

Process Specification for Ultrasonic Inspection of Composites

Engineering Directorate

Structural Engineering Division

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REVISIONS		
VERSION	DESCRIPTION	DATE
Baseline	Original version	5/27/1997
A	Modified Section 3.1 "Levels" to replace MIP's with inspection points; modified Section 6.5 "Reference Standards" to eliminate +/-4 dB requirement; clarified report requirements for work performed at JSC facilities in Section 6.13 "Inspection Report."	8/28/1998
B	Modified the porosity acceptance criteria in Section 7.3 to account for part thickness and test frequency variations.	8/11/2000
C	Reviewed document per QMS requirements. Updated division name, organization codes, and document numbers.	
D	Revised applicable documents and inspection methods	01/04/2010
E	Revised applicable documents and inspection methods	06/29/2011
F	Added NASA-STD-5009 to para. 4.0. Deleted MIL-STD-2154 from para. 5.0, and added ASTM E2375. Deleted Term "Material Data Sheet" from para. 6.4 and 6.12 for clarity.	05/06/2014
G	Revised paragraph 9.0 for uniformity across all NOE PRCs. Revised para. 6.2, and definitions. Added NASA-HDBK-5010 which provides recommended requirements for ultrasonic testing of composite materials.	01/07/2020
H	Updated to incorporate ASTM E2580 and delete language mirrored in ASTM E2580.	

1.0 **SCOPE**

This document establishes the minimum requirements for ultrasonic inspection of laminated composites, bonded laminates, and adhesively bonded honeycomb composite materials.

2.0 **APPLICABILITY**

This specification is applicable to in-process, final, and in-service ultrasonic inspections to detect discontinuities such as disbonds and delaminations planar to the entry surface and foreign materials, porosity, and voids in composite parts with parallel surfaces.

3.0 **USAGE**

This specification shall be invoked by an inspection note on the applicable engineering drawing or by reference in a Process Specification, Task Performance Sheet, Discrepancy Report/Material Review Record, or other appropriate work authorizing document.

The engineering drawing or referencing document shall specify the criteria by which components are judged acceptable. If acceptance criteria are not specified, the acceptance criteria in Section 7.0 shall be used. When there are different acceptance criteria for different areas on a component, the drawing shall be zoned with the acceptance criteria identified for each zone. If the number of components to be inspected and the amount of coverage of each component is not specified, all components shall be examined and shall receive 100 percent liquid penetrant coverage.

A typical ultrasonic inspection note for flight hardware and ground support equipment (GSE) is given below.

ULTRASONICALLY INSPECT PER NASA/JSC PRC-6501.

4.0 **REFERENCES**

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. All documents listed are assumed to be the current revision unless a specific revision is listed. In the case of conflict between this specification and the technical requirements cited in other referenced documents, the requirements of this document take precedence.

ASTM E2580	<i>Standard Practice for Ultrasonic Testing of Flat Panel Composites and Sandwich Core Materials Used in Aerospace Applications</i>
NAS 410	<i>NAS Certification & Qualification of Nondestructive Test Personnel</i>

SNT-TC-1A

Personnel Qualification and Certification in Nondestructive Testing

The following references were used to develop this process specification:

JPR 8500.4

Engineering Drawing System Manual

SOP-007.1

Preparation and Revision of Process Specifications (PRC's)

5.0 MATERIAL REQUIREMENTS

Couplant shall be in accordance with ASTM E2580.

6.0 PROCESS REQUIREMENTS

6.1 GENERAL

Ultrasonic examinations shall be performed in accordance with ASTM E2580 except as modified by this specification.

6.2 WRITTEN PROCEDURE

Part specific written procedures or general procedures and part specific techniques shall include all the information required by ASTM E2580. Procedures for final acceptance inspections performed at JSC should consist of Structural Engineering Division (ES) Detailed Process Instructions (DPIs) or Quality & Flight Equipment Division (NT) NDT Procedures.

6.3 REFERENCE STANDARDS

Reference standards with a configuration and acoustic properties similar to the part under test shall be used to standardize and validate the inspection procedure. Reference standard thickness shall be within 10 percent or 2 plies, whichever is greater, of the part thickness. Laminated composite reference standards should have a porosity content of less than 0.2 percent by volume as verified by cross section and optical analysis of a co-cured test coupon or sacrificial section of the standard. Attenuation shall not vary more than ± 2 dB across the reference standard.

The reference standard shall contain reference flaws representative of the types of defect which must be detected. The reference flaws shall be equal to or smaller than the smallest unacceptable defect. Delamination reference flaws in laminates should be at three depths: near surface, middle, and far surface with near and far surface flaws within 2 or three plies of the surface. Disbond reference flaws should be on both sides of the adhesive layer.

7.0 ACCEPTANCE CRITERIA

If acceptance criteria are not specified in the work authorizing document, the following acceptance criteria shall be used.

7.1 DELAMINATIONS, VOIDS, FOREIGN MATERIAL, AND LAMINATE-TO-LAMINATE DISBONDS

Any single delamination, void, foreign material inclusion, or laminate-to-laminate disbond with a length of 0.25 inch or greater shall be rejected. Any single delamination, void, foreign material inclusion, or laminate-to-laminate disbond with an area of 0.049 square inches or greater shall be rejected. The length and area requirements are separate requirements and must be evaluated individually.

Multiple delaminations, voids, foreign material inclusions, or laminate-to-laminate disbonds with individual lengths less than 0.25 inch and areas less than 0.049 square inches but separated by less than 1 inch shall be rejected.

7.2 LAMINATE-TO-CORE DISBONDS

Any single laminate-to-core disbond with a length of 1 inch or greater shall be rejected. Any single laminate-to-core disbond with an area of 0.785 square inches or greater shall be rejected. The length and area requirements are separate requirements and must be evaluated individually.

Multiple laminate-to-core disbonds with individual lengths less than 1 inch and areas less than 0.785 square inches but separated by less than 6 inches shall be rejected.

7.3 POROSITY

Any area of porosity with a length of 0.5 inch or greater or an area of 0.196 square inches or greater and producing a signal drop relative to the appropriate reference standard equal to or greater than 6 dB shall be reported.

8.0 DEVIATIONS AND WAIVERS

Any deviations or waivers regarding the use of this process specification shall be requested in writing. Requests shall be directed to the JSC Materials and Processes Branch (ES4) with the appropriate justification and rationale. A written response will be provided upon such a request.

9.0 TRAINING AND CERTIFICATION OF PERSONNEL

Personnel performing acceptance inspections of Class I, II, IIIW and GSE hardware shall be qualified and certified, at a minimum, to Level 2 in accordance with NAS 410. Personnel performing acceptance inspections requiring Special NDE shall also be qualified and

certified for Special NDE in accordance with NASA-STD-5009.

Personnel performing acceptance inspections of Class III, STE/D, mockup, and facility hardware shall be qualified and certified in accordance with either NAS 410 or SNT-TC-1A. Personnel making accept/reject decisions shall, at a minimum, be certified to Level 2. Level 3 personnel making accept/reject decisions shall have successfully completed a hands-on practical examination equivalent to the examination required for Level 2. Level 1 personnel may perform acceptance inspections under the direct supervision of a Level 2 but shall not make accept/reject decisions.

Formal qualification and certification is not required for personnel performing engineering evaluation inspections.

10.0 DEFINITIONS

Adhesively Bonded Honeycomb Composite	A composite structure consisting of metallic or nonmetallic face sheets adhesively bonded to a metallic or nonmetallic honeycomb core.
Defect Type	Each flaw type is defined by unique combination of flaw nature, location, depth, and the part cross section containing the flaw.
Disbond	A separation at the adhesive layer of a laminate-to-laminate or laminate-to-core bond.
Foreign Material	Any object contained within the laminated composite, bonded laminate or adhesively bonded honeycomb composite that is not specified on the engineering drawing.
Laminated Composite	A composite material made up of several bonded layers or plies each consisting of unidirectional or woven reinforcement fibers in a polymer matrix.
Porosity	Small gas pores or air pockets within the matrix and/or bondline of a laminated composite or bonded panel.
Void	A relatively large, localized gas pore or air pocket within the matrix and/or bondline of a laminated composite or bonded panel.