BOEING

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INTERCONTINENTAL

TR
Temporary Revision

STRUCTURAL REPAIR MANUAL

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TEMPORARY REVISION 51-40

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Chapter-Section-Subject	Page No.	Date
51-2-2	1,2	Mar 15/92
	13,14	Mar 15/92

991035

FASTENER INSTALLATION AND REMOVAL

1. Fastener Installation

A. Solid shank aluminum rivets, hi-shear rivets, bolts, HI-LOK fasteners, Jo-bolts and blind hi-shear bolts may be installed with hand tools or power tools. Lockbolts must be installed with power tools. See par. 1.B. for hi-shear rivet installation, par. 1.C. for blind hi-shear bolt installation, par. 1.E. for Jo-bolt installation. See par. 1.F. for HI-LOCK fastener installation.

NOTE: The recommended bolts, HI-LOK fasteners, and lockbolts in aluminum structure are aluminum-coated titanium, aluminum-coated A-286, or cadmium-plated A-286. Cadmium-plated alloy-steel fasteners are a structurally acceptable alternative. However, in a corrosive environment the cadmium plating, which is a sacrificial coating, may disappear allowing the alloy-steel fasteners to corrode. This may result in the rust-streaking of the surrounding structure and/or the initiation of corrosion of any adjacent aluminum structure.

All these fasteners, both the recommended and the alternative should be installed wet with the appropriate sealant.

NOTE: Blind bolts used in repairs in this manual are time limited and should be inspected at frequent intervals for looseness. The repairs shown using blind bolts have FAA (DER) approval contingent on accomplishment of the inspections at the intervals stated.

B. With the exception of slipping the collar over the stud and using a special rivet set, the driving procedure for hi-shear rivets is similar to that for solid shank rivets.

NOTE: When installing a hi-shear rivet in a standard rivet hole, check that the hole size is within the limits prescribed in 51-2-5.

Hi-shear rivets may be driven from either end. To drive a hi-shear rivet from the collar end, use a hi-shear rivet set in the rivet gun and a flush-type bucking bar. To drive a hi-shear rivet from the head end, use a flush rivet set in the rivet gun and a hi-shear rivet set in a special bucking bar. See par. 3 for special tools used for installing hi-shear rivets.

NOTE: The maximum grip (measured in 1/16 inch) of the hi-shear rivet shall not exceed the material thickness by more than 1/16 inch.

C. Blind hi-shear bolts are installed by the use of blind bolt hand tools or with a B1750 power unit and gun (par. 3). With a power unit the procedure is as follows:

(1) Install correct mandrel in gun and slide rivet sleeve on mandrel.

(2) Screw rivet expander on mandrel and insert mandrel, with rivet sleeve and rivet expander, into rivet hole.

(3) Operate power unit and gun to retract the mandrel forcing the expander into the rivet sleeve.

(4) Retract mandrel from rivet by reversing motion of the gun.

(5) Install core bolt and torque with a core bolt driver.

D. There are three types of lockbolts; the tension type, the shear type, and the blind type (Fig. 1). The tension type lockbolt is installed with a special pneumatic pulling gun that swages the collar to the bolt and snaps off the excess bolt. The shear type lockbolt is driven with a special lockbolt set fitted to standard riveting equipment. A heavy bucking bar is held against the rivet head, while the set swages the collar into the locking grooves of the lockbolt. Blind lockbolts are installed using a special pull gun that swages the collar into the locking grooves and pulls off the excess bolt. See par. 3.B. for special tools used for installing lockbolts.

D. Cracked Driven Heads

(1) Cracks in driven heads are undesirable from a quality standpoint and must be kept to a minimum.

(2) Cracks on the sides of driven heads which run at a 45-degree angle to the flat surface of the head are caused by upsetting the rivet material beyond the limit of its ductility. Diagonal cracks shall be evaluated as follows:

(a) Hairline or superficial cracks are negligible in all cases regardless of their numbers. Intersecting superficial cracks are also acceptable.

(b) Rivets having diagonal cracks which do not intersect are acceptable. The maximum number shall be tnree.

(c) Rivets with severe cracks are not acceptable and should be replaced.

(3) There are two types of vertical cracks: one caused by a lap in rivet wire, and the other caused by overheat treating of the rivets. It is very important to distinguish between these two types.

(a) Cracks due to lap in rivet wire appear infrequently. The surface exposed by the cracks will be smooth and dull in appearance and will be only a few thousandths deep (0.005 to 0.015). These cracks are acceptable.

(b) When cracks from overheating appear, they are usually found in a large percentage of the rivets being driven. This cracking is due to excessive temperatures being reached during the heat treatment of the rivet.

These cracks are not acceptable, and rivets having these vertical cracks on either head shall be rejected. The batch which was overheated should be segregated and scrapped because the ductility cannot be restored by reheat treatment.

5. Tapered Shank Bolts

A. General

(1) Steel tapered shank fasteners are used in this airplane for their good fatigue properties. Where a new part or repair part is being installed with tapered shank fasteners in existing holes, it will be necessary to use an oversize fastener to ensure correct hole alignment. There are three oversizes provided for each basic size of fastener. Great care must be taken to drill and ream new parts concentrically with the existing holes to remain within the hole limits for the oversize fasteners.

(2) The recommended fasteners in aluminum structure are aluminum-coated titanium, aluminum-coated A-286, or cadmium-plated A-286. Cadmium-plated alloy-steel fasteners are a structurally acceptable alternative. However, in a corrosive environment the cadmium plating, which is a sacrificial coating, may disappear allowing the alloy-steel fastener to corrode. This may result in the rust-streaking of the surrounding structure and/or the initiation of corrosion of any adjacent aluminum structure.

All these fasteners, both the recommended and the alternative should be installed wet with the appropriate sealant.

B. Installation

(1) Tapered shank fasteners can be installed with hand tools, in the specially reamed holes described in 51-2-3, as follows:

(a) Push the fastener into the hole by finger pressure (approximately 10 pounds).

(b) Check the head protrusion with a gage to ensure that it is within the limits shown in Fig. 7.

(c) Tighten the nut with a torque wrench to the loads shown in 51-2-4. It is permissible to drive the fasteners into the tapered holes before tightening the nuts, but as extreme care has to be taken to avoid separation of the plates, it is not recommended for repair purposes.

(2) Examine installed fasteners for head dishing. Smooth uniform dishing is acceptable but bolts showing head dishing with a distinct ring are to be rejected (Fig. 8).

C. Removal

(1) Fastener removal is achieved by removing the nut and driving out the fastener. Due to the interference taper fit of the bolt, this may require some sharp blows initially, therefore the structure must be supported by a bucking bar recessed to accept the bolt during removal. Undamaged bolts may be used again, but must be relubricated with a cetyl acid before use.

MINIMUM ALLOWABLE THICKNESS FOR 100° COUNTERSINKING OF UNDERSTRUCTURES

TEMPORARY REVISION 51-41

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Chapter-Section-Subject	Page No.	Date
51-2-7	3	Jan 6/92

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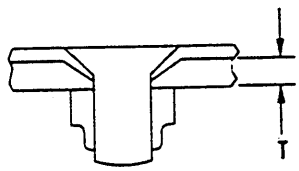
MATERIAL TYPE	MAXIMUM SHEET THICKNESS FOR GIVEN FASTENER DIAMETERS [A]				
	1/8 DIA	5/32 DIA	3/16 DIA	1/4 DIA	5/16 DIA
ALUMINUM ALLOY 2024-T3	0.071	0.071	0.071	0.063	0.050
ALUMINUM ALLOY 7075-T6	0.071	0.071	0.071	0.050	0.040
CORROSION RESISTANT STEEL, ANNEALED	0.063	0.063	0.063	0.063	0.040
CORROSION RESISTANT STEEL, 1/2 HARD	0.040	0.032	0.025	0.020	

NOTE

[A] MAXIMUM SHEET THICKNESS FOR DIMPLING WITH STATIONARY AND PORTABLE EQUIPMENT AT 90 POUNDS LINE PRESSURE.

Coin Dimpling Sheet Thickness
Figure 3



T = THICKNESS OF NON-DIMPLED COUNTERSUNK SHEET

FASTENER TYPE	MINIMUM THICKNESS T FOR GIVEN FASTENER DIAMETERS [A] [B]										
	3/32 DIA	1/8 DIA	5/32 DIA	3/16 DIA	1/4 DIA	5/16 DIA	3/8 DIA	7/16 DIA	1/2 DIA	9/16 DIA	5/8 DIA
TENSION RIVETS, BLIND RIVETS, AND ALUMINUM LOCKBOLTS	0.048	0.056	0.072	0.091	0.124	0.138	0.174				
BACR15CE SHEAR HEAD RIVETS		0.038	0.049	0.060	0.078						
SHEAR BOLTS, SHEAR LOCKBOLTS, AND SHEAR HILOKS				0.060	0.079	0.088	0.101	0.125	0.138		
TENSION BOLTS, TENSION LOCKBOLTS, TENSION HILOKS AND BLIND BOLTS				0.104	0.140	0.174	0.209	0.244	0.278	0.313	0.351

NOTE

[A] COUNTERSINKING OF HOLES FOR FASTENERS SHALL BE USED IN PREFERENCE TO DIMPLING WHEREVER STRENGTH IS NOT SACRIFICED, BECAUSE IT IS MORE ECONOMICAL AND FACILITATES REPAIR. COUNTERSINKING IS LIMITED BY THE MINIMUM SHEET THICKNESS T SHOWN IN THE TABLE. VALUES FOR T ARE BASED ON COUNTERSINK DEPTH NOT TO EXCEED 80% OF NON-DIMPLED COUNTERSUNK MATERIAL THICKNESS.

[B] THESE MINIMUM THICKNESS REQUIREMENTS ARE INTENDED TO PREVENT KNIFE EDGES IN THE COUNTERSUNK SHEET TO REDUCE THE POSSIBILITY OF FATIGUE CRACKING. SPECIFIC REPAIRS, DEFINED ELSEWHERE IN THIS REPAIR MANUAL, WHICH DEVIATE FROM THESE REQUIREMENTS, SUPERSEDE THESE REQUIREMENTS.

Minimum Allowable Thickness for 100° Countersinking of Understructures
Figure 4

MINIMUM ALLOWABLE SHEET THICKNESS FOR 100° COUNTERSINKING

TEMPORARY REVISION 51-42

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51-2-8	5	Jan 6/92

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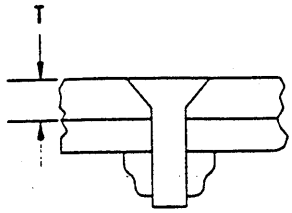

T = THICKNESS OF SHEET HELD IN PLACE BY FLUSH HEAD

FASTENER TYPE	MINIMUM THICKNESS T FOR GIVEN FASTENER DIAMETERS [A] [B]										
	3/32 DIA	1/8 DIA	5/32 DIA	3/16 DIA	1/4 DIA	5/16 DIA	3/8 DIA	7/16 DIA	1/2 DIA	9/16 DIA	5/8 DIA
TENSION RIVETS AND BLIND RIVETS	0.048	0.056	0.072	0.091	0.124	0.138	0.174				
BACR15CE AND NAS 1200 SHEAR HEAD RIVETS		0.038	0.049	0.060	0.078						
SHEAR BOLTS, SHEAR LOCKBOLTS, AND SHEAR HILOKS				0.060	0.079	0.088	0.101	0.125	0.138		
TENSION BOLTS, TENSION LOCKBOLTS, TENSION HILOKS AND BLIND BOLTS				0.104	0.140	0.174	0.209	0.244	0.278	0.313	0.351

NOTE

[A] VALUES APPLY TO ANY COMBINATION OF FASTENER AND FASTENED MATERIAL, AND ARE BASED UPON ZERO FLUSHNESS. WHERE FASTENER HEAD IS PERMITTED BELOW FLUSH, T SHALL BE INCREASED BY AN AMOUNT EQUAL TO THE MAXIMUM PERMITTED BELOW FLUSHNESS. VALUES FOR T ARE BASED ON COUNTERSINK DEPTH NOT TO EXCEED 80% OF MATERIAL THICKNESS. FASTENER HEAD SHALL NOT BE SHAVED TO SATISFY THE 80% THICKNESS LIMIT. USE PROTRUDING HEAD FASTENERS WHEN THICKNESS T IS NOT SUFFICIENT FOR COUNTERSINK FASTENERS.

[B] THESE MINIMUM THICKNESS REQUIREMENTS ARE INTENDED TO PREVENT KNIFE EDGES IN THE COUNTERSUNK SHEET TO REDUCE THE POSSIBILITY OF FATIGUE CRACKING. SPECIFIC REPAIRS, DEFINED ELSEWHERE IN THIS REPAIR MANUAL, WHICH DEVIATE FROM THESE REQUIREMENTS, SUPERSEDE THESE REQUIREMENTS.

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Minimum Sheet Thickness for Countersinking for 100° Head Fasteners
Figure 3

TEMPORARY REVISION 51-43

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Chapter-Section-Subject	Page No.	Date
51-8-4	1 thru 10	Apr 7/95

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FREEZE PLUG INSTALLATION

1. General

A. A freeze plug is a structural repair that can be used to repair aluminum structure. Because the freeze plug is installed with interference in a hole it will transmit compressive loads. A freeze plug is better for durability than a non-interference plug or an open hole.

NOTE: This procedure outlines the installation of aluminum freeze plugs. Installation of freeze plugs at specific locations will require a structural engineering review.

To use freeze plugs, the thickness of the material to be repaired must be a minimum of 0.063 inch.

B. It is best to have parts on each side of the freeze plug to contain it. Refer to Figure 1, Detail I. When the freeze plug cannot be contained between two other parts, use straps, washers, or countersinks. Refer to Figure 1, Detail II. Install the washers and straps with BMS 5-95 sealant between the mating surfaces. Refer to 51-9-1. If more than one structural member is damaged, a separate freeze plug must be used in each part. Refer to Figure 1, Detail III. Shims can be used temporarily between structural members to make sure the freeze plugs are installed flush. Remove those shims after the freeze plug is installed. Skin and bonded doublers can be plugged together if there is no delamination. Refer to Figure 1, Detail IV.

NOTE: To define the edge margin and the diameter of the freeze plug installation, use the diameter of the freeze plug hole and not the diameter of the fastener hole through the freeze plug.

E96370

2. Freeze Plug Installation

A. Straight Shank Freeze Plug Installation

(1) Use the smallest diameter drill and reamer possible to remove the damage. Refer to 51-13-1. Remove the nicks, scratches, burrs, and sharp edges from the freeze plug hole. Make sure the freeze plug will have a minimum of 0.05 inch wall thickness when the fastener hole is drilled through it. Refer to Figure 2, Detail I. Measure the diameter of the freeze plug hole to 4 decimal positions (.XXXX). The cylindricity tolerance on the freeze plug hole is 0.0003 inch. Refer to Figure 3 for the definition of cylindricity. The surface finish of the freeze plug hole must be 63 microinches Ra or smoother. Measure the thickness of the damaged aluminum structure to 3 decimal positions (.XXX). Refer to Figure 2, Section A-A.

(2) The freeze plug shank diameter must be 1.0035 to 1.0040 times larger than the diameter of the hole. For example, if the hole has a diameter of 0.4500 inch, then the freeze plug diameter must be 0.4516/0.4518 inch. Make the straight shank freeze plug from 7075-T6 aluminum with a cylindricity tolerance of 0.0002 inch. Machine the freeze plug outer diameter to a surface finish of 63 microinches Ra or smoother. Measure the final outer diameter of the freeze plug to 4 decimal positions (.XXXX). Apply a chemical conversion coating to all of the freeze plug. Refer to 51-8-0.

(3) For freeze plugs in more than one structural member, chamfer the mating edges of the freeze plug 45° x 0.003/0.006 inch. Refer to Figure 4, Detail I.

(4) The thickness of the freeze plug must be the same or larger than the material thickness that is measured. Drill a pilot hole through the center of the freeze plug, if a fastener will be installed.

WARNING: LIQUID NITROGEN IS APPROXIMATELY MINUS 320°F (MINUS 196°C). WEAR PROTECTIVE CLOTHING, AND USE IN A WELL-VENTILATED AREA TO PREVENT INJURY.

E96371

2. A. (5) Put the freeze plug in liquid nitrogen for a minimum of ten minutes immediately before installation. In thick structure, apply BMS 5-95 sealant to the edges of the hole to help the installation of the freeze plug. Install the freeze plug flush to +0.003/-0.000 inch. Microshave the freeze plug if necessary. Refer to 51-4-1.

(6) For freeze plug in more than one structural member the freeze plug mating surface must be 0.003 inch or less above or below the structure mating surface. Refer to Figure 4, Detail I.

(7) Drill the fastener hole through the freeze plug pilot hole and the structure that is attached. Make sure the freeze plug has a minimum wall thickness of 0.05 inch. Refer to Figure 2, Detail I. Apply a finish to the bare surfaces of the freeze plug that is the same as the finish on the adjacent structure. Refer to 51-8-0. Install a fastener through the freeze plug and the structure that is attached.

B. Countersunk Freeze Plug Installation

CAUTION: COUNTERSUNK FREEZE PLUGS MAY BE UNACCEPTABLE IN CERTAIN SITUATIONS. GET APPROVAL FROM BOEING BEFORE A COUNTERSUNK FREEZE PLUG IS INSTALLED.

(1) Use the smallest diameter drill and reamer possible to remove the damage. Refer to 51-13-1. Remove the nicks, scratches, burrs, and sharp edges from the freeze plug hole. Make sure the freeze plug will have a minimum 0.05 inch wall thickness when the fastener hole is drilled through it. Refer to Figure 5, Section A-A. Measure the diameter of the freeze plug hole to 4 decimal positions (.XXXX). The cylindricity tolerance on the freeze plug hole is 0.0003 inch. Refer to Figure 3 for the definition of cylindricity. The surface finish of the freeze plug hole must be 63 microinches Ra or smoother. Measure the thickness of the damaged aluminum structure to 3 decimal positions (.XXX). Refer to Figure 5, Section A-A.

E96375

2. B. (2) The freeze plug shank diameter must be 1.0035 to 1.0040 times larger than the diameter of the hole. For example, if the hole has a diameter of 0.4500 inch, then the freeze plug diameter must be 0.4516/0.4518 inch. Make the countersunk freeze plug from 7075-T6 aluminum with a cylindricity tolerance of 0.0002 inch. The freeze plug must have a 100° countersink. Machine the freeze plug outer diameter to a surface finish of 63 microinches Ra or smoother. Measure the final shank diameter of the freeze plug to 4 decimal positions (.XXXX). Apply a chemical conversion coating to all of the freeze plug. Refer to 51-8-0.

NOTE: The countersink depth of the freeze plug must not be larger than 50 percent of the aluminum structure thickness. The countersink depth must also not be deeper than the countersink depth of the fastener which was removed. 0.04 to 0.08 inch is the usual range of countersink depths for freeze plugs in the inspar wing skin.

(3) For freeze plugs in more than one structural member, chamfer the mating edges of the freeze plug 45° x 0.003/0.006. Refer to Figure 4, Detail I.

(4) The thickness of the freeze plug must be the same or larger than the material thickness that is measured. The thickness of clad freeze plugs must be +0.003/-0.000 inch of the material thickness. Drill a pilot hole through the center of the freeze plug, if a fastener is to be installed.

(5) Make a 100° countersink in the structure so that the diameter of the countersink is the same as the diameter of the freeze plug. If you are not sure that the adjustment of the countersink tool is correct, make a countersink in a piece of metal that has been discarded. You can do this to make sure that the depth of countersink in the structure will be correct. Refer to 51-2-8.

WARNING: LIQUID NITROGEN IS APPROXIMATELY MINUS 320°F (MINUS 196°C). WEAR PROTECTIVE CLOTHING, AND USE IN A WELL-VENTILATED AREA TO PREVENT INJURY.

E96380

2. B. (7) Put the freeze plug in liquid nitrogen for a minimum of ten minutes immediately before installation. In thick structure apply BMS 5-95 sealant to the edges of the hole to help the installation of the freeze plug. Install the freeze plug flush to +0.003/-0.000 inch. Microshave the freeze plug if necessary. Refer to 51-4-1.

NOTE: Do not microshave the clad side of clad freeze plugs that will be installed in external surfaces that are not painted.

(8) For freeze plugs in more than one structural member, the freeze plug mating surface must be 0.0003 inch or less above or below the structure mating surface. Refer to Figure 4, Detail I.

(9) Drill the fastener hole through the freeze plug pilot hole and the structure that is attached. Make sure the freeze plug has a minimum wall thickness of 0.05 inch. Refer to Figure 5. Apply a finish to the bare surfaces of the freeze plug that is the same as the finish on the adjacent structure. Refer to 51-8-0. Install a fastener through the freeze plug and the structure that is attached.

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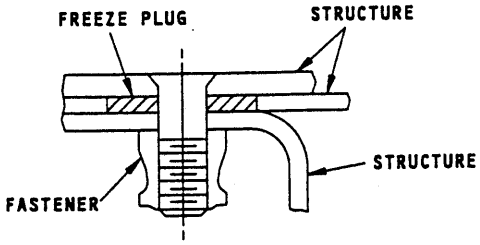
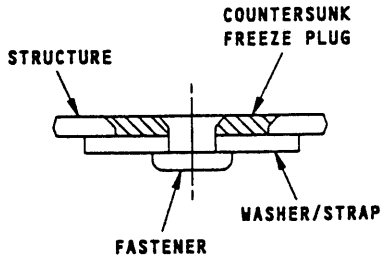


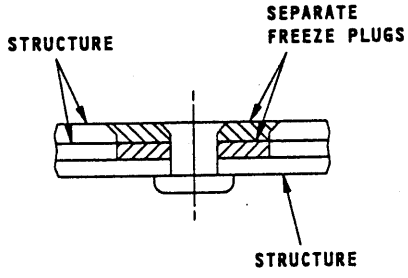
FREEZE PLUG THAT IS CONTAINED BETWEEN TWO OTHER PARTS

DETAIL I



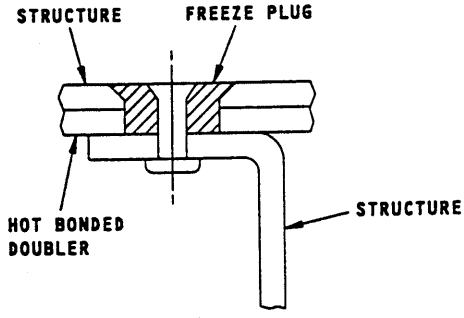
FREEZE PLUG WITH WASHER/STRAP

DETAIL II



FREEZE PLUGS IN MORE THAN ONE STRUCTURAL MEMBER

DETAIL III



SINGLE FREEZE PLUG IN STRUCTURE WITH HOT BONDED DOUBLER

DETAIL IV

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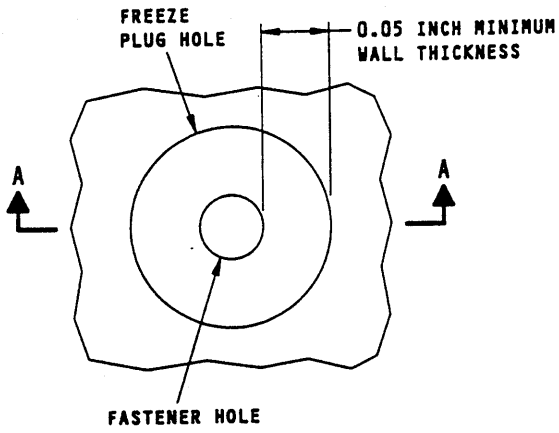
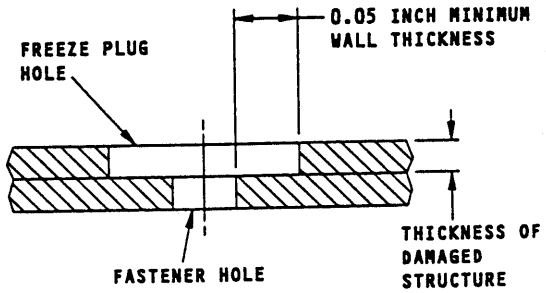
Examples of Freeze Plug Installation
Figure 1

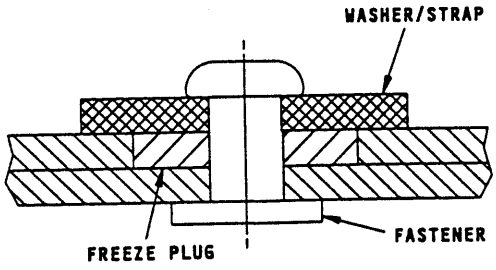


BEFORE INSTALLATION OF
THE FREEZE PLUG

DETAIL I



SECTION A-A



AFTER INSTALLATION OF
THE FREEZE PLUG

Straight Shank Freeze Plug Installation
Figure 2

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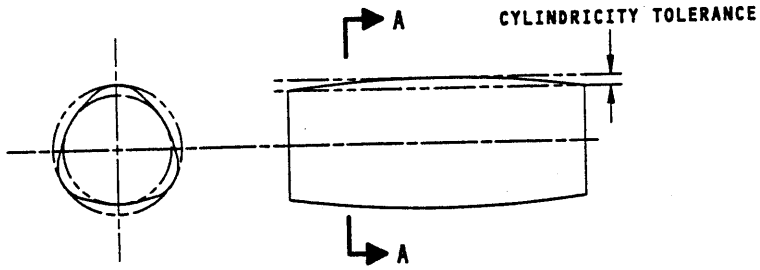


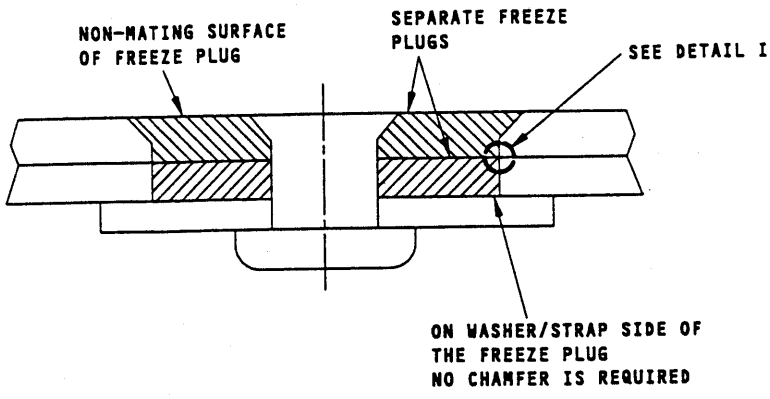
SECTION A-A

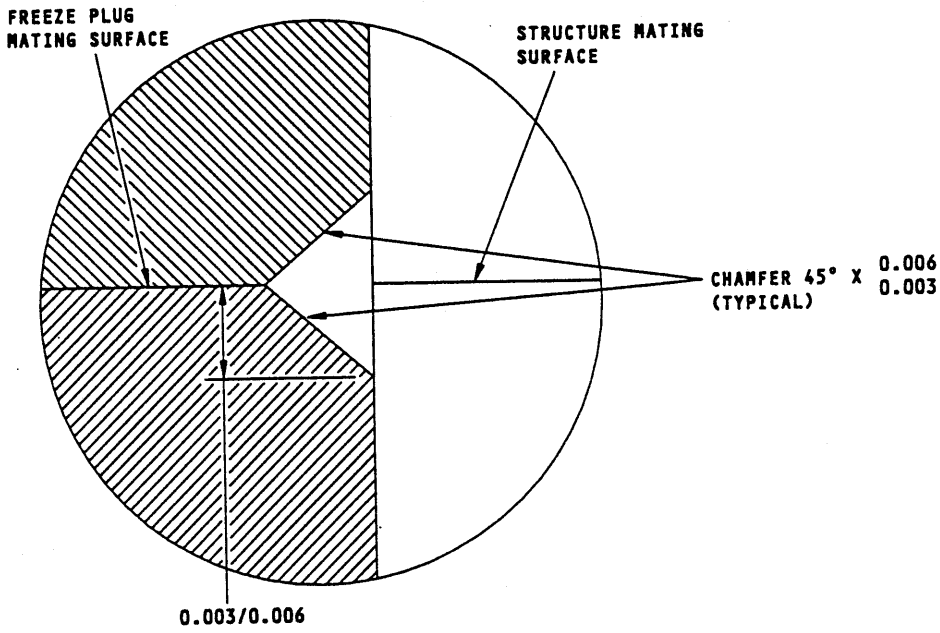
NOTES

- CYLINDRICITY IS A CONDITION WHERE ALL POINTS ON A SURFACE ARE AN EQUAL DISTANCE FROM THE SAME AXIS. A CYLINDRICITY TOLERANCE SPECIFIES AN AREA WITH TWO CYLINDERS AS LIMITS, THAT THE SURFACE MUST BE BETWEEN.
- FOR THE FREEZE PLUG INSTALLATION, THOSE AXES ARE:
  - THE CENTER OF THE HOLE THAT WILL BE REPAIRED.
  - THE CENTER OF THE FREEZE PLUG USED TO REPAIR THE HOLE.
- THE SURFACES THAT THE TOLERANCES APPLY TO ARE:
  - THE HOLE THAT WILL BE REPAIRED.
  - THE FREEZE PLUG USED TO REPAIR THE HOLE.

E96394

Cylindricity
Figure 3





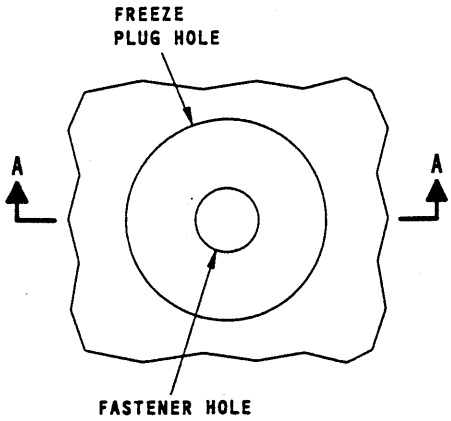
DETAIL I

NOTES

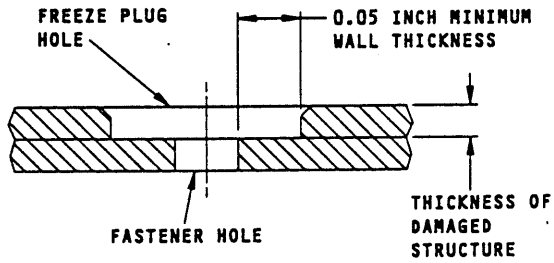
- ALL DIMENSIONS SHOWN ARE IN INCHES.
- THE FREEZE PLUG MATING SURFACE MUST BE 0.003 INCH OR LESS ABOVE OR BELOW THE STRUCTURE MATING SURFACE.

Freeze Plugs in More Than One Structural Member
Figure 4

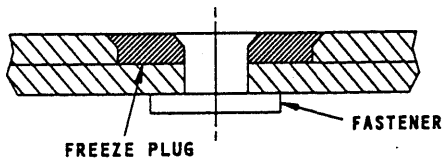
E96399



BEFORE INSTALLATION OF
THE FREEZE PLUG
DETAIL I



SECTION A-A



AFTER INSTALLATION OF
THE FREEZE PLUG

Countersunk Freeze Plug Installation
Figure 5

E96401

TEMPORARY REVISION 51-44

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

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Chapter-Section-Subject	Page No.	Date
51-8-3	1 thru 11	Apr 7/95

E96422

MACHINING AND DRILLING OF TITANIUM AND INCONEL MATERIALS

1. General

A. This section includes special machining and drilling requirements for titanium alloys and inconel.

B. Refer to par. 2 for titanium alloys. Refer to par. 3 for inconel.

2. Titanium Alloys

WARNING: AVOID SOURCES OF IGNITION. SMALL PARTICLES AND FINE SHAVINGS OF TITANIUM IGNITE EASILY AND PRESENT AN EXTREME FIRE HAZARD. TITANIUM DUST IS HIGHLY FLAMMABLE, AND IN THE PROPER CONCENTRATION MAY CAUSE AN EXPLOSION.

WATER IN CONTACT WITH MOLTEN TITANIUM PRESENTS A STEAM EXPLOSION HAZARD. EXTINGUISH FIRES OF TITANIUM WITH ABSOLUTELY DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE BY APPLYING THE POWDER TO A DEPTH OF 1/2 INCH OR MORE OVER THE BURNING METAL. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE.

A. Titanium alloy resembles corrosion resistant steel and is comparable to it in strength. Titanium alloy weighs about 56 percent of the weight of steel.

B. Titanium alloy does not require a protective coating because corrosion resistance is very good; however, it is cathodic to magnesium and aluminum and must be insulated from them. See SRM 51-8-0 and SRM 51-9-1 for protective treatment and fay sealing.

E96426

2. C. Titanium alloy (6AL-4V) can be hand drilled for the smaller sizes only (up to 5/32-inch diameter), since the required high thrust force prevents a uniform chip and causes a breakthrough surge resulting in poor drill lift. Holes larger than 5/32-inch diameter can be hand drilled by starting with a 5/32-inch drill and gradually enlarging the hole in 1/16-inch increments. Standard high speed steel drills are recommended for hand drilling although the drill life for this material may be reduced. The following RPM and IPR (inches per revolution) ranges for hand drilling are recommended for the drill sizes quoted:

1/16	917-1833 RPM; 0.0015 IPR
1/8	458-917 RPM; 0.002 IPR
3/16	229-458 RPM; 0.002 IPR

When conventional drills are used, depth limit, at the speeds listed above, is one drill diameter dry and two drill diameters with a coolant. Drills should be examined and changed frequently as the life is several times shorter than when used for drilling steel. The use of a blunt drill, or allowing a drill to dwell or rub on the work without cutting will produce a polished work hardened surface, and will make it extremely difficult to restart the drilling operation. Titanium has a low thermal conductivity, and when hot has a strong affinity for other metals; chips will often weld themselves to the cutting edge of the drill if the drill speed is too high. When drilling heavy plate or extrusions, the use of water soluble coolants and sulphurized oils are beneficial. Refer also to par. 2.I.(7).

D. Titanium alloys can be hand reamed using straight fluted chucking reamers or reamers with minimum margins (0.010 inch or less). Conventional high speed steel reamers are recommended for hand reaming. Use a drill motor (Fig. 1) with a free speed of less than 600 RPM. Reaming feed rates should be equal to at least to those listed above for drilling. Reaming time for a given hole should be equal to, or less than the drilling time required. Use a maximum feed rate which will give an acceptable hole finish. The reamer should always be cutting. A cutting fluid is required for hole depths greater than one drill diameter. The effect of reaming dry or with a lubricant on the resulting hole size is as follows:

Without lubricant: 0.000 to 0.005 inch over reamer diameter
With lubricant: 0.000 to 0.004 inch over reamer diameter

(1) Final hand reaming requires a minimum cut of 1/32 inch on the diameter for 5/32 inch and larger holes to ensure good hole cleanup. Cut 1/64 inch on the diameter for holes less than 5/32 inch.

E96432

2. D. (2) Remove reamer from the hole before stopping rotation.

(3) When reamers are resized from stock reamers, they are usually circle ground, which increases margin width. Margin widths must be reduced to 0.010-0.015 inch to avoid oversize holes.

E. Generally, countersinking of titanium alloys can be accomplished by using the same speeds and feeds recommended as above, for drilling operations. Hand countersinking for holes greater than 3/16 diameter is impractical due to the higher thrust requirements. Hand fed portable power units can be used with a microstop countersink tool for depth control of holes up to 3/16-inch diameter. A typical tool for this procedure is the Zephyr model ZT 330, manufactured by Zephyr Manufacturing Co., Englewood, California. Use conventional high speed steel cutters. When a coolant is used, speed of the cutter may vary from 25 to 30 SFM expressed as surface feet per minute. Without a coolant, the cutter speed should vary between 20 and 25 SFM.

F. Machining procedures for titanium alloys which involve nonportable tooling procedures may be found in 20-10-07, of the Standard Overhaul Practices Manual, D6-51702.

G. Edge finish requirements shall be one of three types, depending on the repair procedure;

Type I - Deburr. The radius or chamfer shall be approximately 0.008 inch.

Type II - Visual clean up. Remove previously damaged material. Radius or chamfer approximately 0.008 inch.

Type III - Clean up by sanding or machining after specified stock removal. Maintain radius or chamfer of approximately 0.008 inch.

(1) Visual examination of the 0.008-inch radius or chamfer is satisfactory. However, all rough projections, scratches, and nicks must be removed.

AS CUT EDGE	FINISH TYPE
Sheared	III
Nibbled (Portable Tool)	II
Sanded	I
Abrasive Sawed	III

E96436

2. H. Portable Trimming Tools for Titanium Alloys

(1) Tools which operate on a shearing principle, such as roller shears and nibblers generally work well in titanium alloys; however, applicable thickness ranges are considerably narrowed. Saber saws can also be used but their performance is marginal and tool life is poor. Hand routing or similar chip-removal operations are not practical because it is extremely difficult to hold the tool in the cut and to maintain a constant chip load.

(2) Most portable tools are designed for easy-to-cut materials such as aluminum or mild steel. Consequently, their operating speeds are frequently too high, so that they must be throttled down to a more acceptable speed. These tools often are not rigid or powerful enough for the higher loads required to cut titanium alloys, thus limiting the applicable thickness range to only a fraction of the tools' rating. For example a nibbler rated at 0.180 (mild steel) may be limited to only 0.100 inch in titanium. As a general rule for selecting portable trimming tools, choose one with a rated capacity at least twice that of the titanium gage thickness.

(3) Outlined below are specifications of some portable tools that have been used and suggestions for their use.

(4) Roller shearing is an effective method of trimming light-gage skins up to 0.100 inch. Beyond this, edge cracks may be a problem, requiring excessive hand finishing. Specifications are listed in Table I of Fig. 2.

(5) Nibblers

(a) Portable nibblers provide a more versatile approach. They can be used not only for trimming, but also for cutouts and irregular periphery.

(b) Portable nibblers can be used for titanium sheet up to 0.100 inch thick. The resultant edge will be square but scalloped and lightly burred. Excessive burring is a sign that the punch has failed. Hand finishing will be required, but less than 0.010-inch removal will clean up burrs and feed marks. Specifications for three types of nibblers that can be used are listed in Table II of Fig. 2.

E96438

2. H. (5) (c) Low speed motors (approximately 450 strokes per minute) should be used.

(d) With low speed motors, dry cutting is practical. Otherwise a TJ-73 spray (Mobile Oil Company, synthetic, water-soluble oil) should be used to attain a reasonable life.

(6) Saber Saws

(a) Saber saws, such as the Air Speed, Model R, may be used when access is limited. However, cutting rates are slow and tool life is poor. See Table III of Fig. 2.

(7) Vendors for portable trimming tools:

(a) Roller Shears	E.A. Selger and Associates 15532 Commerce Lane Huntington Beach, California 92649 Supplies for Industry 15086 N.E. 40th St. Redmond, Washington 98052
(b) Nibblers	Allen Bradley Co. Rockwell International Corp. 10138 Two Notch Rd. Columbia, South Carolina 29223 Black and Decker /US/Inc. 701 East Joppa Road Towson, Maryland 21204
(c) Saber Saws	Air Speed Tool Co. 1218 South Gerhart St. Los Angeles, California 90022

I. Hand Drilling

(1) Hand drilling is defined as using portable, hand-held, hand-controlled (feed and speed) drilling equipment. See Fig. 1 for a listing of vendor tools which lists general specifications.

(2) Hand feed drilling equipment should only be used where configuration access, tooling problems, or economics prevents the use of positive-power-feed equipment.

(3) The following hand drilling disadvantages must be considered:

(a) Overfeeding and subsequent drill breakage

E96441

2. I. (3) (b) Angular or oversize holes

(c) High operator fatigue

(d) Limited hole size due to thrust requirements

(e) Short drill life

(f) Generally poor hole quality

(g) Subsequent reaming may be required

(4) Size Limitation

(a) A practical maximum hole size for hand drilling in one operation is 5/32-inch diameter. Holes of 3/16-inch diameter can be drilled in one shot but with some difficulty because of the high thrust requirement. Larger holes can be step drilled by starting with a 5/32-inch diameter hole and enlarging it in steps of 0.060 to 0.100 inch on the diameter until the desired size is obtained. Holes up to 3/4-inch diameter have been produced by this method. When right-angle-drive drill motors are used for step drilling, holes should be opened up in 1/32-inch increments because of the additional difficulty of exerting thrust with this type of drill motor.

(5) Equipment

(a) Select a drill motor with a rated free speed in RPM suited to drill diameter. The smaller size drills (1/8- to 5/32-inch diameter) should be used with the 500 to 1000 RPM drill motors. The larger size drills (3/16- to 1/4-inch diameter) should be used with the 300 to 500 RPM drill motors. Offset handle (pistol grip) type drill motors are preferred due to the high thrust forces required.

(6) Clamping

(a) Use temporary bolts, power-driven Cleco clamps, or auxiliary tooling clamps around or adjacent to the hole if possible when two or more pieces of titanium are being drilled together. Additionally, the use of backup on thin or flexible titanium parts aids in producing quality holes and minimizes drill breakage which can occur as the drill breaks through the exit side of the part. This backup also reduces the height of the exit burr.

E96442

2. I. (7) Cutting Fluids

(a) A suitable cutting fluid improves hole tolerance, and cutting tool life. Applying cutting fluid as a spray mist may not always be practical; an alternate method is to use a squeeze bottle and applicator tip to flood the drill and part. Cutting fluid must be used when holes in material over one drill diameter thick are hand drilled or reamed. Freon-Butyl Cellosolve (Dupont T-B1) applied as a spray mist, leaves no residue and is recommended for areas that cannot be disassembled for cleaning after drilling.

(b) Mobil TJ-73 (30 to 1 water mix) applied as a spray is recommended for general use in areas that can be cleaned before repair operations.

WARNING: DO NOT USE FREON IN ENCLOSED AREAS UNLESS ADEQUATE VENTILATION IS PROVIDED FOR THE OPERATOR.

(c) Fluid (Freon T-B1, Freon TF) may be used on installations (sealant and nonsealant) areas which cannot be disassembled for cleaning.

(d) Another recommended cutting and lubricating medium is BOELUBE, which comes in liquid, solid, paste or spray form and is manufactured by:

The Orelube Corporation
201 East Bethpage Road
Plan View, New York 11803-4202

and can be obtained from:

Marketing Masters
P.O. Box 675 1595 North West Gilman Blvd
Issaquah, Washington 98027-5330

(8) Some types of drill motors that can be used are listed. Chuck size refers to drill chuck capacity and not the capability of the unit to drill holes to this diameter in titanium alloys.

E96443

2. I. (9) Vendors of portable hand-drilling equipment:

(a) Ingersoll Rand	Ingersoll Rand Co. Athens Plant 101 North Main Street Athens, Pennsylvania 18810-1707
(b) Chicago Pneumatic	Chicago Pneumatic Tool Co. 2200 Bleecker St. Utica, NY 13503
(c) Rockwell Industrial Tool	Allen Bradley Co. Rockwell International Corp. Industrial Systems and Compounds Group 624 Alpha Drive Highland Heights, Ohio 44143
(d) Jiffy Tool	American Pneumatic Tool Co. 14710 Maple Avenue Gardena, California 90248-1934
(e) Cleco	Cleco Air Tools Dresser Industries Inc. 7007 Pinemont Houston, Texas 77040
(f) D.K. Wayne	Wayne Tool Co. 274 North Franklin P.O. Box 430 Waynesboro, Pennsylvania 17268-1106

3. Inconel

A. Inconel 625 and Inconel 718 are nickel-chromium alloys. Inconel has good resistance to corrosion and maintains strength at elevated temperatures; making it suitable for use in power plant structures.

E96445

3. B. Conventional drilling of Inconel 625 and Inconel 718 can result in high drill failure rates and excessive part rejections. Power feed equipment is recommended for drilling pilot holes in loose parts before assembly, After installation; pilot holes should be transferred to all mating parts before enlargement to final hole size. These alloys may be hand drilled regardless of heat-treat condition. The recommended procedure for gages up to 0.09 is as follows:

(1) Drill Style

(a) Jobbers length stoveburner drills are preferred to conventional cobalt drills because of their stronger construction. The 118-degree point has more resistance to chipping on break through than the 135-degree point usually found on cobalt drills. However, No. 30 or 40 pilot holes may be drilled with cobalt "rivet knock-out" drills (New York Twist Drill Co., Style 3232). The 135-degree point may be used with steel drills. Recommended steel drills are NAS907, types C, P3 or P5 for Inconel 718 and type P9 for Inconel 625.

(2) Feed

(a) Feed rates do not apply to hand drilling, but heavy end thrust while maintaining constant chip is required to achieve satisfactory penetration (E.G., approximately 50 pounds for No. 30 hole). Holes which are 3/16 diameter or larger must not be drilled in one step, two steps are sufficient for holes between 3/16 and 3/8 diameter. Enlargement of pilot holes to 5/32 diameter can be made using 1 inch-foot taper reamers.

(3) Speed

(a) Drill sizes up to No. 30 - 500 rpm maximum

(b) Drill sizes over No. 30 and less than 3/8 - 300 rpm maximum

(c) 3/8 diameter - 150 rpm maximum

(4) Coolant

(a) Coolant is not essential for hand drilling but a spray mist of Freon TVI (available in aerosol cans) will give a slightly longer drill life.

E96448

MANUFACTURER	MODEL	SPEED (RPM)	CHUCK SIZE (INCHES)	TYPE
INGERSOLL RAND	OA2M	800	3/8	OFFSET HANDLE
	OA2N	550	3/8	
	OB2M15	525	3/8	
CHICAGO PNEUMATIC	CP-3020-PUS7H	1100	3/8	OFFSET HANDLE
	CP-3020-PUSLU	800	1/2	
	CP-3020-PUSMU	550	1/2	
	CP-3208-LAFUS	1100	1/4	90° ANGLE HEAD
	CP-3020-LURAY	1350	3/8	
	CP-3020-LUREU	700	1/2	
	CR-3020-LURDU	450	1/2	
BUCKEYE	31D-106	750	5/16	OFFSET HANDLE
	31D-107	450	3/8	
	41D-105	1000	3/8	
	41D-106	725	3/8	
	41D-107	500	3/8	
	21A-625	900	1/4	90° ANGLE HEAD
	21A-626	650	1/4	
	31AR-504	1000	1/4	
	31AR-506	500	1/4	
	41AR-507	3000	1/4	
JIFFY TOOL	500-D-4247	500	3/8	OFFSET HANDLE
	650-D2-4251	650	1/2	
	1006-D2-4248	1000	3/8	
	650-D1-4248	650	3/8	
CLECO	11DP-5	500	5/16	OFFSET
	11DP-10	1000	1/4	
	15DP-4	400	1/2	
	15DP-8	800	1/2	
	6DL-10RAS	800	1/4	90° ANGLE HEAD
	11DL-5RA12	400	5/16	
	11DL-10RA12	799	1/4	
	11DL-15RA12	950	1/4	

DRILL MOTORS
TABLE I

MANUFACTURER	MODEL	SPEED (RPM)	CHUCK SIZE (INCHES)	TYPE
CLECO	11DPV5	150-400	3/8	OFFSET
D.K. WAYNE	MDPMC2038R	240-2200	3/8	
D.K. WAYNE	MDPM712	160-960	1/2	

VARIABLE-SPINDLE-SPEED AIR MOTORS
TABLE II

Hand Drilling Equipment for Titanium
Figure 1

E96451

MANUFACTURER MODEL	QUACKENBUSH QTS-9P	QUACKENBUSH QTS-10P
MILD STEEL RATING	0.141 INCH	0.172 INCH
TITANIUM RATING	0.090 INCH	0.100 INCH
RATED SPEED	60 INCHES/MINUTE	60 INCHES/MINUTE
RECOMMENDED SPEED	40 INCHES/MINUTE	40 INCHES/MINUTE
THROAT DEPTH	2.5 INCHES	2.2 INCHES
MINIMUM RADIUS	10.0 INCHES	10.0 INCHES

ROLLER SHEARS
TABLE I

MANUFACTURER	ROCKWELL	ROCKWELL	BLACK & DECKER
MODEL	61N-702B, -502B -722B, -522B -732B, -532B	61N-703A, -503A	NO. 450
POWERED BY	AIR	AIR	AIR
LENGTH	13.3 INCHES	15.3 INCHES	14.0 INCHES
WEIGHT	8 LBS	12.4 LBS	14.8 LBS
MILD STEEL RATING	0.125 INCH	0.172 INCH	0.172 INCH
TITANIUM RATING	0.080 INCH	0.100 INCH	0.100 INCH
RATED FREE SPEED (STANDARD MOTOR)	1500 SPM	700 SPM	1100 SPM
RECOMMENDED SPEED AT LOAD (OPTIONAL MOTOR)	450 SPM	450 SPM	450 SPM
KERF WIDTH	0.313 INCH	0.250 INCH	0.313 INCH
MINIMUM RADIUS OF CUT	2.0 INCHES	5.0 INCHES	0.34 INCHES
MINIMUM SURFACE CONTOUR RADIUS	4.0 INCHES	6.0 INCHES	NA
STARTING HOLE FOR CUTOUTS	1-5/16 INCHES	1-5/16 INCHES	3.8 INCHES
NEAREST OBSTRUCTION	5 INCHES	0.75 INCH	1.5 INCH

PORTABLE NIBBLERS
TABLE II

TITANIUM THICKNESS	BLADE PITCH	CUTTING RATE	TOOL LIFE
0.040 INCH	32 TEETH/INCH	10 INCHES/MINUTE	24 INCHES
0.070 INCH	24 TEETH/INCH	5 INCHES/MINUTE	100 INCHES
0.125 INCH	18 TEETH/INCH	1 INCHES/MINUTE	7 INCHES

THE ABOVE CUTTING DATA APPLIES TO HIGH-SPEED STEEL BLADES OPERATING AT 90 SURFACE FEET/MINUTE (SFM) AND COOLED WITH TJ-73 (30:1) SPRAY MIST. (CUTTING FLUID TJ-73, A SYNTHETIC, WATER-SOLUBLE OIL IS AVAILABLE FROM THE MOBILE OIL COMPANY. RECOMMENDED CONCENTRATION, ONE PART TJ-73 TO 30 PARTS WATER.) THE FORCES REQUIRED TO MANUALLY FEED A SABER SAW ARE HIGH AND INCREASE WITH THICKER SHEET. THE PRACTICAL THICKNESS LIMIT IS APPROXIMATELY 0.090 INCH. HAND FINISH OF THE EDGE IS NECESSARY.

SABER SAW BLADE DATA
TABLE III

Portable Trimming Tools for Titanium Alloys
Figure 2

E96456

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Chapter-Section-Subject	Page No.	Date
51-1-1	5	Apr 7/95
	6	Apr 7/95
	6A	Apr 7/95

E96485

H. When making structural repairs, it may be necessary to perform an identification test to distinguish between the different aluminum alloys, if the material designations on the sheet metal are obliterated. The hardness test described in 51-5-1 is one of the tests that can be used to identify materials.

3. Magnesium Alloys

A. Magnesium alloys are similar in appearance to aluminum alloys. Magnesium weighs two thirds as much as aluminum; for this reason magnesium alloys are used in the structure in certain low stress applications with resultant saving in weight of the airplane.

B. Forming of magnesium alloy sheets usually must be done at elevated temperatures. Parts that are formed at temperatures below 325°F must be strain relieved.

C. Magnesium alloys can be machined with tools designed for use on steel or brass, provided cutting edges are sharp.

D. Magnesium alloys must not be used where contact with methyl alcohol is possible, such as in liquid deicing and water injection systems. Do not use magnesium parts in integral fuel tank areas.

E. Use Type B rivets (5056-F aluminum alloy) in magnesium alloy parts and use clad 2024-T3 aluminum alloy for repair parts.

WARNING: SMALL PARTICLES AND FINE SHAVINGS OF MAGNESIUM IGNITE EASILY AND PRESENT AN EXTREME FIRE HAZARD. MAGNESIUM DUST IS HIGHLY FLAMMABLE AND, IN THE PROPER CONCENTRATION, MAY CAUSE AN EXPLOSION. WATER IN CONTACT WITH MOLTEN MAGNESIUM PRESENTS A STEAM EXPLOSION HAZARD. EXTINGUISH FIRES OF MAGNESIUM WITH ABSOLUTELY DRY TALC, CALCIUM CARBONATE, SAND OR GRAPHITE BY APPLYING THE POWDER TO A DEPTH OF ONE-HALF INCH, OR MORE, OVER THE BURNING METAL. DO NOT USE FOAM, WATER, CARBONTETRACHLORIDE, OR CARBON DIOXIDE.

E96487

4. Titanium Alloy

A. Titanium alloy resembles corrosion resistant steel and is comparable to it in strength. Titanium alloy weighs about half as much as steel.

B. Titanium alloy does not require a protective coating because its corrosion resistance is very good; however, it is cathodic to magnesium and aluminum and shall be insulated from them similarly to corrosion resistant steel.

C. High speed steel drills can be used to drill titanium alloy, however, drill speeds must be sharply reduced to prevent overheating of titanium and to increase the life of the drill. Nevertheless, when drilling titanium alloy, the life of the drill is several times shorter than its corresponding cutting life when drilling steel. Drills shall be examined and changed frequently because the maintenance of a sharp cutting edge is important. Refer to SRM 51-8-3 to machine and drill titanium materials.

D. Use corrosion resistant steel, Type 302 rivets annealed, and monel rivets to repair titanium alloy.

E. Use hot dimpling tools and procedures for obtaining dimples in titanium alloy.

WARNING: FIRE HAZARDS, WHEN WORKING WITH TITANIUM ALLOY, ARE SIMILAR TO THOSE DESCRIBED FOR MAGNESIUM, AND THE SAME FIRE EXTINGUISHING METHODS SHALL BE USED.

5. Corrosion Resistant Steel

A. Corrosion resistant steel plating is used in some areas of the airplane structure where high strength is required.

B. Steel is cathodic to magnesium and aluminum and must be insulated from them when making repairs. Apply at least three coats of zinc chromate primer to surfaces of magnesium alloy or aluminum alloy which may contact corrosion resistant steel.

E96489

6. Flat Patterns

A. A flat pattern is the outline of the flat blank sheet required to make a bent up or formed part. To make a flat pattern take the dimensions and contours from the damaged or opposite hand part. This may be accomplished by the following methods: shaping a piece of soldering wire around the part, or cutting a cardboard template to fit the part, or scaling the part and making a sketch as illustrated in the following paragraph. The later method is the most accurate. Derive the developed length and lay out the flat pattern.

(1) Make a sketch of the section to be formed (figure 6) showing the following dimensions:

A	=	Flange Length
B	=	Set-back (figure 7)
C	=	Web Length
D	=	Set-back (figure 7)
E	=	Flange Length
B.R.	=	Bend Radius (figure 5)
F	=	Flange Angle
G	=	Flange Angle
T	=	Gage

(2) Derive the developed length by the following formula:

Developed Length = $A-X+C-X_1+E$

X (See figure 8)

X_1 (See figure 8)

E96492

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Chapter-Section-Subject	Page No.	Date
51-2-10	1 and 2	Oct 16/98

HOLE PREPARATION AND STOPDRILLING OF CRACKS

1. Hole Preparation for Repairs

A. Drilling a Fastener Hole in Metal Structure

Hole sizes listed in 51-2-5, Figure 1, and used for the normal repairs within this manual require the use of properly sized and maintained drills. When necessary, use a bushing tool as a guide for obtaining a hole not larger than the drill size and perpendicular to the work surface. Use the proper drill speed (feet per minute) which will leave a smooth, bright, finish throughout the hole surface. A hole which indicates a rough or galled surface should be properly enlarged by a hand-reaming operation to obtain a smooth hole surface. Strict adherence to the recommendations indicated will contribute to the service life of repairs and preventive modifications.

B. Removal of Small Cracks and Fatigue Damaged Material from an Existing Hole (Zero-Timing)

This procedure is recommended for the existing fastener holes before a repair part is installed. Zero-Timing makes the repair durability better. If this procedure is done for all existing fastener holes in the critical rows of the repair (which are usually the perimeter fasteners of the repair doubler in a skin repair) the inspection threshold will start from the time of repair installation. If not, the threshold starts from the time the airplane was delivered.

(1) Visually inspect all the existing holes for irregular surface condition such as burrs, galling, corrosion and out-of-round holes. These irregular surface conditions can interfere with HFEC inspection. Borescope, endoscope or other optical aids can be used to help the visual inspection.

NOTE: If a 'clean-up' is necessary to remove one or more of these conditions, ream the hole 1/64 inch oversize from its existing size. A surface finish of 125 Ra or better is necessary.

(2) Inspect the fastener hole by High Freqency Eddy Current (HFEC) method. Refer 707 NDT Manual, Part 6, 51-00-00 for the inspection of the open hole.

(a) If no cracks are found, make the hole diameter 1/16 inch oversize to remove any fatigue damaged material.

(b) If cracks are found, make the hole diameter larger by 1/64 inch increments until HFEC inspection shows no more cracks. Then, make the hole another 1/16 inch larger to remove any fatigue damaged material.

NOTE: The limit to make the hole larger is different for each situation and depends on the load pattern and the stress levels in the rework area. Sometimes, it may be necessary to install a plug through which a fastener that is the same size as the initial fastener can be installed.

(3) Ream the hole, as required, to the finished size for installation of the fastener and/or the plug.

(4) When a coldworking is necessary, ream the hole to the correct size and do the coldworking.

2. Stop Drilling of Cracks

Stop drilling a crack prevents its growth. Do as follows:

A. Drill of counterbore a 0.25 inch stop hole through the structure at each end of the crack. Drill the hole in a position so that the center of the hole is 0.10 inch past the visible end of the crack.

B. Do an eddy current inspection of each stop hole. Make sure that there are no more cracks on the side opposite from the initial crack. Refer to Par. 1.B.(2) above.

(1) If a crack is not found, make the hole 1/16 inch in diameter larger to remove any fatigue damaged material.

(2) If a crack is found, make the hole larger by 1/64 inch increments until no crack remains. Then, make the hole another 1/16 inch larger to remove any fatigue damaged material.

NOTE: The limit to make the hole larger is different for each situation and depends on the load pattern and the stress levels in the rework area.

(3) In aluminum structures, install a 2017-T3 or 2017-T4 aluminum plug rivet into the stop holes, if necessary.

(4) In titanium, corrosion resistant steel (CRES), and inconel structures, install a monel plug rivet into the stop holes, if necessary.

TEMPORARY REVISION 51-47

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: Added the structural repair definitions.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
51-0	13 thru 17	Oct 16/98

1. Applicability

   A. This subject gives the definitions related to repair classification and inspection for damage tolerant and non-damage tolerant primary or secondary structures as applicable.

   B. It also gives information about the repair assessment process defined for the fuselage pressure boundary structure.

2. General

   A. There are two classifications of repairs in this SRM:

      (1) Repairs that have been evaluated and analyzed for damage tolerance capability and are classified as Category A, B, or C repairs.

      (2) Repairs that have not been evaluated and analyzed for damage tolerance capability and are classified as Permanent, Interim or Time-Limited Repairs.

      NOTE: If a repair is not identified as an interim or time-limited repair it is a permanent repair.

   B. The definitions of the different categories of damage tolerant repairs are as follows:

      (1) Category A Repair: A permanent repair for which the inspections given in the Baseline Zonal Inspection (BZI) are sufficient and no other actions are necessary.

      (2) Category B Repair: A permanent repair for which supplemental inspections are necessary at the specified threshold and repeat intervals.

      (3) Category C Repair: A time-limited repair where supplemental inspections are necessary at the specified threshold and repeat intervals followed by a replaced or reworked repair at the specified time limit.

   C. The definitions of the different types of repairs that have not been evaluated and analyzed for damage tolerance are as follows:

      (1) Permanent Repair: A repair where no action is necessary except the operator's normal maintenance.

      (2) Interim Repair: A repair that has the necessary structural strength and could stay on the aircraft indefinitely. The repair must be inspected at specified intervals and replaced if deterioration is detected or damage is found.

      (3) Time-Limited Repair: A repair that has the necessary structural strength but does not have sufficient durability. This repair must be replaced after a specified time, usually given as a number of flight cycles, flight hours or a calendar time.

Structural Repair Definitions
Figure 6 (Sheet 1)

D. The definitions of the terms as they apply to the repairs are as follows:

(1) Baseline Zonal Inspection (BZI): A set of typical maintenance inspection intervals that are assumed to be performed by most operators, and defined in the Repair Assessment Guidelines document. BZI was the basis for the creation of a list of structural areas or types of repairs that would not require supplemental inspection.

Some SRM repairs were chosen to be Category A or B by comparing their inspection requirements with the baseline zonal inspection intervals for the areas repaired. If the BZI interval was adequate to maintain damage tolerance, the repair was labeled Category A. If not, the repair was labeled Category B. Operators must be aware that if their current inspection intervals exceed the BZI intervals, the repair categories may not apply. See the Repair Assessment Guidelines document (D6-81626) for complete information.

(2) Damage Tolerance: The ability of structure to sustain anticipated loads in the presence of damage, such as fatigue cracks until it is detected through inspection or malfunction, and repaired.

(3) Damage Tolerant Repair: A repair that meets the necessary damage tolerance conditions.

(4) Repeat Intervals: The period in flight cycles, flight hours or calendar time that occurs between the necessary inspections.

(5) Supplemental Inspections: Special inspections of the repaired structure which are done in addition to an operator's normal maintenance.

(6) Threshold: The period in flight cycles, flight hours or calendar time from the time an airplane is delivered or a repair is made until the first supplemental inspection is necessary.

For Category B repairs, the threshold starts from the time the repair was installed if the repair fasteners in the critical rows have been installed in new fastener holes or existing fastener holes that have been zero-timed. If the repair fasteners are installed in existing fastener holes that have not been zero-timed, the inspection threshold will start from the time the airplane was delivered.

(7) Time Limit: The maximum period in flight cycles, flight hours or calendar time that is permitted until it is necessary to replace or rework a time-limited repair.

(8) Zero-Timing: The process used to improve the repair durability in order to make the inspection threshold start from the time the repair is installed. This involves the removal of small cracks and fatigue damaged material by oversizing the existing fastener holes before the repair is installed as given in SRM 51-2-10.

Structural Repair Definitions
Figure 6 (Sheet 2)

E. Damage Tolerance Assessment of Repaired Structure

The damage tolerance assessment of a repair is done to determine the effect that the repair has on the damage tolerance capability, and inspectability of the initial structure. This assessment is also used to identify the inspections that are necessary to keep the repaired structure in an airworthy condition. The SRM will provide the inspection requirements for the repairs that are published in the SRM. However, fuselage repairs developed by the operators will need to be assessed using the Repair Assessment Guidelines document (D6-81626). Refer to Sheet 5 for the process diagram that is given in this document. Damage tolerance assessment of the repaired structure can be completed after an airplane is returned to service.

F. Types of inspections that are used to detect damage in structure are as follows:

(1) General Visual (Surveillance) Inspection: A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

(2) Detailed Inspection: An intensive visual examination of a specific structural area, system, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lightning at an intensity deemed appropriate by the inspector. Inspection aids such as mirrors, magnifying lenses, etc. may be used. Surface cleaning and elaborate access procedures may be required.

(3) Special Detailed (Non-Destructive Testing) Inspection: An intensive examination of a specific item(s), installation, or an assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized inspection techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required.

Non-Destructive Testing (NDT) inspections are used to examine all subsurface damage and most small cracks. NDT is also used in areas where a visual inspection is not sufficient to find the dimensions of damage. NDT procedures recommended for use in the SRM are as follows:

(a) Eddy Current: An NDT procedure which uses eddy currents to find damage in metals that have good conductivity properties. The Eddy Current inspection is the preferred NDT procedure used to find most damage on metal parts. The two types of Eddy Current inspections used in the SRM are as follows:

High Frequency Eddy Current (HFEC) Inspection: Used to find surface cracks, porosity, and corrosion.

Low Frequency Eddy Current (LFEC) Inspection: Used to find subsurface cracks, and corrosion.

Refer to Part 6 of the NDT Manual for the Eddy Current Inspection procedures.

Structural Repair Definitions
Figure 6 (Sheet 3)

(b) Ultrasonic: An NDT procedure which uses sound waves to find surface and subsurface damage (cracks, porosity, delamination, or disbonds, for example) on metal composite materials that have good permeability properties. Refer to Part 4 of the NDT Manual for the Ultrasonic inspection procedures.

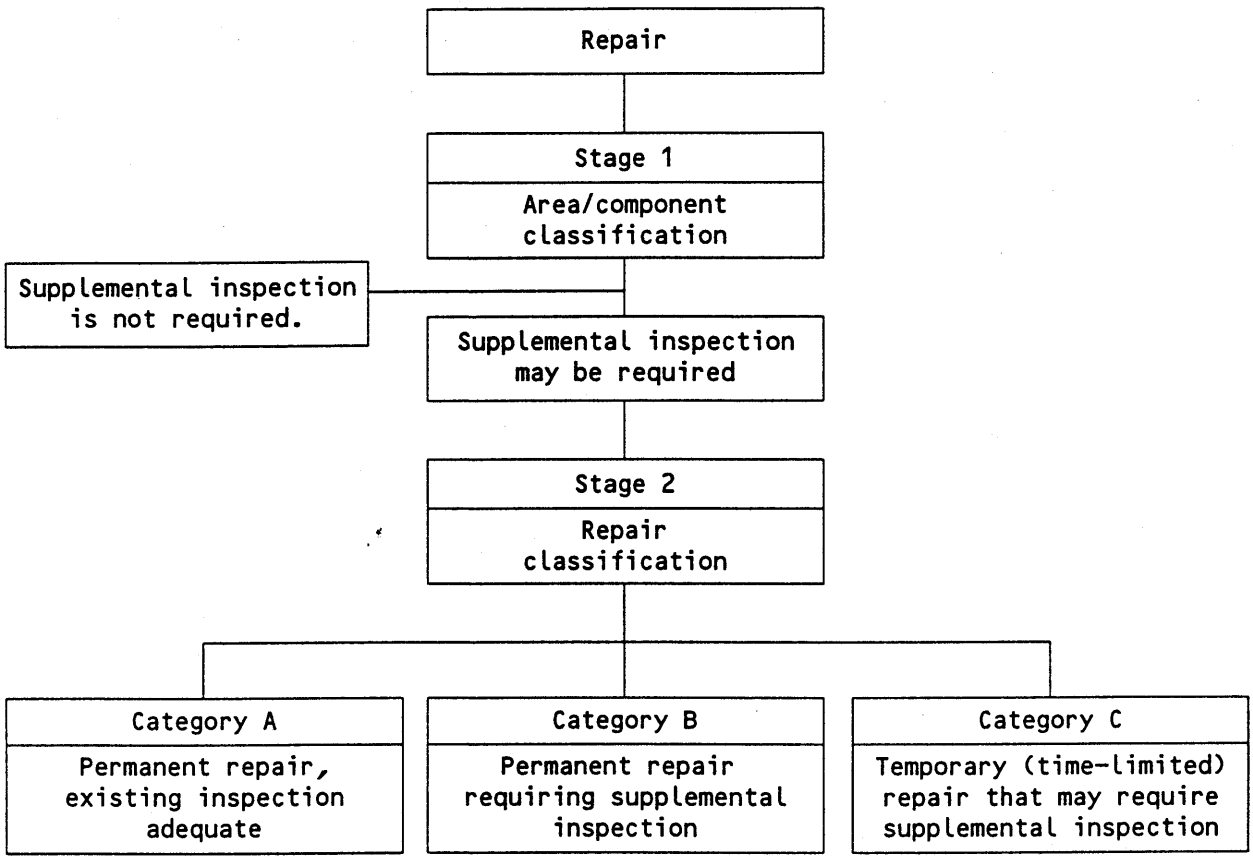
(c) Resonance Frequency: A tap test NDT procedure that can be used to find delaminations and interply disbonds in composite, honeycomb or bonded structures that have thin skins. Refer to Part 1 of the NDT Manual for the Resonance Frequency inspection procedures.

(d) X-Ray: An NDT procedure that uses radiography to find cracks and damage (disbonds, for example) in metallic and composite structures which cannot be accessed for visual inspection. X-Rays can identify if fluids are inside honeycomb parts and can be used to identify the dimensions of the damage. Refer to Part 2 of the NDT Manual for the X-Ray inspection procedures.

(e) Magnetic Particle: An NDT procedure that applies a magnetic field to a ferro-magnetic part which has fine magnetic particles on the surface. The magnetic field causes the magnetic particles to group together in areas that have cracks on or near the surface. Refer to SOPM 20-20-01 for the Magnetic Particle inspection procedures.

(f) Penetrant: Penetrant examination uses the property of a liquid to go into a defect that is open at the surface of the part. The liquid is applied to the surface and permitted to soak in. A developer is applied to pull the liquid out of the defect so it can be seen. Visible penetrants are examined under white light. Fluorescent penetrants are examined under ultraviolet light. Refer to SOPM 20-20-02 for the Penetrant inspection procedures.

Structural Repair Definitions
Figure 6 (Sheet 4)



PROCESS DIAGRAM

Structural Repair Definitions
Figure 6 (Sheet 5)

TEMPORARY REVISION 51-49

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: Added new metal bond technology.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
51-9-1	1 thru 13	DELETED
51-9-2	1 thru 7	DELETED
51-9-3	1 thru 94	Jun 30/06
51-9-4	1 thru 3	Jun 30/06
51-9-5	1 thru 6	Jun 30/06
51-9-6	1 thru 10	Jun 30/06
51-9-7	1 thru 20	Jun 30/06
51-10-1	1 thru 44	DELETED

REPAIR GENERAL - ALUMINUM HONEYCOMB REPAIRS - 250°F (121°C) CURE

1. Applicability

NOTE: The repairs in this subject will not have an effect on a Structurally Significant Item (SSI). Thus, no change to the Supplemental Structural Inspection Document (SSID) inspection program is necessary.

A. This subject gives instructions for 250°F (121°C) cure repairs to bonded aluminum alloy skin and honeycomb core sandwich structure.

B. This subject applies to the repair of Boeing airplane structure that was manufactured at 250°F (121°C) or 350°F (177°C).

C. Only use this procedure if an SRM repair section or an approved repair plan refers to this subject.

D. Do not use this procedure for a rebuild or remanufacture of Boeing airplane structure (or for a repair that is larger than the limits given in Fig. 1).

2. General

A. Refer to the SRM component repair section for:

* The identification of the materials and the references to the engineering drawings
* The allowable damage data
* The references to this subject
* The types of repairs that are permitted and/or the repair size limits (When applicable)
* Other data that is not given in this subject

B. In this subject are the instructions for:

* Damage removal
* Surface preparation procedures for aluminum alloys
* Application of adhesive primers
* Application of film and paste adhesives
* Aluminum honeycomb core splicing
* Vacuum bag procedures
* Cure procedures
* Bond inspection procedures
* Repair procedures

3. References

SRM 51-1-1	Sheet Metal Materials
SRM 51-13-1	Inspection and Removal of Damage
SRM 51-15-0	Control Surface Balancing
SRM 51-8-0	Protective Treatment of Metallic and Composite Materials

BAC 5514	Common Bonding Requirements for Structural Adhesives
BAC 5514-589	Application of Corrosion Inhibiting Adhesive Primer
BAC 5555	Phosphoric Acid Anodizing of Aluminum for Structural Bonding
BSS 7217	Air Cleanliness, Shop Compressed Air
D6-49327	Certification of Autoclaves for Metal Bonding and Curing of Composite Structure
D6-56273	Qualification of Heat Blankets for Hot Bonding
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structure
NDT Part 1, 51-04-00	Ultrasonic
NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure
SOPM 20-30-03	General Cleaning Procedures
SOPM 20-30-97	Solvents for Final Cleaning Before Structural Bonding (Series 97)

4. Definitions

A. Boegel (AC130)

(1) A type of complex inorganic polymer from the sol-gel family of chemical compounds.

B. Damage

(1) Change to the surface of a part that is caused by deterioration, corrosion, disbands, erosion, dents, gouges, cracks, scratches, punctures and holes.

C. Disbond

(1) The failure of a bond adhesive that causes separation between a skin and core or doubler.

D. Durability

(1) A low crack growth rate, a strong bond, and good corrosion protection.

E. Engineering Review

(1) Approval by an engineer with the experience, qualifications and authority to make decisions on structural repairs. The engineer will make sure that the repair design has the necessary airworthiness requirements (the repaired part has the necessary strength, durability, damage tolerance (if necessary), and will function on the airplane correctly).

(2) Boeing can also give an engineering review, if necessary.

F. One-Stage Cure

(1) The core and skins are bonded together at the same time. (One application of heat).

G. Rebuild/Remanufacture

(1) The damage is too large to use repair procedures and materials (manufacturing procedures are necessary). Permission from Boeing and your local regulatory agency can be necessary because of intellectual property, certification, quality control, and safety rules.

NOTE: With permission, you can use the Boeing engineer drawings, material specification, and process specifications.

H. Two-Stage Cure

(1) When the repair parts are bonded in two cure steps (Two separate applications of heat).

(a) The first stage: The core is bonded into the repair and then cured with one side of the core open. (Before the last skin is put on and then cured).

(b) The second stage: The last skin (one or more doublers) is put on and then cured.

I. More sources of definitions

(1) SRM 51-13-1

5. Repair Summary

A. Refer to Table 1 for an index of the paragraphs and figures.

REFERENCE	TITLE
Paragraph 6.	Find the Limits of the Damage
Paragraph 7.	Remove the Damage
Paragraph 8.	Make the repair parts
Paragraph 9.	Installation of the Honeycomb Repair Core
Paragraph 10.	Inspect the fit of the repair parts
Paragraph 11.	Use of the Surface Preparation Procedures
Paragraph 12.	The Phosphoric Acid Containment System (PACS) Procedure
Paragraph 13.	The Phosphoric Acid Non-Tank Anodizing (PANTA) Procedure
Paragraph 14.	The Boegel (AC-130) Prebond Treatment Procedure
Paragraph 15.	Application of BMS 5-89 Adhesive Primer to the Bond Surface
Paragraph 16.	Hydrofluoric (HF) - Alodine Procedure
Paragraph 17.	Application of BAC 5710, Type 60 Adhesive Primer
Paragraph 18.	Application of BMS 5-101 Film Adhesive
Paragraph 19.	Application of BMS 5-92 or BMs 5-141 Paste Adhesive
Paragraph 20.	Cure the bond
Paragraph 21.	Do an examination of the bonded repair
Paragraph 22.	Clean, seal, and finish.

Repair General Index
Table 1 (Sheet 1)

REFERENCE	TITLE
Fig. 1	Repair Options
Fig. 2	Flow Chart of the Repair Steps
Fig. 3	Damage Removal
Fig. 4	Phosphoric Acid Containment System (PACS)
Fig. 5	Phosphoric Acid Non-Tank Anodize (PANTA) Layup
Fig. 6	Polarized Light Test - Verification of Anodic Oxide Film
Fig. 7	Repair Doubler Specifications for Flush Repairs
Fig. 8	Repair Doubler Specifications for External Patch Repairs
Fig. 9	Installation of the Repair Core
Fig. 10	Cure Time for BMS 5-92, Two-part Paste Adhesive
Fig. 11	Cure Time for BMS 5-141 Paste Adhesive
Fig. 12	Installation of the Repair Doubler
Fig. 13	Thermocouple Locations
Fig. 14	Layup of Vacuum Bagging Materials

Repair General Index
Table 1 (Sheet 2)

B. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example. For example, if a circular shaped repair is shown, you can use a non-circular shape as an alternative.

C. This subject contains four surface preparation procedures:

(1) The Phosphoric Acid Containment System (PACS) procedure

(2) The Phosphoric Acid Non-Tank Anodize (PANTA) procedure

(3) The Boegel (AC-130) Prebond Treatment procedure

(4) The Hydrofluoric (HF) - Alodine procedure

D. There are two adhesive primer application procedures:

(1) BMS 5-89 Type I or Type II application procedure

(2) BAC 5710, Type 60 application procedure

E. There are four metal-to-metal bond adhesives used in this subject.

(1) BMS 5-101, Type II film adhesive, cured at 225° to 260°F (107° to 127°C)

(2) BMS 5-92, Type I paste adhesive, cured at 70° to 260°F (21° to 127°C)

(3) BMS 5-92, Type V paste adhesive, cured at 70° to 180°F (21° to 82°C)

(4) BMS 5-141 paste adhesive, cured at 70° to 200°F (21° to 93°C)

F. To make a satisfactory repair, you must do what follows:

(1) Use the correct materials.

(2) Remove all the water and other contamination from the part.

(3) Do the bond procedures in a clean, dry location.

(4) Make the bond surfaces clean.

(5) Do a satisfactory surface preparation.

(6) Make sure that all of the parts have the correct shape and dimensions.

(7) Make sure that the repair parts have the correct flatness or curvature. The parts must install correctly when you apply light finger pressure.

(8) Make sure that the adhesive bondline thickness is correct.

(9) Remove some of the air and gases from the honeycomb core before you start a cure cycle. (Vacuum bagged repair procedure).

(10) Use sufficient pressure, time, and temperature to cure the repair.

G. Identify the material containers with a label that contains the data that follows:

* BMS Specification
* Type
* Class
* Supplier Name
* Batch Number
* Date of preparation

H. Make sure that you do the bond procedures in a clean, dry location (a location that does not have contamination from exhaust fumes, rain, or other unwanted materials). Make sure that shop compressed air does not have water, oil, or other contamination. Use Boeing Specification Support Standard BSS 7217 "Air Cleanliness, Shop Compressed Air" (or the equivalent specification) to see if the shop compressed air is satisfactory.

NOTE: You can make a tent to seal the area from contamination.

I. A phosphoric acid tank anodize procedure is a permitted alternative to the PAA non-tank procedures given in this section. Make sure that your tank facilities, chemicals, and procedures are satisfactory. Refer to Boeing Process Specification BAC 5555, "Phosphoric Acid Anodizing of Aluminum for Structural Bonding" (or the equivalent specification).

J. If you use a heat blanket, make sure that it is qualified and will operate correctly. D6-56273, "Qualification of Heat Blankets for Hot Bonding", is a procedure that Boeing uses. You can refer to this procedure or use an equivalent procedure to qualify your heat blanket.

K. If you use an autoclave, make sure that your autoclave facilities and procedures are satisfactory. Refer to Boeing Process Specification 5514, "Common Bonding Requirements for Structural Adhesives" and D6-49327, "Certification of Autoclaves for Metal Bonding and Curing Composite Structure" (or the equivalent specifications).

L. If you use an oven, make sure that it has equipment that can circulate the heated air, supply a vacuum and control the temperature.

WARNING: USE MECHANICAL AIRFLOW AND BREATHING PROTECTION WHEN YOU WORK IN A CLOSED SPACE OR AREA. MAKE SURE THAT THE FRESH AIR SUPPLY IS NOT BLOCKED. IF YOU GET FLUIDS IN YOUR EYES, FLUSH WITH WATER IMMEDIATELY AND GET MEDICAL AID.

M. Read the manufacturer's safety data sheet (MSDS) for each of the materials you use in this procedure. Wear protective clothing and equipment if it is specified in the MSDS.

N. Keep all resin and adhesive materials in the storage condition specified in the manufacturer's instructions or the Boeing specifications (as applicable). Do not keep the materials out of storage for longer than necessary.

O. Read each CAUTION in this procedure. They will help to prevent damage to the repair and prevent more damage to the airplane part.

P. Read each WARNING in this procedure. They will help to prevent injury to you and others.

Q. Refer to Fig. 1, Repair Options to help you make a decision on the correct repair procedure.

R. Refer to Fig. 2, Flow Chart of the Repair Steps before you start the repair procedure.

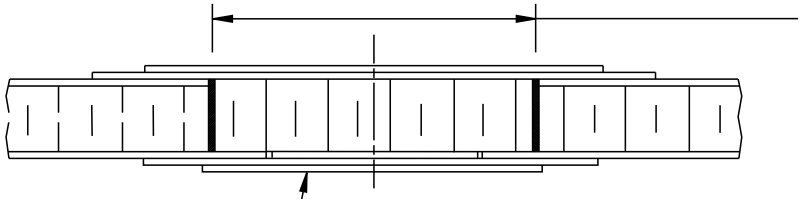
S. Refer to Table 2 and make a repair selection.

SRM Section	Title
51-9-4	Repair of a Disbond at an Edge of Aluminum Honeycomb Structure
51-9-5	Repairs to Small Damage
51-9-6	Septumized Core Repairs
51-9-7	Repairs to Large Damage

Repair Examples
Table 2:

SURFACE PREPARATION	REPAIR TYPE	PASTE ADHESIVES	FILM ADHESIVES	
			VACUUM BAG CURE [A]	AUTOCLAVE CURE [B]
		MAXIMUM DAMAGE SIZE [C]		
HF ALODINE	INTERIM [D]	2.0 INCHES (50 mm) LENGTH OR DIAMETER	2.0 INCHES (50 mm) LENGTH OR DIAMETER	2.0 INCHES (50 mm) LENGTH OR DIAMETER
BOEGEL (AC-130)	INTERIM [D]	2.0 INCHES (50 mm) LENGTH OR DIAMETER	NOT APPLICABLE	NOT APPLICABLE
	PERMANENT	[E]	64 SQUARE INCHES (400 SQUARE CM) [F]	200 SQUARE INCHES (0.13 SQUARE METERS)
TANK PAA, PACS, PANTA	INTERIM [D]	2.0 INCHES (50 mm) LENGTH OR DIAMETER	NOT APPLICABLE	NOT APPLICABLE
	PERMANENT	[E]	64 SQUARE INCHES (400 SQUARE CM) [F]	200 SQUARE INCHES (0.13 SQUARE METERS) SEE DETAIL A [G] [H]

TABLE A



PERMITTED DAMAGE SIZES THAT CAN BE REPAIRED IN AN AUTOCLAVE (APPLICABLE TO SURFACES PREPARED WITH TANK PAA (BAC5555), PACS OR PANTA) [G] [H]

DETAIL I

Repair Options
Figure 1 (Sheet 1)

NOTES:

A OVEN, HEAT BLANKET, HEAT LAMPS OR FORCED HOT AIR ARE PERMITTED. MAKE SURE THAT THE CORRECT CURE TEMPERATURE CAN BE CONTROLLED DURING THE CYCLE. REFER TO PARAGRAPH 20.

B AUTOCLAVE MUST BE PRESSURIZED AS SPECIFIED IN PARAGRAPH 20.

C AFTER YOU FIND AND REMOVE THE DAMAGE AS SPECIFIED IN PARAGRAPH 7.

IF YOU DO A FLUSH REPAIR: THE CUTOUT ON THE SIDE THAT WILL HAVE THE EXTERNAL DOUBLER MUST BE LESS THAN OR EQUAL TO THE SIZES IN THIS TABLE.

D INTERIM REPAIRS MUST BE INSPECTED EACH 24 MONTHS OR LESS, OR EACH 3500 FLIGHT CYCLES OR LESS (NO LATER THAN THE INTERVAL THAT OCCURS FIRST).

E THE MAXIMUM PERMITTED DAMAGE LENGTH (OR DIAMETER) IS 1.0 INCH (25 mm) OR THE ALLOWABLE DAMAGE LIMIT (THE SMALLER OF THE TWO). ONLY BMS 5-92, TYPE V OR BMS 5-141 ARE PERMITTED IN PERMANENT REPAIRS.

F YOU CAN INCREASE THE MAXIMUM SIZE TO 200 SQUARE INCHES (0.13 SQUARE METERS) IF YOU DO THE STEPS THAT FOLLOW:

- DO A TWO STAGE CURE REPAIR PROCEDURE (WHEN HONEYCOMB CORE IS DAMAGED)
- USE BMS 5-121 POSITIONING FABRIC WITH THE FILM ADHESIVE.

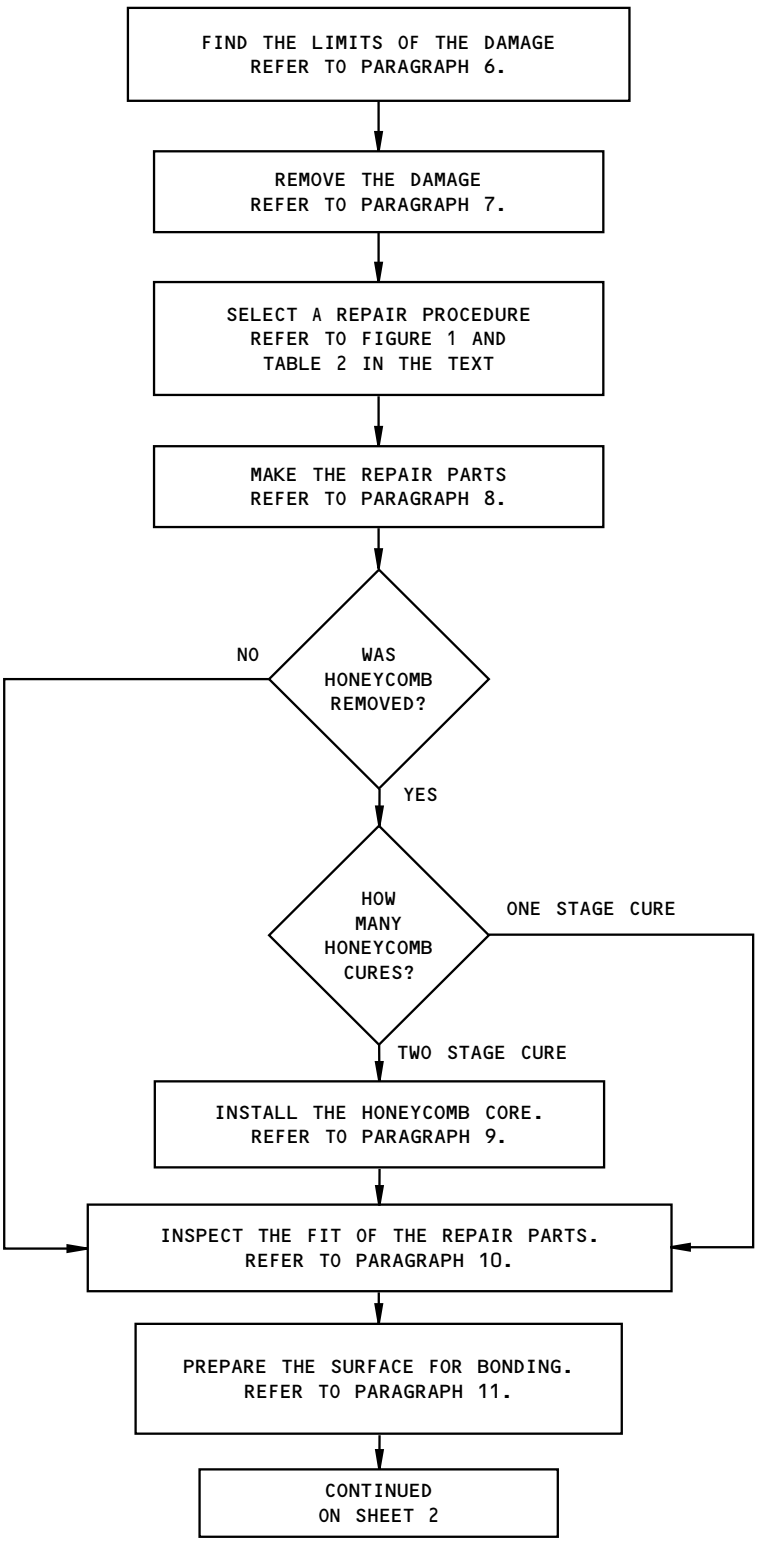
G TO REPAIR DAMAGE THAT IS LARGER THAN 200 SQUARE INCHES (0.13 SQUARE METERS) YOU MUST:

- GET AN ENGINEERING REVIEW
- SEE DETAIL A FOR REPAIR SIZES.

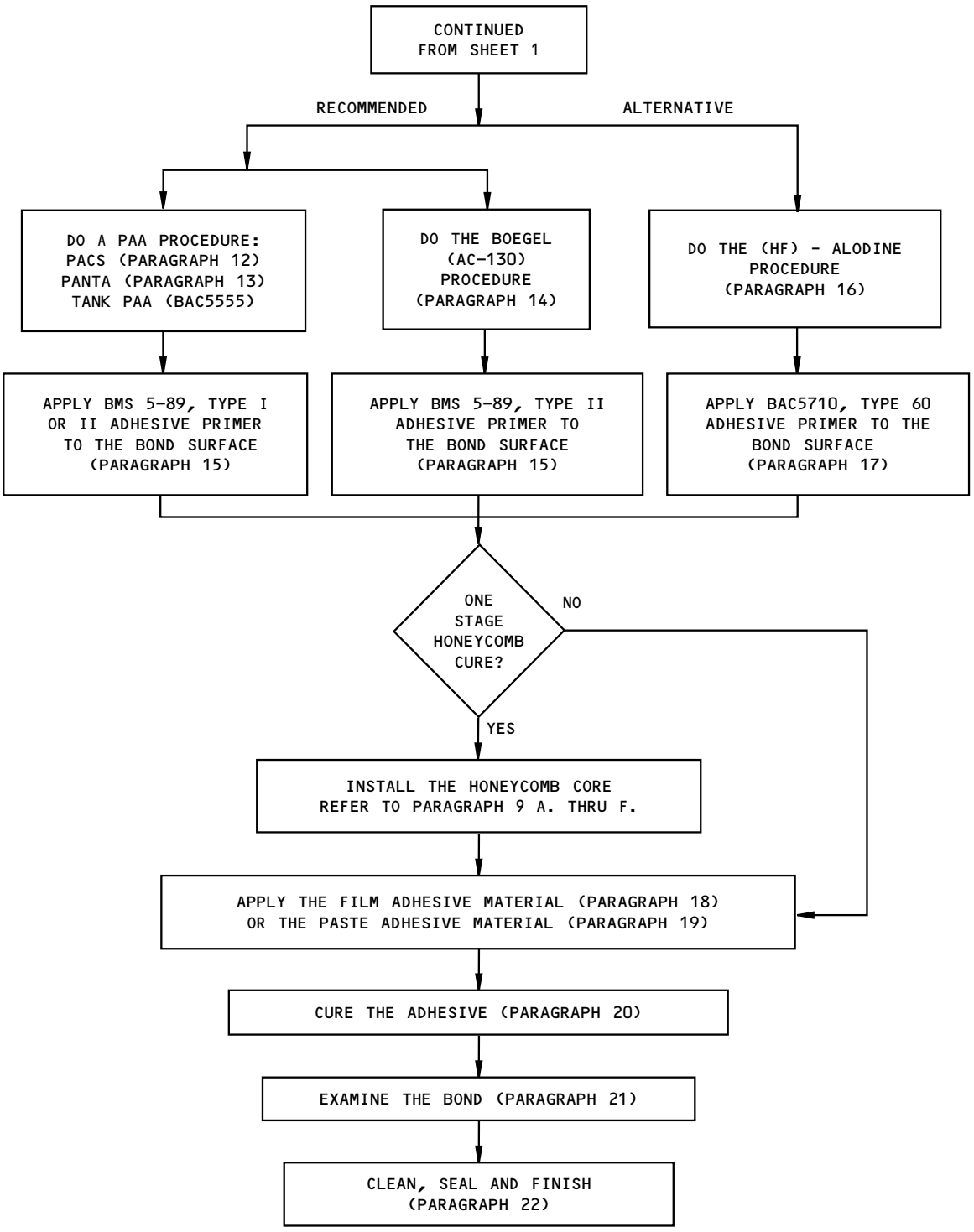
H TO REBUILD/REMANUFACTURE PARTS THAT HAVE DAMAGE TO MORE THAN 200 SQUARE INCHES (0.13 SQUARE METERS) OR MORE THAN 50% OF THE AREA OF THE SKIN TO BE REPAIRED, YOU MUST:

- GET AN ENGINEERING REVIEW
- USE APPROVED ENGINEERING DRAWINGS FOR THE COMPONENT TO BE REPAIRED
- USE APPROVED MATERIALS AND MANUFACTURING PROCESSES SPECIFIED IN THE COMPONENT ENGINEERING DRAWINGS
- RESTORE THE PART TO THE INITIAL DESIGN CONFIGURATION.

Repair Options
Figure 1 (Sheet 2)



Flow Chart of the Repair Steps
Figure 2 (Sheet 1)



Flow Chart of the Repair Steps
Figure 2 (Sheet 2)

6. Find the Limits of the Damage

A. Examine the damage in the repair area.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Clean the damaged area with a soft cloth moist with cleaning solvent. Refer to SOPM 20-30-03 for the applicable cleaning solvent and general cleaning procedures.

CAUTION: USE NON-DESTRUCTIVE PROCEDURES TO MAKE SURE THAT THERE IS NO WATER TRAPPED IN THE PART BEFORE YOU APPLY HEAT TO CURE THE ADHESIVES. DAMAGE TO THE PART WILL OCCUR IF THE WATER IS NOT REMOVED.

(2) Do a visual and NDI examination of the damaged area to find disbonds and other types of damage to the structure.

NOTE: Refer to NDT Part 1, 51-04-00 for instrumented NDI procedures, or NDT Part 1, 51-05-01 for tap test procedures.

B. Examine the initial BMS 5-89 adhesive primer (if applicable).

(1) It is not necessary to remove the initial BMS 5-89 adhesive primer from the bond surface if the primer has the conditions that follow:

(a) There is no contamination from paints, oils, chemicals, or other unwanted materials.

(b) Metal-to-metal bonding - there are no scratches or missing primer that:

1) Show more than 0.1 square inch (65 square mm) of bare metal.

2) Are more than 0.5 inch (13 mm) in length.

3) Are less than 0.5 inch (13 mm) from an edge.

4) Are less than 3.0 inches (75 mm) (edge-to-edge) apart.

(c) Core-to-skin bonding - there are no scratches or missing primer that:

1) Show more than 2.0 square inches (13 square cm) of bare metal at each location.

2) Show more than a cumulative total area of bare metal of 4.0 square inches (26 square cm).

3) Are less than 6.0 inches (150 mm) (edge-to-edge) apart.

NOTE: A group of bare metal areas in a 2.0 square inch (13 square cm) area can be specified as one bare metal area. A group must then be 6.0 inches (150 mm) (edge-to-edge) from a different bare area or group.

(2) In these small areas where there is bare metal or missing primer, do the steps that follow:

(a) Clean the bare metal. Refer to SOPM 20-30-03 for the applicable solvents.

(b) Apply adhesive primer to the bare metal as given in par. 15. or par. 17.

(3) If more adhesive primer is damaged or removed than is permitted, then do one of the surface preparations specified in par. 11.

7. Remove the Damage

NOTE: Use a table or special tool to keep the part in the correct shape if you remove large areas of damage.

A. Remove the damaged skin from the repair area.

NOTE: As an alternative, you can do a surface preparation and apply the adhesive primer on the surface before you remove the damage. Make sure that you prepare an area that is larger than the necessary minimum bond area. This will give you a sufficient bond area if the removed damage is larger than the NDI indication.

WARNING: DO NOT USE EQUIPMENT THAT CAN CAUSE AN ARC OR A SPARK IN AN AREA WHERE THE IGNITION OF FUMES IS POSSIBLE. IF YOU DO, AN EXPLOSION CAN BE THE RESULT.

(1) If the aluminum skin is damaged or has disbonded areas, do the procedure that follows:

(a) Cut and remove the damaged skin in the disbonded areas.

(b) Separate the bonded structures (if applicable and necessary). Refer to Fig. 3 for the steps that follow:

1) Make the wedge(s).

2) Use polyester tape to attach an approximately 0.02-0.06 inch (0.5-1.5 mm) thick metal or plastic sheet adjacent to the bonded area.

WARNING: USE DRY ICE OR COMPRESSED CARBON DIOXIDE GAS ONLY IN AN AREA WHERE THERE IS A SATISFACTORY FLOW OF AIR. HIGH LEVELS OF CARBON DIOXIDE CAN CAUSE INJURY. WEAR PROTECTIVE GLOVES. IF DRY ICE TOUCHES YOUR SKIN OR EYES, GET MEDICAL AID IMMEDIATELY.

3) Push the wedge(s) between the bonded structures. Lightly tap the wedge(s) if necessary.

a) If problems occur, you can apply heat, dry ice (solid carbon dioxide), compressed carbon dioxide gas, or liquid nitrogen to the bond area. This will make the adhesive resin brittle and easier to separate.

NOTE: For best results, keep the temperature at less than 260°F (127°C) if you use heat to remove skin.

(c) Do a check to see if the bond is weak along the perimeter of the area to be repaired.

NOTE: Instrumented Non-destructive Inspection (NDI) procedures will not always find a bond that is weak but not broken.

1) Pull carefully on the edge of the skin to see if the bond will break.

2) If the bond is easily broken, then continue to remove the skin until the bonds are not easily broken.

(2) Remove all the nicks, scratches, gouges, burrs, sharp edges, corrosion and other unwanted material to a smooth surface. If you remove more than 10% of a sheet thickness, do one of the steps that follow:

(a) If the depth of the removed damage is less than 80% of the sheet thickness, refer to 51-9-5.

(b) If the depth of the removed damage is more than 80% of the sheet thickness, cut out the damage. Refer to 51-9-7.

NOTE: A facesheet (skin) can have more than one sheet bonded together. Be careful not to cause damage to the sheet(s) below the damaged sheet(s).

(3) Examine the damaged area for signs of water, oil, fuel, dirt or other contamination in the honeycomb. Remove all fluids, dirt and other contamination.

(a) Use a vacuum or oil-free compressed air to remove water.

(b) Dry the honeycomb core. You can heat the core or use hot air at the wet area for 1 hour (minimum) at 150°F (77°C). Make sure that the temperature does not increase more than 5°F (3°C) a minute. Dry again if necessary.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(c) If a honeycomb core has oil in it, then spray on MEK, MIBK, MPK, or acetone solvent to remove the contamination. Be careful to prevent damage to the adhesive on the opposite skin. Immediately remove the solvent from the core. Let the core become completely dry.

(4) If you are repairing a crack you can do a stop-drill procedure or cut out the damage with a 0.25 inch (6 mm) minimum diameter router bit. Refer to 51-13-1, and 51-9-5 for the stop drill procedure.

(5) For small damage that has a 1.0 inch (25 mm) diameter or less, cut out the damage to a circular shape. Then put BMS 5-28 Type 6 or 7 potting compound or BMS 5-101 Type III liquid pourcoat adhesive in the hole. Refer to Table 3 and 51-9-5.

B. If the aluminum honeycomb core is damaged, do one of the procedures that follow:

NOTE: If the opposite skin is not damaged, be careful to not cut into the opposite aluminum skin. Also, do not cause the bond area to get hot when you use the router.

(1) Full depth core damage:

(a) Remove all of the damaged core.

(b) Lightly abrade the adhesive surface at the bottom of the hole (where the core was).

NOTE: It is not necessary to remove all of the adhesive from the opposite facesheet unless it is in an unsatisfactory condition. The adhesive is unsatisfactory if it has damage from water or other fluids, or if bare metal shows.

(c) Use a vacuum cleaning device to remove dust and particles of the core from the adhesive surface.

(2) For core damage of partial depth, use a septum. See 51-9-6 for repairs that use a septum.

C. Make all the corners of large cutouts in skins and honeycomb sandwich facesheets a minimum of 1.0 inch (25 mm) radius.

D. If you removed skin from above an open core (no core replacement), use a vacuum to remove dust and particles from the open core.

E. Refer to the component engineering drawings or use NDI procedures to find the locations of internal doublers and other repairs. Refer to 51-9-7 for the doubler thicknesses and overlaps to use when cutouts are near a panel edgeband.

8. Make the repair parts

WARNING: USE ONLY EXPLOSION-PROOF EQUIPMENT WHEN YOU DO THESE TYPES OF REPAIRS. IF YOU DO NOT, PERSONAL INJURY AND DAMAGE TO ADJACENT EQUIPMENT CAN BE THE RESULT. WHEN YOU WORK WITH FLAMABLE MATERIALS, HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

A. Make the repair doublers and fillers from material that is the same or an equivalent alloy material and heat treatment as the initial skin. Refer to 51-1-1, for the approved substitution materials.

(1) Do not make doublers and fillers from 7000 series aluminum that are clad on both sides. You can use clad 7000 series aluminum repair parts that are non-clad on one or both sides.

NOTE: This procedure will only let you bond on a non-clad side of a 7000 series aluminum part. Do not use 7000 series aluminum fillers and internal doublers if a side is clad.

(2) As an alternative to the surface preparation and primer application steps in par. 11. through par. 17., you can make your repair doublers and fillers from pre-primed aluminum (aluminum that has the correct surface preparation and adhesive primer on it).

(3) For flush repairs, refer to Fig. 7 for the thickness and dimensions of the repair parts.

(4) For external doubler (non-flush) repairs, refer to Fig. 8 for the thickness and dimensions of the repair parts. Make a chamfer around the edges of external repair doublers that are 0.032 or thicker gage. Refer to Fig. 12.

(5) Remove all the nicks, scratches, gouges, burrs, sharp edges, and other unwanted material from the repair doublers and fillers.

B. If a core repair plug is necessary, do the steps that follow:

(1) Use the same Boeing Material Specification (BMS) material or equivalent BMS-type and alloy as the initial core material.

NOTE: You can increase the durability of the repair if you purchase and use core that is phosphoric acid anodized (BMS 4-4 Class NPA, for example).

(a) You can use the same grade or a one grade higher density core than the initial core material.

(b) If necessary, you can make a full depth core from two pieces that are less than full depth. Refer to 51-9-6 for a repair that uses a septum to make a full depth core from two pieces.

(c) If necessary, you can make a partial depth core if you use a septum. Refer to 51-9-6 for a repair that uses a septum to make a partial depth core.

(2) Make the repair core so that it has the same shape and ribbon direction as the initial core. Make the core so that it will fill the hole. Refer to Fig. 9.

(3) Put the repair core into the hole.

(4) Measure the gap between the outer edges of the initial core and the repair core. Make sure that the gap is less than 0.1 inch (2.5 mm). If the gap is too large, then make another repair core that has the correct fit.

(5) If necessary, cut or abrade the top of the core plug until the core height is –0.00 to +0.005 inch (–0.00 to +0.13 mm) above:

(a) The surface of the adjacent core (when the skin has been removed from above an area of core that will not be replaced), or

(b) The undamaged skin (when the edge the undamaged core is adjacent to the edge of the undamaged skin).

NOTE: The repair core will compress and move down during the cure.

(6) Carefully remove the repair core plug from the hole.

(7) Remove all the burrs and other unwanted material from the repair core.

(8) Use a vacuum cleaning device to remove all the dust and particles from the repair core.

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C. Clean the repair doublers and fillers that do not have primer applied to the surface.

D. Clean the aluminum honeycomb repair core, if used. Make sure that all unwanted materials are removed. Do a vapor de-grease as given in SOPM 20-30-03 or flush the honeycomb core with Series 97 solvent as given in SOPM 20-30-97.

NOTE: To flush the core with solvent, put the core fully into the solvent and leave it for a minimum of 30 seconds. Remove it and let it dry fully. The time to dry fully is approximately 1 hour.

E. Prepare the core mating surfaces.

(1) Abrade the adhesive layer at the bottom of the hole in the initial core to make the surface rough. Use Scotch Brite, Type A, No. 180 or finer pads (or the equivalent).

NOTE: If the adhesive is damaged, then look to see if the adhesive primer is also damaged. Refer to par. 6.B.

(2) Clean the mating surfaces of the initial core, repair core, and the facesheet at the bottom of the hole with a cleaning solvent. Refer to SOPM 20-30-03 for the applicable solvents.

(3) Continue to clean the surfaces until a new moist cloth is clean after it is used. Remove the solvent before it can dry.

(4) Do an inspection of the cleaned repair area. The area must show no signs of a glossy surface.

9. Installation of the Honeycomb Repair Core

A. If you do the one-stage cure repair, then do a surface preparation as specified in par. 11. Then come back to this step and do the honeycomb installation procedure.

NOTE: The steps that follow are applicable for the one-stage and the two-stage cure procedures.

B. If you cut out damage through the top and bottom facesheets, then put the repair doubler(s) and filler(s) on one of the facesheets before you install the core. Refer to Fig. 7 and Fig. 8.

NOTE: If you are doing a core repair that is less than full depth, or if you make a thick core from two thin cores, then use a septum. Refer to 51-9-6 for septumized core repairs.

C. To bond the repair core mating surfaces, you can use foaming adhesive, two-part paste adhesive, or potting compound. Refer to Table 3 for data on the adhesive materials.

NOTE: Before you open the film adhesive or a foaming adhesive container, let the adhesive stay at a temperature of 60°F to 80°F (16°C to 26°C). You can use the adhesive after there is no condensation.

RESIN TYPE (RESIN USE)	POT LIFE	CURE TIME	CURE TEMPERATURE
BMS 5-28, Type 6 or 7 (Potting Compound)	1 hour	1.5 hours	250° to 260° F (121° to 127° C)
BMS 5-90, Type III, Class 250 (Foaming Adhesive)	Not Applicable	1.5 hours	225° to 260° F (107° to 127° C)
BMS 5-92, Type I, or V (Two-part Paste Adhesive)	Refer to Fig. 210	Refer to Fig. 10	Refer to Fig. 10
BMS 5-101, Type III (Liquid Pour Coat Adhesive)	Not Applicable	1.5 hours	225° to 260° F (107° to 127° C)
BMS 5-141 (Two-Part Paste Adhesive)	1 hour (Minimum)	Refer to Fig. 11	Refer to Fig. 11

Cure Instructions for the Adhesives and Potting Compounds to Make a Core Repair
Table 3:

D. To bond the core to the facesheet or repair doubler, you can use a film adhesive or a two-part paste adhesive. Refer to par. 18. or par. 19. for data on the adhesive materials.

E. Core Installation Options.

(1) The procedure in par. 9.F.(1) shows how to install the repair core with film adhesive, and BMS 5-90, Type III, Class 1, Grade 50 or 100 foaming adhesive.

(2) The procedure in par. 9.F.(2) shows how to install the repair core with BMS 5-101, Type II, film adhesive, and BMS 5-28 Type 6 of 7 potting compound.

(3) The procedure in par. 9.F.(3) shows how to install the repair core with BMS 5-92 or BMS 5-141 two-part paste adhesive.

(4) The procedure in par. 9.F.(4) shows how to seal a square edge with BMS 5-101, Type III liquid pourcoat adhesive.

F. Core installation procedures.

(1) Foaming adhesive core splice procedure. Do the steps that follow to install a repair core with film adhesive, and with BMS 5-90, Type III, Class 1, Grade 50 foaming adhesive.

(a) Prepare the facesheet before you bond the core.

1) Use one of the film adhesive types that follow:

* three plies of BMS 5-101, Type II, Grade 5, or
* two plies of BMS 5-101, Type II, Grade 10, or
* one ply of BMS 5-101, Type II, Grade 15

2) Cut the film adhesive to the same dimensions as the bottom surface of the repair core.

3) Put the ply (or plies) of film adhesive at the bottom of the hole in the initial core.

a) Remove the separator sheet from each film adhesive ply.

b) If one-side tacky (OST) adhesive is used, (adhesive that has the mat carrier cloth on one of the outer surfaces), put the non-tacky (cloth) side against the bottom of the repair core.

4) Push the adhesive smoothly and tightly in place. Do not trap air between the adhesive plies and the skin or repair doubler at the bottom of the hole.

(b) Cut a piece of BMS 5-90, Type III or IV Class 1, Grade 50 or Grade 100 foaming adhesive.

NOTE: BMS 5-90 Type IV extrudable adhesive is an alternative that can be used in a pressurized autoclave.

1) Cut the adhesive to a sufficient length to wind fully around the inner cell wall splicesurfaces (of the hole in the initial core).

NOTE: Cut the BMS 5-90, Type III, foaming adhesive to make each end attach in a butt-joint. You are also permitted to have a maximum 1/8 inch (3 mm) overlap.

2) If the adhesive has a separator sheet on each side, then remove one of them now. Keep the tacky side against the cell walls in the hole.

3) Wind the foaming adhesive around the inside of the hole in the initial core. Make sure that the adhesive touches all of the core splice surfaces.

4) Remove the separator sheet from the open side of the adhesive.

NOTE: The adhesive must fill a minimum of 3/4 of the clearance between the initial core and the repair core. If necessary, you can apply more than one layer of the BMS 5-90 adhesive material to the repair core.

(c) Align the ribbon direction of the repair core in the same direction as the core to be repaired. Put the repair core inside the hole.

NOTE: The maximum error permitted is ±5 degrees in the vertical direction and the ribbon direction. See Fig. 9.

1) Make sure that the repair core plug is pushed into the adhesive at the bottom of the hole.

(2) Potting compound core splice procedure. Do the steps that follow to install a repair core with the adhesive film and BMS 5-28, Type 6 or 7 potting compound.

(a) Prepare the facesheet for bonding the core.

1) Use one of the film adhesive types that follow:

* three plies of BMS 5-101, Type II, Grade 5, or
* two plies of BMS 5-101, Type II, Grade 10, or
* one ply of BMS 5-101, Type II, Grade 15.

2) Cut the film adhesive to the same dimension as the bottom surface of the repair core.

3) Put the ply (or plies) of film adhesive at the bottom of the hole in the initial core.

a) Remove the separator sheet from each film adhesive ply.

b) If one-side tacky (OST) adhesive is used, (adhesive that has the mat carrier cloth on one of the outer surfaces), put the non-tacky (cloth) side against the bottom of the repair core.

(b) Apply a sufficient quantity of BMS 5-28, Type 6 or 7 potting compound to the mating sides of the initial and repair cores. The potting compound must fill all of the area between the repair core and the core to be repaired.

(c) Align the ribbon direction of the repair core in the same direction as the core to be repaired. Put the repair core inside the hole.

NOTE: The maximum error permitted is ±5 degrees in the vertical direction and the ribbon direction. See Fig. 9.

1) Make sure that the repair core has a tight interference in the core hole.

2) Make sure that the repair core plug is pushed into the adhesive at the bottom of the hole.

(3) Paste adhesive core splice and core to skin bond procedure. Do the steps that follow to install a repair core with BMS 5-92, Type I or V, or BMS 5-141 two-part paste adhesive.

(a) The edges of the repair core must be a minimum of 2.0 inches (50 mm) from attached fittings. The repair core must also be a minimum of 2.0 inches (50 mm) from the outer edges of the initial core.

(b) Prepare the facesheet for bonding the core. Apply a 0.04 to 0.08 inch (1.0 to 2.0 mm) thick layer of adhesive to the first surface that the core will be bonded to.

NOTE: Example: at the bottom of the hole in the initial core. As an alternative, you can wet two plies of BMS 9-3, Type H-2 or H-3 dry glass fabric with the paste adhesive and put them in the bottom of the hole.

(c) Apply a sufficient quantity of adhesive to the mating sides of the initial and repair cores. The adhesive thickness must fill all of the area between the repair core and the core to be repaired.

(d) Align the ribbon direction of the repair core in the same direction as the core to be repaired. Put the repair core into the core hole.

NOTE: The maximum error permitted is ±5 degrees in the vertical direction and the ribbon direction. See Fig. 9.

1) Make sure that the repair core has a tight interference in the core hole.

2) Make sure that the repair core plug is pushed into the adhesive at the bottom of the hole.

(4) Seal procedure for a square edge panel assembly.

NOTE: 51-9-7, Fig. 2 shows examples of square edges of honeycomb core that are sealed.

(a) If PAA core is used, you can put BMS 5-95 sealant on the open edges after the repair to the honeycomb panel is completed.

(b) On bare aluminum core, apply BMS 5-101, Type III, liquid pourcoat adhesive to seal the square edge. Do what follows:

1) Clean the repair core again.

2) Measure 3 to 6 core cells in from the perimeter edge of the repair core. Apply the BMS 5-101, Type III liquid pourcoat adhesive on the applicable cells of the repair core. You can dip the core cells into the adhesive or pour the adhesive on to the core cells.

NOTE: If you use the pour procedure, apply the adhesive to one side of the repair core first. Turn the core over and apply other side. Make sure that the adhesive fully covers the cell walls.

3) Put the repair core on clean, absorbent, oil-free paper.

NOTE: After the adhesive is applied, you have less than 3 minutes to drain the extra liquid adhesive from the cells.

a) If there is too much liquid adhesive in the core cells, let the extra adhesive drain away.

b) After the extra liquid adhesive has drained away, put the repair core on another clean oil-free paper to help the extra liquid adhesive continue to drain.

4) Let the repair core air-dry at ambient temperature on a clean oil-free paper for 30 to 40 minutes.

5) After the air dry time, oven dry the BMS 5-101, Type III at 180°F to 190°F (82°C to 88°C) for 30 to 35 minutes before you install the repair core.

NOTE: Protect the core from contamination.

G. Two-stage honeycomb core cure repair procedure. Refer to Fig. 9 for the steps that follow:

NOTE: If you do a one-stage honeycomb core cure repair procedure, then the steps that follow are not necessary.

(1) Bagging procedure:

(a) Put thermocouples at the edges and bottom of the core.

(b) Find a heat blanket that is larger, than the replacement core.

1) The heat blanket must be sufficient to extend 2.0 inches (50 mm) or more, from the edges of the replacement core.

2) Use the dimensions of the blanket to find the correct dimensions of the layup and vacuum bag materials.

(c) Cut a layer of perforated FEP release film to the same dimensions as the heat blanket. Put the release film on the open replacement core. Make sure that the edges of the release film are an equal distance from the edges of the replacement core.

(d) Cut a layer of dry peel ply or fiberglass bleeder material that is 2.0 inches (50 mm) larger, all around, than the dimensions of the heat blanket. Put the peel ply (or bleeder) on the perforated FEP. Make sure that the edges of the peel ply (bleeder) extend 2.0 inches (50 mm) from the edges of the FEP.

(e) Cut a layer of solid FEP release film, to the same dimension as the heat blanket. Put the release film on the peel ply (bleeder). Make sure that the edges of the release film are an equal distance from the edges of the dry peel ply (bleeder).

(f) Cut a layer of dry peel ply material that is 2.0 inches (50 mm) larger, all around, than the dimensions of the heat blanket. Put the peel ply on the solid FEP. Make sure that the edges of the peel ply extend 2.0 inches (50 mm) from the edges of the FEP.

(g) Put the heat blanket on the peel ply. Make sure that the edges of the heat blanket are an equal distance from the edges of the peel ply.

(h) You can put a thermocouple on the heat blanket (optional). If the heat blanket gets too hot, you can turn off the power before you damage the skin panel.

(i) If the heat blanket extends more than 3.0 inches (75 mm) from the edge of the cutout, you can do this recommended procedure:

NOTE: If a heat blanket gets too hot, it can cause damage to the repair and to the adhesive in the undamaged skin. To help prevent damage (if the heat blanket gets too hot), do not let the heat blanket touch more skin than is necessary. Insulation between the heat blanket and the skin is recommended.

1) Put the edge of the insulation 2.0 to 3.0 inches (50 to 75 mm) from the edge of the cutout in the top facesheet.

2) Let the insulation material extend to the end of the heat blanket (at a minimum).

(j) Put four to six layers of glass fabric (or two layers of 0.04 inch (1.0 mm) breather fabric, or one layer of 0.1 inch (2.5 mm) breather fabric) above the heat blanket as a breather. Make sure that the breather is sufficient to extend from the edges of the heat blanket.

(k) Put a vacuum base above the fiberglass breather cloth for each vacuum port and vacuum gage port.

(l) Put on the vacuum bag sealant.

(m) Make a hole in the outer vacuum bag at the vacuum base location for each vacuum port and vacuum gage port.

(n) Put the vacuum bag film on the repair area.

(o) Connect the vacuum port and vacuum gage ports to their vacuum bases.

(p) If necessary, put insulation material on the outer surface of the vacuum bag.

(2) Cure the repair.

(a) Refer to Table 3 for the cure instructions.

(b) When the cure time is completed, decrease the temperature at a rate of 5°F (3°C) a minute.

(3) When the temperature is less than 125°F (52°C), release the vacuum pressure and remove the vacuum bag equipment.

(4) Remove the thermocouple wires from the repair area.

NOTE: Part of the thermocouple wires can stay in the cured adhesive if you cannot remove them. Cut the thermocouple wires so that the ends of the wires are below the surface of the core.

(5) Abrade the top of the core until it is flush with the top of the adjacent core or skin (that which applies). Refer to Fig. 9.

(6) Use a vacuum cleaning device to remove dust and particles from the open core and the repair area.

(7) Do a visual inspection of the core splice. If you see areas that are not bonded, then fill the voids with a core splice adhesive or potting compound. Measure the length of the filled areas.

(a) If the total cumulative length of the filled areas is more than 2.0 inches (50 mm), then cure the core splice material and do par. 9.G.(5) through par. 9.G.(7) again.

(b) If the total cumulative length of the filled areas is 2.0 inches (50 mm) or less, then do all of the applicable steps that remain in this procedure.

10. Inspect the fit of the repair parts

A. See if light finger pressure can make all the areas of the repair part touch the surface to be bonded.

B. Examine and measure the bondline for all repair doublers that have an area of 64 square inches (410 square cm) or more.

(1) The verifilm test is a satisfactory procedure to make sure that you have the permitted bondline thickness. Other procedures are permitted if you can make sure that the bondline thickness is satisfactory.

(2) Make sure that you have a bondline thickness of between 0.002 and 0.020 inch (0.05 to 0.50 mm).

C. If you do a verifilm test, do the steps that follow:

(1) Put a ply of 0.001 or 0.002 inch (0.025 or 0.050 mm) non-perforated FEP release film above the repair area.

NOTE: If there is open honeycomb core, use 0.004-0.007 inch (0.10 to 0.18 mm) thick PVC film. You can use a different material if:

* It does not cause contamination of the core, and
* It will let the honeycomb pattern (from the honeycomb core) show on the adhesive.

(2) Put on to the release film the same adhesive type that you use to do the repair.

NOTE: If a paste adhesive is used, make sure that you apply the adhesive at a constant thickness. If a film adhesive is used, make sure that you use the same number of plies and the same grade that you use in the repair.

(3) Put a ply of nonperforated FEP release film or PVC film above the adhesive.

(4) Put the repair doublers and fillers on the release film the same as you do for the repair.

(5) Apply a vacuum bag and cure the adhesive as specified in par. 18. You are permitted to cure the adhesive for half of the time specified for the repair.

(6) After the verifilm check is completed, disassemble the parts and do a visual inspection of the cured adhesive.

(a) The adhesive must be between 0.002 inches (0.05 mm) and 0.020 inch (0.50 mm) thick.

(b) Make sure that the parts did not move during the cure.

(c) Make the sure that there are no voids that are larger than 0.10 inch (2.5 mm) in diameter.

(d) If there is open honeycomb core, make sure that you can clearly see the honeycomb pattern on the adhesive for all of the open core. Make sure that the core is not crushed.

(7) If the test is satisfactory, then discard the cured adhesive and the used release film materials. If the test is not satisfactory, then do one or more of the steps that follow:

(a) Repeat the verifilm test with an additional ply of Grade 5 or 10 film adhesive. If the test is satisfactory, make sure that you use the same number of plies of adhesive and the same grades when you do the repair.

(b) Repeat the verifilm test with weight or pressure added. If the test is satisfactory, make sure that you use the same weight or pressure when you do the repair.

(c) Check the shape and fit-up of the repair parts. Adjust if necessary, and then repeat the verifilm test.

(d) Ask Boeing for help if necessary.

D. Apply the adhesive as given in par. 18. or par. 19.

11. Use of the Surface Preparation Procedures

CAUTION: DO NOT BOND A CLAD SURFACE OF A CLAD 7000 SERIES ALUMINUM PART. THE RESULT CAN BE CORROSION AT THE BOND INTERFACE OF THE REPAIR.

A. Do a surface preparation procedure only on aluminum surfaces that are not primed. Remove all unwanted primer and other material before you continue with the procedure.

B. Refer to Fig. 1 for the permitted repair size limit for each surface preparation procedure.

NOTE: These procedures prepare the aluminum surfaces for metal-to-metal bonding and bonding metal face sheets to aluminum honeycomb core.

C. Phosphoric Acid Anodized (PAA) aluminum gives the best surface preparation for bonding. You can get PAA repair parts from the list that follows:

(1) Purchase parts that come with the PAA surface and the adhesive primer on them.

(2) Do a tank PAA procedure as specified in Boeing Process Specification BAC 5555 "Phosphoric Acid Anodizing of Aluminum for Structural Bonding".

(3) Do the PACS or PANTA surface preparation procedure.

D. The PACS and PANTA procedures are PAA alternatives to tank PAA procedures to prepare an aluminum surface for bonding.

E. As an alternative to the PANTA or PACS procedures, you can use the Boegel (AC-130) procedure.

F. The HF - Alodine procedure can only be used for small, interim repairs.

12. The Phosphoric Acid Containment System (PACS) Procedure

NOTE: The Phosphoric Acid Containment System (PACS) procedure is covered by U.S. patent numbers 4,882,016 and 4,988,414 and other patent applications assigned to The Boeing Company. Repair stations that have Boeing licenses and operators of Boeing aircraft are permitted to use this procedure. For data regarding licensing for non-Boeing applications, call the Chief Patent Counsel, The Boeing Company.

A. The necessary PACS materials are:

(1) Phosphoric Acid, 75-80% (by weight), as given in Federal Specification A-A-55820

(2) Copper Wire

(3) Corrosion Resistant Steel (300 Series CRES) Wire Mesh

(4) DC Power Supply

(5) Vacuum Sealing Compound

(6) Nylon Vacuum Bag Film

(7) Solvent and Acid Resistant Tape

(8) 3M Scotch Brite Pads, Type A, Very Fine

(9) Fiberglass Breather Cloth

(10) Nylon Breather Material (11) Aluminum Foil Tape

(12) Solid FEP

(13) Blue Litmus Paper

(14) Acetone or Methyl Propyl Ketone (MPK) Solvent

(15) BMS 5-89 Adhesive Primer

(16) Plastic Film (Mylar, acetate, polyester or equivalent plastic material)

WARNING: KEEP ACIDS AWAY FROM HEAT, FIRE, AND SPARKS. ACID FUMES ARE FLAMMABLE AND TOXIC. INJURY TO PERSONNEL CAN BE THE RESULT. DO NOT PERMIT ACIDS TO MIX WITH OTHER MATERIALS. MAKE SURE THAT THE AIR SUPPLY TO THE AREA IS NOT BLOCKED.

USE RUBBER GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION WHEN YOU WORK WITH PHOSPHORIC ACID. THE ACID CAN BURN YOUR EYES AND SKIN AND CAUSE INJURY. IF THE ACID TOUCHES THESE AREAS, FLUSH WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

B. Make the phosphoric acid solution.

(1) Calculate how much solution is necessary.

NOTE: In this step, you have a minimum of two times as much solution than is needed for the anodize process. This is because it is necessary to have sufficient solution on the area to be anodized:

* During the time needed to get the specified voltage, and
* To make sure that the solution flows for a minimum of 20 minutes.

(a) Make sure that a minimum of 1.0 gallon (4.0 liters) of phosphoric acid solution for each 100 square inches (645 square cm) of treatment area is prepared and connected.

(b) As an alternative, you can circulate the acid and use it two times on the bond surface. Start with a minimum of 1/2 gallon (2.0 liters) of solution for each 100 square inches (645 square cm) of treatment area.

WARNING: ALWAYS ADD ACID TO WATER WHEN YOU MIX THEM. IF YOU ADD WATER TO ACID, THE ACID WILL BECOME VERY HOT AND WILL NOT BE STABLE. THIS CAN CAUSE INJURY TO PERSONS.

(2) To make the phosphoric acid solution, add 14 ± 1/3 fluid ounces (410± 10 ml) of 75-80% phosphoric acid to each 135 ± 2 fluid ounces (4.0 liters ± 60 ml) of distilled water.

C. Clean and abrade the repair surfaces.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface will look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean, dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(5) Isolate the mechanical fasteners and all the areas that are not damaged. Use aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent).

(6) Put on a mask to seal all areas where the damage goes through a skin. To make the mask: put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, you can temporarily fill the hole before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(7) Flush with clean water. You can also wipe with a clean, wet, lint-free cloth until no residue shows on the cloth.

D. Do a visual inspection for a water-break-free surface.

(1) Flush the surface with clean (mineral-free or de-ionized) water. Do this for 30 seconds or until the surface has a continuous water film on all of the repair area.

NOTE: The preferred water temperature is between 50° and 100 °F (10 ° and 38 °C).

(2) After the flush procedure is completed, the water film on the bond surface must stay continuous for a minimum of 30 seconds.

NOTE: The water surface tension at the edges of an aluminum skin can cause the water film to pull away from the edge a small distance. This condition is permitted unless it is caused by surface contamination or incorrect abrading.

(3) If the film does not stay continuous for a minimum of 30 seconds, do par. 12.C. and par. 12.D. again.

E. Put a layer of plastic film (Mylar, acetate, polyester or an equivalent material) on the bench tops and other work areas. This will help to prevent the contamination of the repair parts.

F. Assemble the PACS immediately after you clean the repair surface. Refer to Fig. 4.

CAUTION: DO NOT USE A STAINLESS STEEL SCREEN IF IT SHOWS CORROSION OR OTHER DETERIORATION. IF YOU DO, IT IS POSSIBLE THAT THERE WILL NOT BE THE NECESSARY AMOUNT OF CURRENT FLOW THROUGH THE SCREEN.

(1) Cut a piece of the stainless steel screen to the shape and dimensions of the surface area to be anodized. Use 300 series alloy CRES with a wire gauge that is a minimum of American Wire Gauge (AWG) #20 (0.03 inch (0.8 mm) diameter) and a maximum of #14 (0.06 inch (1.5 mm) diameter).

NOTE: AWG #18 (0.04 inch (1.0 mm) diameter) is the usual type of stainless steel screen used.

(2) Make a record of the dimensions of the area to be anodized and do a calculation of the area. This data will be used later to make a calculation of the volume of acid divided by the area that was anodized.

(3) Attach conductive negative (–) cathode wire(s) to the stainless steel screen. Make sure that there is a minimum of one wire for each 30 square inches (200 square cm) of the repair area. Use a sufficient length of wire to prevent tension in the wire between the power supply and the PACS assembly. Put the same space between each of the wires.

NOTE: The negative (–) cathode wire must have a good electrical conductivity with the stainless steel screen. Make sure that the wires and clamps are sufficiently large to transmit the necessary electrical current.

(4) Cut three or four ply layers of non-woven mat breather material. Each layer must be a minimum of 1.0 inch (25 mm) larger than the stainless steel screen (to make sure that the screen will not touch the surface of the part).

(5) Put two layers of the breather material on the area to be anodized. Align each layer with each other. Make sure that the breather material extends 0.5 inch (13 mm) from each edge of the area to be anodized.

NOTE: On repair areas that are vertical or not easy to get to, use tape to attach each breather cloth layer.

CAUTION: MAKE SURE THAT THE STAINLESS STEEL SCREEN AND CATHODE WIRE DOES NOT TOUCH THE ALUMINUM REPAIR SURFACE. THE RESULT CAN BE DAMAGE TO THE PARTS.

(6) Put the screen on the breather material. Make sure that the edges of the screen are 0.5 inch (13 mm) from the edges of the breather material.

(7) Put one or two layers of breather material on the screen. (Two layers above the screen are recommended for areas larger than 64 square inches (410 square cm). Have the edges align with the edges of the breather material below.

(8) Put acid inlet tube(s) between the breather cloth layers at one edge. Do not put the inlet tube on the stainless steel screen. If you use two or more inlet tubes, put the tubes sufficiently far apart to make the surface fully wet.

NOTE: Use two or more acid solution inlet tubes for repair sizes that are larger than 64 square inches (410 square cm). This is necessary to keep the bond surface fully wet during the anodize procedure.

(9) Put the vacuum outlet tube(s) between the breather cloths at the opposite edge. Do not put the outlet tube on the stainless steel screen.

(10) Apply vacuum sealing compound on the aluminum part 1.0 inch (25 mm) or less from the edges of the breather cloth.

(11) Cut a piece of vacuum bag film that is approximately 5.0 inches (130 mm) larger than the breather cloths. Put it fully around the repair area.

(12) Remove all the wrinkles in the vacuum bag.

(13) Seal the cathode wire(s) and the inlet tube(s).

(14) Connect the outlet tube between the vacuum probe and the catch basin.

(15) Attach the three-way valve to the inlet tube(s).

(a) Turn the valve to the closed position (no flow of water or acid solution).

(b) Connect one valve line to a container with the phosphoric acid solution that you made in par. 12.B.

(c) Connect a second valve line to the water supply.

(16) If the surface to be anodized is vertical or face down, then Boeing recommends that you use two vacuum bags (an inner bag and an outer bag). The outer vacuum bag will contain the acid if there is leakage from the inner vacuum bag. If the surface is face up (as shown in Fig. 4) then the outer vacuum bag is not necessary.

(a) If the outer vacuum bag is necessary, go to par. 12.F.(17).

(b) If the outer vacuum bag will not be used, then do the steps that follow:

1) Start a vacuum in the vacuum bag and seal all the leaks.

NOTE: The vacuum is through the drain line from the catch basin to the outlet tube.

2) Go to par. 12.F.(18).

(17) When you use two vacuum bags, do the steps that follow:

(a) Put a minimum of four continuous plies of fiberglass breather cloth around the inner vacuum bag.

(b) Put a vacuum base above the fiberglass breather cloth.

(c) Cut a second piece of vacuum bag film for the outer vacuum bag. Make sure that it is larger than the inner bag and fiberglass breather cloth.

(d) Put the outer vacuum bag above the fiberglass breather cloth and the inner bag layup. Seal it to the metal surface. Make sure that the outer bag is sealed. Remove all the wrinkles.

NOTE: Make sure that the cathode wire, inlet tube(s), and outlet tube(s) go below the outer bag. Seal it at the edge of the bag.

(e) Make a hole in the outer vacuum bag at the vacuum base location for the vacuum port.

(f) Connect the vacuum port and vacuum gage port to the vacuum base.

(g) Start a vacuum in the inner bag and seal all the leaks.

NOTE: The vacuum is through the drain line from the catch basin to the outlet tube.

(h) Start a vacuum in the outer bag and seal all the leaks.

NOTE: The vacuum in the outer bag will hold the inner bag and the parts in their positions.

(18) Connect the wires to a DC power supply.

NOTE: Use a battery or a DC power supply as the power source for the anodizing procedure. The power source must have a capacity of 10 volts, minimum. The power source must also have a capacity of 8 amps/square foot (86 amps/square meter), minimum.

(a) Connect the negative (-) cathode wire that is attached to the stainless steel screen, to the negative lead on the power source.

(b) Connect the positive (+) anode wire to the aluminum part surface to be anodized, and to the positive (+) lead on the power source.

G. Do the PACS anodize procedure.

(1) Before you let the acid solution flow:

(a) Make a record of the initial quantity (in fluid ounces or liters, as applicable) of the acid in the container.

NOTE: This record will be necessary for the calculation in par. 12.G.(9)(a).

(b) If you recycle the acid solution, you must have a procedure to measure or calculate the total quantity of solution that flowed on the bond surface.

(2) Make sure that the temperature of the acid and aluminum part stays between 70 ° and 85 ° F (21 ° and 29 ° C) during the anodizing procedure.

(3) Open the three-way valve to let the phosphoric acid solution flow from its container to the inner vacuum bag.

(a) Let a sufficient quantity of acid to flow in until the non-woven mat breather material becomes soaked. Make sure that you keep a sufficient and continuous acid solution flow rate.

(b) Use a minimum of 0.03 fluid ounce (1.0 ml) a minute for each square inch (1.5 ml a minute for each 10 square cm) to be anodized. This quantity is necessary to keep the surface fully wet.

(4) Do the steps that follow (as soon as possible) in the sequence that follows:

(a) Set the voltage and current positions to zero on the electrical power supply.

(b) Start the electrical power supply.

(c) Increase the current adjustment to the full open position.

(d) Slowly increase the voltage (approximately 5 volts for each minute) until it is between 9.5 to 10 volts (DC).

(e) Do a check of the amperage after it gets to the correct voltage.

NOTE: A fast increase in the current (more than 20% of the stable value) could be a sign that the surface is burning. Add more acid solution. If this is an unsatisfactory solution, an electrical short could be the cause. Stop the procedure and look for the problem.

1) In one minute or less, the current will become stable.

2) The current density at 9.5 to 10 volts (DC) must be in a range that is between 0.014 and 0.048 amperes/square inches (0.0022 and 0.0074 amperes/square cm).

(f) Apply the 9.5 to 10 volts (DC) for 18 to 22 minutes.

CAUTION: DO NOT LET THE ASSEMBLY BECOME DRY. THE RESULT CAN BE A BURNED SURFACE OR A SURFACE TREATMENT THAT IS UNSATISFACTORY. ADD MORE ACID AS NECESSARY TO KEEP THE SURFACE FULLY WET.

(5) Make sure that there is a steady flow of acid over all of the surface of the part during the anodizing procedure. Signs that the acid flow rate is not sufficient or signs of local dry areas are:

* An increase in current after it has stabilized, or
* A significant increase in temperature, or
* A lightening of the color of the breather cloth.

NOTE: The breather cloth will change to a darker color when it becomes soaked with the phosphoric acid.

(6) Stop the electrical power after the specified anodizing time.

(7) Quickly, make a record of the quantity of phosphoric acid that stays in the container.

NOTE: This record will be necessary for the calculation in par. 12.G.(9)(a).

(8) Immediately, turn the three-way valve to let the rinse water flow from the container to the inner bag.

(a) Flush with a quantity of water equal to 0.03 fluid ounces (1.0 ml) a minute for each square inch (1.5 ml a minute for each 10 square cm) that was anodized.

(b) The rinse water must flush freely against all of the anodized surface.

(9) Flush the bag with rinse water for a minimum of 5 minutes. Do the steps that follow, while the rinse water flushes the anodized surface:

(a) Calculate the quantity of phosphoric acid that was used.

(b) Subtract the quantity of phosphoric acid (the record you made in par. 12.G.(9)(a)) from the initial quantity (the record you made in par. 12.G.(1)).

(c) Divide the volume of phosphoric acid that was used, by the area that was anodized (Use the data from the record you made in par. 12.F.(2)).

(d) If the calculated quantity of phosphoric acid used is less than 1/3 fluid ounce (10 ml) for each square inch (15 ml for each 10 square cm) of area that was anodized, then do par. 12.G.(1) through par. 12.G.(7) again.

(e) Stop the flow of rinse water if the calculated quantity of phosphoric acid used is sufficient.

H. Quickly, disassemble the PACS layup.

(1) Stop the vacuum and disconnect all of the tubing.

(2) Remove the outer vacuum bag and the fiberglass breather cloth. Be careful to not let contamination or other unwanted material get on the anodized surface.

NOTE: Do not touch the anodized surface with your bare skin or with gloves that have contamination on them. Do not let the adhesive tape touch the anodized surface.

(3) Remove the inner vacuum bag, the breather cloths, and the stainless steel screen layup.

(4) Discard the tape, the inner bag, the breather cloth, and the stainless steel screen in an approved container. Make sure to discard these materials by a procedure that is permitted by local health, safety, and environmental authorities.

I. Flush the anodized surface with clean (mineral-free or de-ionized) water for 5 minutes. This will remove all possible phosphoric acid solution.

NOTE: Do not wipe or rub the repair surfaces.

J. Let the anodized surface fully dry at room temperature. As an alternative, you can dry the parts with forced, clean, dry, filtered air that is a maximum of 160°F (71°C) until the surface is fully dry.

NOTE: You must apply the adhesive primer in less than 24 hours after the surface is anodized. Prevent the contamination of the anodized surface by moisture, dust, oil fumes, engine exhaust, or other unwanted material. Do not touch the dried anodized surfaces. Do not apply tape to the anodized surfaces.

K. Examine the anodized surface. You can use a Phosphoric Acid Anodize Detector (dichroscope) or do the polarized filter color inspection test that follows:

NOTE: You can purchase a Phosphoric Acid Anodize Detector (part number WCI-AD55) from West Coast Industries, Inc., 14900 Whitman Ave N, Seattle, WA 98133.

(1) Polarized filter color inspection test.

(a) Use a fluorescent light source on the anodized area.

(b) Put a polarizing filter between yourself and the treated surface and look at the reflected light (from the surface) at an angle of 5 degrees or less. It can be helpful to put the light source at a glancing angle. Refer to Fig. 6.

(c) While you look at the surface through the polarizing filter, turn the filter 90 degrees. A correctly anodized surface gives a constant change in color (on all areas of the anodized surface) when you look through the filter. The colors seen most frequently are purple, yellow, and green.

NOTE: It is not easy to see the colors on a rough or contoured surface. To find out if a surface is anodized correctly, change the view angle of the polarizing filter to see if the anodic coating is satisfactory.

(2) The anodize procedure is not successful if you find one or more of the conditions that follow:

(a) There are sudden changes in color as a result of stains, contamination, fingerprints, or other parts that touched the surface.

(b) There are electrical burns or pits.

(c) There are areas of the surface to be bonded that are not anodized.

(3) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on all the areas of the anodized surface.

(4) If the color inspection test on a rough or contoured surface is not successful, you can do alternative tests to make sure you have a good anodized surface. Do one or more of the tests that follow:

(a) Use an ohmmeter to do a resistance test of the anodized surface. Make sure that the ohmmeter probes are clean.

1) Carefully, put the ohmmeter probes on the anodized surface. Make sure that you do not damage the anodized surface with the ohmmeter probes.

2) Carefully touch the surface with the sides of the probes first, then lay them down. If the surface has a resistance of more than 20,000 ohms (20 kohms) the test is successful.

(b) Do an infrared filter test to measure the weight of the anodize coating. Use an infrared filter device that is tuned to measure phosphoric acid anodize oxides. If the infrared filter test shows an anodized coating that is more than 20mg/square foot (215mg/square Meter), the test is successful.

NOTE: A source for the infrared filter is as follows: Personal Instruments, LLC 18 Commerce Road Newton, CT 06470 (203) 426-0152.

(c) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on 90 percent or more of the anodized surface and one or more of the alternative tests are satisfactory.

(5) If the anodize procedure is not successful, you must do all of the steps in par. 12. again. (You must remove the unsatisfactory anodic oxide by abrasion as given in par. 12.C.).

L. If you put a mask on open honeycomb core during par. 12.C.(6)/REPAIR GENERAL, then remove it now. Make sure that you do not touch or contaminate the surfaces that have been anodized. Do not let moisture get into the core cells.

(1) Do a visual check for moisture in the cells. If you see moisture, use blue litmus paper to make sure that there is no acid contamination.

(a) If the litmus paper changes to a red color, there is acid contamination in the core cells. Flush the core with water. Use more blue litmus paper and do a check for acid again.

(b) If the litmus paper stays blue, there is no acid in the core. Remove the moisture, then continue with the procedure.

(2) Make sure that the core is fully dry before you apply the adhesive primer.

M. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

N. Apply the BMS 5-89 adhesive primer in less than 24 hours after the anodize procedure is completed. Refer to par. 15.

13. The Phosphoric Acid Non-Tank Anodizing (PANTA) Procedure

A. The materials that you need are:

(1) Phosphoric Acid, 75-80% (by weight), as given in Federal Specification A-A-55820 or (optional) pre-mixed phosphoric acid gel

(2) (Optional) Floculated Silica (Cab-o-Sil, Grade M-5, or PTG)

(3) Copper Wire

(4) Corrosion Resistant Steel (300 Series CRES) Wire Mesh

(5) Gauze or Cheesecloth (Cotton, Clean and lint-free)

(6) DC Power Supply

(7) Solvent and Acid Resistant Tape

(8) 3M Scotch Brite Pads, Type A, Very Fine

(9) Aluminum Foil Tape

(10) Solid FEP

(11) Blue Litmus Paper

(12) Acetone or Methyl Propyl Ketone (MPK) Solvent

(13) BMS 5-89 Adhesive Primer

(14) Plastic Film (Mylar, acetate, polyester or equivalent plastic material)

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USE RUBBER GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION.WHEN YOU WORK WITH PHOSPHORIC ACID. THE ACID CAN BURN YOUR EYES AND SKIN AND CAUSE INJURY. IF THE ACID TOUCHES THESE AREAS, FLUSH WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

B. Make the phosphoric acid solution (or gel).

WARNING: ALWAYS ADD ACID TO WATER WHEN YOU MIX THEM. IF YOU ADD WATER TO ACID, THE ACID WILL BECOME VERY HOT AND WILL NOT BE STABLE. THIS CAN CAUSE INJURY TO PERSONS.

(1) To make the phosphoric acid solution, add 14 ± 1/3 fluid ounces (410± 10 ml) of 75-80% phosphoric acid to each 135 ± 2 fluid ounces (4.0 liters ± 60 ml) of distilled water.

(2) As an option, you can make the phosphoric acid solution thicker. Mix flocculated silica (Cab-OSil, Grade M-5 or PTG) with the phosphoric acid until the acid solution and silica become a gel.

NOTE: You can also get the phosphoric acid gel mixture from a vender (supplier).

C. Clean and abrade the repair surfaces.

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(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface should look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(5) Isolate the mechanical fasteners and all the areas that are not damaged. Use aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent). This will prevent acid contamination.

(6) Put on a mask to seal all areas where the damage goes through a skin. To make the mask, put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, make sure that the hole is filled before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(7) Flush with clean water and/or wipe with a clean, wet, lint-free cloth until no visible residue appears on the cloth.

D. Do a visual inspection for a water-break-free surface.

(1) Flush the surface with clean (mineral-free or de-ionized) water. Do this for 30 seconds or until the surface has a continuous water film on all of the repair area.

NOTE: The preferred water temperature is between 50° and 100°F (10 ° and 38°C).

(2) After the flush procedure is completed, the water film on the bond surface must stay continuous for a minimum of 30 seconds.

NOTE: The water surface tension at the edges of an aluminum skin can cause the water film to pull away from the edge a small distance. This condition is permitted unless it is caused by visible surface contamination or incorrect abrading.

(3) If the film does not remain continuous for a minimum of 30 seconds, do par. 13.C. and 13.D. again.

E. Put a layer of plastic film (Mylar, acetate, polyester or an equivalent material) on the bench tops and other work areas. This will help to prevent the contamination of the repair parts.

F. Assemble the PANTA system immediately after you clean the repair surfaces. Refer to Fig. 5 when you do the steps that follow:

(1) Make a dam to prevent the acid solution (or gel) and rinse water from going into the adjacent structure. To make the dam, build up aluminum foil, acid resistant tape, solid FEP, or other acceptable material around the surface to be treated.

CAUTION: DO NOT USE A STAINLESS STEEL SCREEN IF IT SHOWS CORROSION OR OTHER DETERIORATION. IF YOU DO, IT IS POSSIBLE THAT THERE WILL NOT BE THE NECESSARY AMOUNT OF CURRENT FLOW THROUGH THE SCREEN.

(2) Cut a piece of the stainless steel screen to the shape and dimensions of the surface area to be treated. Use a 300 series alloy CRES with a wire gauge that is a minimum of American Wire Gauge (AWG) #20 (0.03 inch (0.8 mm) diameter) and a maximum of #14 (0.06 inch (1.5 mm) diameter).

NOTE: AWG #18 (0.04 inch (1.0 mm) diameter) is the usual type of stainless steel screen used.

(3) Set up an acid drain and rinse water recovery basin to hold the waste acid and rinse water after the anodize procedure is completed.

(4) Apply the acid and layup materials.

NOTE: You have 30 minutes maximum after you apply the phosphoric acid to start the anodize procedure.

(a) Make sure the temperature of the aluminum part and the acid solution (or gel) during the anodizing procedure is between 70 ° and 85 ° F (21 ° and 29 ° C).

(b) Keep the surface wet with acid solution (or gel) at all times. If the surface starts to dry, add more acid solution (or gel).

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USE RUBBER GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION WHEN YOU WORK WITH PHOSPHORIC ACID. THE ACID CAN BURN YOUR EYES AND SKIN AND CAUSE INJURY. IF THE ACID TOUCHES THESE AREAS, FLUSH WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

(c) Apply a smooth layer of phosphoric acid solution (or gel) to the aluminum surfaces.

(d) Cut a layer of gauze (or the equivalent absorbent, porous material) that is larger than the area to be anodized.

1) Put the gauze on the acid layer. Extend the gauze 0.5 inch (13 mm) minimum, from the edges of the area to be anodized. Do this until two or three layers of the gauze are assembled.

2) Keep the thickness to a minimum to prevent gasses from being trapped (but make sure that there is enough so that the screen will not touch the surface to be anodized).

3) Remove the wrinkles. If necessary you can use a paint brush or a plastic sweeper to make sure the acid fully soaks the gauze.

NOTE: You can pre-soak the gauze. The gauze can be pre-soaked by squeezing the acid gel solution through the gauze by hand. Use rubber gloves for protection.

CAUTION: MAKE SURE THAT THE STAINLESS STEEL SCREEN AND CATHODE WIRE DOES NOT TOUCH THE ALUMINUM REPAIR SURFACE. THE RESULT CAN BE DAMAGE TO THE PARTS.

(e) Put the stainless steel screen on the layers of gauze and acid.

CAUTION: MAKE SURE THAT THE SURFACE OF THE REPAIR AREA IS OPEN TO THE AIR TO PERMIT THE RELEASE OF UNWANTED GASES. IF YOU DO NOT, THE REPAIR WILL BE UNSATISFACTORY.

(f) Add a layer of phosphoric acid solution (or gel) to the stainless steel screen to make sure that the solution fully covers the screen.

(5) Make the electrical connections.

(a) Attach a conductive negative (–) cathode wire to the stainless steel screen. Make sure that there is a minimum of one wire for each 30 square inches (200 square cm) of the repair area. The length of the wire must be sufficient so that there is no tension between the power supply and the PANTA assembly. The wires must be evenly spaced apart.

NOTE: The negative (–) cathode wire must have a good electrical conductivity with the stainless steel screen. Make sure that the wires and clamps are large enough to carry the necessary electrical current.

(b) Connect the negative (–) cathode wire that is attached to the stainless steel screen to the negative lead on the power source. Connect the positive (+) anode wire to the aluminum part surface to be anodized, and to the positive (+) lead on the power source.

NOTE: Use a battery or a DC power supply as the power source for the anodizing procedure. The power source must have a capacity of 10 volts, minimum. The power source must also have a capacity of 8 amps/square foot (86 amp/square meter), minimum.

CAUTION: DO NOT LET THE ASSEMBLY BECOME DRY. THE RESULT CAN BE A BURNED SURFACE OR A SURFACE TREATMENT THAT IS UNSATISFACTORY. ADD MORE ACID AS NECESSARY TO KEEP THE SURFACE FULLY WET.

G. Do the PANTA procedure.

(1) Do the steps that follow in the sequence that follows:

NOTE: You have less than 30 minutes to start the electricity after you apply the acid.

(a) Set the voltage and current positions to zero on the electrical power supply.

(b) Start the electrical power supply.

(c) Increase the current adjustment to the full open position.

(d) Slowly increase the voltage (approximately 5 volts for each minute) until it is between 9.5 to 10 volts (DC).

(e) Do a check of the amperage after it gets to the correct voltage.

NOTE: A fast increase in the current (more than 20% of the stable value) could be a sign that the surface is burning. Add more acid solution (or gel). If this is an unsatisfactory solution, an electrical short could be the cause. Stop the procedure and look for the problem.

1) In one minute or less, the current will become stable.

2) The current density at 9.5 to 10 volts (DC) must be in a range that is between 0.014 and 0.048 amperes/square inches (0.0022 and 0.0074 amperes/square cm).

(f) Apply the 9.5 to 10 volts (DC) for 10 to 12 minutes.

CAUTION: DO NOT LET THE ASSEMBLY BECOME DRY. THE RESULT CAN BE A BURNED SURFACE OR A SURFACE TREATMENT THAT IS UNSATISFACTORY. ADD MORE ACID AS NECESSARY TO KEEP THE SURFACE FULLY WET.

(2) Stop the electrical power after the specified time.

(3) Immediately, remove the screen and the gauze breather cloth. Discard these materials. Use a method to discard these materials that is permitted by your local safety, health, and environmental authorities.

(4) Immediately, flush the phosphoric acid from the anodized surfaces with clean water. The time interval between power shut-off and the start of the flush must not be more than 2.5 minutes. Flush with clean (mineral free or de-ionized) water for a minimum of 5 minutes.

NOTE: Do not rub or wipe the repair surface.

H. Let the anodized surface fully dry at room temperature. As an alternative, you can dry the parts with forced, clean, dry, filtered air that is a maximum of 160° F (71° C) until the surface is fully dry.

NOTE: You must apply the adhesive primer in less than 24 hours after the surface is anodized. Prevent the contamination of the anodized surface by moisture, dust, oil fumes, engine exhaust or other unwanted material. Do not touch the dried anodized surfaces. Do not apply tape to the anodized surfaces.

I. Examine the anodized surface. You can use a Phosphoric Acid Anodize Detector (dichroscope) or do the polarized filter color inspection test that follows:

NOTE: You can purchase a Phosphoric Acid Anodize Detector (part number WCI-AD55) from West Coast Industries, Inc., 14900 Whitman Ave N, Seattle, WA 98133.

(1) Polarized filter color inspection test.

(a) Use a fluorescent light source on the anodized area.

(b) Put a polarizing filter between yourself and the treated surface and look at the reflected light (from the surface) at an angle of 5 degrees or less. It can be helpful to put the light source at a glancing angle. Refer to Fig. 6.

(c) While you look at the surface through the polarizing filter, turn the filter 90 degrees. A correctly anodized surface gives a constant change in color (on all areas of the anodized surface) when you look through the filter. The colors seen most frequently are purple, yellow, and green.

NOTE: It is not easy to see the colors on a rough or contoured surface. To find out if a surface is anodized correctly, change the view angle of the polarizing filter to see if the anodic coating is satisfactory.

(2) The anodize procedure is not successful if you find one or more of the conditions that follow:

(a) There are sudden changes in color as a result of stains, contamination, fingerprints, or other parts that touched the surface.

(b) There are electrical burns or pits.

(c) There are areas of the surface to be bonded that are not anodized.

(3) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on all the areas of the anodized surface.

(4) If the color inspection test on a rough or contoured surface is not successful, you can do alternative tests to make sure you have a good anodized surface. Do one or more of the tests that follow:

(a) Use an ohmmeter to do a resistance test of the anodized surface. Make sure that the ohmmeter probes are clean.

1) Carefully, put the ohmmeter probes on the anodized surface. Make sure that you do not damage the anodized surface with the ohmmeter probes.

2) Carefully touch the surface with the sides of the probes first, then lay them down. If the surface has a resistance of more than 20,000 ohms (20 kohms) the test is successful.

(b) Do an infrared filter test to measure the weight of the anodize coating. Use an infrared filter device that is tuned to measure phosphoric acid anodize oxides. If the infrared filter test shows an anodized coating that is more than 20mg/square foot (215mg/square Meter), the test is successful.

NOTE: A source for the infrared filter is as follows: Personal Instruments, LLC 18 Commerce Road Newton, CT 06470 (203) 426-0152.

(c) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on 90 percent or more of the anodized surface and one or more of the alternative tests are satisfactory.

(5) If the anodize procedure is not successful, you must do all of the steps in par. 13. again. (You must remove the unsatisfactory anodic oxide by abrasion as given in par. 13.C.).

J. If you put a mask on open honeycomb core during par. 13.C.(6), then remove it now. Make sure that you do not touch or contaminate the surfaces that have been anodized. Do not let moisture get into the core cells.

(1) Do a visual check for moisture in the cells. If you see moisture, use blue litmus paper to make sure that there is no acid contamination.

(a) If the litmus paper changes to a red color, there is acid contamination in the core cells. Flush the core with water. Use more blue litmus paper and do a check for acid again.

(b) If the litmus paper stays blue, there is no acid in the core. Remove the moisture, then continue with the procedure.

(2) Make sure that the core is fully dry before you apply the adhesive primer.

K. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

L. Apply BMS 5-89 adhesive primer in less than 24 hours after the anodize procedure is completed. Refer to par. 15.

14. The Boegel (AC-130) Prebond Treatment Procedure

NOTE: The Boegel (AC-130) Prebond Treatment materials must be purchased from an approved Boeing licensed supplier.

A. The materials that you need are:

(1) AC-130 Sol-Gel Kit (Source: Advanced Chemistry and Technology, 7341 Anaconda Avenue, Garden Grove, CA 92841, 800-732-4470)

(2) Cheesecloth, gauze or clean cotton rags, or BMS 15-5, Class A wipers

(3) Acetone or Methyl Propyl Ketone (MPK) Solvent

(4) BMS 5-89 Type II (BR 6747-1 only) Adhesive Primer

(5) Merit Shur Stik ALO Resin Bond, #180-grit Abrasive Papers (Source: Merit Abrasives, Customer Service, 2770 W. Washington St., Stephenville, TX 76401-3798, Tel: 800 421-1936, Fax: 800 472-3094, website: www.meritabr.com). Refer to Table 4 for product identification.

ALO Resin Bond 180 Grit Sanding Discs				
Disc Diameter	Quick-Change PowerLock Discs			Shur Stik Adhesive Backed Discs
1/2 inch (13 mm)	N/A	N/A	N/A	71108
3/4 inch (19 mm)	61010	65109	64325	71122
1 inch (25 mm)	61023	65124	66252	71137
1 1/2 inches (38 mm)	61036	65139	66251	71152
2 inches (50 mm)	61050	65154	64916	71167
3 inches (75 mm)	61064	65169	66187	71182
4 inches (100 mm)	61078	65184	64843	71197
5 inches (125 mm)	N/A	N/A	N/A	72024
6 inches (150 mm)	N/A	N/A	N/A	72053

Merit Sandpaper Ordering Information
Table 4

B. Prepare the repair area for the Boegel (AC-130) Prebond Treatment procedure.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface will look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

C. Mix the components of kit as given in the manufacturer's instructions. Use a kit size that is the best for the area to be treated. Example: approximately 50 ml of the Boegel (AC-130) solution is satisfactory to treat 200 square inches (1300 square cm) of bond zone. Scale it up if necessary.

(1) 30 minutes after you mix the components, you can apply Boegel (AC130) to the surface to be treated.

NOTE: 30 minutes is the minimum time necessary for the components to react.

(2) Use the mixture after the abrade steps that follow, but not after 10 hours.

CAUTION: USE THE SANDPAPER THAT IS SPECIFIED IN THIS PROCEDURE. SOME TYPES OF SANDPAPER CAN CAUSE A WEAK BOND.

D. Fully abrade the repair area again.

(1) Use a random orbital sander or die grinder.

(a) Make sure that the sander or grinder will not get oil contamination on the sandpaper or the bond surface.

(b) Only use a sander or grinder that has a vented or filtered exhaust for the dust particles.

(2) Use Merit ALO Resin Bond, 180-Grit, alumina sandpaper (Merit Abrasives, 201 W. Manville Street, P.O. Box 5477, Compton, CA 90224-5477).

(3) Abrade for a minimum of 1 minute for each 40 square inches (260 square cm) in area.

(a) Move the sander/grinder in one direction on the panel surface.

(b) Change the sandpaper after each 30 seconds that you abrade. Change the direction of movement by 90 degrees each time that the sandpaper is changed.

NOTE: This procedure is necessary to remove the metal oxide layer on the aluminum and make the surface reactive for the Boegel (AC-130).

(c) Make sure that all of the repair area is fully abraded, including the edges.

(d) After all of the surface has been abraded, change the sandpaper and fully abrade the surface again. Move the sander in a random direction on all of the panel surface.

NOTE: You can abrade a maximum of 200 square inches (1300 square cm) on the last sheet of sandpaper. Do not abrade the surface for more than 30 seconds.

(4) Example: If you treat a section that is 80 square inches (520 square cm) do the steps that follow:

(a) Abrade the surface in one direction for a minimum of 30 seconds.

(b) Change the sandpaper, and then abrade in a 90 degree direction for a minimum of 30 seconds. Then change the sandpaper again. Repeat this for a total treatment time of 2 minutes, minimum (with 4 sheets of sandpaper).

(c) Then, change the sandpaper and abrade all of the surface for 30 seconds more.

(5) Do a visual inspection. The surface should have a fully abraded appearance. If not, do the abrade steps again.

(6) Remove the loose grit residue with clean, dry compressed nitrogen or air. Keep the surface clean until you apply the Boegel (AC-130) Solution.

(7) Apply the Boegel (AC-130) solution in less than 30 minutes after you complete the abrade steps.

NOTE: After 30 minutes the surface will begin to oxidize. Then you will need to do the abrade steps again to remove the oxide layer.

WARNING: DO NOT PERMIT THE BOEGEL (AC-130) SOLUTION TO TOUCH YOUR FACE OR EYES. USE APPROVED PROTECTION PROCEDURES. IF THE SOLUTION TOUCHES THESE AREAS, IRRITATION TO THE EYES AND SKIN CAN OCCUR.

E. Apply the Boegel (AC-130) solution.

(1) Put on a mask to seal all areas where the damage goes through a skin. To make the mask, put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, make sure that the hole is filled before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(2) Isolate the mechanical fasteners and all the other areas that are not damaged. Use aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent). This will prevent contamination.

(3) Make sure that the temperature of the Boegel and aluminum part stays between 50° and 100° F (10° and 38° C) during the procedure.

(4) Apply the solution to the bond surface to be treated with a clean, natural (non-metallic) bristle brush or with a sprayer.

(5) Apply a sufficient quantity of solution to cause the solution to drain from the bond surface. Keep the bond surface fully and continuously wet with the solution for 2 minutes, minimum.

(6) When the 2 minutes is completed, the wetted surface must look like a water-break-free surface.

NOTE: The solution surface tension at the edges of an aluminum skin can cause the solution film to pull away from the edge a small distance. This condition is permitted unless it is caused by surface contamination or incorrect abrading.

(a) The solution film on the bond surface must stay continuous for a minimum of 30 seconds.

(b) If the solution film does not stay continuous for a minimum of 30 seconds, there is surface contamination. Do the cleaning, abrasion and application steps again.

(7) If the break-free surface test is satisfactory, then drain off the remaining solution.

(8) If you see drops of solution in crevices, pockets, or other contained areas, then they must be removed.

(a) Lightly blow off the drops of solution with filtered dry air, or

(b) Carefully remove the drops with clean cheesecloth or other absorbent material that is moist with Boegel (AC-130).

NOTE: Do not rub or wipe the surface. Do not touch the surface with your bare skin or with gloves that have contamination on them.

F. Let the treated surfaces dry at room temperature for 60 minutes, minimum. You can use an oven, heat lamp, or forced air that is oil-free and is no hotter than 160° F (71° C) to dry the parts.

G. Examine all of the treated surface. The surface must look dry and not have dust, fingerprints or other contamination. Use filtered forced air to remove dust. If there is contamination that cannot be removed with forced air, then clean, abrade, and do the Boegel steps again.

NOTE: It is possible that you see stains on the prepared surface after the surface is dry. These stains are permitted.

H. If you put a mask on open honeycomb core during par. 14.E.(1), then remove it now. Make sure that you do not touch the surface to be bonded. Do not let moisture get into the core cells. Make sure that the core is fully dry before you apply the adhesive primer.

I. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

J. Apply BMS 5-89, Type II (BR 6747-1 only) adhesive primer not later than 24 hours after you apply the Boegel (AC-130) solution. Refer to par. 15. Clean the bond surface and do the Boegel (AC-130) procedure again if the bond surface has contamination.

15. Application of BMS 5-89 Adhesive Primer to the Bond Surface

A. Remove the primer from storage. Do not open the container until it is between 65° and 90° F (18° and 32° C).

NOTE: Refer to Boeing Process Specification BAC 5514-589 "Application of Corrosion Inhibiting Adhesive Primer" for the storage and shelf life specifications. Do not use a primer that shows signs of deterioration. Do a check for signs of lumps or gelatin.

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DO NOT USE SOLVENT BASED PRIMERS IN AREAS WITH EQUIPMENT THAT PRODUCE HEAT OR A SPARK. IF YOU DO, AN EXPLOSION CAN OCCUR AND CAUSE INJURY.

CAUTION: PREVENT CONTAMINATION OF THE PARTS AFTER YOU DO A SURFACE PREPARATION. WEAR CLEAN GLOVES, OR USE HOOKS TO MOVE THE PARTS. DO NOT APPLY THE PRIMER IF THE TEMPERATURE IS LESS THAN 50° F (10° C) OR MORE THAN 85 PERCENT OF THE RELATIVE HUMIDITY. IF YOU DO NOT OBEY, THE RESULT CAN BE AN UNSATISFACTORY BOND.

B. Mix the BMS 5-89 adhesive primer. Use the manufacturer's instructions, or Boeing Process Specification BAC 5514-589 "Application of Corrosion Inhibiting Adhesive Primer".

C. Apply the BMS 5-89 adhesive primer.

NOTE: BMS 5-89 must be baked after it is applied. Because you cannot measure the thickness until after you bake, you need sufficient training or experience to know what a good thickness looks like (You can also use a visual reference standard, or you can do an experiment on an aluminum part that will not be used for the repair). It is permitted for you to apply BMS 5-89 primer on painted surfaces adjacent to the bare aluminum surface. It is not necessary to measure the thickness of the primer that is applied to the painted surfaces adjacent to the bare aluminum. It is not necessary to measure the thickness of the primer on the edges of the repair parts or the edges of the removed damage area. You have a maximum of 120 hours to start the baking procedure.

(1) Apply the primer to a thickness that will be between 0.00015 and 0.00040 inch (0.004 and 0.010 mm) after baking.

NOTE: It can be necessary to apply the primer two or more times to get it to the specified thickness. Continuously shake the container (that has the primer) each 3 to 5 seconds until the procedure is completed.

(2) Apply the primer to the edges of the repair parts and the edges at the removed damage area.

CAUTION: DO NOT USE FORCED AIR ON THE WET SURFACE. DEFECTS AND DAMAGE TO THE PRIMER CAN OCCUR. PROTECT THE PRIMER FROM DUST OR OTHER CONTAMINATION. IF YOU DO NOT, THE STRENGTH OF THE REPAIR CAN BE REDUCED.

D. Let the primer dry. If more than one side will have primer, make sure that the first side is dry before you apply primer to the second side.

NOTE: Do not use Type I or III primer if you did the Boegel (AC-130) surface preparation.

(1) BMS 5-89, Type I solvent based primer can be dried for 30 minutes at room temperature. As an alternative, you can dry the primer with a heat lamp that is no hotter than 200° F (93° C) until the primer is hard (tack-free).

(2) BMS 5-89, Type II or III water based primer can be dried at room temperature, or with a heat lamp until all of the water that you see is gone (the primer does not look wet).

(3) After BMS 5-89, Type III primer has dried, let it stay for 15 more minutes (minimum) before you start to bake.

E. Bake the primer at 240° ±20° F (116° ±12° C) for 30 to 120 minutes. Use an oven, heat lamp, or hot air.

NOTE: As an alternative, you can do a two stage cure. First, bake the primer at 175° F (80° C) for 2 hours minimum. Then do the layup. The cure will be complete when the adhesive is cured.

F. Measure the primer thickness. You can use an eddy current procedure, a visual standard, or a procedure that gives the equivalent satisfactory results.

(1) If the primer is not at the specified thickness, then you must remove the primer.

(a) Do one of the surface preparations in par. 11. and put adhesive primer on the bond surface again.

(b) Bake the primer and measure the thickness again.

(2) If the thickness is satisfactory, apply the adhesive as given in par. 18. or par. 19.

16. Hydrofluoric (HF) - Alodine Procedure

NOTE: This surface preparation procedure has size limits. Refer to Fig.1.

A. The materials that you need are:

(1) Hydrofluoric Acid (HF)

(2) 3M Scotch-Brite, Type A, very fine pads or a high grade alumina sandpaper (180-grit or finer)

(3) Aluminum Foil Tape

(4) Solid FEP

(5) Cheesecloth, gauze or clean cotton rags, or BMS 5-15 Class A wipers

(6) Blue litmus paper

(7) Alodine 1200

(8) Acetone or Methyl Propyl Ketone (MPK) Solvent

(9) BAC 5710 Type 60 Adhesive Primer

B. Clean and abrade the repair surfaces.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface should look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

CAUTION: DO NOT PERMIT THE ACID SOLUTION TO TOUCH OTHER SURFACES ADJACENT TO THE REPAIR BOND AREAS. IF IT DOES, THE RESULT CAN BE DAMAGE TO THE PAINT AND ADHESIVE SYSTEMS.

(5) Isolate the mechanical fasteners and all the areas that are not damaged, with aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent). This will prevent acid contamination.

(6) Put on a mask to seal all areas where the damage goes through a skin. To make the mask, put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, make sure that the hole is filled before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(7) Flush with clean water and/or wipe with a clean, lint-free cloth until no visible residue appears on the cloth.

C. Do a visual inspection for a water-break-free surface.

(1) Flush the surface with clean (mineral-free or de-ionized) water. Do this for 30 seconds or until the surface has a continuous water film on all of the repair area.

NOTE: The preferred water temperature is between 50° and 100° F (10° and 38° C).

(2) After the flush procedure is completed, the water film on the bond surface must stay continuous for a minimum of 30 seconds.

NOTE: The water surface tension at the edges of an aluminum skin can cause the water film to pull away from the edge a small distance. This condition is permitted unless it is caused by visible surface contamination or incorrect abrading.

(3) If the film does not remain continuous for a minimum of 30 seconds, do par. 16.B. and par. 16.C.

WARNING: DO NOT BREATHE THE FUMES WHEN YOU DO WORK WITH HYDROFLUORIC ACID SOLUTIONS. USE MECHANICAL AIRFLOW AND RESPIRATORY PROTECTION. DO NOT LET THE SOLUTIONS TOUCH YOUR EYES OR SKIN. WEAR GLOVES AND PROTECTIVE CLOTHING. IF YOU DO NOT OBEY, YOU CAN CAUSE SKIN IRRITATION OR INJURY. IF THE SOLUTION TOUCHES YOUR EYES, CLEAN WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

D. Prepare the Alodine 1200 solution as given in 51-8-0. Let it stay mixed for one hour before you use it.

NOTE: A dirty solution is not satisfactory for use. Prepare the solution in small quantities. Discard the solution if you do not use it before 24 hours or if the solution is dirty. If you use non-distilled water, then add nitric acid to control the pH of the solution. For the Alodine 1200 product, the pH must be between 1.5 and 2.0. Use pHydrion papers to check the pH of the solution.

E. Do the HF acid etch procedure.

(1) Make sure that the temperature of the HF acid and the aluminum part stays between 50° and 100° F (10° and 38° C) during the etch procedure.

(2) Make a clean cloth moist, but do not soak it, with a 2 percent solution of HF acid. Rub the bond mating surface area with the moist cloth. Let the solution stay on the surface for 15 to 30 seconds.

(3) Quickly rub mating surfaces of the bond area with the moist cloth.

(4) Let the HF solution stay on the surface for approximately 15 to 30 seconds.

(5) Quickly remove the solution with a cloth moist with clean water.

NOTE: Do not permit the cloth to touch the etched surface for more than 2 minutes. Do not permit the cloth to touch surfaces that were not etched with the HF solution and then to touch the etched surfaces. This will cause contamination of the etched surfaces.

F. Apply the Alodine solution to the etched area as given in 51-8-0.

NOTE: Do not permit the etched surfaces to dry before you apply the chemical conversion coating.

(1) Make sure that the temperature of the Alodine and the aluminum part stays between 50° and 100° F (10° and 38° C) during the procedure.

(2) Apply the Alodine solution to the etched area in less than 60 seconds after the HF acid etch procedure is completed.

(a) Apply the Alodine solution with a fiber or nylon brush, or clean, dry cheesecloth.

NOTE: Make sure that you apply a sufficient quantity of chemical conversion coating to give a smooth layer.

(b) Make sure that the etched area stays moist with Alodine solution for 3 to 4 minutes.

CAUTION: USE CARE WHEN YOU RINSE THE COATED SURFACE. IF YOU DO NOT, THE RESULT CAN BE AN UNSATISFACTORY CHEMICAL CONVERSION COATING. THE NEW COATING IS FRAGILE AND CAN BE EASILY DAMAGED.

(3) Rinse the area with a moist, but not soaked, cheesecloth. Make sure that the cheesecloth and water are clean.

NOTE: Lightly touch the surface for 1 to 2 minutes. Then, do it again with another clean moist cheesecloth to remove more of the solution from the surface. Do not wipe the surface.

(4) Do a check of the repair area to see if acid remains on the surface.

(a) Look at the repair surface and all of the crevices in the repair area.

(b) If you see moisture, use blue litmus paper to make sure that there is no acid on the surface or in the crevices.

NOTE: If the litmus paper remains blue then remove the moisture and continue with the procedure. If the litmus paper changes to a red color, then acid remains on the surface. You must do par. 16.F.(3) and par. 16.F.(4) again until the litmus paper remains blue.

CAUTION: USE CARE WHEN YOU DRY THE COATED SURFACE. DO NOT WIPE OR RUB THE SURFACE. THE NEW COATING IS FRAGILE AND CAN BE EASILY DAMAGED.

(5) Carefully dry the surface with clean dry cheesecloth to remove the rinse water. If necessary, do this again to remove the water from the surface.

WARNING: DO NOT PERMIT THE CHEMICAL CONVERSION COATING TO DRY ON THE BRUSHES OR CHEESECLOTH. MAKE SURE THAT YOU WASH ALL OF THE COATING FROM THE FROM THESE MATERIALS BEFORE IT IS DRY. WRING OUT THE MATERIALS AND PUT THEM INTO A FIRE-PROOF CONTAINER. IF YOU DO NOT, THE RESULT CAN BE A CHEMICAL FIRE CAUSED BY SPONTANEOUS COMBUSTION.

(6) Do not put materials that have Alodine on them in the same container with materials that have solvent on them.

(a) Wash all of the Alodine from the materials used for the application, before the materials are discarded.

(b) Discard the materials in an approved container. Use a procedure to discard these materials that is permitted by your local safety, health, and environmental authorities.

(7) Permit the surfaces to fully air-dry. You are permitted to use filtered hot air up to a maximum of 130° F (54° C). A minimum 15 minutes is recommended.

NOTE: You must apply the final finish or start the adhesive procedures as soon as possible after the chemical conversion coating is dry. Wear clean gloves to keep contamination from the part.

G. Do a visual check of the repair surface for a powdery coating. All Alodine coatings must be free of powder.

(1) If you find a powdery coating on the surface, then you must do par. 16.F.(3) through par. 16.F.(7) and par. 16.G. again until the surface is free of powder.

(2) If the surface is free of powder, then continue with the procedure.

H. If you put a mask on open honeycomb core during par. 16.B.(6), then remove it now. Make sure that you do not touch the surface to be anodized. Do not let moisture get into the core cells.

(1) Do a visual check for moisture in the cells. If you see moisture, use blue litmus paper to make sure that there is no acid contamination.

(a) If the litmus paper changes to a red color, there is acid contamination in the core cells. Flush the core with water. Use more blue litmus paper and do a check for acid again.

(b) If the litmus paper stays blue, there is no acid in the core. Remove the moisture, then continue with the procedure.

(2) Make sure that the core is fully dry before you apply the adhesive primer.

I. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

J. Apply the BAC 5710, Type 60 adhesive primer not later than 24 hours after you apply the Alodine. Refer to par. 17. Clean the bond surface and do the HF Alodine procedure again if the bond surface has contamination.

17. Application of BAC 5710, Type 60 Adhesive Primer

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

WARNING: DO NOT USE SOLVENT BASED PRIMERS IN AREAS WITH EQUIPMENT THAT PRODUCE HEAT OR A SPARK. IF YOU DO, AN EXPLOSION CAN OCCUR AND CAUSE INJURY.

A. Mix the Courtaulds Aerospace 515X346 primer with 910X520 catalyst and the 020-702 thinner. Refer to Table 5 for the mixture ratio of the primer components.

B. Prepare the mixture as given in the manufacturer's instructions.

(1) Permit the mixture to stay at room temperature for 30 minutes before you apply it to the surface.

(2) Apply the primer before 60 minutes after you apply the chemical conversion coating to the repair area.

NOTE: Do not apply the primer if its pot-life has expired (8 hours at 77°F (25°C)).

COMPONENTS	MIX RATIO BY VOLUME
515X346 Base	4 parts
910X520 Catalyst	1 part
020-702 Thinner	4 parts

Necessary Mix Ration for the BAC 5710, Type 60 Primer Components
Table 5:

CAUTION: PREVENT CONTAMINATION OF THE PARTS AFTER YOU DO A SURFACE PREPARATION. WEAR CLEAN GLOVES, OR USE HOOKS TO MOVE THE PARTS. DO NOT APPLY THE PRIMER IF THE TEMPERATURE IS LESS THAN 50° F (10° C) OR MORE THAN 85 PERCENT OF THE RELATIVE HUMIDITY. IF YOU DO NOT OBEY, THE RESULT CAN BE AN UNSATISFACTORY BOND.

C. Apply a layer of primer to the surface to give a 0.0002 to 0.0008 inch (0.005 to 0.020 mm) dry film thickness.

D. Measure the primer thickness with an eddy current procedure, or a procedure that uses a visual standard, or with a procedure that gives the equivalent satisfactory results.

NOTE: If the primer is more than the specified thickness, then you must remove the primer, do the HF chemical conversion procedure, and apply the primer again. Do not continue unless you have the correct primer thickness. If a second layer of the primer is necessary, permit the first layer to air dry for 1 hour before you apply the second layer.

E. Permit the primer to air dry at a temperature between 70°F and 90°F (21°C and 32°C) for 60 to 90 minutes before you apply the adhesive.

(1) Keep the primed mating surfaces free from contamination and sunlight.

(2) Do not store the primed mating surfaces for more than 7 days before you make the bond.

(3) Do not wipe the primed mating surfaces with solvent before you make the bond.

F. Apply the adhesive as given in par. 18. or par. 19.L. as applicable. Refer to Fig. 1 for repair size limitations.

18. Application of BMS 5-101 Film Adhesive

A. Make a clear plastic template that shows the size and shape of the largest external doubler and the damage cutout. Use the template to make ink marks on the primed surface where the largest external doubler must be put.

NOTE: Use a water-resistant, alcohol based ink pen that will not contaminate or damage the primer or the adhesive. You can use a Sharpie2 SAN30000, SAN35000, or SAN37000 Series fine point pen (or an equivalent pen). Sharpie2 pens are a trademark of the Sanford Corporation.

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B. Make sure that you do these application steps in a clean area. Use a tabletop or other non-airplane component work surface when you cut adhesive film.

(1) Clean all the work surfaces, templates, and tools with solvent. Remove all contamination. Refer to SOPM 20-30-03.

(2) If necessary, you can put clean vacuum bag film on the work surface to keep contamination off the adhesive.

C. Cut a layer of BMS 5-121 positioning fabric to a larger diameter than the largest repair doubler. Cut the fabric so that the edge of the fabric is 0.5 inch (13 mm) minimum, from the edges of the largest repair doubler.

NOTE: BMS 5-121 positioning fabric is not necessary when you use a pressurized autoclave. Positioning fabric is necessary when you use a vacuum bag procedure on a honeycomb panel with more than 64 square inches (400 square cm) of open core. If two sides of a honeycomb panel are repaired with external doublers, it is not necessary to use positioning fabric on more than one side. If you do a flush repair, put the positioning fabric on the side that has the external doubler. As an option, you can use positioning fabric on repairs that are 64 square inches (400 square cm) or less.

D. Cut the film adhesive. Refer to Fig. 12 for the steps that follow:

(1) Use only certified film adhesives from the Boeing Material Specification Qualified Products List (QPL).

NOTE: A manufacturer can make an adhesive film material that can be qualified to BMS 5-129 and/or to BMS 5-101 and be listed in each Qualified Products List (QPL). Do not use a BMS 5-129 material for a metal bond repair unless the material has been tested and certified to the BMS 5-101 specification also.

(2) Keep the bag that contains the roll of film adhesive at room temperature until there is no condensation on the bag.

NOTE: Do not touch the adhesive with your bare skin. Wear gloves to protect the adhesive from contamination.

(3) Put the film adhesive on a clean work surface. Make sure that the film adhesive side that is against the work surface has a separator sheet.

(a) If you use OST with BMS 5-121 positioning fabric, make sure that the mat side is up, tacky side down, against the work surface. If you use OST without the positioning fabric, make sure that the tacky side is up, mat side down, against the work surface.

NOTE: OST film adhesive has a mat carrier cloth on one of the outer surfaces, thus producing one side that is more tacky than the other side. Non–OST mat or knit film adhesive has a carrier cloth in the middle of the adhesive, thus both sides are equally tacky. Both OST and Non-OST can be used with BMS 5-121 positioning fabric.

(b) If you are using BMS 5-101 Grade 5 film adhesive, then put two plies on the work surface. Make sure that you remove the separator sheet (or sheets) between the plies.

(c) If you are using BMS 5-101 Grade 10 or 15 film adhesive, then put one ply on the work surface.

NOTE: Do not use Grade 15 film adhesive to bond parts that have a gage thickness of 0.020 inch or less.

(4) Put the repair part with the surface to be bonded against the adhesive. If there is a separator sheet on top of the adhesive, make sure that it is removed.

(5) Cut the film adhesive all around the repair part with a sharp knife. Let the film adhesive extend 0.01 to 0.1 inch (0.3 to 2.5 mm) from the edge of the repair part.

(6) If you are using BMS 5-101 Type II, Grade 5 or 10 film adhesive, and the repair has an open core, then cut a piece of adhesive to the same dimensions as the open core. (Do not do this step if you are using a Grade 15 film adhesive).

NOTE: If a piece of OST film adhesive is not a symmetrical shape, then make sure that you cut it so that the mat side will be up when you put it on the honeycomb core.

E. Put the BMS 5-121 positioning fabric (when specified) on to the area to be repaired. Make sure that the edges of the fabric go past the marks that were made in par. 18.A. a minimum of 0.5 inches (13 mm).

NOTE: If you can not see the marks through the fabric, then use the template again to make marks that will show the position of the largest external doubler.

F. Put each of the repair parts (one at a time and in the correct sequence) on to the surface to be repaired. Refer to Fig. 12 and the applicable repair procedure in Table 2.

(1) Remove the separator sheet from each repair part before it is installed.

(2) Apply equal and light finger pressure to each repair part as it is installed.

(3) Apply small pieces of high-temperature polyester tape (or equivalent) to the edges of the repair part(s) to hold the part(s) on to the part to be repaired.

G. Do the instructions that follow to assemble the vacuum bag. Refer to Fig. 14.

(1) Put a breather strip all around and against the edges of the largest external repair doubler.

NOTE: Put the breather strips on the BMS 5-121 positioning fabric (when the fabric is specified).

(2) Put thermocouples at the edges and top of the repair doubler(s) as given in Fig. 13.

NOTE: Use thermocouples and a measurement system that can measure temperature to a minimum accuracy of ±5°F (±3°C).

(3) Connect the thermocouples to the applicable temperature recorder devices.

(4) Get a heat blanket that is a minimum 2 inches (50 mm) larger all around than the largest repair doubler.

(5) Use the heat blanket dimensions to find the correct dimensions of the layup and bagging materials.

(a) Cut two layers of dry peel ply that are 2 inches (50 mm) larger all around than the dimensions of the heat blanket. Put one of the dry peel plies on the repair part(s). Make sure that the edges of the peel ply extend an equal distance from the edges of the largest repair doubler.

(b) Cut a layer of solid or perforated FEP parting film to the same dimensions as the heat blanket. Put the parting film on to the dry peel ply. Make sure that the edges of the parting film are an equal distance from the edges of the peel ply.

(c) Put the second dry peel ply on to the first peel ply and the parting film. Make sure that the edges of the second peel ply are against the edges of the first peel ply.

(6) Protect the component to be repaired from too much heat.

(a) If there are attached fittings on the part to be repaired, then put insulation material between the attached fittings and the heat blanket.

(b) If the heat blanket extends more than 3.0 inches (75 mm) from the edge of the damage cutout, you can do this recommended procedure:

NOTE: If a heat blanket gets too hot, it can cause damage to the repair and to the adhesive in the undamaged skin. To help prevent damage (if the heat blanket gets too hot), do not let the heat blanket touch more skin than is necessary. Insulation between the heat blanket and the skin is recommended.

1) Put one edge of each insulation material on the skin, 2.0 to 3.0 inches (50 to 75 mm) from the edge of the damage cutout.

2) Put the opposite edge of each insulation material where the edges of the heat blanket will be.

(7) Put the heat blanket on to the top peel ply. Make sure that edges of the heat blanket are an equal distance from the edges of the peel ply (and the insulation, if applicable).

(8) Put four to six layers of glass fabric (or two layers of 0.04 inch (1.0 mm) breather fabric, or one layer of 0.1 inch (2.5 mm) breather fabric) above the heat blanket as a breather. Make sure that the breather is 2 inches (50 mm) larger all around than the heat blanket.

(9) Put a vacuum base above the fiberglass breather cloth for each vacuum port and vacuum gage port.

(10) Put on the vacuum bag sealant.

(a) You can put the vacuum bag sealant all around the area to be repaired, or

(b) If you use an envelope bag procedure, then seal the open part of the bag with the sealant.

(11) Make a hole in the outer vacuum bag at the vacuum base location for each vacuum port and vacuum gage port.

(12) Put the vacuum bag film on the repair area.

(13) Connect the vacuum port and vacuum gage ports to their vacuum bases.

NOTE: A procedure to remove the vacuum source will be necessary, that will not decrease the vacuum in the bag. If necessary, put a valve on the vacuum line between the vacuum bag and the vacuum source.

(14) If necessary, put insulation material on the outer surface of the vacuum bag.

19. Application of BMS 5-92 or BMS 5-141 Paste Adhesive

NOTE: Only small repair sizes can use these adhesives. Refer to Fig. 1 for permitted repair sizes.

A. Make a clear plastic template that shows the size and shape of the largest external doubler and the damage cutout. Use the template to make ink marks on the primed surface where the largest external doubler must be put.

NOTE: Use a water-resistant, alcohol based ink pen that will not contaminate or damage the primer or the adhesive. You can use a Sharpie2 SAN30000, SAN35000, or SAN37000 Series fine point pen (or an equivalent pen). Sharpie2 pens are a trademark of the Sanford Corporation.

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CAUTION: MAKE SURE THAT YOU DO THIS PROCEDURE IN A CLEAN AREA. DO NOT LET CONTAMINATION OF THE REPAIR PARTS OCCUR. IF YOU DO NOT OBEY, YOU CAN CAUSE AN UNSATISFACTORY REPAIR.

B. Clean the work area, templates, and tools with solvent before you start to apply the adhesive. Refer to SOPM 20-30-03 for the applicable solvents and procedures.

CAUTION: DO NOT MIX MORE THAN 450 GRAMS OF BMS 5-141 AT ONE TIME. IF YOU DO, AN EXOTHERMIC REACTION (A BUILD-UP OF HEAT) CAN OCCUR. THE RESULT CAN BE DAMAGE TO THE ADHESIVE.

C. Use one of the adhesives that follow:

(1) BMS 5-92

(a) Type V, Class 1 or Class 2 (preferred).

(b) Type I, Class 4 (alternative).

(2) BMS 5-141

D. Refer to the manufacturer's instructions to mix paste adhesives. Tap the container or use a satisfactory procedure to remove air bubbles from the mixture.

NOTE: As an aid to make sure that you get the necessary thickness on the bond surface, you can add up to 1 percent by weight of 0.005 inch (0.13 mm) diameter glass beads. Mix the glass beads with the Part B hardener before you add the Part A base.

E. Apply a thin, smooth layer of paste adhesive to all of the mating surfaces.

NOTE: Do not touch the adhesive with your bare skin. Wear gloves to protect the adhesive from contamination.

(1) Make sure that the mating surfaces have adhesive primer on them before you apply the paste adhesive.

(2) After you mix the adhesive, apply the mixture to the repair parts as soon you can, but not after the pot-life has expired. Make sure that the mating surfaces have sufficient adhesive so that it will squeeze out from the edges of the repair part(s) when you mate them.

(3) After you apply the adhesive, you have a maximum of 5 minutes to mate the repair parts(s). (After 5 minutes, the adhesive will get a thin, cured skin layer on it, that will make it difficult to get a good bond).

F. Install the repair parts.

(1) Put the repair parts into their correct positions.

NOTE: Use a satisfactory procedure to remove air bubbles from that can be below each repair part. For example, you can put one edge of the repair part on the component. Then slowly put the repair part on the adhesive.

(2) Apply a equal and continuous pressure of 1 psi (7 kPa) minimum, to the surface of the repair parts. Let the adhesive squeeze out all around the edges.

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G. Clean all of the unwanted adhesive from the repair parts with solvent before you continue with the cure. Refer to SOPM 20-30-03 for the applicable solvents and procedures. Remove all of the contamination.

NOTE: Do not permit the solvent to get in the bond line.

20. Cure the bond

A. Vacuum bag procedure for film adhesives. (See par. 20.C. for autoclave cure).

(1) Remove some of the air out of the honeycomb core before you start the cure.

(a) Use an initial vacuum of 3 to 5 inches (7.6 to 12.7 cm) of mercury (Hg) for 15 minutes.

(b) Apply a vacuum to a minimum of 22 inches (56 cm) of mercury (Hg) for 1 minute.

(2) Do an inspection of the vacuum bag. Look for leaks in the vacuum bag.

NOTE: A vacuum bag that has a leak can cause porosity in the adhesive and a weak bond.

(a) Remove the vacuum source.

NOTE: Do not disconnect the vacuum line(s). This can cause a loss of vacuum in the bag.

(b) Monitor the vacuum gage. After 5 minutes, the total difference in the vacuum must be less than 5 inches of (12.7 cm) of mercury (Hg).

WARNING: USE ONLY EXPLOSION-PROOF EQUIPMENT WHEN YOU DO THESE TYPES OF REPAIRS. IF YOU DO NOT, PERSONAL INJURY AND DAMAGE TO ADJACENT EQUIPMENT CAN BE THE RESULT. WHEN YOU WORK WITH FLAMABLE MATERIALS, HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

(3) Cure the bond as given in Table 6.

(a) You can use hot air, heat lamps, or a radiant heater with the heat blankets, if necessary.

(b) Start to measure the cure time after the thermocouples show the bond to be at the specified cure temperature.

ADHESIVE SPECIFICATION	CURE TEMPERATURE	CURE TIME (MINIMUM)	RATE OF TEMPERATURE INCREASE PER MINUTE
BMS 5-92, Type I or V Adhesive Resin	Refer to Fig. 210	Refer to Fig. 210	Not Applicable
BMS 5-101 Adhesive Film	225°F to 260°F (107°C to 127°C)	90 minutes	3 ± 2° F (2 ± 1° C)
BMS 5-141 Adhesive Paste	Refer to Fig. 211	Refer to Fig. 211	Not Applicable

Adhesive Cure Data
Table 6:

(4) Apply and keep a vacuum at a minimum of 20 inches (50 cm) of mercury (Hg) during the cure cycle.

(5) If it is necessary to add more pressure, put shot-bags, clamps or other mechanical pressure on to the repair area.

NOTE: If the repair is on a honeycomb panel, this pressure can prevent a disbond, (during the cure cycle) between the undamaged skin and core.

(a) The pressure must be applied equally to all the areas. The total pressure on a honeycomb panel must not be more than 25 psi (170 kPa).

(b) Use cast ceramic, plaster, or plastic tools when you apply pressure to the outer skin on a contoured or rounded panel.

(6) When the cure time is completed, decrease the temperature at a rate of 5°F (3°C) a minute.

(7) Let the repaired part decrease in temperature to 150°F (66°C) or less before you release the pressure.

NOTE: If a temperature indication goes below the specified cure temperature, then extend the cure time before you decrease the temperature. Continue at the specified cure temperature for a minimum time equal to the time that the indication was below the specified cure temperature.

B. Paste adhesives.

(1) Continue to apply 1 psi (7 kPa) minimum pressure.

(2) You can decrease the cure times for paste adhesives if you increase the cure temperature of the repair. Refer to Fig. 10 and Fig. 11 for the time-temperature cure charts. You can use an oven, hot air, heat lamps, or a radiant heater to increase the cure temperature.

NOTE: To keep the strength in the aluminum material, do not use a cure temperature that is more than 260° F (127° C).

C. If you use an autoclave:

(1) Make sure that you use an applicable tool to hold all of the parts in their positions during the repair procedure.

NOTE: In most (but not all) conditions, the tool must be the same contour as the part to be cured.

(2) Increase the pressure and temperature in the autoclave as specified in Boeing Process Specification BAC 5514 "Common Bonding Requirements for Structural Adhesives" (or equivalent procedure).

(3) Cure the bond as given in Table 6.

(4) After the cure is completed, decrease the pressure and temperature as specified in Boeing Process Specification BAC 5514 "Common Bonding Requirements for Structural Adhesives" (or equivalent procedure).

21. Do an examination of the bonded repair

A. Use a synthetic fiber material (Scotchbrite2 pads, for example) to remove all fabric, plastic film, and thermocouple materials that are bonded to the outside of the repair. Make sure that you do not scratch the aluminum or remove clad material.

B. Do a visual inspection of the repair doubler(s).

(1) Look for a continuous bead of cured adhesive around the edges of each repair doubler. Look for disbonds, gaps, or a failure of the bond line. No disbonds, gaps or failures at the bond line (that you can see) are permitted. If some of the bead is missing or not fully cured, the repair is unsatisfactory.

NOTE: A bead that is not fully cured will be soft and tacky.

(2) Look to see if a repair doubler moved during the cure. Movement of 0.06 inches (1.5 mm) or less is permitted.

C. A post repair Non-Destructive Inspection (NDI) of the repair area is recommended.

(1) If a heat blanket was used, then do an NDI of the area that was below the heat blanket. If you use NDI procedures, refer to NDT Part 1, 51-01-01 and NDT Part 1, 51-04-00. Other NDI procedures, if they are satisfactory, are also permitted.

NOTE: You can use a tap test procedure as an alternative inspection procedure for a skin thickness that is a 0.040 inch (1.0 mm) or less. Use the tap test as given in NDT Part 1, 51-05-01.

(2) Continue to use NDI to examine the area 8 inches (20 cm) from where the edges of the heat blanket were.

(3) If you find an NDI indication that shows a possible disbond, you can do additional tests and analysis to verify that it is a disbond. If tests and analysis verify that the repair has a disbond, then the repair is unsatisfactory.

D. Remove all repair parts that have an unsatisfactory bond or cut out and repair the area that is disbonded. Do all of the necessary repair steps to make the repair satisfactory.

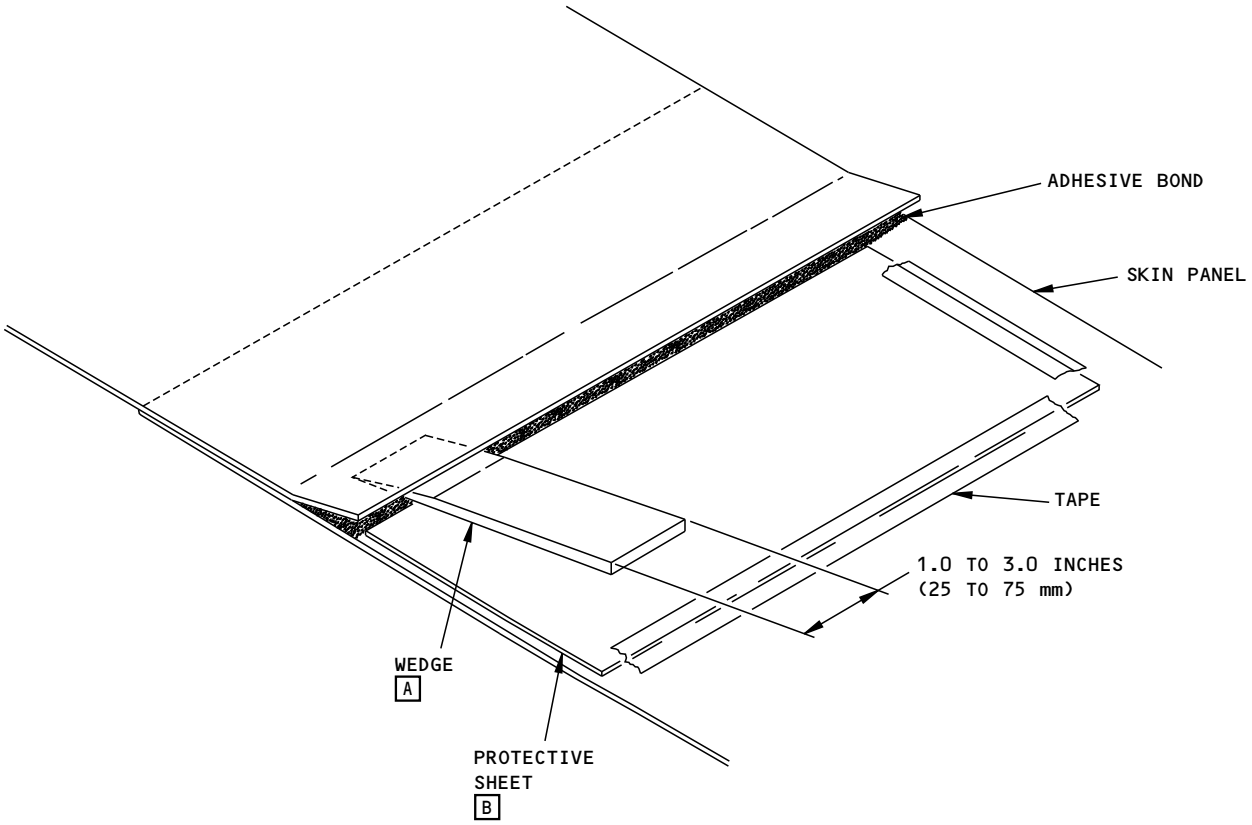
22. Clean, seal and finish

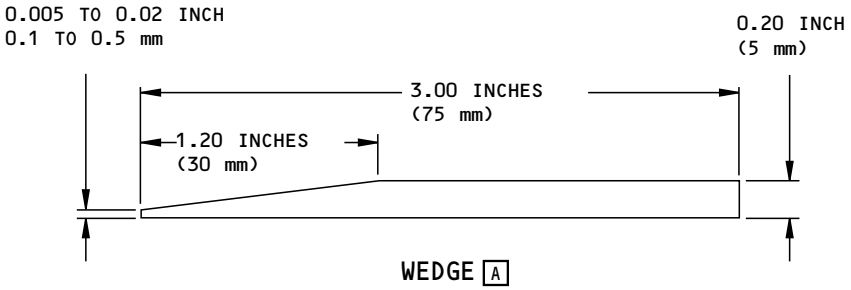
A. If the repair is satisfactory, then clean the surfaces that are to be sealed and finished. Refer to 51-8-0.

B. Seal all of the gaps and edges of the doubler(s).

C. Apply a protective finish to the bare surfaces as given in 51-8-0.

D. If a control surface was repaired, then a rebalance can be necessary. Refer to 51-15-0.





WEDGE A

SEPARATION OF THE BONDED PARTS WITH WEDGES

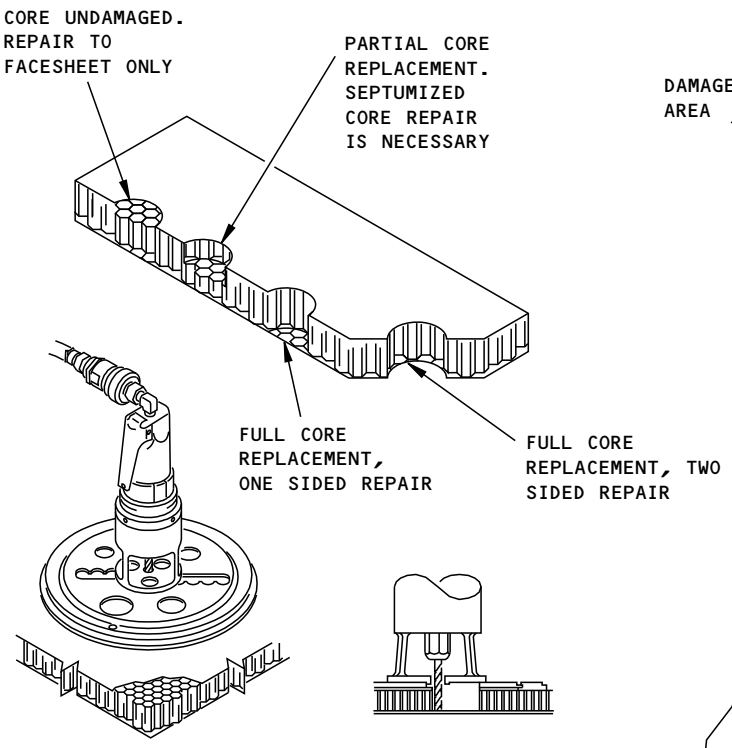
DETAIL I

NOTES

A WOOD OR PLASTIC ARE EXAMPLE MATERIALS

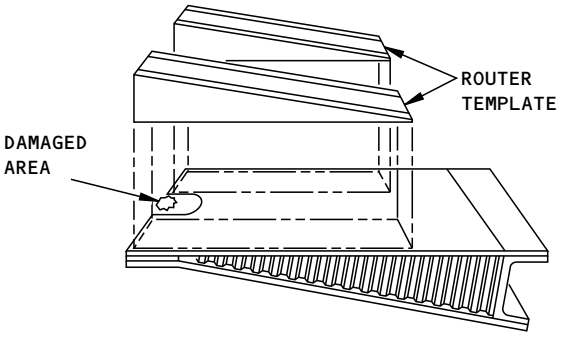
B METAL OR PLASTIC ARE EXAMPLE MATERIALS

Damage Removal Procedures
Figure 3 (Sheet 1)



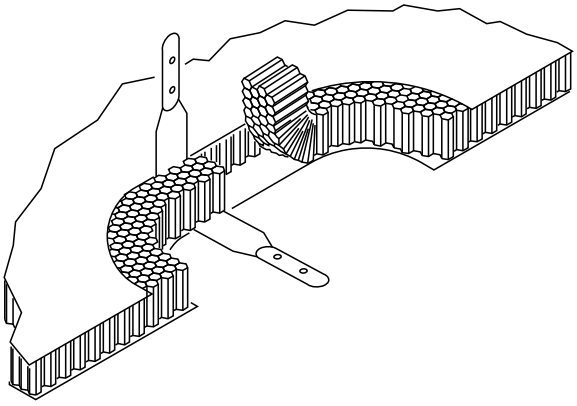
HONEYCOMB CORE REMOVAL

DETAIL II



REMOVING HONEYCOMB CORE
FROM A TAPERED CONTROL SURFACE

DETAIL III



REMOVAL OF CORE WITH CORE KNIFE

DETAIL IV

INSTRUCTIONS

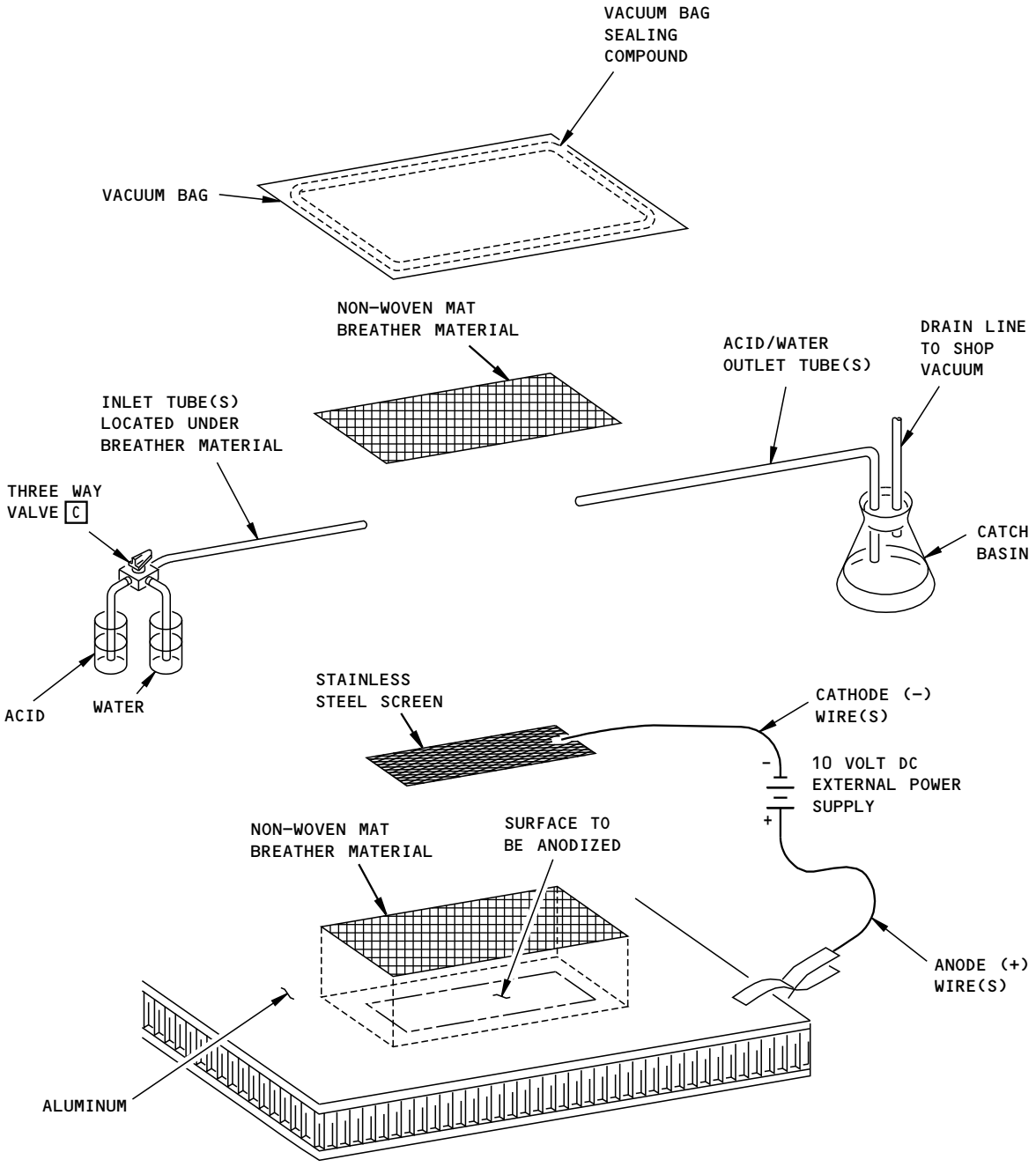
1. REMOVE THE FACE SHEET AND/OR CORE WITH A POWER ROUTER, USING A ROUTER TEMPLATE TO PROTECT THE UNDAMAGED PART OF THE FACE SHEET. REFER TO SRM 51-13-1 FOR INSTRUCTIONS ON THE USE OF A ROUTER AND TEMPLATE

   NOTE: THE ROUTER CAN BE ADJUSTED TO REMOVE: ONE OF THE FACE SHEETS ONLY, A FACE SHEET AND PART OF THE CORE, A FACE SHEET AND ALL OF THE CORE, OR BOTH THE FACE SHEETS AND CORE. SEE DETAIL II.

2. IF YOU ARE ROUTING A TAPERED PART, YOU CAN USE WEDGE SHAPED ROUTER TEMPLATES. THIS WILL PERMIT THE ROUTER TO CUT THE CORE MATERIAL PARALLEL WITH THE LOWER SURFACE. SEE DETAIL III.

3. IT IS PERMITTED TO REMOVE HONEYCOMB CORE WITH A CORE KNIFE. SEE DETAIL IV.

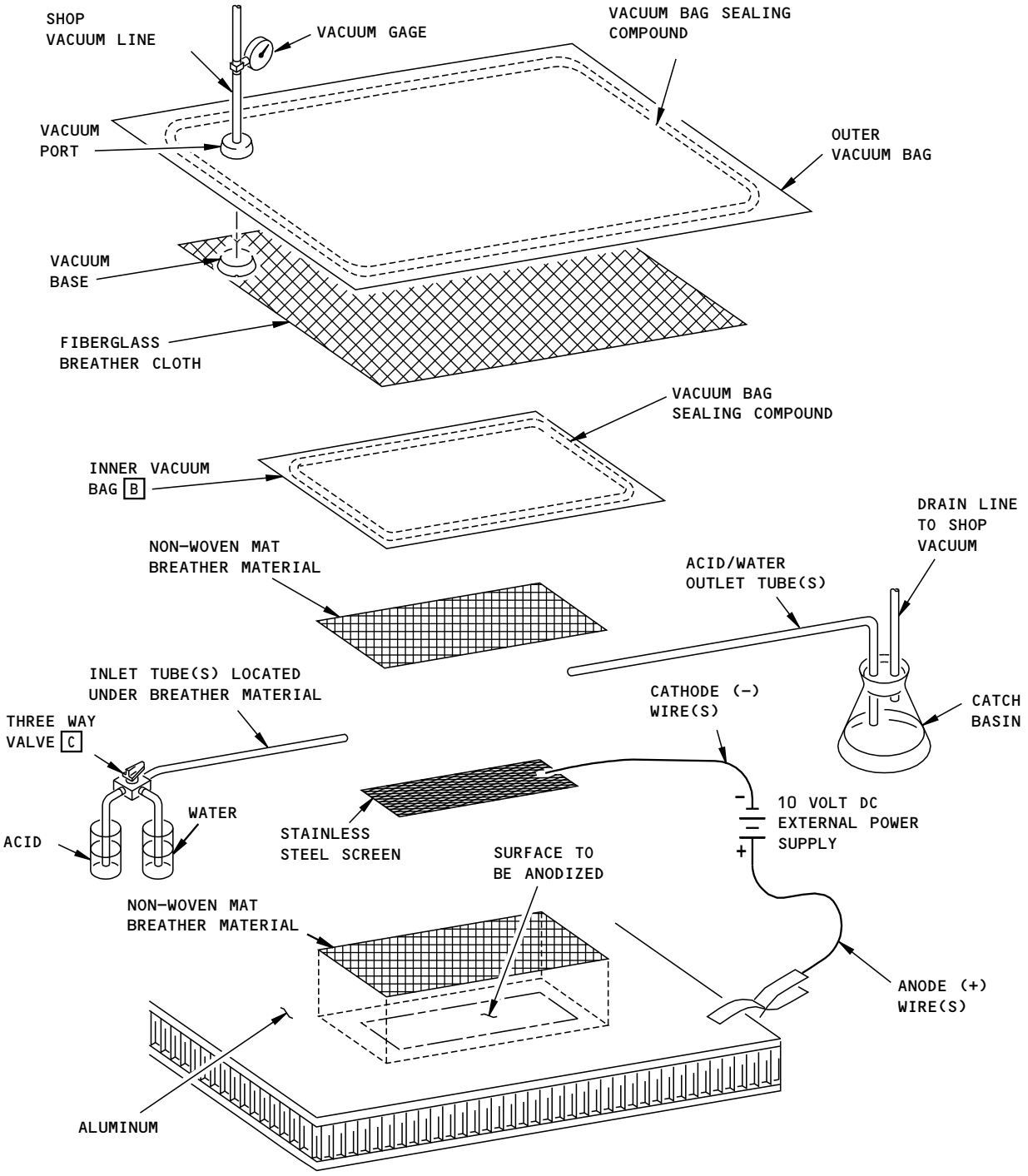
Damage Removal Procedures
Figure 3 (Sheet 2)



ONE VACUUM BAG SYSTEM A

DETAIL I

Phosphoric Acid Containment System (PACS)
Figure 4 (Sheet 1)



TWO VACUUM BAG SYSTEM A

DETAIL II

Phosphoric Acid Containment System (PACS)
Figure 4 (Sheet 2)

NOTES

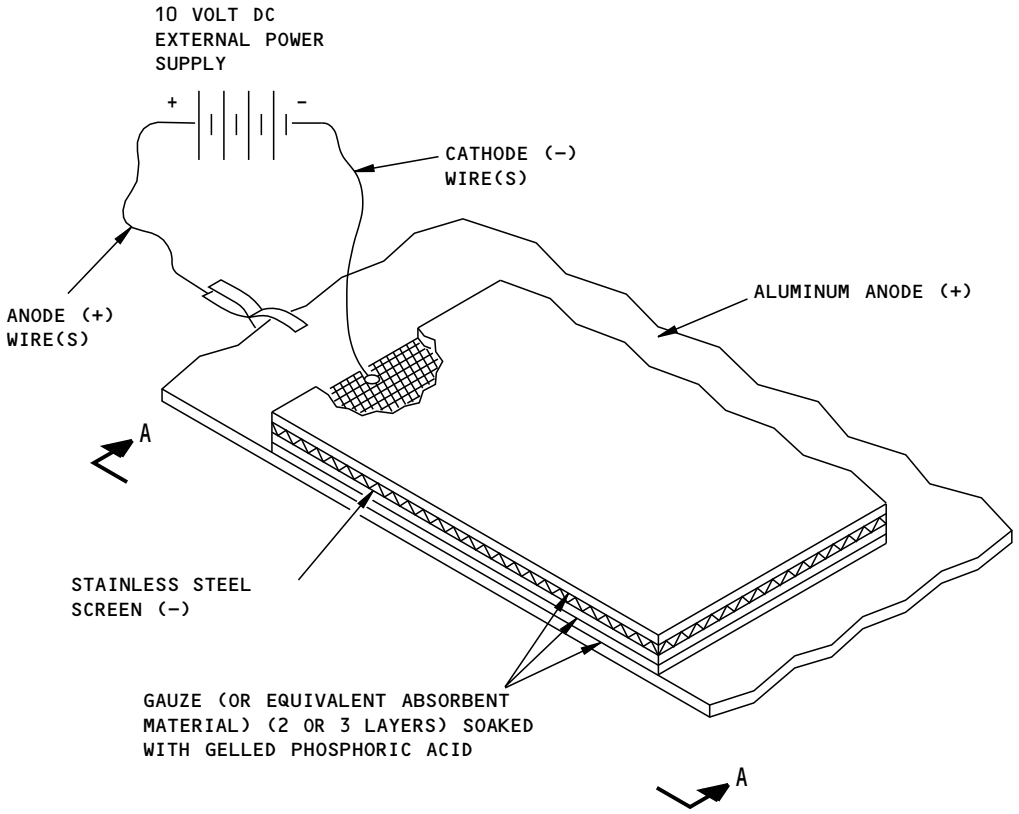
A WHEN THE SURFACE TO BE ANODIZED IS FACE UP (AS SHOWN IN THIS FIGURE), THE SECOND, OUTER VACUUM BAG IS OPTIONAL. IF THE SURFACE TO BE ANODIZED IS FACE DOWN OR IF THE SURFACE IS VERTICAL, THEN BOEING RECOMMENDS THAT YOU USE AN OUTER VACUUM BAG. THE OUTER VACUUM BAG WILL CONTAIN THE ACID IF THERE IS LEAKAGE FROM THE INNER VACUUM BAG. SEE DETAIL I FOR THE ONE VACUUM BAG SYSTEM, SEE DETAIL II FOR THE TWO VACUUM BAG SYSTEM.

B AFTER YOU ARE FINISHED WITH THE PACS PROCEDURE, DO A CHECK FOR ACID LEAKAGE BEFORE YOU REMOVE THE INNER VACUUM BAG. IF THERE WAS ACID LEAKAGE, RINSE AND REMOVE ALL OF THE ACID AND OTHER CONTAMINATION FROM THE ALUMINUM FIRST.
THEN REMOVE THE INNER VACUUM BAG.

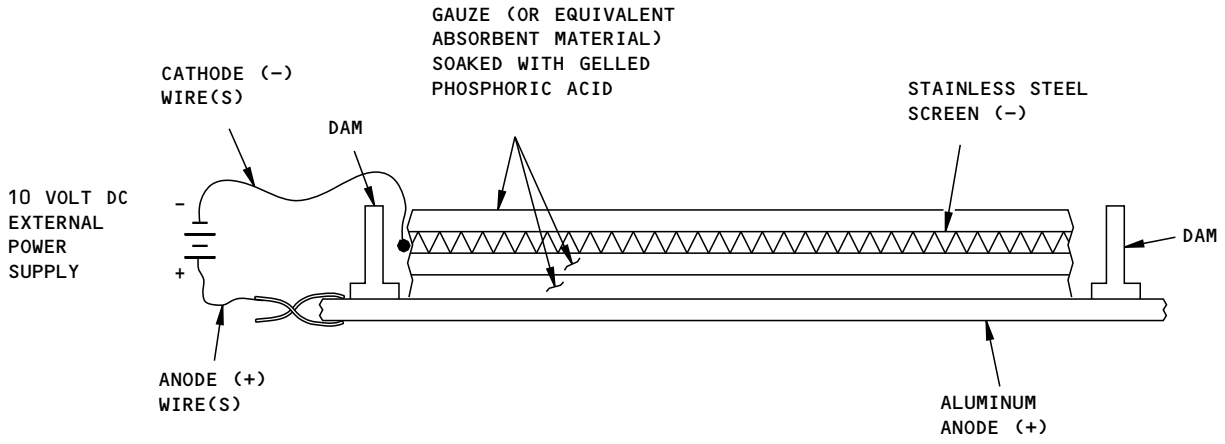
C THE THREE-WAY VALVE OPERATION MUST PERMIT THE CONDITIONS THAT FOLLOW:

- NO FLOW (OFF)
- FLOW OF ACID ONLY
- FLOW OF RINSE WATER ONLY

Phosphoric Acid Containment System (PACS)
Figure 4 (Sheet 3)

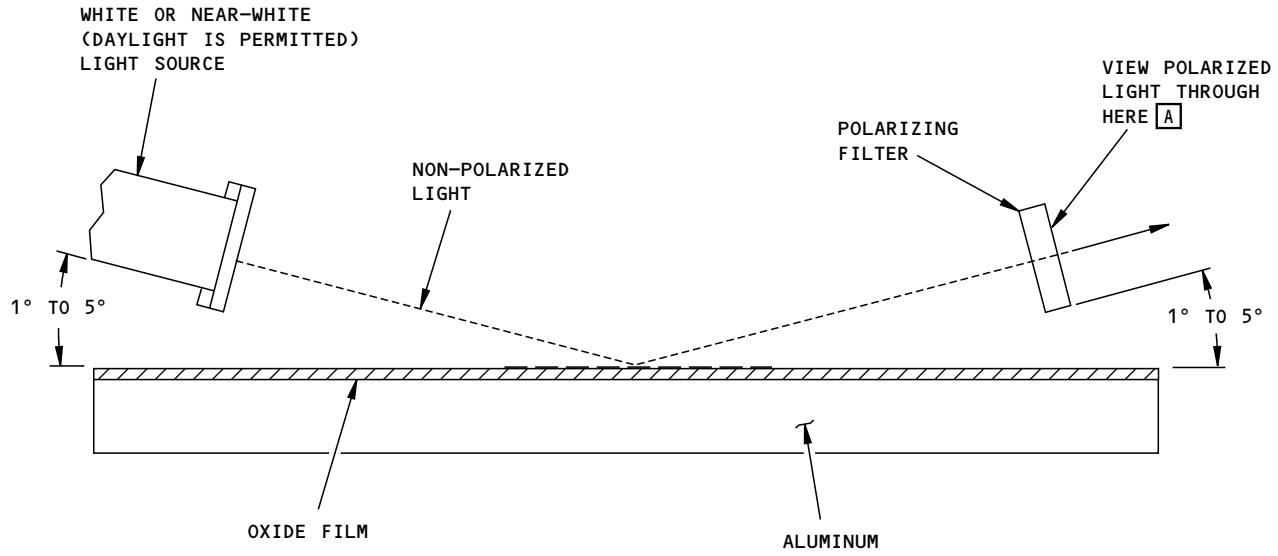


TYPICAL PANTA LAYUP (DAM NOT SHOWN)
DETAIL I



SECTION A–A

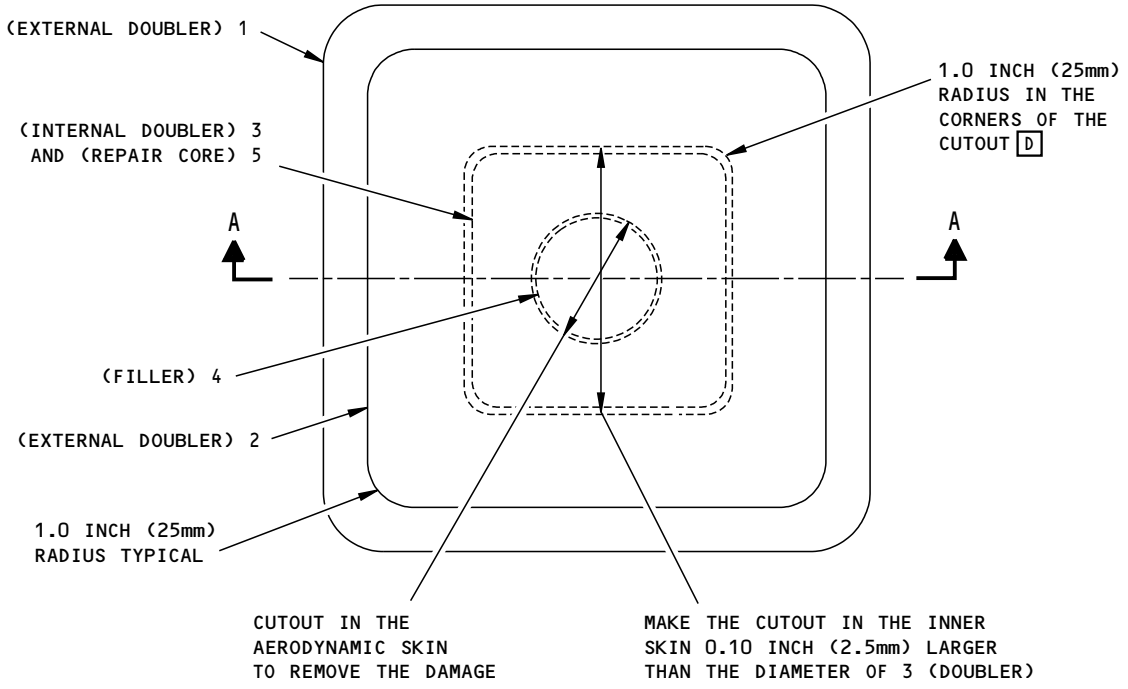
Phosphoric Acid Non-Tank Anodize (PANTA) Layup
Figure 5



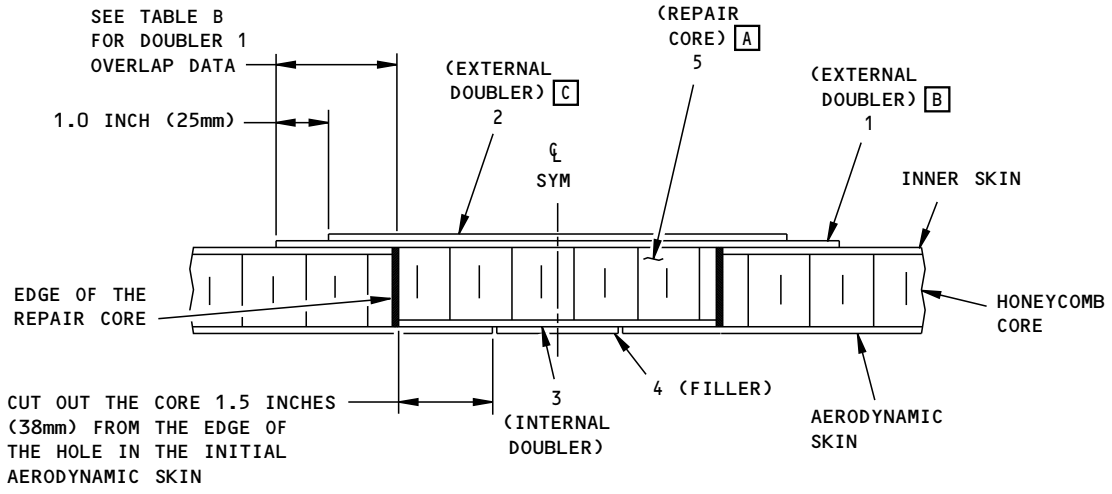
NOTES

A VIEW THE LIGHT AS YOU ROTATE (TURN) THE FILTER 90° TO INSPECT FOR A COLOR CHANGE

Polarized Light Test - Verification of Anodic Oxide Film
Figure 6

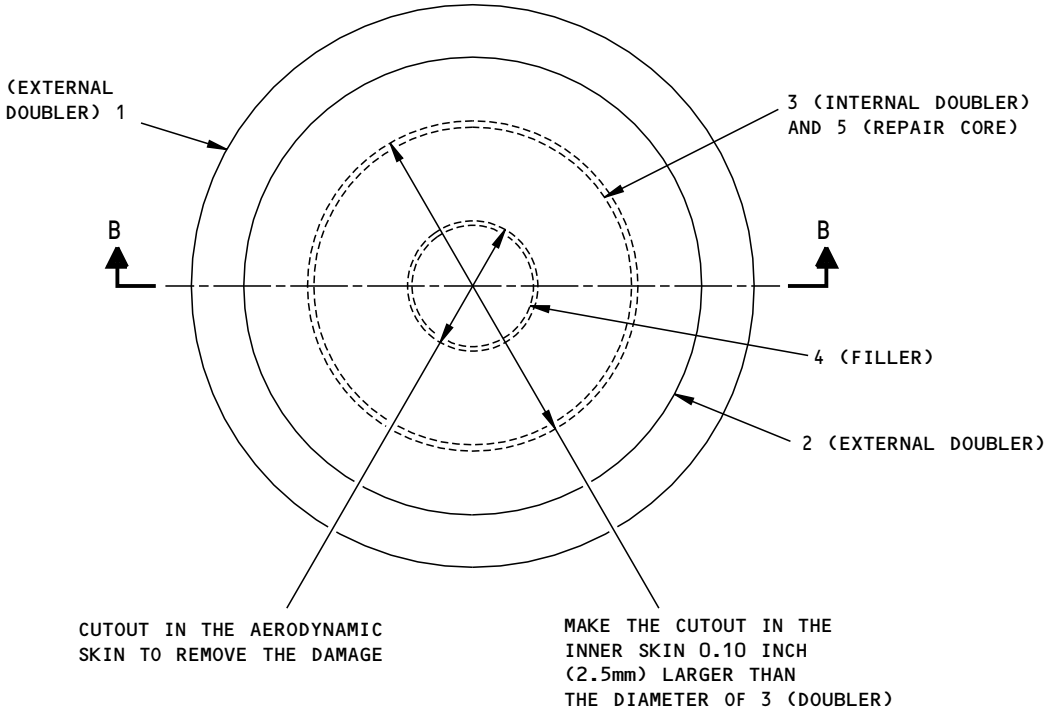


DETAIL I

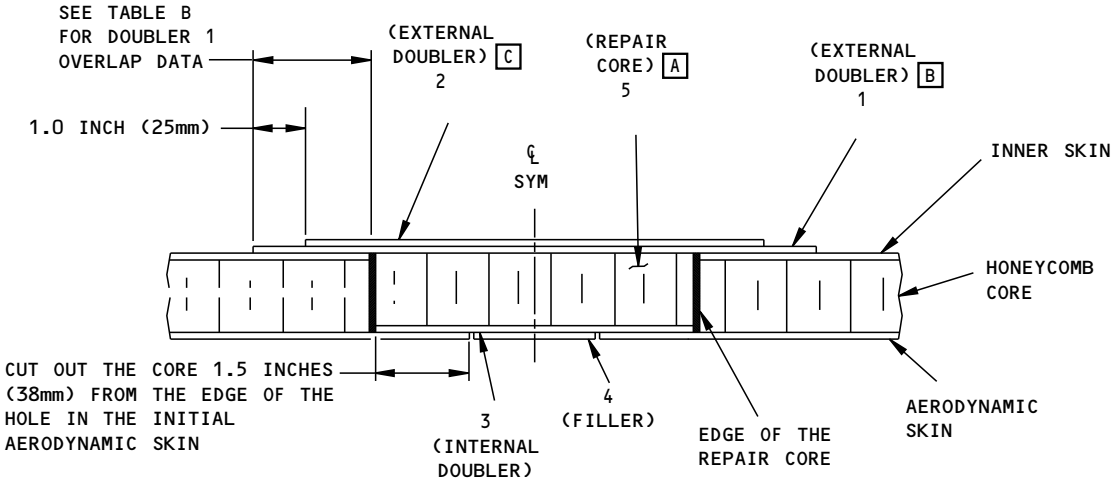


SECTION A–A

Repair Doubler Specifications for Flush Repairs
Figure 7 (Sheet 1)



DETAIL II



SECTION B-B

Repair Doubler Specifications for Flush Repairs
Figure 7 (Sheet 2)

REPAIR PART THICKNESS (INCHES) FOR BONDED REPAIRS				
INITIAL SKIN GAGE RANGE	PART 1 EXTERNAL DOUBLER	PART 2 EXTERNAL DOUBLER	PART 3 INTERNAL DOUBLER	PART 4 FILLER
0.012 TO 0.020	SAME AS THE INITIAL SKIN	NOT NECESSARY		
0.021 TO 0.025	0.025 [B]	[B]		
0.026 TO 0.032	0.032 [B] [E]	[B]		
0.033 TO 0.041	0.016	0.025	SAME AS THE AERODYNAMIC SKIN	SAME AS THE AERODYNAMIC SKIN
0.042 TO 0.045	0.020	0.025		
0.046 TO 0.050	0.025	0.025		
0.051 TO 0.057	0.025	0.032 [E]		
0.058 TO 0.064	0.032 [E]	0.032 [E]		
0.065 TO 0.072	0.032 [E]	0.040 [E]		
0.073 TO 0.080	0.040 [E]	0.040 [E]		

TABLE I

INITIAL SKIN THICKNESS	THE MINIMUM OVERLAP DIMENSION OF DOUBLER 1
0.00 TO 0.032	1.5 INCHES (38 mm)
> 0.032	2.5 INCHES (63 mm)

TABLE II

REPAIR PART THICKNESS (INCHES) FOR HIGH CURVATURE REPAIRS		
INITIAL SKIN	PART 1 EXTERNAL DOUBLER	PART 2 EXTERNAL DOUBLER
0.021 TO 0.028	0.012	0.016
0.029 TO 0.032	0.012	0.020

TABLE III

Repair Doubler Specifications for Flush Repairs
Figure 7 (Sheet 3)

NOTES

- USE THIS FIGURE TO DETERMINE THE DOUBLER DIMENSIONS ONLY.
- THE MATERIAL FOR THE REPAIR PARTS MUST BE EQUIVALENT TO THE SAME BOEING MATERIAL SPECIFICATION (BMS) AND HEAT TREAT AS THE SKIN TO BE REPAIRED.
- BONDING SURFACES OF 2000 SERIES ALUMINUM DOUBLERS CAN BE CLAD OR NON-CLAD (BARE). BONDING SURFACES OF 7000 SERIES ALUMINUM DOUBLERS MUST BE NON-CLAD (BARE).

[A] MAKE THE PART 5 REPAIR CORE LEVEL WITH THE OUTER SURFACE OF THE SKIN TO BE REPAIRED. (UNLESS SPECIFIED DIFERENTLY IN A SPECIFIC REPAIR).

[B] FOR THE INITIAL SKIN THICKNESSES THAT ARE 0.021 TO 0.032 GAGE, THE PART 2 (EXTERNAL DOUBLER) IS NOT NECESSARY IF THE SKIN IS FLAT, OR IF THE PART 1 DOUBLER CAN TOUCH ALL OF THE BOND SURFACE WITH ONLY LIGHT FINGER PRESSURE.

IF THE SKIN SURFACE HAS A HIGH CURVATURE, YOU CAN DO ONE OF THE STEPS THAT FOLLOW:

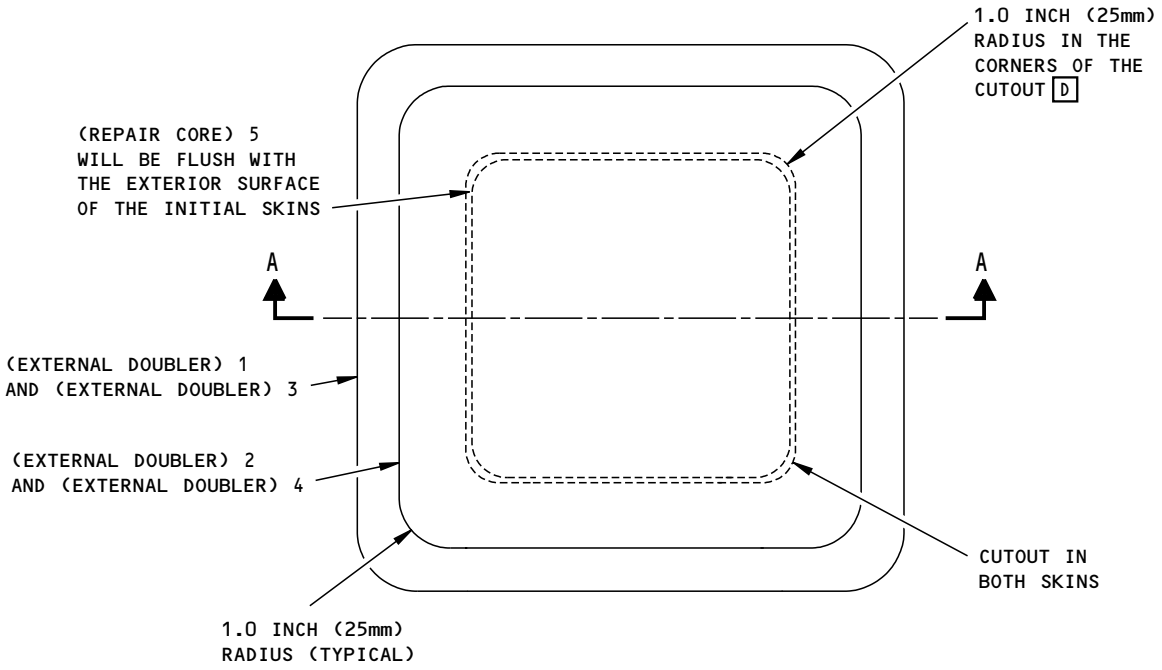
- MAKE THE PART 1 DOUBLER TO THE SAME CURVATURE AS THE SKIN SURFACE, SO THAT LIGHT FINGER PRESSURE MAKES THE DOUBLER TOUCH ALL OF THE SKIN SURFACE, OR
- MAKE THE PART 1 DOUBLER FROM 0.012 GAGE, AND MAKE THE PART 2 DOUBLER FROM THE THICKNESS SPECIFIED IN TABLE III.

[C] WHEN YOU USE THE PART 2 (EXTERNAL DOUBLER), MAKE THE PART 2 (EXTERNAL DOUBLER) 1.0 INCH (25 mm) SMALLER ALL AROUND THAN THE PART 1 (EXTERNAL DOUBLER).

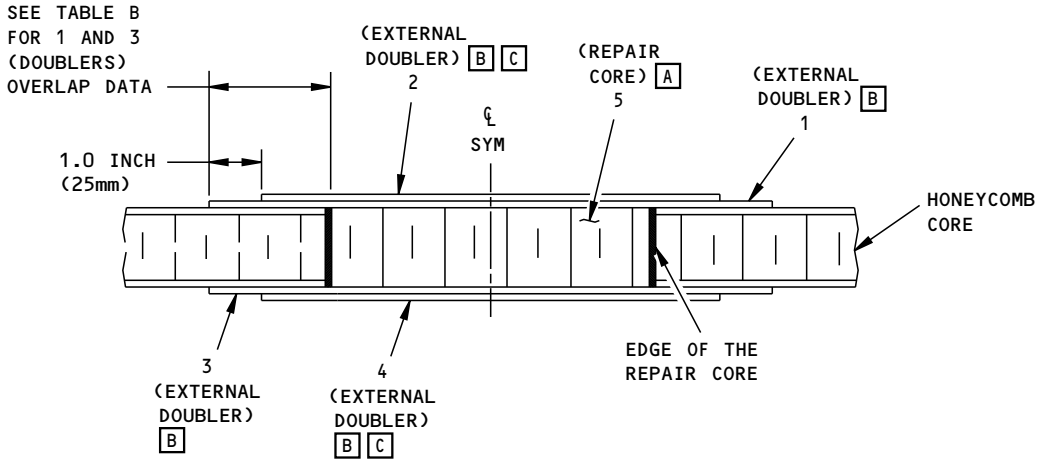
[D] IF YOU ARE REPAIRING A CRACK, GOUGE, OR SMALL HOLE, YOU CAN USE A MINIMUM RADIUS THAT IS 0.25 INCH (6 mm).

[E] CHAMFER ALL EDGES OF THE DOUBLER AS SHOWN IN FIGURE 12 FOR DOUBLERS 0.032 GAGE AND THICKER.

Repair Doubler Specifications for Flush Repairs
Figure 7 (Sheet 4)

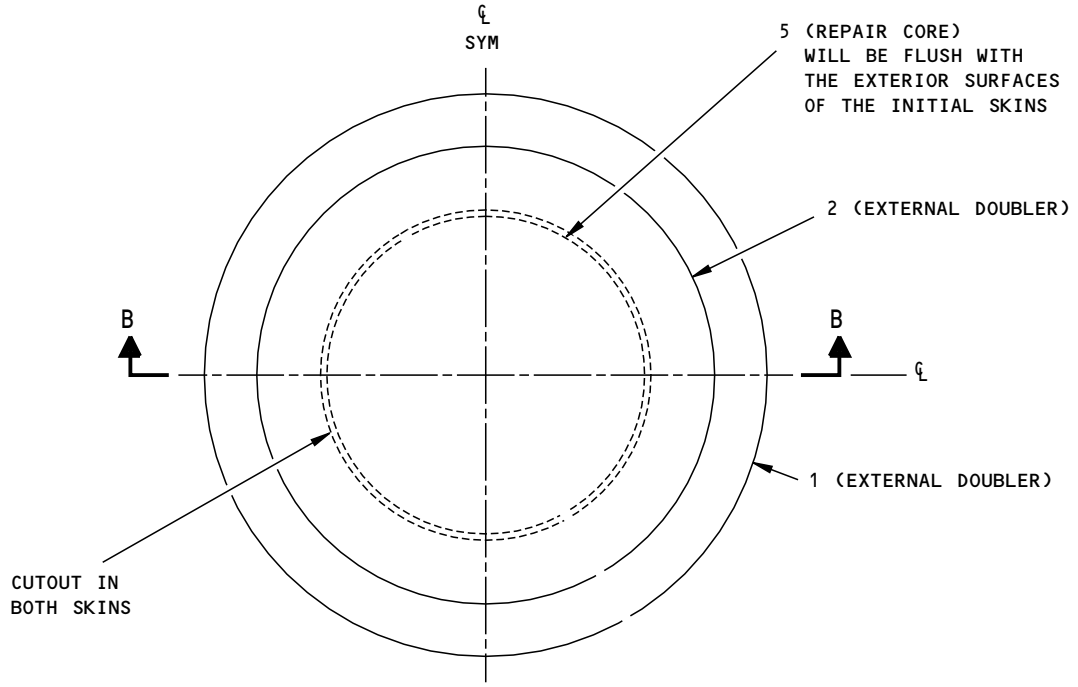


DETAIL I

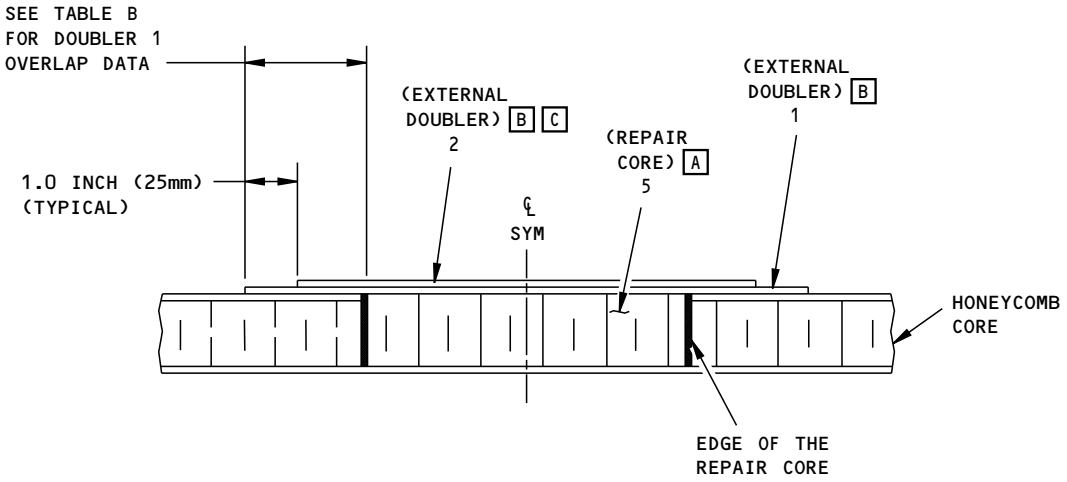


TWO-SIDED REPAIR SHOWN
SEE DETAIL II FOR ONE SIDED REPAIR
SECTION A-A

Repair Doubler Specifications for External Patch Repairs
Figure 8 (Sheet 1)



DETAIL II



ONE-SIDED REPAIR SHOWN
SEE DETAIL I FOR TWO-SIDED REPAIR
SECTION B-B

Repair Doubler Specifications for External Patch Repairs
Figure 8 (Sheet 2)

REPAIR PART THICKNESS (INCHES) FOR BONDED REPAIRS		
INITIAL SKIN GAGE RANGE	PART 1 AND 3 DOUBLER	PART 2 AND 4 DOUBLER
0.012 TO 0.020	SAME AS THE INITIAL SKIN	NOT NECESSARY
0.021 TO 0.025	0.025 [B]	[B]
0.026 TO 0.032	0.032 [B] [E]	[B]
0.033 TO 0.041	0.016	0.025
0.042 TO 0.045	0.020	0.025
0.046 TO 0.050	0.025	0.025
0.051 TO 0.057	0.025	0.032 [E]
0.058 TO 0.064	0.032 [E]	0.032 [E]
0.065 TO 0.072	0.032 [E]	0.040 [E]
0.073 TO 0.080	0.040 [E]	0.040 [E]

TABLE I

INITIAL SKIN THICKNESS	THE MINIMUM OVERLAP DIMENSION OF DOUBLERS 1 AND 3
0.00 TO 0.032	1.5 INCHES (38mm)
> 0.032	2.5 INCHES (63mm)

TABLE II

REPAIR PART THICKNESS (INCHES) FOR HIGH CURVATURE REPAIRS		
INITIAL SKIN	PART 1 AND 3 DOUBLER	PART 2 AND 4 DOUBLER
0.021 TO 0.028	0.012	0.016
0.029 TO 0.032	0.012	0.020

TABLE III

Repair Doubler Specifications for External Patch Repairs
Figure 8 (Sheet 3)

NOTES

- USE THIS FIGURE TO DETERMINE THE DOUBLER DIMENSIONS ONLY.
- THE MATERIAL FOR THE REPAIR PARTS MUST BE EQUIVALENT TO THE SAME BOEING MATERIAL SPECIFICATION (BMS) AND HEAT TREAT AS THE SKIN TO BE REPAIRED.
- BONDING SURFACES OF 2000 SERIES ALUMINUM DOUBLERS CAN BE CLAD OR NON-CLAD (BARE). BONDING SURFACES OF 7000 SERIES ALUMINUM DOUBLERS MUST BE NON-CLAD (BARE).

[A] MAKE THE PART 5 REPAIR CORE TO BE LEVEL WITH THE OUTER SURFACE OF THE SKIN TO BE REPAIRED (UNLESS SPECIFIED DIFFERENTLY IN A SPECIFIC REPAIR).

[B] FOR THE INITIAL SKIN THICKNESSES THAT ARE BETWEEN 0.021 AND 0.032 GAGE, THE PARTS 2 AND 4 DOUBLERS ARE NOT NECESSARY IF THE INITIAL SKIN IS FLAT OR IF THE PARTS 1 AND 3 DOUBLERS CAN TOUCH ALL OF THE BOND SURFACE WITH ONLY LIGHT FINGER PRESSURE.

IF THE SKIN SURFACE HAS A HIGH CURVATURE, YOU CAN DO ONE OF THE STEPS THAT FOLLOW:

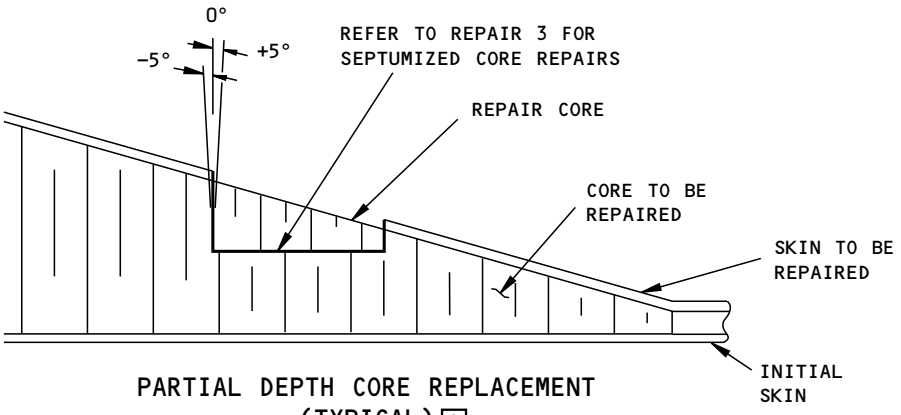
- MAKE THE PARTS 1 AND 3 DOUBLERS TO THE SAME CURVATURE AS THE SKIN SURFACE, SO THAT LIGHT FINGER PRESSURE MAKES THE DOUBLERS TOUCH ALL OF THE SKIN SURFACE, OR
- MAKE THE PARTS 1 AND 3 DOUBLERS FROM 0.012 GAGE, AND MAKE THE PARTS 2 AND 4 DOUBLERS FROM THE THICKNESS SPECIFIED IN TABLE III.

[C] WHEN YOU USE THE PART 2 AND 4 DOUBLERS, MAKE THE PARTS 2 AND 4 DOUBLERS 1.0 INCH (25 mm) SMALLER ALL AROUND THAN THE PARTS 1 AND 3 DOUBLERS.

[D] IF YOU ARE REPAIRING A CRACK, GOUGE, OR SMALL HOLE, YOU CAN USE A MINIMUM RADIUS THAT IS 0.25 INCH (6 mm).

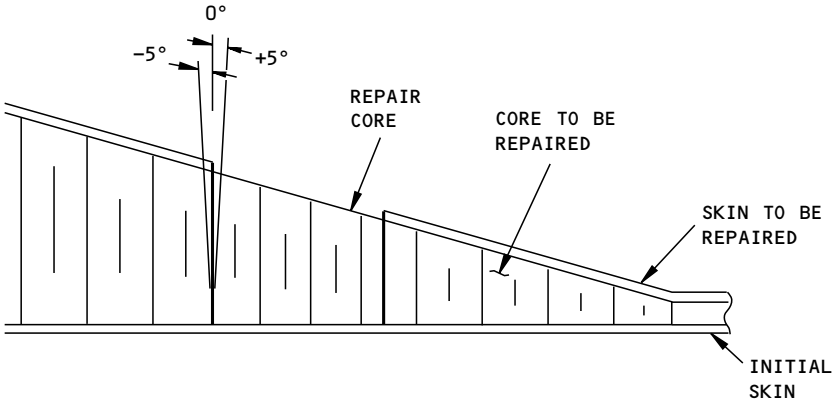
[E] CHAMFER ALL EDGES OF THE DOUBLER AS SHOWN IN FIGURE 12 FOR DOUBLERS 0.032 GAGE AND THICKER

Repair Doubler Specifications for External Patch Repairs
Figure 8 (Sheet 4)



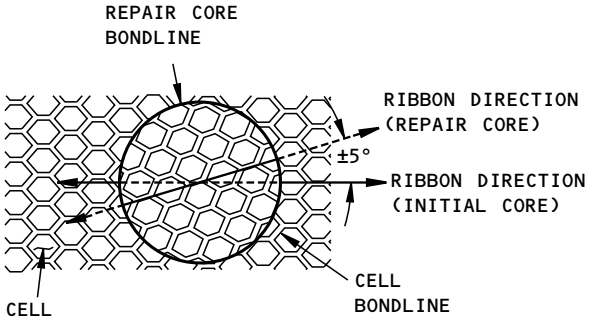
PARTIAL DEPTH CORE REPLACEMENT
(TYPICAL) [A]

DETAIL I



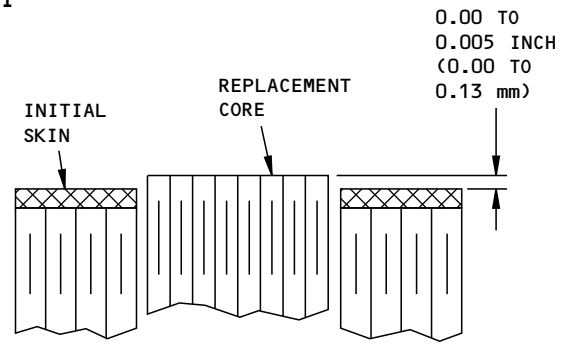
FULL DEPTH CORE REPLACEMENT
(TYPICAL) [A]

DETAIL II



CORE ALIGNMENT

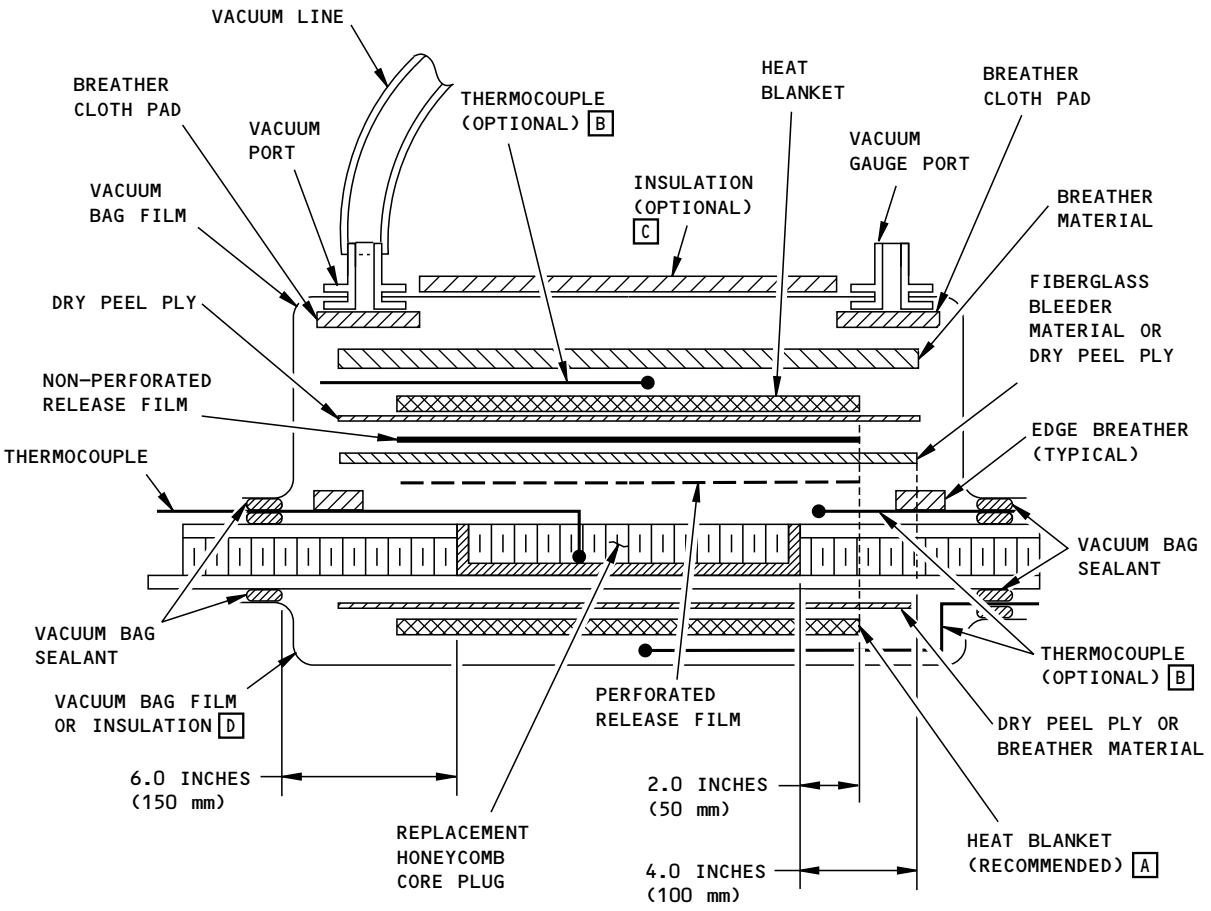
DETAIL III



INITIAL CORE HEIGHT
(BEFORE CURE)

DETAIL IV

Installation of the Repair Core
Figure 9 (Sheet 1)



VACUUM BAG PROCEDURE FOR REPLACEMENT CORE
WHEN THE TWO STAGE CURE PROCEDURE IS USED

DETAIL V

NOTES

A MAXIMUM ERROR OF THE CELL WALLS AFTER INSTALLATION OF THE REPAIR CORE.

B YOU CAN USE THESE THERMOCOUPLES TO MAKE SURE THAT IF THE HEAT BLANKET GETS TOO HOT, YOU CAN TURN OFF THE POWER SUPPLY BEFORE YOU DAMAGE THE SKIN PANEL.

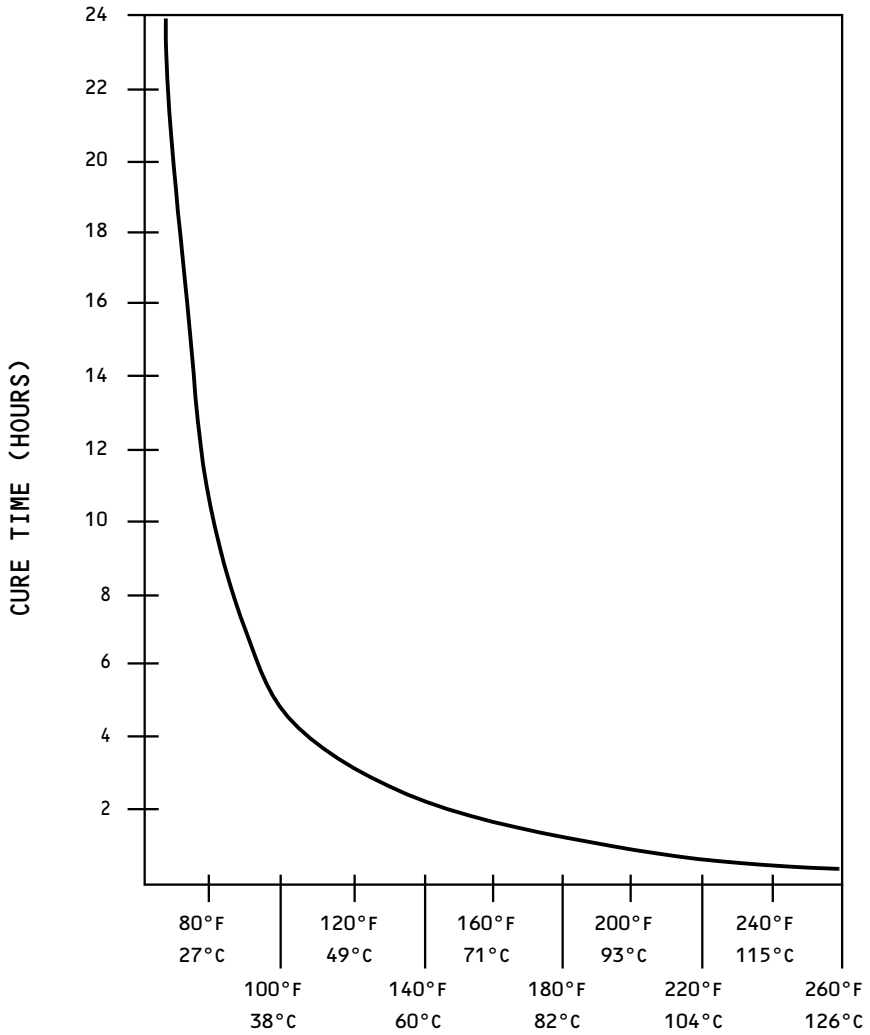
C 4-8 PLIES OF BREATHER MATERIAL IS AN EXAMPLE. YOU CAN USE OTHER INSULATION MATERIALS ALSO. THIS WILL KEEP THE HEAT IN THE REPAIR AREA.

D IF YOU USE A HEAT BLANKET ON THE UNDAMAGED SIDE, MAKE SURE THAT THE HEAT BLANKET CAN BE HELD AGAINST THE PART. A VACUUM BAG CAN BE USED TO HOLD THE HEAT BLANKET, OR YOU CAN PUT THE PART ON A TOOL SURFACE (WITH INSULATION BETWEEN THE HEAT BLANKET AND THE TOOL SURFACE.

Installation of the Repair Core
Figure 9 (Sheet 2)

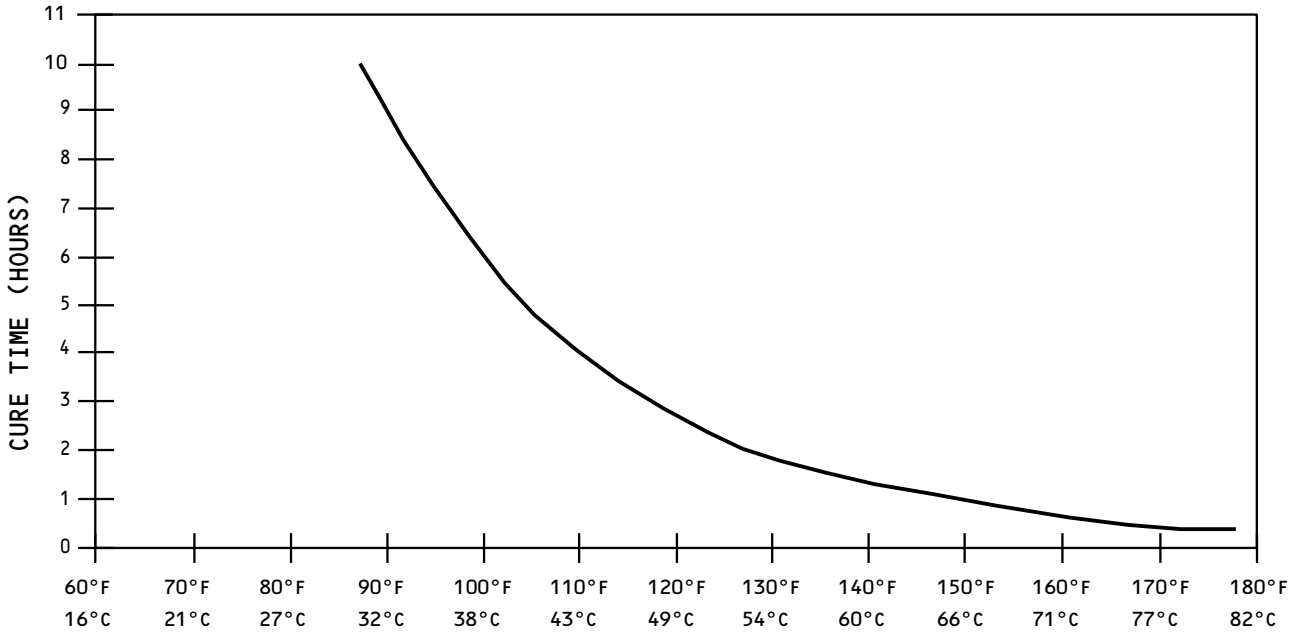
CLASS	POT LIFE AT LESS THAN 80°F (27°C)	PARTS BY WEIGHT PART A (BASE)		PARTS BY WEIGHT PART B (HARDENER)
		TYPE I	TYPE V	TYPE I AND V
1	20 MINUTES MAXIMUM	140	49	100
2	60 MINUTES MAXIMUM	140	49	100
3	90 MINUTES MAXIMUM	140	---	100
4	120 MINUTES MAXIMUM	140	---	100

BMS 5-92 TWO-PART PASTE ADHESIVE MIXTURE DATA
TABLE I



BMS 5-92, TYPE I CURE TEMPERATURE
CHART I

Cure Time for BMS 5-92, Two-part Paste Adhesive
Figure 10 (Sheet 1)



BMS 5-92, TYPE V, CLASS 2 CURE TEMPERATURE
CHART II

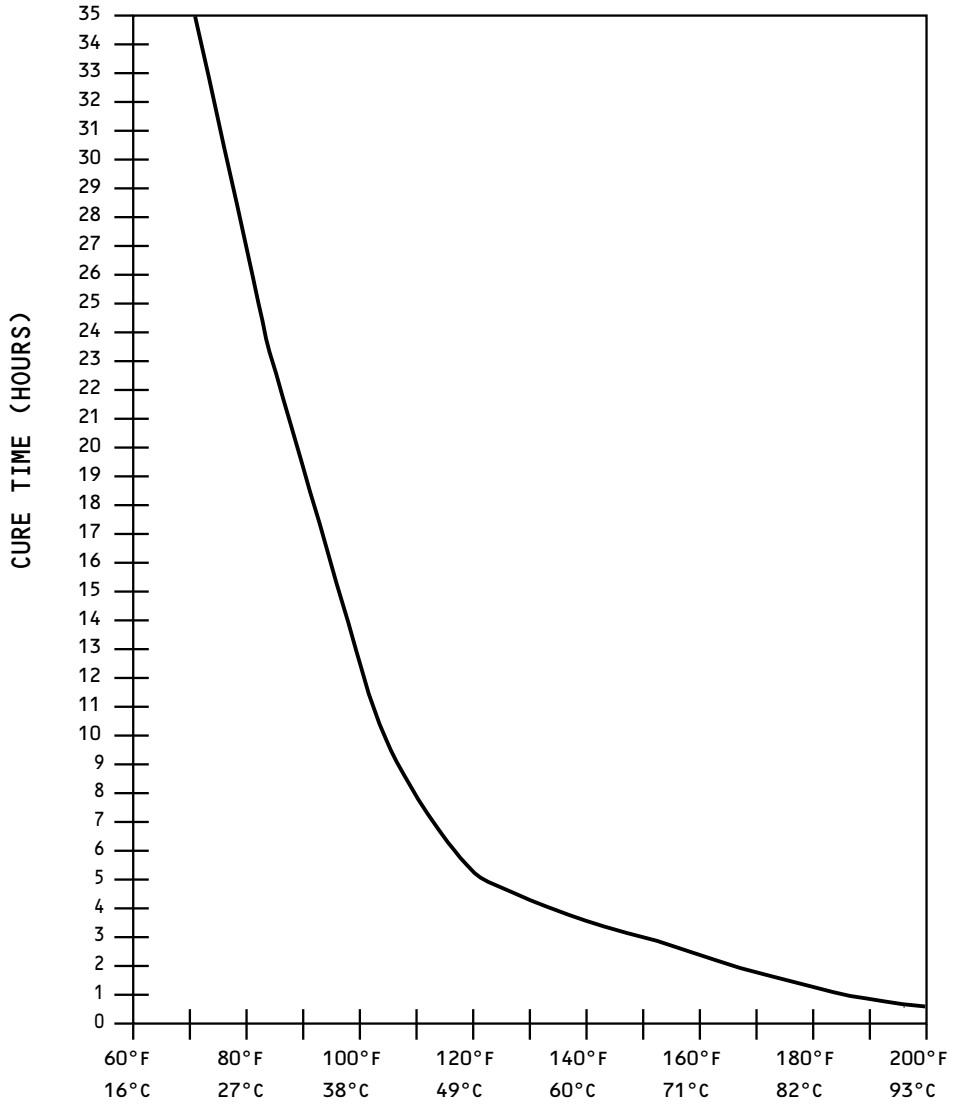
NOTES

- IF A TYPE IS NOT SPECIFIED IT IS PREFERRED THAT YOU USE TYPE V.
- CURE UNDER PRESSURE AS FOLLOWS:

  (1) BMS5-92, TYPE V, CLASS 1 ADHESIVE:
  3 HOURS MINIMUM AT 70 TO 100°F (21 TO 38°C), OR
  2 HOURS MINIMUM AT 120 TO 130°F (49 TO 54°C).

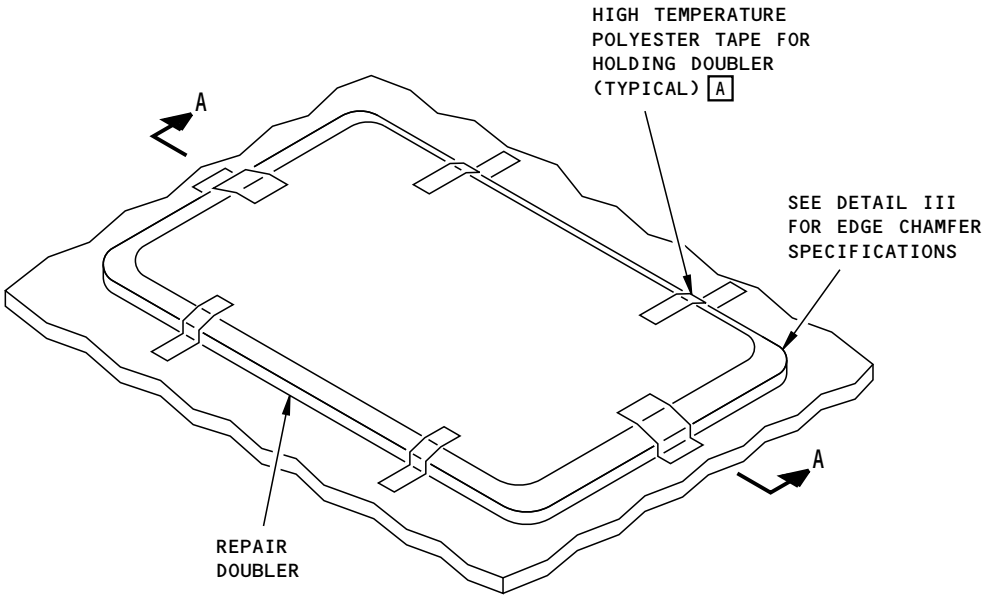
  (2) BMS5-92, TYPE V, CLASS 2 ADHESIVE:
  7 HOURS MINIMUM AT 70 TO 100°F (21 TO 38°C) OR SEE CHART II.

Cure Time for BMS 5-92, Two-part Paste Adhesive
Figure 10 (Sheet 2)



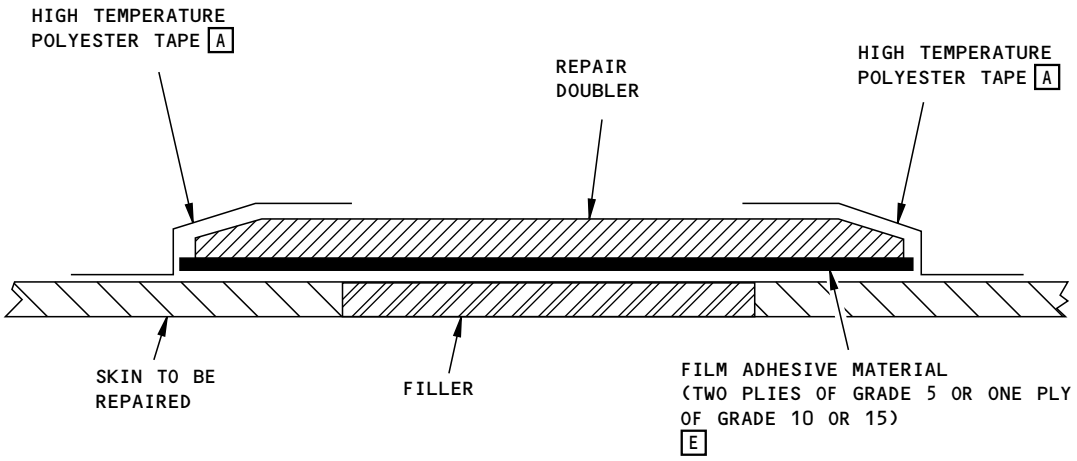
BMS 5-141 CURE TEMPERATURE

Cure Time for BMS 5-141 Paste Adhesive
Figure 11



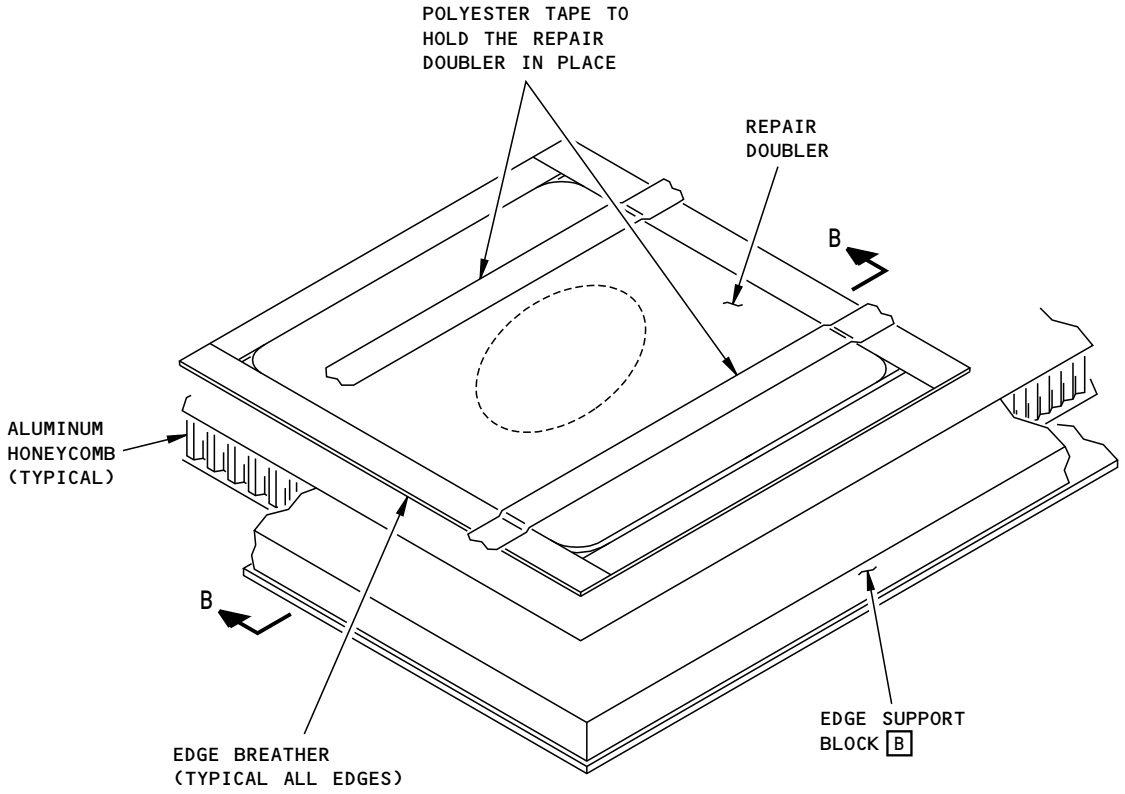
METAL TO METAL
(NO HONEYCOMB)

DETAIL I



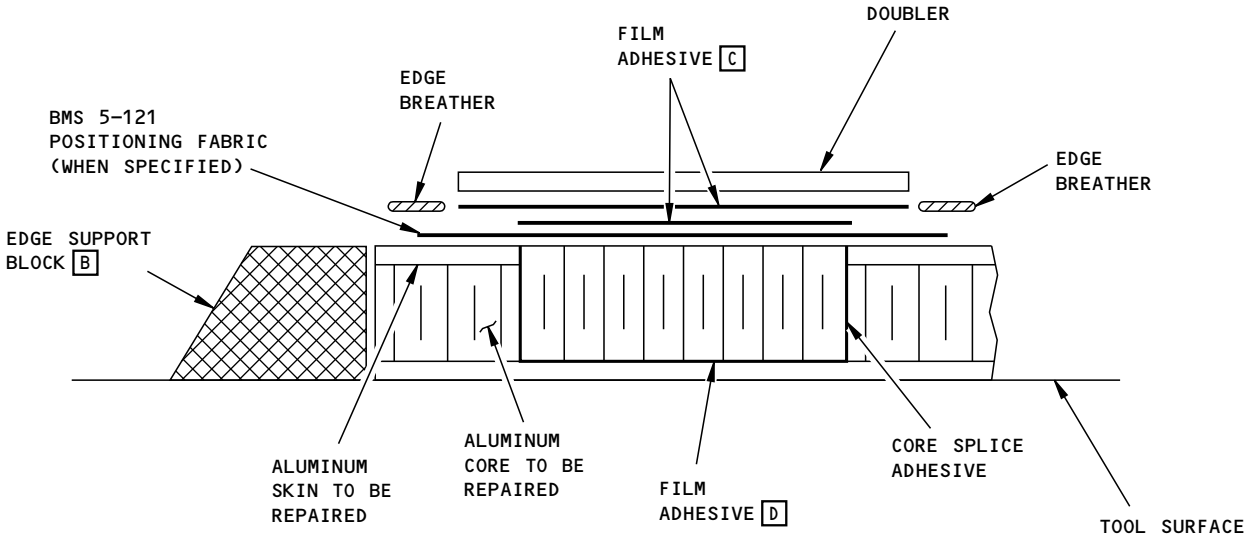
SECTION A-A

Installation of the Repair Doubler
Figure 12 (Sheet 1)

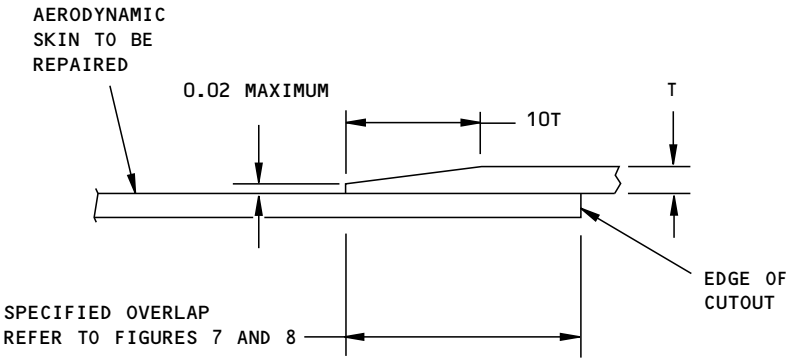


DETAIL II

Installation of the Repair Doubler
Figure 12 (Sheet 2)

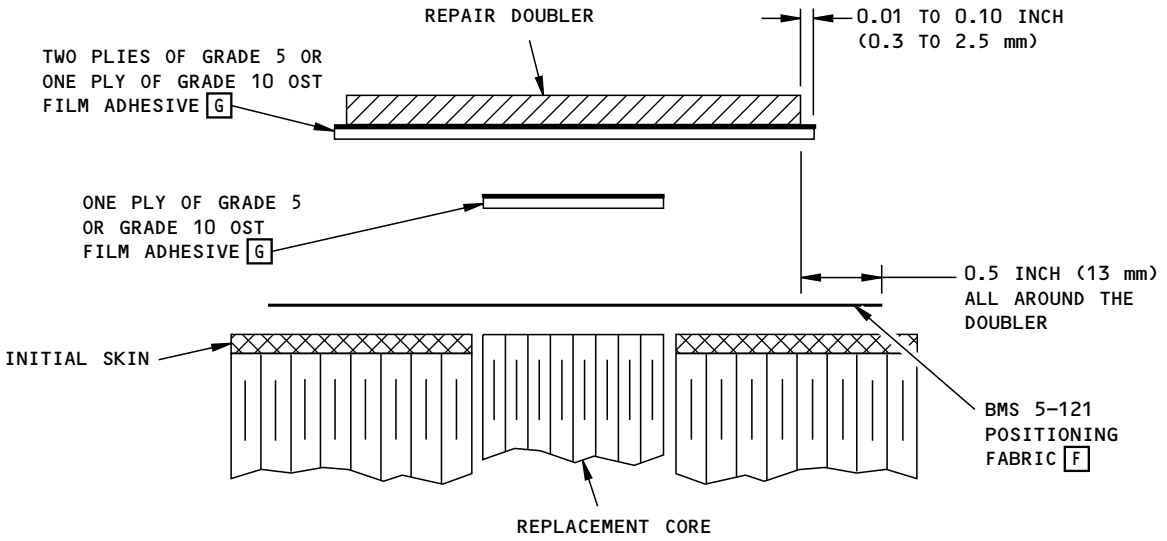


SECTION B-B

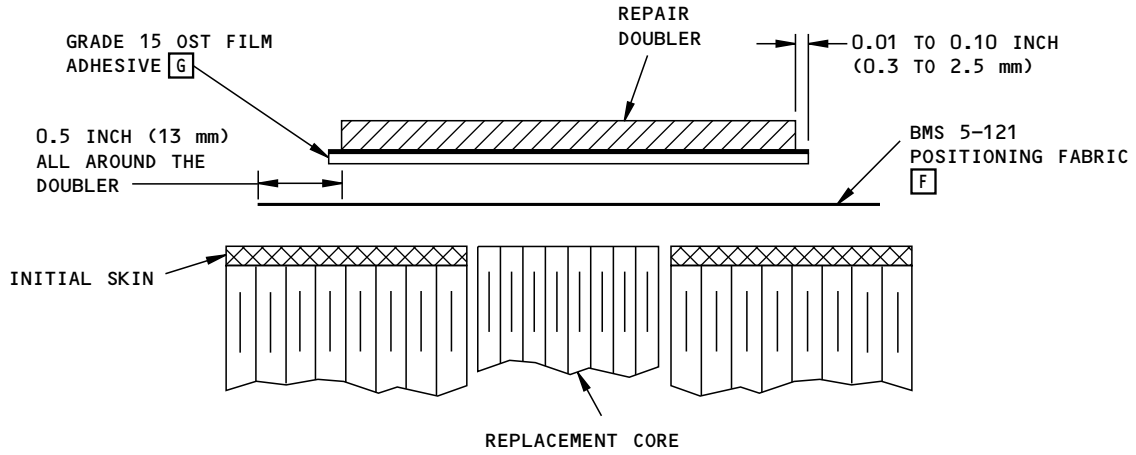


TYPICAL CHAMFERED EXTERNAL PATCH
(GAGE THICKNESS 0.032 AND MORE)
DETAIL III

Installation of the Repair Doubler
Figure 12 (Sheet 3)



INSTALLATION OF EXTERNAL DOUBLER AND GRADE 5
OR GRADE 10 OST FILM ADHESIVE

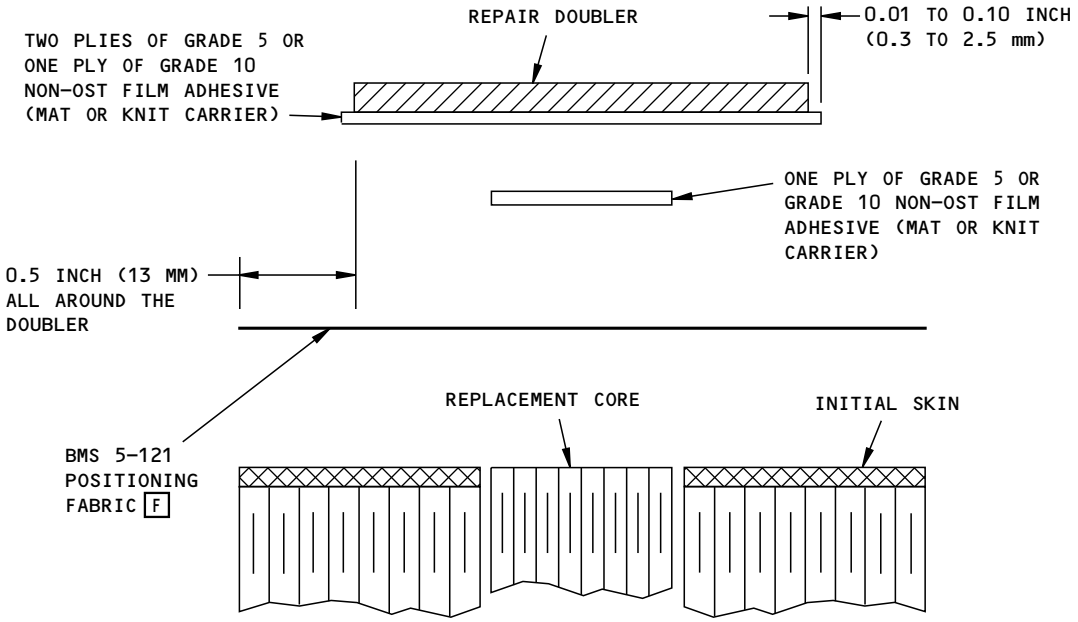


INSTALLATION OF EXTERNAL DOUBLER AND
GRADE 15 OST FILM ADHESIVE E

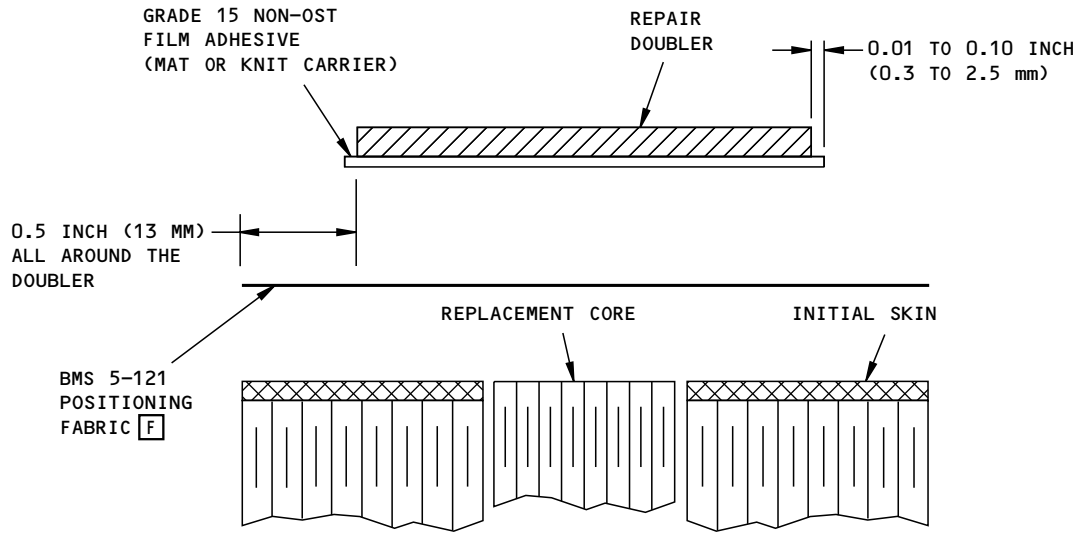
INSTRUCTIONS TO APPLY ONE-SIDE-TACKY (OST)
FILM ADHESIVE G

DETAIL IV

Installation of the Repair Doubler
Figure 12 (Sheet 4)



INSTALLATION OF EXTERNAL DOUBLER AND GRADE 5
OR GRADE 10 NON-OST FILM ADHESIVE



INSTALLATION OF EXTERNAL DOUBLER GRADE 15
NON-OST FILM ADHESIVE E
INSTRUCTIONS TO APPLY NON-OST FILM ADHESIVE
DETAIL V

Installation of the Repair Doubler
Figure 12 (Sheet 5)

NOTES

- THIS IS APPLICABLE FOR THE FILM ADHESIVE BOND PROCEDURE.
- MAKE SURE THAT ALL SEPARATOR SHEETS ARE REMOVED BEFORE YOU ASSEMBLE THE REPAIR PARTS.

[A] APPLY TAPE TO HOLD THE REPAIR DOUBLER IN POSITION DURING THE CURE. DO NOT SEAL THE EDGES OF THE PANEL. IF YOU SEAL THE EDGES OF THE PANEL WITH TAPE, IT CAN PREVENT THE FLOW OF THE ADHESIVE MATERIAL AND THE REMOVAL OF AIR DURING THE FINAL STAGE OF THE CURE. APPLY LESS THAN 25 PERCENT OF THE EDGE LENGTH OF THE REPAIR DOUBLER WITH TAPE.

[B] ONLY NECESSARY FOR SQUARE EDGED HONEYCOMB PANELS.

[C] USE THREE PLIES OF GRADE 5, TWO PLIES OF GRADE 10 OR ONE PLY OF GRADE 15 BETWEEN THE REPAIR DOUBLER AND THE CORE. IF GRADE 5 OR GRADE 10 IS USED, MAKE THE BOTTOM PLY THE SAME DIMENSIONS AS THE CORE. MAKE THE TOP PLY (PLIES) THE SAME SIZE AS THE THE DOUBLER. SEE DETAIL IV AND DETAIL V.

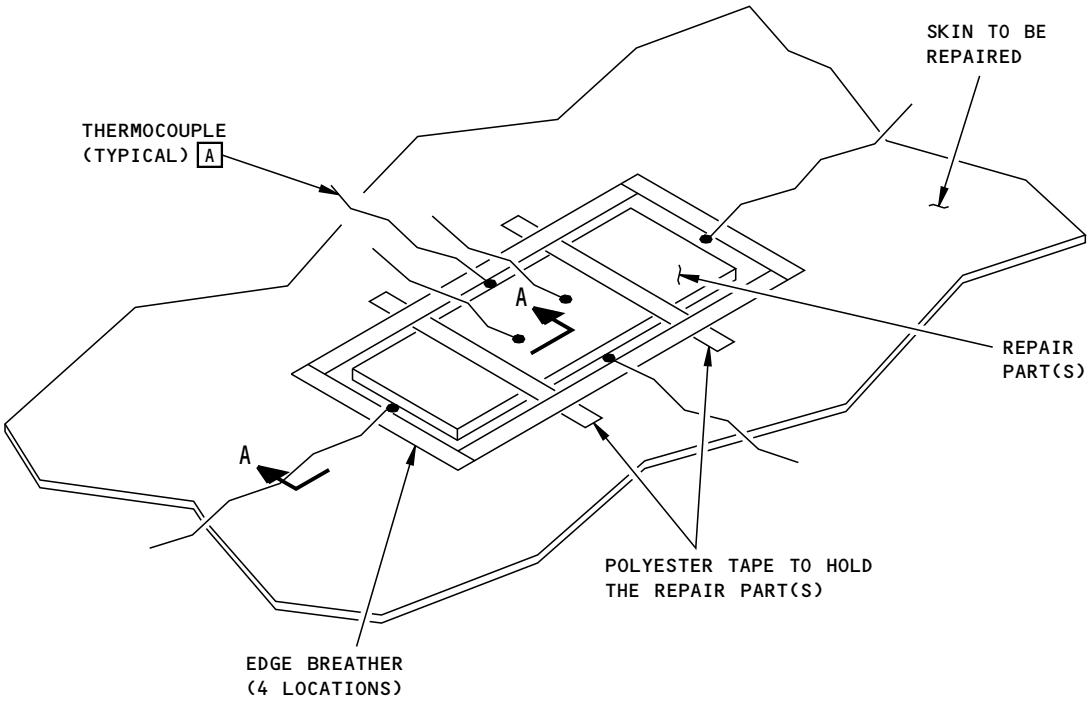
[D] USE THREE PLIES OF GRADE 5, TWO PLIES OF GRADE 10 OR ONE PLY OF GRADE 15 CUT TO THE SAME DIMENSIONS AS THE HOLE.

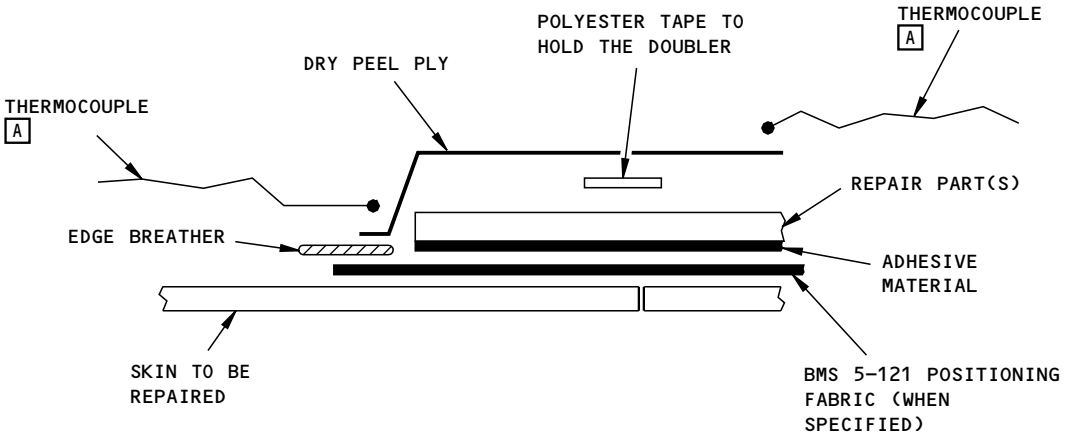
[E] DO NOT USE GRADE 15 FILM ADHESIVE IF THE DOUBLER TO BE BONDED IS ≤ 0.020 GAGE

[F] WHEN YOU DO A REPAIR THAT IS NOT CURED IN A PRESSURIZED AUTOCLAVE, USE BMS 5-121 POSITIONING FABRIC ON A SIDE THAT HAS AN EXTERNAL DOUBLER.

[G] IF OST IS INSTALLED WITH BMS 5-121 POSITIONING FABRIC, THEN PUT THE TACKY SIDE DOWN AGAINST THE POSITIONING FABRIC. IF OST IS INSTALLED WITHOUT POSITIONING FABRIC (WHEN THERE IS 64 SQUARE INCHES (400 SQUARE cm) OR LESS OF OPEN CORE) THEN PUT THE MAT SIDE DOWN AGAINST THE OPEN CORE.

Installation of the Repair Doubler
Figure 12 (Sheet 6)

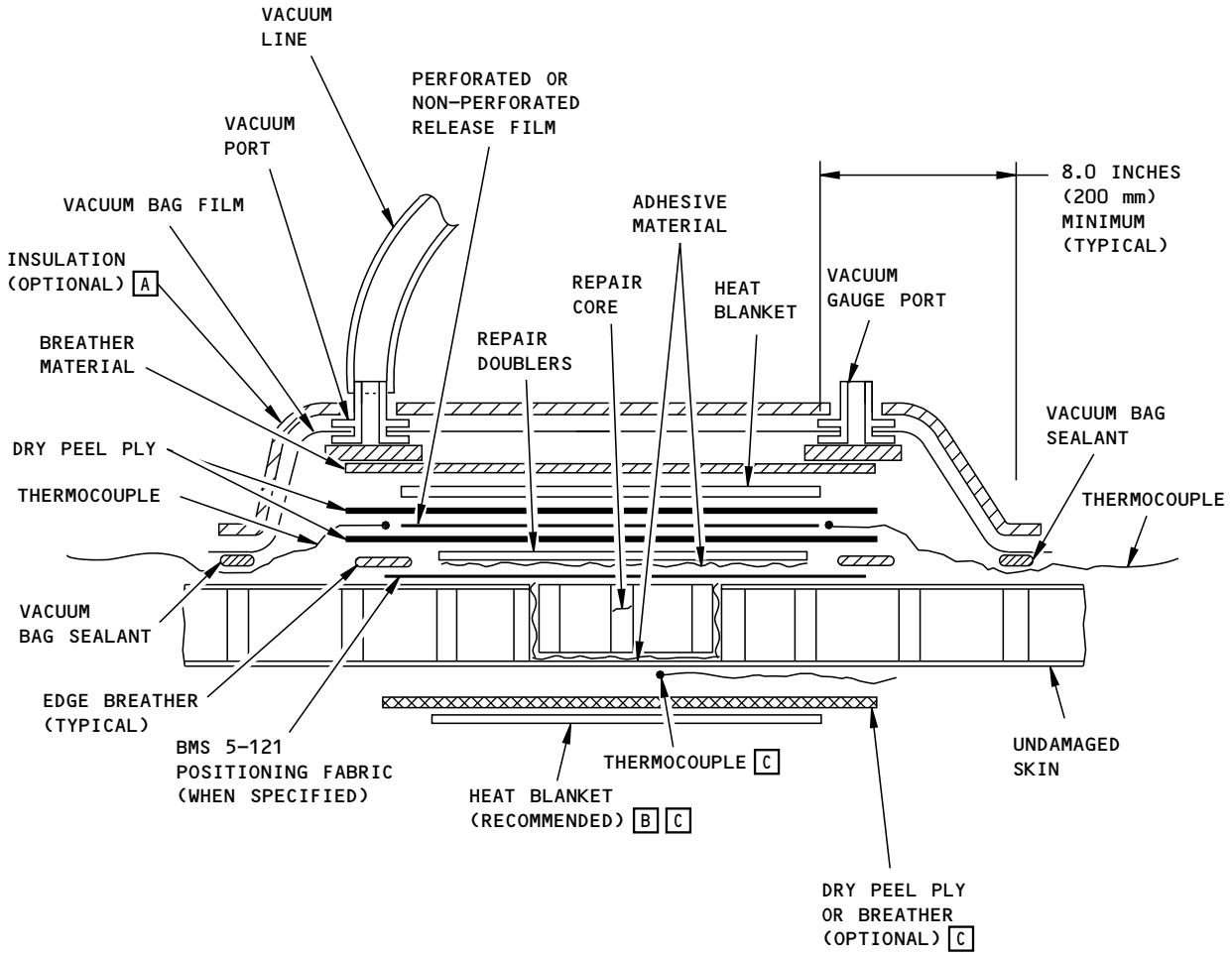




SECTION A-A

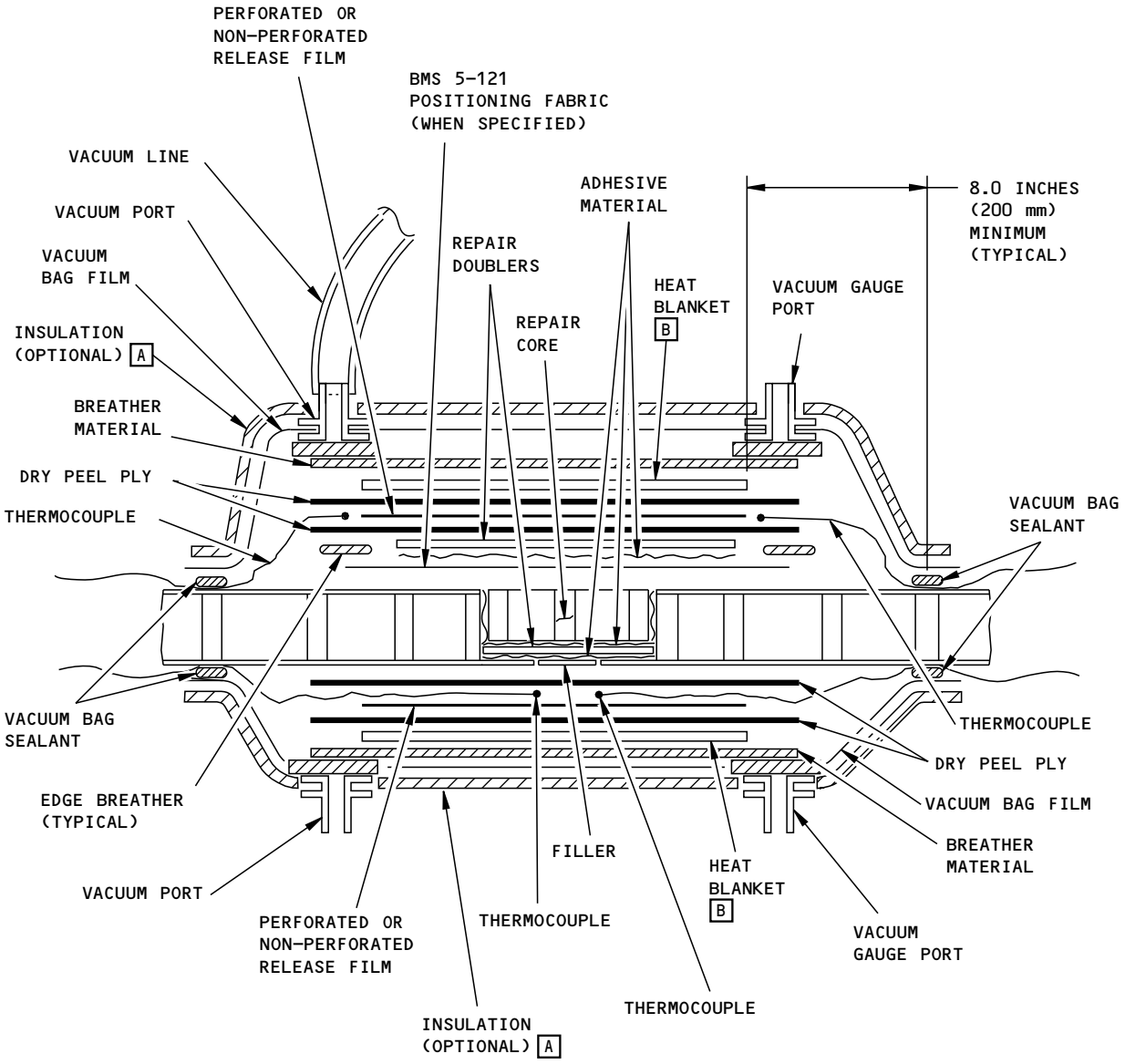
A REPAIRS MUST HAVE A MINIMUM OF ONE THERMOCOUPLE ABOVE THE REPAIR PART(S) AND TWO THERMOCOUPLES AT THE EDGES OF THE LARGEST REPAIR PART. ONE THERMOCOUPLE ABOVE THE REPAIR PART(S) FOR EVERY 36 SQUARE INCHES (0.025 SQUARE METERS) IS RECOMMENDED. SPACE THE THERMOCOUPLES EQUAL DISTANCES ABOVE AND AROUND THE REPAIR PART(S).

Thermocouple Locations
Figure 13



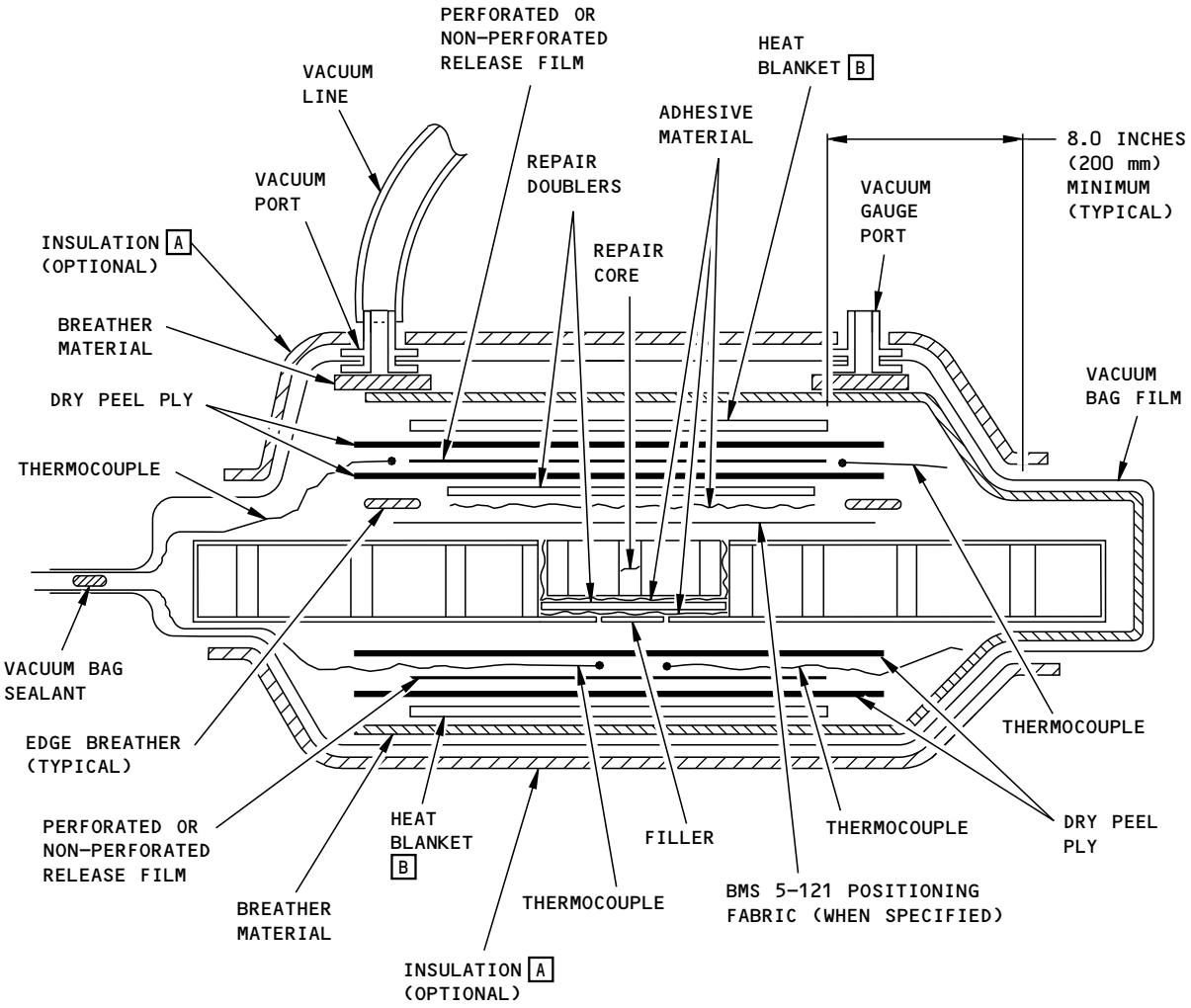
REPAIR OF DAMAGE TO ONE SIDE
DETAIL I

Layup of Vacuum Bagging Materials
Figure 14 (Sheet 1)



REPAIR OF DAMAGE TO BOTH SIDES
(SEPARATE VACUUM BAGS)
DETAIL II

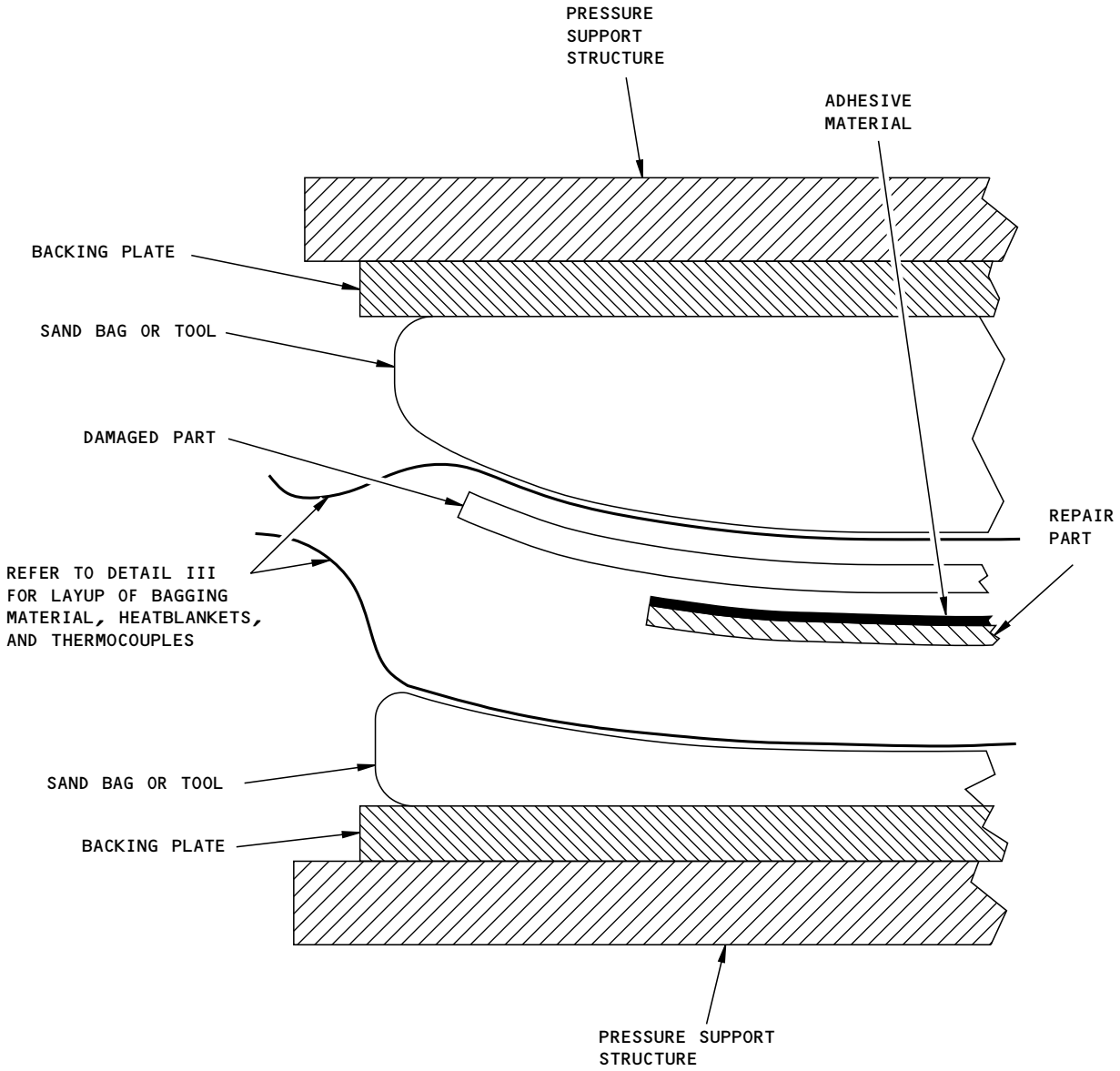
Layup of Vacuum Bagging Materials
Figure 14 (Sheet 2)



REPAIR OF DAMAGE TO BOTH SIDES
(ENVELOPE BAG)

DETAIL III

Layup of Vacuum Bagging Materials
Figure 14 (Sheet 3)



APPLICATION OF PRESSURE FOR ROUNDED OR CONTOURED PANELS

DETAIL IV

Layup of Vacuum Bagging Materials
Figure 14 (Sheet 4)

NOTES

- THIS FIGURE SHOWS THE LAYUP FOR A ONE STAGE CURE PROCEDURE. THE LAYUP FOR THE SECOND STAGE OF A TWO STAGE CURE PROCEDURE IS ALMOST THE SAME. REFER TO FIGURE 9 FOR THE INSTRUCTIONS TO DO THE FIRST STAGE OF A TWO STAGE CURE PROCEDURE.

[A] 4-8 PLIES OF BREATHER MATERIAL IS AN EXAMPLE. YOU CAN USE OTHER INSULATING MATERIALS ALSO. THIS WILL KEEP THE HEAT IN THE REPAIR AREA.

[B] YOU CAN USE THESE THERMOCOUPLES TO MAKE SURE THAT IF THE HEAT BLANKET GETS TOO HOT, YOU CAN TURN OFF THE POWER SUPPLY BEFORE YOU DAMAGE THE SKIN PANEL.

[C] IF YOU DO A TWO STAGE CURE PROCEDURE TO REPAIR THE CORE, REFER TO FIGURE 8 FOR THE FIRST STAGE OF THE PROCEDURE. IF YOU DO THE ONE STAGE CURE PROCEDURE, THEN YOU MUST HAVE ACCESS TO EACH SIDE OF THE HONEYCOMB PANEL.

- PUT A THERMOCOUPLE ON THE UNDAMAGED FACESHEET AT THE LOCATION OF THE REPAIR CORE. IT IS RECOMMENDED THAT YOU PUT A DRY PEEL PLY OR BREATHER AND HEAT BLANKET ABOVE THE THERMOCOUPLE ON THE UNDAMAGED SKIN.

TWO STAGE CURE PROCEDURE IS NECESSARY TO REPAIR THE CORE IF:

- THE DAMAGE IS LARGER THAN 64 SQUARE INCHES (0.041 SQUARE METERS) OR,
- IF YOU CAN NOT PUT A THERMOCOUPLE AT THE REPAIR CORE LOCATION ON EACH SIDE OF THE HONEYCOMB PANEL.

Layup of Vacuum Bagging Materials
Figure 14 (Sheet 5)

REPAIR OF A DISBOND AT AN EDGE OF ALUMINUM HONEYCOMB STRUCTURE

1. Applicability

   A. This procedure is a typical repair that is applicable to damage on the edge of an aluminum honeycomb panel.

2. General

   A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedure for each type of example.

   B. Refer to Fig. 1 for this procedure.

      (1) A disbond of a facesheet cannot be deeper than 0.50 inch (12.5mm) into the panel edgeband.

      (2) The cumulative (total) length of multiple disbonds cannot be longer than 30 percent of the length of the edge.

      (3) The initial adhesive primer (between the separated skins) must be satisfactory.

3. References

SRM 51-9-3	Repair General – Aluminum Honeycomb Repairs – 250°F (121°C) Cure
SRM 51-9-7	Repairs to Large Damage

4. Repair Procedures

   A. Find the limits of the damage. If you have cracks or corrosion to the edge, then refer to 51-9-7, for the repair instructions.

   B. Remove all of the water and other contamination, in and around the damaged area.

      NOTE: The area must be fully dry before you continue on with this repair procedure. If necessary, you can dry the area at a faster rate with an external heat source. Limit the temperature to a maximum of 150°F (66°C).

   C. Inspect the primer to make sure that it has not been damaged as given in 51-9-3, Par. 6.

   D. Prepare and apply a two part paste adhesive in the disbonded area as given in 51-9-3, Par. 19.

E. Use a clamp to hold the skins together. Use a light clamping pressure to hold the skins together.

NOTE: To apply the clamping pressure equally, use wood, metal, or phenolic wedges (or blocks, if more applicable) between the skin and clamps.

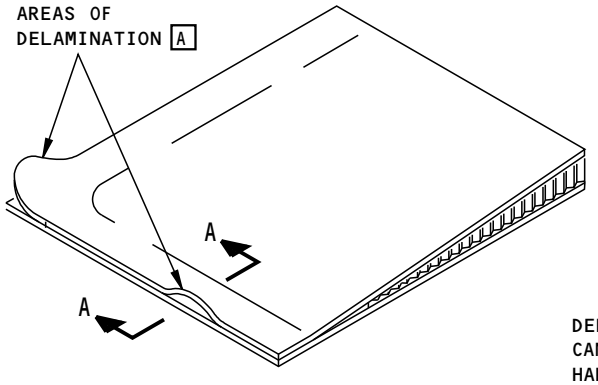
(1) Make sure that there is no air caught in-between the adhesive material and the skins.

(2) Remove unwanted adhesive material that can appear from the edge of the disbonded area.

F. Cure the repair as given in 51-9-3, Par. 20.

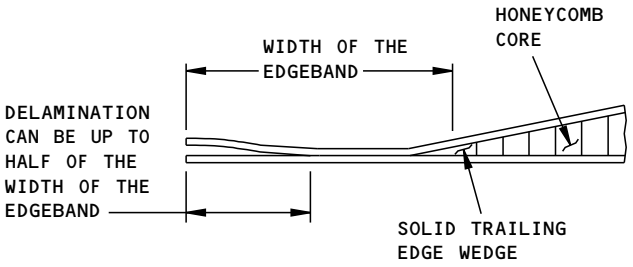
G. Examine the repair as given in 51-9-3, Par. 21.

H. Clean, seal and finish as given in 51-9-3, Par. 22.

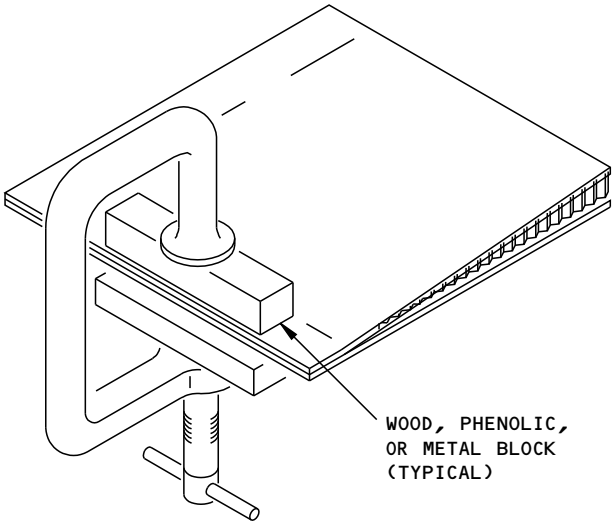


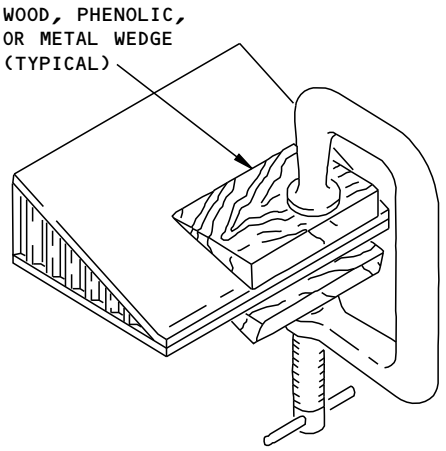
EXAMPLES OF
DELAMINATION

DETAIL I



SECTION A-A





EXAMPLES OF ALUMINUM SKINS THAT
ARE HELD TOGETHER WITH CLAMPS

DETAIL II

NOTES

[A] THE DISBOND MUST NOT GO INTO THE HONEYCOMB CORE. DISBONDS AT FASTENER HOLES ARE NOT PERMITTED. THE CUMULATIVE (TOTAL) LENGTH OF MULTIPLE DISBONDS MUST BE LESS THAN 30% OF THE LENGTH OF THE EDGEBAND.

Repair of Disbonds at an Edge
Figure 1

REPAIRS TO SMALL DAMAGE

1. Applicability

   A. This procedure has typical repairs that are applicable to dents, nicks, creases, gouges, cracks and small holes on one side of an aluminum honeycomb sandwich structure. Refer to 51-10-1 for the damage definitions.

      NOTE: These repairs are limited to damage that is 2.0 inches (50 mm) or less in length and diameter. These repairs are interim when paste adhesive is used. Inspect past adhesive repairs each 24 months or less, or each 3500 flight cycles or less (no later than the interval that occurs first). Refer to Fig. 1 for other repair options.

   B. Refer to 51-9-7 for all damage that is larger than 2.0 inches (50 mm) in length and diameter.

2. General

   A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedure for each type of example.

   B. Proximity of repairs.

      (1) Repair doublers must be a minimum of 2.0 inches (50 mm) apart, edge to edge.

      (2) If a repair doubler will be closer than 2.0 inches (50 mm) to an adjacent repair doubler, then use one doubler for the multiple damage areas.

         NOTE: If the repair doubler will be too close to a doubler from an old repair, then you can remove the old doubler. Then use one large doubler for the old damage and the new damage.

   C. Refer to 51-9-3, Fig. 1 for repair sizes and options.

      (1) Refer to Fig. 1 for the layout of a dent repair.

      (2) Refer to Fig. 2 for the layout of a repair to a nick, gouge or crack in the skin.

      (3) Refer to Fig. 3 for the layout of a small hole repair.

   D. Refer to 51-9-3, Table 3 for the cure information for the adhesive.

3. References

SRM 51-9-3	Repair General - Aluminum Honeycomb Repairs - 250°F (121°C) Cure
SRM 51-9-7	Repairs to Large Damage
SRM 51-13-1	Inspection and Removal of Damage
NDT Part 1, 51-04-00	Ultrasonic Bond Inspection of Metal-to-Metal Bonding and Honeycomb Structures
NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure

4. Repair Instructions

A. Do a non-destructive inspection (NDI) to find the limits of the visible damage. If there is delaminated skin then cut out the damaged area and do a hole repair. Refer to NDT Part 1, 51-05-01 or NDT Part 1, 51-04-00.

B. Remove the surface finish and all contamination as specified in 51-9-3.

C. Repair to a surface that has a crack.

(1) Stop drill the ends of cracks as specified in 51-13-1.

(2) If there is an adhesive primer on the surface then do an inspection as specified in 51-9-3, par. 6.B. If the primer is in a satisfactory condition, then permit the primer to remain. Clean the primer as specified in 51-9-3, par. 6.B.

(3) If there is no adhesive primer, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in 51-9-3, par. 11.

D. Repair to a surface that has a small hole.

(1) Remove the damaged skin and core.

(2) The maximum size of a hole that can be filled with potting compound is 1.0 inch (25 mm) in diameter. If the hole is larger than 1.0 inch (25 mm), then make and install a repair core as specified in 51-9-3, par. 8, and 51-9-3, par. 9.

(3) If there is an adhesive primer on the surface then do an inspection as specified in 51-9-3, par. 6.B. If the primer is in a satisfactory condition, then permit the primer to remain. Clean the primer as specified in 51-9-3, par. 6.B.

(4) If there is no adhesive primer, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in 51-9-3, par. 11.

E. Repair of dents.

(1) If the depth of a dent is equal or deeper than two times the skin thickness, then the dent repair is time-limited. Remove the doubler at 24 months (or less) or each 3500 flight cycles or less (no later than the interval that occurs first) and do a hole repair.

(2) Apply strong finger pressure to the damaged area to see if the core compresses. If the core compresses, then the dent repair is time-limited. Remove the doubler at 24 months (or less) or each 3500 flight cycles or less (no later than the interval that occurs first) and do a hole repair.

(3) If there is an adhesive primer on the surface then do an inspection as specified in 51-9-3, par. 6.B. If the primer is in a satisfactory condition, then permit the primer to remain. Clean the primer as specified in 51-9-3, par. 6.B.

(4) Fill the dent. Do one of the procedures that follow:

(a) Potting compound procedure.

1) Abrade the area of the dent with 180 grit sandpaper. Fill with BMS 5-28, Type 6 or 7 potting compound.

2) Cure as specified in 51-9-3, Table 3.

3) Abrade the potting compound until it is flush with the undamaged skin. If there is adhesive primer on the surface to be bonded, do not damage the primer during the sanding procedure.

4) If there is no adhesive primer on the surface to be bonded, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in 51-9-3, par. 11.

(b) Paste adhesive procedure.

1) If there is no adhesive primer on the surface to be bonded, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in 51-9-3, par. 11.

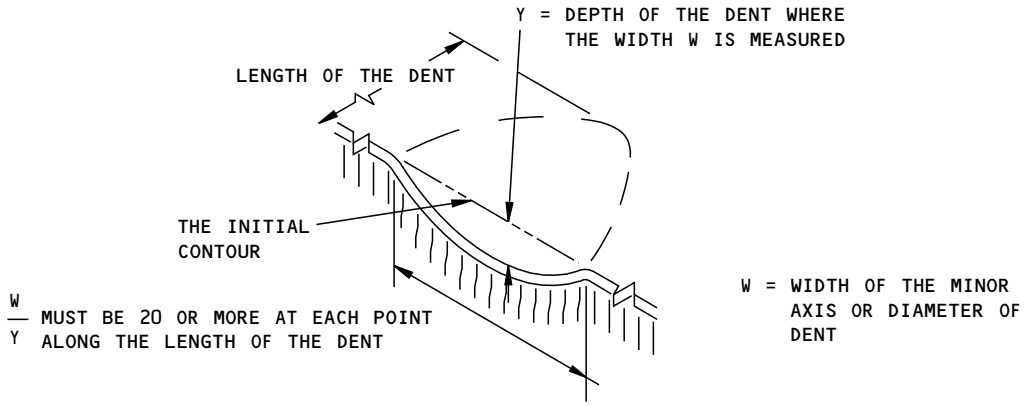
2) Fill the dent with the same paste adhesive that will be used to bond the doubler.

(c) Film adhesive procedure.

1) If there is no adhesive primer on the surface to be bonded, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in 51-9-3, par. 11.

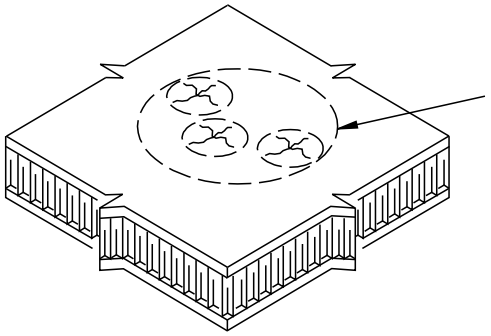
2) Fill the dent with the same film adhesive that will be used to bond the doubler. You can add BMS 5-121 positioning fabric to the adhesive inside the dent, (if necessary).

F. Refer to 51-9-3 for the bonding procedure and other repair steps.

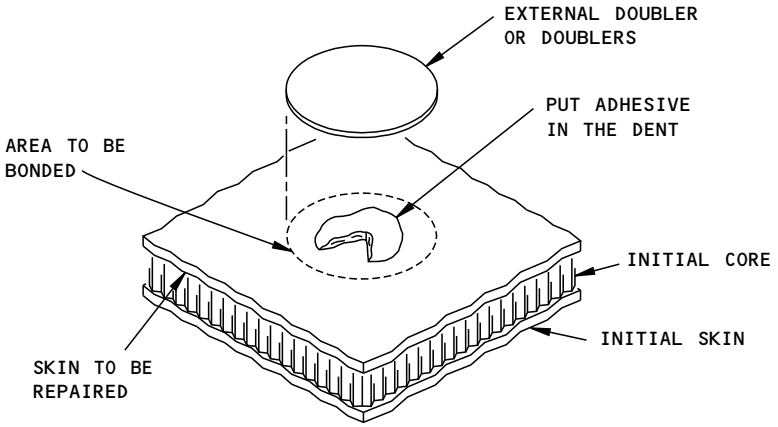


DENT THAT IS PERMITTED IN METAL HONEYCOMB STRUCTURE

DETAIL I



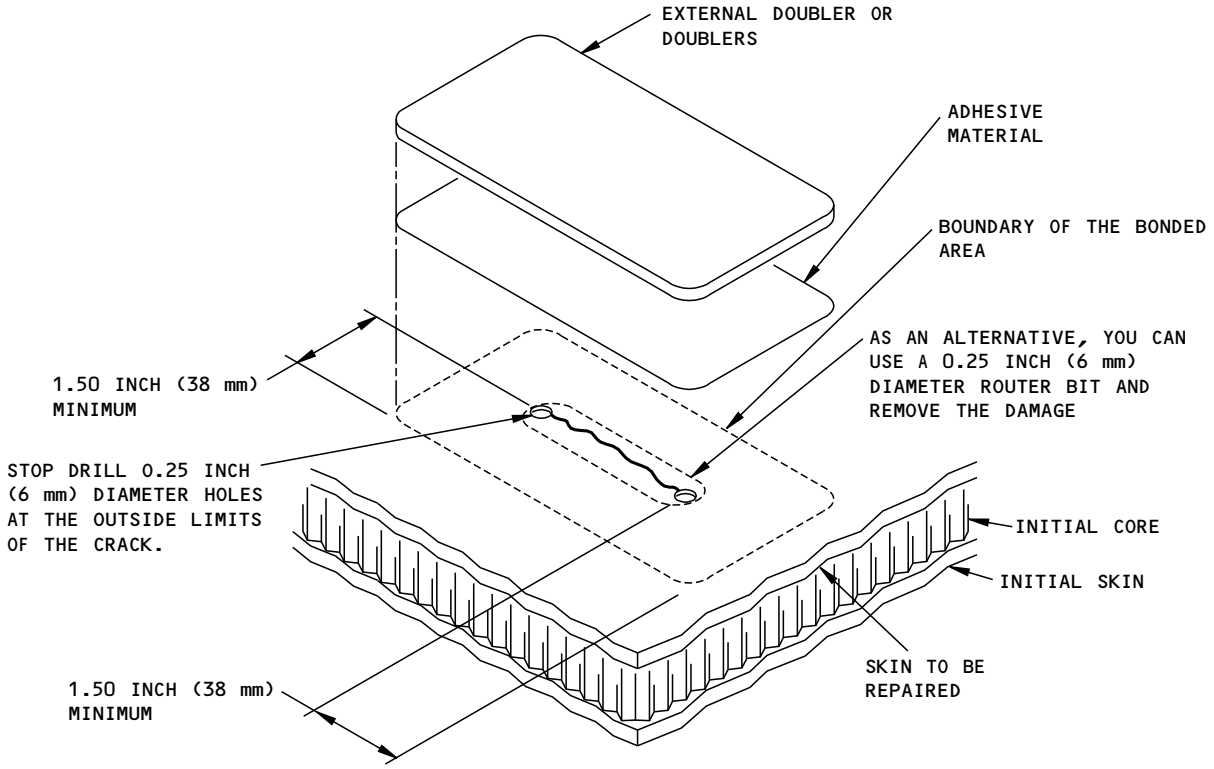
DETAIL II



LAYOUT OF THE REPAIR PARTS

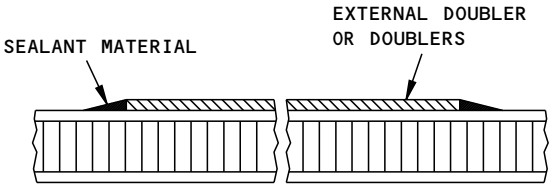
DETAIL III

External Doubler Repair of a Dent
Figure 1



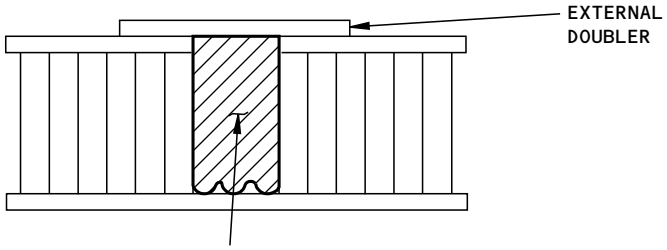
LAYOUT OF THE REPAIR PARTS

DETAIL I



SECTION THROUGH THE REPAIR
(TYPICAL)

External Doubler Repair of a Nick, Gouge, or Crack in the Skin
Figure 2

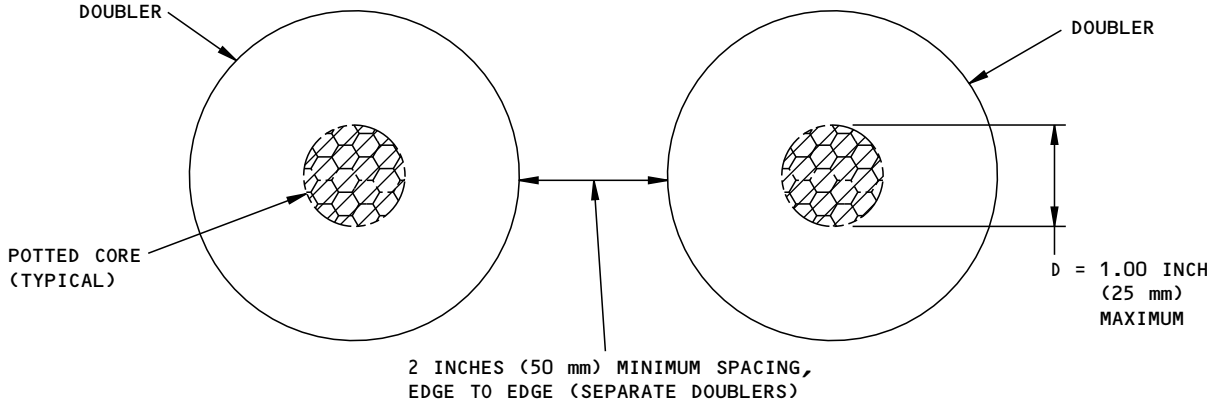


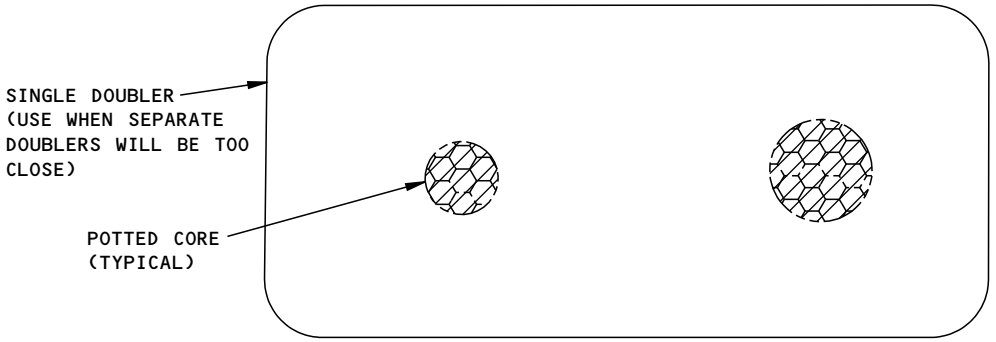
FILL THE CORE CELLS WITH BMS 5-28 TYPE 6 OR 7 POTTING COMPOUND

MAKE THE CELL WALLS STRAIGHT, OR CUT OUT THE CORE IF NECESSARY, TO MAKE IT EASY TO APPLY THE POTTING COMPOUND

PERMITTED DEPTH OF POTTING COMPOUND

DETAIL I





PERMITTED SPACING OF POTTED AREAS

DETAIL II

Potted Core Repair for Small Damage
Figure 3

SEPTUMIZED CORE REPAIRS

1. Applicability

   A. This procedure is an alternative to the full depth honeycomb core repair.

   B. This repair uses a septum:

      (1) To bond a partial depth core to an initial core, or

      (2) To bond two separate cores together to make a full depth core.

2. General

   A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example.

   B. Refer to 51-9-3 and 51-9-7, to repair the removed skin.

   C. Refer to Fig.1 for the configuration of the repair parts in a partial depth core replacement.

   D. Refer to Fig. 3 for the configuration of the repair parts in a full depth core replacement.

3. References

51-9-2	Glass Fabric Reinforced Epoxy and Phenolic Laminates Repair
51-9-3	Repair General – Aluminum Honeycomb Repairs – 250°F (121°C) Cure
51-9-7	Repairs to Large Damage
51-11-1	Glass Fabric Strengthened Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs – 250°F (121°C) Cure

4. Remove the Damage

   A. Find the size limits for the damage as given in 51-9-3, par. 6.

   B. Remove the damage as given in 51-9-3, par. 7.

      (1) If the core material removed is less than 1/3 the full depth of the core, then remove a sufficient quantity of the core so that the repair septum will be located at a depth of 1/3 to 2/3 the full depth of the core. Then do the steps in par. 5.

      (2) If the core material removed is more than 2/3 the full depth of the core, then do one of the steps that follow:

         (a) Do the full depth septumized core steps in par. 6. or,

         (b) Do a full depth core repair steps as specified in 51-9-3, par. 9.

5. Partial Depth Septumized Core Repair

NOTE: This repair is cured in two stages.

A. Make the repair septum from pre-cured BMS 9-3 glass fabric impregnated with BMS 8-301 Class I epoxy resin, or pre-cured BMS 8-79 glass fabric reinforced plastic (GFRP) laminate or an aluminum alloy sheet. Make the septum the same size as the hole in the component to be repaired.

(1) Refer to 51-11-1 to make pre-cured GFRP.

(a) Lightly abrade the surface resin with 180-grit or finer abrasive paper to remove the glossy surface from the pre-cured GFRP.

(b) Do not sand into the glass fibers.

(2) If you use an aluminum sheet septum, then refer to 51-9-3 and do the steps that follow:

NOTE: Do not use clad 7000 series alloy aluminum as a septum.

(a) Do a surface preparation on each side of the septum, then

(b) Put an adhesive primer on each side of the septum.

B. Make the honeycomb repair core. Refer to 51-9-3, par. 8.

C. Apply the adhesive materials. Refer to Fig. 1 for the applicable adhesive and the steps that follow:

(1) Put film adhesive into the hole. Refer to 51-9-3, par. 9.

(2) Put the septum in the hole.

(3) Put a layer of film adhesive on the septum as specified in Fig. 1.

(4) Install the honeycomb repair core. Refer to 51-9-3, par. 9.

D. Do the first stage of the two stage cure. Refer to 51-9-3, par. 9.

E. Do a visual inspection of the repair area after the cure is completed and the thermocouples have been removed.

(1) Look for areas of disbond in the adhesive bond between the repair core and the initial core. There must be no gaps or disbonds in these areas.

NOTE: If you find disbonds in the adhesive surface, then fill them with BMS 5-28, Type 6 or Type 7 potting compound. Cure the BMS 5-28 potting compound during the final stage of the cure.

(2) Look for disbonds in the adhesive materials between the septum and the repair core.

(a) If the diameter of the repair septum is larger than 2.0 inches, (50 mm) and you find disbands that are larger than 3/8 inch (10 mm) in diameter, then the repair is not satisfactory.

(b) If the diameter of the repair septum is less than 2.0 inches (50 mm), then no visible disbonds are permitted.

6. Full Depth Septumized Core Repair

NOTE: This repair is cured in three stages.

A. Cut two pieces of honeycomb core that are a minimum of 1.0 inch (25 mm) diameter larger than the hole in the component to be repaired.

B. Each piece of honeycomb core must be a minimum of 1/3 the depth of the hole and a maximum of 2/3 the depth of the hole.

C. The core/septum assembly must be higher than the depth of the hole.

NOTE: This will permit you to abrade the top of the core to make it flush with the skin surface.

D. Make the repair septum from pre-cured BMS 9-3 glass fabric impregnated with BMS 8-301 Class I epoxy resin, or pre-cured BMS 8-79 glass fabric reinforced plastic (GFRP), or an aluminum alloy sheet.

NOTE: Make the septum approximately the same size as the repair core blankets.

(1) Refer to 51-9-2 or 51-11-1 to make pre-cured GFRP laminate.

(a) Lightly abrade the surface resin of the cured GFRP laminate with180-grit or finer abrasive paper to remove the glossy surface.

(b) Do not sand into the glass fibers.

(2) If you use an aluminum sheet septum, then refer to 51-9-3 and do the steps that follow:

NOTE: Do not use clad 7000 series alloy aluminum as a septum.

(a) Do a surface preparation on each side of the septum, then

(b) Put an adhesive primer on each side of the septum.

E. Apply the adhesive materials. Refer to Fig. 2 for the applicable adhesive and the steps that follow:

(1) Put film adhesive on the mating surface of the first honeycomb core blanket that you will bond the septum to.

(2) Put the septum on the first honeycomb core blanket.

(3) Put film adhesive on the septum.

(4) Put the second honeycomb core blanket on to the septum. Make sure that the ribbon direction is the same as the bottom core.

F. Cure the honeycomb core/septum assembly. Refer to Fig. 2.

(1) Put the assembly on a clean, hard, and flat surface.

(2) Put edge support blocks against the edges of the assembly.

(3) Do the vacuum bag layup.

(4) Cure the assembly as specified in 51-11-1, if the GFRP septum is used or 51-9-3, par. 20. if the aluminum septum is used.

G. Cut the core/septum assembly to the necessary shape. (A core cylinder, for example).

H. Look for disbonds in the adhesive materials between the septum and the two honeycomb repair cores.

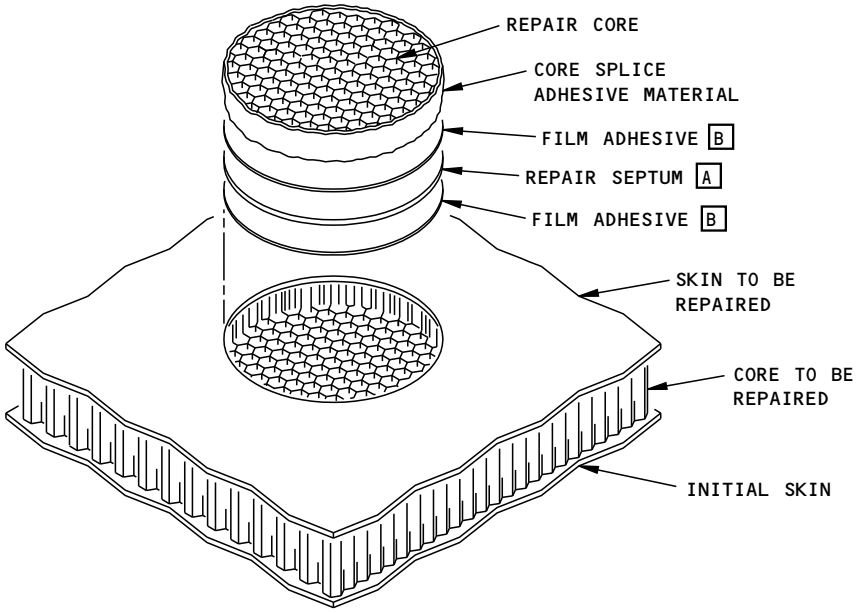
(1) If the diameter of the repair septum is larger than 2.0 inches, (50 mm) and you find disbonds that are larger than 3/8 inch (10 mm) in diameter, then the repair is not satisfactory.

(2) If the diameter of the repair septum is less than 2.0 inches (50 mm), then no visible disbonds are permitted.

I. Install the honeycomb repair core/septum assembly and do the second stage of the three stage cure. Refer to 51-9-3, par. 9.

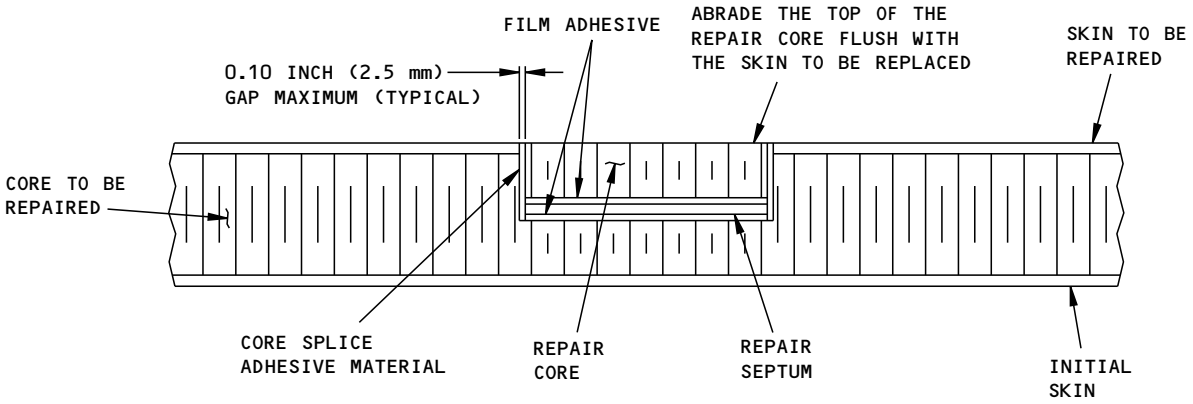
7. Complete the Repair

A. Complete the repair as specified in 51-9-3 and 51-9-7.



LAYOUT OF THE REPAIR PARTS

DETAIL I



SECTION THROUGH THE CENTER OF THE REPAIR AREA

Bonded Doubler Repair That Uses an Internal Septum For a Less Than Full Depth Core Replacement
Figure 1 (Sheet 1)

NOTES

- REFER TO 51-9-3 FOR REPAIR CORE INSTALLATION PROCEDURES.

[A] MAKE THE SEPTUM OUT OF PRE-CURED GLASS FABRIC REINFORCED PLASTIC (GFRP) LAMINATE OR AN ALUMINUM ALLOY SHEET:

A. TO MAKE A RE-CURED GFRP LAMINATE FROM DRY FABRIC, REFER TO 51-9-2. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- IMPREGNATE AND THEN CURE TWO PLIES OF BMS 9-3, TYPE H-2 GLASS FABRIC AND BMS 8-301, CLASS I EPOXY RESIN, OR
- IMPREGNATE AND THEN CURE THREE PLIES OF BMS 9-3, TYPE D GLASS FABRIC AND BMS 8-301. CLASS I EPOXY RESIN.

B. TO MAKE A PRE-CURED GFRP PREPREG LAMINATE, REFER TO 51-11-1. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- TWO PLIES OF BMS 8-79, CLASS III, STYLE 1581 OR 7781, OR
- THREE PLIES OF BMS 8-79, CLASS III, STYLE 120 OR 220.

C. TO MAKE AN ALUMINUM ALLOY SHEET SEPTUM, USE 0.012 - 0.020 INCH THICK ALUMINUM.

- USE THE SAME BOEING MATERIAL SPECIFICATION (BMS) ALUMINUM MATERIAL, (OR AN EQUIVALENT ALUMINUM MATERIAL). USE THE SAME (OR SIMILAR) HEAT-TREAT AS THE INITIAL ALUMINUM SKIN THAT IS TO BE REPAIRED.
- DO NOT USE 7000 SERIES ALUMINUM THAT HAS A CLAD SURFACE. IF THE SKIN TO BE REPAIRED IS A CLAD 7000 SERIES ALUMINUM, THEN USE AN UNCLAD 7000 SERIES ALUMINUM.

[B] APPLY THE ADHESIVE MATERIALS TO THE TWO MATING SURFACES OF THE REPAIR SEPTUM AS FOLLOWS:

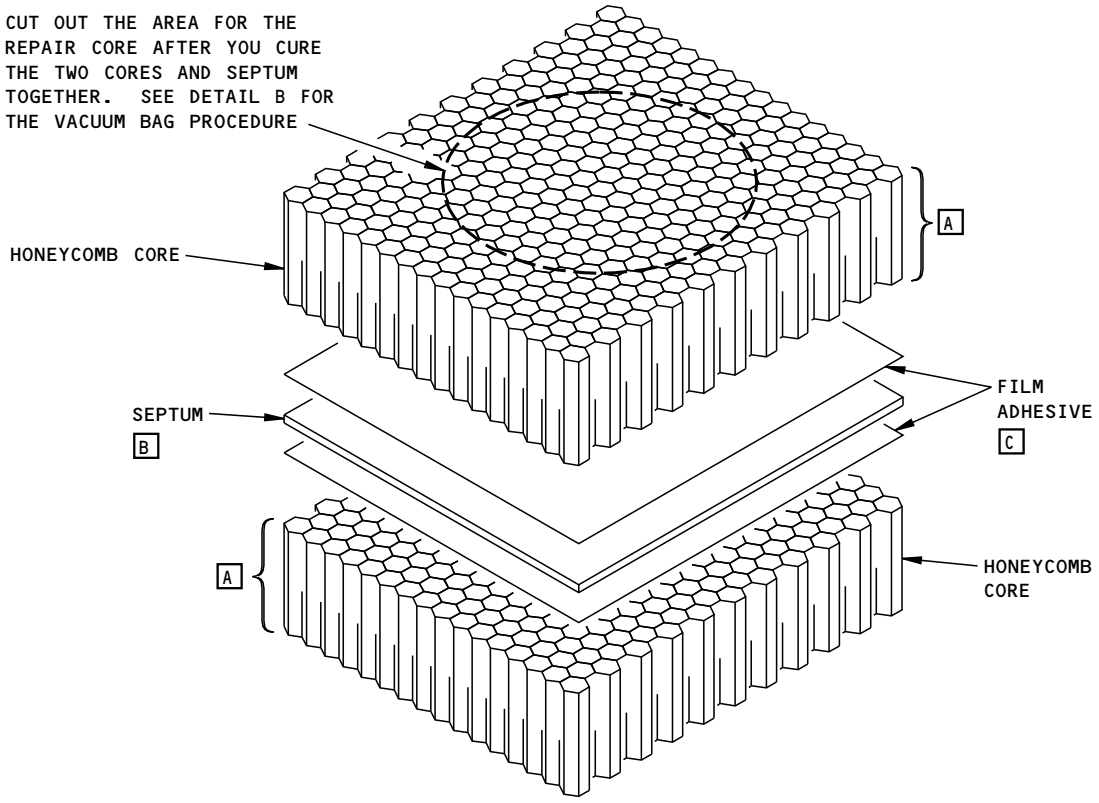
A. FOR THE PRE-CURED GFRP SEPTUM:

- APPLY TWO LAYERS OF BMS 5-129, TYPE IV, GRADE 10 ADHESIVE FILM.

B. FOR THE ALUMINUM SEPTUM:

- APPLY TWO LAYERS OF BMS 5-101, GRADE 10 OR ONE LAYER OF BMS 5-101, GRADE 15 ADHESIVE FILM.

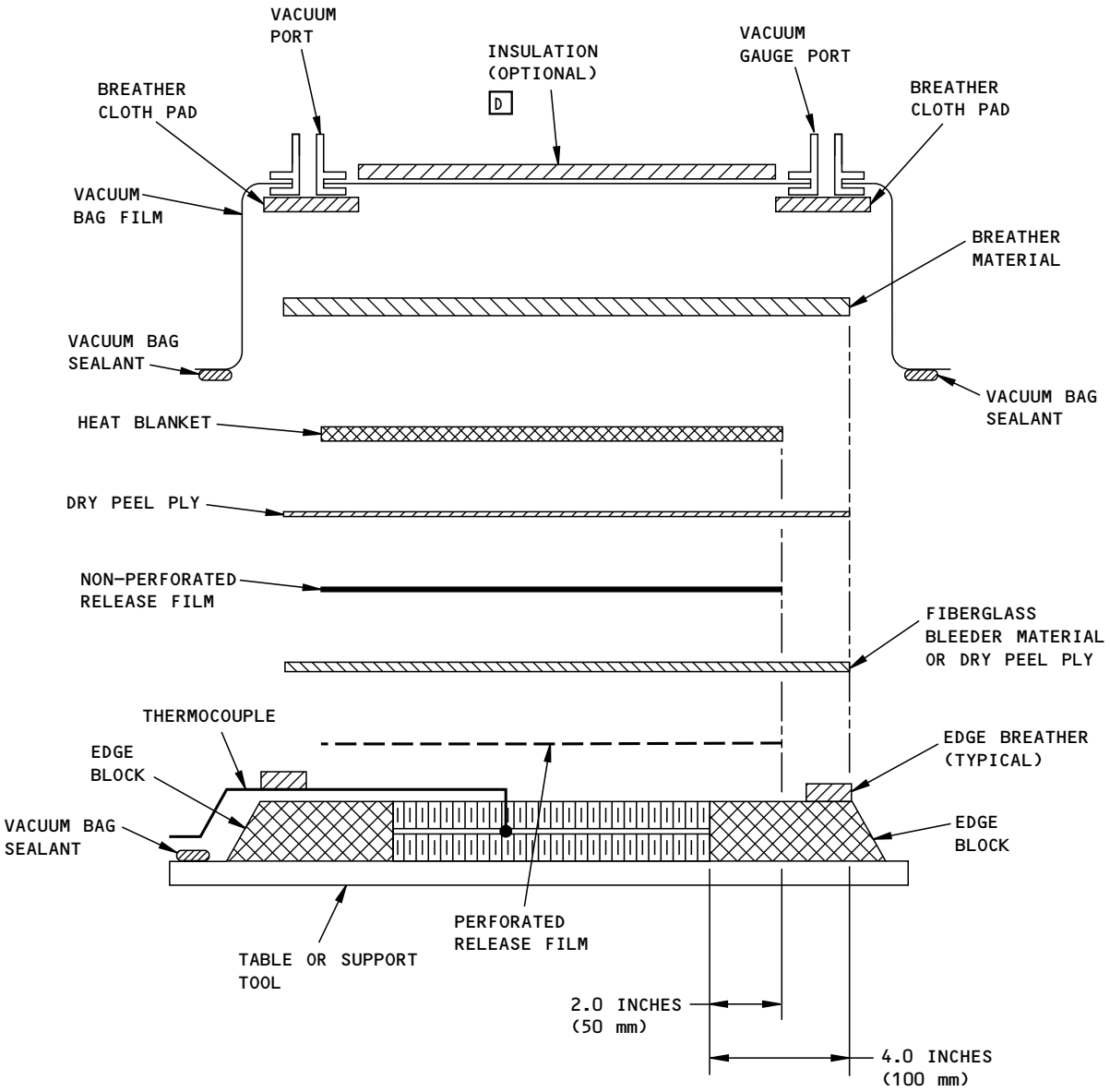
Bonded Doubler Repair That Uses an Internal Septum For a Less Than Full Depth Core Replacement
Figure 1 (Sheet 2)



LAYOUT OF THE CORE SEPTUM ASSEMBLY

DETAIL I

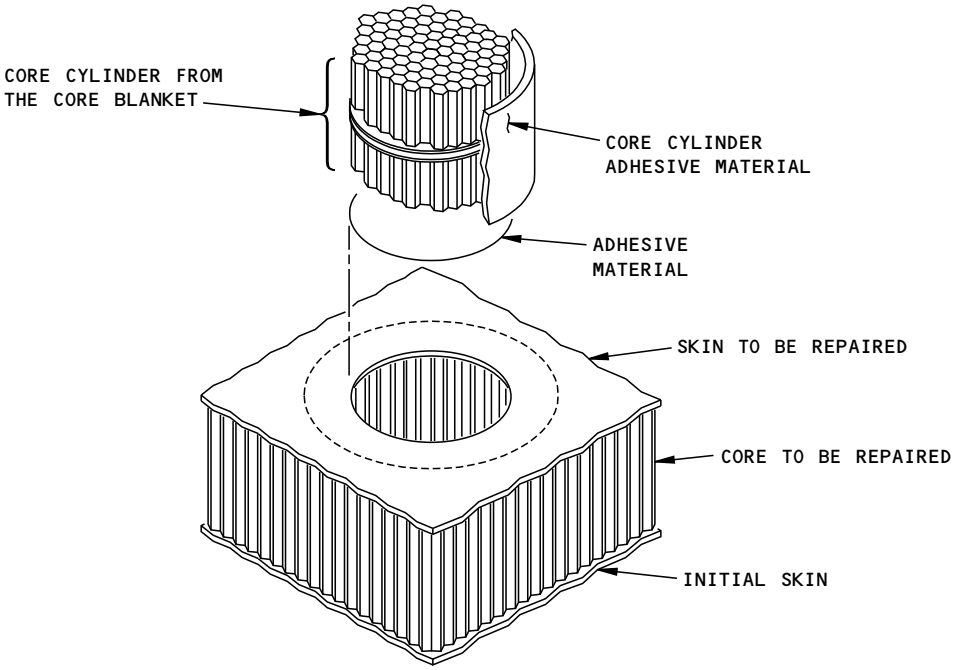
Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 2 (Sheet 1)



VACUUM BAG PROCEDURE

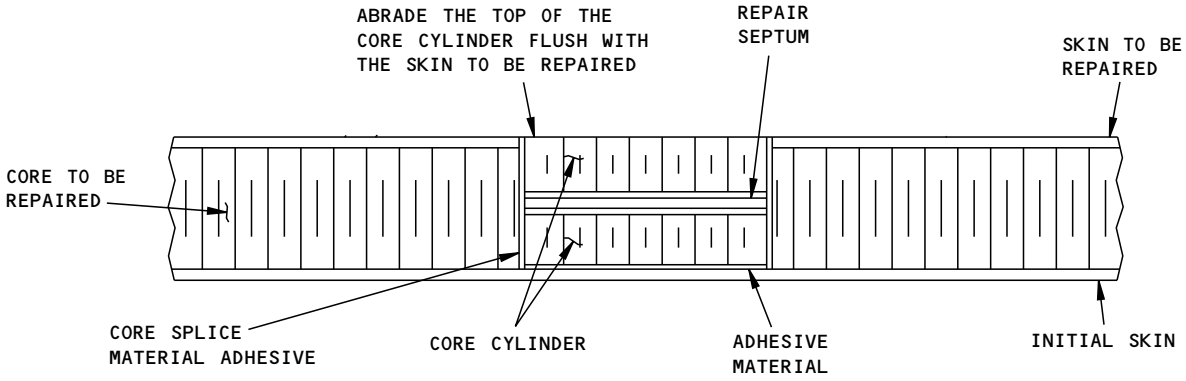
DETAIL II

Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 2 (Sheet 2)



LAYOUT OF THE REPAIR PARTS FOR DAMAGE
TO FULL DEPTH CORE AND ONE SKIN

DETAIL III



SECTION THROUGH THE CENTER OF THE REPAIR AREA

Bonded Doubler Repair That Uses Two Cores and an
Internal Septum for Full Core Replacement
Figure 2 (Sheet 3)

NOTES

- REFER TO 51-9-3 FOR REPAIR CORE INSTALLATION PROCEDURES.

[A] THE HEIGHT OF EACH CORE MUST BE A MINIMUM OF 1/3 THE DEPTH OF THE HOLE AND A MAXIMUM OF 2/3 THE DEPTH OF THE HOLE.

[B] MAKE THE SEPTUM OUT OF PRE-CURED GLASS FABRIC REINFORCED PLASTIC (GFRP) LAMINATE OR AN ALUMINUM ALLOY SHEET:

A. TO MAKE A PRE-CURED GFRP LAMINATE FROM DRY FABRIC, REFER TO SRM 51-9-2. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- IMPREGNATE AND THEN CURE TWO PLIES OF BMS 9-3, TYPE H-2 GLASS FABRIC AND BMS 8-301, CLASS I EPOXY RESIN, OR
- IMPREGNATE AND THEN CURE THREE PLIES OF BMS 9-3, TYPE D GLASS FABRIC AND BMS 8-301, CLASS I EPOXY RESIN.

B. TO MAKE A PRE-CURED GFRP PREPREG LAMINATE, REFER TO SRM 51-11-1. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- TWO PLIES OF BMS 8-79, CLASS III, STYLE 1581 OR 7781, OR
- THREE PLIES OF BMS 8-79, CLASS III, STYLE 120 OR 220.

C. TO MAKE AN ALUMINUM ALLOY SHEET SEPTUM, USE 0.012 - 0.020 INCH THICK ALUMINUM.

- USE THE SAME BOEING MATERIAL SPECIFICATION (BMS) ALUMINUM MATERIAL, (OR AN EQUIVALENT ALUMINUM MATERIAL). USE THE SAME (OR SIMILAR) HEAT-TREAT AS THE INITIAL ALUMINUM SKIN THAT IS TO BE REPAIRED.
- DO NOT USE 7000 SERIES ALUMINUM THAT HAS A CLAD SURFACE. IF THE SKIN TO BE REPAIRED IS A CLAD 7000 SERIES ALUMINUM, THEN USE AN UNCLAD 7000 SERIES ALUMINUM.

[C] APPLY THE ADHESIVE MATERIALS TO THE TWO MATING SURFACES OF THE REPAIR SEPTUM AS FOLLOWS:

A. FOR THE PRE-CURED GFRP SEPTUM:

- APPLY TWO LAYERS OF BMS 5-129, TYPE IV, GRADE 10 ADHESIVE FILM.

B. FOR THE ALUMINUM SEPTUM:

- APPLY TWO LAYERS OF BMS 5-101, GRADE 10 OR ONE LAYER OF BMS 5-101, GRADE 15 ADHESIVE FILM.

[D] 4-8 PLIES OF BREATHER MATERIAL FOR EXAMPLE. YOU CAN USE OTHER INSULATION MATERIALS ALSO. THIS WILL KEEP THE HEAT IN THE REPAIR AREA.

Bonded Doubler Repair That Uses Two Cores and an
Internal Septum for Full Core Replacement
Figure 2 (Sheet 4)

REPAIRS TO LARGE DAMAGE

1. Applicability

   A. Repair 4 has typical repairs for aluminum honeycomb sandwich structure with large damage.

   B. In these repairs, it will be necessary to remove and replace the damaged area of the skin and/or core.

2. General

   A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example.

   B. If you have damage to the skin and core away from the edge, then refer to Fig. 1 for the layout of the repair parts.

   C. If you have damage at the edge, then refer to Fig. 2 for the layout of the repair parts.

   D. If you have damage from an edge to an edge, then refer to Fig. 3 for the layout of the repair parts.

3. References

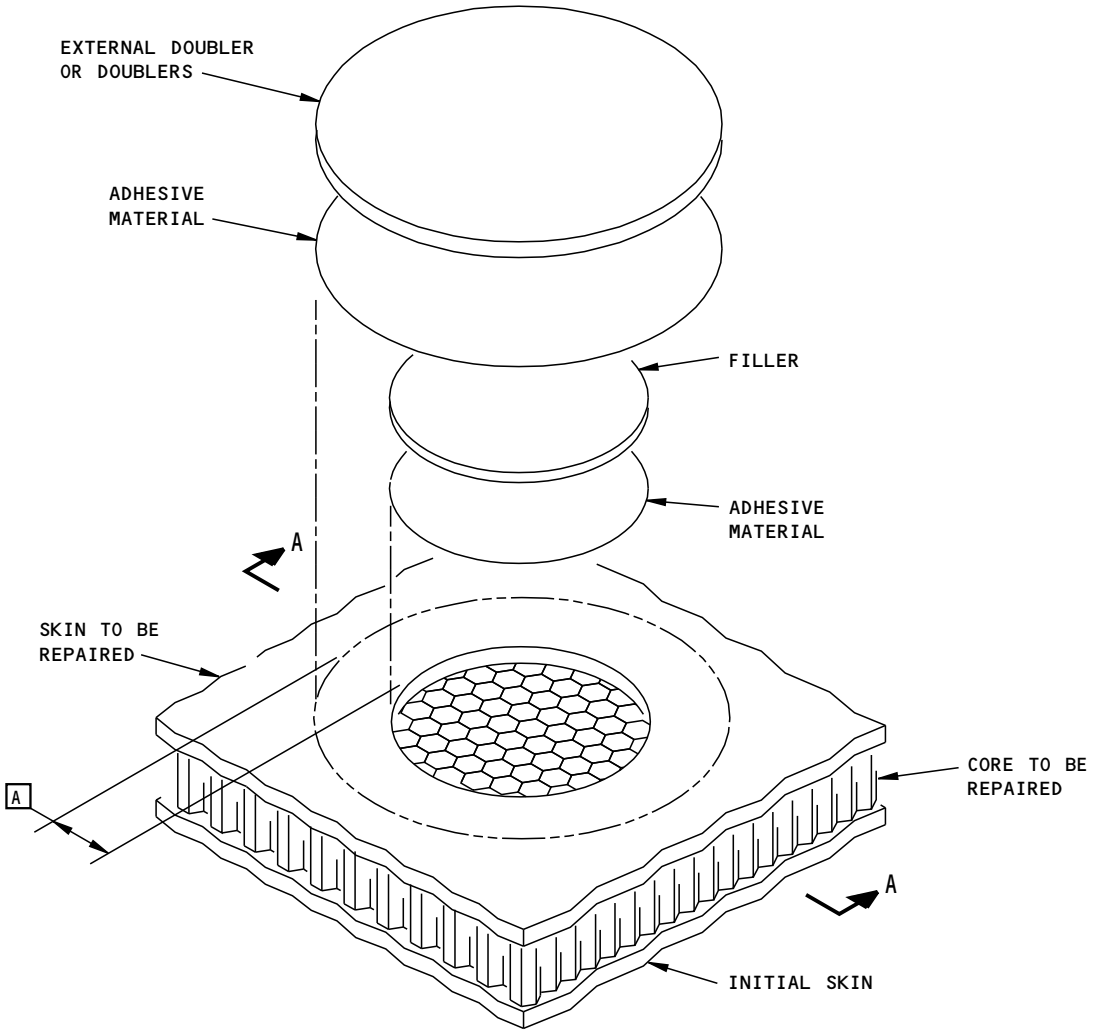
SRM 51-9-3	Repair General – Aluminum Honeycomb Repairs – 250°F (121°C) Cure

4. Repair Instructions

   A. Find and remove the damage as specified in 51-9-3, par. 6 and par. 7.

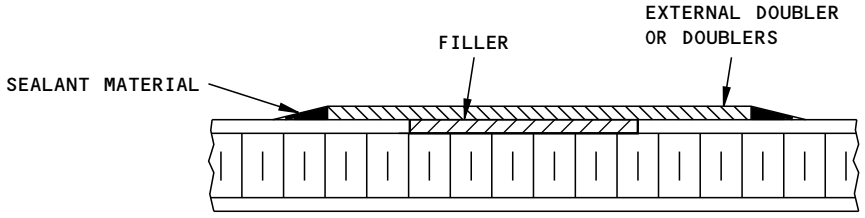
   B. Refer to the component engineering drawings or use NDI procedures to find the locations of internal doublers and other repairs. Refer to the repair figures for the doubler thicknesses and overlaps to use when cutouts are near a panel edgeband.

   C. Refer to 51-9-3 for the repair steps.



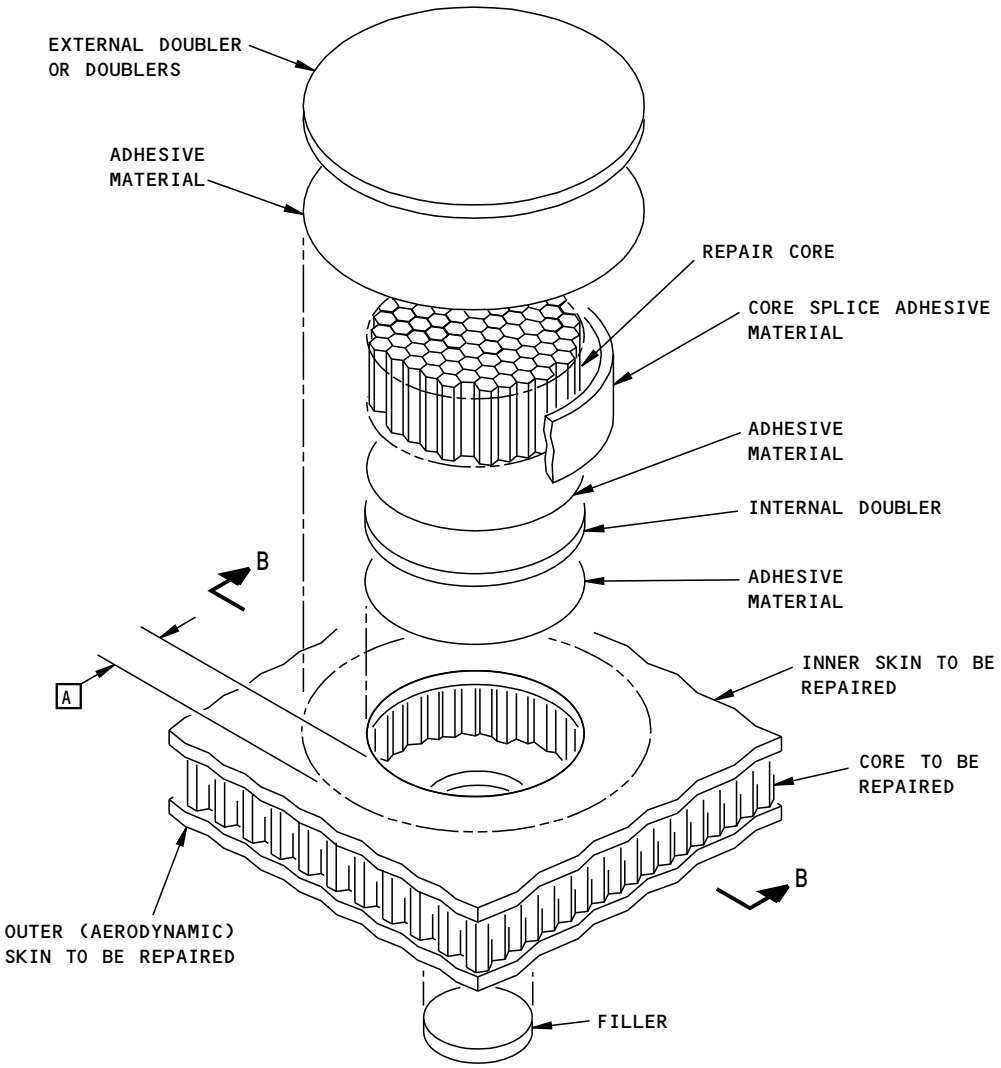
EXTERNAL DOUBLER AND FILLER REPAIR TO ONE SKIN

DETAIL I

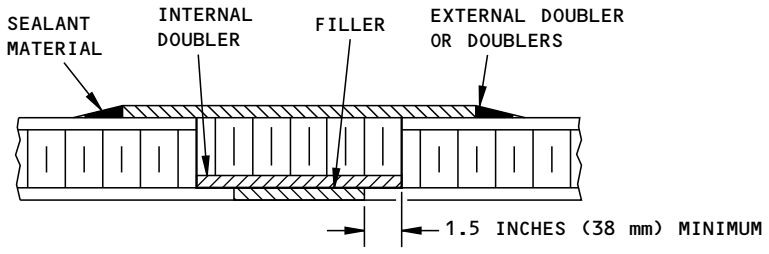


SECTION A-A

Repair of Damage Away From the Panel Edges
Figure 1 (Sheet 1)

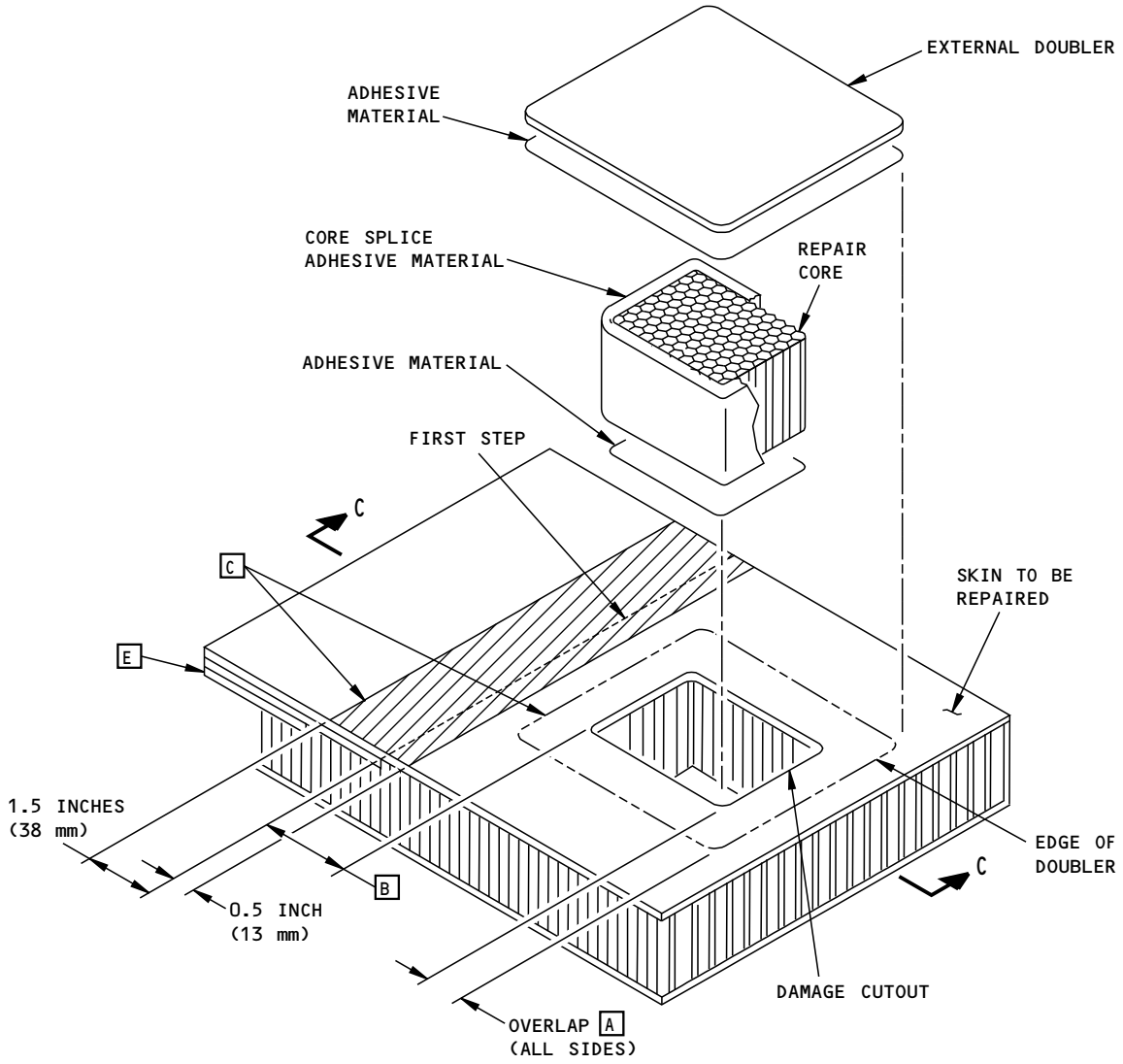


REPAIR TO CORE AND TWO SKINS
DETAIL II

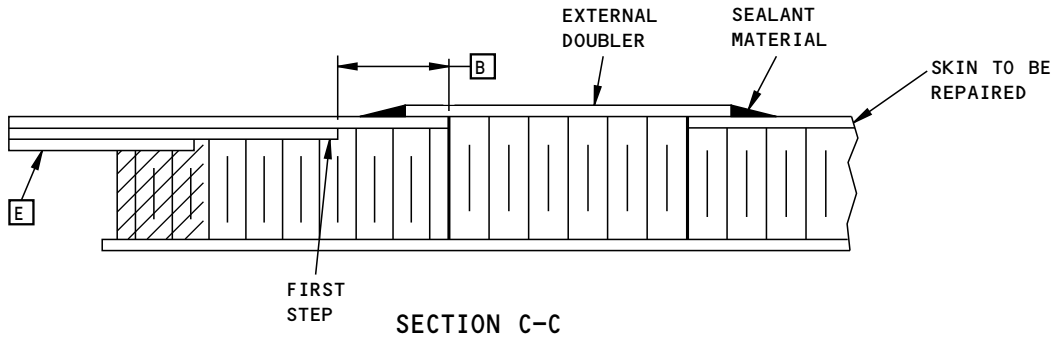


SECTION B–B

Repair of Damage Away From the Panel Edges
Figure 1 (Sheet 2)

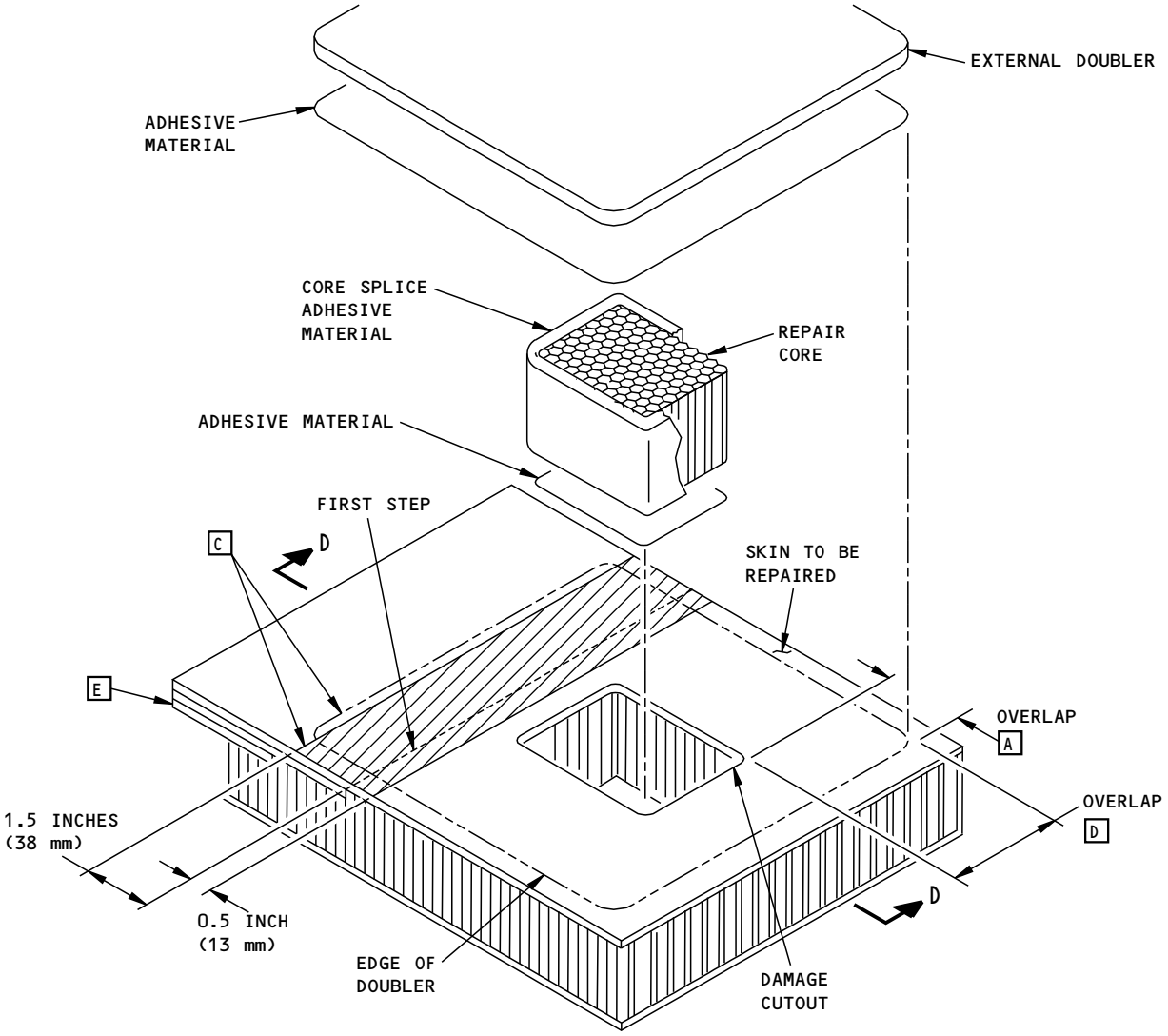


REPAIR NEAR AN INTERNAL DOUBLER
DETAIL III

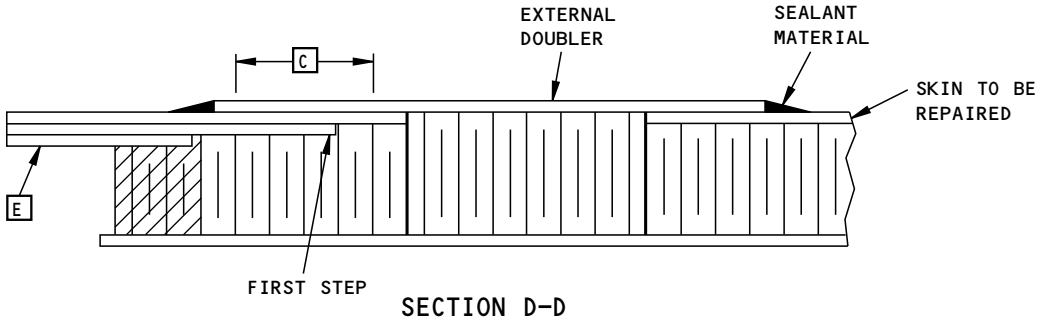


SECTION C-C

Repair of Damage Away From the Panel Edges
Figure 1 (Sheet 3)



REPAIR TO PART OF AN INTERNAL DOUBLER
DETAIL IV



SECTION D–D

Repair of Damage Away From the Panel Edges
Figure 1 (Sheet 4)

NOTES

- REFER TO 51-9-3 FOR THE REPAIR STEPS.
- IT IS PERMITTED TO USE NDI PROCEDURES OR ENGINEERING DRAWINGS TO FIND THE LOCATIONS OF INTERNAL DOUBLERS AND MACHINED STEPS.

[A] REFER TO 51-9-3, FIG. 7 OR 8 (AS APPLICABLE) FOR THE MINIMUM OVERLAP DIMENSION.

[B] IF THE EDGE OF THE CUTOUT IS CLOSER THAN 0.5 INCHES (13 mm) TO THE EDGE OF AN INTERNAL DOUBLER (OR THE EDGE OF A CHEM-MILLED OR MACHINED STEP) THEN DO ONE OF THE STEPS THAT FOLLOW:

- REFER TO THE SPECIFIC COMPONENT REPAIR SECTION TO SEE IF THERE IS AN APPLICABLE REPAIR.
- CUT OUT THE DAMAGE TO THE EDGE OF THE PANEL AND THEN DO ONE OF THE REPAIRS IN 51-9-7, FIG. 2.
- ASK BOEING

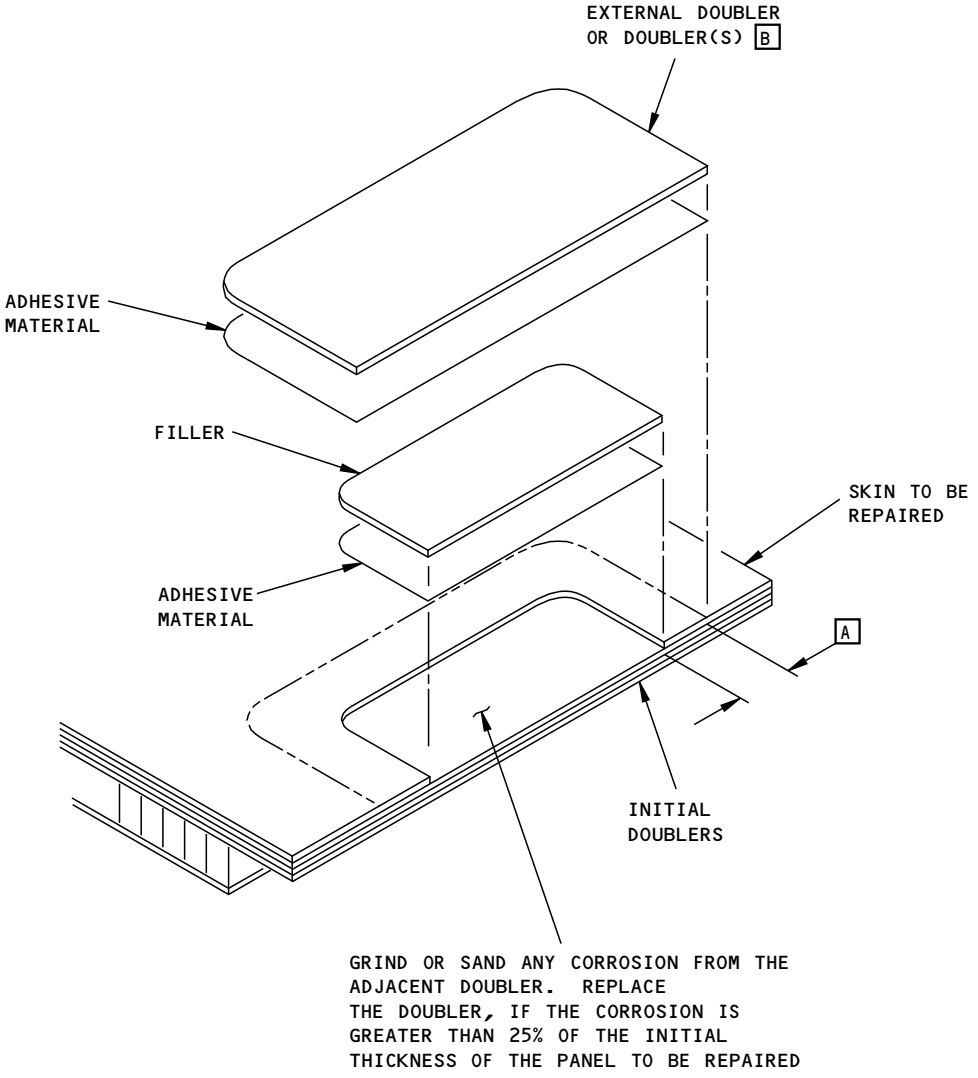
[C] IF THE EDGE OF AN EXTERNAL DOUBLER WILL BE CLOSER THAN 0.5 INCH (13 mm) TO THE FIRST STEP, OR WILL NOT BE FARTHER THAN 1.5 INCHES (38 mm) PAST THE FIRST STEP, THEN SEE DETAIL IV AND DO THE STEPS THAT FOLLOW:

- EXTEND THE EXTERNAL DOUBLER SO THAT THE EDGE OF THE DOUBLER WHICH IS CLOSEST TO THE FIRST STEP IS FARTHER THAN 1.5 INCHES (38 mm) PAST THE EDGE OF THE FIRST STEP.

[D] INCREASE THE OVERLAP ON BOTH SIDES OF THE CUTOUT BY 0.5 INCH (13 mm).

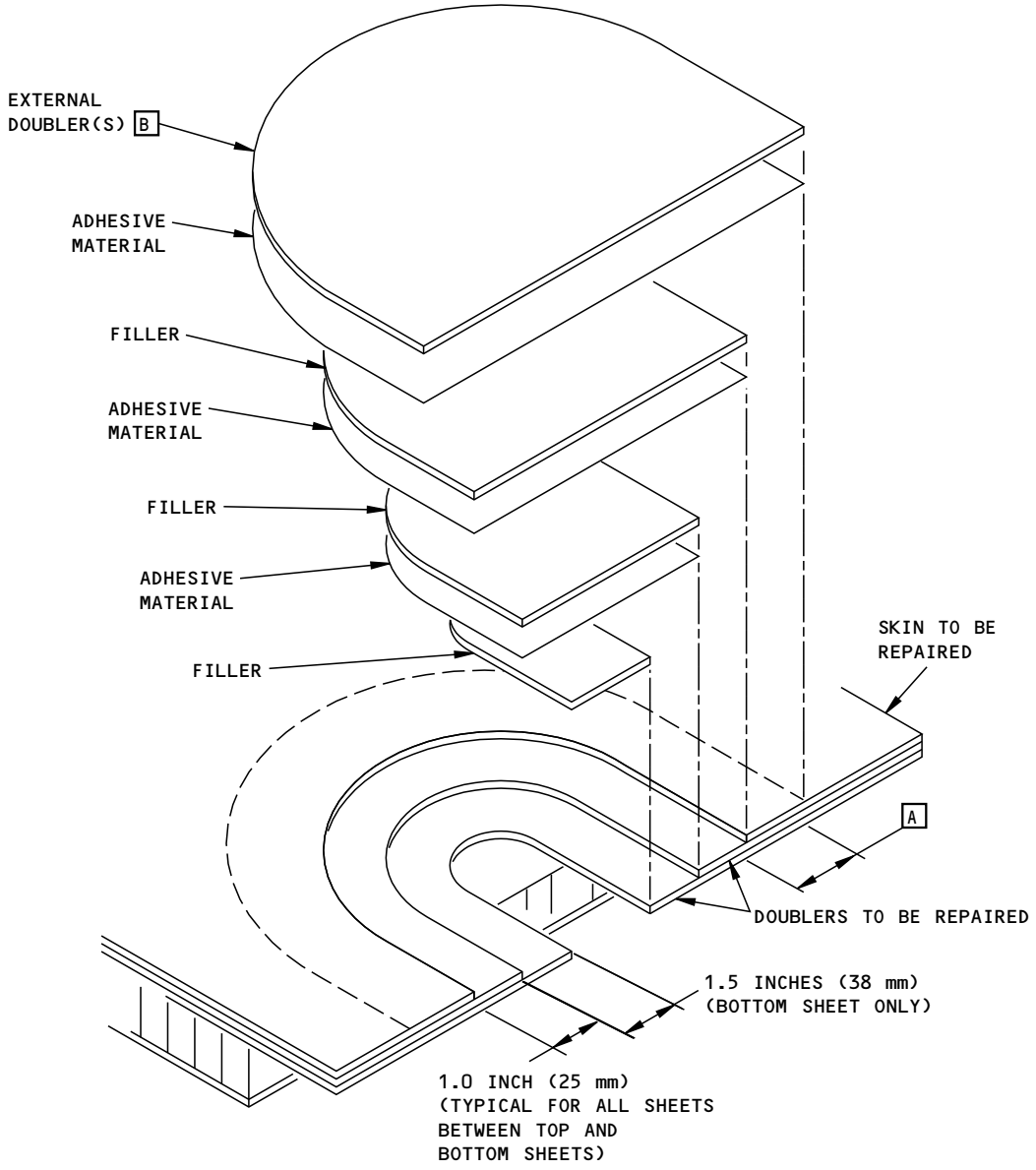
[E] A PANEL WITH AN EDGEBAND THAT WAS MANUFACTURED WITH MULTIPLE DOUBLERS IS SHOWN. USE THE SAME PROCEDURE TO REPAIR A PANEL WITH A MACHINED OR CHEM-MILLED SKIN. IF AN INTERNAL DOUBLER IS DAMAGED, SEE [B].

Repair of Damage Away From the Panel Edges
Figure 1 (Sheet 5)



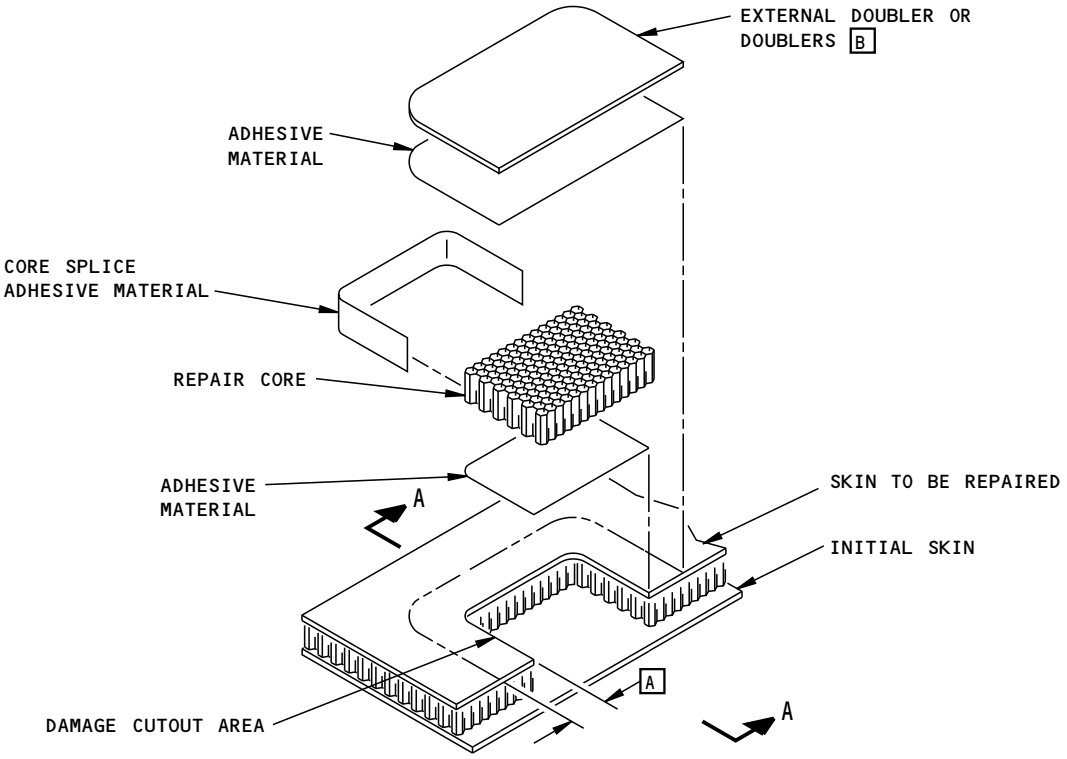
DETAIL I

Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 1)



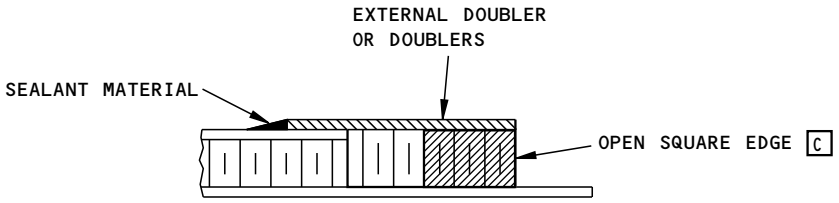
DETAIL II

Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 2)



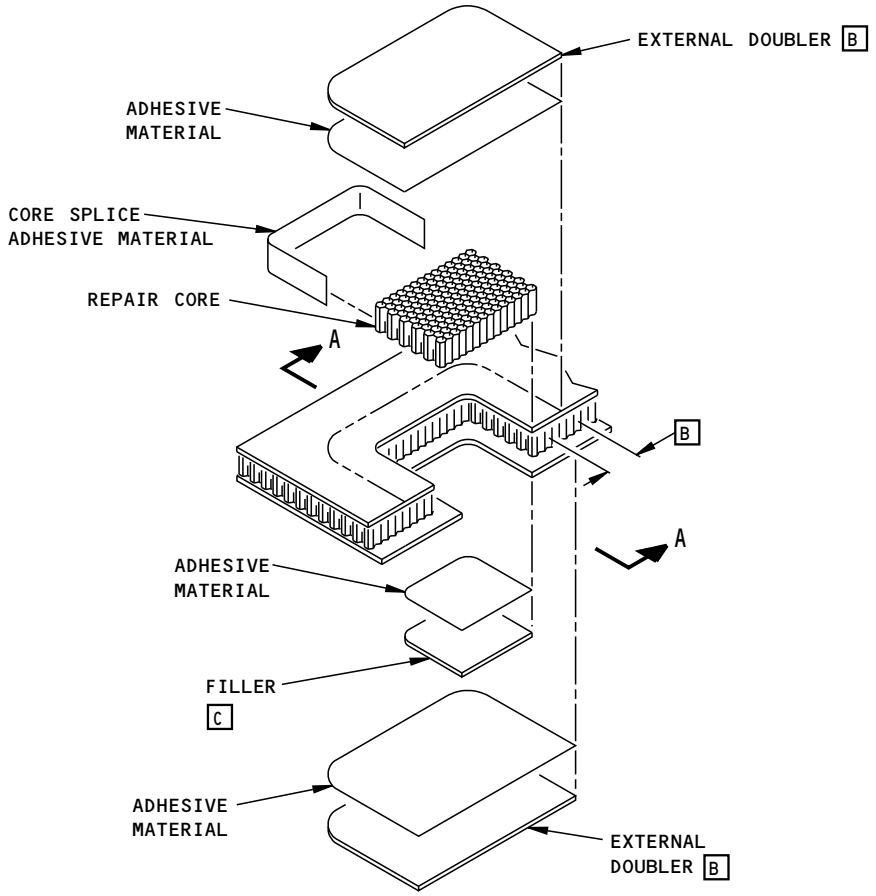
REPAIR TO ONE SKIN ONLY
(SQUARE EDGE CONFIGURATION)

DETAIL III



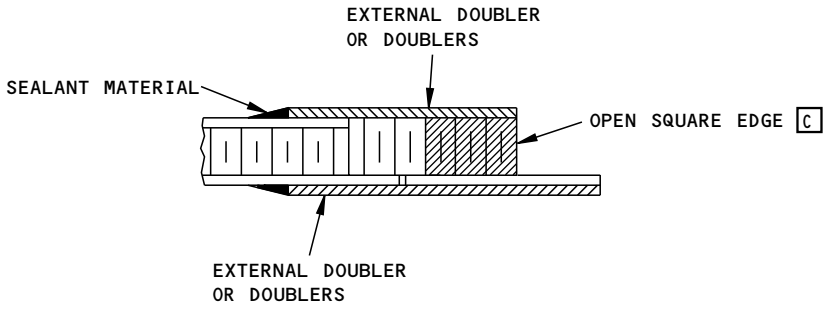
SECTION A–A

Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 3)



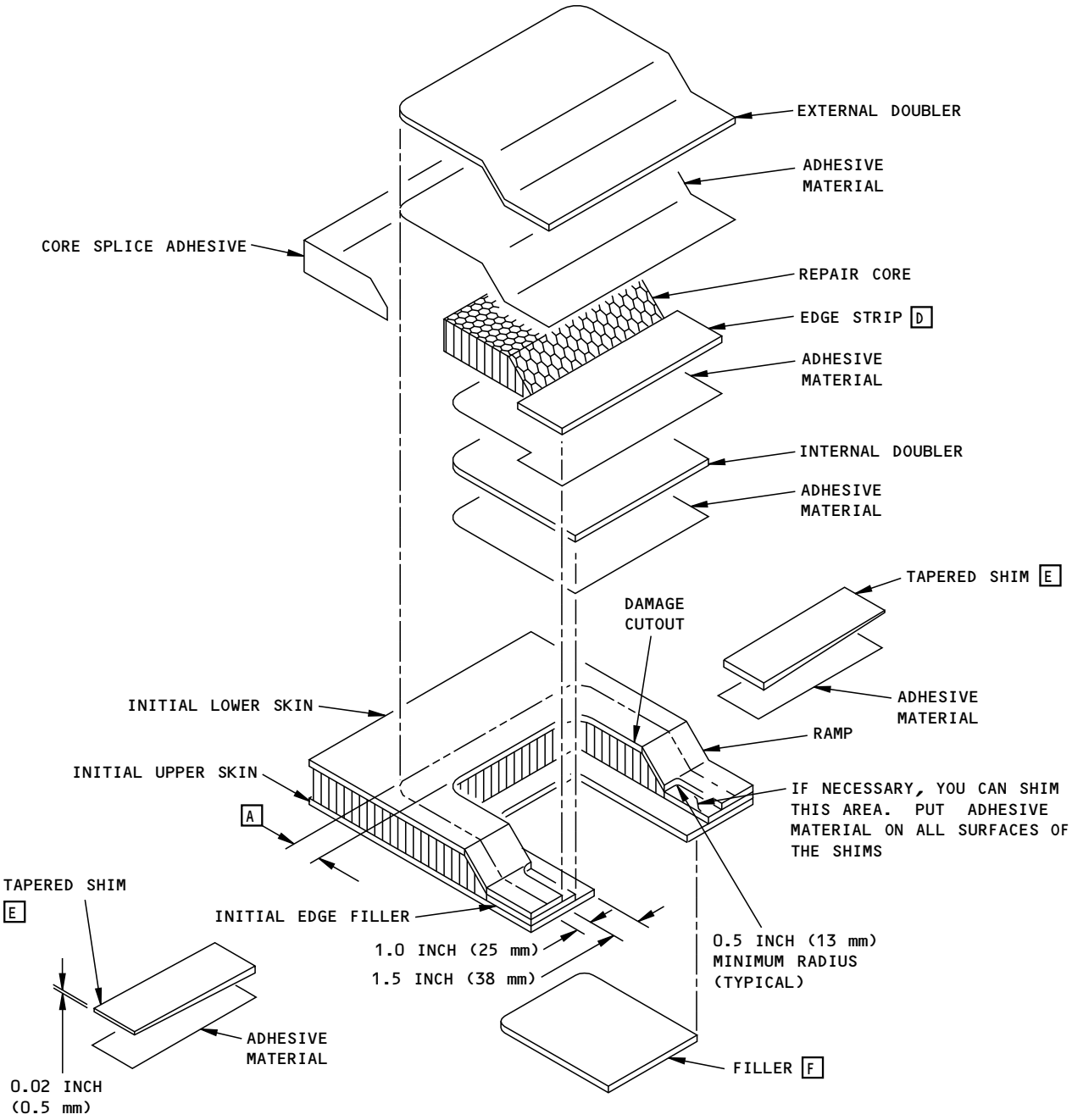
REPAIR TO BOTH SKINS
(SQUARE EDGE CONFIGURATION)

DETAIL IV



SECTION B-B

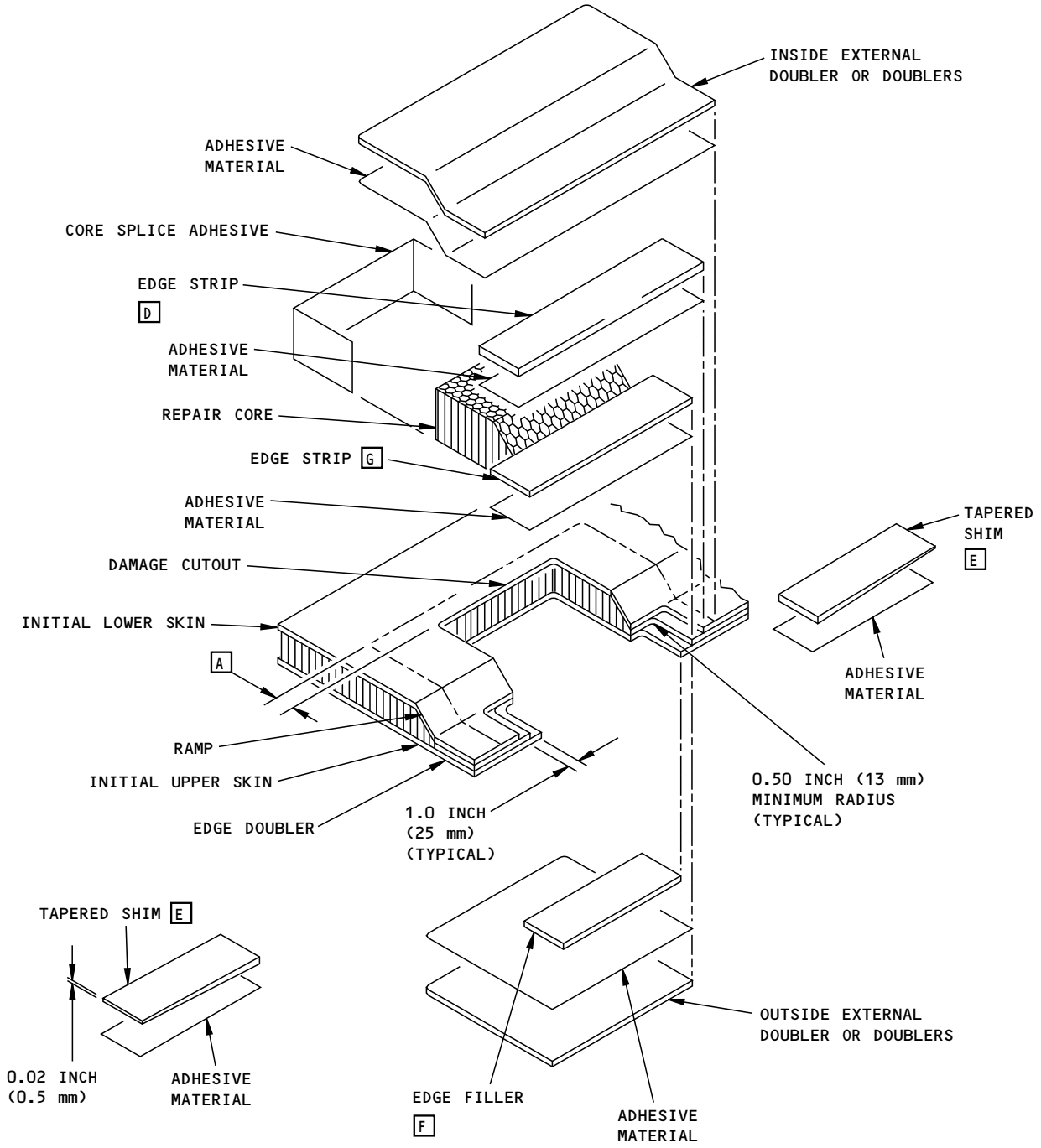
Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 4)



FLUSH REPAIR (RAMP CONFIGURATION)

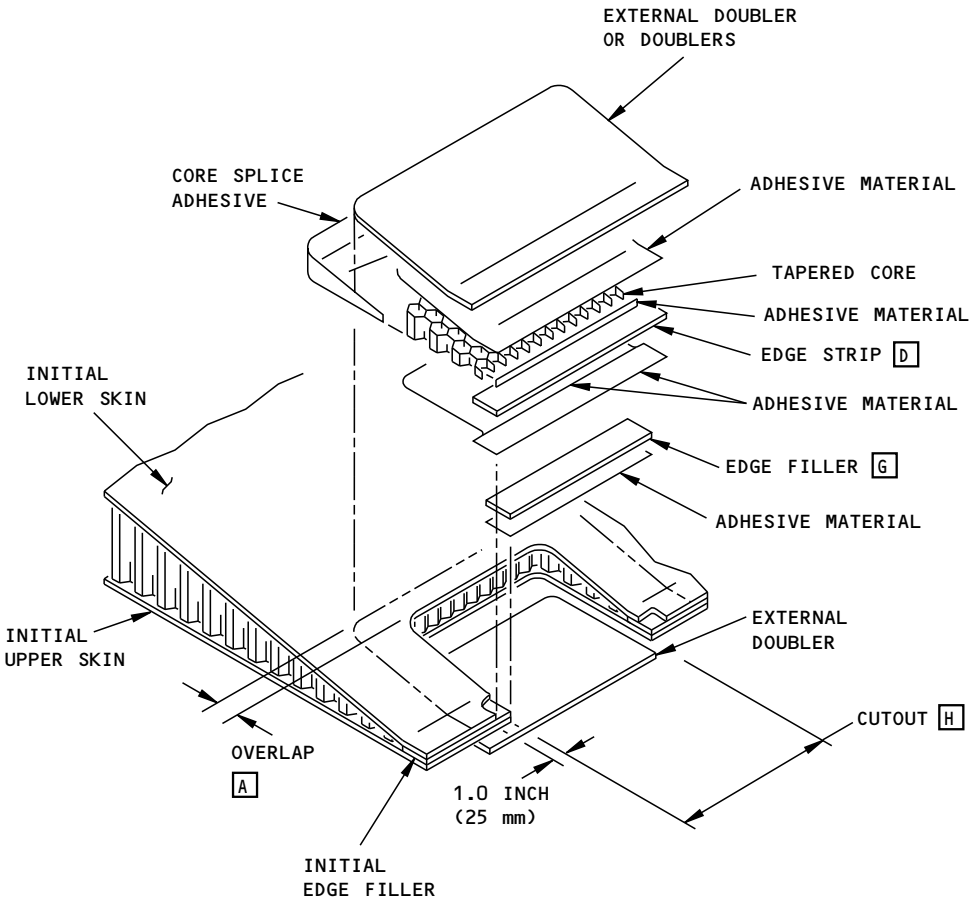
DETAIL V

Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 5)



NON-FLUSH REPAIR (RAMP CONFIGURATION)
DETAIL VI

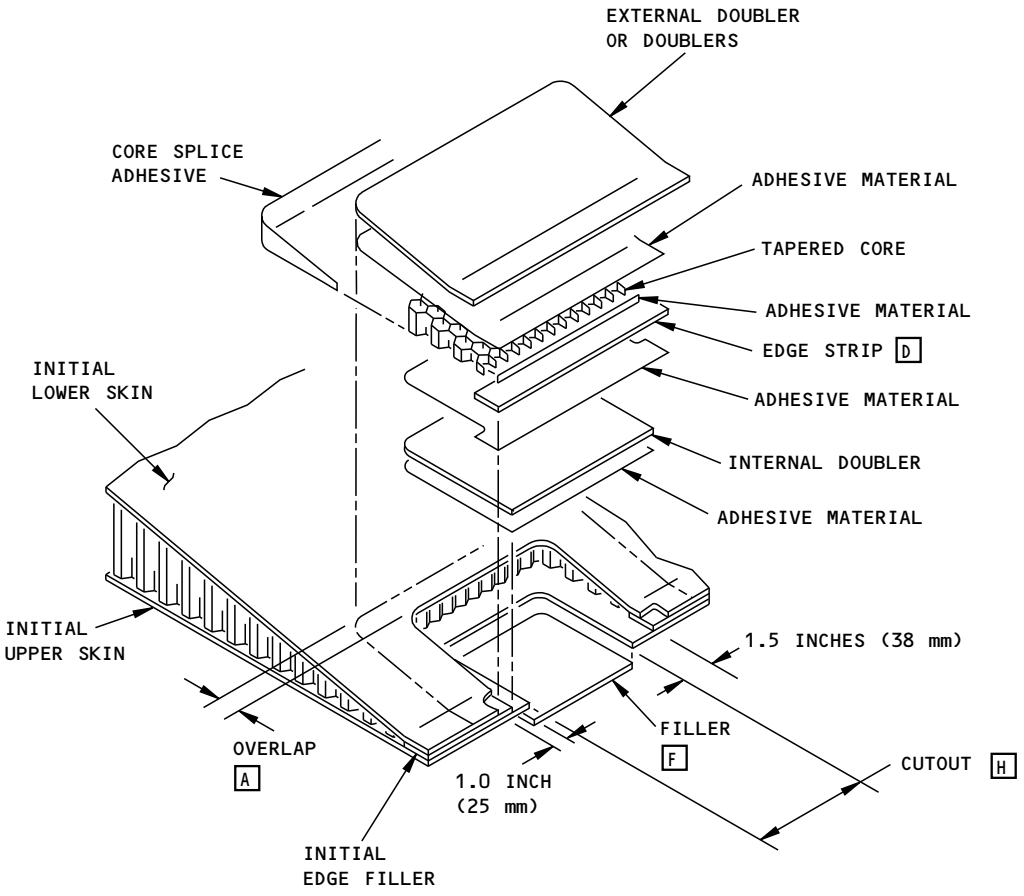
Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 6)



TRAILING EDGE REPAIR WITH TWO EXTERNAL DOUBLERS

DETAIL VII

Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 7)



TRAILING EDGE REPAIR WITH AN EXTERNAL AND INTERNAL DOUBLER

DETAIL VIII

Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 8)

NOTES

- REFER TO 51-9-3 FOR THE REPAIR STEPS

A REFER TO 51-9-3, FIG. 7 OR FIG. 8 (AS APPLICABLE) FOR THE MINIMUM OVERLAP DIMENSION.

B IF THE LENGTH OR WIDTH OF THE MATERIAL THAT IS REMOVED FROM THE OUTER SKIN IS 1.0 INCH (25 mm) OR LESS, THEN USE AN EXTERNAL DOUBLER(S) THICKNESS AS SPECIFIED IN 51-9-3, FIG. 8.

IF THE LENGTH OR WIDTH OF THE MATERIAL THAT IS REMOVED FROM THE OUTER SKIN IS MORE THAN 1.0 INCH (25 mm), THEN USE AN EXTERNAL DOUBLER(S) THICKNESS AS SPECIFIED IN 51-9-3, FIG. 8 FOR AN INITIAL SKIN THICKNESS THAT IS ONE GAGE RANGE THICKER.

C SEAL THE OPEN EDGE OF THE REPAIR CORE AS GIVEN IN 51-9-3, PAR. 9.F.

D MAKE THE EDGE FILLER FROM THE SAME BOEING MATERIALS SPECIFICATION (BMS) MATERIAL OR AN EQUIVALENT MATERIAL THAT IS THE SAME THICKNESS AS THE INITIAL UPPER OR LOWER SKIN AS APPLICABLE.

E PUT THE TAPERED SHIMS NEXT TO THE INSIDE EXTERNAL DOUBLER ON THE EDGE BAND.

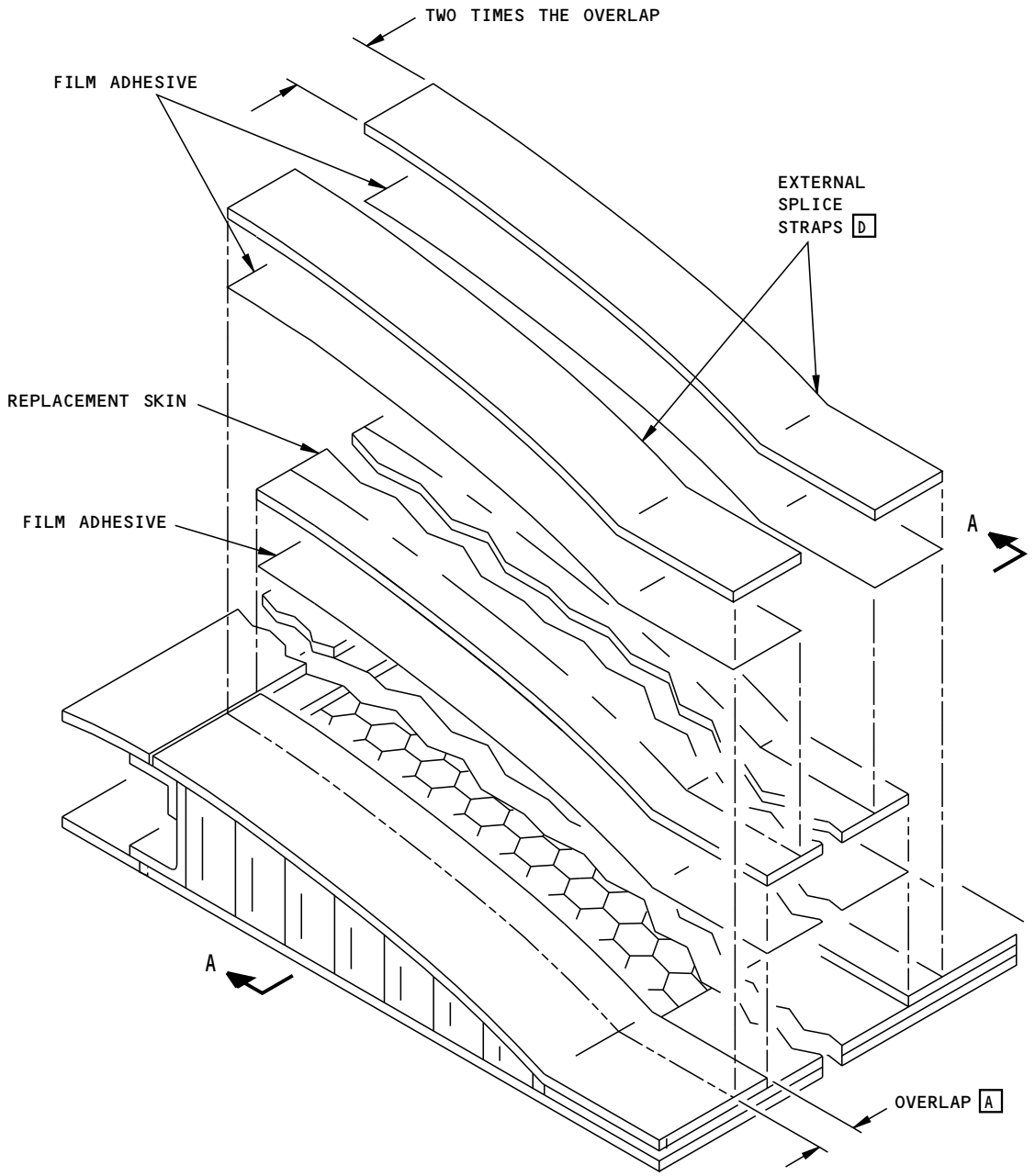
F MAKE THE FILLER FROM THE SAME BOEING MATERIALS SPECIFICATION (BMS) MATERIAL OR AN EQUIVALENT MATERIAL THAT IS THE SAME THICKNESS AS THE INITIAL UPPER OR LOWER SKIN AS APPLICABLE.

G MAKE THE EDGE FILLER FROM THE SAME THICKNESS AS THE INITIAL EDGE FILLER.

H THE MAXIMUM PERMITTED WIDTH OF CUTOUT IN THE TRAILING EDGE IS 50% OF THE TOTAL INITIAL WIDTH. IF MORE THAN 50% OF THE WIDTH IS DAMAGED, THEN DO THE STEPS THAT FOLLOW:

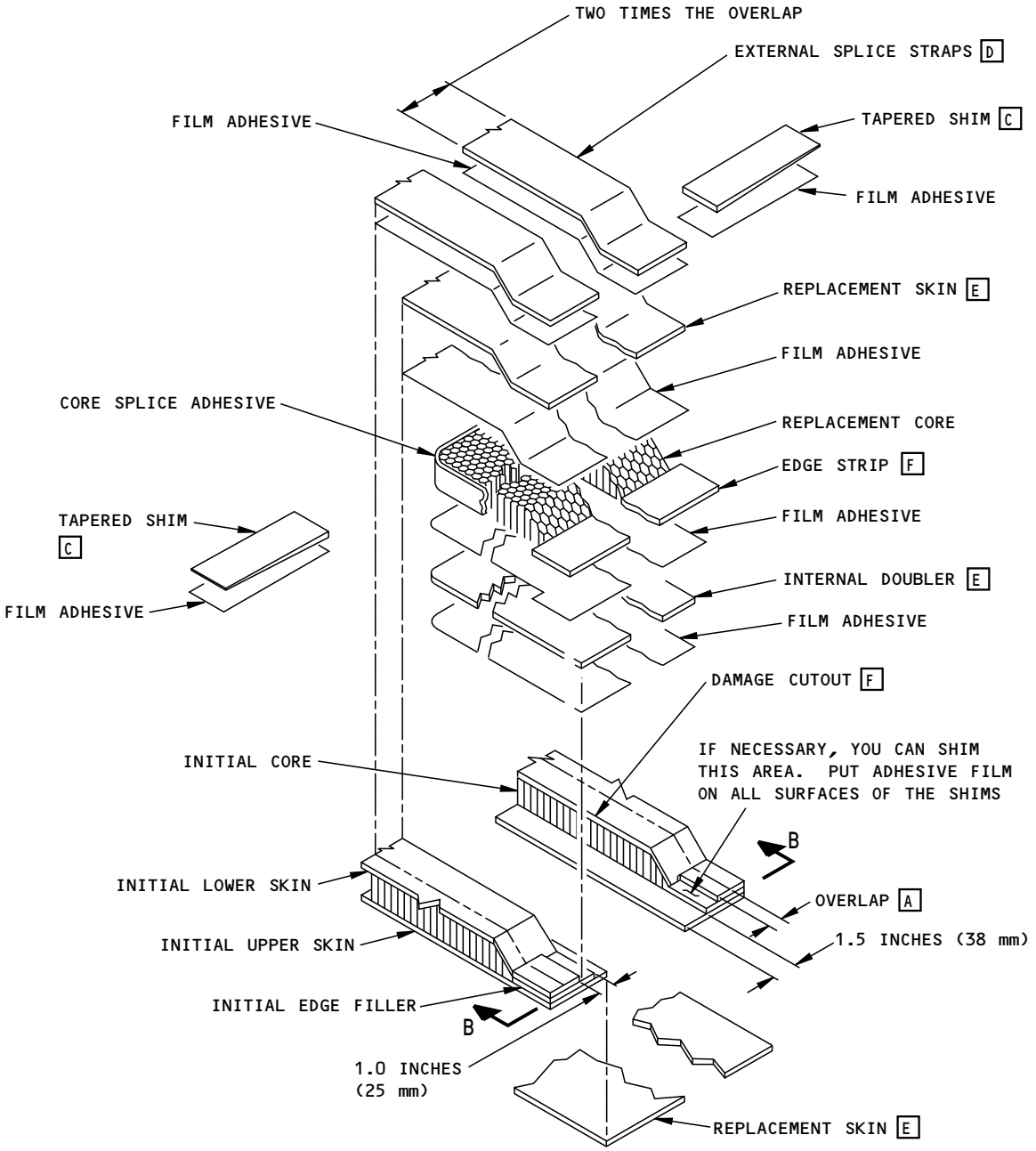
- GET AN ENGINEERING REVIEW
- USE APPROVED ENGINEERING DRAWINGS FOR THE COMPONENT
- USE APPROVED MATERIALS AND MANUFACTURING PROCESSES SPECIFIED IN THE COMPONENT ENGINEERING DRAWINGS.

Repair of Damage at the Edge of a Panel
Figure 2 (Sheet 9)



REPAIR TO ONE SKIN ONLY
DETAIL I

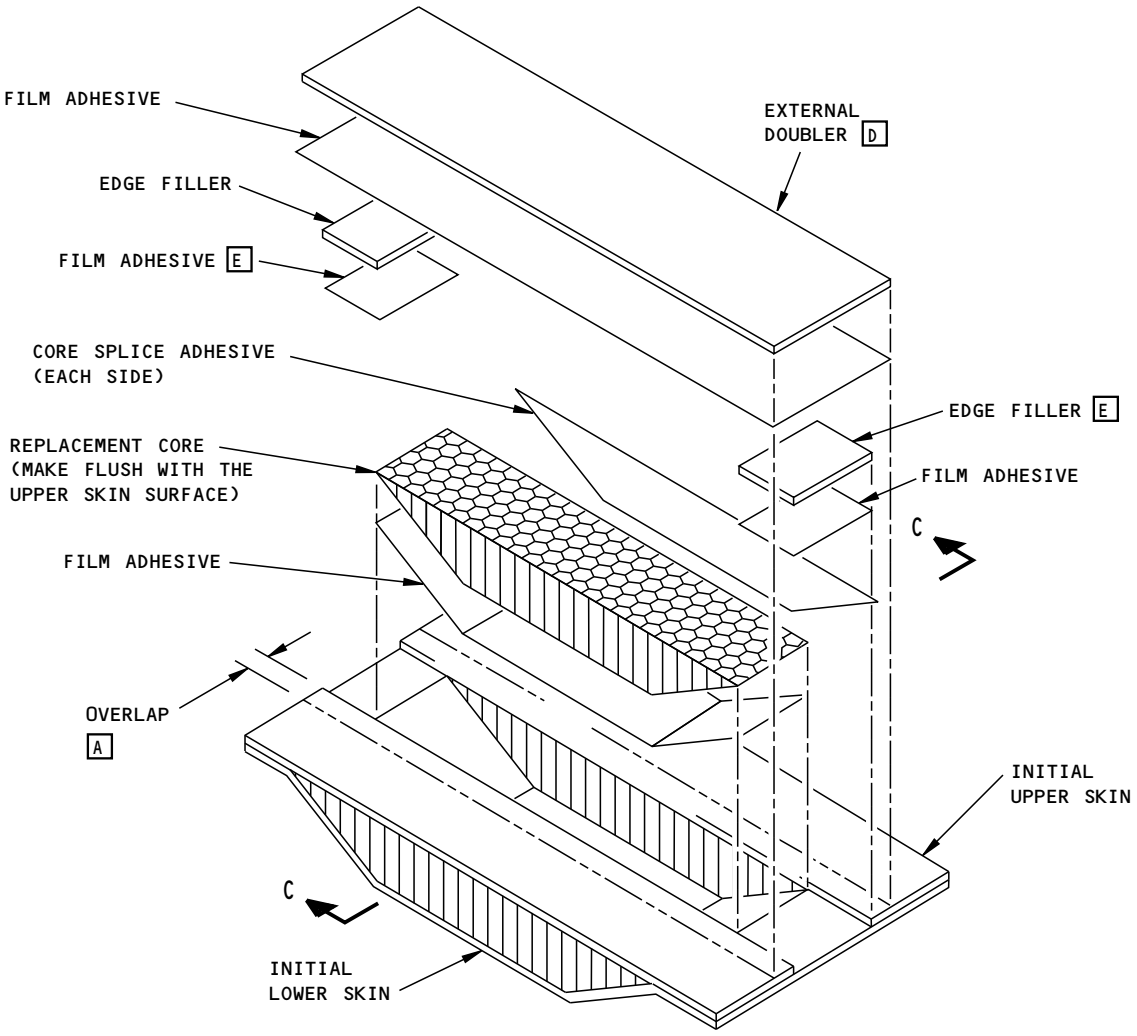
Repair of Damage That is from Edge to Edge
Figure 3 (Sheet 1)



REPAIR TO TWO SKINS AND CORE
(REPLACEMENT CORE FLUSH WITH INITIAL CORE)

DETAIL II

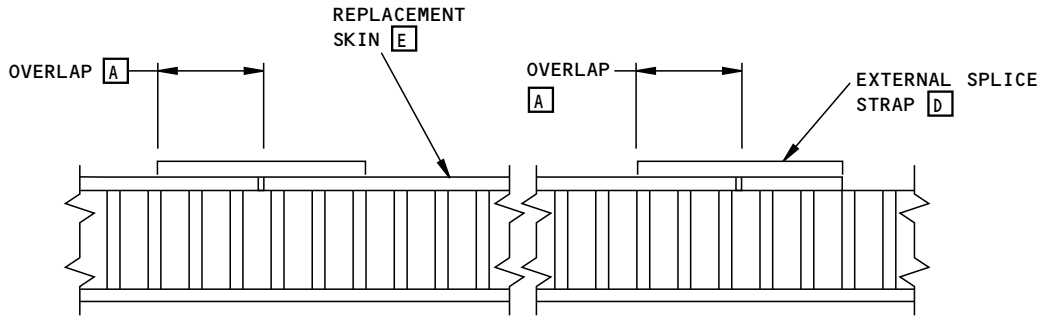
Repair of Damage That is from Edge to Edge
Figure 3 (Sheet 2)



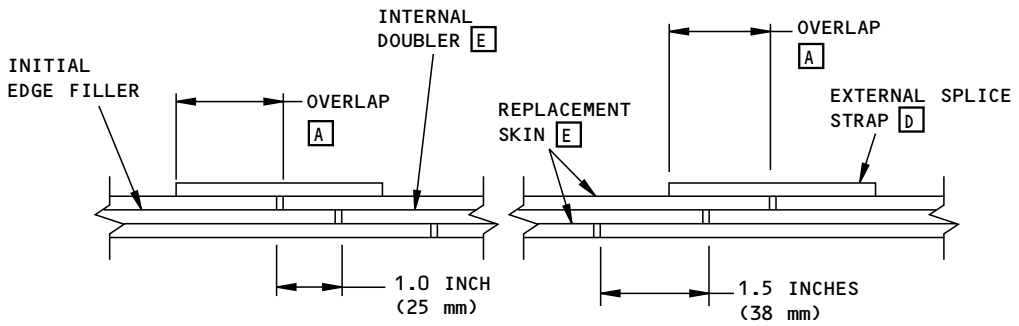
REPAIR TO ONE SKIN AND CORE
(REPLACEMENT CORE FLUSH WITH AN INITIAL SKIN)

DETAIL III

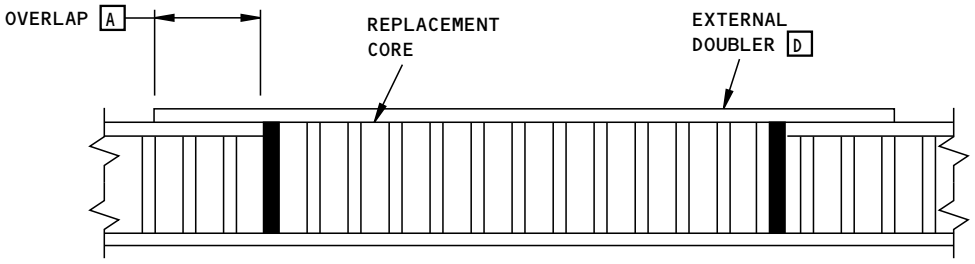
Repair of Damage That is from Edge to Edge
Figure 3 (Sheet 3)



SECTION A–A



SECTION B–B



SECTION C–C

Repair of Damage That is from Edge to Edge
Figure 3 (Sheet 4)

NOTES

- REFER TO 51-9-3 FOR THE REPAIR STEPS.

[A] REFER TO 51-9-3, FIG. 7 OR FIG. 8 (AS APPLICABLE) FOR THE MINIMUM OVERLAP DIMENSION.

[B] USE SHIMS IF NECESSARY.

[C] PUT A TAPERED SHIM NEXT TO EACH OF THE INSIDE EXTERNAL DOUBLERS ON THE EDGEBAND.

[D] REFER TO 51-9-3, FIG. 7 OR 8 FOR DOUBLER THICKNESS.

[E] MAKE FROM THE SAME BOEING MATERIALS SPECIFICATION (BMS) MATERIAL OR AN EQUIVALENT MATERIAL THAT IS THE SAME THICKNESS AS THE INITIAL UPPER OR LOWER SKIN AS APPLICABLE.

[F] MAKE FROM THE SAME THICKNESS AS THE INITIAL EDGE FILLER.

[G] AS AN ALTERNATIVE, YOU CAN CUT THE INITIAL SKIN AWAY FROM THE EDGE OF THE CORE. THERE IS NO MINIMUM OR MAXIMUM DISTANCE FROM THE EDGE OF THE THE SKIN TO THE EDGE OF THE CORE.

Repair of Damage That is from Edge to Edge
Figure 3 (Sheet 5)

D6-2962

TEMPORARY REVISION NR. DFW 53-22

INSERT IN FRONT OF SUBCHAPTER 53-2-1, PAGE 6A

REASON FOR CHANGE: TCA RVSM Implementation and Autopilot Replacement - Phase II

INSTRUCTION: Insert updated page block.

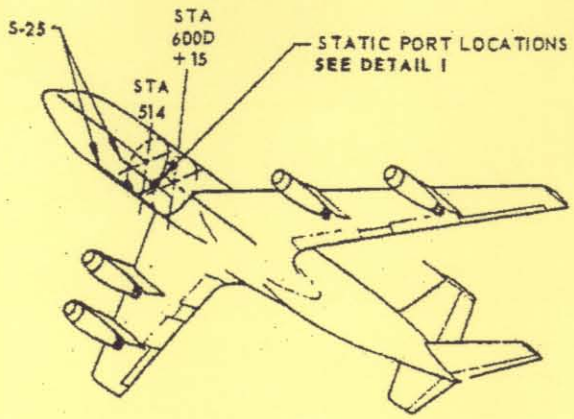
INTENTIONALLY LEFT BLANK

PRELIMINARY RESULTS

NOTE: The insertion of this TR has to be listed in the Record of Temporary Revisions at the beginning of Volume 1.

RVSM STATIC PORT CRITICAL ZONES DETERMINATION AND DAMAGE LIMITATIONS

IICN: 1P-SRMX-53-0003-01



PRELIMINARY RESULTS

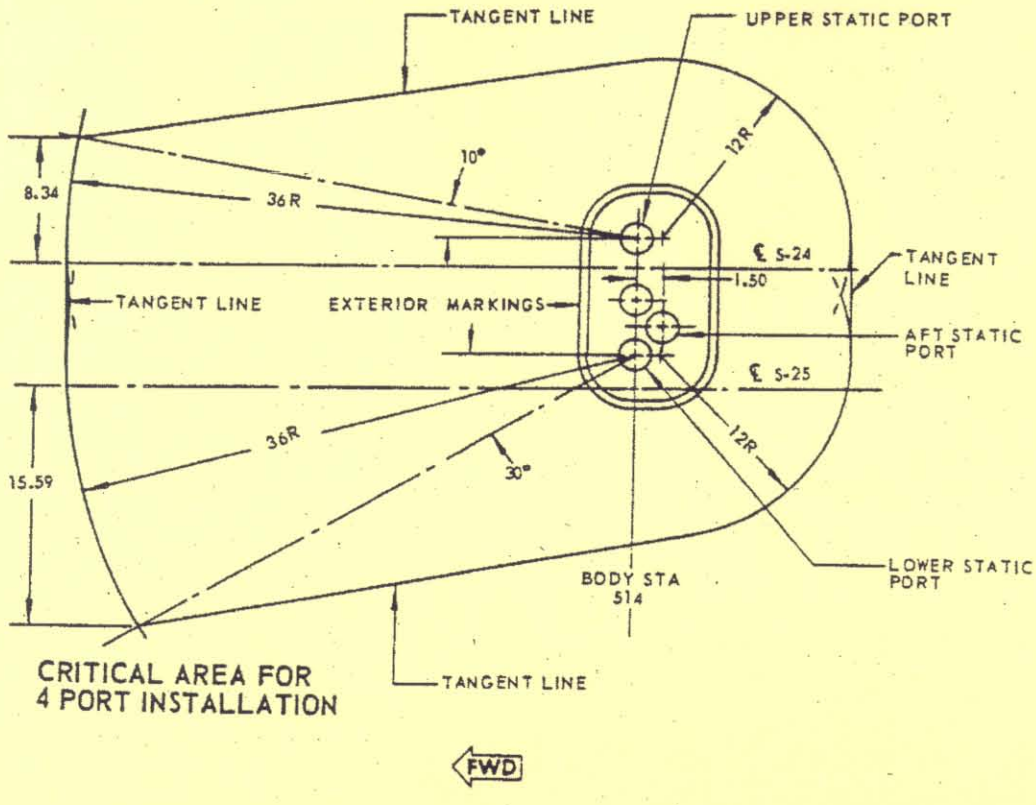
NOTE:

- FOR INSTALLATION OR REPLACEMENT OF STATIC PORTS SEE 34-2-31 OF THE MAINTENANCE MANUAL.
- SEE DETAILS FOR TYPICAL STATIC PORT INSTALLATIONS. INSTALL FLUSH SKIN REPAIRS PER 53-3-2 FIGURES 2,4 OR 6 AS APPLICABLE, WHEREVER PRACTICAL. THE EXTERIOR SURFACE OF STATIC PORT WITHIN A THREE-INCH RADIUS OF THE PORT SHALL BE FLUSH WITHIN +0.009 TO -0.006 INCH MAXIMUM MEASURED AS A CLEARANCE BETWEEN THIS SURFACE AND THE EDGE OF A SIX INCH STRAIGHT EDGE PLACED HORIZONTALLY AGAINST THE SURFACE AND CENTERED ON THE PORT CENTERLINE. THIS MEASUREMENT SHALL BE TAKEN ACROSS THE CENTER OF THE PORT AND ONE INCH ABOVE AND BELOW THE PORT. ALL RIVETS WITHIN A THREE-INCH RADIUS OF EACH PORT SHALL BE FLUSH WITH THE SKIN WITHIN 0.005 INCH MAXIMUM.
- WHERE SUCH FLUSH SKIN INSTALLATIONS ARE IMPRACTICAL, NONFLUSH PATCHES ARE PERMISSIBLE PROVIDED THE FOLLOWING LIMITATIONS ARE NOT EXCEEDED:
  - ANY EDGE OR CORNER OF A PROTRUDING PATCH MUST NOT BE LOCATED WITHIN THE CRITICAL AREA SHOWN IN FIGURE 3A (SHEET 2 of 2).
  - PATCH MATERIALS GAGE MUST NOT EXCEED 0.080 INCH.
  - PATCH EDGES MUST BE BEVELED PER 53-3-2 FIGURE 1.

Damage Limitations for Fuselage Skin in Vicinity of
Static Pressure Ports (Section 43 Fwd)
Figure 3A (Sheet 1 of 2)

IICN: 1P-SRMX-53-0005-01

PRELIMINARY RESULTS



DETAIL I

Damage Limitation for Fuselage Skin in Vicinity of
Static Ressure Ports (Section 43 Fwd)
Figure 3A (Sheet 2 of 2)

1. Irregularity Determination

A. The following features of the irregularity are to be identified:

(1) The kind of shape, such as

(a) A round contour with a roughty maximum around its center point, or

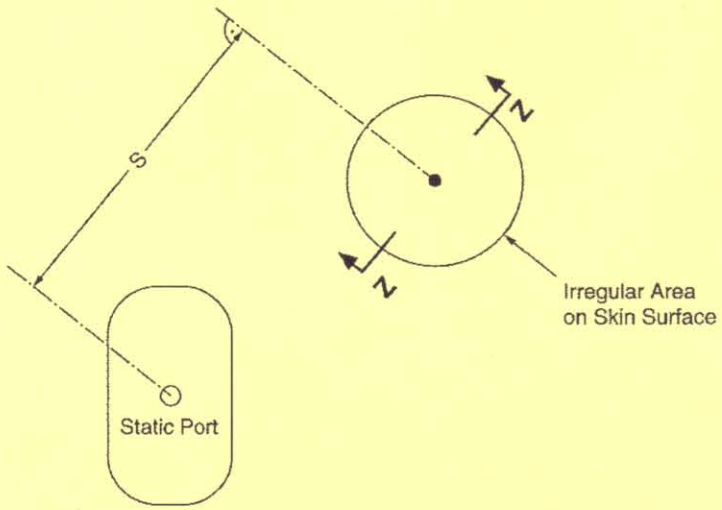
(b) An oval contour.

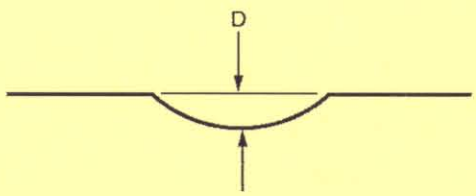
For case a), as shown in Figure 3B:

(2) The hight (/depth) of the maximum,

(3) The distance between the maximum point and the static port

-SRMX-53-0009-01





SECTION Z-Z

D = Maximum depth or height of irregularity

S = Minimal acceptance distance from static pressure port to nearest edge of irregularity (i.e. to point where deviation from the normal contour begins).

PRELIMINARY RESULTS

Damage Limitation for Fuselage Skin in Vicinity of
Static Ressure Ports (Section 43 Fwd)
Round Skin Irregularity
Figure 3B

For case b), as shown in Figure 3C:

(2) The hight/depth values of some prominent points on the irregularities ridge/groove line must be plottet on the limit chart

- the point with the maximum of the height/depth irregularities (dimension D),
- the ends of the longish structure (corner marks),
- the nearest ridge (or groove) point (dimension S),

(3) The distance between the static port and the points specified immediately above

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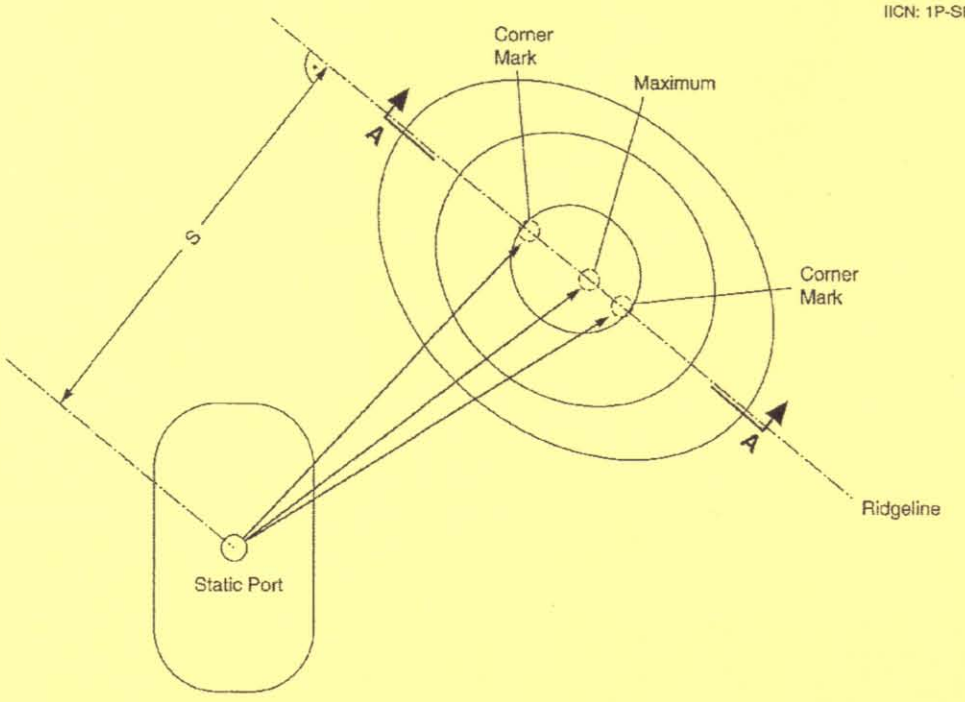

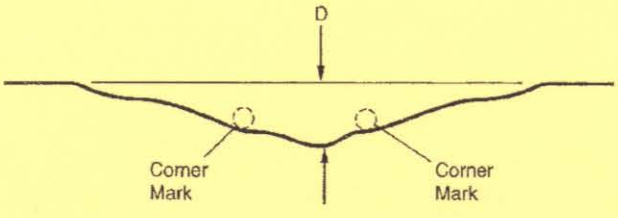

SECTION A-A

D = Maximum depth or height of irregularity

S = Minimal acceptance distance from static pressure port to nearest edge of irregularity (i.e. to point where deviation from the normal contour begins).

PRELIMINARY RESULTS

Damage Limitation for Fuselage Skin in Vicinity of Static Ressure Ports (Section 43 Fwd)
Oval Skin Irregularity
Figure 3C

The method is conservative and considers the most severe effect for:

- any scale parameter about the irregularity's size parallel to the skin,
- any flow direction.

CAUTION:

- ONLY SINGLE SKIN SHAPE IRREGULATIES ON THE AIRCRAFT SKIN ARE SUBJECT OF THIS METHOD.
- IN CASE OF COMBINATIONS OF MULTIPLE SKIN SHAPE IRREGULATIES, CONTACT THE SPECIALIST FOR CONTINUED AIRWORTHINESS.

B. The pairs of measurement must be entered in the diagram of Figure 3D.

NOTE: If no point in the diagram is within the shaded area, the specific irregularity is non-significant for the RVSM operation. If there is no other defect or malfunction that would contribute to an error in the barometric altitude, the aircraft may still be dispatched for operation in the RVSM airspace.

(1) Example:

(a) A height or depth of 0.025 inch in a distance of 17 inch is still acceptable.

(b) A height or depth of 0.02 inch with its center point in a distance of 5 inch to the static port may result in a significant error of the barometric altitude.

In case of a height or depth value being inside the shaded area, there will have to be additional special checks, such as:

- 3D-photogrammetric survey around the static port and based on a similar survey done in advance, an estimation about the expected barometric altitude error.

or another set of calibration/verification flight tests

- with GPS-based Monitoring Unit(GMU), or
- with the complete trailing cone equipment.

Figure 3H shows the shaded area as cross section of one side of that limit cone. Irregularities that within the shaded aera may result in changes of the static pressure which cannot be ignored. If such irregularities are identified, it is mandatory to operate out of the RVSM airspace.

CAUTION: THE EXISTENCE OF A SPECIFIC DAMAGE MAY RESULT IN THE NEED TO REPAIR THE AIRCRAFT FOR OTHER REASONS. RELEASE TO FLIGHT MUST CONSIDER ALL AIRCRAFT SYSTEMS AND OPERATING PROCEDURES.

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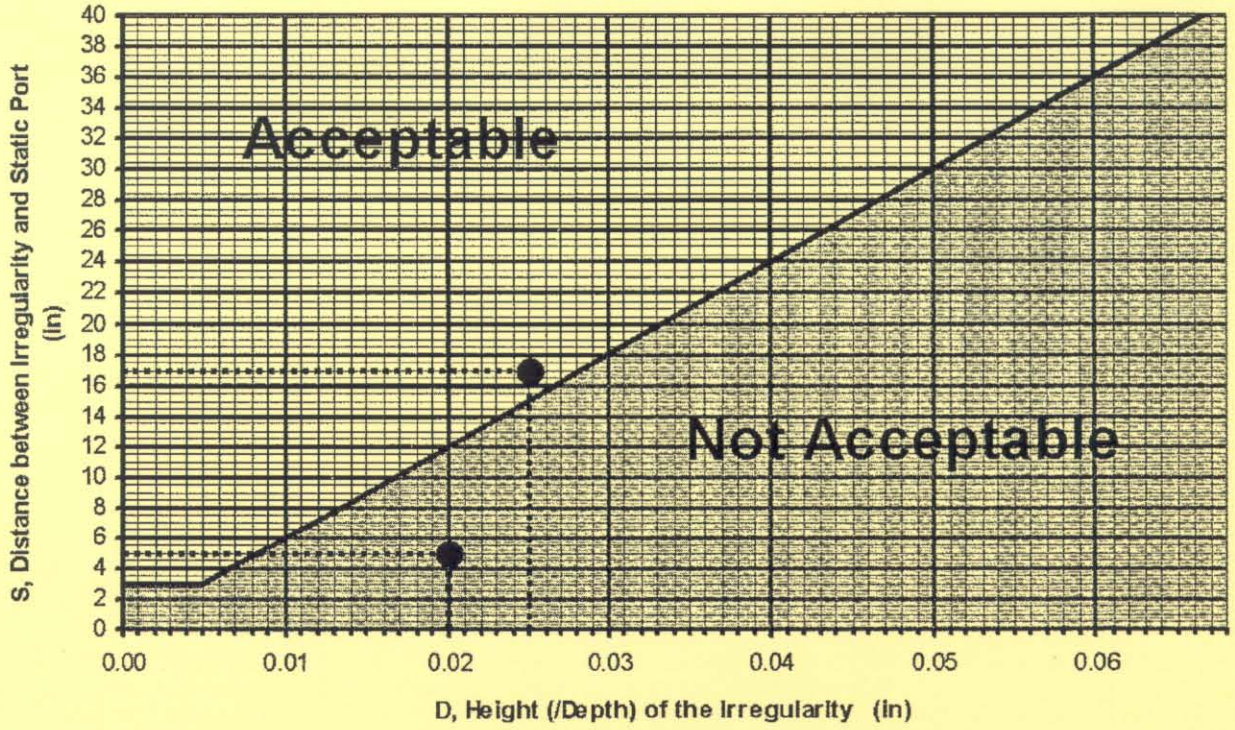

PRELIMINARY RESULTS

Damage Limitation for Fuselage Skin in Vicinity of
Static Ressure Ports (Section 43 Fwd)
Operating Limits for RVSM
Figure 3D

NOTE:

- IF VISIBLE SURFACE DAMAGE IRREGULARITIES ARE SEEN WITHIN A 3-INCH RADIUS OF THE AIRSPEED SYSTEM FLUSH STATIC PORTS, OR IN THE EVENT OF DAMAGE WHICH EXCEEDS THE ALLOWABLE LIMITS, AND ARE NOT REPAIRABLE PER THE RESTRICTIONS SHOWN IN FIGURE 3D ,CONTACT THE SPECIALIST FOR CONTINUED AIRWORTHINESS BEFORE OPERATING THE AIRCRAFT IN RVSM AIRSPACE. TO ENSURE THE AIRCRAFT STILL MEETS THE REQUIREMENTS FOR RVSM OPERATION, SURFACE MEASUREMENTS OR SKIN WAVINESS CHECKS WILL NEED TO BE MADE TO ENSURE ADHERENCE TO RVSM TOLERANCES.

- DENT LIMITS RELATE ONLY TO AERODYNAMIC EFFECTS ON THE AIRSPEED/ALTIMETRY SYSTEM. ANY APPLICABLE STRUCTURAL RESTRICTIONS ON DENTS MUST ALSO BE MET.

- THE LIMITS SHOWN ARE BASED ON MAINTAINING OPTIMUM PERFORMANCE OF THE PRIMARY AIRSPEED/ALTIMETRY SYSTEM. LARGER IRREGULARITIES MAY BE ACCEPTABLE ON A TEMPORARY BASIS OR IN THE VICINITY OF OTHER FLUSH STATIC PORTS, BUT WILL NOT BE ALLOWED IN THE PRIMARY AIRSPEED SYSTEM FLUSH STATIC PORTS WHEN OPERATING IN RVSM AIRSPACE.

- FOR DAMAGE EXCEEDING THE ALLOWABLE LIMITS, REFER TO SHEETS 6C AND 6D FOR SKIN REPAIR RESTRICTIONS FOR SKIN REPAIRS IN THE VICINITY OF AIRSPEED SYSTEM STATIC PORTS.

- FOR A ROUND FORM DAMAGE THE DISTANCE "S" APPLIES REGARDLESS OF THE DIRECTION OF THE IRREGULARITY FROM THE PRESSURE PORT (SEE FIGURE 3B).

- FOR AN OVAL FORM DAMAGE THE DISTANCE "S" APPLIES REGARDLESS OF THE DIRECTION OF THE IRREGULARITY FROM THE PRESSURE PORT (SEE FIGURE 3C)

- AN ACCUMULATION OF IRREGULARITIES WHICH MAY BE INDIVIDUALLY ACCEPTABLE CAN HAVE AN ADDITIVE EFFECT AND SHOULD BE AVOIDED.

- FOR RVSM OPERATION, NO MORE THAN ONE SURFACE IRREGULARITIES ARE ALLOWED IN THE VICINITY OF THE PRIMARY AIRSPEED SYSTEM FLUSH STATIC PORTS ON BOTH SIDES OF THE AIRCRAFT.

- FOR RVSM OPERATION, IN ADDITION TO THE ABOVE LIMITS, NO VISIBLE SURFACE IRREGULARITIES ARE ALLOWED WITHIN A 3-INCH RADIUS OF THE PRIMARY AIRSPEED SYSTEM FLUSH STATIC PORTS.

PRELIMINARY RESULTS

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TEMPORARY REVISION 53-24

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: To incorporate a change of preferred fasteners used in Figure 2, to add optional, interim repair.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
53-3-6	2A	Jun 15/92
	3	Jun 15/92

A55566

REPAIR INSTRUCTIONS

1. Get access to the rear side of the pressure bulkhead.
2. Stop drill the ends of the crack 0.25 inch in diameter. Refer to 51-2-10.
3. Make the repair plate. See Table I. Form the repair plate to fit the contour of the pressure bulkhead.
4. Remove the fasteners from the stiffeners of the pressure bulkhead where the repair plate will be attached. See Detail I.
5. Put the repair plate into position on the pressure bulkhead. Drill the fastener holes.
6. Remove the repair plate.
7. Remove all nicks, scratches, gouges, burrs and sharp edges from the repair plate and the bare edges of the pressure bulkhead.
8. Apply a chemical conversion coating to the repair plate and to the bare edges of the pressure bulkhead. Refer to 51-8-0.
9. Apply a layer of BMS 10-11, Type I primer to the repair plate and to the bare edges of the pressure bulkhead.
10. Install the repair plate. Make a faying surface seal between the repair plate and the pressure bulkhead with BMS 5-95 sealant. Refer to 51-1-3.
11. Apply the finish as given in 51-2-0 of the Maintenance Manual.

NOTES

- WHEN YOU USE THIS REPAIR REFER TO:
  - 51-13-1 FOR GENERAL REPAIR PROCEDURES
  - 51-1-3 FOR SEALING OF REPAIRS
  - 51-2-0 FOR FASTENER CODE, REMOVAL AND INSTALLATION, HOLES SIZES AND EDGE MARGINS
  - 51-8-0 FOR PROTECTIVE TREATMENT OF METAL
  - 51-2-0 OF THE MAINTENANCE MANUAL FOR INTERIOR AND EXTERIOR FINISHES.

[A] AS AN OPTION, 0.032 CLAD 2024-T4 MAY BE USED IF NECESSARY.

[B] AS AN OPTION, NAS1398D5 BLIND RIVETS MAY BE USED FOR AN INTERIM REPAIR. BLIND RIVET REPAIRS MUST BE INSPECTED EVERY 3000 FLIGHTS. BLIND RIVETS MUST BE REPLACED WITH BACR15BB6D SOLID RIVETS AT THE NEXT OVERHAUL, BUT NOT LATER THAN 10,000 FLIGHTS AFTER INSTALLATION. THIS INTERIM REPAIR HAS FAA APPROVAL CONTINGENT ON ACCOMPLISHMENT OF THE INSPECTIONS AND THE REPLACEMENT OF THE BLIND FASTENERS AT THE INTERVALS CONTAINED HEREIN.

FASTENER SYMBOLS

⊕ INITIAL FASTENER LOCATION. INSTALL A BACR15BB5D RIVET [B]

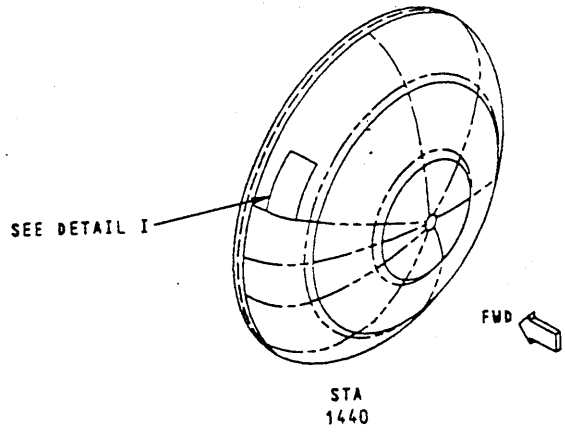
⊕ REPAIR FASTENER LOCATION. INSTALL A BACR15BB5D [B]

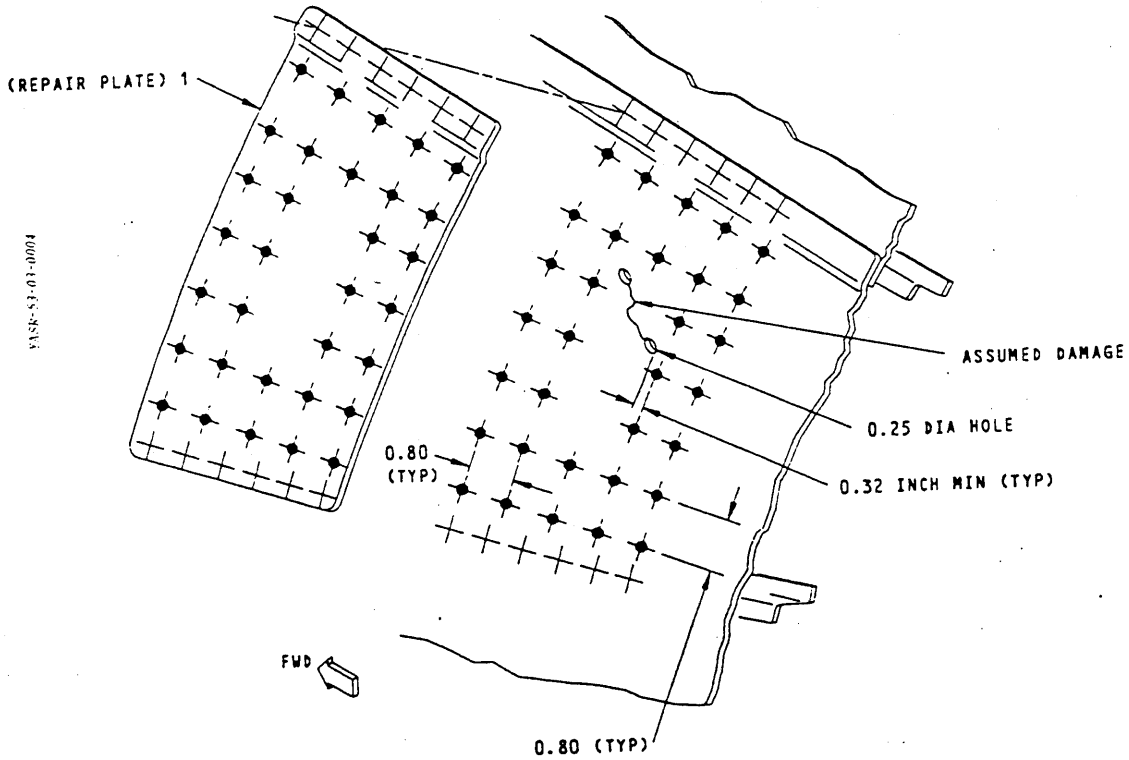
REPAIR MATERIAL			
PART		QTY	MATERIAL
1	REPAIR PLATE	1	0.032 CLAD 2024-T3 [A]

TABLE I

A55054

Repair to Pressure Bulkhead at Station 1440
Figure 2 (Sheet 1)





DETAIL I

Repair to Pressure Bulkhead at Station 1440
Figure 2 (Sheet 2)

A55407

FUSELAGE SKIN - EXTERNAL REPAIR AT LAP SPLICE

TEMPORARY REVISION 53-25

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: To change fuselage skin external repair at a lap splice.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
53-3-2	6	Feb 1/93
	6B	Feb 1/93
	7	Feb 1/93

REPAIR INSTRUCTIONS

1. Remove the fasteners from the longitudinal lap splices as necessary.
2. Use the tape to put a stainless steel sheet approximately 0.025 thick on the fuselage skin as shown in 51-9-1, Fig. 3.

CAUTION: CUT THE DAMAGED PART OF THE SKIN CAREFULLY TO PREVENT DAMAGE TO THE TEAR STRAP. IF THE TEAR STRAP IS DAMAGED, IT MUST BE REPAIRED TO KEEP THE FAIL-SAFE STRENGTH OF THE INITIAL TEAR STRAP.

3. Cut out the damaged skin. The top and bottom of the cutout must be parallel to the stringer. Do not cut the stringer. If the stringer is damaged, repair the stringer as shown in 53-3-4, Fig. 1 or Fig. 3.
4. Radius the corners of the cutout. Put all of the skin which is out of contour back to contour.
5. Install countersink washers in the initial holes in the skin, which will be below the repair plate. Refer to 51-2-8, Fig. 4 for countersink repair washers.
6. Make the repair parts.
7. Assemble the repair parts. Drill the fastener holes.
8. Remove the repair parts.
9. Remove all of the nicks, scratches, gouges, burrs, and sharp edges from the skin and the repair parts.
10. Apply a chemical conversion coating to the repair parts and to the bare edges of the skin. Refer to 51-80-0.
11. Apply one layer of BMS 10-79, Type III primer to the repair parts and to the bare edges of the skin.
12. Install the repair parts with BMS 5-95 sealant between the mating surfaces.
13. Install the non-aluminum fasteners wet with BMS 5-95 sealant. Refer to Table I for solid rivet repair. Refer to Table II for blind rivet repair.
14. Apply a finish to the repair area. Refer to 51-2 of the Maintenance Manual.

NOTES

- USE THIS REPAIR WHEN THE OVERLAPPING AND OVERLAPPED SKINS OF ANY LAP JOINT ARE DAMAGED OR HAVE CORROSION.
- DO NOT USE BLIND RIVET REPAIRS WHERE DOUBLERS, TRIPLERS, OR STRUCTURE THAT IS NOT TYPICAL ARE INSTALLED UNLESS:
  - THE BLIND RIVETS WILL BE CORRECTLY SEATED ON THE INTERNAL STRUCTURE.
  - SUFFICIENT RIVET SPACING AND EDGE MARGINS ARE KEPT.
- BLIND RIVET REPAIRS MUST BE INSPECTED AFTER EACH 3000 FLIGHTS. BLIND RIVET REPAIRS MUST BE REPLACED WITH A FLUSH OR EXTERNAL SOLID FASTENER REPAIR AT THE NEXT OVERHAUL (NO MORE THAN 10,000 FLIGHTS AFTER THE BLIND RIVET REPAIR IS INSTALLED).
- WHEN BLIND RIVETS ARE INSTALLED WITH SOLID RIVETS, USE THE SOLID RIVETS SHOWN IN TABLE I. THE SOLID RIVETS MUST BE 1/32 LARGER IN DIAMETER THAN THE SIZE OF THE BLIND RIVETS.
- WHEN YOU USE THIS REPAIR REFER TO:
  - 51-1-3 FOR SEALING OF REPAIRS
  - 51-2 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES AND EDGE MARGINS.
  - 51-4-1 FOR AERODYNAMIC SMOOTHNESS REQUIREMENTS
  - 51-8-0 FOR PROTECTIVE TREATMENT OF METAL
  - 51-2-0 OF THE MAINTENANCE MANUAL FOR INTERIOR AND EXTERIOR FINISHES

[A] USE THE SAME MATERIAL AND HEAT TREAT AS THE INITIAL SKIN. REFER TO TABLE I AND TABLE II FOR THE GAGE OF THE REPAIR SKIN.

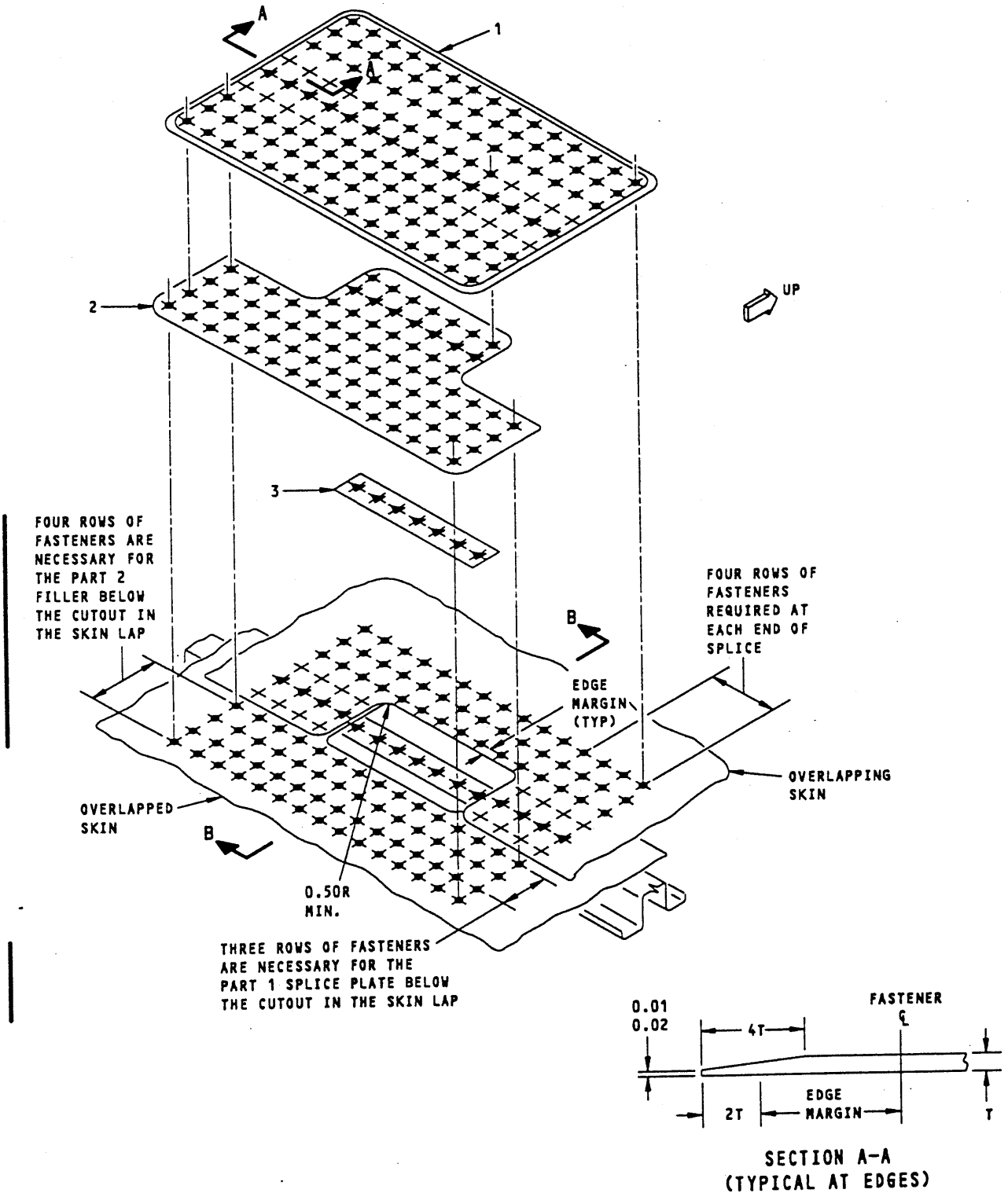
[B] USE THE SAME MATERIAL, HEAT TREAT, AND GAGE AS THE OVERLAPPING SKIN.

[C] USE THE SAME MATERIAL, HEAT TREAT, AND GAGE AS THE OVERLAPPED SKIN.

[D] INSTALL THE FASTENERS WET WITH BMS 5-95 SEALANT.

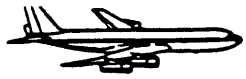
A09012

Fuselage Skin - External Repair at Lap Splice
Figure 5 (Sheet 1)

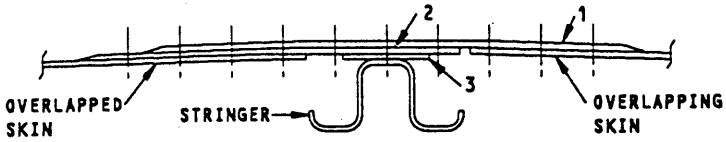


Fuselage Skin - External Repair at Lap Splice
Figure 5 (Sheet 3)

A08683



STRATOLINER
STRUCTURAL REPAIR



SECTION B-B
SECTION THROUGH DAMAGE

INITIAL SKIN GAGE	REPAIR DOUBLER GAGE	PREFERRED FASTENER ✦ [F] [G]	OPTIONAL FASTENER ✦ [G]	SPACING P± 0.03	EDGE MARGIN ± 0.05
0.040	0.045	BACR15BB5D		0.78	0.32
0.045	0.050	BACR15CE5D		0.78	0.37
			BACR15BB6D	0.94	0.37
0.050	0.056	BACR15CE5D		0.78	0.37
			BACR15BB6D	0.94	0.43
0.056	0.063	BACR15CE6D	BACR15BB6D	0.94	0.43
0.063	0.071	BACR15CE6D	BACR15BB6D	0.94	0.43
0.071	0.080	BACR15CE6D	BACR15BB6D	0.94	0.43
0.080	0.090	BACR15CE8D	BACR15BB8D	1.25	0.55
0.090	0.100	BACR15CE8D	BACR15BB8D	1.25	0.55
0.100-0.125	[H]	BACR15CE8D	BACR15BB8D	1.25	0.55

FOR SOLID RIVET REPAIR ONLY
TABLE I

INITIAL SKIN GAGE	REPAIR SKIN GAGE	PREFERRED FASTENER ✦ [D]	NUMBER OF ROWS		SPACING P± 0.03	EDGE MARGIN ± 0.05
			LONGITUDINAL	CIRCUMFERENTIAL		
0.040	0.045	NAS1398D5	3	4	0.78	0.37
0.045	0.050	NAS1398D5	3	4	0.78	0.37
0.050	0.056	NAS1398D5	3	4	0.94	0.43
0.056	0.063	NAS1398D6	3	4	0.94	0.43
0.063	0.071	NAS1398D6	3	4	0.94	0.43
0.071	0.080	NAS1398D6	3	4	0.94	0.43
0.080	0.090	NAS1398D8	3	4	1.25	0.43
0.090	0.100	NAS1398D8	3	4	1.25	0.55
0.100-0.125	[H]	NAS1398D8	3	5	1.25	0.55

FOR BLIND RIVET REPAIR ONLY [E]
TABLE II
Fuselage Skin - External Repair at Lap Splice
Figure 5 (Sheet 4)

A08803

TEMPORARY REVISION 53-26

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: To change fuselage skin lap joint flush repair.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
53-3-2	8	Feb 1/93
	8A	Feb 1/93
	8B	Feb 1/93
	9	Feb 1/93

REPAIR INSTRUCTIONS

If an external repair was done as shown in 53-3-2, figure 5:

- Drill out the fasteners
- Remove the external plate and all the sealant material
- Do steps 3 through 8

CAUTION: CUT THE DAMAGED PART OF THE SKIN CAREFULLY TO PREVENT DAMAGE TO THE TEAR STRAP. IF THE TEAR STRAP IS DAMAGED, IT MUST BE REPAIRED TO KEEP THE FAIL-SAFE STRENGTH OF THE INITIAL TEAR STRAP.

1. Cut out the damaged skin. The top and bottom of the cutout must be parallel to the stringer.
2. Radius the corners of the cutout. Put all of the skin which is out of contour back to contour.
3. Make the repair parts.
4. Assemble the repair parts. Drill the fastener holes. Refer to 53-3-4, Fig. 1 or Fig. 3 for repair of a stringer, if necessary.
5. Remove the repair parts.
6. Remove all of the nicks, scratches, gouges, burrs, and sharp edges from the skin and the repair parts.
7. Apply a chemical conversion coating to the repair parts and to the bare edges of the skin. Refer to 51-8-0.
8. Apply one layer of BMS 10-79, Type III primer to the repair parts and the bare edges of the skin.
9. Install the repair parts with BMS 5-95 sealant between the mating surfaces.
10. Install the non-aluminum fasteners wet with BMS 5-95 sealant. Refer to Table II.
11. Apply BMS 5-95 sealant in the space between the filler and the initial skin.
12. Apply a finish to the repair area. Refer to 51-2 of the Maintenance Manual.

NOTES

- WHEN YOU USE THIS REPAIR REFER TO:
  - 51-1-3 FOR SEALING OF REPAIRS
  - 51-2 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES AND EDGE MARGINS
  - 51-4-1 FOR AERODYNAMIC SMOOTHNESS REQUIREMENTS
  - 51-8-0 FOR PROTECTIVE TREATMENT OF METAL
  - 51-2-0 OF THE MAINTENANCE MANUAL FOR INTERIOR AND EXTERIOR FINISHES

[A] USE THE SAME MATERIAL AND HEAT TREAT AS THE INITIAL SKIN. REFER TO TABLE II FOR THE GAGE OF THE REPAIR SKIN.

[B] USE THE SAME MATERIAL, HEAT TREAT, AND GAGE AS THE OVERLAPPED SKIN.

[C] USE THE SAME MATERIAL, HEAT TREAT, AND GAGE AS THE OVERLAPPING SKIN.

[D] REFER TO DETAIL I AND TABLE II FOR THE DIMENSIONS OF THE TAPERED FILLER.

[E] MS20426D() RIVETS CAN BE USED. THE DEPTH OF THE COUNTERSINK MUST NOT BE LARGER THAN THE DEPTH OF THE COUNTERSINK OF THE EQUIVALENT BACR15CE RIVETS. SHAVE THE RIVET HEADS AS NECESSARY TO USE THE MS20426D() RIVETS.

[F] THE FASTENER COUNTERSINKS MUST NOT BE LARGER THAN 80% OF THE THICKNESS OF THE PLATE. IF THIS CANNOT BE DONE, PROTRUDING HEAD FASTENERS (BACR15BB()D, OPTIONAL MS20470D()) MUST BE USED.

[G] USE THE SAME GAGE AS THE INITIAL SKIN.

[H] KEEP A 0.07 TO 0.05-INCH SPACE BETWEEN THE PART 3 FILLER AND THE INITIAL SKIN CUTOUT ALL AROUND.

A09307

Skin Lap Joint Flush Repair
Figure 6 (Sheet 1)

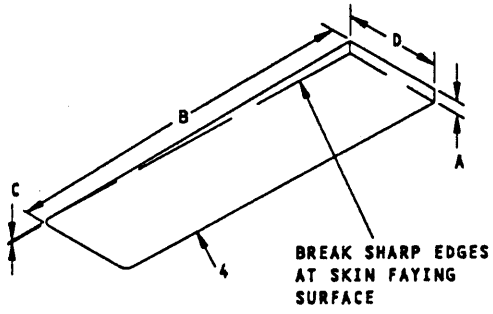
FASTENER SYMBOLS

- INITIAL FASTENER LOCATION. REFER TO SERVICE BULLETIN 707-2962 FOR SKIN GAGES THAT ARE 0.050 INCH OR LESS. FOR SKIN GAGES THAT ARE THICKER THAN 0.050, REFER TO TABLE II.
- INITIAL FASTENER LOCATION. USE THE SAME TYPE, SIZE, AND MATERIAL AS THE INITIAL FASTENER. [F]
- REPAIR FASTENER LOCATION. REFER TO TABLE II.

REPAIR MATERIAL			
PART		QTY	MATERIAL
1	DOUBLER	1	[A]
2	FILLER	1	[B]
3	FILLER	1	[C]
4	TAPERED FILLER	2	2024-T3 [D]

DIMENSIONS FOR TAPERED FILLER				
INITIAL SKIN GAGE	DIM. A	DIM. B	DIM. C	DIM. D
0.040	0.045	6.0	0.02 0.01	1.00
0.045	0.050	6.0	0.02 0.01	1.00
0.050	0.056	6.0	0.02 0.01	1.00
0.056	0.063	6.0	0.02 0.01	1.00
0.063	0.071	6.0	0.02 0.01	1.00
0.071	0.080	6.0	0.02 0.01	1.00
0.080	0.090	6.0	0.02 0.01	1.00
0.090	0.100	6.0	0.02 0.01	1.00
0.100	0.100	6.0	0.02 0.01	1.00
0.125	0.125	8.0	0.02 0.01	1.00

TABLE I



DETAIL I

A09274

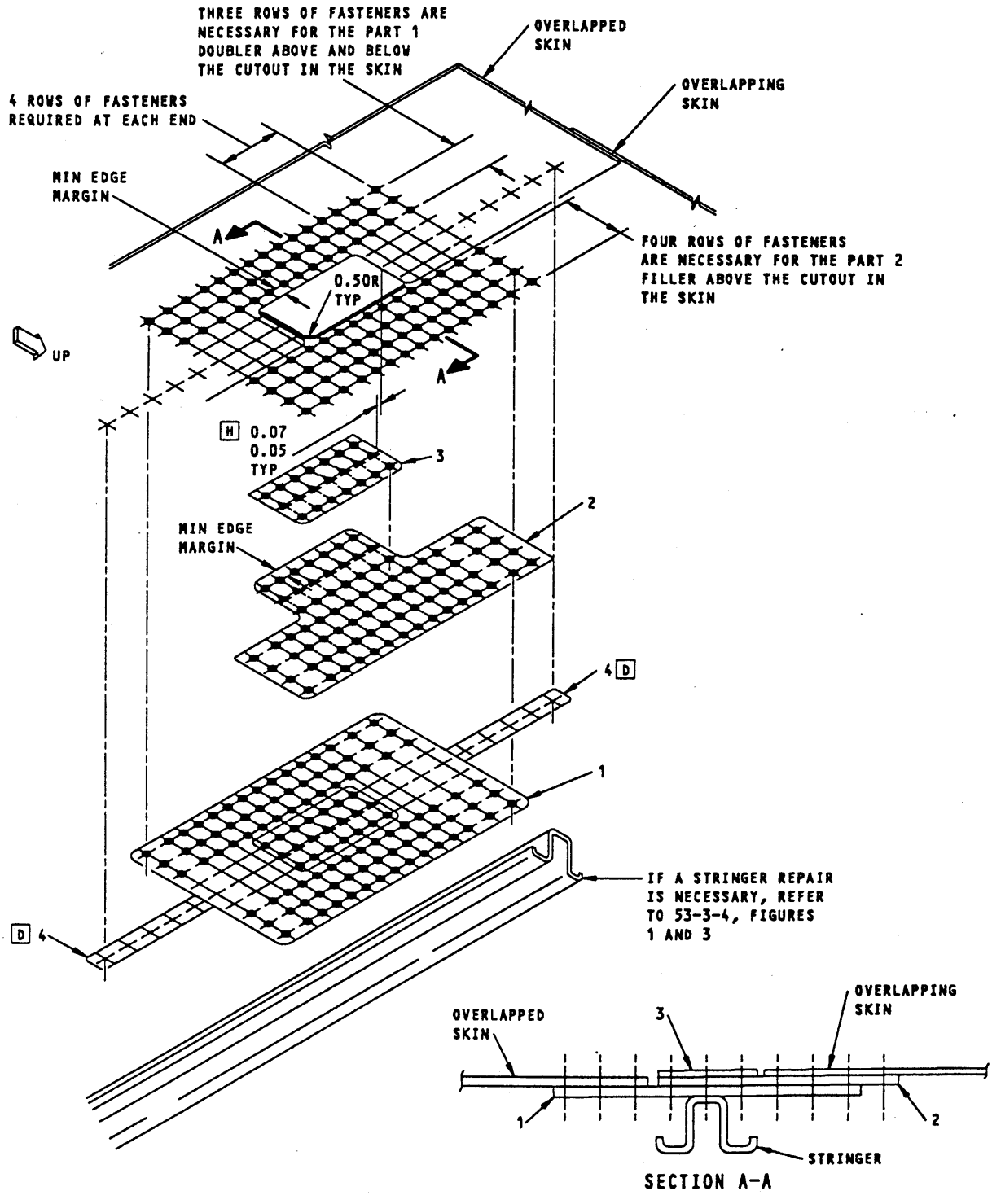
Skin Lap Joint Flush Repair
Figure 6 (Sheet 2)

INITIAL SKIN GAGE	REPAIR DOUBLER GAGE	FASTENER [E] [F]		FASTENER SPACING ± 0.03	EDGE MARGIN ± 0.05
		PREFERRED ✦	OPTIONAL ✦		
0.040	0.045	BACR15BB6D	BACR15BB5D	0.94 0.78	0.37 0.32
0.045	0.050	BACR15BB6D	BACR15BB5D	0.94 0.78	0.37 0.32
0.050	0.056	BACR15CE5D	BACR15BB6D	0.78 0.94	0.37 0.37
0.056	0.063	BACR15CE5D	BACR15BB6D	0.78 0.94	0.37 0.37
0.063	0.071	BACR15CE6D	BACR15BB6D	0.94 0.94	0.43 0.37
0.071	0.080	BACR15CE6D	BACR15BB6D	0.94 0.94	0.43 0.37
0.080	0.090	BACR15CE8D	BACR15BB8D	1.25 1.25	0.55 0.48
0.090	0.100	BACR15CE8D	BACE15BB8D	1.25 1.25	0.55 0.48
0.100-0.125	[G]	BACR15CE8D	BACR15BB8D	1.25 1.25	0.55 0.48

TABLE II

A09188

Skin Lap Joint - Flush Repair
Figure 6 (Sheet 3)



A09407

Skin Lap Joint - Flush Repair
Figure 6 (Sheet 4)

TEMPORARY REVISION 53-27

FILING INSTRUCTIONS

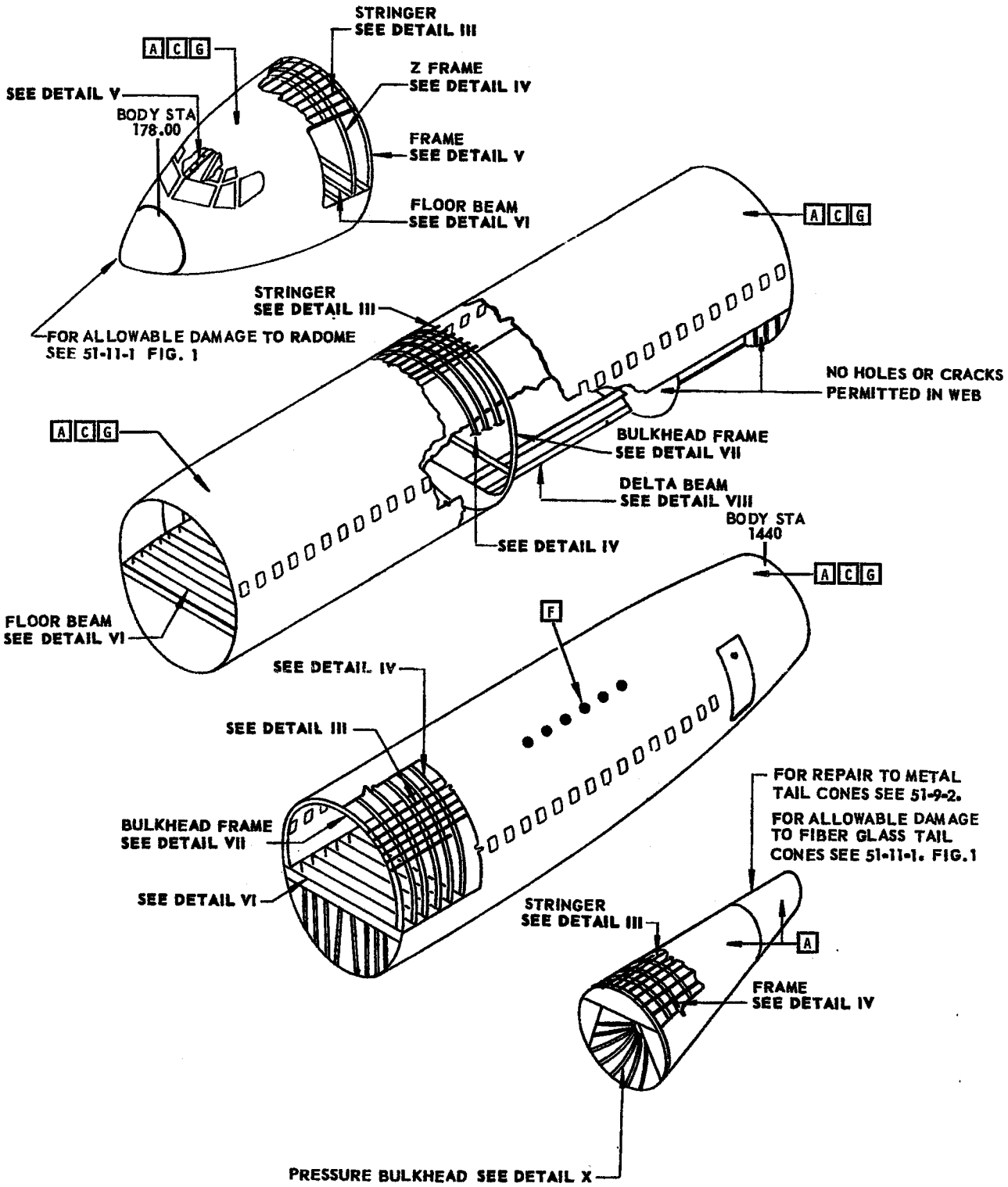
For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: Added new damage and rework limits to fuselage skin allowable damage.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
53-2-1	1	May 17/06
	2	May 17/06
	4A	May 17/06
	4B	BLANK
	5	May 17/06



Allowable Damage - Fuselage
Figure 1 (Sheet 1)

NOTES

FOR GENERAL REPAIR PROCEDURES REFER TO 51-13-1, PAR. 2

CLEAN UP NICKS TO 1.00 MIN RADIUS.

FOR AERODYNAMIC SMOOTHNESS RE UIREMENTS REFER TO 51-4-1.

IN THE FUSELAGE CAVITY, MAXIMUM ALLOWABLE CROSS SECTION AREA REMOVED INCLUDING ALL EXISTING HOLES SHALL NOT EXCEED 15 OF THE TOTAL CROSS SECTIONAL AREA (SKIN AND CONTIGUOUS INTERNAL STRUCTURE) IN ANY LOCAL REGION EXCEPT IN THE CROWN AREA BETWEEN BS 600 AND BS 1160, S-6LH AND S-6RH WHERE ONLY 10 OUT IS ALLOWED.

MAXIMUM DEPTH OF SCRATCH OR GOUGE NOT TO EXCEED 1/4 MATERIAL THICKNESS PROVIDING RE UIREMENTS IN ABOVE PARAGRAPH ARE MAINTAINED. ROUND OUT AND TREAT ALL SCRATCHES AND GOUGES PER DETAIL I.

MAINTAIN EDGE MARGIN ON ALL FASTENERS.

[A] MAXIMUM OF DEPTH OF A SCRATCH OR GOUGE IN THE SKIN AND PRESSURE WEBS, IS NOT TO EXCEED THAT GIVEN IN FIG. 2. ROUND OUT AND TREAT ALL SCRATCHES AND GOUGES PER DETAIL I. FOR ADDITIONAL LIMITATIONS AND REPAIR INFORMATION SEE FIG. 2.

[B] AFTER CLEAN UP

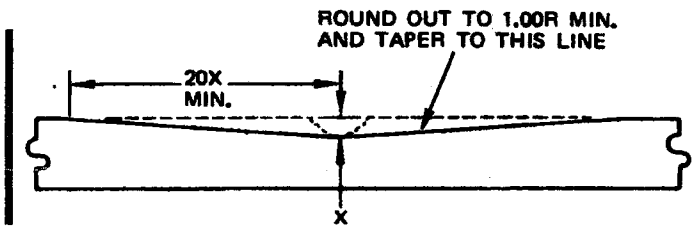
[C] SMOOTH DENTS IN THE FUSELAGE SKIN WHICH DO NOT EXCEED THE LIMITS ESTABLISHED BY FIG. 4 AND WHICH HAVE NO PULLED OR LOOSE RIVETS, CREASES, GOUGES OR CRACKS ARE CONSIDERED ALLOWABLE. REPAIR DENTS WHICH EXHIBIT PULLED OR LOOSE RIVETS, CREASES, GOUGES OR CRACKS PER FIG. 2.

[D] PLUG HOLES WITH RIVETS.

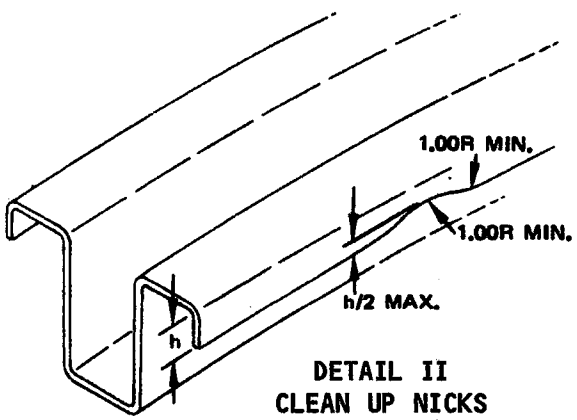
[E] PLUG ONLY IF OUTSIDE THE CENTER HALF OF WEB WIDTH. PLUG WITH RIVETS TO MAX. DIA OF 0.25. BEYOND THIS DIA PLUG WITH 5056 SLUGS INSTALLED WET WITH PRIMER. IF MATERIAL IS 2024 DO NOT INSTALL 5056 SLUGS.

[F] FOR REPAIR OF LIGHTNING STRIKE DAMAGE SEE 53-3-2, FIG. 22.

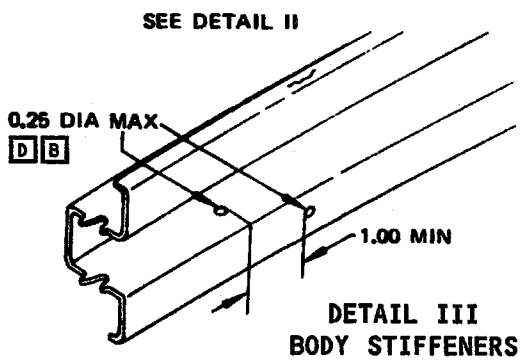
[G] SEE DETAIL XI THRU XIII FOR LAP SPLICE, BUTT JOINT AND REPAIR PERIPHERY DAMAGE AND REWORK LIMITS. IF YOU CAN NOT REMOVE THE DAMAGE WITHIN THE LIMITS AS GIVEN IN APPLICABLE DETAILS, CONTACT THE BOEING COMPANY WITH DESCRIPTION OF DAMAGE FOR REWORK AND/OR REPAIR INFORMATION.



DETAIL I
SECTION THROUGH GOUGE

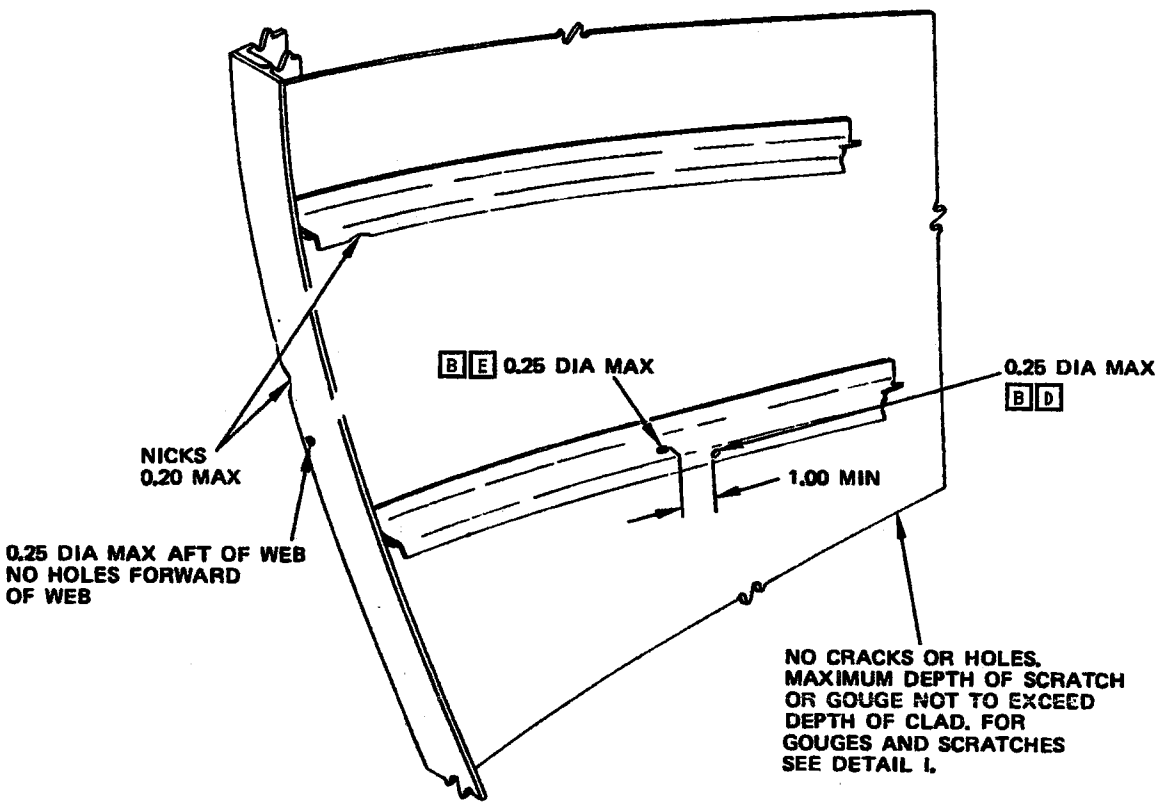


DETAIL II
CLEAN UP NICKS



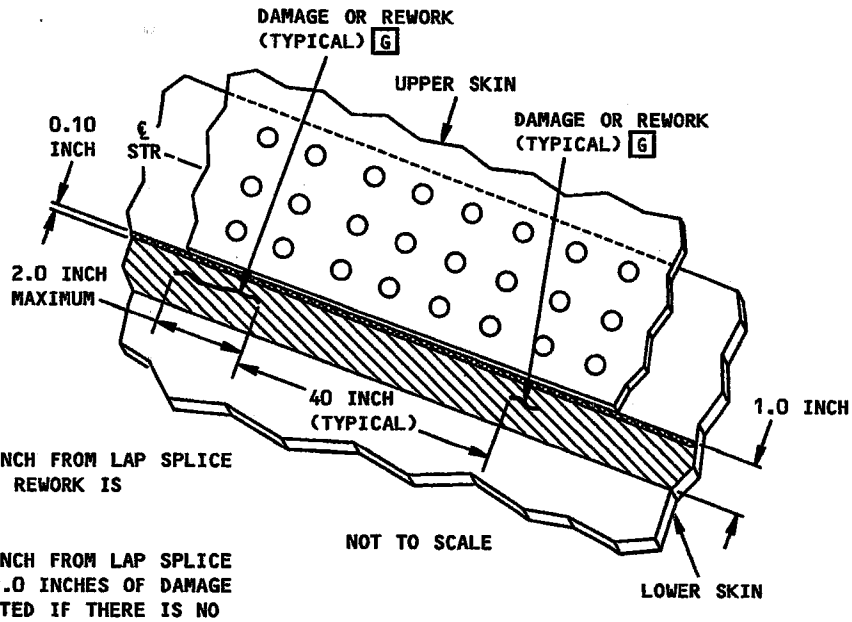
DETAIL III
BODY STIFFENERS

Allowable Damage - Fuselage
Figure 1 (Sheet 2)



DETAIL X
PRESSURE BULKHEAD

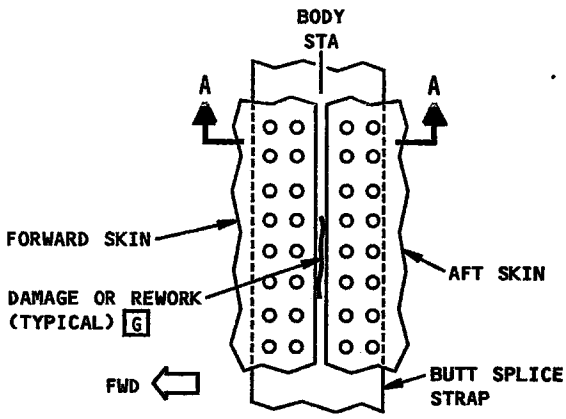
Allowable Damage - Fuselage
Figure 1 (Sheet 5)



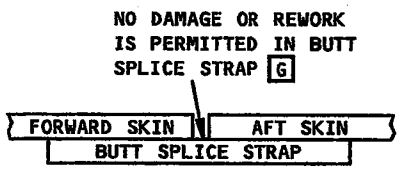
0.00 INCH TO 0.10 INCH FROM LAP SPLICE EDGE. NO DAMAGE OR REWORK IS PERMITTED. G

0.10 INCH TO 1.00 INCH FROM LAP SPLICE EDGE. MAXIMUM OF 2.0 INCHES OF DAMAGE OR REWORK IS PERMITTED IF THERE IS NO OTHER DAMAGE OR REWORK IN THE ZONE WITHIN 40 INCHES FORWARD OR AFT. A G

SKIN LONGITUDINAL LAP SPLICE LIMITS
DETAIL XI

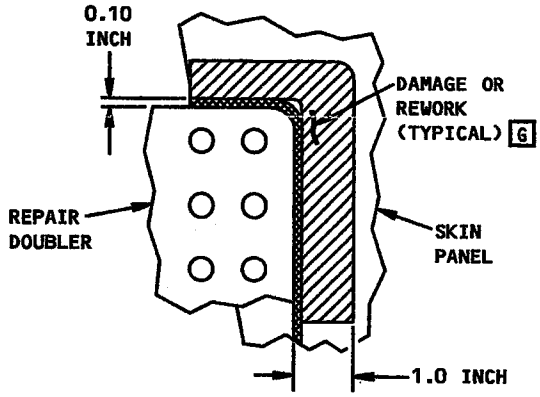


TYPICAL SKIN BUTT JOINT



SECTION A-A

CIRCUMFERENTIAL BUTT SPLICE LIMITS
DETAIL XII



TYPICAL SKIN EXTERNAL REPAIR
DOUBLER PARTIAL VIEW

0.00 INCH TO 0.10 INCH FROM EDGE OF REPAIR DOUBLER. NO DAMAGE OR REWORK IS PERMITTED. G

0.10 INCH TO 1.00 INCH FROM EDGE OF REPAIR DOUBLER. MAXIMUM OF 2.0 INCHES REWORK OF DAMAGE IS PERMITTED, IF THERE IS NO OTHER DAMAGE OR REWORK IN THE ZONE AROUND THE REPAIR WITHIN 40 INCHES. A G

REPAIR PERIPHERY LIMITS
DETAIL XIII

Allowable Damage - Fuselage
Figure 1 (Sheet 6)

TEMPORARY REVISION 56-2

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: To incorporate Passenger Window Frame Repairs.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
56-3-1	1 thru 7	Aug 15/91

962401

REPAIR INSTRUCTIONS

1. Clean up the damage as described in 56-2-1. Make sure that a minimum of 0.05 inch of sound material remains (See Section A-A). More extensive damage requires window frame replacement. Where the damage is confined to the lower flange, the shorter doubler part 1 may be used. Damage which extends further around the frame requires the use of the part 2 doubler.

   For repair of cracks in the window forging, see Fig. 2.

2. Remove the fasteners which will be common to the repair doubler.

3. Install repair washers in the existing countersinks in the skin. Refer to 51-2-8.

4. Make the repair doubler.

5. Locate, drill, ream and countersink the fastener holes. See Detail I.

6. Remove sharp edges from the repair doubler 0.015 R to 0.030 R, except at the faying surface of the doubler.

7. Apply the alodine to the doubler. Refer to 51-8-0.

8. Clean skin and doubler with Methyl Ethyl Ketone (MEK).

9. Install the repair parts with BMS 5-95 sealant between the faying surfaces. Install the fasteners wet with BMS 5-95 sealant.

10. Fill irregularities in window frame with BMS 5-28, Type 3 sealant as necessary to give a smooth surface for the window seal.

    NOTE: To avoid unnecessary hand working of the epoxy filler, use a metal strip and parting film of polyethylene clamped up until the cure is complete.

11. Apply the finish to the repair area. Refer to 51-20-0 of the 720 Maintenance Manual.

NOTES

- WHEN YOU USE THIS REPAIR REFER TO:
  - 51-1-3 FOR SEALING OF REPAIRS
  - 51-2 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES, EDGE MARGINS, OVERSIZE FASTENERS AND COUNTERSINK REPAIR WASHERS
  - 51-4-1 FOR AERODYNAMIC SMOOTHNESS REQUIREMENTS
  - 51-8-0 FOR PROTECTIVE TREATMENT OF METAL
  - 51-2-0 OF THE 720 MAINTENANCE MANUAL FOR INTERIOR AND EXTERIOR FINISHES.
- TOLERANCES ± 0.030 INCH UNLESS OTHERWISE NOTED
- PICK UP EXISTING FASTENER LOCATIONS ONLY. DO NOT ADD ANY NEW LOCATIONS.

FASTENER SYMBOLS

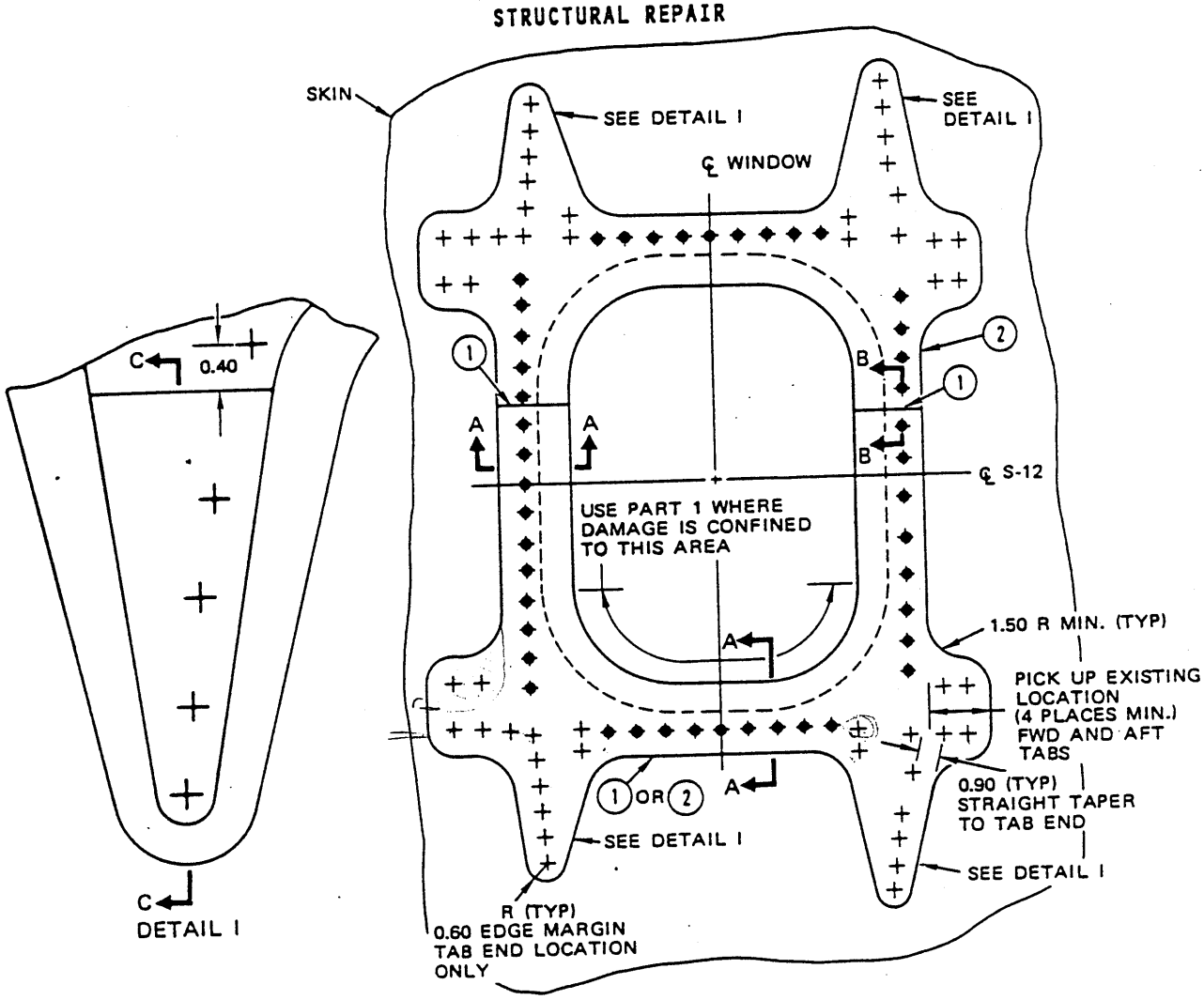
+ EXISTING FASTENER. INSTALL BACB30FQ8 1/64 INCH OVERSIZE HEX DRIVE BOLT WITH BACC30AG COLLAR.

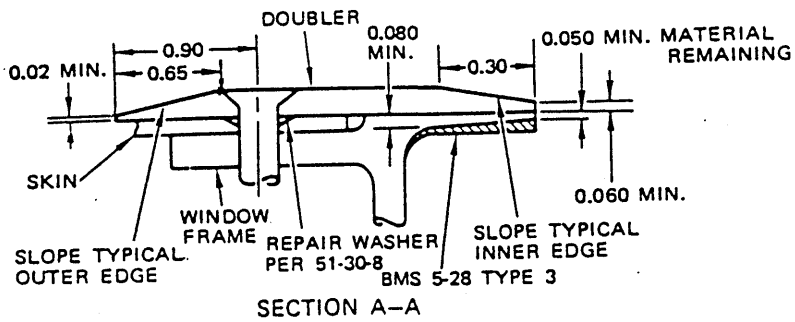
✦ REPAIR FASTENER. INSTALL BACB30DY8-( )X 1/64 INCH OVERSIZE TENSION LOCKBOLT WITH NAS 1080 COLLAR.

REPAIR MATERIAL			
PART		QTY	MATERIAL
1	DOUBLER	1	0.160 CLAD 2024-T3
2	DOUBLER	1	0.160 CLAD 2024-T3

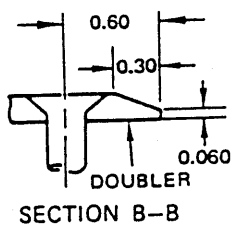
REPAIR MATERIAL
TABLE I

Passenger Window Frame - External Repair
Figure 1 (Sheet 1)

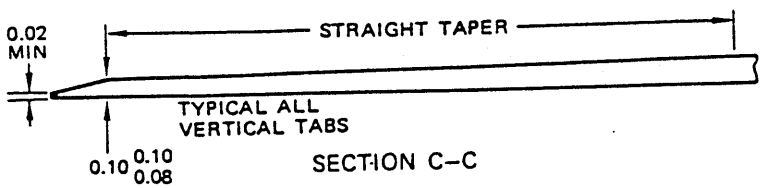




SECTION A–A



SECTION B–B



SECTION C–C

L.H. SIDE VIEW R.H. OPPOSITE

Passenger Window Frame - External Repair
Figure 1 (Sheet 2)

APPLICABILITY

THIS REPAIR IS APPLICABLE TO PASSENGER WINDOW FRAMES WHICH ARE CRACKED. THIS REPAIR CAN ONLY BE USED WHEN THE CRACK IS FOUND IN THE SHADED AREAS AS SHOWN IN DETAILS I AND II.

REPAIR INSTRUCTIONS

NOTE: A CRACK IN THE HORIZONTAL FLANGE OF THE WINDOW FRAME REQUIRES AN INTERNAL REPAIR ANGLE PART 1 AND AN EXTERNAL DOUBLER PART 3 (SEE DETAIL I). THE EXTERNAL DOUBLER PART 3 MAY BE USED TO REPAIR THE UPPER OR LOWER HORIZONTAL FLANGES OF THE WINDOW FRAME BY ROTATING THE DOUBLER 180 DEGREES. A CRACK IN THE VERTICAL FLANGE OF THE WINDOW FRAME REQUIRES AN INTERNAL REPAIR ANGLE PART 2 AND AN EXTERNAL DOUBLER PART 4 (SEE DETAIL II).

1. Remove the original fasteners and the sealant as necessary to accomplish the repair.

2. Inspect the window forging area around the crack using eddy current NDT procedures to ensure that no other cracks are present. Refer to Part 6 of the 720 Nondestructive Test Manual, (D6-48023). If other cracks are found, contact the Boeing Company.

3. Stop drill the ends of the cracks. Refer to 51-2-10.

4. Clean up the damage as described in 56-0-1. (Refer to Fig. 1 for additional damage repair restrictions.)

5. Remove all burrs, nicks, scratches and gouges.

6. Remove sharp edges 0.015 R to 0.030 R except at the faying surface of the doubler.

7. Make the repair parts. Refer to Fig. 1 for the fabrication of the external doublers.

8. Assemble the repair parts. Locate, drill, ream and countersink the repair fastener holes as necessary.

9. Apply alodine and one coat of BMS 10-11 primer to all bare aluminum surfaces on the repair parts and on the reworked surfaces of the original parts. Refer to 51-8-0.

10. Cadmium plate the CRES repair angle and apply the finish with two layers of BMS 10-11 primer. Refer to 51-8-0.

11. Install repair washers in the existing countersink holes in the skin per to 51-2-8.

12. Install the repair parts with BMS 5-95 sealant between the faying surfaces.

13. Install the fasteners wet with BMS 5-95 sealant.

14. Apply the finish to the repair areas. Refer to 51-2-0 of the 720 Maintenance Manual.

NOTES

- WHEN YOU USE THIS REPAIR REFER TO:
  - 51-1-3 FOR SEALING OF REPAIRS
  - 51-2 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES, EDGE MARGINS, OVERSIZE FASTENERS AND COUNTERSINK REPAIR WASHERS
  - 51-4-1 FOR AERODYNAMIC SMOOTHNESS REQUIREMENTS
  - 51-8-0 FOR PROTECTIVE TREATMENT OF METAL
  - 51-2-0 OF THE 720 MAINTENANCE MANUAL FOR INTERIOR AND EXTERIOR FINISHES.
  - PART 6 OF THE 720 NONDESTRUCTIVE TEST MANUAL (D6-48023) FOR EDDY CURRENT INSPECTION PROCEDURES.

[A] THIS REPAIR IS LIMITED TO CRACKS IN THE CENTER PORTION OF THE SKIN ATTACH FLANGE AND THE INBOARD FLANGE OF THE WINDOW FORGING AS SHOWN BY THE SHADED AREA IN DETAILS I AND II.

Passenger Window Frame - Forging Repair
Figure 2 (Sheet 1)

FASTENER SYMBOLS

+ EXISTING FASTENERS

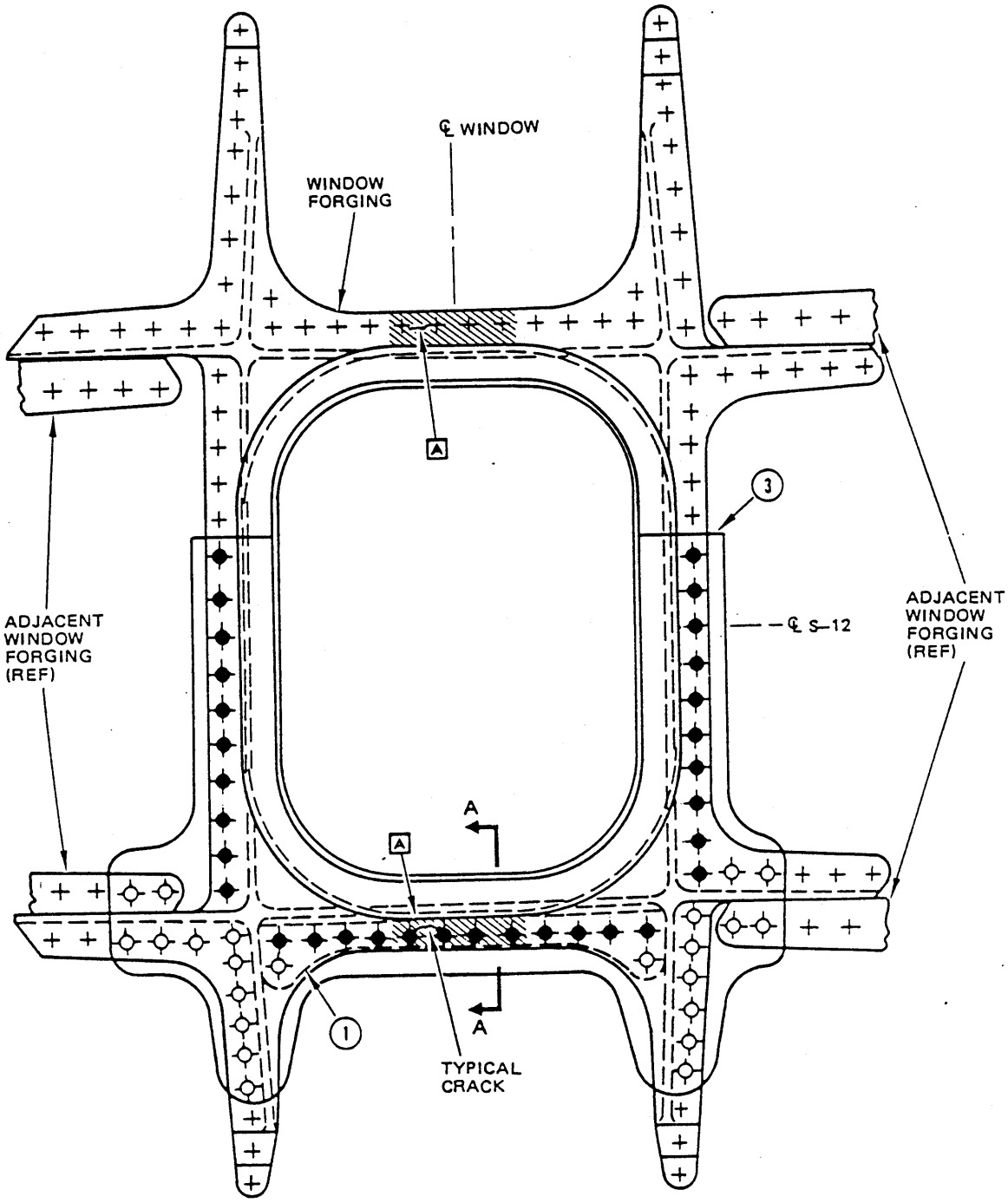
✦ REPAIR FASTENER. INSTALL BACB30DY8-( )X 1/64 INCH OVERSIZE TENSION LOCKBOLT WITH NAS 1080 COLLAR.

REPAIR FASTENER. INSTALL BACB30FQ8 1/64 INCH OVERSIZE HEX DRIVE BOLT WITH BACC30AG COLLAR.

REPAIR MATERIAL			
PART		QTY	MATERIAL
1	ANGLE	1	0.090 CRES AISI 301 HALF HARD
2	ANGLE	1	0.090 CRES AISI 301 HALF HARD
3	DOUBLER	1	0.160 CLAD 2024-T3
4	DOUBLER	1	0.160 CLAD 2024-T3

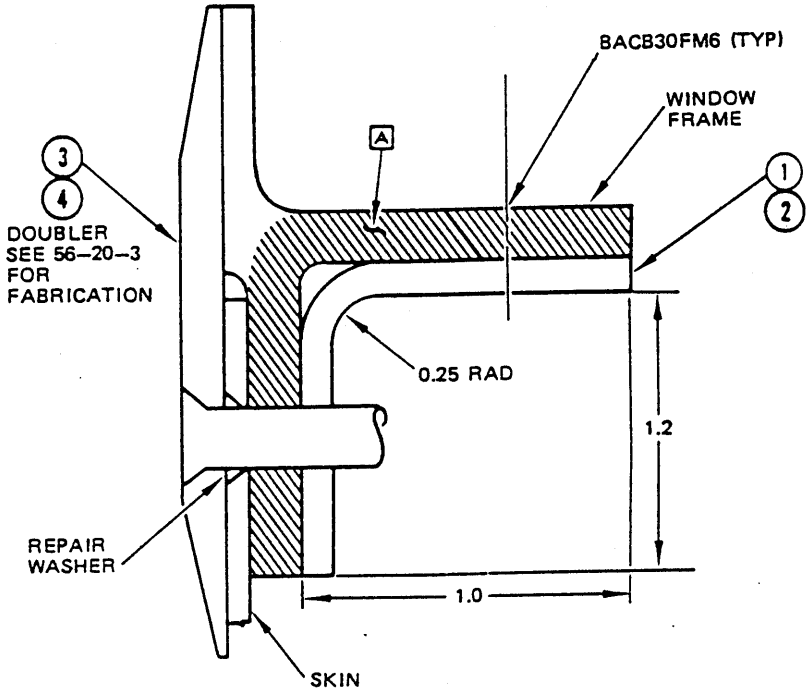
REPAIR MATERIAL
TABLE I

Passenger Window Frame - Forging Repair
Figure 2 (Sheet 2)



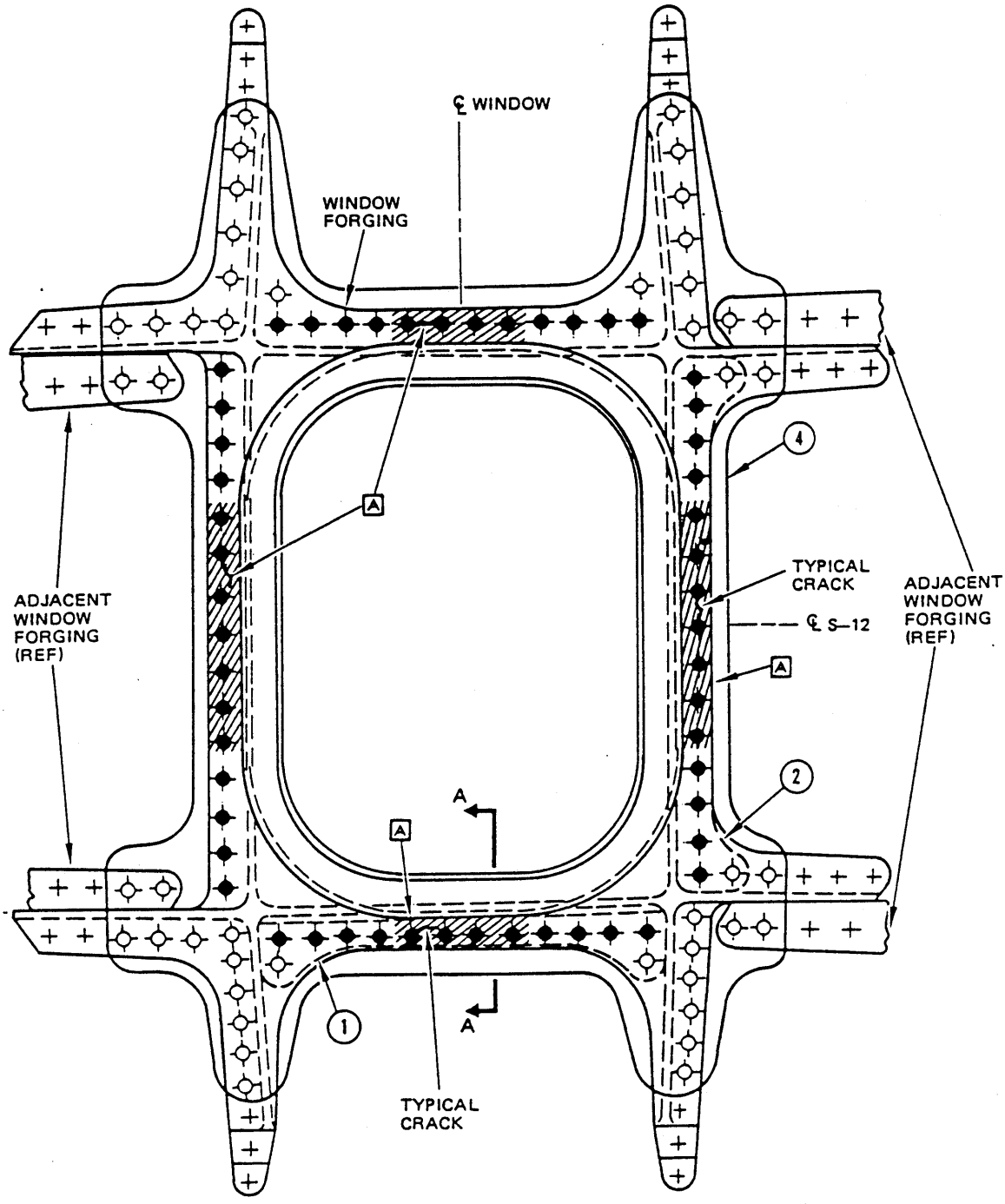
REPAIRS TO CRACKS IN HORIZONTAL FLANGES
DETAIL I

Passenger Window Frame - Forging Repair
Figure 2 (Sheet 3)



SECTION A–A (TYPICAL)

Passenger Window Frame - Forging Repair
Figure 2 (Sheet 4)



REPAIRS TO CRACKS IN VERTICAL OR BOTH VERTICAL AND HORIZONTAL FLANGES

DETAIL II

Passenger Window Frame - Forging Repair
Figure 2 (Sheet 5)

TEMPORARY REVISION 57-10

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: To add allowable damage limits to fastener areas on the inspar wing skin.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
57-2-1	2J thru 2N	Apr 7/95

E96470

APPLICABILITY

THESE BLENDOUT AND FASTENER REPLACEMENT INSTRUCTIONS ARE APPLICABLE WHEN THERE IS DAMAGE AROUND FASTENER HOLE AREAS IN THE EXTERNAL SURFACE OF THE WING INSPAR SKINS.

WHEN YOU DO THE DAMAGE REMOVAL OR FASTENER REPLACEMENT PROCEDURES, REFER TO SRM 57-2-1, FIG. 1A. FIG. 1A GIVES THE ALLOWABLE DAMAGE LIMITS OF THE WING INSPAR SKIN OUTBOARD OF BBL 70.5.

BLENDOUT INSTRUCTIONS

1. Remove the damage or corrosion from the skin. If there are steel fasteners in the corrosion area, remove them before you remove the damage or corrosion from the skin.

   CAUTION: DO NOT GRIND INTO A TITANIUM FASTENER. SMALL PARTICLES OF TITANIUM ARE FLAMMABLE. SAND INTO THE FASTENER MANUALLY OR WITH TOOLS. REFER TO PAR. 4. IN SRM 51-1-1.

2. See Table I for the maximum depth of material permitted to be removed from a fastener head.

   For aluminum rivets, sand or grind into the fastener head to remove the damage or corrosion around the fastener. For titanium fasteners, sand the fastener area to remove the damage or corrosion. See Detail I.

   Make the blendout area smooth to 125 microinches R_a or better.

3. Examine the area of the cleanup for remaining damage or corrosion. Do a 10x visual inspection to make sure the damage is removed from the surface. Do an ultrasonic inspection to make sure there is no damage under the surface. If:

   A. - All damage is removed.
   - The material removed from the fastener head is not more than the depth in Table I.

   Do the instructions in Procedure I.

   B. - There is remaining damage or corrosion, or
   - The material removed from the fastener head is more than the depth in Table I, or
   - The fastener is not listed in Table I.

   The fastener must be removed and replaced. Do the instructions in Procedure II.

PROCEDURE I

1. Shot peen the damage area.
2. Apply Alodine 600. Refer to SRM 51-8-0.
3. Apply one layer of BMS 10-79, Type III primer. Refer to SOPM 20-44-04.
4. Restore an aerodynamic surface:
   - Fill the area with BMS 5-95 sealant
   - Let the sealant cure
   - Apply one more layer of BMS 10-79, Type III primer over the sealant. Refer to SOPM 20-44-04
   - Apply one layer of BMS 10-100 to the upper skin. Apply BMS 5-95, Class F sealant plus BMS 10-60 protective enamel to the lower skin.

PROCEDURE II

WARNING: REMOVE THE FUEL FROM THE TANKS. SUPPLY THE TANK WITH A GOOD FLOW OF AIR. FUEL VAPORS ARE DANGEROUS AND EXPLOSIVE. REFER TO AMM 28-0.

1. Remove the fastener. [A]
2. Remove the damage or corrosion from around the fastener hole, but do not blend the area. Refer to SRM 57-2-1 Fig. 1A for the allowable damage limits of the inspar skin.
3. Do a 10x visual inspection to make sure the damage is removed from the surface.
   - If the damage is more than the limits given in SRM 57-2-1, Fig. 1A, do note [G].
   - If the damage is not more than the limits given in SRM 57-2-1, Fig. 1A, blend the damage area. Refer to Detail II. Make the blendout smooth to 125 microinches R_a or better.
4. Do a penetrant inspection to make sure the damage is removed from the surface. Do an ultrasonic inspection to make sure there is no damage under the surface.
5. Do a high frequency eddy current (HFEC) test around the fastener hole area and in the hole to make sure there are no cracks. Refer to NDT Part 6, 57-30-07. If there are signs of a crack in the hole, go to the Boeing Company for instructions.
6. Shot peen the damaged area.
7. Drill and countersink the fastener hole. [B] [C]
8. Apply Alodine 600 to the blendout area and countersink. Refer to SRM 51-8-2.

E96471

Wing Inspar Skin - Removal of Damage at a Fastener
Figure 1B (Sheet 1)

BLENDOUT INSTRUCTIONS (CONT)

PROCEDURE II (CONT)

9. Apply one layer of BMS 10-79, Type III primer to the blendout area and the countersink. Refer to SOPM 20-44-04.
10. Install the fastener wet with sealant and seal the collar. Refer to SRM 51-9-1.

    NOTE: If the initial fastener is a steel hex drive bolt or lockbolt, install a 1/64 inch or 1/32 inch oversize hex drive bolt. Use a hex drive bolt that has the same type of head as the initial fastener.
11. Restore an aerodynamic surface:
    - Fill the area with BMS 5-95 sealant
    - Let the sealant cure
    - Apply one more layer of BMS 10-79, Type III primer over the sealant. Refer to SOPM 20-44-04
    - Apply one layer of BMS 10-100 to the upper skin. Apply BMS 5-95, Class F sealant plus BMS 10-60 protective enamel to the lower skin.

NOTES

- D = THE DIAMETER OF A FASTENER OR A FREEZE PLUG
- THE NONDESTRUCTIVE INSPECTION (NDI) PROCEDURES SPECIFIED IN THE INSTRUCTIONS ARE BOEING RECOMMENDATIONS. THE OPERATOR MUST MAKE A DECISION, GIVEN THEIR EXPERIENCE, IF THESE PROCEDURES ARE APPLICABLE TO THE TYPE OF DAMAGE FOUND.
- HEX DRIVE BOLTS MADE OF ALUMINUM COATED TITANIUM ARE MORE DURABLE THAN HEX DRIVE BOLTS MADE OF CADMIUM PLATED STEEL. THUS HEX DRIVE BOLTS MADE OF ALUMINUM COATED TITANIUM ARE PREFERRED.
- ALL DIMENSIONS ARE IN INCHES, UNLESS GIVEN DIFFERENTLY
- REFER TO AMM 28-0 FOR DEFUELING A FUEL TANK
- REFER TO AMM 51-2-0 FOR INTERIOR AND EXTERIOR FINISHES
- REFER TO AMM 51-2-12 FOR CORROSION CONTROL ON THE SKIN AND FASTENERS
- REFER TO NDT MANUAL, PART 4, 57-30-07 FOR ULTRASONIC INSPECTION PROCEDURES ON WING SKINS
- REFER TO NDT MANUAL, PART 6, 57-30-07 FOR THE EDDY CURRENT PROCEDURES ON WING SKINS
- REFER TO SOPM 20-10-03 FOR SHOT PEEN PROCEDURES
- REFER TO SOPM 20-20-02 FOR PENETRANT INSPECTION PROCEDURES
- REFER TO SOPM 20-44-04 FOR THE APPLICATION OF CORROSION RESISTANT PRIMER
- REFER TO SRM 51-2-2 FOR FASTENER REMOVAL AND INSTALLATION
- REFER TO SRM 51-2-3 FOR FASTENER SUBSTITUTION
- REFER TO SRM 51-2-5 FOR FASTENER HOLE SIZES
- REFER TO SRM 51-2-11 FOR COLD WORKING HOLES FOR FATIGUE IMPROVEMENT.
- REFER TO SRM 51-4-1 FOR AERODYNAMIC SMOOTHNESS
- REFER TO SRM 51-8-0 FOR PROTECTIVE TREATMENT OF METAL REPAIR PARTS
- REFER TO SRM 51-8-4 FOR FREEZE PLUG INSTALLATION
- REFER TO SRM 51-9-1 FOR REPAIR SEALING
- REFER TO SRM 51-13-1 FOR GENERAL REPAIR PROCEDURES.

[A] WHEN YOU REMOVE FASTENERS THAT ATTACH THE SKIN TO A STRUCTURE, DO AS FOLLOWS:
- DO NOT REMOVE MORE THAN 75% OF THE FASTENERS AT ONE TIME
- KEEP A MINIMUM OF ONE FASTENER, IN A ROW OF FOUR FASTENERS, IN POSITION.

[B] SEE TABLE II OR TABLE III FOR THE REPLACEMENT FASTENER. DO NOT USE TABLE III UNLESS THE REMAINING SKIN THICKNESS IS LESS THAN THE MINIMUM THICKNESS SHOWN IN TABLE II.

MAKE SURE ALL OF THE COUNTERSINK IS CLEANED UP. IF THE COUNTERSINK IS NOT CLEANED UP WITH THE FASTENER FROM TABLE II OR TABLE III, GO TO THE BOEING COMPANY FOR INSTRUCTIONS.

[C] COLD WORK ALL HOLES IN THE LOWER WING SKIN. USE THE HIGH INTERFERENCE COLD WORK METHOD. REFER TO SRM 51-2-11.

COLD WORK HOES IN THE UPPER WING SKIN, INBOARD OF WBL 545, AS GIVEN IN SRM 51-2-11. KEEP EDGE MARGINS TO A MINIMUM OF 1.750.

NOTE: IF AN AIRPLANE IS COVERED IN A SERVICE BULLETIN, COLD WORK THE HOLES AS GIVEN IN THAT SERVICE BULLETIN.

SOME AIRPLANES REQUIRE AN INSPECTION AS GIVEN IN AIRWORTHINESS DIRECTIVE AD 94-10-06. IN THIS CASE, YOU MUST GET APPROVAL FROM THE APPLICABLE REGULATORY AUTHORITY TO REWORK THE AREAS EXAMINED IN THIS DIRECTIVE.

E96472

Wing Inspar Skin - Removal of Damage at a Fastener
Figure 1B (Sheet 2)

NOTES (CONTINUED)

[D] DO NOT GRIND INTO THE HEAD OF A FASTENER THAT DOES NOT HAVE A REPLACEMENT GIVEN IN TABLE II.

[E] IF A FASTENER IS NOT LISTED, GO TO THE BOEING COMPANY. THE BOEING COMPANY WILL TELL YOU WHICH REPLACEMENT FASTENER TO USE.

[F] IF THE THICKNESS OF THE SKIN AT THE FASTENER AFTER CLEANUP IS LESS THAN THE MINIMUM SHOWN, DO AS FOLLOWS:

- FOR AN INITIAL ALUMINUM RIVET WITH A 30° TO 82° COUNTERSINK, SEE TABLE III
- FOR THE OTHER FASTENERS GIVEN IN THE TABLE, DO NOTE [H] OR GET INSTRUCTIONS FROM THE BOEING COMPANY.

[G] IF THE SKIN THICKNESS AT THE FASTENER AFTER CLEANUP WILL BE LESS THAN THE MINIMUMS SHOWN:

- GIVE THE BOEING COMPANY DETAILS OF THE CLEANUP, OR
- DO NOTE [H].

[H] DO A COUNTERSUNK FREEZE PLUG REPAIR AND GIVE THE BOEING COMPANY DETAILS OF THE DAMAGE IF ALL OF THESE CONDITIONS APPLY:

- A FASTENER THAT IS ONE SIZE LARGER WILL NOT REMOVE CORROSION IF INSTALLED
- THE DEPTH OF THE CORROSION IS MORE THAN 30 PERCENT OF THE SKIN THICKNESS
- CORROSION IS MORE THAN 1/32 INCH AROUND THE FASTENER HOLE, BUT NOT MORE THAN 0.35 INCH FROM THE CENTERLINE OF THE HOLE
- THERE IS A MINIMUM OF 50 PERCENT OF THE INITIAL MATERIAL REMAINING BETWEEN TWO ADJACENT FASTENERS. THE MAXIMUM DIAMETER OF THE FREEZE PLUG MUST BE 0.7 INCH.

REFER TO SRM 51-8-4 FOR A FREEZE PLUG REPAIR. KEEP EDGE MARGINS TO A MINIMUM OF 2D.

[I] THIS FASTENER IS PREFERRED IF THE DEPTH OF CORROSION REMOVAL IS BETWEEN 0.035 INCH AND THE MAXIMUM LIMITS GIVEN IN SRM 57-2-1, FIGURE 1A.

INITIAL FASTENER	MAXIMUM DEPTH OF MATERIAL REMOVAL FROM A FASTENER HEAD (INCH) [D]			
	3/16 DIA	1/4 DIA	5/16 DIA	3/8 DIA
ALUMINUM RIVET WITH 82°/30° COUNTERSINK	0.01	0.02	0.02	0.02

TABLE I

Wing Inspar Skin - Removal of Damage at a Fastener
Figure 1B (Sheet 3)

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INITIAL FASTENER [E]	FASTENER DIA (INCH)	MINIMUM THICKNESS OF THE REMAINING SKIN [F]	REPLACEMENT FASTENER [C]
ALUMINUM RIVET WITH 82°/30° COUNTERSINK	3/16	0.10	BACB30NY6K()Y BOLT WITH A BACC30AC6 COLLAR BACB30NW6K()Y BOLT WITH A BACC30R6 COLLAR [I]
	1/4	0.13	BACB30NY8K()Y BOLT WITH A BACC30AC8 COLLAR BACB30NW8K()Y BOLT WITH A BACC30R8 COLLAR [I]
	5/16	0.16	BACB30NY10K()Y BOLT WITH A BACC30AC10 COLLAR BACB30NW10K()Y BOLT WITH A BACC30R10 COLLAR [I]
	3/8	0.19	BACB30NY12K()Y BOLT WITH A BACC30AC12 COLLAR BACB30NW12K()Y BOLT WITH A BACC30R12 COLLAR [I]

TABLE II

INITIAL FASTENER	FASTENER DIA (INCH)	MINIMUM THICKNESS OF THE REMAINING SKIN INCH [G]	REPLACEMENT FASTENER [C]
ALUMINUM RIVET WITH 82°/30° COUNTERSINK	3/16	0.08	BACB30NW6K()Y BOLT WITH A BACC30R6 COLLAR
	1/4	0.09	BACB30NW8K()Y BOLT WITH A BACC30R8 COLLAR
	5/16	0.10	BACB30NW10K()Y BOLT WITH A BACC30R10 COLLAR
	3/8	0.11	BACB30NW12K()Y BOLT WITH A BACC30R12 COLLAR

TABLE III

Wing Inspar Skin - Removal of Damage at a Fastener
Figure 1B (Sheet 4)

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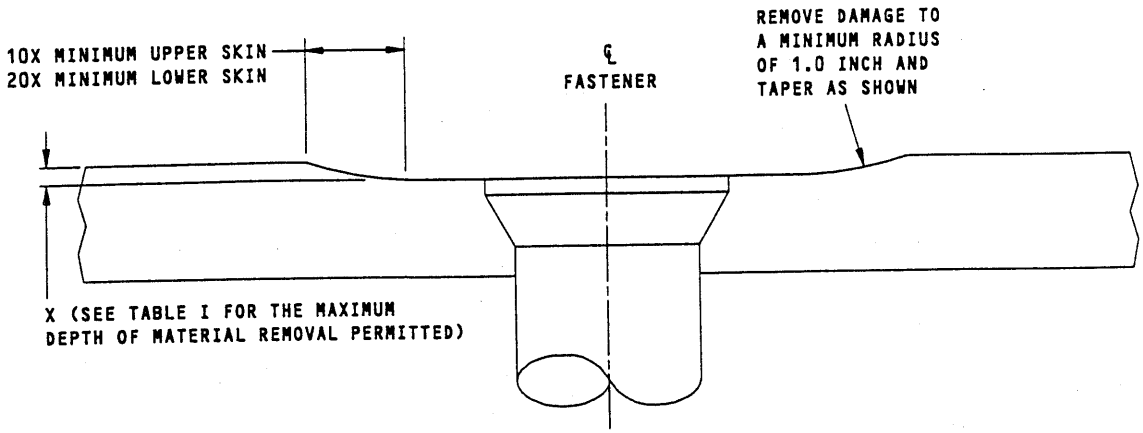
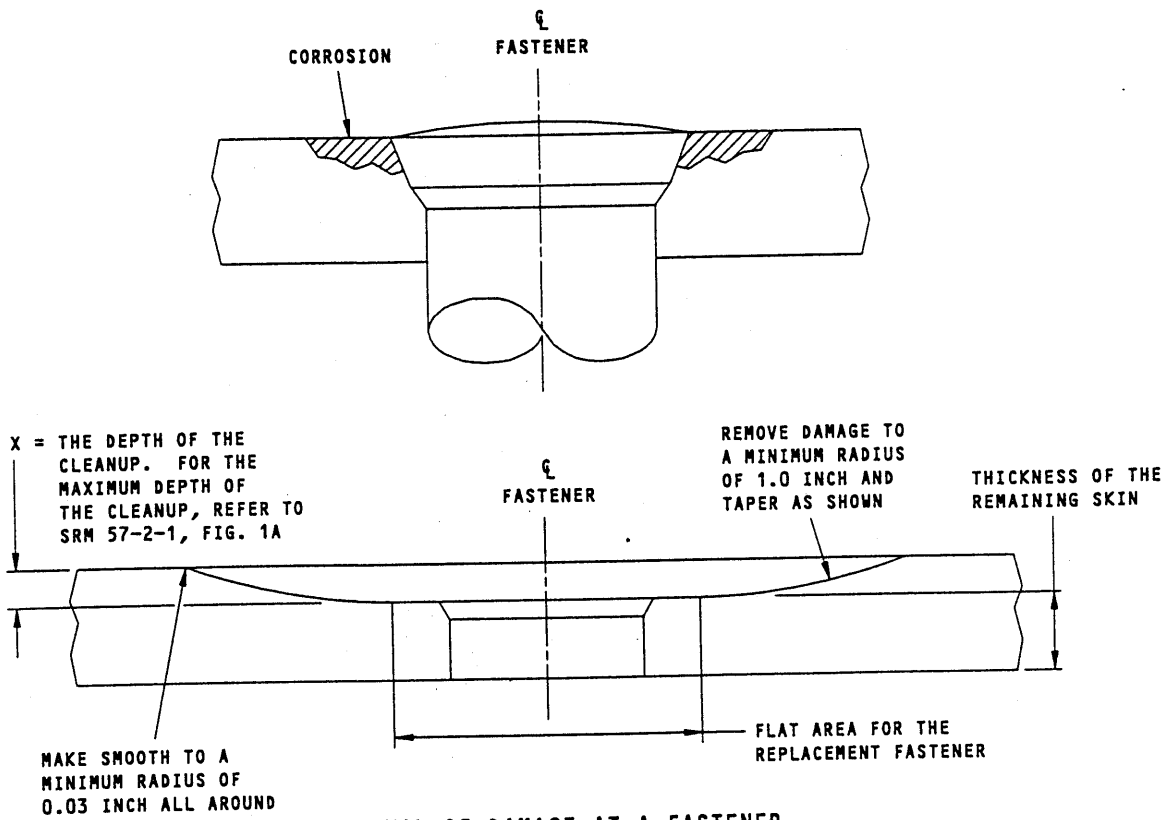


REMOVAL OF DAMAGE BY THE FASTENER-GRIND METHOD
DETAIL I



REMOVAL OF DAMAGE AT A FASTENER
DETAIL II

Wing Inspar Skin - Removal of Damage at a Fastener
Figure 1B (Sheet 5)

E96479

ALLOWABLE DAMAGE - WING SKIN OUTBOARD OF BBL 70.5

TEMPORARY REVISION 57-11

FILING INSTRUCTIONS

For the printed manual, file this temporary revision adjacent to the page(s) affected.

For the microfilm supplement, file this temporary revision in sequence by ATA number. Mark the microfilm cartridge to indicate that it has been changed by temporary revision(s).

Revision reason: Added an 0.080-inch limit for skin thicknesses, after blendout, in a fuel tank area.

This temporary revision furnishes an advance copy of the following page(s) which supersede any previously issued page(s). The information thereon is to be used until this temporary revision is either incorporated or rescinded.

Chapter-Section-Subject	Page No.	Date
57-2-1	2E	Apr 28/95

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NOTES

- DAMAGE TO INSPAR WING SKINS BY NICKS, SCRATCHES, GOUGES, CRACKS, ABRASIONS AND CORROSION IS ALLOWABLE PROVIDED THAT ALL OF THE LIMITATIONS IN TABLE I OR TABLE II ARE NOT EXCEEDED. DAMAGE DEPTH AND LOSS OF CROSS-SECTIONAL AREA ARE TO BE DETERMINED AFTER CLEAN-UP (SEE DETAIL I)

  THESE ALLOWABLE DAMAGE LIMITS ARE NOT APPLICABLE IF THERE IS UNREPAIRED DAMAGE TO ANY STIFFENER IN THE SAME AREA.

[A] ALLOWABLE DAMAGE LIMITATIONS ARE NOT APPLICABLE IN THE FOLLOWING AREAS (CONSULT THE BOEING COMMERCIAL AIRPLANE CO. FOR SPECIFIC INSTRUCTIONS)

1. WITHIN 1.50 OF ANY CHORD-WISE ROW OF FASTENERS.
2. FORWARD OF A LINE 1.50 AFT OF THE AFT ROW OF FASTENERS ATTACHING THE SKIN TO THE FRONT SPAR.
3. AFT OF A LINE 1.50 FORWARD OF THE FORWARD ROW OF FASTENERS ATTACHING THE SKIN TO THE REAR SPAR.
4. WITHIN 1.50 OF FASTENERS IN THE SPANWISE SKIN SPLICES.
5. WHERE THE REMAINING SKIN THICKNESS WOULD BE LESS THAN 0.080 INCH IN A FUEL TANK AREA.

[B] LOSS OF CROSS-SECTIONAL AREA ON A LINE PERPENDICULAR TO THE REAR SPAR. MULTIPLE AREAS OF DAMAGE ARE TO BE CONSIDERED ON THE SAME LINE IF LESS THAN 1.50 FROM EACH OTHER MEASURED SPANWISE (SEE DETAIL II).

[C] WHERE THE STIFFENER ADJACENT TO A SPAR FORMS A TAPERED PANEL WITH THE SPAR, THE ALLOWABLE DAMAGE LIMITATIONS APPLY TO THE AREA BETWEEN THE SPAR AND THE SECOND STIFFENER, UNLESS THE DISTANCE BETWEEN THE SPAR AND ADJACENT STIFFENER IS EQUIVALENT TO LOCAL STIFFENER SPACING.

[D] DISREGARD STIFFENERS 5A, 6A, AND 7A, BETWEEN WS 948 AND WS 960 IF INSTALLED.

Allowable Damage - Wing Skin Outboard of BBL 70.5
Figure 1A (Sheet 3)

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