PART 4 - ULTRASONIC

BONDTEST INSPECTION OF METAL BONDED PARTS AND NON-METAL LAMINATES

1. Purpose

A. This procedure uses high frequency bondtest equipment to a find a bondline delamination in metal-to-metal and non-metal-to-non-metal parts. This procedure also will find interply delaminations in non-metal laminates.

NOTE: High frequency bondtesters are those that use a transducer and couplant. They can find smaller defects than low frequency (no couplant) bondtesters.

B. This procedure must not be used to do the inspection of honeycomb sandwich assemblies. To do the inspection of skin-to-core disbonds and core damage in honeycomb sandwich assemblies, refer to Part 4, 51-00-05.

C. This procedure can be used to find voids or bond separation only. It cannot be used to measure bond strength.

2. Equipment

NOTE: Refer to Part 1, 51-01-00, for data about the equipment manufacturers.

A. Bondtest Instrument

(1) The instruments specified below can be used to do this procedure:

(a) 210 Bondtester (NDT Instruments)

NOTE: Because of its display limit, use the 210 Bondtester to do metal bond inspections only.

(b) Bondascope 2100 (NDT Instruments)

(c) Fokker Bondtester, Model 70 and Model 80

(d) Bondmaster (Staveley Instruments)

(e) M1Z-21SR and S9-R (Zetec, Inc.)

B. Transducers

(1) The transducers used for high frequency bondtesters are supplied with the inspection instrument.

C. Couplant

(1) Use a thin couplant with properties as follows:

(a) Thin as possible.

(b) Does not damage the structure or contaminate the surfaces to be bonded.

NOTE: Do not use a couplant that has a silicone base.

(c) Does not have an effect on the bondtester indication.

D. Reference Standards

(1) For metal parts:

(a) Make a reference standard which has the same skin and doubler thicknesses as the inspection area. If the same skin and/or doubler thickness is not available, use a thickness gage that is one gage more. Example: the inspection area has a skin and doubler thickness of 0.036 inch (0.91 mm). Use 0.040 inch (1 mm) thickness material if 0.036 inch (0.91 mm) is not available. Include in this reference standard a 0.50 inch (12.7 mm) diameter disbond area. This disbond area can be made if you drill a spotface to the adhesive bondline.

(b) A reference standard for general uses can be made from strips of the aluminum skin thicknesses used in your airplanes. See reference standard NDT1033-n shown in Detail I. You can also buy this reference standard from the NDT Engineering Group Corp. Refer to Part 1, 51-01-00.

(c) A discarded part can be used as an alternative to a reference standard if you drill spotfaces to the correct bondline locations.

(2) For non-metal parts:

(a) For graphite parts, make a laminate step wedge or get one from Boeing Spares. Refer to Part 1, 51-04-00, Figure 8.

(b) For fiberglass or Kevlar parts, make a laminate step wedge as shown in Part 1, 51-04-00, Figure 8.

(c) For inspection of repairs, you can use the repair reference standards given in Part 1, 51-01-01, to cause example indications. Use of these reference standards is optional.

3. Preparation for Inspection

A. Get the engineering drawings, if possible, that show the structure and thicknesses in the inspection area.

B. Clean loose dirt, paint flakes, or blisters from the inspection surface.

4. Instrument Calibration

A. Get the correct transducer for the inspection material thicknesses and structure. Refer to the instrument instruction manual.

B. Set the instrument frequency as specified in the instrument instruction manual.

C. Calibrate the instrument to examine metal-to-metal bonded parts for disbonds at the bondline, as follows:

(1) Put couplant on the reference standard in a bonded area and in the disbonded area.

(2) Calibrate the instrument to get a clear signal from the bonded and the disbonded areas.

(3) Lift the transducer off of the reference standard to identify the lift-off signal. Make sure the lift-off signal is easily identified.

NOTE: The lift-off signal is used to identify a loss of coupling between the transducer and the part during the scan inspection.

(4) Put the transducer back on the bonded area and make a scan across the disbond area to find a scan speed that will give a clear disbond signal. Use the same speed during the scan inspection.

(5) Do steps 4.C.(1) thru (4) again for each material thickness, if parts with multiple thicknesses are to be examined.

D. Calibrate the instrument to examine non-metal-to-non-metal bonded parts for disbonds at the bondline and/or interply delaminations in a non-metal laminate as follows:

(1) Put couplant on all the thicknesses of the reference standard that are equal to the total thickness of the part to be examined and the steps within the total thickness of the part to be examined.

(2) Calibrate the instrument on the reference standard to get clear signals from the full thickness of the part to be examined to steps within the thickness range of the part to be examined as follows:

(a) To find disbonds at the bondline of two laminate parts bonded together, get a signal that equals the total thickness of the bonded part and a signal from the thickness of the single layer laminate that the transducer is put on.

(b) To find interply delaminations in a laminate, identify the signals from the steps of the reference standard, from the total thickness of the part to the minimum thickness (one ply thick of the part).

(3) Lift the transducer from the reference standard to identify the lift-off signal. Make sure the lift-off signal is easily identified.

NOTE: The lift-off signal is used to identify a loss of coupling between the transducer and the part during the scan inspection.

5. Inspection Procedure

A. Examine metal-to-metal bonded parts for disbonds at the bondline as follows:

(1) Calibrate the instrument as specified in par. 4.C.

(2) Put couplant on and adjacent to the inspection area.

(3) Put the transducer on an area adjacent to the inspection area that is bonded to get a signal from the total thickness. Make sure the material thicknesses for each part in the adjacent area is the same as the inspection area to be examined. The signal can be different from the siganl you got from the reference standard if:

NOTE: It is not important that the signal from the total thickness be the same as the signal from the reference standard because of the conditions that follow. It is very important that the transducer is not on a disbond area.

(a) The material thickness is not the same as the reference standard.

(b) The adhesive type and/or thickness in the inspection area can be different than that in the reference standard.

(c) The back surface of the inspection area has structure attached and/or sealant.

(d) The quality of the bond (porosity in the adhesive) is not as good as the bond in the reference standard.

(4) Move the transducer away from the bonded area to a single thickness area to get a signal. The signal from the single thickness identifies how a disbond signal will look. The signal can be different from the signal you got from the reference standard if the material thickness is different.

NOTE: It is not important that the signal from the single thickness be the same as the signal from a disbond area of the reference standard.

(5) Examine the inspection area as follows:

(a) Make slow scans along areas that are of a contant thickness.

(b) For areas where it is necessary to do more than one scan, use a transducer scan increment that is one third the diameter of the disbond.

(c) When possible, it is recommended to use a guide or a straight edge to control the movement of the transducer during the inspection.

(d) During the scan inspection, monitor the instrument display for a sudden change which is not caused by structural changes in the part.

NOTE: It is important to monitor for coupling loss (lift-off signal) during the scan.

B. Examine non-metal-to-non-metal bonded parts for disbonds at the bondline and/or interply delaminations in a laminate as follows:

(1) Calibrate the instrument as specified in par. 4.D.

(2) Put couplant on and adjacent to the inspection area.

(3) Put the transducer on an area adjacent to the inspection area to get a signal from the total thickness. Make sure the thicknesses of the laminate(s) in the adjacent area are the same as the inspection area to be examined. The signal can be different from the signal you got from the reference standard if:

NOTE: It is not important that the signal from the total thickness be the same as the signal from the reference standard because of the conditions that follow. It is very important that the transducer is not on a disbond area or an area with delaminations.

(a) The laminate(s) and/or adhesive thickness (bondline disbond inspection) is different than that in the reference standard.

NOTE: Porosity in laminates can cause the instrument to give an indication that the part is thicker than the actual part to be examined.

(b) The back surface of the area has structure attached and/or sealant.

(4) To do a bondline disbond inspection, move the transducer away from the bonded area to a single laminate area to get a signal. The signal from the single laminate identifies how a disbond signal will look. The signal can be different from the signal you got from the reference standard if the material thickness is different.

NOTE: It is not important that the signal from the single thickness be the same as the signal from a disbond area of the reference standard.

(5) Examine the inspection area as follows:

(a) Make slow scans along areas that are of a constant thickness.

(b) For areas where it is necessary to do more than one scan, use a transducer scan increment that is one third the diameter of the disbond.

(c) When possible, it is recommended to use a guide or a straightedge to control the movement of the transducer during the inspection.

(d) During the scan inspection, monitor the instrument display for a sudden change which is not caused by structural changes in the part.

NOTE: It is important to monitor for coupling loss (lift-off signal) during the scan.

6. Inspection Results

A. An indication of a sudden thickness decrease that occurs on the instrument display which is not caused by a structural change in the part is a possible disbond or delamination. This area must be examined some more.

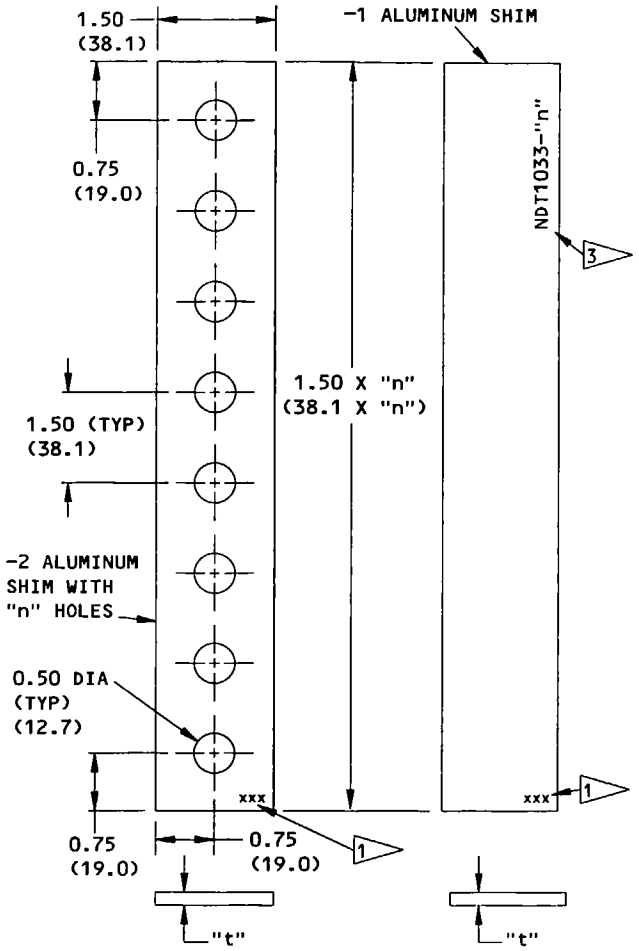
B. Slow changes on the instrument display can be caused by conditions such as:

(1) Small changes in the part thickness (tapered skins).

(2) Change in the quality of the bond (porosity in the adhesive) and/or adhesive thickness.

(3) Changes in the thickness of coatings and/or sealants on the back surface of the part.

C. Refer to the engineering drawings to make sure of the configuration of the structure. If necessary, get access to the back surface to do a visual examination to help identify the causes of slow changes.



PROCEDURE TO MAKE THE REFERENCE STANDARD:

1. CUT "n" PAIRS OF ALUMINUM SHIMS. SEE 2.
2. DE-BURR THE EDGES.
3. SOLVENT CLEAN THE PARTS.
4. PREPARE THE SURFACES TO BE BONDED BY PHOSPHORIC ACID ANODIZING OR HF/CHEMICAL CONVERSION COATING AS SPECIFIED IN SRM 51-9-1.
5. APPLY PRIMER TO ONE SIDE OF EACH SHIM AS SPECIFIED IN SRM 51-9-1.
6. CUT A SQUARE OF BMS 5-101, TYPE 2, GRADE 5 (GRADE 10 OPTIONAL) ADHESIVE SO THAT THE SIDES OF THE SQUARE ARE EQUAL TO THE LENGTH OF THE SHIMS (1.50 X "n" INCHES OR 38.1 X "n" MM)
7. APPLY THE SIDES OF THE ALUMINUM SHIMS THAT HAVE THE PRIMER TO THE ADHESIVE SO THAT THE THICKNESS OF THE SHIMS INCREASES.
8. APPLY THE DRILLED ALUMINUM SHIMS TO THE OPPOSITE SURFACE OF THE ADHESIVE SO THEY ARE TURNED 90° TO THE ALUMINUM SHIMS (SEE VIEW (A)).
9. TRIM THE ADHESIVE FROM THE HOLES WITH A SHARP KNIFE.
10. SEAL ALL THE JOINTS WITH POLYESTER TAPE.
11. PRESS THE POLYESTER TAPE INTO THE BOTTOM OF ALL THE HOLES TO CONTAIN THE ADHESIVE FLASH.
12. ENVELOPE BAG AND CURE AT 250° FOR 120 MINUTES AS SPECIFIED IN SRM 51-10-1.
13. REMOVE THE CURED ADHESIVE FLASH FROM THE BOTTOM OF THE HOLES WITH ABRASIVES OR EPOXY REMOVER.
14. DO A THROUGH-TRANSMISSION INSPECTION TO EXAMINE FOR DISBONDS. REFER TO PART 4, 51-00-02. DISBONDS 0.375 INCHES (9.5 mm) IN DIAMETER OR LARGER ARE NOT PERMITTED.

NOTES

- ALL DIMENSIONS ARE IN INCHES (MILLIMETERS IN PARENTHESES)
- TOLERANCES:

INCHES	MILLIMETERS
X.XXX = ±0.005	X.XX = ±0.10
X.XX = ±0.025	X.X = ±0.5
X.X = ±0.050	X = ±1

- SURFACE ROUGHNESS: 125 R_a OR BETTER
- MATERIAL: 2000, 6000 OR 7000 SERIES ALUMINUM
- PARTS LIST:

PART NO.	DESCRIPTION	QUANTITY	THICKNESS 2
-1	ALUMINUM SHIM	1	"t"
-2	ALUMINUM SHIM WITH DRILLED HOLES	1	"t"

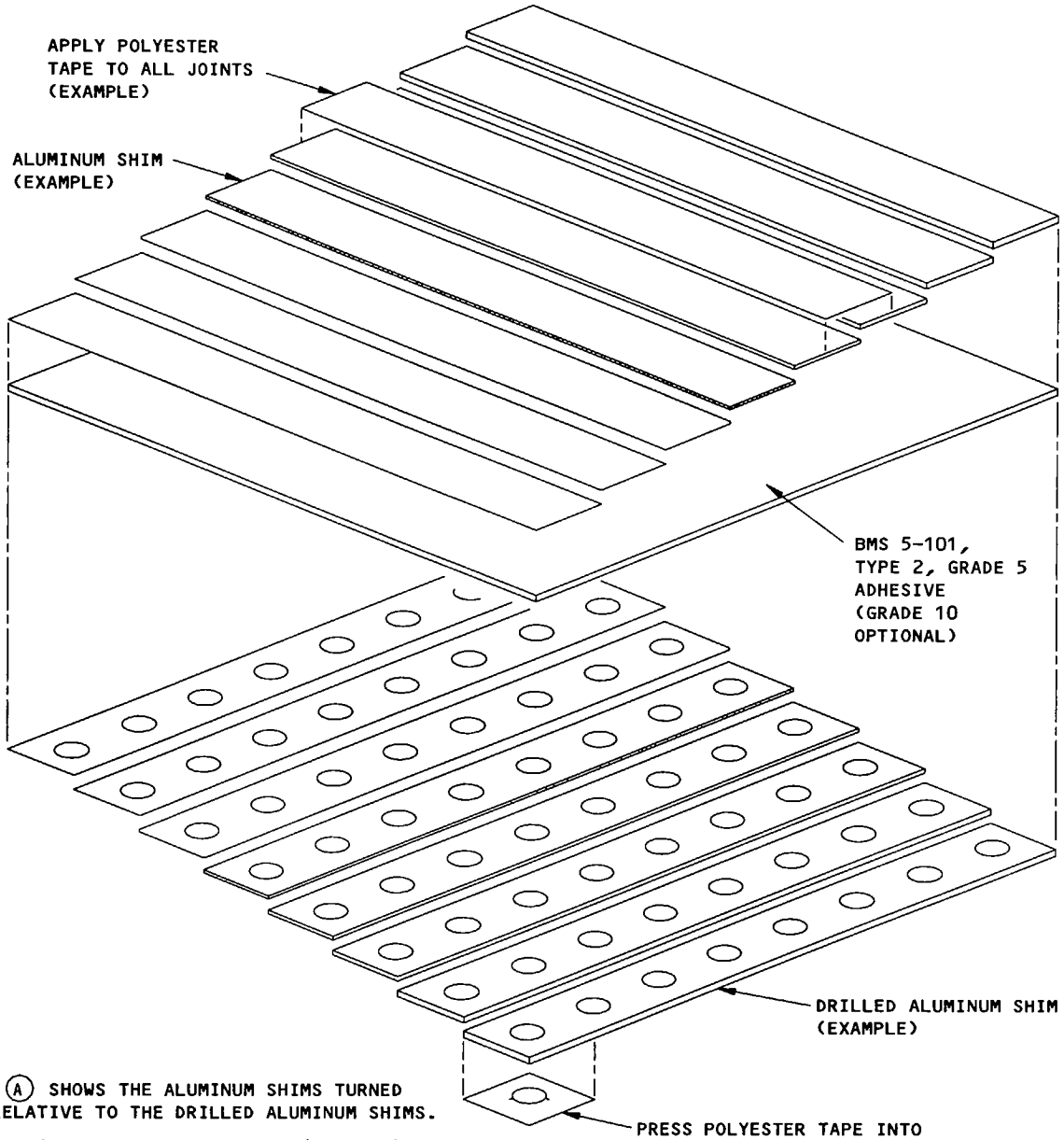
1 ETCH OR STEEL STAMP THE SHIM THICKNESSES

2 USE THE TABLE BELOW TO HELP YOU IDENTIFY THE ALUMINUM SHIMS NECESSARY TO MAKE YOUR REFERENCE STANDARD. CHOOSE A -1 AND -2 SHIM FOR EACH SKIN GAGE USED ON YOUR AIRPLANES FOR A TOTAL OF "n" PAIRS OF ALUMINUM SHIMS. USUAL BOEING SKIN GAGES ARE IDENTIFIED IN THE TABLE BELOW. NOT ALL GAGES ARE LISTED.

SKIN GAGE	-1 SHIM	-2 SHIM
"t" = 0.016 (0.41)		
0.020 (0.51)		
0.025 (0.64)		
0.032 (0.81)		
0.040 (1.02)		
0.050 (1.27)		
0.063 (1.60)		
0.080 (2.03)		
0.100 (2.54)		
0.125 (3.18)		
	TOTAL: "n"	TOTAL: "n"

3 ETCH OR STEEL STAMP THE REFERENCE STANDARD NUMBER AND DASH NUMBER ("n") EQUAL TO THE NUMBER OF STEPS.

METAL BOND REFERENCE STANDARD NDT1033-n
DETAIL I (SHEET 1)



SHIM ORIENTATION

(A)

NOTES

- VIEW (A) SHOWS THE ALUMINUM SHIMS TURNED 90° RELATIVE TO THE DRILLED ALUMINUM SHIMS.
- USE THE ENVELOPE BAG PROCEDURE (NO TOOL) TO BOND THE SHIMS TOGETHER.
- USE POLYESTER ("FLASH") TAPE TO SEAL AROUND THE EDGES OF THE HOLES AND ALONG THE EDGES OF THE SHIMS.
- USE ABRASIVES OR EPOXY REMOVER TO TRIM THE EXCESS CURED ADHESIVE FROM THE INTERIOR OF THE HOLES. GRADE 5 ADHESIVE IS RECOMMENDED SO THAT THERE IS LESS ADHESIVE TO REMOVE.

METAL BOND REFERENCE STANDARD NDT1033-n
DETAIL I (SHEET 2)