

MIL-A-83376(USAF)

26 July 1972
(See 6.3)

MILITARY SPECIFICATION

ADHESIVE BONDED ALUMINUM HONEYCOMB SANDWICH
STRUCTURES, ACCEPTANCE CRITERIA

1. SCOPE

1.1 This specification establishes the acceptance criteria and inspection requirements for adhesive bonded honeycomb sandwich structures including the metal-to-metal bonding found in these structures. (See 6.1)

1.2 Classification. The classification of adhesive bonded honeycomb structures specified in this specification shall be of the following types:

(a) Type I: Primary structure. The primary structure shall be that structure which is essential to the basic airframe structural integrity and failure of which would cause significant hazard to operating personnel resulting in loss of mission capability or jeopardizing flight safety (includes loss of major components or loss of control).

(b) Type II: Secondary structure. The secondary structure shall be that structure which is essential to the aerospace vehicle performance or mission accomplishment and whose failure would cause degradation of aerospace vehicle performance or mission capabilities.

(c) Type III: Nonstructural (limited strength). Nonstructural shall be that structure which is not essential to basic aerospace structural integrity or does not contribute directly to aerospace vehicle performance or mission accomplishment. Its failure would not significantly affect the structural integrity, aerospace vehicle performance or mission accomplishment.

1.2.1 This structural classification shall be specified on the engineering drawing.

1.2.2 Structural defects specified in this specification shall be face-to-core voids and disbonds, metal-to-metal voids, bond voids, core splice voids, core splice gaps, dents and markoffs. These defects are defined in Section 6 of this specification.

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2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

MIL-A-132 Adhesive, Heat Resistant, Airframe Structural, Metal to Metal

Military

MIL-A-25463 Adhesive, Metallic Structural Sandwich Construction

MIL-C-83281 Coating, Phototropic, Detection of Defects (In Materials and Structures)

MIL-A-83377 Adhesive Bonding for Aerospace Systems, Guidelines For

STANDARDS

Military

MIL-STD-860 Fokker Ultrasonic Adhesive Bond Test

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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3. REQUIREMENTS

3.1 General. The adhesive bonded aluminum honeycomb structure to be inspected shall be inspected to the requirements specified herein.

3.2 Metal-to-metal bonds in honeycomb sandwich assemblies.

3.2.1 Dimensions. When measured as shown in figure 1 individual disbonds or voids shall not have any dimension greater than 15 times the thickness of the thinnest adherend, or 1.0 inch whichever is smaller or a "S" dimension greater than 15 percent of the shortest "W" of the bondline.

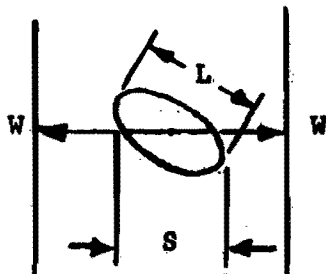


Figure 1. Dimensions

S is the width of void in the "W" direction.

L is the longest dimension of void

W is the smallest dimension of the metal-to-metal bond area containing the void.

The width of void is in the "W" direction.

When "W" is less than 2 inches, "S" shall be less than .25 inch.

3.2.2 Permissible areas.

3.2.2.1 The maximum permissible area of an individual void or disbond is as follows:

- (a) Type I structure: 0.375 square inches,
- (b) Type II structure: 0.500 square inches, and
- (c) Type III structure: 1.000 square inches.

3.2.2.2 The minimum permissible spacing distance as measured in figure 2 between void boundaries is as follows:

- (a) Type I structure: 4 times the largest void or disbond dimension measured on a line between the centers of the two voids.
- (b) Type II structure: minimum distance is 3 times the void or disbond dimension.
- (c) Type III structure: 2 times the largest void or disbond area.

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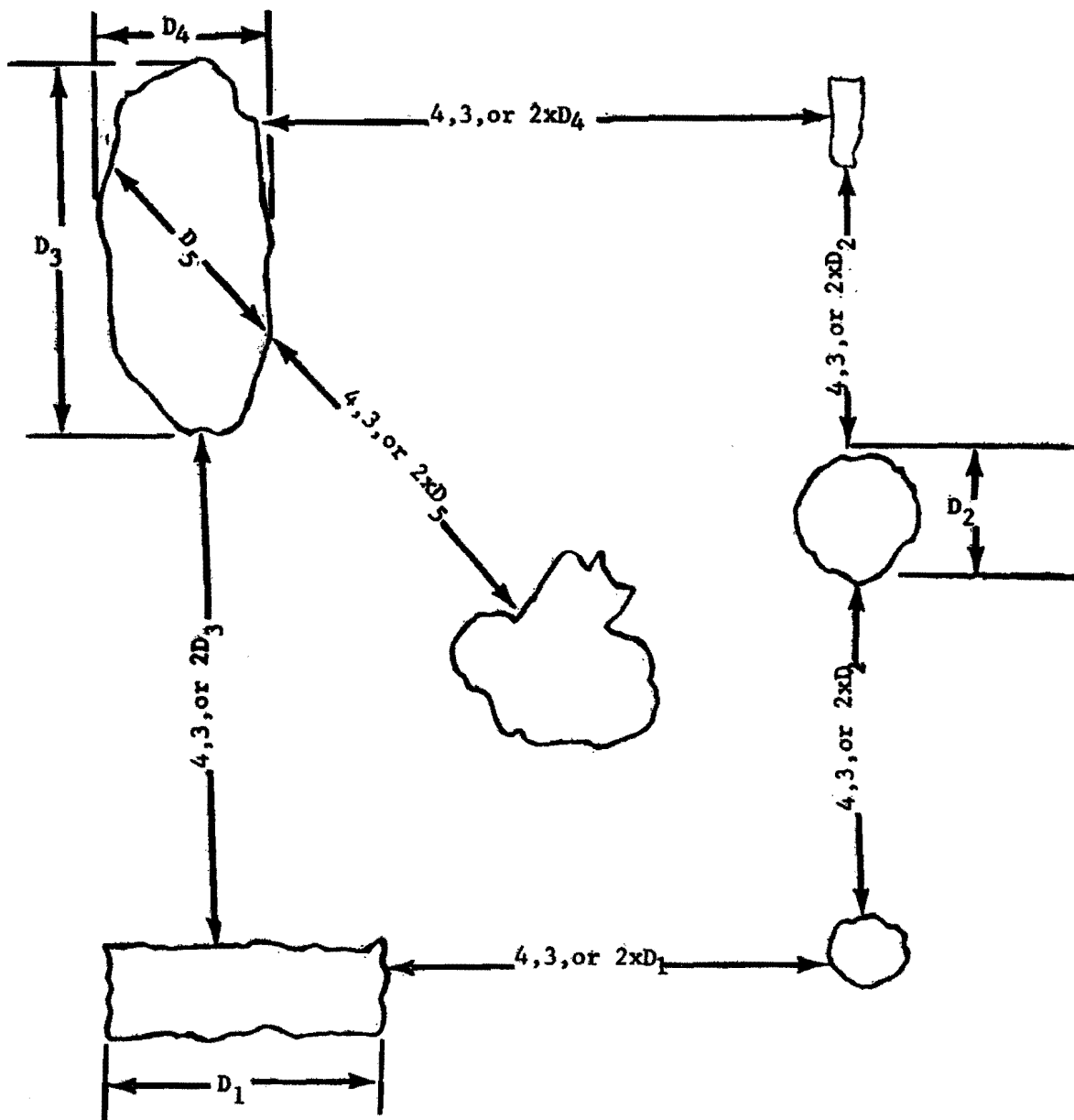


Figure 2. Measuring disbond spacing.

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3.2.2.3 No voids, disbonds, or porosity shall be permitted within 0.125 inch of any bond joint edge.

3.2.2.4 The aggregate unbonded length of disbonds along any straight area, between two parallel lines $\frac{1}{4}$ inch apart shall not exceed 15 percent of the length of the bond line, when measured along the direction of the parallel lines.

3.2.2.5 The maximum permissible void or disbond area of the metal-to-metal bond area within an assembly is 1 percent on type I structure, 2 percent on type II structure and 5 percent on type III structure.

3.2.2.6 The maximum permissible disbond area of the metal-to-metal bond area contained within a 6 inch diameter circle is 8 percent of that area so contained for types I and II structures and 15 percent of that area so contained for type III structure.

3.3 Face-to-core bonds. No voids or disbonds shall be allowed in face-to-core or doubler-to-core bonds.

3.4 Core splice, core-to-edgemember, or core-to-insert bonds.

3.4.1 The maximum permissible core gap that is filled with adhesive or the equivalent as shown in figures 3, 4, and 5 shall be equal to 0.125 inch for type I structure and one cell diameter of the largest cell common to the core joint or 0.25 inch, whichever is smaller for types II and III structure.

3.4.2 The maximum permissible core joint void or disbond dimension shall be 0.5 inch or 3 adjacent cells, whichever is smaller, per linear foot and shall not exceed 5 percent of core-to-core bond area (splice height times splice length).

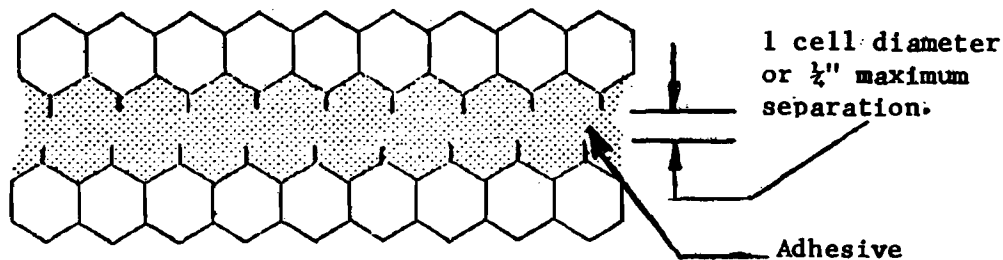


Figure 3. Core splice.

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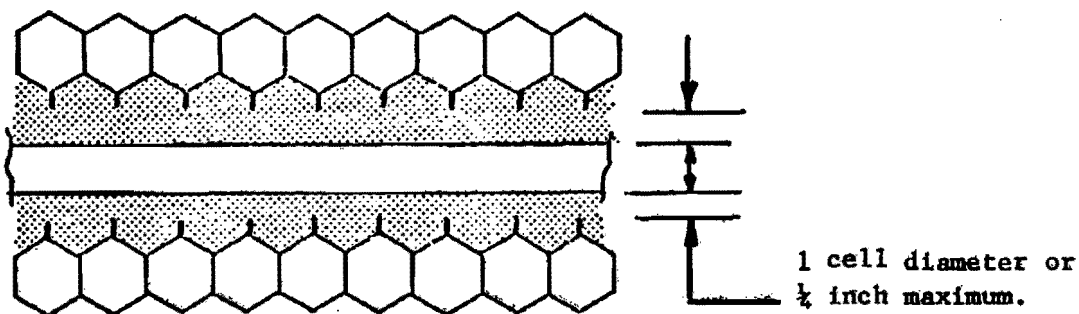


Figure 4. Core to insert.

- Note: 1. The maximum void or disbond $\frac{1}{2}$ inch or 3 adjacent cells, whichever is smaller, per linear foot
2. Total void or disbond must not exceed 5 percent of total core to insert bond area.

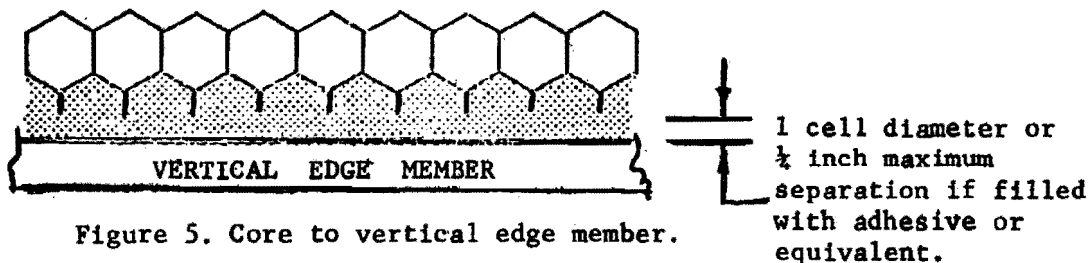


Figure 5. Core to vertical edge member.

- Note: 1. Adhesive maximum void or disbond $\frac{1}{2}$ inch or 3 adjacent cells, whichever is smaller, per linear foot.
2. Total disbond must not exceed 5 percent of total core to edge member bond area.

3.4.3 The maximum core to beveled edge member voids, disbonds and gaps shall be as shown in figure 6.

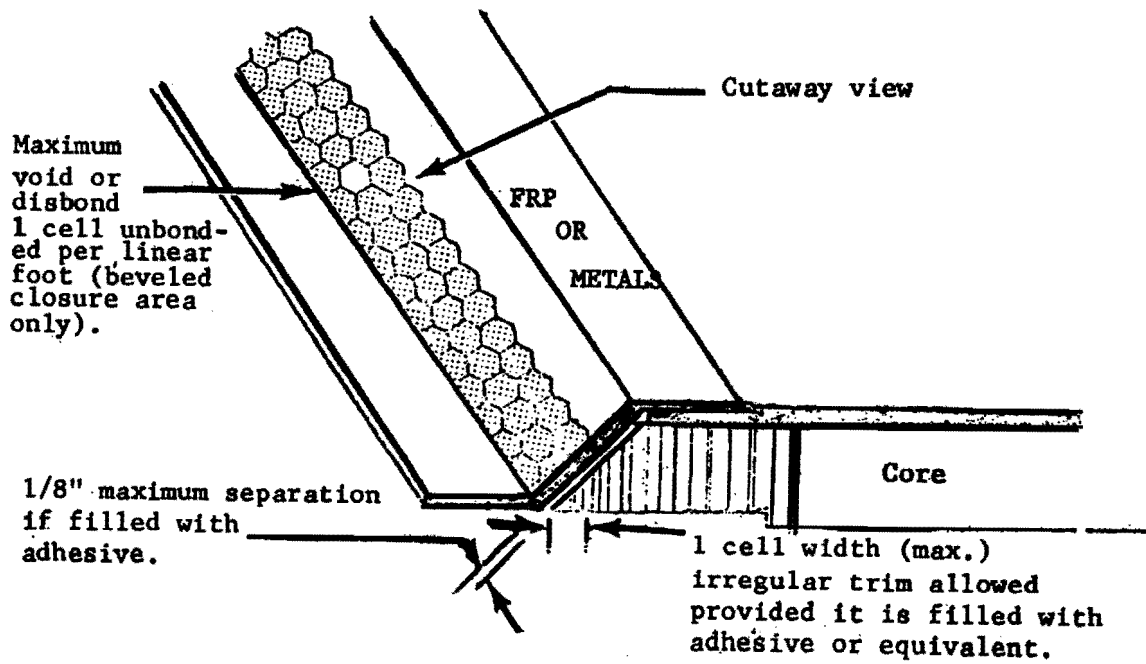


Figure 6. Core to beveled edge member.

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3.5 Sandwich face dents.

3.5.1 Dents. Dents shall not exhibit creases, sharp edges, or wrinkles as shown in figure 7. Sharp edges and crimps are unacceptable if their radius is sharper than two times the skin thickness.

3.5.1.1 Dents in the face of sandwich assemblies shall be measured as follows:

(a) Using a straight edge placed across the dent in flat assemblies or a reference edge placed across the dent in contoured assemblies, the diameter shall be measured to the nearest 0.1 inch.

(b) The depth shall be measured, using depth gauges, feeler gauges or wire gauges, at the deepest point to the nearest .001 inch.

3.5.1.2 The dent area shall be inspected for disbands in accordance with MIL-A-83377.

3.5.2 Dimensions.

3.5.2.1 Diameter. The maximum permissible dent diameter is 1.5 inches for type I structure, 2 inches for type II structure, and 3 inches for type III structure.

3.5.2.2 Depth. The maximum permissible dent depth is 0.006 inches for type I structure, 0.020 inches for type II structure, and 0.050 inches for type III structures.

3.5.2.3 Areas. The maximum permissible dent area within an assembly is 1 percent on type I structure, 2 percent on type II structure, and 5 percent on type III structure.

3.5.2.4 Spacing. The minimum permissible distance between dent centers is 6.0 inches for type I structures, 4.0 inches for type II structure, and 3.0 inches for type III.

3.5.2.4.1 The minimum permissible distance between dent center and the edge of solid members is 10.0 inches for type I structure, 6 inches for type II structure and 3.0 inches for type III structure.

3.5.3 Dent limitations. Dent limitations as required for cosmetic purposes shall be established by the contractor's quality assurance.

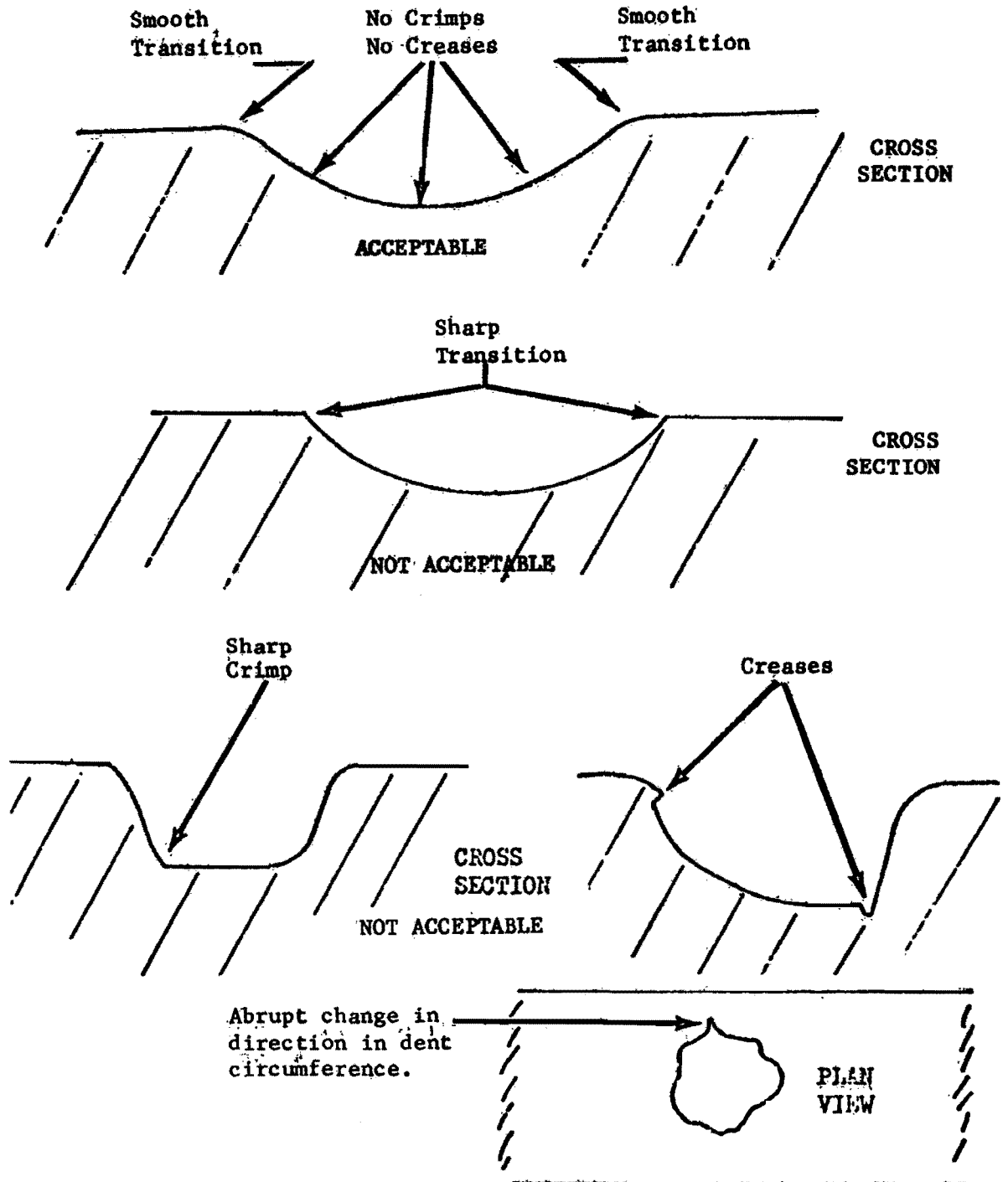
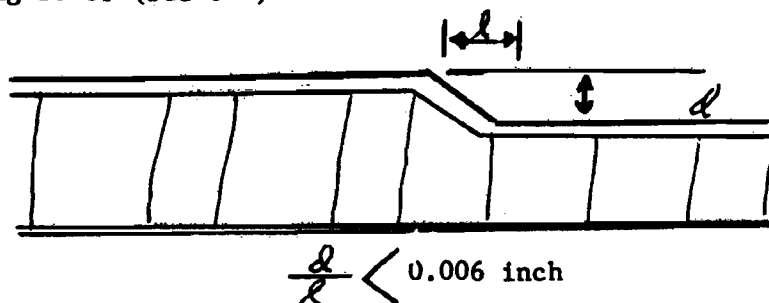


Figure 7. Sandwich face dents.

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3.6 Face markoff. The face markoff for all type I structure and type II compression critical structure shall be limited as shown in figure 8. (see 6)



Maximum markoff depth allowed: Type I: 0.006 inch, or
 .006 inch/inch of "l"
 Type II: .010 inch/inch of "l"
 Type III: .015 inch/inch of "l"

Figure 8. Markoff

3.7 Nondestructive inspection.

3.7.1 Assemblies shall be nondestructive inspected for adherence to the requirements of this specification and in accordance with MIL-A-83377.

3.7.2 Nondestructive inspection physical standards shall be constructed to incorporate the acceptance criteria contained herein. Standards shall be of similar construction as the parts to be inspected, and shall contain voids or disbonds of the maximum allowed sizes. Nondestructive process procedures shall be approved as specified in MIL-A-83377.

3.8 Destructive inspection.

3.8.1 Destructive inspection of an assembly shall be conducted as specified in MIL-A-83377 to ensure that the bonded components meet the criteria contained in this specification. The destructive test shall be performed in accordance with 4.2.3.

3.8.2 The destructive test results shall be evaluated to the requirements of this specification and in the contractors process specification as specified in MIL-A-83377.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 An effective quality assurance system shall be provided to ensure inspection operation performance by personnel who have demonstrated their ability to apply this criteria to the assemblies being inspected, as specified in MIL-A-83377.

4.1.2 Assemblies failing to meet the criteria contained herein shall be rejected, and referred to a Materials Review Board for action.

4.1.3 Method of sampling for inspection shall be in accordance with MIL-A-83377.

4.2 Tests

4.2.1 Bond continuity. Continuity of bonds shall be determined by inspecting the entire bond area using inspection procedures for which standards and detail operating procedures have been developed.

4.2.1.2 Bond inspection frequency shall be as specified in MIL-A-83377.

4.2.1.3 Ultrasonics (pulse echo resonance through transmission), ultrasonic bond tests, harmonics, infrared, liquid crystals or phototropic coating specified in MIL-C-83281 shall be used for this inspection, as applicable, and as specified in the contractor's process specification described in MIL-A-83377. Other suitable standardized nondestructive inspection methods may be employed when specially agreed on by the contractor and the procuring activity.

4.2.1.4 Radiographic inspection is not required for core splices, core-to-insert, or core-to-edge bonds if final face is applied in a subsequent bond stage such that visual inspection of these bonds is possible.

4.2.1.5 Bond strength shall be as specified in MIL-STD-860.

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4.2.3 Destructive testing. When destructive testing is required as specified in MIL-A-83377, the following procedure shall be used.

- a. Assembly shall first be nondestructive tested using production procedures.
- b. Areas shall be selected for removing test specimens.
- c. Specimens shall be removed from the assembly being careful not to damage bonds.
- d. The specimens shall be of a size and shape permitted by the assembly size and shape; also as required for testing to MIL-A-83377, generated contractor process specification and as specified in MMM-A-132 and MIL-A-25463, as applicable.
- e. The remainder of the assembly shall be disassembled for visual inspection at all bondlines.
- f. The specimens shall be tested in accordance with and meet the minimum requirements of this specification, MIL-A-25463 MIL-A-83377, MMM-A-132 and the contractors specification, as applicable.
- g. Correlation between destructive and nondestructive methods will be used to verify the nondestructive procedures, sensitivity, and reliability.

4.2.4 Leak testing. Bonded honeycomb assemblies shall be leak tested in accordance with MIL-A-83377.

5. PREPARATION FOR DELIVERY

(Not applicable.)

6. NOTES

6.1 Intended use. This specification is intended to evaluate the quality of bonded aluminum sandwich assemblies used on aerospace structures.

6.2 Definitions. The defects covered in this specification are defined as follows.

6.2.1 Face-to-core voids and disbonds. Any unbonded area occurring between the facing and the honeycomb core or between doublers and core.

6.2.2 Metal-to-metal voids or disbonds. Any unbonded area occurring between two solid, nonporous members that are joined by an adhesive bondline.

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6.2.3 Bond void or disbond. A local discontinuity either wholly within or on the surface of a bond line.

6.2.4 Porosity. A series of small discontinuities or voids closely spaced. The outer peripheral edges of porosity areas shall be outlined and the porosity areas treated as an unbonded area of similar size and shape.

6.2.5 Core splice void or disbond. Any unbonded area existing in the plane of a bond between two core segments.

6.2.6 Core splice gap. That distance between core segment edges and other core segments or solid members that is filled with core splice adhesive or equivalent.

6.2.7 Dents. Local depressions in sandwich faces is a result of damage impact or excessive local pressure.

6.2.8 Markoff. A step occurring in the facing of a normally flat bonded honeycomb sandwich.

6.3 Supersession data. Throughout this specification MIL-A-83377 is specified. MIL-A-83377 will be used by the Air Force in place of MIL-A-9067.

Custodian:
Air Force - 11

Preparing activity:
Air Force - 11

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