COMPONENT MAINTENANCE MANUAL

REPAIR OF ALUMINUM FUEL TUBES

PART NUMBER NONE

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COMPONENT MAINTENANCE MANUAL

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To: All holders of REPAIR OF ALUMINUM FUEL TUBES 28-00-10.

Attached is the current revision to this COMPONENT MAINTENANCE MANUAL

The COMPONENT MAINTENANCE 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

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Location of Change	Description of Change
	NO HIGHLIGHTS

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COMPONENT MAINTENANCE MANUAL

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

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COMPONENT MAINTENANCE MANUAL

TEMPORARY REVISION AND SERVICE BULLETIN RECORD

BOEING SERVICE BULLETIN	BOEING TEMPORARY REVISION	OTHER DIRECTIVE	DATE OF INCORPORATION INTO MANUAL

COMPONENT MAINTENANCE 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	
Number	Date	Date	Initials

Revision		Filed	
Number	Date	Date	Initials

Revision		Filed	
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Temporary Revision		Inserted		Removed	
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Temporary Revision		Inserted		Removed	
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Temporary Revision		Inserted		Removed	
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INTRODUCTION

1. General

A. The instructions in this manual supply the data necessary to do the maintenance functions together with the test, fault isolation, repair, and replacement of the defective parts.

B. This manual is divided into different parts:

(1) Title Page

(2) Transmittal Letter

(3) Highlights

(4) List of Effective Pages

(5) Table of Contents

(6) Temporary Revision & Service Bulletin Record

(7) Record of Revisions

(8) Record of Temporary Revisions

(9) Introduction

(10) Procedures & IPL Sections

C. Components that can be repaired have a different repair number for each specified repair. To find the repair number location of a component, look in the Repair-General procedure at the beginning of the REPAIR section. The Repair-General procedure also has an explanation of the True Position Dimension symbols used.

D. All dimensions, measures, quantities and weights included are in English units. When metric equivalents are given they will be in the parentheses that follow the English units.

E. The introduction to the Illustrated Parts List (IPL) shows how the IPL data is used.

F. Design changes, optional parts, configuration differences and Service Bulletin modifications may cause different part numbers. These part numbers are identified in the IPL with an alphabetical letter which is added to the end of the basic item number. This new item number is referred to as an alpha-variant. Throughout the manual, IPL basic item number references also apply to alpha-variants unless shown differently.

G. The tool reference numbers found in the individual procedures and in the Special Tools, Fixtures, and Equipment section are used to identify if a tool is a standard tool (STD-XXXX), a commercial tool (COM-XXXX), or a Special Tool (SPL-XXXX). This reference number is also used to distinguish between tools with similar names in the same procedure. These reference numbers are for use in the documentation only. They are not to be used for ordering tools.

REPAIR OF ALUMINUM FUEL TUBES - DESCRIPTION AND OPERATION

1. Description

A. This manual contains Boeing recommended procedures for repair of aluminum tubing used in airplane fuel systems. Repairs included range from a temporary method acceptable for small defects, to permanent methods involving replacement of tube sections in case of more extensive damage.

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REPAIR

1. Contents

A. Repair, replacement, and refinish instructions are included in separate sections, as listed.

Table 601:

P/N	NAME	REPAIR
- - - - -	COUPLING	1-1
- - - - -	TEMPORARY WELD	2-1
- - - - -	PERMANENT WELD	2-2
- - - - -	ELECTRICAL BONDING OF FUEL TUBES	3-1
- - - - -	DENT/WRINKLE	4-1

2. General

A. For small damaged areas, permanent repair of aluminum fuel tubing can be accomplished by removing short sections of tubing, and installing a rigid tube coupling. For larger areas of tube damage, which exceed the limit of tube section cutout required for installation of a single tube coupling, a longer section of the tube must be cut away and replaced with a new section of tube connected by two rigid couplings. Alternatively, some repairs may be accomplished more economically by replacing the entire end of a tube using a rigid tube coupling. All fuel tube repair work must conform to the applicable standard practices and references listed below:

NOTE: Acceptability of tube wear limits must be reviewed on an individual basis.

B. A temporary repair method for aluminum fuel tubing involves the weld repair of small punctures, cracks, and wear-through. Since this method can cause hard spots and stress concentrations, the repaired tube is limited for flight hour service use. A permanent weld repair method involves removal of the damaged section of tubing and replacing it by welding in a new section.

C. If possible, determine and correct cause of tube failure.

3. Standard Practices and References

A. Refer to the following standard practices as applicable, for details of procedures in individual repairs.

(1) SOPM 20-11-03 Repair of Electrical Terminations and Electrical Bonding Areas

(2) SOPM 20-20-02 Penetrant Methods of Inspection

(3) SOPM 20-30-02 Stripping of Protective Finishes

(4) SOPM 20-30-03 General Cleaning Procedures

(5) SOPM 20-30-80 Solvents for General Cleaning of Metal

(6) SOPM 20-30-88 Solvents for Final Cleaning of Metal Before Non-Structural Bonding

(7) SOPM 20-43-03 Alodizing

(8) SOPM 20-50-00 Installation of Tube Assemblies and Components

(9) SOPM 20-50-02 Installation of Safetying Devices

(10) SOPM 20-50-10 Application of Stencils, Insignia, Silk Screen, Part Numbering and Identification Markings

(11) SOPM 20-60-01 Cleaning Materials

B. Additional information may be obtained by reference to the following Boeing Process Specifications and Documents:

(1) BAC 5001-1 Tube Cut-Off, Tube End Forming

(2) BAC 5001-2 Pressure Testing

(3) BAC 5001-3 Tube Bending

(4) BAC 5001-5 Roller Swaged Tube End Fabrication

(5) BAC 5748 Abrasive Cleaning, Deburring and Finishing

(6) BAC 5765 Cleaning and Deoxidizing Aluminum Alloys

(7) BAC 5975 Fusion Welding of Metals

(8) BSS BSS7041 Radiographic Inspection, Radiography (Film)

(9) BAC D2024 Groove Configuration

4. Materials

NOTE: Equivalent substitutes may be used.

A. Solvent – Series 80 solvent, B01000 (SOPM 20-30-80)

B. Solvent – Series 88 solvent, B01008 (SOPM 20-30-88)

C. Lockwire – lockwire, G01048 MS20995C32

COUPLING METHOD - REPAIR 1-1

1. General

A. This procedure gives the data that is necessary to repair aluminum fuel tubing using the coupling method.

B. Refer to REPAIR-GENERAL, Paragraph 3. for the Standard Overhaul Practices Manual (SOPM) subjects and references identified in this procedure.

C. Refer to REPAIR-GENERAL, Paragraph 4. for the description of the Material codes identified in this procedure.

D. The coupling method of tube repair is approved on aluminum fuel tubing when an installation clearance of approximately 0.25 inches is available between the coupling nut and adjacent structure or components, and only if the coupling can be installed on a straight section of tube.

CAUTION: INCORRECT TUBE LENGTH AND/OR MISALIGNMENT CAN INDUCE STRESSES IN TUBE ASSEMBLY, WHICH MAY LEAD TO COUPLING LEAKAGE, BLOWOFF, OR OTHER FAILURE.

E. When replacing sections of bent tubing, ensure that tube length is correct and that proper alignment is obtained on installation. Cutout of bent tube sections should include adequate straight sections on each end to allow for swaging tool clearance (BAC 5001-1).

F. Repair is accomplished with tubing removed from airplane.

G. All repaired tube sections must be electrically bonded per REPAIR 3-1.

2. Approved Rigid Couplings for Tube Repair

A. Coupling standards approved for fuel tubing repair are presented in REPAIR 1-1, Table 601.

Table 601: Approved Rigid Couplings

PART NAME	BOEING SERIES	HYDRAFLOW SERIES	WIGGINS SERIES	MS PART NO.
Body	BACC42T-	TC001-	S83051-	- -
Ferrule	BACF32F-	TC010-	S83052-	- -
Nut	BACN10KP-	TC002-	S8305-	- -
Ring	BACR12BR-	TC001-	8395-	- -
O-Ring	- -	- -	- -	MS29513 *[1]

*[1] Standard O-ring sizes as defined by MS33666. O-ring material to be selected on the basis of fluid compatibility.

B. Use of flexible and semi-flexible couplings may be approved on an individual basis, when it can be shown that the tube is adequately supported and the flexibility is desired.

3. Coupling Installation Procedures

A. Determine length T of tube section cutout required to accommodate coupling fittings (REPAIR 1-1, Figure 601).

B. Cut out damaged tube section per BAC 5001-1.

C. Fabricate replacement tube section in accordance with drawing specifications for original tube.

D. Swage coupling fittings onto tube ends per BAC 5001-5.

E. Assemble coupling per REPAIR 1-1, Figure 602 and install lockwire, G01048 per SOPM 20-20-02, double-twist method.

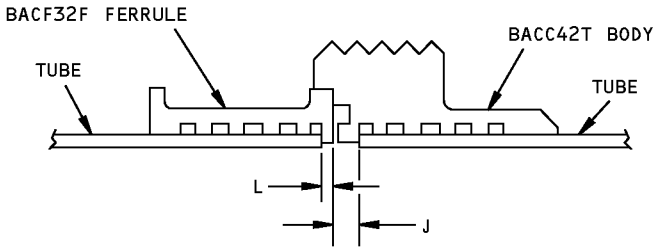
F. Install bonding jumper between tube sections per SOPM 20-11-03 and REPAIR 3-1.

4. Coupling Repair Examples

A. A typical repair for a tube with a crack running circumferentially on a fuel tube is shown in REPAIR 1-1, Figure 603. Since the width of the damaged area is less than the section cutout required to install the coupling (REPAIR 1-1, Figure 601), the single coupling repair method is acceptable.

B. In certain situations, such as a crack close to supports, structure, or the end of a tube section, replacement of the tube end section, as shown in REPAIR 1-1, Figure 604, would be more economical.

C. When length of damaged tubing exceeds amount of section cutout required to install a single coupling, longer sections of tubing may be removed and replaced using two coupling joints as shown in REPAIR 1-1, Figure 605.



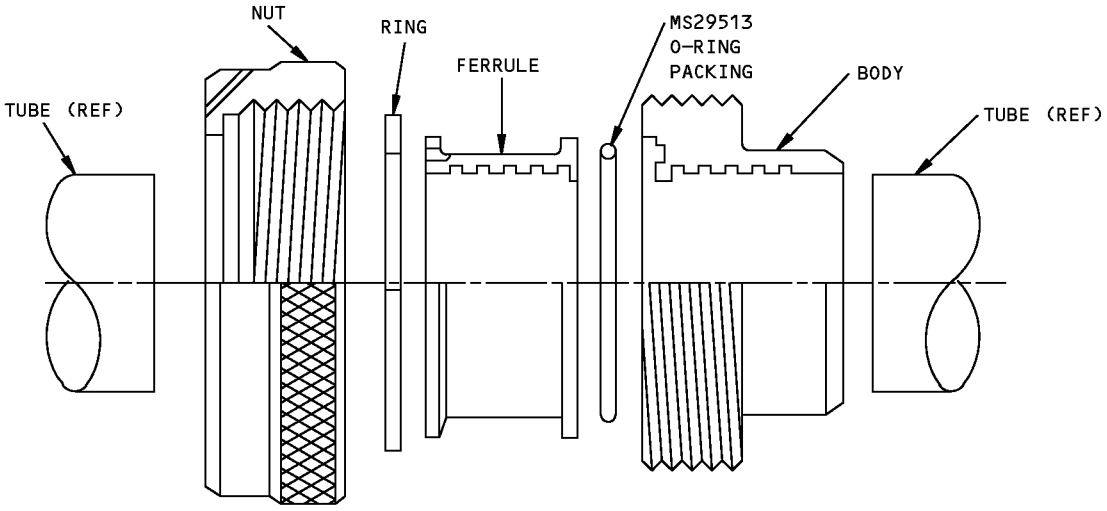
T = L + J

WHERE: T = REQUIRED TUBE SECTION CUTOUT FOR COUPLING INSTALLATION
L = TUBE SETBACK FOR COUPLING FERRULE
J = TUBE SETBACK FOR COUPLING BODY

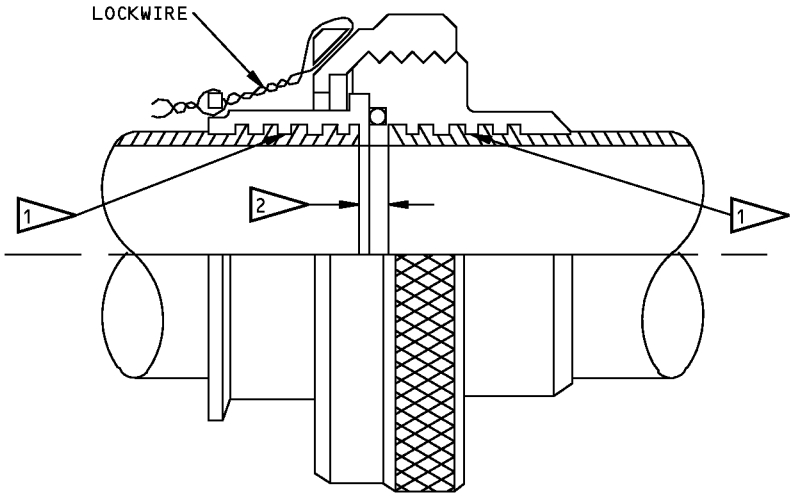
TUBE NUMBER	TUBE SIZE	L	J	T
4 5 6 8	1/4 5/16 3/8 1/2	0.035	0.09	0.125
10 12 14 16 20 24 28	5/8 3/4 7/8 1 1 1/4 1 1/2 1 3/4		0.10	0.135
32	2		0.105	
36 40	2 1/4 2 1/2		0.110	0.140
48 56	3 3 1/2		0.060	0.095
64	4	0.035		0.135
72 80	4 1/2 5	0.080	0.100	0.180
88	5 1/2		0.130	0.210

NOTE: ALL DIMENSIONS ARE IN INCHES

Tube Section Cutout to Accommodate Coupling
Figure 601



EXPLODED VIEW



ASSEMBLED VIEW

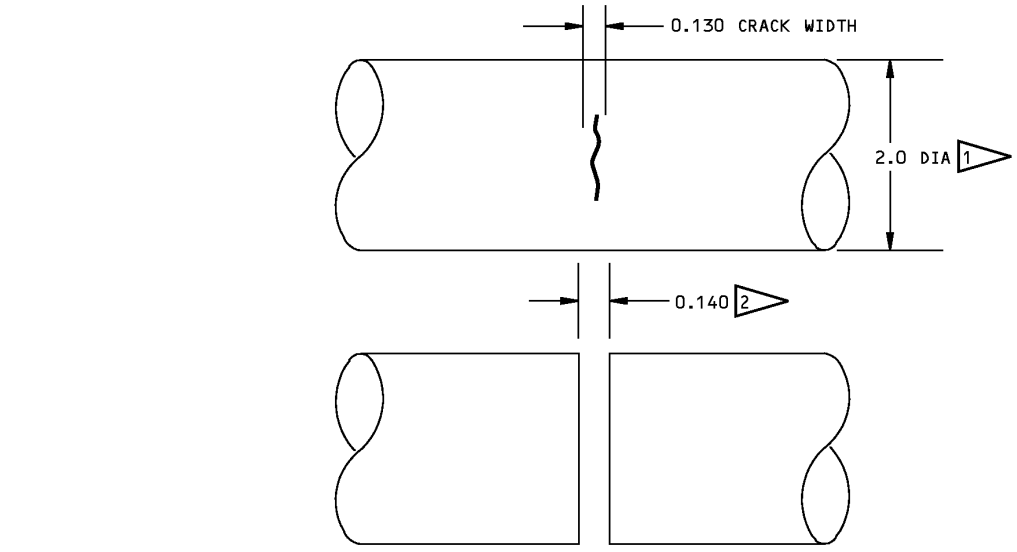
PART NAME	PART NUMBER	
	BOEING STD.	AEROSPACE STD.
BODY	BACC42T	AS1732
NUT	BACN10KP	AS1734
RING	BACR12BR	AS1736
FERRULE	BACF32F	AS1737

CONVERSION FROM SUPERSEDED BOEING STANDARD TO SUPERSEDING AEROSPACE STANDARD

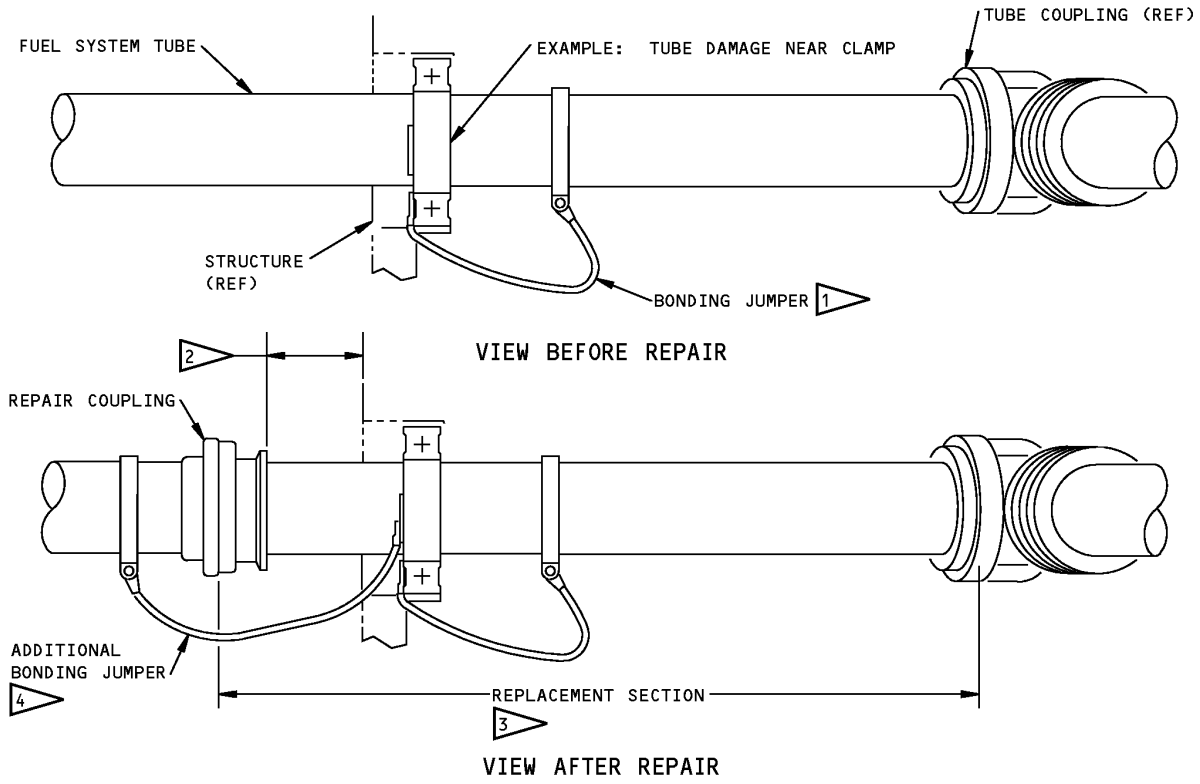
1 COUPLING FITTINGS SWAGED ONTO CUT TUBE ENDS PER BAC 5001-5

2 TUBE SECTION CUTOUT "T" PER FIG. 602

Rigid Tube Coupling Installation
Figure 602



Example of Single Coupling Repair
Figure 603



1 INSTALLATION PART

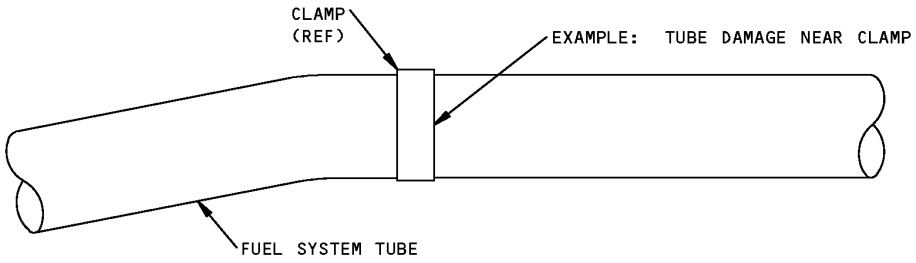
2 LOCATE COUPLING AS REQUIRED TO CLEAR DAMAGED AREA AND TO PROVIDE ADEQUATE CLEARANCE BETWEEN COUPLING AND STRUCTURE

3 FABRICATE REPLACEMENT SECTION PER CONTROLLING BOEING PROCESS SPECIFICATIONS LISTED IN REPAIR-GENERAL

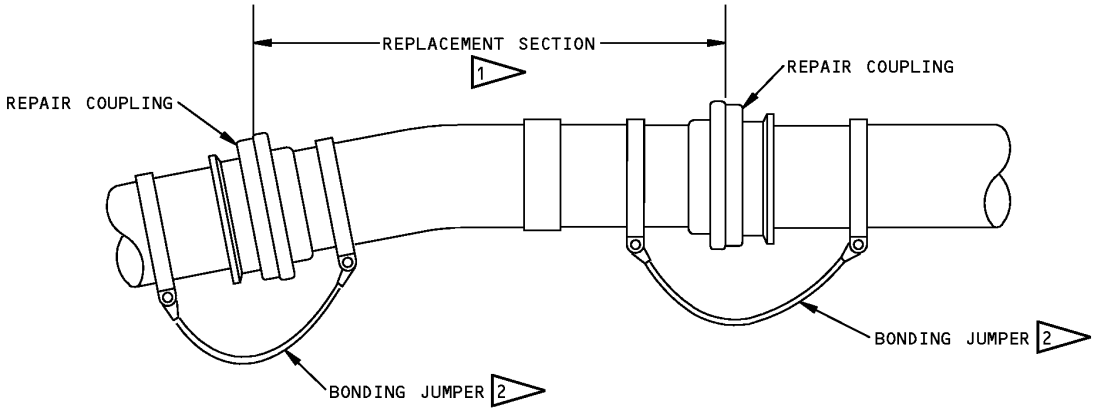
4 INSTALL PER REPAIR 3-1

NOTE: REPAIR OF STRAIGHT TUBE SECTION SHOWN. REPAIR OF RADIUS BENT TUBING SIMILAR.

Replacement of Tube End Section
Figure 604



VIEW BEFORE REPAIR



VIEW AFTER REPAIR

1 FABRICATE REPLACEMENT SECTION PER CONTROLLING BOEING PROCESS SPECIFICATIONS LISTED IN REPAIR-GENERAL

2 INSTALL PER REPAIR 3-1

Section Replacement Using Two Coupling Joints
Figure 605

TEMPORARY WELD REPAIR METHOD - REPAIR 2-1

1. General

A. This procedure gives the data that is necessary to repair aluminum fuel tubing using the temporary weld repair method.

B. Refer to REPAIR-GENERAL, Paragraph 3. for the Standard Overhaul Practices Manual (SOPM) subjects and references identified in this procedure.

C. Refer to REPAIR-GENERAL, Paragraph 4. for the description of the Material codes identified in this procedure.

CAUTION: A TEMPORARILY REPAIRED TUBE MUST BE REPLACED WITH A NEW SECTION OF TUBE WITHIN A MAXIMUM OF 250 FLIGHT HOURS.

D. This is a temporary repair method approved for 6061 and 5052 aluminum fuel system tubing, and is applicable only to tubes with wear-through damage, cracks, or punctures.

E. Repair is accomplished with tubing removed from airplane.

2. Repair Procedures

CAUTION: FAILURE TO CLEAN TUBING MAY RESULT IN CONTAMINATION OF THE WELD, THEREBY AFFECTING WELD QUALITY.

A. Completely clean inner and outer surfaces of entire tube section with Series 80 solvent, B01000 (SOPM 20-30-80), per SOPM 20-30-03.

B. If tubing is cracked, drill 3/32-inch stop holes at each end of crack.

C. Clean tubing per BAC 5765, Method 3, or use soft-bristle stainless steel wire brush, STD-130 to descale and remove all protective coatings and oxides from area to be welded, per BAC 5748.

NOTE: Wire brushes used for descaling must have bristles of austenitic corrosion-resistant steel or nickel-silver.

D. Remove all residue by wiping or rinsing with Series 88 solvent, B01008 (SOPM 20-30-88).

CAUTION: EXCESSIVE PRESSURE WITHIN TUBE DURING WELDING MAY ADVERSELY AFFECT WELD BEAD CONFIGURATION.

E. Fusion weld damaged area by gas tungsten arc process per BAC 5975, Class A, using 4043 filler rod.

3. Inspection and Testing

A. Penetrant check welded area per SOPM 20-20-02.

B. Rinse with Series 88 solvent, B01008 (SOPM 20-30-88).

C. Hydrostatically test repaired tube to 240 psig per BAC 5001-2. There shall be no leakage.

NOTE: Use the pressure test value shown on the engineering drawing to hydrostatic test fuel vent or drain tubes. Contact Boeing if a pressure test value is not shown on the drawing.

4. Refinish

A. Finish repaired area with appropriate protective coatings as required to meet original tube finish requirements.

PERMANENT WELD REPAIR METHOD - REPAIR 2-2

1. General

A. This procedure gives the data that is necessary to make a permanent weld repair.

B. Refer to REPAIR-GENERAL, Paragraph 3. for the Standard Overhaul Practices Manual (SOPM) subjects and references identified in this procedure.

C. Refer to REPAIR-GENERAL, Paragraph 4. for the description of the Material codes identified in this procedure.

CAUTION: PATCH REPAIR OF TUBING IS NOT APPROVED.

D. An acceptable method of permanent weld repair for 6061 and 5052 aluminum tubing, is to cut out a length of tube as required to remove the damaged area. The removed section is replaced by square butt welding a tube fabricated to the original tube material specifications.

E. Repair is accomplished with tubing removed from airplane.

2. Repair Procedures

CAUTION: FAILURE TO CLEAN TUBING MAY RESULT IN CONTAMINATION OF THE WELD, THEREBY AFFECTING WELD QUALITY.

A. Completely clean inner and outer surfaces of entire tube section with Series 80 solvent, B01000 (SOPM 20-30-80), per SOPM 20-30-03.

B. Secure tube in a jig with adequate clamping to prevent tube misalignment during welding.

NOTE: Tube ends should be indexed to ensure that repaired tube is of correct length and in proper alignment for reinstallation.

CAUTION: REPLACEMENT OF SHORT SECTIONS OF TUBE WITHIN A RADIUS BEND IS NOT APPROVED.

C. Cut out length of tube as required to remove entire damaged section. Tube section cutout should be at least one inch long to allow for adequate bead separation and bead uniformity. If damage occurs on a radius bend of tubing, replace entire section of tubing between radius bend tangents, plus an additional 0.25 inches, minimum, at each tangent.

D. Cut a replacement section of tubing to length, from stock made to original tube specifications, or equivalent.

E. Completely clean inner and outer surfaces of replacement tube section with Series 80 solvent, B01000 (SOPM 20-30-80) per SOPM 20-30-03.

F. Clean ends of tubing to be welded per BAC 5765, Method 3, or use soft-bristle stainless steel wire brush, STD-130 to descale and remove all protective coatings and oxides from area to be welded, per BAC 5748.

NOTE: Wire brushes used for descaling must have bristles of austenitic corrosion-resistant steel or nickel-silver.

G. Remove all residue by wiping or rinsing with Series 88 solvent, B01008 (SOPM 20-30-88).

CAUTION: EXCESSIVE PRESSURE WITHIN TUBE DURING WELDING MAY ADVERSELY AFFECT WELD BEAD CONFIGURATION.

H. Purge inside of tube with argon gas and keep filled with flowing (low volume) argon gas during welding.

I. Fusion weld (square butt) replacement tube section in place by gas tungsten arc process per BAC 5975, Class A, using 4043 filler rod.

3. Inspection and Testing

A. Penetrant check welded area per SOPM 20-20-02.

B. Radiographic inspect per BSS BSS7041, optional for the fuel vent or drain tubes unless required by the engineering drawing.

C. Rinse with Series 88 solvent, B01008 (SOPM 20-30-88).

D. Hydrostatically test repaired tube to 240 psig per BAC 5001-2. There shall be no leakage.

NOTE: Use the pressure test value shown on the engineering drawing to hydrostatic test fuel vent or drain tubes. Contact Boeing if a pressure test value is not shown on the drawing.

4. Refinish

A. Finish repaired tube section with appropriate protective coatings as required to meet original tube finish requirements.

ELECTRICAL BONDING OF FUEL TUBES - REPAIR 3-1

1. General

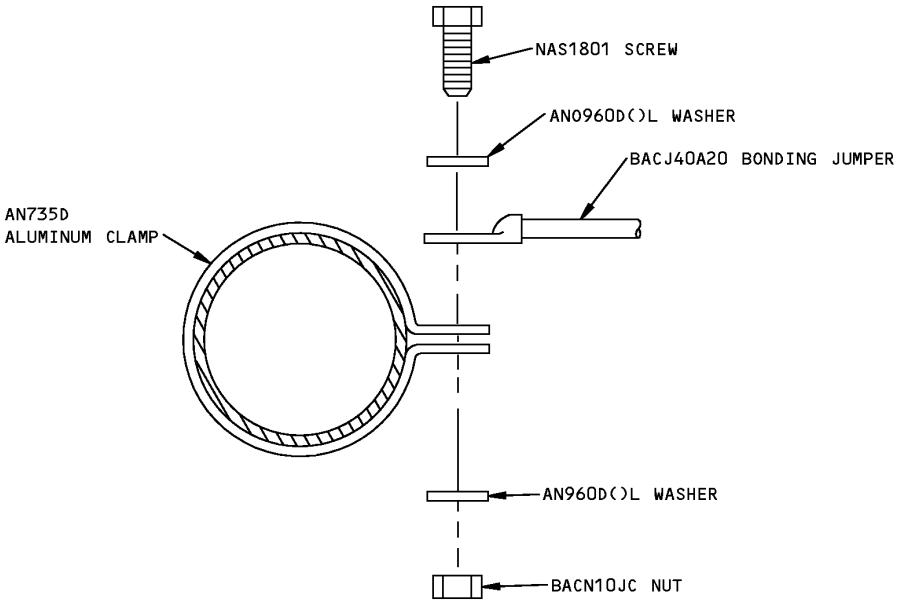
A. This procedure gives the data that is necessary to electrically bond fuel tubes.

B. Refer to REPAIR-GENERAL, Paragraph 3. for the Standard Overhaul Practices Manual (SOPM) subjects and references identified in this procedure.

2. Procedure

A. Attach bonding jumper per REPAIR 3-1, Figure 601, to connect old and new sections of tube.

NOTE: All repaired tubing must be electrically bonded after reinstallation on the airplane, as specified in applicable Maintenance Manual procedures.



Typical Bonding Jumper Installation
Figure 601

DENT/WRINKLE REPAIR PROCEDURE - REPAIR 4-1

1. General

A. This procedure gives the data that is necessary to remove dents and wrinkles from aluminum vent or drain tubes, with low system operating pressures.

B. The repair is accomplished with the tube removed from the airplane.

C. All the repaired tube sections must be electrically bonded per REPAIR 4-1.

D. Refer to REPAIR-GENERAL, Paragraph 3. for the Standard Overhaul Practices Manual (SOPM) subjects and references identified in this procedure.

E. Refer to REPAIR-GENERAL, Paragraph 4. for the description of the Material codes identified in this procedure.

2. Tube Repair

A. Procedure

CAUTION: USE NON-METALLIC TOOLS. METALLIC TOOLS ARE ONLY ALLOWED FOR INTERNAL MANDRELS OR ANVILS IF NECESSARY TO REMOVE WRINKLES.

(1) Fully clean the inner and outer surfaces of the tube section with a Series 80 solvent, B01000 (SOPM 20-30-80) per SOPM 20-30-03.

(2) Secure the tube in an adequate fixture to prevent movement if necessary.

(3) Remove wrinkles and/or dents as specified in BAC 5001-12. Reworked areas must meet the specifications of SOPM 20-50-00.

(4) Wipe or rinse with a Series 88 solvent, B01008 (SOPM 20-30-88) to remove all residue.

3. Inspection and Testing

A. Penetrant inspect reworked areas as specified in SOPM 20-20-02.

B. Radiographic inspect (BSS 7041, Radiographic Inspection), optional unless required by the engineering drawing.

C. Do a hydrostatic test of the repaired fuel vent or drain tube as specified in BAC 5001-2, there must be no leakage. Refer to the engineering drawing for the required pressure test value. Contact Boeing if a pressure test value is not on the drawing.

4. Refinish

A. Apply the applicable protective finish to the repaired area as shown on the design data.

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