) (per MIL-E-917 requirements).
   2. Barrel-type nuts and/or screws shall be engaged a minimum of 2-1/2 threads, where used on terminal boards, switches, etc. When the correct lug is used with specifie terminal board, lockwashers or other locking devices are not required. The close fi of the terminal within the terminal board barrier precludes

turning and loosening of the connection.

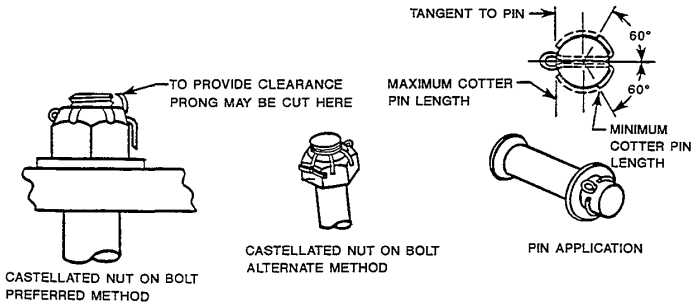


Figure 5-1. Typical Cotter Pin Installations

5-2.1 Lockwire - Two Bolts and Three Bolts - New Work. The following define the PREFERRED installation criteria for lockwire installations:

a. Less than 6 inches between parts lockwired.

b. No sharp edges on lockwire holes or corners of fasteners.

c. Wire started in right direction to prevent bolt from loosening. Lockwire shall tighten as the fastener loosens.

d. Wire must be tight enough so wire will not come up over head of fastener.

e. Lockwire shall have about the following number of turns per inch and be in contact with each other throughout the entire twisted length: (Note that two twists equal one turn.)

   1. 0.032″ Wire - 3 turns per inch.
   2. 0.062″ Wire - 1-1/2 turns per inch.

f. Wire tight enough to maintain position: about 1/8″ slack for the firs 3 inches plus about 1/16″ for each additional inch. Wire shall be tight but not overstressed.

g. End finishe as follows and bent in against bolt for safety.

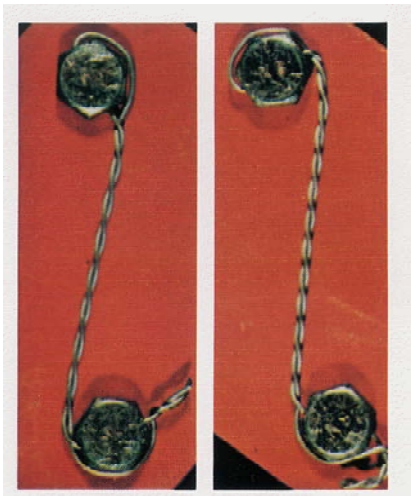
   1. Nuclear. about 1-1/2 turns minimum.
   2. Non-nuclear. 1-1/2 to 2-1/2 turns (1/4″ - 1/2″).

h. No damage to lockwire such as nicks, scratches, or tool marks that exceed 1/4 of the wire strand thickness. No kinks shall be permitted.

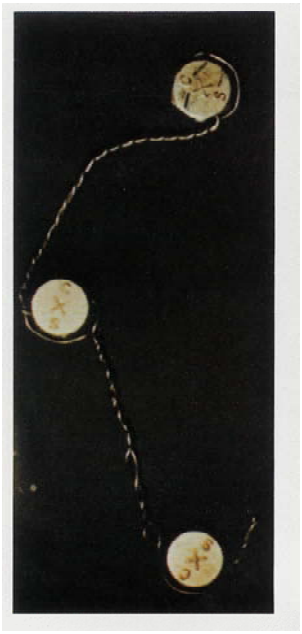
PREFERRED
Fasteners lockwired in pairs.
Lockwire twisted in proper direction, right hand twist for right hand threaded bolt, with left hand twist for finish

PREFERRED
For an odd number of fasteners, a group of three may be wired together.
Lockwire twisted in proper direction, right hand twist for right hand threaded bolt, with left hand twist to third bolt and left hand twist for finish

NOT ACCEPTABLE
LEFT PHOTO - Lockwire started in wrong direction. Does not prevent bolt from loosening.
RIGHT PHOTO - Lockwire twisted wrong (left hand twist for right hand threaded bolt). Top also installed in a loosening direction.



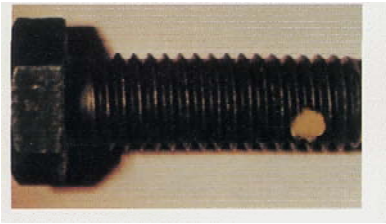
NOT ACCEPTABLE
LEFT PHOTO - End does not finis with minimum of 1-1/2 turns. End not bent in against bolt for safety.
RIGHT PHOTO - End twisted in wrong direction (i.e., twisted with a right hand twist vice the required left hand twist).



NOT ACCEPTABLE
Lockwire is too loose. Slack exceeds the allowable criteria of less than 1/8″ slack for the firs 3 inches plus 3/64″ max for each additional inch.
Wires do not meet minimum 3 turns per inch (0.032″ wire) and are not in contact with each other throughout entire twisted length.
End not bent against bolt for safety.

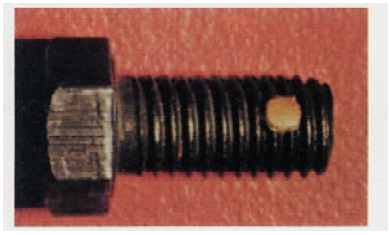
5-2.2 Nyloc Bolt - New Work.

PREFERRED
Minimum of 6 dots approximately 0.032 inches diameter, raised or depressed approximately 0.010 inches, top location preferred. Side location is acceptable.



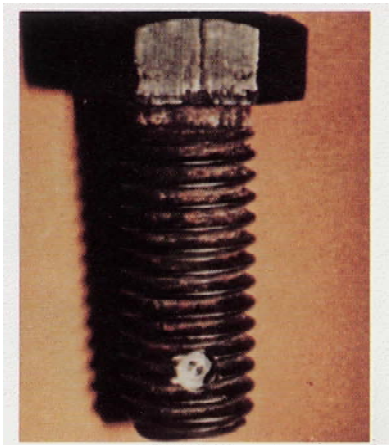
PREFERRED
New NYLOC.

PREFERRED
Minimum of 6 dots approximately 0.032 inches diameter, raised or depressed approximately 0.010 inches, top location preferred. Side location is acceptable.

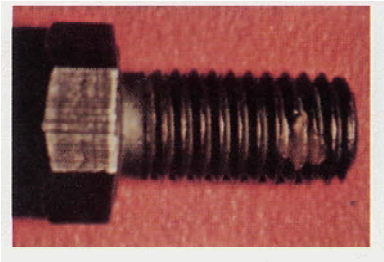


PREFERRED
New NYLOC.

NOT ACCEPTABLE
No dots on head for identification



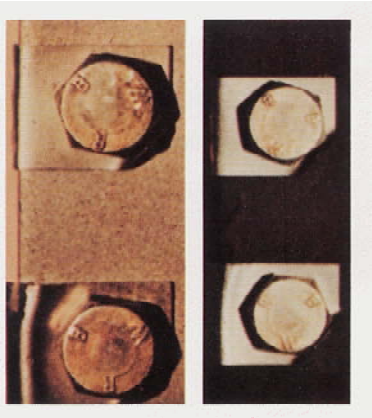
NOT ACCEPTABLE
NYLOC missing.



NOT ACCEPTABLE
Reused NYLOC is not acceptable.

5-2.3 Lock Tabs - New Work.

ACCEPTABLE
One corner of tab turned up tight against fla of bolt head; end of tab turned down fir against base. No cracks or tears at bend radii.
ACCEPTABLE
Two corners of tab turned up against flat of bolt head with at least one tight; end of tab turned down fir against base. No crack or tears at bend radii.
ACCEPTABLE
One corner of tab turned up tight against fla of bolt head; end corner of tab turned down fir against base to prevent counter-clockwise loosening of right hand bolt. No cracks or tears at bend radii.



NOT ACCEPTABLE
Corner of tab not turned up tight against fla of head.
NOT ACCEPTABLE
End of tab not turned down fir against base.

5-2.4 Lockwiring Angle Connectors - 45° and 90° - New Work.

PREFERRED

Lockwired so that lockwire is put in tension if coupling collar loosens.

Lockwire twisted 6-8 turns per inch (0.020″ wire).

Wired from adapter coupling ring to tab on backshell.

Wire shall be tight but not over-stressed.

Wire termination bent to remove sharp edges. Pigtail of 1/4″ to 1/2″ (3-6 twists). Bent back or under to prevent it from becoming a snag.

Right hand twist or left hand twist.

ACCEPTABLE

When the backshell does not have a hole provided and there is no other provision for maintaining backshell/connector orientation, use a CRES hose clamp to secure the lockwire.

Note that lockwire may either be secured by installing the lockwire through one of the slots (as shown) or around width of hose clamp band.

ACCEPTABLE
Lockwired with visible slack. There shall be less than 1/8″ slack for the firs three inches plus a maximum of 3/64″ for each additional inch.

NOT ACCEPTABLE
Lockwired wrong direction, does not prevent locking ring from turning.

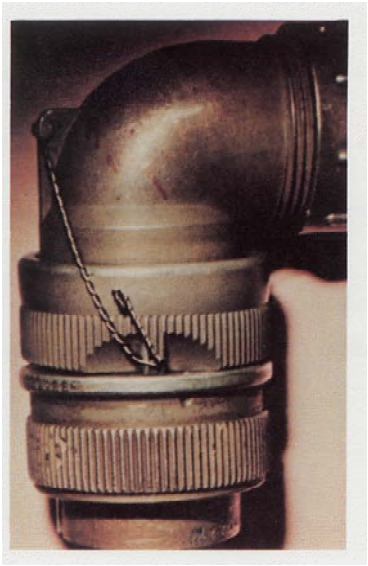
5-3. LOCKING DEVICES - GENERAL REQUIREMENTS - OLD WORK.

The following general criteria applies to inspection of old work:

a. Lockwiring: ACCEPTABLE provided it meets the following requirements:
   1. The lockwire is tight, unbroken, and installed such that the lockwire tightens as the fastener loosens.
   2. Visual inspection shows no nicks or scratches that exceed 1/4 of the lockwire strand thickness.
   3. The ends of the lockwire are twisted and no indication of unravelling exists.

b. Lock tabs:
   1. Detailed inspection of existing locktabs not required.
   2. Existing locktabs are ACCEPTABLE if the tabs are positioned to prevent rotation in the loosening position.

5-3.1 Locking Devices - Old Work.



ACCEPTABLE
Lockwired from tab on backshell to adapter coupling ring, instead of adapter coupling ring to tab backshell, but will prevent locking ring from turning.

ACCEPTABLE
Twisted too tight but no evidence of fatigue.

5-4. THREAD PROTRUSION.

Acceptable thread engagement of nuts must result in a minimum bolt protrusion of 1 thread. Bolt protrusion in excess of 1 thread is acceptable provided that electrical clearance and creepage distances are met. If during inspection the end of the bolt is found to be flus with the top surface of the nut, this condition does not need to be corrected until the bolt/nut fastener is disassembled for other maintenance.

ACCEPTABLE
Min. thread protrusion.

ACCEPTABLE for existing work
NOT ACCEPTABLE for new work
Flush.

NOT ACCEPTABLE
Less than flush

CHAPTER 6

LACING, SEIZING AND DRESSING OF CONDUCTORS

6-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

6-2. LACING, SEIZING, AND DRESSING - GENERAL REQUIREMENTS - NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability for the lacing, seizing, and dressing of conductors. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition.

General requirements for lacing, seizing, and dressing of electrical conductors include the following:

a. Cable straps shall be installed in accordance with the procedures for strapping and supporting wire bundles in electrical equipment of MIL-STD-2003-1.

b. Spiral wrap, when used in lieu of cable straps or lacing, shall be installed in accordance with the procedures for lacing and wrapping wire bundles in electrical and electronic equipment of MIL-STD-2003-1.

c. Lacing of wire bundles shall be in accordance with the procedures for lacing and wrapping wire bundles in electrical and electronic equipment of MIL-STD-2003-1.

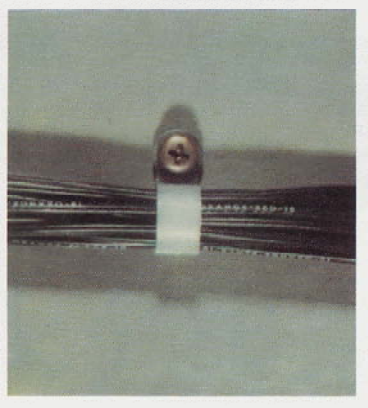
d. The use of zip tubing in nuclear applications has been discontinued per NAVSEA 0989-031-4000. Zip tubing (refer to paragraph 6-2.3) will still be allowed on certain availabilities. In lieu of zip tubing, Expando Grade FR sleeving or spiral wrap should be used for nuclear installations. Expando Grade FR sleeving and spiral wrap shall be installed per paragraph G/I 2 of NAVSEA 0989-031-4000. A nuclear spiral wrap sample is shown in paragraph 6-2.5.

6-2.1 Cable Clamps - New Work.

NOTE

Do not use nylon clamps where temperature exceeds 185° F.

ACCEPTABLE
Preformed metal clamp over channel rubber.

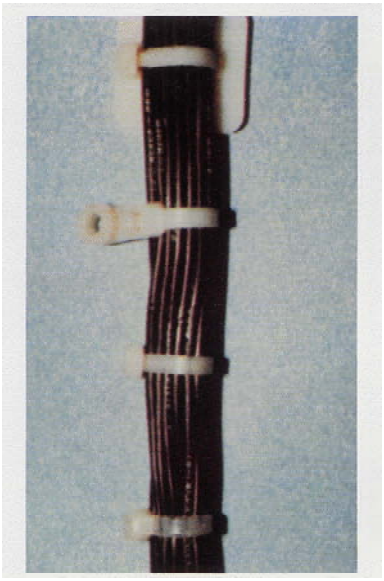


ACCEPTABLE
Wire bundle secured by nylon clamp.

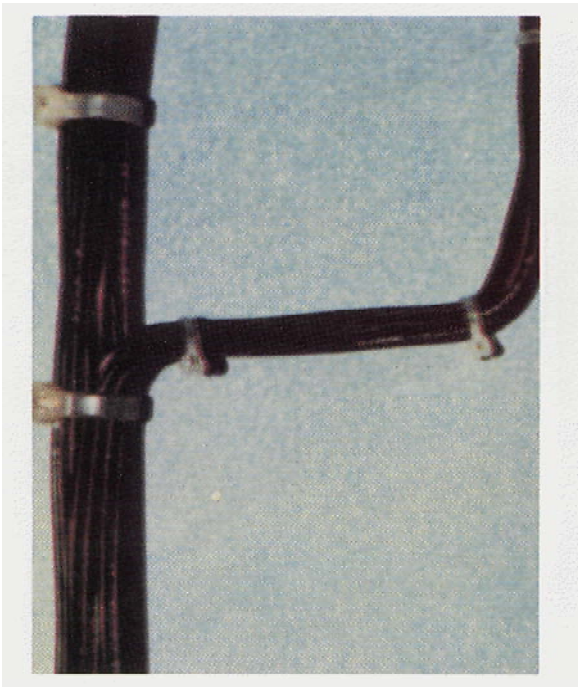
6-2.2 Cable Straps/Tie Wraps - New Work.

NOTE

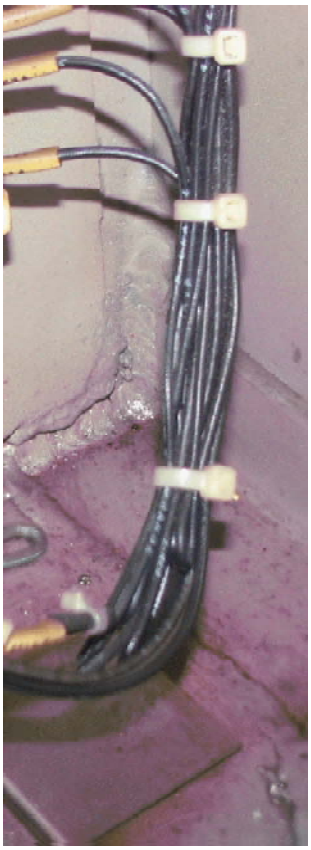
Do not use tie wraps where temperature exceeds 185° F.



ACCEPTABLE
Tie-wrap - with support base.
Tie-wrap - support type.
The spacing between support type tie-wraps shall not exceed 10 inches.
Tie-wrap - with plastic tab.
Tie-wrap - with internal metal tab.



ACCEPTABLE
Spacing between tie wraps shall be as required to suit installation, but shall not exceed 2-1/2 times the diameter of the wire bundle or 2 inches, whichever is greater.
Tie-wraps tight but not enough to damage conductor insulation.



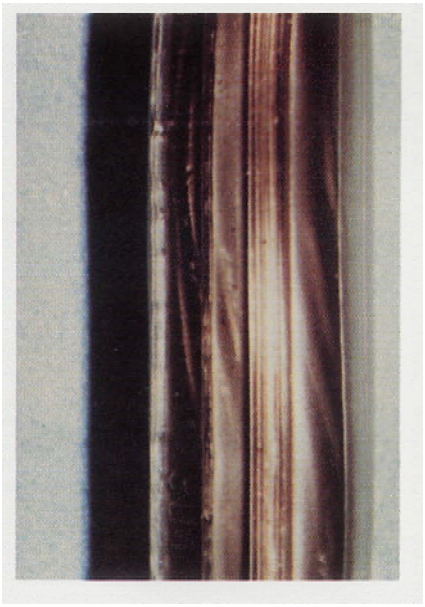
NOT ACCEPTABLE
Individual wires or wire bundles that are not laced, strapped, supported, shielded, or clamped to prevent chafin due to vibration are not acceptable.

ACCEPTABLE
Wiring harnesses shall be laced and routed to prevent potential interference with component or panel support members as panel doors are moved through their normal ranges.

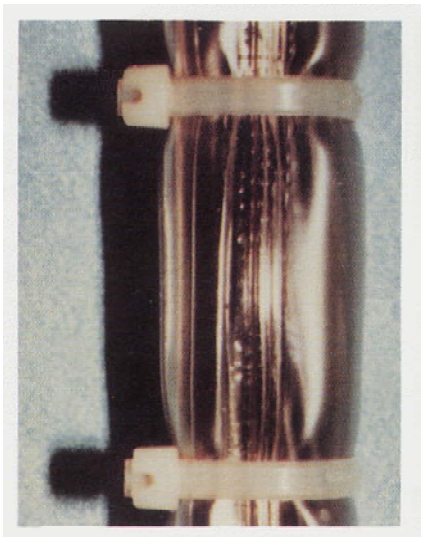
6-2.3 Zip Tubing - New Work.

NOTE

Do not use zip tubing in nuclear areas. Use spiral wrap (as shown in paragraph 6-2.5) or Expando Grade FR sleeving. Existing installations of **zip tubing need not be replaced. If existing installations are damaged but repairable, these may be repaired vice being replaced.**

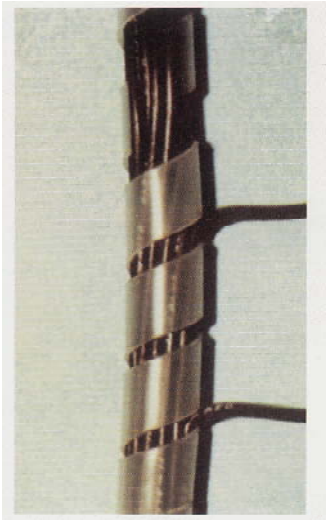


ACCEPTABLE
Zip tubing - tubing zipped closed entire length for flexin in drawers or doors.
Tie wraps on ends of zip tubing to prevent opening is acceptable.
Zip tubing may be opened within 1/2 inch from ends in a non-chafin area.

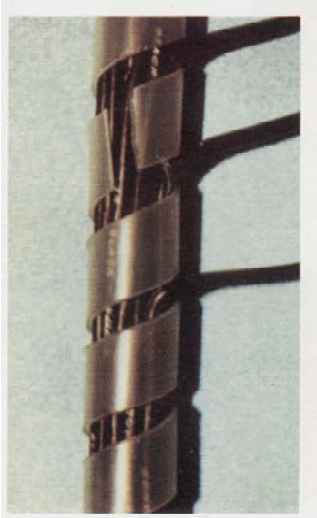


NOT ACCEPTABLE
Zip tubing not zipped closed.
Tie-wraps restrict flexibilit of zip tubing.

6-2.4 Spiral Wrap - Non-Nuclear - New Work. Spiral wrap may be used in lieu of tie wraps or lacing, but not for use in flexin applications.



ACCEPTABLE
Spiral wrap tight on conductors.
Start of spiral wrap hooked into bundle curling around inner conductors.
Finish of spiral wrap hooked into bundle curling around inner conductors.



NOT ACCEPTABLE
Spiral wrap excessively loose and permits moving of wrap.
Start of spiral wrap not hooked into bundle.
Finish of spiral wrap not hooked into bundle.

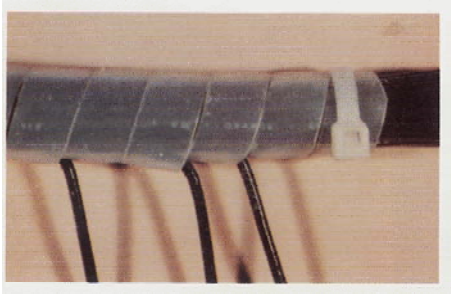
6-2.5 Spiral Wrap - Nuclear - New Work. For new installations in nuclear areas, spiral wrap shall be installed per the following requirements. Spiral wrap or Expando Grade FR sleeving shall be used in lieu of zip tubing.

a. Edges of spiral wrap are butted against each other so that the cable is completely covered.

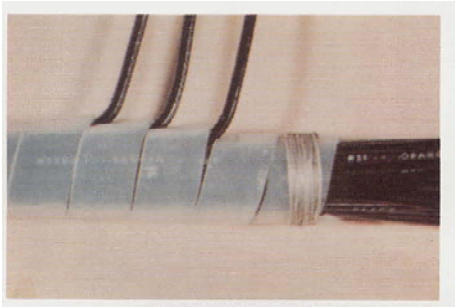
b. No sharp edges on spiral wrap.

c. Both ends shall be secured with nylon tie straps (tie wraps), lacing cord or tape. Lacing cord and tape: For temperatures up to 105° C, lacing cord or tape shall be unwaxed nylon, type P, in accordance with MIL-DTL-713; glass fibe (resin coated), type SR-4.5, in accordance with MIL-I-3158; or nylon, type I or V, with fin ishes A, C, or E, in accordance with A-A-52084. For temperatures up to 130 °C, lacing cord shall be neoprene treated glass (form 2) in accordance with MIL-Y-1140. For temperatures up to 200° C, lacing cord to tape shall be silicone treated glass cord or sleeving, of glass or polyamide tape, types IV or V with finishe D or F, in accordance with A-A-52083.

d. For the cable length protected by the spiral wrap, the cable bundle does not protrude beyond the outside diameter of the spiral wrap.



ACCEPTABLE (Nuclear)
Sample with end secured with tie-wrap.



ACCEPTABLE (Nuclear)
Sample with end secured with lacing cord.

6.3 LACING, SEIZING, AND DRESSING - GENERAL REQUIREMENTS - OLD WORK.

The following criteria should be used in inspecting old work:

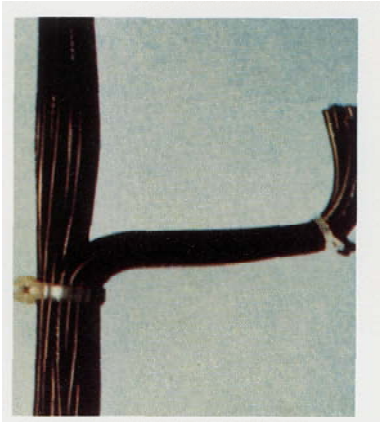
a. Lacing. ACCEPTABLE if lacing is intact and tight on trunk.

b. Zip tubing. Same as new work (refer to paragraph 6-2.3).

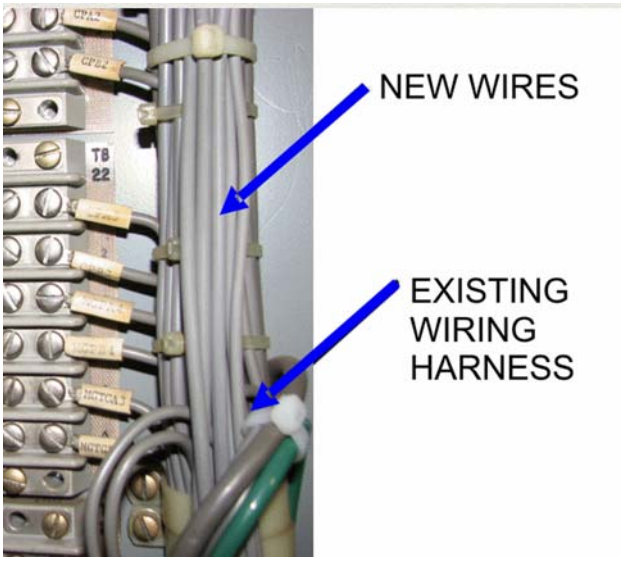
c. Spiral wrap (non-nuclear). Same as new work (refer to paragraph 6-2.4).

d. Spiral wrap (nuclear). Same as new work (refer to paragraph 6-2.5).

e. Metal clamp. ACCEPTABLE if wire insulation is not damaged or chafed.



ACCEPTABLE
Tie-wrap spacing that exceeds new work criteria as long as wires are no more than slightly splayed.



ACCEPTABLE
Lacing of several wires to an existing wiring harness or bundle, unless harness operation is impaired or the wires exhibit insulation damage due to interference fit is acceptable.

6-4. WIRING HARNESSES.

The following criteria should be used in inspecting old work:

a. Wiring harnesses that are not properly laced and routed to prevent potential interference with components or panel support members as panel doors are moved through their normal ranges are not acceptable.

b. Lacing of several wires to an existing wiring harness or bundle, unless harness operation is impaired or the wires exhibit insulation damage due to interference fi is acceptable.

c. Individual wires or wire bundles that are not laced, strapped, supported, shielded, or clamped to prevent chafing due to vibration are not acceptable.

d. Extra holes can be added but not used for wiring harness are acceptable. Existing holes in panel are acceptable as long as they are under the cover and pose no spray tight problem. Do not fi these unless there is a spray tight issue. There are Panel Fastener Improvement Mod's made on DC switchboards. Do not plug weld the existing holes also additional holes can be added for the new thumb screws.

CHAPTER 7

CLEANLINESS AND CORROSION

7-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

7-2. CLEANLINESS AND CORROSION - GENERAL REQUIREMENTS.

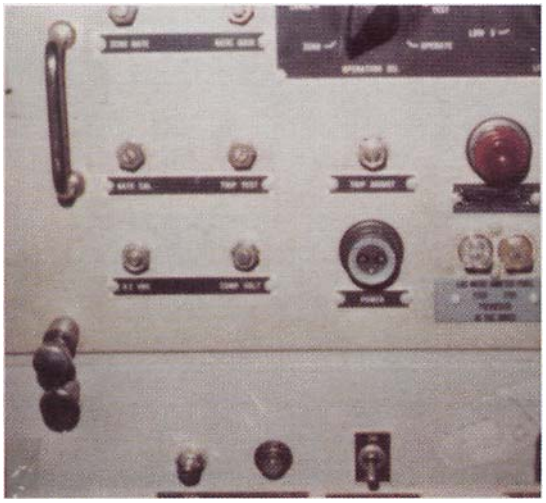
This chapter provides guidelines for evaluating the acceptability and unacceptability of cleanliness and corrosion conditions for electrical equipment. This chapter covers both internal and external cleanliness and corrosion requirements, and applies to both nuclear and non-nuclear work. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition.

7-3. CLEANLINESS - GENERAL REQUIREMENTS.

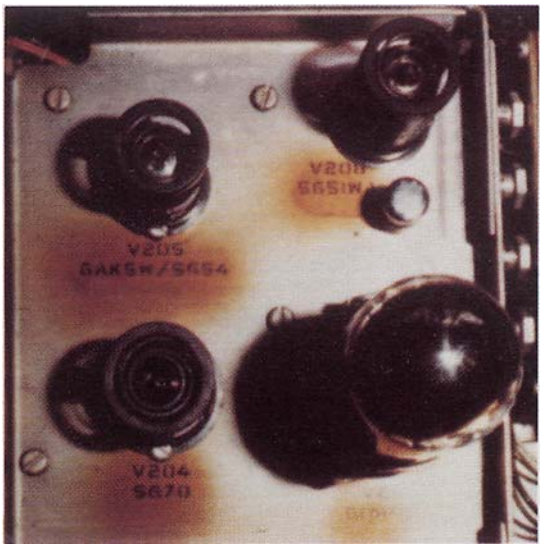
In general, components shall be free of foreign material such as rags, paper, grease, oil, water, pieces of cable sleeving, unauthorized tape, adrift hardware (washers, screws, nuts, bolts, etc.), dirt, dust, lint, paint chips, metal chips, carbon or copper dust, solvents, grime films and paint on connection surfaces. For external applications (e.g., top of switchboards), the following conditions are acceptable: a normal day-to-day dust accumulation, discoloration (not related to overheating), paint splatter on nameplates that does not affect legibility, and paint on exposed non-contact surfaces of gaskets.

When inspecting for cleanliness, the inspector shall be as specifi as possible in documenting deficiencies For example, a deficienc such as "foreign material in switchboard" is not specific the deficienc should state the type (or types) of foreign material observed and location within the switchboard.

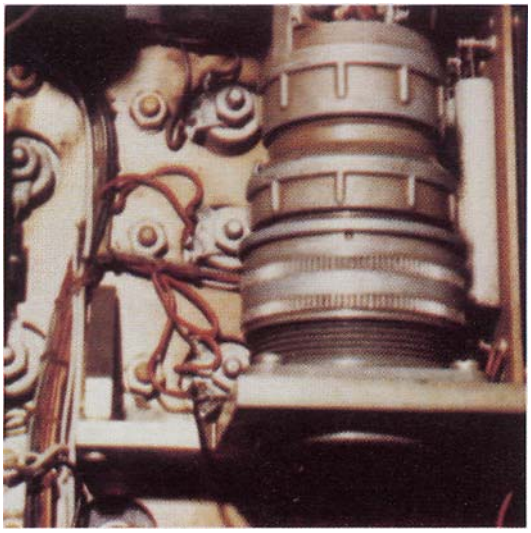
7-3.1 Discoloration.



ACCEPTABLE
Discoloration of panel from paint.

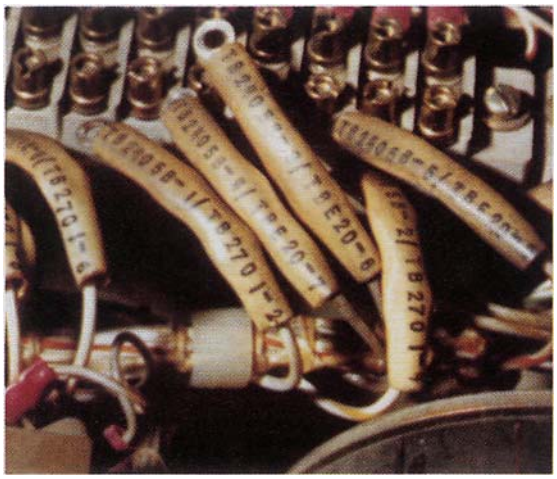


ACCEPTABLE
Discoloration from lacquer spray.



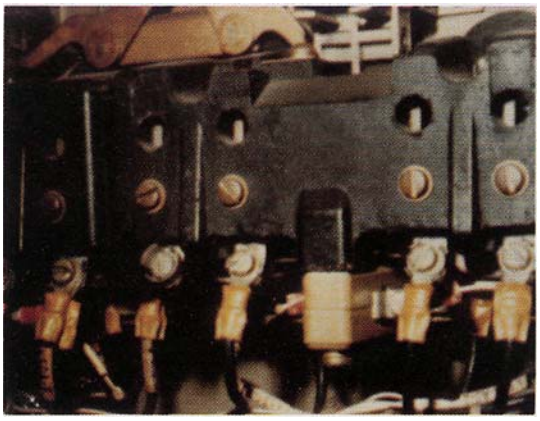
ACCEPTABLE
Normal discoloration on interior panel wall.

7-3.2 Discoloration Cleanliness (Dust).



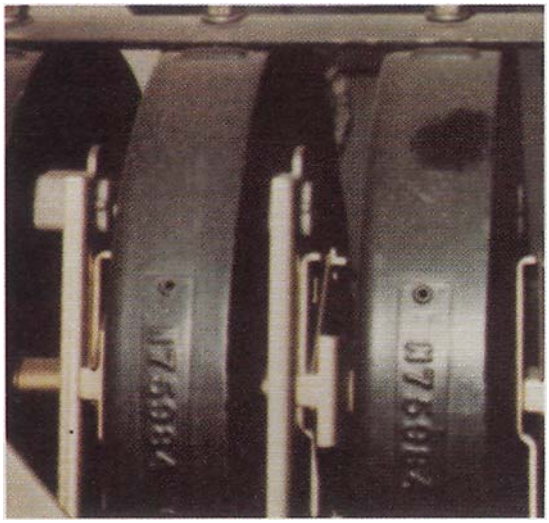
ACCEPTABLE
Discolored sleeve.

ACCEPTABLE
Light dust on lip of panel cover; discoloration of name plate.

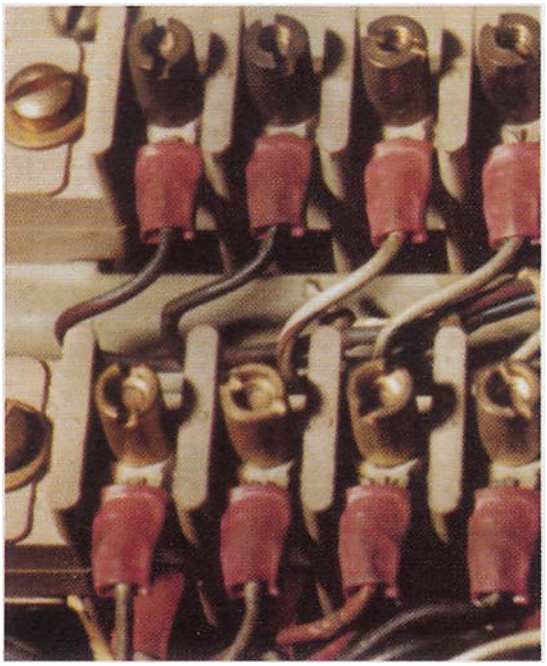


ACCEPTABLE
Light dust on relay and associated wiring.

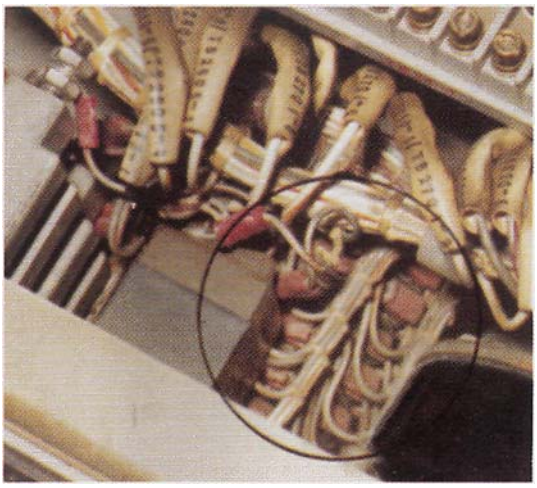
7-3.3 Cleanliness (Dust).



ACCEPTABLE
Light dust on rheostats.

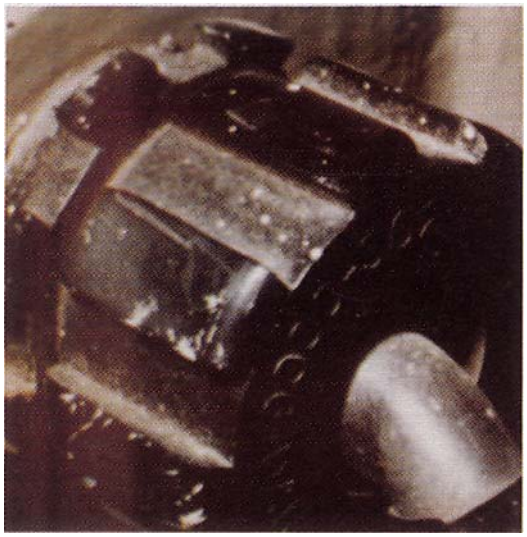


ACCEPTABLE
Light dust on wiring.

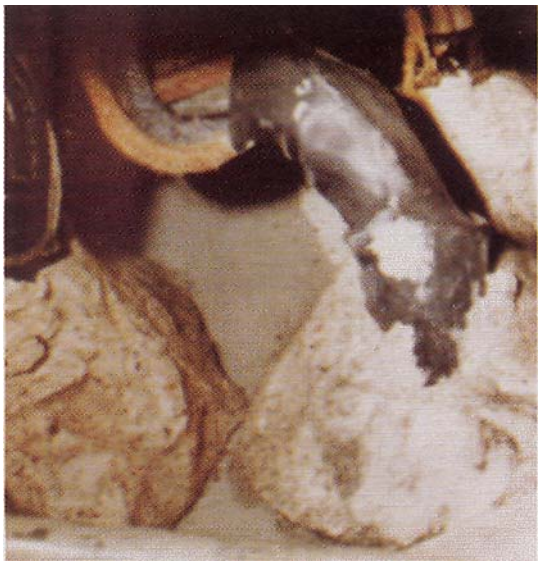


ACCEPTABLE
Light dust on wiring to switch (slightly below and to the right of the center of the photo).

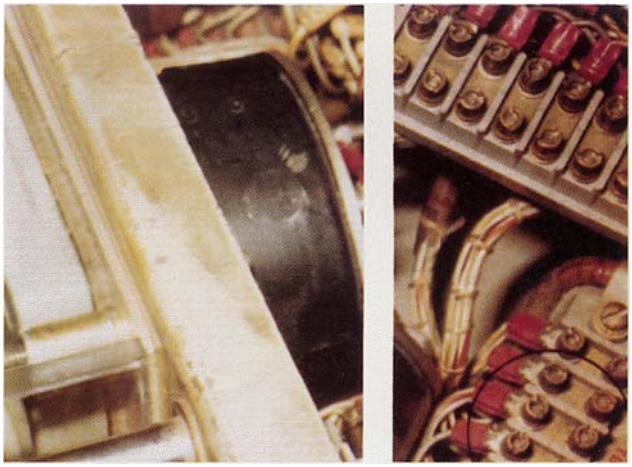
7-3.4 Cleanliness (Dust, Paint, Splatter, Grime).



ACCEPTABLE
Light dust and paint spatter.



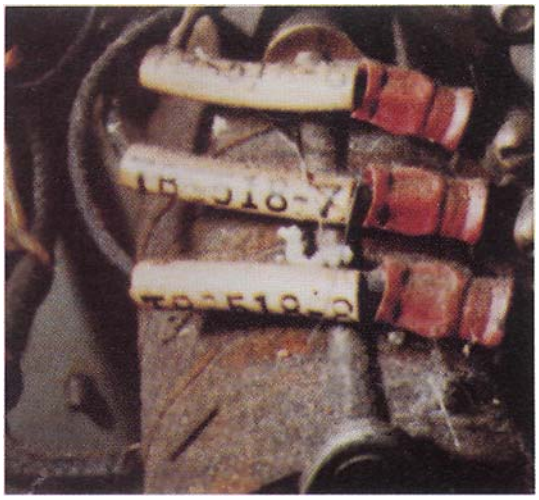
ACCEPTABLE
Light fixe dust on and around sealer at cubicle entrance.



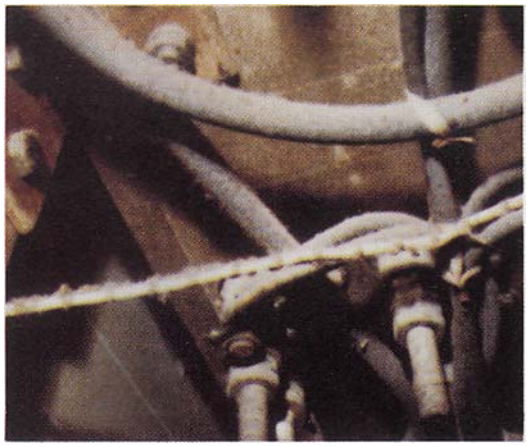
NOT ACCEPTABLE
LEFT PHOTO - Grime on top front edge of drawer. (Surface was grimy to the touch vice being discolored.)
RIGHT PHOTO - Fuzzy dust buildup (lower right section of the photo).

7-3.5 Cleanliness (Dust and Debris).

ACCEPTABLE
Piece of dust in drawer.

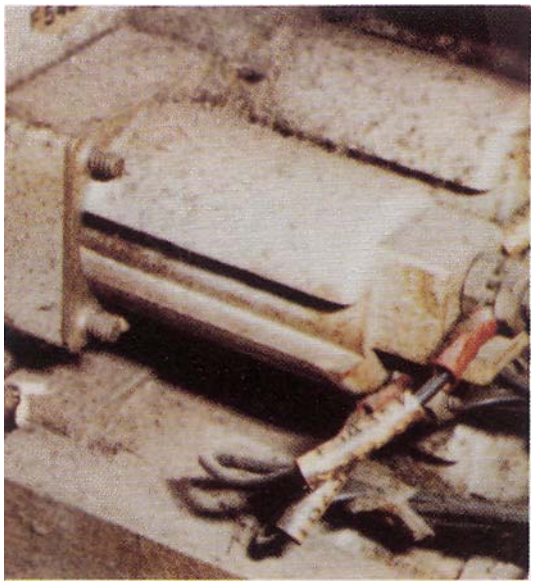


NOT ACCEPTABLE
Dust and debris on rotary snap switch.

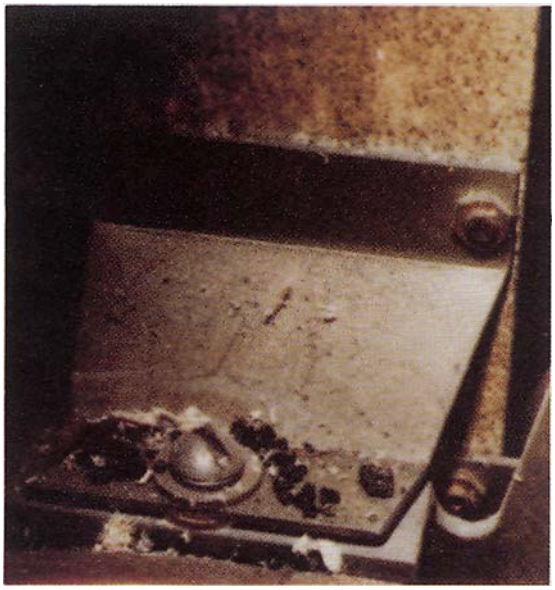


NOT ACCEPTABLE
Dust on bus connections and associated wiring.

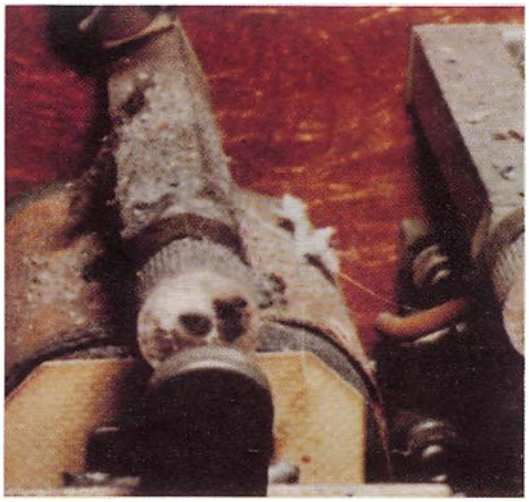
7-3.6 Cleanliness (Oily Dust, Dust and Debris).



NOT ACCEPTABLE
Oily dust on fuse holder and associated wiring.



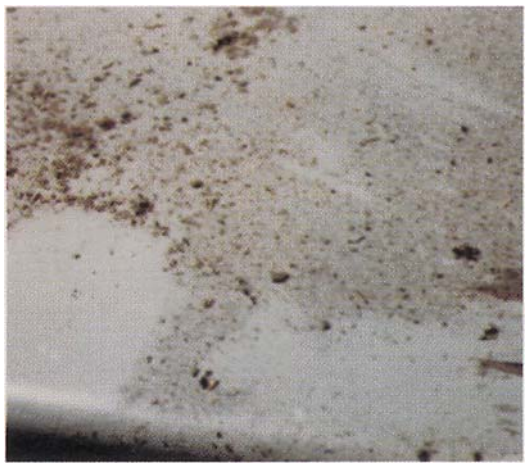
NOT ACCEPTABLE
Dust and debris on arc chute.



NOT ACCEPTABLE
Dust and debris on relay.

7-3.7 Cleanliness (Dirt, Grease, Unsecured Hardware).

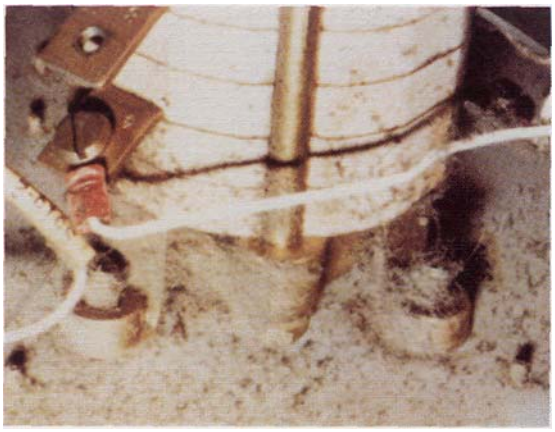
NOT ACCEPTABLE
Permanently removed panel indicators with holes taped over.



NOT ACCEPTABLE
Dirt and grease on exterior panel top.

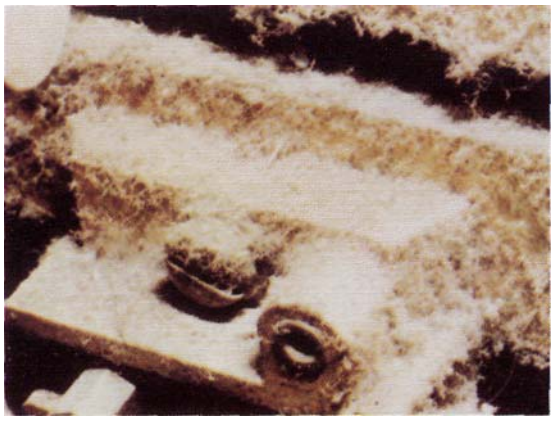
NOT ACCEPTABLE
Excessive dirt with unsecured hardware in interior of panel.

7-3.8 Cleanliness (Oily Dust).



NOT ACCEPTABLE
Excessive oily dust within rotary snap enclosure.

NOT ACCEPTABLE
Excessive oily dust on wiring of snap switch and/or in bottom of enclosure.



NOT ACCEPTABLE
Excessive oily dust on terminal boards.

7-3.9 Switchboard, Panel Enclosure Cleanliness. The presence of foreign material such as dirt, dust, metal fil ings, paintchips, condensation, or adrift hardware is not acceptable. The presence of grease or oil, where it is not intended by design, is not acceptable.

a. Some dust and lint is acceptable, provided it has not accumulated to the extent it results in a visible layer.

b. Loose, flaking or blistering rust or corrosion is not acceptable.

c. Minor scratches or chips that do not penetrate to bare metal is acceptable.

d. Green corrosion (oxidation) adhering to but not affecting operation of metal fasteners (bolts, screws) is acceptable.

e. Verify metal enclosures are grounded to the hull. Resistance to ground is to be less than 0.3 ohms.

f. Ground connection must be securely fastened with metal to metal contact. Missing, broken or disconnected ground straps are not acceptable.

g. Paint on the ground strap or lug is acceptable.

h. Paint splatter on electrical components, provided it is not on electrical contact surfaces, is acceptable. Paint splatter on nameplates which does not affect legibility is acceptable.

i. Slight discoloration or stain on components that otherwise function satisfactorily is acceptable.

j. Sleeving that has a coating of sticky residue that does not affect the legibility of the marker or operation of the equipment is acceptable.

7-4. CORROSION - GENERAL REQUIREMENTS.

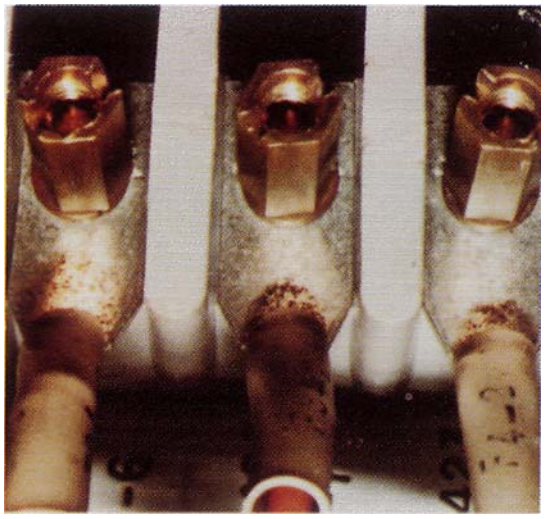
The following criteria applies:

a. Electrical Components/Connections/Contact Surfaces: These shall be free from moisture, corrosion, oxidation, rust, scale, electrolysis, and evidence of overheating. The following conditions are ACCEPTABLE:
   1. Tarnish (brown to black discoloration forming blotchy patterns on silver-plated surfaces),
   2. Thin adherent patina (green coating on surface of copper, possible indication of presence of moisture, and
   3. Rust pitting which does not constitute a continuous fil of rust.

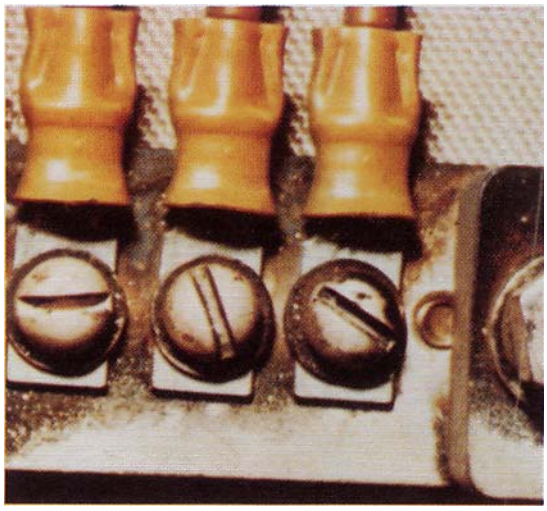
b. Metal Surfaces/Enclosures/Mechanical Components: Loose rust or other products of corrosion which are flak

ing, chipping, or blistering are unacceptable. Chipped paint is unacceptable if bare metal is exposed. Repair of surface scratches beyond what is necessary to prevent corrosion is not required. Paint removed due to accessing equipment (such as drawer slide wear) is acceptable. The acceptance of wearing surfaces should not need painting, examples are 2002 breaker cover guide pins and cradle tracks where breaker wheels travel.

7-4.1 Tarnish/Corrosion - Electrical Connections.



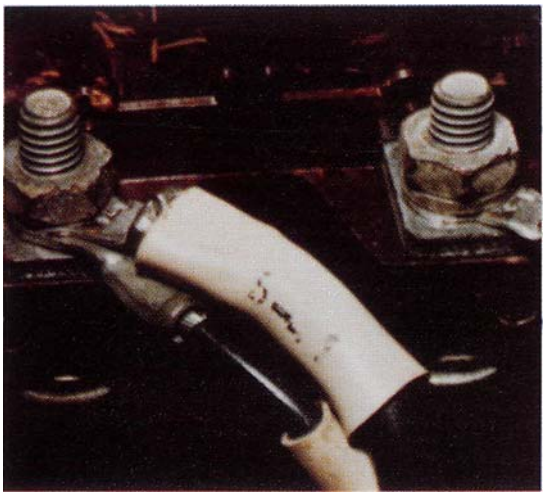
ACCEPTABLE
Thin adherent fil of corrosion on terminal lug palms.



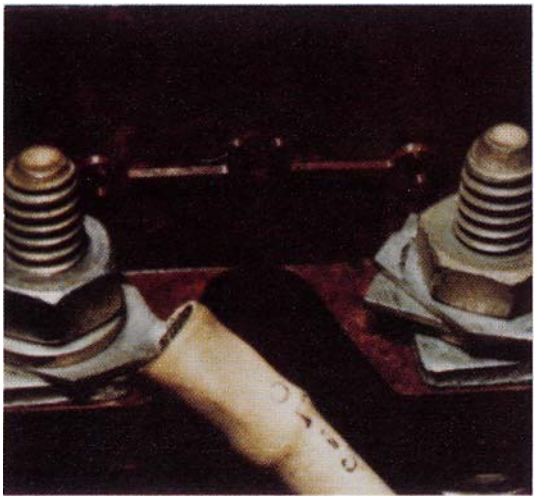
ACCEPTABLE
Tarnish, identifie as brown to black discolorations on tinned or silver plated surfaces.

ACCEPTABLE
Thin adherent patina, identifie as green discoloration on copper, bronze or brass surfaces.

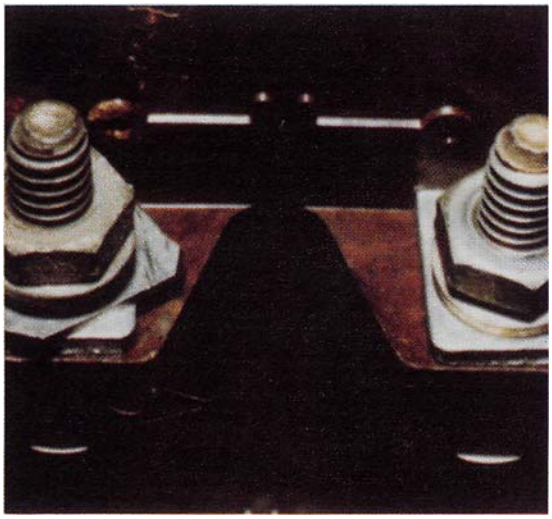
7-4.2 Rust/Corrosion/Discoloration - Electrical Connections.



ACCEPTABLE
Light rust on bolts and nuts.



ACCEPTABLE
Discoloration of bolts and nuts.



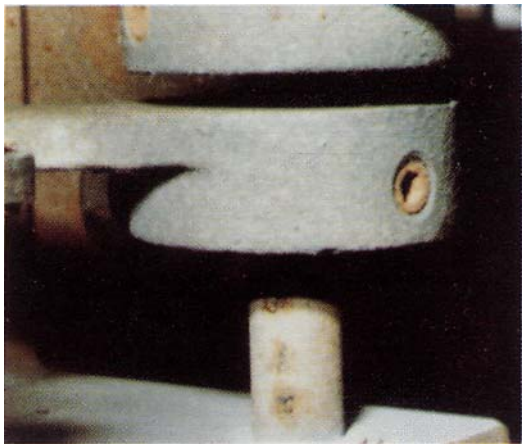
ACCEPTABLE
Light corrosion on bolts, nuts, washers or terminal lugs.

NOT ACCEPTABLE
Corrosion at connection points and corrosive deterioration of conductor strands.

NOT ACCEPTABLE
Corrosion at connection points and corrosive deterioration of conductor strands.

NOT ACCEPTABLE
Corrosion at connection points and corrosive deterioration of conductor strands.

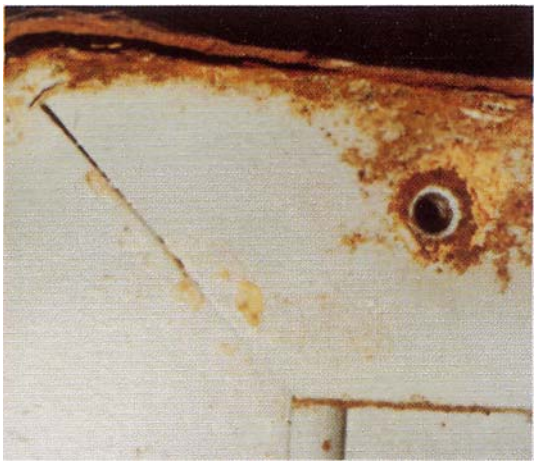
7-4.3 Rust/Discoloration - Panels/Components.



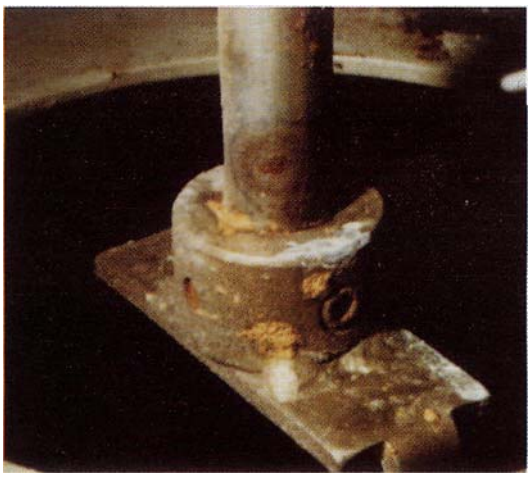
ACCEPTABLE
Light rust adhering to base metal shaft and set screws of mechanical component.

ACCEPTABLE
Discoloration of buswork from tarnishing or a previously used cleaning agent.

7-4.4 Rust/Corrosion - Panels/Components.

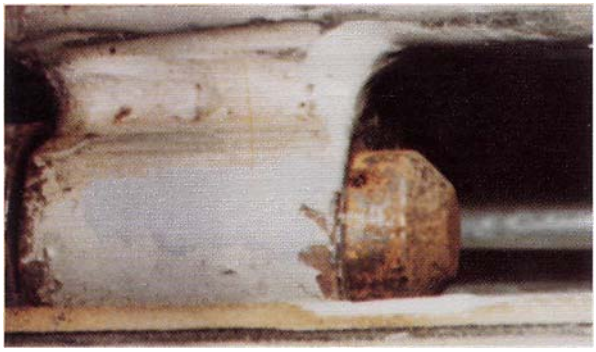


NOT ACCEPTABLE
Exterior of panel showing loose rust flakin and blistering.

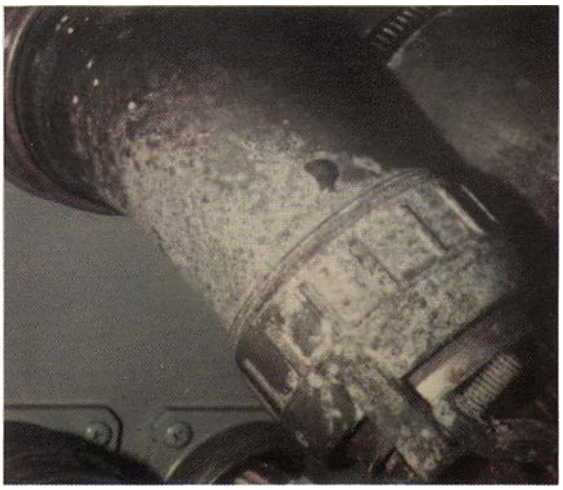


NOT ACCEPTABLE
Mechanical component showing loose rust with blistering.

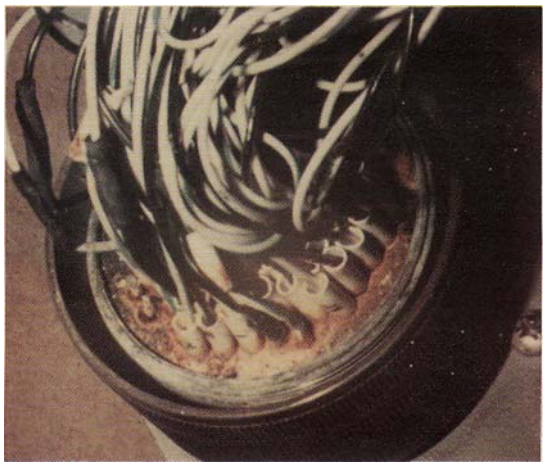
NOT ACCEPTABLE
Interior of panel showing excessive rust buildup and flaking Electrical connection rust and corrosion.



NOT ACCEPTABLE
Exterior panel hinge with rust.



NOT ACCEPTABLE
Heavy corrosion on connector backshell.



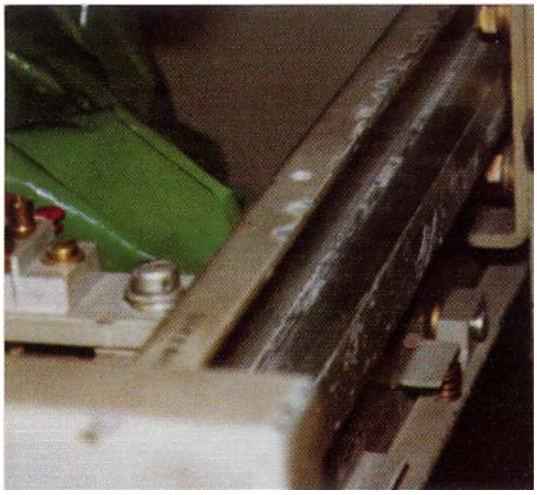
NOT ACCEPTABLE
Contamination/corrosion inside connector from poor environmental seal or lack of seal.

NOT ACCEPTABLE
Exterior top of panel showing loose rust chipping and blistering.

NOT ACCEPTABLE

Exterior top of panel with lift hole showing loose rust flakin and chipping.

NOT ACCEPTABLE
Interior of panel showing excessive rust buildup with blistering.



NOT ACCEPTABLE
Chipped paint (bare metal exposed) on drawer slide. Paint removed due to accessing equipment (such as drawer slide wear) is acceptable.

CHAPTER 8

BUS WORK

8-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

8-2. BUS WORK - GENERAL REQUIREMENTS - NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability of bus work installation. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition.

a. Evidence of overheating such as black or red oxide coating, green or blue corrosive coating (typically appearing as concentric patterns around bolt heads), or dilution by underlying copper, is not acceptable.

b. Coated bus work that is blackened charred, blistered, or cracked is not acceptable.

c. Peeling silver plating or plating exhibiting areas of exposed copper within 1 inch of contact surfaces is not acceptable.

d. Bus work connections must be tight and show no signs of overheating.

e. Clearance and creepage distances:

   1. Visually inspect the clearance and creepage distance for non-component and component termination bus points to ensure the requirements of MIL-E-917 are met.
   2. Visually inspect for proper clearance between wires and bus bars to ensure clearance is not less than 1/4 inch, except at wire to bus connections.

f. Locking devices such as split rings or external tooth lockwashers, castellated nuts, cotter pins, or safety wires, unless specifie by design, are not acceptable.

NOT ACCEPTABLE
Over heated lug has lost all of its silver plating and has green corrosive coating.

NOT ACCEPTABLE
Overheated lead on an AQB-A101 breaker base. The connection was found to be loose.

NOT ACCEPTABLE
Overheated lead in a controller. The connection was found to be loose.

NOT ACCEPTABLE
Overheated connection point on a circuit breaker base. The connection screw was found to be loose.

NOT ACCEPTABLE
Overheated stud on breaker mounting base.

8-2.1 Silver Plating. Peeling silver plating or plating exhibiting areas of exposed copper within one inch of contact surface is not acceptable.

NOT ACCEPTABLE
Copper bus was inserted without silver plating.

NOT ACCEPTABLE
Sliver plating peeling off of AQB Breaker stabs. AQB-A400.

NOT ACCEPTABLE
Silver plating that is coming off the breaker base bus bar stabs. AQB-A101.

8-2.2 Bus Work - Marking. Bus work that does not have clearly marked phase identificatio or Danger "__" voltage warning plates is not acceptable.

ACCEPTABLE

8-3. BUS BAR DISCOLORATION /TARNISH.

a. Blotchy brown tarnish on silver-plated surfaces is acceptable if it is not a continuous film

b. Black tarnish on silver plated surfaces is acceptable if it is not a continuous film

c. Green patina on copper or silver plated surfaces is acceptable if it is not a continuous fil but should be cleaned as much as possible if it's around connection points.

8-3.1 Silver Sulfid Tarnish /Overheating.

a. Silver sulfid tarnish - is a chemical reaction between silver and the sulfur in the air. Sulfur, which is the by product of combustion, forms a black compound with a red or green or both types of discolorations of varying hues.

b. Over heating - An oxidized copper color permeating the silver plated surface around a bolt head or nut is evi-

dence of overheating, which causes the silver to diffuse into the copper bus bar. Oxidation reactions caused by excessive overheating result in black, deep red or green discolorations of varying hue typically forming concentric patterns in silver plate surface of bus bar around bolt heads or nuts.

Some discoloration of silver-plated electrical connections may be caused by overheating or silver sulfid tarnish. Where no other evidence of overheating exists (e.g., arc marks, loose connections, charred wire insulation, etc.) and discoloration can be entirely removed by silver cleaners, the discoloration is caused by silver sulfid tarnish.

NOTE

If you need to disassemble or if the cleaning of the bus bar or connections is extensive to clean then contact the Engineering code. After cleaning the bus bar or lug connections, if it still has signs of over heating then contact the Engineering code.

8-4. BUS WORK CORROSION.

a. Bus work connections, which are corroded as opposed to tarnished shall be inspected by Engineering to verify that current carrying contact surfaces are completely corrosion free. Rough or peeling silver plating, is not acceptable; contact Engineering if found.

CHAPTER 9

INSTRUMENTATION

9-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

9-2. INSTRUMENTATION - GENERAL REQUIREMENTS - NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability of instrumentation installation. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition.

9-2.1 Instrumentation – New and Old Work. Meters that have bent pointers or cracked face plates are not acceptable.

a. Meter face plates that have small chips, scratches, and hairline cracks, so long as meter operation is not affected, are acceptable.

b. Meters that do not have current calibration or calibration not required stickers are not acceptable.

c. Plug connectors to meters must be properly mated; loose or missing amphenol hardware is not acceptable.

NOT ACCEPTABLE
Meter has bent pointer and cracked faceplate.

ACCEPTABLE
"CALIBRATION NOT REQUIRED" sticker visible as required.

ACCEPTABLE
Calibration sticker visible as required.

ACCEPTABLE
Amphenal hardware intact. Not loose or missing.

CHAPTER 10

MISCELLANEOUS ELECTRICAL COMPONENTS

10-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

10-2. MISCELLANEOUS ELECTRICAL COMPONENTS - GENERAL REQUIREMENTS - NEW WORK.

This chapter provides guidelines for evaluating the acceptability and unacceptability of miscellaneous electrical component installation of items such as fuses and fuse holders, switches, resistors, relays, etc. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition.

10-3. SWITCHES.

Switches with loose knobs are not acceptable.

a. Switches that do not toggle or retain spring back action or do not operate smoothly and stop at the proper location, or align with markings are not acceptable.

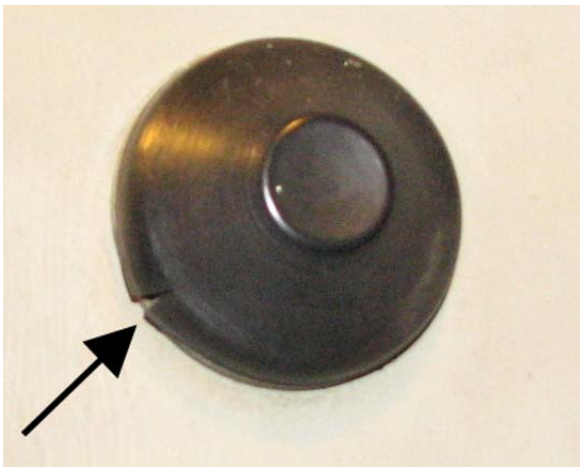
b. Light corrosion on switch shafts and mounting hardware not affecting the operation of an item is acceptable.

c. Torn switch rubber boots are not acceptable. Spot checking three or four washers per cover or panel side to ensure sealing capabilities is sufficient will allow acceptance of that section.

d. Switches that are cracked, broken, or show signs of overheating or improper switching action are not acceptable.

e. Switches that are loose or improperly mounted are not acceptable.

ACCEPTABLE



NOT ACCEPTABLE
Torn switch rubber boots are not acceptable.

10-4. FUSES AND FUSE HOLDERS.

a. Visible cracks or chips that penetrate the thickness of the molded material or reduce the physical strength of the fuse holder are not acceptable.

b. Chips or hairline cracks in fuse indictors are acceptable. The criteria for chips and hairline cracks must be so as not to extend all the way through the material and render it fragile or compromise the integrity of the indicator.

c. Gaskets or O-rings must be resilient, free of cracks, oil, grease, and paint.

d. Loose, corroded or missing fasteners are not acceptable.

e. Bent or broken fuse clips are not acceptable; fuse clip must make fir contact with fuse. Lack of spring action of the fuse holder is not acceptable, if applicable.

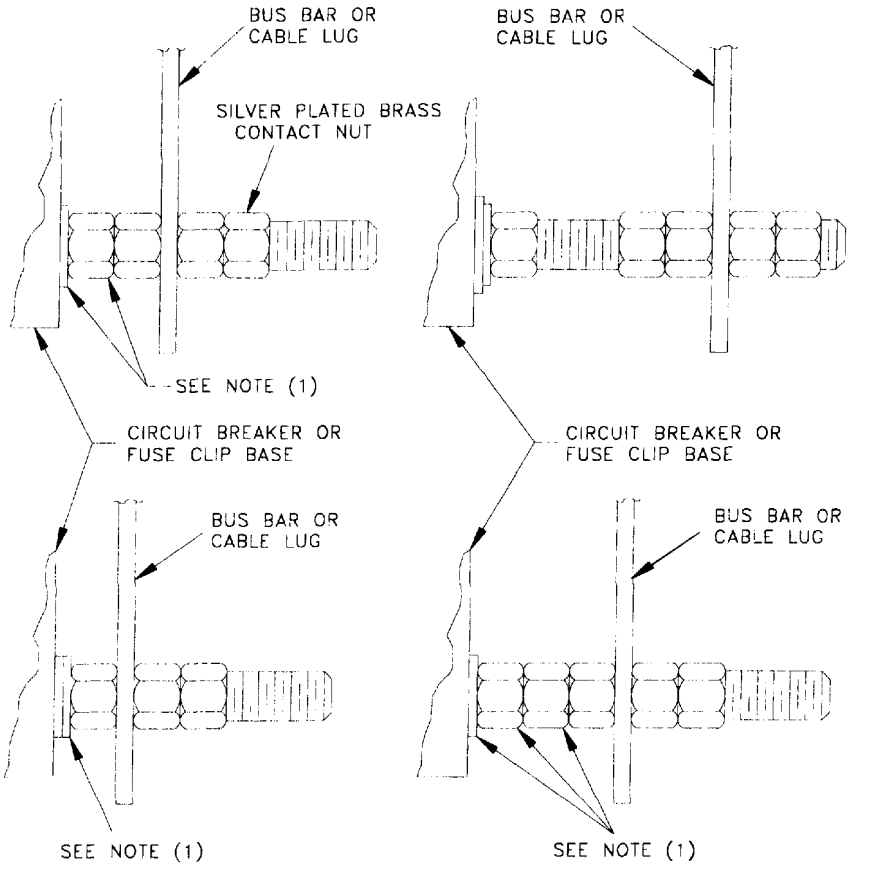
f. Missing silver plating on fuse clips is not acceptable.

g. Fuses that are cracked, broken, or have improper rating and type are not acceptable.

h. Evidence of overheating is not acceptable.

i. Fuse clip connections must be in accordance with Figure 10-1.

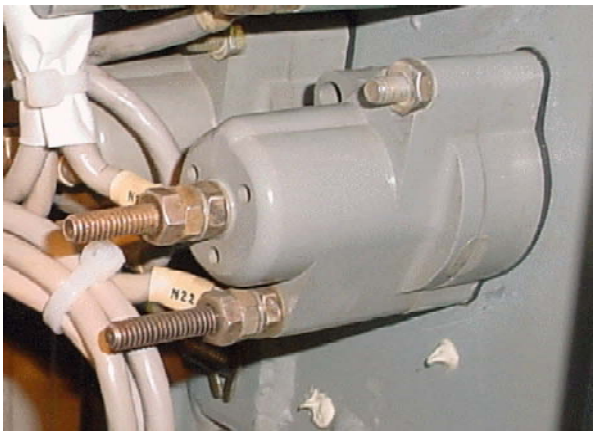
j. Solder Tip Fuses are acceptable per NAVSEA 07T letter dated August 26, 2005. The fuse holders that are affected by this are FHL14G (Large Round) and the FHL35W (Small Round) fuse holders.



NOTES:

1. Flat washers may be used as spacers, where necessary, to allow proper bus matchup to studs.
2. When using AQB breaker contact nuts, flat washers are not required.

Figure 10-1. Typical Fuse Clip Connections



ACCEPTABLE
Fuse holder installed with properly installed gasket.

ACCEPTABLE
Fuse holder with properly installed gasket and O-ring.

NOT ACCEPTABLE
Fuse holder with chips that penetrate the thickness of the molded material and a bent or broken spring.

ACCEPTABLE
Fuse holder must not be bent or broken.

ACCEPTABLE
Fuse indicator with hairline cracks.

ACCEPTABLE
Fuse with proper rating and type shown.

ACCEPTABLE
Fuses which have no cracks and their caps do not rotate or turn.

10-5. TERMINAL BOARDS.

a. Visible cracks or broken terminal boards are not acceptable.

b. Terminal boards with damaged dividers next to unused connection points are acceptable.

c. Slightly bent terminal posts, generally less than 15 degrees from axis, provided the terminal is not part of a mating connection and allows for a full contact tightening is acceptable.

d. Evidence of overheating is not acceptable.

e. Loose, corroded, or missing fasteners are not acceptable.

f. Missing washers and/or nuts on spare terminal screws are acceptable.

g. Illegible or missing terminal or terminal block marking strips are not acceptable.

10-6. TRANSFORMERS, RESISTORS AND RHEOSTATS.

a. Evidence of overheating (blistered or discolored) is not acceptable.

b. Cracked or broken insulation/ceramic is not acceptable.

c. Chipped ceramic on terminal areas of slide-wire type resistors, as long as no windings are exposed, is acceptable.

d. Loose or missing fasteners are not acceptable.

e. Rheostats with loose/broken wires, knobs, and swing arms are not acceptable. Potentiometers with missing locknuts are not acceptable. Shaft binding or improper mechanical wiper operation is not acceptable.

f. Verify proper electrical operation of EPCP/AEPCP rheostats and potentiometers. Wiper arm contacts must maintain electrical contact providing smooth variation of resistance throughout the operating range. Rough or binding action of the control shaft, improper wiper operation, or dead spots are not acceptable.

g. Broken or damaged protective devices are not acceptable.

NOT ACCEPTABLE
Current transformer on right that started to melt and sag off its mounting bolts.

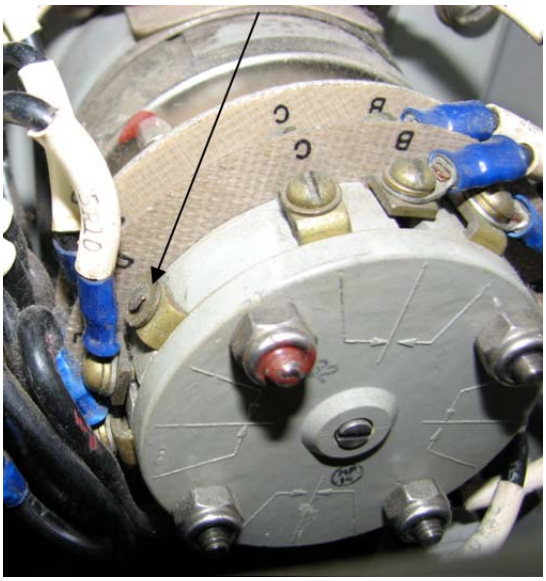
NOT ACCEPTABLE
Resistor with exposed windings.

NOT ACCEPTABLE
Resistor with signs of overheating.

10-7. RELAYS.

a. Relays with loose or broken connections are not acceptable.

b. Visible relay contacts that are pitted, burned, or show signs of overheating are not acceptable.



NOT ACCEPTABLE
The relay pictured shows that the connection has broken off of the screw. The wire is not shown.

10-8. COILS AND CAPACITORS.

a. Coils and capacitors that show signs of overheating (bulging wax or oil leaks) and physical damage are not acceptable.

b. Coils and capacitors that are chipped, cracked, or have broken or loose connections are not acceptable.

10-9. INDICATOR LAMPS OR LIGHT ASSEMBLIES.

a. Indicator lamps that have missing bulbs are not acceptable.

b. Indicator lamps that have cracked, damaged, or discolored lenses due to overheating are not acceptable.

c. Chips or hairline cracks in indicating light lenses are acceptable.

d. Indicator lamp assemblies with cracked/broken or missing gaskets are not acceptable.

e. Loose electrical connections or broken terminals are not acceptable.

NOT ACCEPTABLE
Indicator lamp with missing bulb.

ACCEPTABLE
No missing bulbs in indicator lamp.

ACCEPTABLE
No cracks or heating discoloration on indicator lamp lens.

10-10. PRINTED CIRCUIT BOARDS.

a. Printed circuit boards that are cracked are not acceptable.

b. Printed circuit boards that show signs of delaminating or overheating are not acceptable.

c. Superficia dark brown to black heat discoloration (no charring) on component mounting boards beneath heat producing components such as resistors, provided the board is functionally structurally sound, is acceptable.

d. Printed circuit board clamping devices that do not secure circuit card are not acceptable.

10-11. SLIDES, LATCHES AND HINGES.

a. Hinges must operate smoothly and provide proper alignment of door fasteners.

b. Loose or missing fasteners are not acceptable.

c. Slides that do not operate smoothly and provide proper engagement are not acceptable.

d. Door positioning devices that do not operate smoothly or have loose or missing fasteners are not acceptable.

ACCEPTABLE
Door positioning devices that do not have loose or missing fasteners.

ACCEPTABLE
Door positioning devices that do not have loose or missing fasteners.

10-12. COMPONENT MOUNTING HARDWARE.

a. Loose component mounting hardware is not acceptable. Missing equipment, internal covers, insulators, guards, or shields are not acceptable.

b. Missing locking devices on mounting brackets are acceptable as long as the mounting bolts, screws, or rivets are firml secured and no relative motion is possible between the attached parts.

c. (For non current carrying only) Common hardware items such as screws, nuts, lockwashers, etc., which have been replaced by different type material (e.g., brass screw replaced by CRES screw) are acceptable. Replacement hardware must have the same or higher required technical characteristics.

d. Cracked, broken, or missing protective covers on test jacks and lanyards are not acceptable.

e. Missing or illegible component markings, except on components used during operation or maintenance, alignment, or testing, provided the component can be identifie by reference to its associated technical manual, are acceptable.

f. Light corrosion on mounting hardware not affecting the operation of an item is acceptable.

10-13. AQB/MOLDED CASE BREAKER AND AQB/MOLDED CASE BREAKER MOUNTING BASES.

a. Visible cracks on wall sections between phases or between a phase and ground are not acceptable.

b. Visible cracks in non-wall sections which do not jeopardize dielectric or structural integrity and are less than 0.75 inches in length and less than 50 percent of the length of the surface which is cracked are acceptable.

c. Surface cracks due to stress relief or usage which do not jeopardize dielectric or structural integrity must not exceed 1.5 inches in length and be less than 50 percent of the length of the surface which is cracked.

d. Visible cracks around molded inserts are not acceptable. Cracking due to stress relief must not exceed 2 inches in length.

e. Loose, corroded, or missing fasteners are not acceptable.

f. Evidence of overheating is not acceptable.

g. Bent or broken clips are not acceptable. Each clip must make fir contact with the plug in unit.

10-14. ACB CRADLE AND STATIONARY COMPONENTS.

a. Visible cracks, bends, or excessive wear is not acceptable.

b. Corrosion is not acceptable.

c. Loose or missing fasteners are not acceptable.

d. Loose, bent, corroded, or broken primary or secondary disconnects are not acceptable.

e. Peeling silver plating or plating exhibiting areas of exposed copper within one inch of contact surfaces is not acceptable.

f. Evidence of overheating is not acceptable.

g. Rack out mechanism must operate smoothly without binding. Rack out lever must move freely up and down without binding. Retainer plates must be lubricated.

10-15. POWER RECEPTACLES/TEST PLUG OR JACKS.

a. Missing covers are not acceptable.

b. Broken, frayed, or missing cover lanyards are not acceptable.

c. Loose or missing mounting hardware is not acceptable.

d. Chipped test jacks that do not compromise proper function or retention of test leads and do not cause any electrical part of the probe to contact the equipment enclosure or side of the test jack or adversely affect circuit performance is acceptable.

ACCEPTABLE
Proper installation of protective covers on test jacks and lanyards.

ACCEPTABLE
Proper installation of protective covers on test jacks and lanyards.

10-16. ARC FAULT.

CAUTION

To decrease the risk of disabling or damaging arc fault sensors, care should taken in handling or working around arc fault sensors. If arc fault sensors are disabled or damaged, there is increased risk of fire personnel injury, and equipment damage caused by undetected electrical currents, heat and energy released during an arcing event. Make sure all cables are grounded. Utilize wire removal forms where applicable.

a. Torn or missing neoprene gaskets are not acceptable.

b. Sensors must be secure in their bases.

c. Sensor bases should not be in contact with anything that would ground them to the switchboard enclosure.

d. Water staining around neoprene gaskets are not acceptable.

e. Cracked lenses are not acceptable.

10-17. POWER STAB AND CONTROL STAB.

Loose or missing fasteners are not acceptable.

Terminal block stationary:

a. Visible cracks or bends are not acceptable.

b. Evidence of overheating is not acceptable.

c. Loose or broken terminal lugs are not acceptable.

10-18. CONTACT CLIP.

a. Evidence of arcing or overheating is not acceptable.

b. Clip must not be sprung; contact gap width larger than required for snug fi on mating stab is not acceptable.

10-19. NAMEPLATES.

Missing or illegible nameplates or information plates are not acceptable. Nameplates or information plates that are not secured properly are not acceptable.

a. Paint splatter on nameplates which does not affect visibility is acceptable.

b. Missing locking devices on mounting brackets is acceptable as long as the mounting bolts, screws, or rivets are firml secured and that no relative motion is possible between the attached parts.

c. Chipped or cracked label plates (nameplate) which do not affect installation or legibility of the label plate (nameplate) is acceptable.

10-20. WIRING.

The following criteria should be used in inspecting old work:

a. Cracked, chafed, cut, gouged, or torn insulation is not acceptable.

b. Blistered, charred, brittle, or markedly discolored insulation is not acceptable.

c. Wiring that has damaged insulation where exposed copper is present is not acceptable.

d. Wiring that is taut which could cause subsequent breakage of the wire, part, or terminal due to stress is not acceptable.

e. Wiring and cabling with slight discoloration is acceptable if the insulation has not been deformed, cracked, or brittle due to overheating.

f. Wiring or cabling which is satisfactory but does not provide sufficient slack for future relugging or connector replacement, unless there is a potential for damage due to frequent flexing is acceptable. Excess lead length is allowed, provided minimum bend radius is not violated, does not interfere with proper equipment operation, and is properly laced and secured.

g. Missing spare wires in a bundle, provided some usable spares still exist is acceptable.

h. Nicked portions of wiring insulation that do not penetrate greater than 50 percent are acceptable.

i. Loose wiring support fasteners are not acceptable.

j. Improper crimps or conductor wire not extending through entire crimp are not acceptable.

k. Conductor wire that extends beyond the lug barrel, but does not interfere with installation of fasteners or other lugs is acceptable.

l. Conductor wire that is less than flus with the end of lug barrel, but still visible and extends through the entire crimp is acceptable.

m. Soldered connections that show signs of burnt insulation, insufficient or excessive solder, bird caging, cold, disturbed or wicked solder joints are not acceptable.

n. Existing solder joints which do not meet the latest standards of lead wrap, amount of solder, solder coverage, or lead stress relief bends, but provide a sound mechanical and electrical connection is acceptable.

o. Leads with broken, cut, or nicked strands, or have strands left out of lug that exceed the following listed in Table 10-1 are not acceptable.

p. Lugs that have heat-shrunk wire markers or insulation secured to them should not be removed to verify the above criteria unless visible evidence of damage to the wire insulation or terminal lug is noticeable.

q. Loose fittin wire markers should only be removed if it can be easily performed without movement of the terminal lead.

Table 10-1. Wiring Strands

Number of Strands	Max allowable Nicked, Cut, or Broken Strands
<7	0
7-15	1
16-18	2
19-25	3
26-36	4
37-40	5
>41	6

Wire splices must number no more than 1 at each end of a wire and meet the requirements of MIL-STD-2003.

Wire/wire harnesses or cables supported by bus bars are not acceptable.

10-21. CABLES.

The following criteria should be used in inspecting old work:

a. Missing, broken, or disconnected ground straps are not acceptable.

b. Ground straps with broken strands are acceptable as long as the current carrying capacity is not less than the feed cable.

c. Connectors/receptacles with loose, damaged backshells/clamps or have improper grommet seal around cables are not acceptable.

d. Connectors/receptacles with bent, broken, or missing pins or phenolic inserts that are cracked or carbonized are not acceptable.

e. Bent, scratched, or dented connector shells where integrity of electrical connection is not affected. The criteria must be that the male and/or female pins of the connectors must be capable of proper insertion into the receptacle without undue force. Also, the connector must appear to be capable of making proper electrical contact.

f. Missing spare pins in plugs are acceptable as long as some spares exist.

g. Lockwire that is installed in the wrong direction, shows excessive slack, or is over-stressed is not acceptable.

h. Cable tags that are illegible or broken are not acceptable.

i. Disassembling cable bundles to verify cable tags only is not required nor desired.

j. Cables that are loose in stuffing tubes or stuffing tubes that are loose or sealed improperly are not acceptable.

k. Missing connector jack gaskets, loose connector jack, or mounting hardware is not acceptable.

l. Gaps between rubber blocks of the cable transit device are not acceptable.

m. Poured epoxy that does not form a complete seal around cables or cable entrance is not acceptable.

n. Cables (new work) entering panels that do not meet cable bend radius requirements are not acceptable.

o. Cables that are not properly supported/banded at firs hanger are not acceptable.

p. Existing cabling that has been damaged by improper bend radius or grossly violates bend radius requirements is not acceptable.

q. Missing spare wires in a cable as long as some usable spares still exist is acceptable.

10-22. GROUNDING STRAPS.

Equipment mounted on a hinged door, with voltage in excess of 30 volts, must have a ground connection in accordance with NSTM Chapter 300. If ground connection is not present, the deficienc should be identifie for installation.

ACCEPTABLE
Grounding strap is properly installed and connected to the switchboard frame.

ACCEPTABLE
Grounding strap is properly installed and connected to the switchboard hinged door.

CHAPTER 11

SPRAYTIGHT INTEGRITY

11-1. SAFETY INTRODUCTION.

Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 provides the Navy-wide fundamental philosophy and high level requirements that shall be used when planning and executing all evolutions involving shipboard electrical equipment. Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300 principles apply to all such work and operations even where additional detailed requirements exist. As stated in Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300, safety from electrical hazards during any form of work can best be ensured by completely deenergizing equipment. Deenergized equipment shall be tagged out in accordance with Tag-Out User Manual (TUM), NAVSEA S0400-AD-URN-010/TUM.

In planning any electrical maintenance evolution, the responsible activity shall conduct a review of all governing documents to ensure that the specifi risks associated with the maintenance evolution are fully understood by all maintenance personnel and their supervisors and that appropriate risk mitigation steps are in place to ensure personnel and equipment safety. Supervisors must ensure all maintenance personnel understand the physical orientations and characteristics of electrical hazards present and the work isolation boundaries established to support personnel safety.

11-2. SPRAYTIGHT INTEGRITY - GENERAL REQUIREMENTS.

This chapter provides guidelines for evaluating the acceptability and unacceptably of spraytight integrity of items such as switchboards, load centers, and panels. When the requirements of this manual conflic with another document invoked for particular equipment or systems (technical manual, maintenance requirement, or operating manual), the requirements set forth in the invoked document for that equipment or system shall govern. This chapter is intended to show various examples of acceptable and unacceptable conditions. However, this chapter is not intended to show every example of acceptable and unacceptable condition.

a. Visually inspect for spraytight integrity in accordance with NSTM Chapter 300.

b. Damage to panel, panel covers, louvers, or doors that affects the equipment spraytight integrity, such as major dents or bends, is not acceptable.

c. Minor dents in panels which do not cause mechanical interferences or affect electrical creepage/clearance or spraytight integrity is acceptable.

d. The criteria for a minor dent must be a dent for which the affected area is less than the area of a 25 cent piece and the protrusion above or below the normal surface level is less than 1/8 inch (the thickness of two 25 cent pieces).

e. Loose or missing gaskets are not acceptable.

f. Gasket mating surfaces must be free of nicks, burrs, loose paint, or other defects that form a leakage path.

g. Cover gaskets must be 100 percent bonded.

h. Cover gaskets not fully compressed against the mating surface when cover screws are properly tightened are not acceptable.

i. Paint on exposed non-contact surfaces of gaskets is acceptable.

j. Permanent joints and penetrations of external panels or covers must be gasketed or caulked with sealing compound.

k. Loose, bent, or missing fasteners are not acceptable.

l. Damage to fastener bolt head or screw slot that degrades its functionality is not acceptable.

m. Acceptable thread engagement of nuts must result in a minimum bolt protrusion of one (1) thread.

n. Bolt protrusion in excess of one (1) thread is acceptable provided that electrical clearance and creepage distances are met.

o. If during inspection the end of the bolt is found to be flus with the top surface of the nut, this condition does not need to be corrected until the bolt/nut fastener is disassembled for other maintenance.

p. Use of unauthorized fasteners, fastener seals, receptacles, retainers, or washers is not acceptable.

q. Captive fasteners (including their gaskets and retainers) that cannot be easily threaded into switchboard and tightened without binding are not acceptable.

r. Captive hardware that does not remain captive is not acceptable.

s. Multi Cable Transits (MCT) that are not properly installed or do not provide proper sealing capabilities are not acceptable.

t. MCT rubber blocks that are uneven but form a complete seal around cables or cable entrances are acceptable.

u. Bottom spray shield drains must be free of visible obstructions.

v. Report to engineering code for evaluation switchboard/panels that do not have drains, such as side drains, T drains, or holes in their transition plates.

w. Cracked or broken Plexiglas covers are not acceptable.

x. Small chips or hairline cracks are acceptable as long as the protective feature is not compromised.

y. The criteria for chips and hairline cracks must be so as not to extend all the way through the material and render it fragile or compromise the integrity of the indicator.

z. Cracked, broken, or opaque polycabonate windows on panels are not acceptable.

aa. Illegible, broken, or missing warning or information plates are not acceptable.

ab. Unauthorized attachments, openings, or holes are not acceptable.

ac. Probe fuse holder position locking key and fuseholder ground testholes must be sealed with RTV sealant.

ad. Drip shields (if applicable) mounting hardware that does not provide a tight seal is not acceptable.

ae. Hardware that penetrates through the cover (i.e., label plate screws, door positioner mounting screws, or fuse holder mounting screws) that do not have RTV or gaskets installed are not acceptable.

11-3. PENETRATION OF PANEL COVERS AND WALLS FOR SPRAYTIGHT.

a. All hinged or removable panels and doors shall be gasketed.

b. Gaskets shall be free of paint, grease or foreign matter on the contact surface. They shall not be cut, split, twisted, dry rotted, cracked or otherwise damaged. Paint on gaskets is acceptable provided it is not on the contact surface.

c. The contact surface under gaskets shall be free of warps, bends or other surface irregularities that may cause flui leakage paths.

d. Gaskets shall be one piece continuous, with a single joint around the perimeter of panels or covers. The single joint shall be fused to provide an uninterrupted bond.

e. All hardware that penetrates through the cover like label plate screws, door positioning mounting screws or Fuse holders mounting screws that does not have RTV or gasket material is not acceptable.

f. Holes that penetrate through switchboard covers or switchboard walls that do not have spray tight protection is not acceptable.

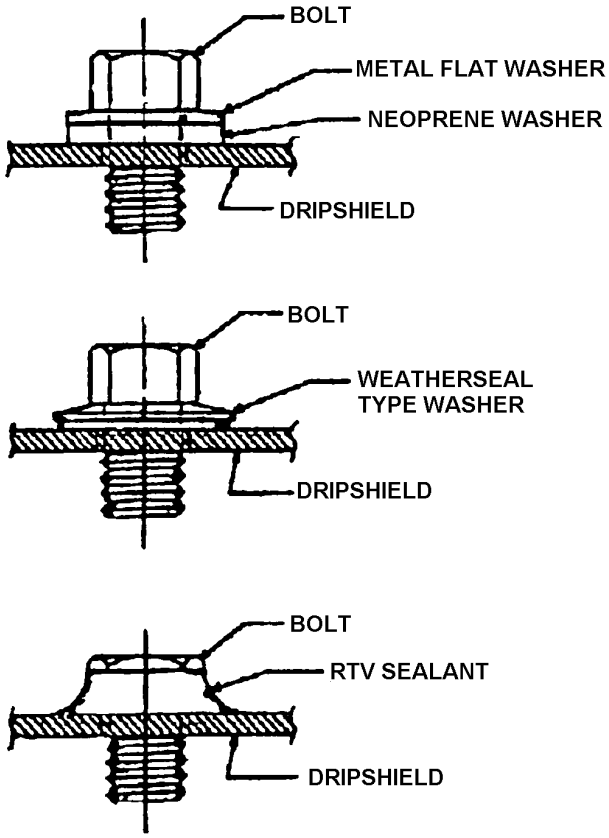
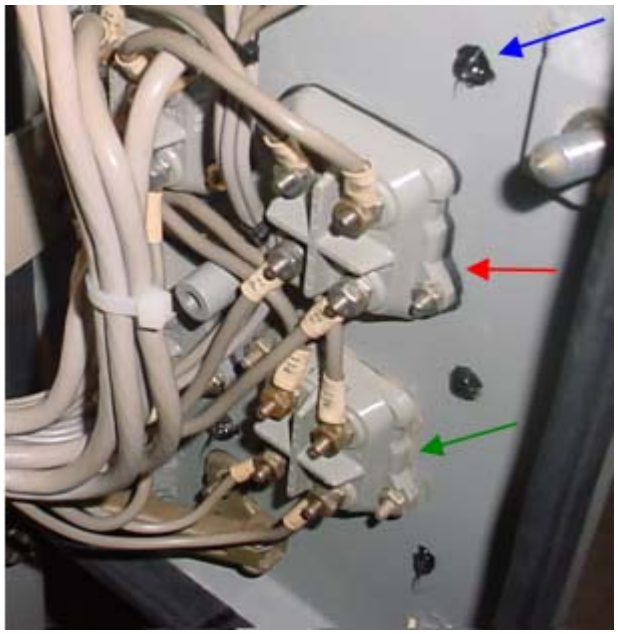


Figure 11-1. Dripshield Mounting Bolts, Acceptable Seals



Screws that penetrate the switchboard doors or outside walls should have RTV applied (Blue Arrow). (Old Work) Grey or clear RTV is acceptable. Do not replace.
Fuse Holders that attach to the door should have a gasket attached as shown to the left (Red Arrow). (Old Work) RTV instead of a gasket is acceptable (Green Arrow).

Ref: NAVSEAINST 4160.3 NAVSEA S0005-AA-GYD-030/TMMP

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