



STANDARD OVERHAUL PRACTICES MANUAL

ASSEMBLY OF SWAGED CABLES

**PART NUMBER
NONE**

BOEING PROPRIETARY, CONFIDENTIAL, AND/OR TRADE SECRET

Copyright © 1995 The Boeing Company
Unpublished Work - All Rights Reserved

Boeing claims copyright in each page of this document only to the extent that the page contains copyrightable subject matter. Boeing also claims copyright in this document as a compilation and/or collective work.

This document includes proprietary information owned by The Boeing Company and/or one or more third parties. Treatment of the document and the information it contains is governed by contract with Boeing. For more information, contact The Boeing Company, P.O. Box 3707, Seattle, Washington 98124.

Boeing, the Boeing signature, the Boeing symbol, 707, 717, 727, 737, 747, 757, 767, 777, 787, Dreamliner, BBJ, DC-8, DC-9, DC-10, KC-10, KDC-10, MD-10, MD-11, MD-80, MD-88, MD-90, P-8A, Poseidon and the Boeing livery are all trademarks owned by The Boeing Company; and no trademark license is granted in connection with this document unless provided in writing by Boeing.

PUBLISHED BY BOEING COMMERCIAL AIRPLANES GROUP, SEATTLE, WASHINGTON, USA
A DIVISION OF THE BOEING COMPANY
PAGE DATE: Jul 01/2009

20-50-16

Page 1
Jul 01/2009



STANDARD OVERHAUL PRACTICES MANUAL

Revision No. 9
Jul 01/2009

To: All holders of ASSEMBLY OF SWAGED CABLES 20-50-16.

Attached is the current revision to this STANDARD OVERHAUL PRACTICES MANUAL

The STANDARD OVERHAUL PRACTICES MANUAL is furnished either as a printed manual, on microfilm, or digital products, or any combination of the three. This revision replaces all previous microfilm cartridges or digital products. All microfilm and digital products are reissued with all obsolete data deleted and all updated pages added.

For printed manuals, changes are indicated on the List of Effective Pages (LEP). The pages which are revised will be identified on the LEP by an R (Revised), A (Added), O (Overflow, i.e. changes to the document structure and/or page layout), or D (Deleted). Each page in the LEP is identified by Chapter-Section-Subject number, page number and page date.

Pages replaced or made obsolete by this revision should be removed and destroyed.

ATTENTION

IF YOU RECEIVE PRINTED REVISIONS, PLEASE VERIFY THAT YOU HAVE RECEIVED AND FILED THE PREVIOUS REVISION. BOEING MUST BE NOTIFIED WITHIN 30 DAYS IF YOU HAVE NOT RECEIVED THE PREVIOUS REVISION. REQUESTS FOR REVISIONS OTHER THAN THE PREVIOUS REVISION WILL REQUIRE A COMPLETE MANUAL REPRINT SUBJECT TO REPRINT CHARGES SHOWN IN THE DATA AND SERVICES CATALOG.

20-50-16

TRANSMITTAL LETTER

Page 1

Jul 01/2009

PART NUMBER NONE



STANDARD OVERHAUL PRACTICES MANUAL

Location of Change

Description of Change

NO HIGHLIGHTS

20-50-16

HIGHLIGHTS

Page 1

Jul 01/2009



STANDARD OVERHAUL PRACTICES MANUAL

Subject/Page	Date	Subject/Page	Date	Subject/Page	Date
TITLE PAGE					
O 1	Jul 01/2009				
2	BLANK				
20-50-16 TRANSMITTAL LETTER					
O 1	Jul 01/2009				
2	BLANK				
20-50-16 HIGHLIGHTS					
O 1	Jul 01/2009				
2	BLANK				
20-50-16 EFFECTIVE PAGES					
1	Jul 01/2009				
2	BLANK				
20-50-16 CONTENTS					
1	Nov 01/2006				
2	BLANK				
20-50-16 REVISION RECORD					
1	Jul 01/2005				
2	Jul 01/2005				
20-50-16 RECORD OF TEMPORARY REVISIONS					
1	Jul 01/2005				
2	Jul 01/2005				
20-50-16 INTRODUCTION					
1	Jul 01/2005				
2	BLANK				
20-50-16 SUBJECT					
1	Jul 01/2005				
2	Jul 01/2005				
3	Nov 01/2006				
4	Jul 01/2005				
5	Jul 01/2005				
6	Jul 01/2005				
7	Jul 01/2005				
8	Nov 01/2006				
9	Jul 01/2005				
10	Mar 01/2007				

A = Added, R = Revised, D = Deleted, O = Overflow

20-50-16

EFFECTIVE PAGES

Page 1

Jul 01/2009



STANDARD OVERHAUL PRACTICES MANUAL

TABLE OF CONTENTS

<u>Paragraph Title</u>	<u>Page</u>
ASSEMBLY OF SWAGED CABLES	1
INTRODUCTION	1
MATERIALS	1
DEFINITIONS	1
CALCULATION OF CABLE LENGTH	1
ASSEMBLY OF THE PIECES	3
SWAGING	3
PROOF TEST	6
IDENTIFICATION	8
PROTECTION	10

20-50-16

CONTENTS

Page 1

Nov 01/2006



STANDARD OVERHAUL PRACTICES MANUAL

All revisions to this manual will be accompanied by transmittal sheet bearing the revision number. Enter the revision number in numerical order, together with the revision date, the date filed and the initials of the person filing.

Revision		Filed		Revision		Filed	
Number	Date	Date	Initials	Number	Date	Date	Initials

20-50-16

REVISION RECORD

Page 1

Jul 01/2005



STANDARD OVERHAUL PRACTICES MANUAL

All temporary revisions to this manual will be accompanied by a cover sheet bearing the temporary revision number. Enter the temporary revision number in numerical order, together with the temporary revision date, the date the temporary revision is inserted and the initials of the person filing.

When the temporary revision is incorporated or cancelled, and the pages are removed, enter the date the pages are removed and the initials of the person who removed the temporary revision.

Temporary Revision		Inserted		Removed		Temporary Revision		Inserted		Removed	
Number	Date	Date	Initials	Date	Initials	Date	Initials	Number	Date	Date	Initials

20-50-16

RECORD OF TEMPORARY REVISION



STANDARD OVERHAUL PRACTICES MANUAL

Temporary Revision		Inserted		Removed	
Number	Date	Date	Initials	Date	Initials

Temporary Revision		Inserted		Removed	
Date	Initials	Number	Date	Date	Initials



STANDARD OVERHAUL PRACTICES MANUAL

INTRODUCTION

1. General

- A. The instructions in this manual tell how to do standard shop procedures during maintenance functions from simple checks and replacement to complete shop-type repair.
- B. This manual is divided into separate sections:
 - (1) Title Page
 - (2) Transmittal Letter
 - (3) Highlights
 - (4) Effective Pages
 - (5) Contents
 - (6) Revision Record
 - (7) Record of Temporary Revisions
 - (8) Introduction
 - (9) Procedures
- C. Refer to SOPM 20-00-00 for a definition of standard industry practices, vendor names and addresses, and an explanation of the True Position Dimensioning symbols used.
- D. The data is general. It is not about all situations or specific installations. Use it as a guide to help you write minimum standards.
- E. If the component overhaul instructions are different from the data in this subject, use the component overhaul instructions.

20-50-16

INTRODUCTION

Page 1

Jul 01/2005



STANDARD OVERHAUL PRACTICES MANUAL

ASSEMBLY OF SWAGED CABLES

1. INTRODUCTION

- A. The data in this subject comes from Boeing Process Specification BAC5002. The airline has a copy of the Boeing Process Specification Manual.
- B. The data is general. It is not about all situations or specific installations. Use this data to help you write minimum requirements.
- C. Refer to SOPM 20-00-00 for a full list of all the vendor names and addresses.

2. MATERIALS

- A. Grease – BMS 3-24 (Ref SOPM 20-60-03)
- B. Oil – Non-detergent, SAE 10W, source optional
- C. Barrier material – MIL-B-22191, Type I, II or III
- D. Tubing, thermal, adhesive – MIL-I-23053/4, Class 2

3. DEFINITIONS

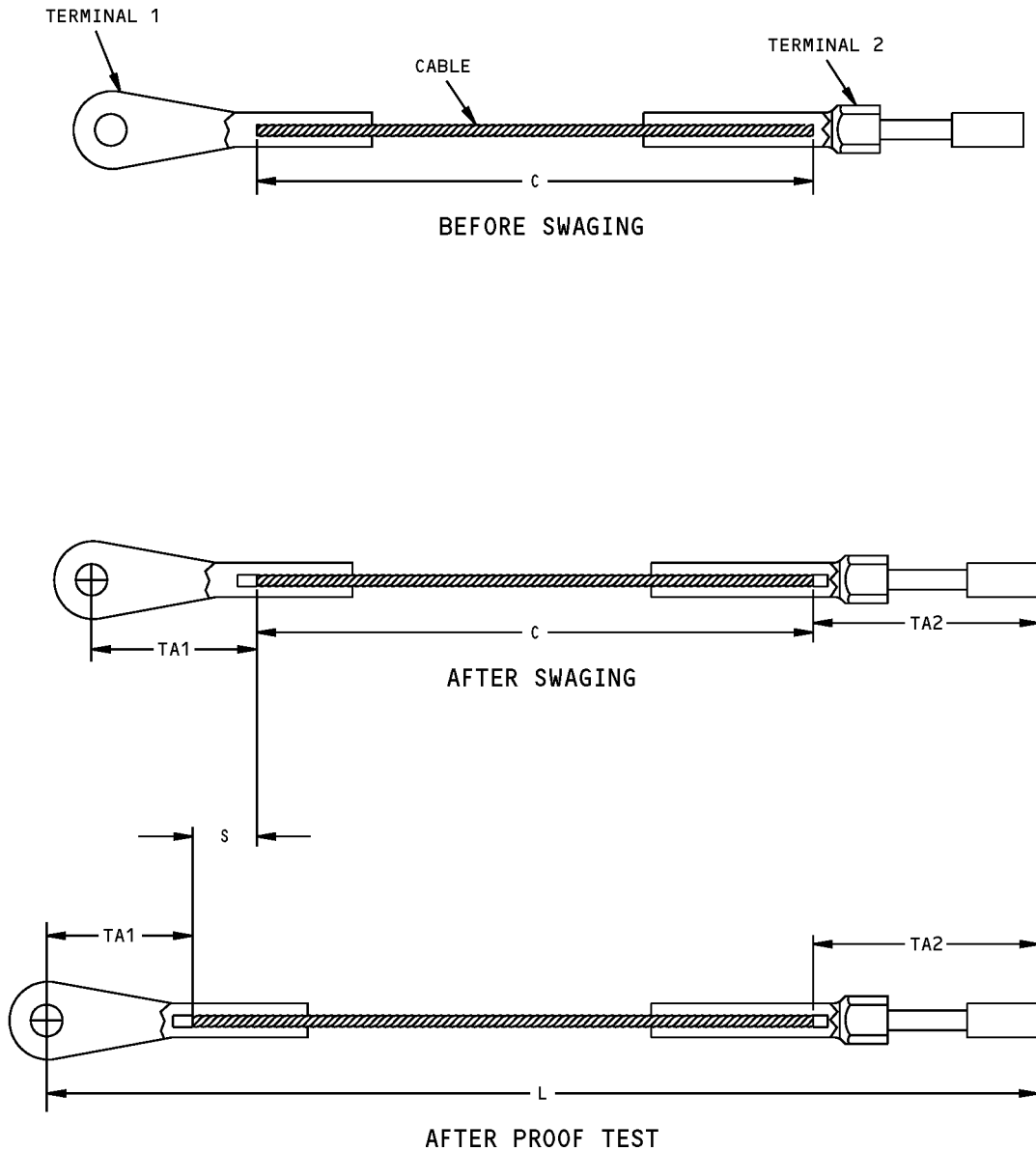
- A. One-stage assembly – The cable is completely assembled and given a proof test before it is installed in the airplane. The terminals are installed on each end of the cable at the same time.
- B. Pneumatic swaging – The terminal is swaged on the cable in dies hit with a hammer in a straight line. The terminal is turned slowly in the dies and hit in a fast series with the hammer.
- C. Press swaging – The terminal is compressed between two dies. The terminal is put in the lower die and hit once with a hammer on the upper die. Then the terminal is turned 1/4 turn and hit again. This is continued until the terminal gets to the required size, but with a minimum number of hammer hits.
- D. Rotary swaging – The terminal is swaged on the cable in dies hit with a hammer around the circumference. The terminal is put into the dies and held there until it gets to the required size.
- E. Two-stage assembly – The cable is assembled in two steps. In the first step, a terminal is installed on only one end of the cable and this assembly is given a proof test. In the second step, the other end is assembled and give a proof test after the cable is installed in the next higher assembly or in the airplane.

4. CALCULATION OF CABLE LENGTH

- A. The total length of the cable after assembly and the test will be longer than the lengths of the terminals and the cable before they are assembled. The terminals will be longer after they are swaged, and the cable will be longer after the proof test. Make sure you include an allowance for each of these changes before you cut the cable to the required length. See Figure 1 for details.
- B. In the two-stage assembly method, do the assembly and proof test at the first end of the cable. Then measure the length of the cable to the location where the other end will be. Make a reference mark here, or cut the cable to a length which is a known amount longer than the required length. After you install the cable, use the mark or remove the known amount before you swage the terminal on the second end of the cable.
- C. When you cut the cable wire rope, make sure the cut is clean and the strands do not wind off or come apart.

20-50-16

STANDARD OVERHAUL PRACTICES MANUAL



$C = L - (TA1 + TA2 + S)$ WHERE:
 C = CUT LENGTH OF CABLE
 L = FINAL ASSEMBLY LENGTH
 S = AMOUNT OF INCREASED CABLE LENGTH AFTER PROOF TEST
 $TA1$ = TERMINAL 1 ALLOWANCE AFTER SWAGING
 $TA2$ = TERMINAL 2 ALLOWANCE AFTER SWAGING

Cable Length Calculations
Figure 1

20-50-16



STANDARD OVERHAUL PRACTICES MANUAL

5. ASSEMBLY OF THE PIECES

- A. If the wire rope has a nylon jacket, remove the nylon from the end of the wire rope before you put the rope in the terminal. Remove a length of nylon to give 1/2 inch maximum clearance between the terminal and the jacket after the rope is installed in the terminal.
- B. Put the cut end of the wire rope into the bore of the terminal, down to the full depth of the bore.
- C. If the bore of the terminal does not go completely through, make sure the wire rope is at the full depth by one of these procedures:
 - (1) Measure the depth of the bore. Mark this as a length from the end of the wire rope before you install and swage the terminal.
 - (2) Use an approved nondestructive procedure after you do the proof test.
- D. Terminals can be staked on the wire rope to keep them in the correct position before they are swaged. After swaging, the depth of this stake must be a maximum of 0.003 inch. The stake must be within the minimum swage length given by Paragraph 6.F. below.
- E. If this cable assembly will be part marked with a heat-shrink tube, be sure to put the tube on the cable before you install the terminal. Refer to Paragraph 8. for more information about identification.

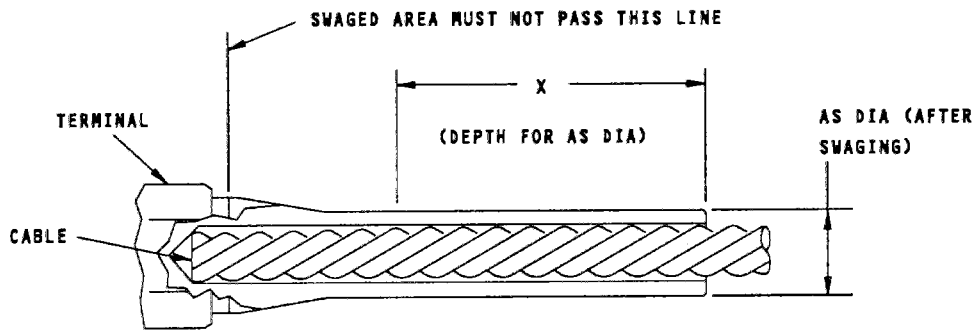
6. SWAGING

- A. You can use rotary swaging, press swaging, or pneumatic swaging. These procedures are compared in Paragraph 3.
- B. The swaging must smoothly cold-work the terminal until its dimensions agree with the data given by Paragraph 6.F.
- C. During the swaging procedure, do not let the die touch the hex, the fork, or the eye of the terminal.
- D. You can use BMS 3-24 grease or SAE 10W oil to prevent damage to the terminals or the dies.
- E. Do not swage the same terminal a second time, or soak it while it is in the dies.
- F. After the swage, the terminals must agree with:
 - (1) The applicable MS or BAC part standard, for the ball end and cylindrical terminals
 - (2) Figure 2 for MIL-T-781 standard terminals.
- G. The swaged terminal must have no pits, die marks, cracks that could be seen with a 10-power lens, or other surface defects caused by the swage procedure. Small nicks or dents are satisfactory if the swaged surface is 63 microinches or smoother.
- H. The threaded, eye, or fork end of the terminal must be straight with the centerline of the swaged end as shown in Figure 3. Do not try to bend a swaged terminal which is not straight.
- I. The length of the swaged cable assembly must agree with the required length when measured under these loads:
 - (1) 17-23 pounds, for cables with wire rope diameter (without the nylon jacket) of 3/32 inch or smaller
 - (2) 37-43 pounds, for cables with wire rope diameter (without the nylon jacket) of 3/32 inch.
- J. The cable assembly must not have kinks, damaged nylon jacket, popped cores, broken wire strands, or wire ends above the terminal ends.

20-50-16



STANDARD OVERHAUL PRACTICES MANUAL



CABLE DIA	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
X (MINIMUM)	0.70	0.80	1.05	1.29	1.31	1.55	1.70	1.89	2.06	3.12
AS DIA (MAX)	0.138	0.190	0.219	0.250	0.313	0.375	0.438	0.500	0.563	0.625
AS DIA (MIN) 1	0.133	0.185	0.214	0.243	0.306	0.368	0.431	0.492	0.555	0.617
AS DIA (MIN) 2	0.128	0.180	0.209	0.236	0.299	0.361	0.424	0.484	0.547	0.609

ALL DIMENSIONS ARE IN INCHES

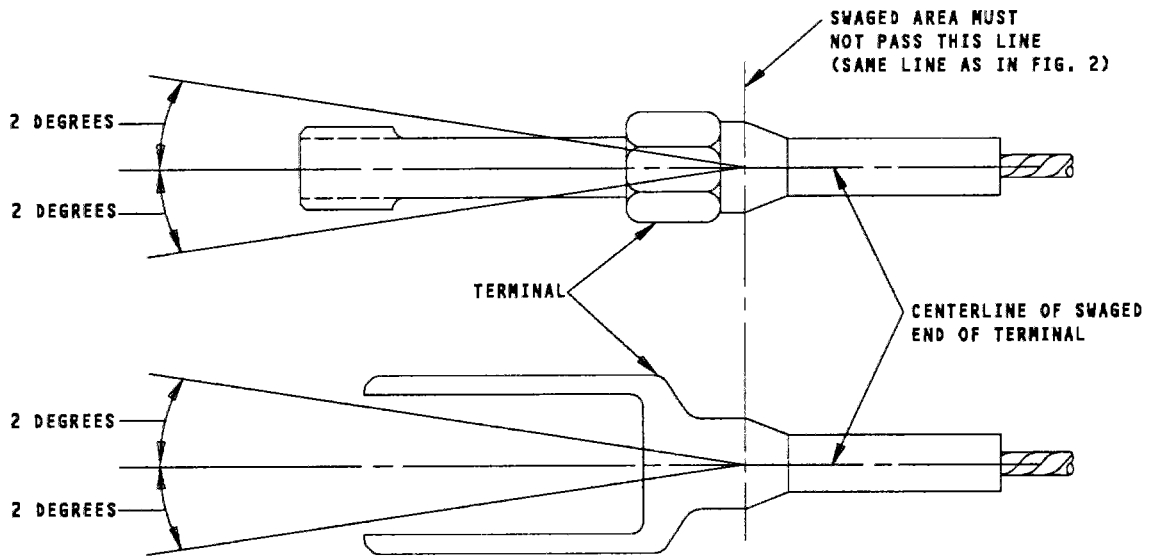
1 BASIC MINIMUM DIAMETER AFTER SWAGING

2 IN THE AREA OF THE ORIGINAL DESIGN TAPER, THE END OF THE SWAGED AREA CAN HAVE THIS MINIMUM DIAMETER

Dimensions After Swaging for MIL-T-781 Standard Terminals
Figure 2

20-50-16

STANDARD OVERHAUL PRACTICES MANUAL



Limits for Bent Terminals After Swaging
Figure 3

20-50-16



STANDARD OVERHAUL PRACTICES MANUAL

7. PROOF TEST

- A. Do a proof test on each cable assembly. Use the loads given by Figure 4. These loads are 60 percent of the load which will break the cable. Apply the load, smoothly and gradually, by a dead load or a test machine in not less than 3 seconds. Hold the load for a minimum of 5 seconds. Release the load smoothly and gradually.
- B. During the test, the terminals must not move along the cable. To see if the terminal moves, mark the cable before the test, or use an approved nondestructive procedure after the test.
- C. The cable surface or jacket must not be damaged if it is held by the load during the proof test.

20-50-16



STANDARD OVERHAUL PRACTICES MANUAL

WIRE ROPE TYPE	CABLE DIAMETER (INCH) ▸									
	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
BMS 7-265 OR MIL-W-83420 COMP. A CARBON STEEL, 7 BY 7	313 288	577 552	—	—	—	—	—	—	—	—
BMS 7-265 OR MIL-W-83420 COMP. A CARBON STEEL, 7 BY 19	—	625 600	1260 1200	1765 1680	2645 2520	3530 3360	4410 4200	5040 4800	6175 5880	9075 8640
BMS 7-265 OR MIL-W-83420 COMP. B CRES, 7 BY 7	313 288	577 552	—	—	—	—	—	—	—	—
BMS 7-265 OR MIL-W-83420 COMP. B CRES, 7 BY 19	—	577 552	1106 1056	1510 1440	2330 2220	3150 3000	4030 3840	4910 4680	5670 5400	7560 7200
MIL-W-87161 CARBON STEEL AND CRES	325 300	755 720	1325 1260	2080 1980	2960 2820	3970 3780	5170 4920	—	7870 7500	—

▸ IF THE CABLE HAS A NYLON JACKET, USE THE DIAMETER OF THE WIRE ROPE WITHOUT THE JACKET

Proof Test Loads for Cable Assemblies
Figure 4

20-50-16



STANDARD OVERHAUL PRACTICES MANUAL

8. IDENTIFICATION

- A. If the cable assembly has MS20658, MS20667, MS20668, MS21259, or MS21260 terminals, or a terminal with a swaged surface area the same or larger than a MS21259-3 terminal, permanently mark it per Paragraph 8.B. Temporarily mark all other cable assemblies per Paragraph 8.C.

B. Permanent Identification

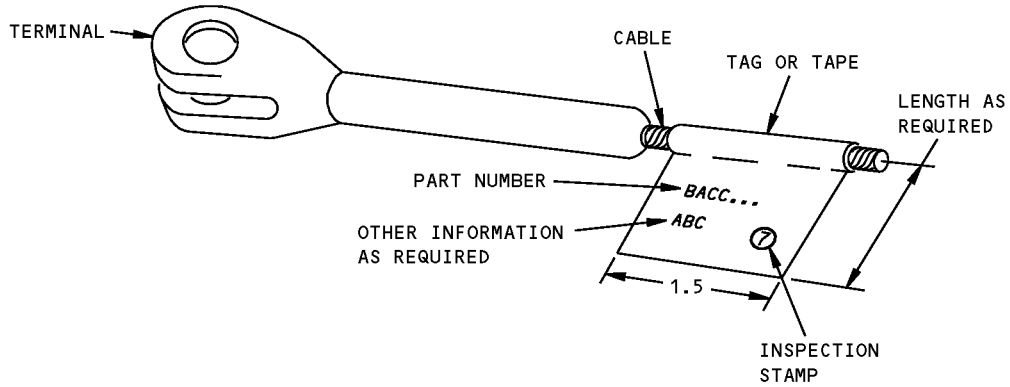
NOTE: You can mark with electrochemical etch per Paragraph 8.B.(1) before you swage, or install a hot-stamped heat-shrink tube per Paragraph 8.B.(2) after you swage that terminal on the cable.

- (1) Electrochemical Etch – Before you swage the terminal on the cable, etch the part number and other information on the shank per SOPM 20-50-10 and Figure 5.
 - (2) Hot-Stamped Heat-Shrink Tube
 - (a) Get the correct heat-shrink tube for the cable diameter per Figure 5.
 - (b) Hot-stamp the tubing per BAC5152 with the part number and other information.
 - (c) Wipe the shank of the terminal with solvent. Be careful not to remove lubricant from the cable.
 - (d) Put the marked tube on the shank of the terminal as shown in Figure 5. Shrink the tube with a hot-air gun at 500°F.
- C. Temporary Identification – Put a tag or tape on the cable as shown in Figure 5. Print, type, or stamp the part number and other information on the tag or the tape.

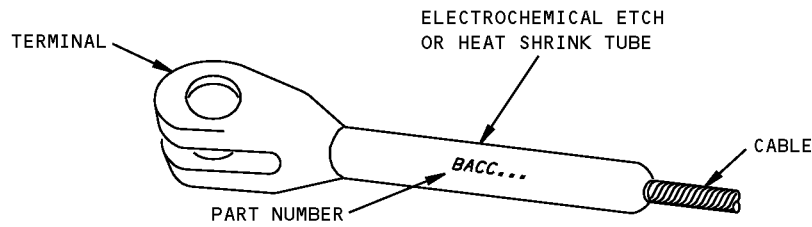
20-50-16



STANDARD OVERHAUL PRACTICES MANUAL



TEMPORARY IDENTIFICATION



PERMANENT IDENTIFICATION

CABLE DIAMETER	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
REQUIRED TUBE ID	0.250	0.250 OR 0.375	0.250 OR 0.375	0.375	0.375 OR 0.500	0.500	0.500 OR 0.750	0.750	0.750 OR 1.000	1.000

ALL DIMENSIONS ARE IN INCHES

Identification of Cable Assemblies
Figure 5

20-50-16



STANDARD OVERHAUL PRACTICES MANUAL

9. PROTECTION

- A. Lubricate per SOPM 20-50-07 all carbon steel wire rope that does not have a jacket. Do not apply grease to CRES wire rope.
- B. When you put away the cables, keep them straight, or put them in coils no smaller than the diameters of Table 1.

Table 1: Minimum Coil Diameters for Storage

CABLE DIAMETER (INCH)	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
MINIMUM COIL DIA (INCHES) (COMMERCIAL)	9	9	12	12	12	12	15	15	18	18
MINIMUM COIL DIA (MILITARY)	10	15	19	24	29	33	38	43	47	57

- C. Put the coils of cable in standard bags or bags made of MIL-B-22191 barrier materials. Close the bags with a heat seal, or fold and staple them closed.
- D. If the cable has a metal-clad section more than 12 inches longer than the coil diameter, put only the coils in the bag. If the clad section is shorter than this, put all of the cable assembly in one bag.

20-50-16