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MILITARY SPECIFICATION

PLASTIC LAMINATE AND SANDWICH CONSTRUCTION PARTS AND ASSEMBLY,
AIRCRAFT STRUCTURAL, PROCESS SPECIFICATION REQUIREMENTS

This specification is approved for use by all Departments and
Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification provides detailed instructions for the preparation of, and requirements to be included in, process specifications required for the processing, inspection, pre-fit, and assembly of structural plastic laminate and sandwich construction parts for aircraft.

1.2 Classification. This specification covers the following types and classes of parts:

Type I - Plastic laminate (6.2.8).

Type II - Sandwich constructed parts of plastic laminates
(Type I) and nonmetallic or metallic cores (6.2.18).

2. APPLICABLE DOCUMENTS

2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

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MIL-A-83377 Adhesive Bonding (Structural) for Aerospace and Other
Systems, Requirements for

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Systems Engineering and Standardization Department (Code 53), Naval Air Engineering Center, Lakehurst, NJ 08733-5100, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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- MIL-I-45208 Inspection System Requirements
- MIL-I-6870 Inspection Program Requirements, Nondestructive for Aircraft and Missile Materials and Parts

STANDARDS

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- MIL-STD-490 Specification Practices
- MIL-STD-1520 Corrective Action and Disposition System for Nonconforming Material
- MIL-STD-45662 Calibration Systems Requirements

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Documents Order Desk, Bldg 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Contractor process specification (contr prcs spec). A process specification shall be prepared by the prime contractor (6.2.15) or obtained from a subcontractor (6.2.21) and approved by the prime contractor and submitted for approval to the procuring activity. The submitted contr prcs spec shall be titled, numbered and dated and shall include a detailed description of the manufacturing and fabrication processes, including the methods to control manufacturing variables. The contr prcs spec is defined as a singular process specification or a package of two or more specifications, that when put together provide all the required information. The contr prcs spec shall comply with the requirements of this specification. In addition, the contr prcs spec should conform to the format established by MIL-STD-490.

3.1.1 Availability. The contr prcs spec shall be finalized and made available by the prime contractor by the critical design review of engineering and manufacturing development of material to which it applies. During the course of production, the contr prcs spec shall also be made available for use by authorized Government and Industry inspectors in the facilities of the prime contractor, his subcontractors, or his vendors. It shall also be made available, on request, for review by engineers of the procuring activity.

3.1.2 Compliance. The prime contractor represents that compliance (see 4.1) with such process specifications will produce parts meeting all the contract requirements. Any change in materials, design, tooling, or process which affects material properties or part performance shall require resubmittal and approval by the procuring activity. The following requirements, processes, inspection methods, and precautions shall be listed.

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3.1.3 Referenced documents. The contr prcs spec shall only reference those documents or specifications which have been approved by the procuring activity. Documents listed in the DODISS (ie. Federal, Military and DoD-adopted Industry specifications, standards, handbooks, etc.) shall be acceptable unless specifically disapproved by the procuring activity. Company or contractor specifications shall be acceptable for use when approved by the procuring activity.

3.2 Chemical and personnel safety. Materials and processes shall be selected to meet environmental and hazardous waste regulations, and occupational safety and health requirements.

3.3. Materials and equipment. Materials and equipment selected to be used in the fabrication process and which are necessary for the production of quality end items shall be listed and approved by the procuring activity.

3.3.1 Materials. Materials shall be so selected that parts are consistently produced in conformance with the applicable laminate or sandwich specification, purchase order or engineering drawing(s). Materials used directly in the part shall conform to applicable specifications (see 3.1.3).

3.3.2 Equipment. Equipment used in the fabrication process shall be described. The maintenance system and calibration system (3.3.2.1), where applicable, shall also be described.

3.3.2.1 Equipment calibration. A calibration system for all measuring and test equipment shall be established in accordance with MIL-STD-45662.

3.4 Material storage, facilities control and tooling.

3.4.1 Material storage. The following environmental storage conditions and limits shall be listed in the contr prcs spec:

- a. Temperature.
- b. Humidity.
- c. Maximum time of storage.
- d. Maximum time out of storage (see handling life, 6.2.7).
- e. Requirements for handling refrigerated materials, or other material requiring special handling.
- f. Criteria for determining suitability of materials taken from storage.

Prior to use, resins, adhesives, primers, and preimpregnated fabric and tape should be brought up to room temperature in a closed container to avoid moisture contamination.

3.4.1.1 Refrigerated storage life. The refrigerated storage life begins from the date of manufacture or shipping, as applicable, and shall be warranted by the manufacturer. The contr prcs spec shall specify:

- a. The refrigerated storage life, handling life and mechanical life shall be specified as to time, temperature and humidity.
- b. Tracking methods for monitoring out-time during shipping and storage.

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3.4.1.2 Material testing. Incoming material shall be inspected in accordance with 4.3.1. If the storage life has been exceeded for preimpregnated fabric and tape, the resin flow, gel time, volatile content, and significant matrix dominated mechanical properties shall be determined prior to use. Procedures for testing and extending of storage life of material which has exceeded its storage life shall be specified in the contr prcs spec.

3.4.2 Facilities control.

3.4.2.1 Environmental controls. The atmospheric pressure, temperature, humidity and cleanliness maintenance shall be described in the contr prcs spec where ply kitting, tape laying, adhesive application, and bagging operations are conducted.

3.4.2.2 Cleanliness. Special handling requirements relating to the cleanliness of the operations shall be given in the contr prcs spec, where applicable, such as the use of clean cotton gloves during processing.

3.4.3. Tooling. Tooling shall be designed and fabricated, as necessary, to construct quality, dimensionally accurate, and mechanically and electrically acceptable composite parts. Tool drawings shall be prepared for significant tools, such as bond and cure tools and major assembly tools. Tooling materials and designs shall be selected based upon the tolerance requirements of the engineering drawings and the curing/processing requirements of the raw material. Tooling shall be constructed to minimize shimming during assembly. Critical tools shall be inspected periodically to ensure control of tool and part dimensional tolerances (see 4.3.5). Methods and frequency of inspecting for, compensating for, and repairing tool wear and distortion, as applicable, shall be described in the contr prcs spec, as applicable.

3.4.3.1 Prove out. Procedures for tooling prove out (6.2.17) shall be described in detail.

3.5 Raw material preparation, lay-up and fabricating procedure. Each step in the manufacture of the laminate (Type I) or sandwich (Type II) part shall be completely described as outlined below.

3.5.1 Type I - laminates.

3.5.1.1 Wet lay-up. The resin to be used shall be one that complies with an applicable specification (see 3.1.3) and shall be listed (3.3) in the contr prcs spec. The procedure for use and curing of resin shall not conflict with the resin manufacturer's or prepregger's approved instruction sheet, except where the fabricator has determined more suitable curing systems and curing cycle for a particular application. Alternate curing cycles shall be fully described in the contr prcs spec and supporting data shall be submitted prior to approval. The procedure and equipment used for mixing resins, catalysts and hardeners shall be described where applicable.

3.5.1.2 Dry lay-up. The prepreg to be used shall be listed (3.3) in the

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contr prcs spec and shall be one that complies with an applicable specification (3.1.3).

3.5.2 Type II - sandwich.

3.5.2.1 Materials. The adhesive and core material to be used shall be listed (3.3) in the contr prcs spec and shall be one that complies with an applicable specification (see 3.1.3). Unless otherwise specified in the applicable engineering drawing, the pieces of core material shall be laid up in the direction of core ribbon as specified in the applicable sandwich specification. The procedure for use and curing of adhesive shall not conflict with the adhesive manufacturer's approved instruction sheet, except where fabricator has determined more suitable curing cycles for a particular application. These shall be fully described in the contr prcs spec, and confirming data shall be required prior to approval.

3.5.2.2 Bonding. Core-to-core and face-to-core bonding shall be performed in accordance with MIL-A-83377. The contr prcs spec shall contain a description of the methods used to maintain critical bond line thickness based on the adhesive system selected.

3.5.3 Laminating and curing procedure. The following general information shall be given in the contr prcs spec:

3.5.3.1 Laminating.

- a. Procedures for preparation of tool surfaces, impregnation of fabric and tape as applicable, cutting of prepreg, and lay-up and compaction of lay-ups.
- b. The bagging sequence, describing release film, bleeder plies, breather plies and caul plates.
- c. Methods for tracking out-time of materials taken from refrigerated storage.

3.5.3.2 Curing.

- a. Temperature and time process windows, or parameters, for the application of vacuum, heat, and pressure.
- b. Method of applying and controlling heat to cure the laminate or sandwich part.
- c. Location and calibration system (3.3.2.1) of thermocouples.
- d. Postcure time and temperature.
- e. Postcure heat-up and cool down, atmosphere, and part support.
- f. Cocuring procedures, as applicable.

The specific recorded charts for each part shall be made available in accordance with 4.3.3.2.1. Room temperature and ultraviolet light curing systems shall not be used unless approved by the procuring activity. Confirming data shall be required prior to approval.

3.5.4 Drilling and trimming. The following drilling and trimming procedures and equipment shall be listed in the contr prcs spec:

- a. Routers, drills, saws, metal cutting tools, high pressure water jets and grinding wheels used for drilling, reaming, counter-sinking,

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- trimming and finishing of the part.
- b. Tools shall be described in detail and feed rates, speeds, backup materials, cooling, and dust removal system descriptions given.
- c. Sealing methods, where applicable.
- d. Acceptable levels of hole and edge quality, dimensional checks and inspection methods.
- e. Out-of-roundness tolerances and inspection methods.
- f. Acceptance criteria and corrective action for edge delamination and fiber breakout.

The contractor shall develop test data to determine machining and drilling processes in order to prevent overheating, breakout, and dimensional nonconformity. Lubricants and coolants shall be used when applicable to improve hole quality. When required by the contr prcs spec, cut edges shall be inspected for delaminations and defects. Damage caused by overheating shall not be allowed.

3.6 Defects.

3.6.1 Laminate (Type I) defects. The minimum requirements for the laminate parts and maximum allowable and repairable defects for structural zones shall be as specified by the contractor. The following shall be specified in the contr prcs spec:

- a. Structural zones shall be defined based on design requirements.
- b. Levels of allowable defects, and the number and density of defects that originate from the production process for each zone shall be defined in the prcs spec.
- c. Acceptance and rejection criteria for all defects listed herein.
- d. Repair procedures and nondestructive inspection methods (4.3.3.4) used to verify repair quality shall be described in detail and repaired areas recorded (4.3.3.2).

Any defect that will be completely removed from the part at a later stage of manufacture is acceptable. The acceptance of any and all defects and repairs, insofar as they affect the serviceability of the part, is the responsibility of the prime contractor. Any part having defects in nature, size, location or extent beyond approved repairable conditions shall be corrected or disposed of, as applicable, in accordance with MIL-STD-1520. Defects to be specified are as follows:

3.6.1.1 Porosity and voids. Porosity is defined as a condition of small trapped pockets of air, gas or voids within a laminate part. Voids are a condition of air or gas that has been trapped and cured into a laminate part. Porosity is an aggregation of microvoids. Attenuation levels for porosity shall be correlated with significant mechanical properties. Porosity and voids shall be specified as follows:

- a. Void size or porosity dispersion/area.
- b. Location.
- c. A quantifiable NDT variable (e.g. ultrasonic attenuation)

3.6.1.2 Overlaps. The minimum and maximum overlap for each layer of fabric or tape shall be as specified in the drawing.

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3.6.1.3 Gaps. Gaps are defined as the space between butted edges of faying surfaces (mating surfaces), or two pieces of broadgoods or tape. Step plate gaps are defined as a gap between the ends of plies and the vertical component of a metal stepped (splice) plate. Gaps shall be as specified as follows:

- a. Maximum acceptable repairable size.
- b. Location.
- c. Number, maximum allowed in a given area.

3.6.1.4 Cracks (fractures). Cracks are defined as fractures in either the matrix or both matrix and fibers. Cracks shall be specified in the contr prcs spec as follows:

- a. Maximum acceptable size.
- b. Location.
- c. Number, maximum allowed in a given area.

3.6.1.5 Surface pits and pin holes. Pits are defined as small, regular or irregular craters in the surface of a plastic, usually of a width approximately the same order of magnitude as its depth. Pin holes are defined as small cavities that penetrate the surface of a cured part. None shall be allowed beyond the first layer. Within the first layer the following shall be specified:

- a. Maximum repairable size.
- b. Location.
- c. Number, maximum allowed in given area.

3.6.1.6 Blisters. Blisters are air-containing areas in which there is a lack of bond between any two plies of fabric or tape in a laminate. The following limits shall be specified:

- a. Layers in which no blisters are allowed.
- b. Size of blisters allowed in remaining layers.
- c. Number of blisters allowed in a specified area and in relationship to one another.
- d. Location.

3.6.1.7 Resin starved areas. Resin starved areas are defined as areas in which the fabric, tape or fibers are not adequately coated with resin. The acceptable levels of resin starved areas shall be specified in the contr prcs spec.

3.6.1.8 Tackiness. Tackiness is defined as a soft or fluid area of resin that has not fully cured. Evidence of tackiness in the finished part shall not be allowed. Methods for determining tackiness shall be specified in the contr prcs spec.

3.6.1.9 Wrinkles. A wrinkle is defined as a imperfection in laminated plastics that has the appearance of a crease or fold in one or more sheets of the paper, fabric, or the base, which has been pressed in. The following

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parameters shall be specified in the contr prcs spec:

- a. Size, maximum.
- b. Location, limitation.
- c. Repairable or nonrepairable.

3.6.1.10 Delamination and non-bonds. Delamination(s) are defined as the separation of the layers of material in a laminate. A non-bond indicates that the laminate never bonded during the cycle cure. The following shall be specified in the contr prcs spec:

- a. Size, maximum.
- b. Location, depth and proximity to other defects or to edge.

3.6.1.11 Foreign matter. There shall be no foreign objects or substances in the laminate part which will cause structural or electrical nonserviceability of the part. Foreign matter shall be defined as any material not included in the contr prcs spec or engineering drawing. Foreign material in the lay-up area shall be demonstrated to be detectable by production non-destructive inspection (NDI) techniques (3.10.2). Maximum allowable foreign material sizes shall be determined by the contractor for various materials, and inclusions exceeding these sizes shall require engineering disposition.

3.6.1.12 Breakout and splintering. Breakout is defined as fiber separation or breakage of surface plies at drilled or machined edges. Splintering is a combination of cracking and delamination of the outer skin. Breakout and splintering shall be minimized through control of feeds and speeds, machine tool/drill bit replacement, and backside support where possible. For each breakout and splintering area, specify rejectable defect criteria:

- a. Size.
- b. Location.
- c. Number, maximum per area.
- d. Repairable or nonrepairable.

3.6.1.13 Bridging. A condition where fibers do not move into or conform to radii and corners during molding, resulting in voids and dimensional control problems.

3.6.1.14 Fiber distortion. An abrupt change in fiber orientation.

3.6.1.15 Resin rich areas. Localized area filled with resin and lacking reinforcing material.

3.6.2 Sandwich construction (Type II) defects. The minimum requirements for the sandwich parts and the maximum allowable and repairable defects for structural zones shall be as specified by the prime contractor. Any sandwich parts having defects in nature, size, location or extent beyond approved repairable conditions shall be disposed of, as applicable, in accordance with MIL-STD-1520. Defects to be specified are as follows:

3.6.2.1 Unbonded areas. The following limits shall be given for

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unrepaired unbonded areas between the laminate (skin) and core, between pieces of core material, or between laminate and metal. The following shall be specified in the contr prcs spec:

- a. Maximum repairable unbonded area between skin and core and between pieces of core.
- b. Size, maximum.
- c. Location, (including proximity to other defects, edges or fastener holes).

3.6.2.2 Laminate (skin) defects. Skin defects shall be allowed to the extent specified in 3.6.1.

3.6.2.3 Core crushes. Core crushes are defined as a collapse, distortion or compression of the core.

3.6.2.4 Cell distortion. Cell distortion and variation of ribbon direction shall be defined.

3.7 Mechanical and physical requirements.

3.7.1 Cured laminates (Type I). The mechanical and physical properties of the laminate in 4.3.3.1.2, where applicable, shall be tested for in accordance with and defined in the applicable laminate specification.

3.7.2 Bonded sandwich construction (Type II). The mechanical properties for sandwich construction in 4.3.3.1.2 shall be tested for in accordance with and defined in the applicable sandwich specification. The requirements of 3.7.1 shall also be met.

3.8 Electrical requirements (where applicable). The laminate or sandwich construction parts shall conform to the electrical requirements of the applicable laminate or sandwich construction specifications.

3.9 Dimensional requirements. The laminate (Type I) and sandwich construction (Type II) parts shall meet the dimensional requirements of the drawings, specification or contract for the specified parts.

3.10 Inspection and testing. The contractors inspection and testing program shall meet the requirements of MIL-I-45208. Visual and nondestructive inspection methods shall be described in detail in the contr prcs spec as contained herein.

3.10.1 Visual inspection. Visual inspection procedures to detect surface defects such as in 3.6 shall be described in detail.

3.10.2 Nondestructive testing and inspection. A nondestructive inspection and testing program shall be established in accordance with MIL-I-6870. Methods and equipment used for nondestructive inspection shall be described in detail. All nondestructive testing shall be performed in accordance with the contr prcs spec. The appropriate nondestructive testing methods shall be determined for all zones of structure to ensure rejectable defects may be found. Sampling plans shall be defined based on structural zones (see 3.6.1) and may be used for nondestructive testing. All sampling

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plans shall identify the statistical risk of not detecting a rejectable defect.

3.10.2.1 Ultrasonic inspection and testing. The following equipment, methods and standards shall be described:

- a. Inspection method type.
- b. Manufacturer and model numbers of instrumentation (include recording equipment, alarm equipment and electronic distance-amplitude correction equipment).
- c. Description of manipulating and scanning equipment.
- d. Couplant.
- e. Method of establishing scan sensitivity and index determination for concave and convex surfaces, if applicable.
- f. Scanning plan.
- g. Reference standards.
- h. Discontinuity evaluation procedure.
- i. Attenuation - dB loss (thick section), dB loss (thin section).
- j. Criteria for flaw type, size, and number.
- k. Description of recording methods and how traceability is established.
- l. Sampling plan.
- m. Part positioning including water path length and sound entry angle.
- n. Set up calibration using the applicable reference standard.
- o. Any special requirements relative to the specific technique (such as, when using focused transducers the waterpath shall be such as to position the focal point to maximize detection of the maximum (or smaller) allowable size defect at any depth and location in the structure).
- p. Any other pertinent data.

3.10.2.2 Radiographic testing and inspection. The following equipment, methods and standards shall be described:

- a. Manufacturer and model numbers of equipment, KVP rating, focal spot size, and tube head type.
- b. Reference standards or radiographs.
- c. Kilovoltage.
- d. Level of exposure (duration) in milliamperes minutes or Curies.
- e. Focal film distance.
- f. Film density range in the area of interest.
- g. Film brand, type and size.
- h. Screens (type and thickness).
- i. Penetrameter thickness, type, number, and placement.
- j. Quality level of penetrameter.
- k. Film processing (manual or automatic).
- l. Description of marker positioning.
- m. Acceptance criteria.
- n. Sampling plan.

3.10.2.3 Other. Other non-destructive inspection and testing techniques shall be described in regard to the sampling plan, equipment, recording methods, and any other pertinent details.

3.11 Pre-fit. The procedures for pre-fit shall be described in detail.

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3.12 Assembly. The fitting of parts and drilling and shimming procedures shall be performed in order to obtain an acceptable fit as established by the contr prcs spec or the engineering drawing. In the assembly operation, gaps between parts shall be minimized without excessive force to assure structural integrity, prevent pre-stress or damage to composite and improve fuel sealing (where applicable). Sanding of substructure parts to minimize gaps shall be restricted to the outer resin layer only. The outer reinforcement ply may be removed if not required for structural purposes. The electrical properties (3.8) and lightning strike protection materials should not be degraded if the first ply must be removed.

3.12.1 Dimensional checks. The contractor shall verify, through sufficient sampling techniques, the composite assembly meets the dimensional requirements of the engineering drawing.

3.12.2 Fixturing. The fixtures, frames, or jigs used in the mounting of substructures (ie. ribs, spars, hardware) to the composite part, and their placement shall be described in the contr prcs spec.

3.12.3 Shimming. The contractor shall determine the maximum allowable gaps during the assembly process based on structural requirements, laminate thickness, drilling technique, fastener style, and shim type. The maximum allowable gap shall be that which minimizes the risk of ply delamination during assembly.

3.12.3.1 Shimming materials. Shimming materials (liquid and solid) shall be listed (see 3.3). The requirements and test methods for shimming compounds, such as shelf life, vertical flow, thixotropic characteristics, pot life, application life, cure time, density, hardness, thickness, compressive strength, shear strength and environmental resistance, shall be as specified by the prime contractor.

3.12.3.2 Shimming application. The following shall be described in the contr prcs spec:

- a. Methods for preparing the surface.
- b. Methods for applying and curing liquid and solid shims.
- c. Methods for control of gap sizes.
- d. Gap sizes, if not shown on the engineering drawing.
- e. Techniques for excess shim removal.

3.12.4 Fastening. Interference fit fasteners are discouraged from use in structural composite assemblies. Process for verifying length and installing fasteners shall be described in the contr prcs spec. Description of tools, torque or preload indicators, and bolt lubricants and sealants shall be given.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the

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contractor 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of Section 3. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements; however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Process specification. The primary and continuing purpose of the acceptance tests is to ensure that all the requirements and procedures of the approved contract specifications are continuously complied with during the production of parts. This shall be accomplished by periodic review of the production processes, inspection methods, controls, and other items covered by the process specification for conformance with the requirements of the latter. The process specification shall contain all the general requirements for sampling, inspection and testing. Specific and detailed requirements shall be as specified on the engineering drawing.

4.3 Classification of inspection. The inspections, which include examinations and tests, performed under this specification shall be classified as contained herein.

4.3.1 Incoming material inspection. The incoming material inspection, including sampling and testing, of all materials or laminates to be used in the fabrication of all laminates (Type I) or sandwich construction (Type II) shall be in accordance with their applicable specification (3.1.3).

4.3.2 First article inspection. Prior to fabrication of production parts, fabrication procedures for each part shall be verified to assure conformity with the engineering drawing requirements as well as the physical and mechanical requirements. The contractor shall specify and define a first part to be prepared in accordance with 3.5 on the tooling to be used in manufacturing the contracted part. Conformance with the requirements of 3.6 and 3.9 shall be verified by visual inspection (3.10.1) and nondestructive inspection (3.10.2). Following testing to 3.6 and 3.9, the part shall be cut into specimens for testing for conformance with the requirements of 3.7 and 3.8. A destructive test plan shall be submitted to the procuring activity for approval. The first article destructive test plan shall include, but is not limited to, the requirements of 4.3.3.1.2 (including photomicrographs) and other tests required to verify part integrity. Additional mechanical property tests representative of the critical failure mode for critical zones (see 6.2.4) of the part shall also be conducted. For buckling critical structure, the compression strength and modulus test shall be conducted. First article

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inspection shall be performed for all new tooling, or for any major change in design, materials, or process which could alter the properties or performance of the finished part.

4.3.3 Production inspection.

4.3.3.1 Process control testing.

4.3.3.1.1 Sampling. Unless otherwise specified in the contract, the fabricator shall specify and define the size, source and sampling rate of specimens for testing for conformance to the requirements of 3.7, 3.8 and 3.9. Critical parts (see 6.2.4) shall be tested 100 percent. Specimens shall consist of tab ends, cut-outs or cut-offs of production parts or elements, or test panels from a typical lay-up of the part from the same bag, tool and processing conditions.

4.3.3.1.2 Tests. Test methods shall be described in the contract process specification if not shown in the applicable laminate or sandwich specification (see 3.7). The following physical and mechanical property values shall be determined:

- a. Laminates.
 - 1. Degree of cure.
 - 2. Interlaminar shear strength (short beam shear).
 - 3. Void content.
 - 4. Ply orientation.
 - 5. Critical mechanical property tests (where applicable and approved by the procuring activity).

Ply orientation/stacking shall be determined through the use of photomicrographs or other suitable methods to determine conformance of the part with the engineering drawing or part specification.

- b. Sandwich construction.
 - 1. Sandwich flexure.
 - 2. Flatwise tension.

4.3.3.2 Documentation. All parts shall be accompanied by a traveler sheet through production and final inspection. The traveler sheet shall contain check-off inspection points for each step in the manufacturing and inspection processes. A minimum check off inspection shall contain the following:

- a. Incoming material inspection (4.3.1).
- b. First article inspection (preproduction) testing (4.3.2).
- c. Any deviation from process (3.1.2).
 - ie. Any abnormality or otherwise deviation/substitution from the required process.
- d. Process control test results (4.3.3.1).
- e. Facilities (4.3.4) and tooling inspection (4.3.5).
- f. Repairs (4.4), retest (4.5), and rejection (4.6), if applicable.
- g. Final quality assurance verification.

4.3.3.2.1 Cure records. Time, temperature, vacuum and pressure recorded charts (see 3.5.3) shall accompany each traveler sheet or the records shall be

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maintained with adequate traceability in accordance with the contract.

4.3.4 Facilities inspection. An inspection plan shall be established and described in detail in the contr prcs spec for the periodic verification of cleanliness and to verify the proper control of the facilities and operations. Such inspection shall cover areas used for the storage, cutting, lay-up and curing of material and the fabrication of cured parts. The time and date of the last inspection shall be documented (4.3.3.2). Conditions found during such inspection which may be detrimental to the finished part shall be recorded and corrective actions described. Such records shall be made available, in accordance with the contract, to the purchaser upon request.

4.3.5 Tooling inspection. An inspection plan shall be established and described for the periodic inspection of critical tooling (3.4.3). Such inspection shall include verification of dimensional accuracy and examination for tool wear and distortion. The time and date of the last inspection shall be documented (4.3.3.2).

4.4 Repairs. The contractor will supply the actions required to correct any defects of a repairable nature as specified by contracts for specific parts. Nonconforming parts judged repairable to the extent specified in 3.6 shall be repaired such that the repaired parts conform to the requirements stated in 3.7 and 3.8 as well as the engineering drawing, and demonstrate conformance with 3.6 through nondestructive inspection. The methods used for correcting defects of a repairable nature to conform to the above requirements shall be fully described in the contr prcs spec and shall be substantiated by appropriate test data.

4.5 Retesting. All retesting of parts repaired in accordance with 4.4 shall be documented on the applicable traveler sheet. Such documentation shall include type of defects, methods of repair and results of retesting.

4.6 Rejection. Rejected parts shall not be resubmitted for inspection without furnishing all particulars concerning previous rejection and measures taken to overcome the defects.

5. PACKAGING

(This section is not applicable to this document.)

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This specification is intended to cover minimum requirements for the preparation of process specifications for the manufacture of composite parts. This specification does not constitute a requirement for any additional process specification.

6.2 Definitions.

6.2.1 Bleeder. Porous material used to absorb excess resin from prepreg during cure.

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6.2.2 Breather. A loosely woven or matted material that will serve as a continuous vacuum path over a part but not in contact with the resin.

6.2.3 Compaction. The application of pressure to compact the lay-up.

6.2.4 Critical zone. A critical zone of a part or component is defined as one that carries primary aircraft loads and is essential in maintaining aircraft structural integrity. These zones must meet certain materials and fabrication standards and test requirements. The failure of a critical zone of a part or component during operating conditions could cause loss of the aircraft or one of its major components, loss of control, unintentional release of or inability to release any armament store, failure of weapon installation components, or which may cause significant injury to occupants of the aircraft.

6.2.5 Cut-off. An extension built on a part for removal as waste or for testing purposes.

6.2.6 Debulking. Compacting of laminates at room temperature or under moderate heat and vacuum to insure seating on the tool, to prevent wrinkles and to remove volatiles and air.

6.2.7 Handling life (Working life). The length of time that the material can be exposed to temperatures between 60°F and 80°F and retain its handleability.

6.2.8 Laminate. A product made by bonding together two or more layers (laminae) of material or materials.

6.2.9 Lay-up area. The fabrication area where raw materials are cut, plied, assembled or kitted.

6.2.10 Manufacturing process instruction (MPI). A step-by-step manufacturing procedure that provides greater control, precision, and repeatability in operations.

6.2.11 Mechanical life (Open mold life). The out-of-refrigeration to cure time through which the material remains capable of attaining the required mechanical and physical properties when laid up after its handling life.

6.2.12 Non-critical zone. A zone is considered non-critical where a failure would not affect efficiency of the system or part or endanger personnel. These zones of parts or components are not necessary to ensure structural integrity.

6.2.13 NDT (NDI). Non-destructive testing (non-destructive inspection) techniques used to detect internal anomalies in a structure without degrading the chemical, physical or mechanical properties of the structure.

6.2.14 Pre-fit. 1) The process of dry fitting of detail parts that are to be molded or bonded together to form a structural part. 2) A process to check the fit of mating detail parts in an assembly prior to adhesive bonding to insure proper bond lines. Mechanically fastened structures are also

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pre-fit sometimes to establish shimming requirements.

6.2.15 Prime contractor. A prime contractor is a contractor fabricating components, or subcontracting the fabrication of parts or all such components, under direct contract with the Government; or a fabricator supplying components direct to the Government.

6.2.16 - Process control test panel. A standard test panel made at the same time from the same material stocks, and under the same bag (or in series with) and the same conditions as the production unit to ensure that the proper physical and mechanical properties were attained during the cure cycle.

6.2.17 Prove Out. The process of fabricating the first part on an inspected tool using the procedures specified in the process specification.

6.2.18 Sandwich construction. A structural panel concept consisting in its simplest form of two relatively thin, parallel sheets of structural material bonded to and separated by a relatively thick, lightweight core.

6.2.19 Semi-critical zone. A zone is semi-critical when a failure could reduce overall effectiveness of the system but endangering of personnel would not be experienced. These zones include but are not limited to zones which serve to transfer aircraft loads to primary structural members. Normally, the allowable defects in these zones is greater than that allowed for critical zones.

6.2.20 Storage life (Shelf life): The length of time the material will retain its handling life, mechanical life, and all other requirements of the applicable material specification while exposed to specified temperatures while contained in its original packaging system.

6.2.21 Subcontractor. A subcontractor is a fabricator supplying components to a prime contractor.

6.2.22 Test coupon(s). Coupon(s) which are cut from the process control test panel or cut-offs. The test coupon is used to verify the physical and mechanical properties of the composite part.

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27-4.75-1 exempts the requirement for a DD Form 1423.

<u>Reference Para.</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
3.1	DI-E-3130	Process Specification	---
3.4.3	DI-DRPR-81008	Special tooling drawings and associated lists	---

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The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMS DL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4. Acceptable specifications and standards. The following list of standards may be incorporated into the contr prcs spec or may be used for guidance or information in the development of the process specification.

MIL-Q-9858	Quality Program Requirements
MIL-STD-401	Sandwich Construction and Core Materials; General Test Methods
MIL-STD-1944	Polymer Matrix Composites
MIL-HDBK-733	Radiography
MIL-HDBK-787	Nondestructive Testing Methods of Composite Materials - Ultrasonics
ARP 1611	Quality Inspection Procedure, Composites, Tracer Fluoroscopy
NAS 999	Nondestructive Inspection of Advanced Composites

6.5 Subject term (keyword) listing.

Adhesive
Bonding
Composite
Curing
Epoxy
Prepreg
Resin

6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
Army - MI
Navy - AS
Air Force - 11

Preparing Activity:
Navy - AS
(Project No. CMPS-0076)

Review Activity:
DGSC - GS

User Activity:
Army - ME

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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1. RECOMMEND A CHANGE		1. DOCUMENT NUMBER MIL-P-9400C		2. DOCUMENT DATE (YYMMDD) 14 November 1991	
3. DOCUMENT TITLE PLASTIC LAMINATE AND SANDWICH CONSTRUCTION PARTS AND ASSEMBLY, AIRCRAFT STRUCTURAL, PROCESS SPECIFICATION REQUIREMENTS					
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)					
5. REASON FOR RECOMMENDATION					
6. SUBMITTER					
a. NAME (Last, First, Middle Initial)			b. ORGANIZATION		
c. ADDRESS (Include Zip Code)			d. TELEPHONE (Include Area Code)		7. DATE SUBMITTED (YYMMDD)
			(1) Commercial		
			(2) AUTOVON		
			(3) (If applicable)		
8. PREPARING ACTIVITY					
a. NAME Commanding Officer Naval Air Engineering Center			b. TELEPHONE (Include Area Code) (1) Commercial (908) 323-7455 (2) AUTOVON 624-7455		
c. ADDRESS (Include Zip Code) SESD Code 5312 Lakehurst, NJ 08733-5100			IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340		