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	SUBJECT: FIBERGLASS REINFORCED PLASTIC LAMINATES; VACUUM-BAGGED, FABRICATION OF			

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TECHNICAL PROCESS SPECIFICATION

REVIEWED DATE	REV.	DATE	REV BY	PAGES AFFECTED	REMARKS
	E	02/07/04	GLW	ALL	Added revision page, Added 1.4, Revised 1.2, Table I, 3.2.2.2.1, 3.2.2.2.2, & 3.2.2.2.3. Added 3.2.2.2.4 Revised 3.2.4.2, 3.2.5.4, Added 3.2.5.5. Revised 3.3.2, 3.3.2.1. Added 3.3.2.2. And 3.3.2.3. Revised 3.4.1.2, 3.4.4.1.1. Added 3.4.4.1.2, Revised 4.5, 4.5.3 & 4.5.4

PROCESS SPECIFICATION

1. SCOPE.

1.1 Scope. This specification covers the detail instructions, controls, inspection and test requirements for the fabrication of glass fiber (fiberglass) reinforced plastic laminates formed under low pressure (vacuum bagged) of 10 to 15 psi during the curing process. Procedures are presented for the use of polyester, epoxy, phenolic, silicone, and polyamide resins, both in the form of liquid resin systems and preimpregnated fabrics. This specification is prepared in accordance with the requirements of MIL–P–9400 Type I for plastic laminates. Selection guidelines are presented in 6.1.1.

1.2 Effectivity. This specification is a complete revision of TPS 2-522, dated 19 December 2002, and supersedes AC003006-002 and AC0M3006-002 in part. For previous design using AC003006-002 and AC0M3006-002, see section 6.3. This specification is effective upon the release of the Document Release Notice (DRN). Changed paragraphs from the previous revision are marked by a solid black bar in the left-hand margin. A cross reference of superseded TPSs is shown in 6.2.

1.3 Classification. Plastic laminates covered by this specification are of the following classification as applicable: TYPE which relates to the end use of the part; GRADE which covers the structural requirement; COMPOSITION which covers the resin to be used; FORM which covers the physical state of the resin; and CATEGORY which covers the heat and flame resistance of the resin system. Fire resistant and heat release materials indicated herein shall be in accordance with FAR 25.853. NOTE, where burn test requirements are not firm or known by design contact the burn test coordinator for determination (reference 6.1). Reinforcement shall be glass cloth conforming to AMS–C–9084 (see 3.2.3.1).

1.3.1 Type.

TYPE I – General Purpose (Non-electrical)

TYPE II – Radio Frequency

TYPE III – Radar Frequency

1.3.2 Grade.

GRADE A – Structural Applications (Includes all exterior surfaces)

GRADE B – Nonstructural

1.3.3 Composition.

COMPOSITION l – Polyester Resin

FORM (a) – Liquid Resin System

CATEGORY (l) – Applications up to l80°F

CATEGORY (2) – Applications up to 250°F

CATEGORY (3) – Applications up to 180°F (Fire resistant, meets FAR 25.853, 60 second vertical)

FORM (b) – Resin Preimpregnated in Fabric

CATEGORY (l) – Applications up to 250°F (Fire resistant, meets FAR 25.853, 60 second vertical)

CATEGORY (2) – Applications up to 350°F (Fire resistant, meets FAR 25.853, 60 second vertical)

COMPOSITION 2 – Epoxy Resin

FORM (a) – Liquid Resin System

CATEGORY (l) – Applications up to l80°F

CATEGORY (2) – Applications up to 300°F

CATEGORY (3) – Applications up to 180°F (Fire resistant, meets FAR 25.853, 60 second vertical)

FORM (b) – Resin Preimpregnated in Fabric

CATEGORY (l) – Applications up to 180°F

CATEGORY (2) – Applications up to 350°F and short time exposure of 30 minutes at 500°F

CATEGORY (3) – Applications up to 180°F (Fire resistant, meets FAR 25.853, 12 second vertical)

COMPOSITION 3 – Phenolic Resin (Fire resistant material)

FORM (a) – Liquid Resin (Rework resin only)

FORM (b) – Resin Preimpregnated in Fabric

CATEGORY (1) – Applications up to 350°F, (Fire resistant, FAR 25.853, 60 second vertical and Heat Release Rate Compliant, (OSU 65/65)

CATEGORY (2) – Applications up to 350°F and short time exposure at 30 minutes at 500°F

CATEGORY (3) – Applications up to 500°F (Continuous exposure)

CATEGORY (4) – Applications (interior) up to 175°F, (Fire resistant, meets FAR 25.853, 60 second vertical and Heat Release Rate Compliant, (OSU 65/65)

COMPOSITION 4 – Silicone Resin (Fire resistant material, meets FAR 25.853, 60 second vertical)

FORM (a) – Liquid Resin (Rework resin only)

FORM (b) – Resin Preimpregnated in Fabric

COMPOSITION 5 – Polyimide Resin

FORM (a) – Liquid Resin (Rework resin only)

FORM (b) – Preimpregnated Fabric

CATEGORY (l) – Applications up to 350°F

CATEGORY (2) – Applications up to 700°F

1.4 **Order of precedence.** If there is a conflict between the Engineering drawing and this specification, the Engineering drawing shall take precedence.

2. APPLICABLE DOCUMENTS.

2.1 **Government documents.** The following documents shall form a part of this specification to the extent specified herein. Unless otherwise specified, the current issue shall apply

SPECIFICATIONS

Federal

Federal Aviation Regulation

FAR Part 25	Airworthiness Standards: Transport Category Airplanes

Military

[redacted]	Plastic Laminate and Sandwich Construction, Process Specification Requirements
[redacted]	Plastics for Aerospace Vehicles

2.2 **Non–Government documents.** The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the current issue shall apply.

SPECIFICATIONS

Society of Automotive Engineers

[redacted]	Cloth, Glass, Finished, for Resin Laminates

American Society for Testing and Materials

ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

ASTM D2583	Standard Test Method for Indention Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D2584	Standard Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D5486	Standard Specification for Pressure-Sensitive Tape for Packaging, Box Closure, and Sealing

L-3 Communications Integration Systems, Technical Process Specifications

TPS 2–106	Holes, Preparation of
TPS 2-523	Structural Fiberglass Repair
TPS 7-200	Environment Controlled Requirements For

3. REQUIREMENTS.

3.1 Equipment.

3.1.1 Tooling/ Production Aids. Molds, mandrels and similar forming tools as necessary for shaping the parts. These tools shall be fabricated of a material that will not inhibit the cure of the resin, be impervious to the resin, will hold a vacuum and will withstand the cure temperature and pressure. Heat resistant reinforced plastic or metal molds are recommended for use with prepregs.

3.1.2 Heating equipment. An oven capable of maintaining uniform heat up to the specified cure temperature for the resin system in use within plus or minus 10°F.

3.1.3 Vacuum equipment. Vacuum equipment capable of maintaining a minimum vacuum of 26 inches of mercury.

3.1.4 Auxiliary equipment. Vacuum hoses, cutting and trimming tools, smoothing irons, press–down tools, heat guns, heat blankets, and similar shop equipment.

3.1.5 Hardness indicator. Barcol Impressor Tester, Model GYZJ 934–1, supplied by Barber–Colman Co., CAGE 65149 or equivalent.

3.2 Materials.

3.2.1 Resins and preimpregnated fabric. Approved materials are as specified in Table I. The type, grade, composition, and category shall be specified on the Engineering Drawing. Materials utilized other than those specified in Table I require Materials and Process Engineering and Stress approval prior to use and shall be specified on the applicable Engineering Drawing.

TABLE I
APPROVED MATERIALS

Composition (Resin Type)	Form	Category (Service Temp.)	Type (Application)	Grade (Structural Requirement)	Specific Material	Manufacturer	Cage
1 - Polyester	(a) Liquid	(1)	I, II, & III	A & B	Laminac 4128	U.S. Chemical Co.	94977
		(1) & (2)	I, II, & III	A & B	Selectron 5016	Pittsburg Plate Glass	47695
		(1) (2)& (3)	I, II, & III	A & B	Hetron 92FR	Ashland Chemical Corp	73675
		(1) (2) & (3)	I	A & B	Dion FR6604T	Indspec Chemical Corp	75395
	(b) Prepreg	(1) & (2)	I, II, & III	A & B	F-141-* P604C-*	Hexcel Corp. Fibercote Industries	91610 57929
		(1) & (2)	I, II, & III	A & B	Cycom 4102A-* (Formerly Corlar 4102A)	Cytec Fiberite	07314
2 - Epoxy	(a) Liquid	(1) & (2)***	I, II, & III	A & B	Epon 828 or Epon 815	Shell Chemical Co.	22893
		(1) & (3)	I, II, & III	A & B	Epocast 50A (Formerly Epocast 1835)	Ciba-Geigy Corp. Furane Products M&T Chemicals, Inc.	99384
	(b) Prepreg	(2)***	I, II, & III	A & B	E293-*	Cytec Fiberite	07314
		(2)***	I, II, & III	A & B	F161-*	Hexcel Corp.	91610
		(1) & (3)	I, II, & III	A & B	F155-*	Hexcel Corp.	91610
		(1) & (3)		A & B	E761-*	Fibercote Industries	57929
		(1)		A & B	E765-*	Fibercote Industries	57929
		(1) & (3)		B*****	MXB7701-*	Cytec Fiberite	07314
		(1) & (3)		B*****	MXB7214-*	Cytec Fiberite	07314
3 - Phenolic	(b) Prepreg	(1) (2) & (3) ****	I	A & B	MXB6070-*	Cytec Fiberite	07314
		(2)***	I	A & B	F502*	Fibercote Industries	57929
		(4)	I	B	SPH2400M*	Cytec Fiberite	07314
4 - Silicone	(a) Liquid				DC2106 (with 0-17% XY-15 Catalyst)**	Dow Corning Corp.	71984
	(b) Prepreg				No Material Qualified		
5 - Polyimide	(a) Liquid				F174**	Hexcel Corp.	91610
	(b) Prepreg	(1) & (2)	I, II, & III	A & B	F174-Cloth as Specified	Hexcel Corp.	91610

* Style 1581 or 7781 standard. Other cloth may be used if specified by engineering drawing.

** Rework resin only.

*** In order to meet Category 2 the material must be cured per Table III.

**** In order to meet Category 2 and 3 must be cured per Table III.

***** Not to be used for Grade A parts unless specified by Engineering drawing.

3.2.2 Curing agents and accelerators.

3.2.2.1 Curing agents and accelerators for polyester resins.

3.2.2.1.1 Luperco ATC Paste (benzoyl peroxide, 50% dispersion in tricresyl phosphate), supplied by Pennwalt Corp. Lucidol Division, (Formerly Wallace and Tiernan, Inc.), CAGE 75675.

3.2.2.1.2 Luperox DDM-9 (methyl ethyl ketone peroxide), supplied by Pennwalt Corp. Lucidol Division, CAGE 75675.

3.2.2.1.3 Cobalt Naphthenate Accelerator, 6% solution, supplied by Pennwalt Corp. Lucidol Division, (Formerly Wallace and Tiernan, Inc.), CAGE 75675.

3.2.2.2 Curing agents and accelerators for epoxy resins.

3.2.2.2.1 Curing Agent Z, TI or U, supplied by Resolution Performance Products LLC., CAGE 3FBZ6 (for use with Epon 828).

3.2.2.2.2 Diethylenetriamine (DETA), supplied by Resolution Performance Products LLC., CAGE 3FBZ6 (for use with Epon 828).

3.2.2.2.3 Triethylenetetramine (TETA), supplied by Resolution Performance Products LLC., CAGE 3FBZ6 (for use with Epon 828).

3.2.2.2.4 Curing agent Epocast 946, Epocast 9449 or Epocast 9816 supplied by Vantico Inc., CAGE 99384 (for use with Epocast 50A).

3.2.3 Glass reinforcement.

3.2.3.1 Glass cloth. Glass cloth 181–150 (1581) or 181-75 (7781) conforming to AMS–C-9084, Type VIIIA or VIIIB shall be used for glass reinforcement unless otherwise specified on the drawing. AMS-C-9084 replaces (MIL-C-9084). Any part numbers established by the original specification remain unchanged. Material identified as MIL-C-9084 or AMS-C-9084 are considered one and the same.

3.2.3.2 Glass mat. Glass mat may be used to fabricate Grade B (nonstructural) parts if specified on the drawing. If the weight of mat to be used is not specified on the applicable drawing, one and one half ounce (1-1/2 oz./ft^2) shall be used, commercially available.

3.2.4 Release agent.

3.2.4.1 Wax, Kantstik Paste or Honey Paste Wax, supplied Specialty Products Co., CAGE 22400, or equivalent.

3.2.4.2 Release–All Safelease 30, supplied by Airtech International Inc., CAGE 53912 or Frekote 44-NC, supplied by Hysol Division of Loctite Aerospace, CAGE 04347 or equivalent.

3.2.5 Vacuum bagging materials.

3.2.5.1 Bagging and barrier films. Suitable films to bag parts that will withstand the heat and vacuum required to cure parts and will release from the lay–up.

3.2.5.1.1 Capran 980 film, .002 inch thick, manufactured by Allied Chemical Co., CAGE 82196.

3.2.5.1.2 VAC–PAK–HS–8171 film,.002, .003 or .005 inches thick, furnished by Airtech International Inc., CAGE 53912.

3.2.5.1.3 HI-STRETCH Film 357TFN, non-perforated film, supplied by De-comp, Rt 3, Box 288, Cleveland Okla., 74020, CAGE AAAQZ.

3.2.5.1.4 IPPLON DP1000, color orange, .002 inched thick, non-perforated film, supplied Airtech International, CAGE 52912.

3.2.5.1.5 Perforated film, A4000, .001 inches thick, supplied by Airtech International, CAGE 53912 or A5000, .001 inches thick, supplied by Richmond Aircraft Products, CAGE 85670.

3.2.5.2 **Bag sealing compound.** Compound No. 9151, supplied by Schnee–Morehead, CAGE 53309, or equivalent heat resistant vacuum bag sealing compounds that will adhere to Capran 980.

3.2.5.3 **Bleeder material.**

a. Airweave SS supplied by Airtech International Inc. or equivalent, CAGE 53912.
b. Burlflo 4822 (thin fabric) and Burlflo 75051 (thick fabric) supplied by Burlington Industrial Fabrics Co., CAGE 88730.
c. Style 1581 glass cloth, any supplier.
d. Style 7500 glass cloth, any supplier.

3.2.5.4 **Release fabric.** D200TFP Release Fabric, supplied by De-Comp Composites, Inc., CAGE 0MAH3 or Release Ease 234TFP Fabric, supplied by Airtech International Inc., CAGE 53912.

3.2.5.5 **Shrink tape.** Hi-Shrink tape, available in 1¼ & 2½ inch widths, supplied by Airtech International Inc., CAGE 53912 or De-Comp Composites, Inc., CAGE 0MAH3.

3.2.6 **Miscellaneous materials.**

3.2.6.1 **Cleaning solvents.** All cleaning shall be accomplished using Kop-Coat T825, CAGE 00297, technical grade Methyl Propyl Ketone (MPK), Acetone, MPK/Acetone blend or other solvent approved by L-3/IS Materials and Process Engineering.

3.2.6.2 Glass fiber, milled fiber, RP32 1/32 inch screen size, manufactured by Ciba Geigy Corp Formulated Materials Group, CAGE 02684, or equivalent supplier.

3.2.6.3 Styrene Monomer, Dow N99, Dow Chemical Co., CAGE 71984, or Monsanto LM–100, Monsanto Chemical Co., Plastic Div., CAGE 86539, or equivalent.

3.2.6.4 Cloth or film backed adhesive tape, 2 inches wide such as supplied by Dutch Brand Div. of Nashua Corp., CAGE 82784, or a 2 inch wide waterproof tape conforming to ASTM D5486, Type 3, Class I, Color (optional).

3.2.6.5 Rubber gloves, commercially available.

3.2.6.6 Glycerine or equivalent lubricating oil, commercially available.

3.2.7 **Breather material.**

a. Style 1581 glass cloth, any supplier.
b. Burlflo 4822, supplied by Burlington Industrial Fabric Co., CAGE 88730.
c. Airweave SS supplied by Airtech International Inc., Torrance, CA., CAGE 53912 or equivalent.
d. Style 7500 glass cloth, any supplier.

3.3 General requirements.

3.3.1 Material storage and handling precautions.

3.3.1.1 Resin storage. Resin shall be stored in closed containers in a cool, dry area at a temperature ranging from slightly above freezing to under 77°F. Storage at temperatures in excess of 77°F shortens the shelf life of the resin.

3.3.1.2 Curing agent storage. Curing agents and catalysts shall be stored in closed containers at temperatures ranging from 36° to 77°F. During storage, accelerator shall be separated from other curing agents to prevent these materials coming in contact with each other due to spillage or breakage.

3.3.1.3 Accelerators storage. Accelerators should be stored in closed containers under refrigeration.

3.3.1.4 Glass cloth and mat storage. Glass cloth and mats shall be stored in a clean, dry area. Rolls of cloth shall be protected from dust and other contamination during shipment and storage by wrapping in paper, plastic film or similar protective material.

3.3.1.5 Preimpregnated (prepreg) fiberglass storage. Prepreg material shall be stored at 0°F or lower, in sealed moisture resistant bags such as 6 mil (or heavier) polyethylene plastic. Rolls shall be stored in the horizontal position. Prepreg material shall be allowed to come to room temperature before unsealing and removing from the plastic bag. Prepreg material when not being used shall be returned to its original container in a sealed bag and returned to cold storage. A 40° ± 5°F cold storage box may be used as a holding area, prior to use at room temperature, to maintain a working supply of prepreg. Materials held in the 40°F box shall be used within the 10 days or returned to the 0°F freezer. Maintain a working supply by transferring a roll of prepreg from the 0° box to the 40°F box as each roll is used completely in lay up of parts. Inventory control shall be conducted so that the oldest material is used first. Each batch of prepreg shall be qualified for production use by a test panel defined by 3.3.2.

3.3.1.6 Out time for prepreg. A record of out time (time material is out of storage and exposed to temperature above 45°F) shall be maintained for all prepreg material by material designation, batch and roll number. After 168 hours exposure at temperatures above 45°F, the prepreg must be discarded. Exposure time is cumulative and begins to accumulate from the date the prepreg is received by Quality until the cure cycle is initiated.

3.3.1.7 Shelf life for prepreg. Each new batch of prepreg stored at 0°F for 180 days shall require requalification for production use by a test panel defined in 3.3.2. This requalification shall expire after 90 days and thereafter the shelf life may be extended for 30 days as long as the material meets the test requirements in 4.5. Shelf life for prepreg shall begin the date the test panel is fabricated.

3.3.2 Production acceptance test panel. An acceptance test panel shall be fabricated representative of each Grade "A" classification production part. This test panel, unless otherwise specified on the drawing, shall be a 12 x 12 inch minimum size, flat, parallel laminated, 10 ply laminate if 1581 or 7781 type fabric is used. For other type fabric, use sufficient plies to obtain a panel thickness of approximately 0.100 inch. This test panel shall be fabricated simultaneously with the production part or parts it represents. It shall be made with the same batch of materials (resin curing agents and glass reinforcement or prepreg) that is used in the production part

or parts. It shall be laid up and bagged under the same vacuum hookup and cured at the same time and under the same conditions as the production part or parts it represents. The mold or plate used for fabrication and cure of the test panel shall be similar in thickness so the heat up rate of the test panel will represent the production part. Suggested mold material is .250 inch thick aluminum plate. The cured test panel shall be identified as to the production part or parts it represents, along with the batch number of the materials from which it was made, plus warp direction; then submitted to the test laboratory for testing as prescribed in 4.5. No production test panel is required for Grade "B" parts.

3.3.2.1 **Production part acceptance level.** The mechanical strength properties for Grade A laminates including Tensile strength, compressive strength and Barcol hardness, shall be within the limits specified in Table II. Parts represented by test panels that are not within this specified range shall be rejected and presented to a Materials Review Board (MRB) or approving authority for engineering disposition.

3.3.2.2 **Material evaluation acceptance level.** The physical properties and mechanical strength for laminates produced for material qualification and acceptance shall be within the limits specified in Table II. Material represented by test panels that are not within this specified range shall be rejected and presented to a Materials Review Board (MRB) or approving authority for engineering disposition.

TABLE II
ACCEPTANCE TEST VALUES FOR LAMINATE TEST PANELS

Classification	Tensile Strength 1/ 2/	Compressive Strength 1/ 2/	Resin Content (Range)	Specific Gravity (Range)	Barcol Hardness (Min. Avg.)
Composition 1 - Polyester					
All Forms and Categories	40,000 PSI	35,000 PSI	30 ± 5%	1.70 to 1.95	60
Composition 2 - Epoxy					
Form (a) all Categories and Form (b) Category (1)	48,000 PSI	50,000 PSI	30 ± 5%	1.70 to 1.95	60
Form (b) Category (2)	45,000 PSI	47,000 PSI	27 ± 5%	1.60 to 1.90	60
Composition 3 - Phenolic					
Form (b) Categories 1, 2, 3	40,000 PSI	35,000 PSI	27 ± 5%	1.60 to 1.90	55
Composition 4 - Silicone					
All Forms	30,000 PSI	18,000 PSI	30 ± 5%	1.60 to 1.90	50
Composition 5 - Polyimide 3/					
All Forms	50,000 PSI	45,000 PSI	26 ± 5%	1.50 to 1.90	55

1/ All values are minimum for the average of five specimens. Test values are for parallel laminates made of style 1581 or 7781 glass cloth tested in the 0 degree (parallel) warp direction. Acceptance values for other style fabric and different warp directions shall be as specified on the drawing.

2/ Minimum acceptance values are for process control and not to be used for design or material allowable data. Contact Stress Group for design allowables.

3/ Composition 5 values are for polyimide/fiberglass or polyimide/quartz.

3.3.2.3 **Permanent record.** For Grade A production parts, a permanent record shall be part of the Planning Ticket/Work Order for that part. The recorded data shall consist of the following information:

a. Material used _____ Batch # _____

b. Cure temperature _____

c. Tensile strength (average) _____ psi

d. Compressive strength (average) _____ psi

e. Barcol Hardness _____

3.3.3 **Additional testing of parts.** Other tests, test panels and testing of production parts shall be accomplished when and as specified on the applicable drawing or contract requirements.

3.3.4 **Close tolerance parts.** Close tolerance parts, on which grinding, sanding or milling of surfaces to dimension is not permitted by the Engineering drawing, or is impractical, shall be formed in matched die tooling only.

3.3.5 **Lay up area.** All lay up of materials per this specification shall be performed only in a controlled area conforming to a minimum of class 400,000 per TPS 7-200. Particle count shall consist of particles five microns and greater. Parts produced during a period when the controlled area conditions are not as specified (per TPS 7-200) shall be rejected.

3.4 **Fabrication procedures.**

3.4.1 **Mold preparation.** All molds shall be as listed in 3.1.1. These molds shall have enough edge distance to allow for excess material past trim line and for adequate bagging room.

3.4.1.1 **Cleaning of the mold.** The surface of the mold shall be smooth and free of lumps, resin build–up and dust. Scrape or sand smooth as necessary, then wipe with a clean cloth moistened with solvent per 3.2.6.1.

3.4.1.2 **Parting agent on mold.** Coat the mold thoroughly with a uniform thin coat of release agent per 3.2.4.2. When preparing a new mold or a mold that has been out of service the release agent shall be cured 30 minutes at 300° ± 10°F followed with one to three separate coats of polishing wax per 3.2.4.1. Polish each coat thoroughly before applying the next coat. A uniform thin coat of release agent per 3.2.4.2 and permitted to thoroughly dry is all that is required for molds that have been in service.

3.4.1.3 **Preheat mold.** Prior to beginning the lay-up of prepreg, it is permissible to warm the mold to aid in the positioning of the first ply of material. This may be accomplished by placing the mold in a circulating air oven with a temperature setting of 100 ± 10°F for a period of time required to adequately warm the mold.

3.4.2 **Fabric impregnation.** (Applicable to Form (a) – Liquid Resins only.)

3.4.2.1 **Fabric cutting.** Cut the glass fabric to the approximate flat pattern desired, plus 2 inches excess on all–edges.

3.4.2.2 **Resin requirement.** Weigh out amount of liquid resin, plus curing agent, at least equal to weight of cloth to be impregnated. Catalyze the resin, as applicable, per Table III.

NOTE Use only freshly catalyzed resins for glass impregnation. Resin that shows signs of jelling, thickening or lumping shall not be used.

3.4.2.3 **Ply impregnation.** Impregnate each ply thoroughly. The cloth changes from white to resin color when wetted with resin. Make sure the lay-up is free of folds, wrinkles or foreign matter before applying next ply. The number of plies which may be cured in one operation will depend on part size and configuration, but twenty plies shall be considered a maximum for one lay-up cure operation. In cases where more than one lay-up and curing operation is necessary to obtain the required thickness, the first lay-up shall contain a peel ply which shall be removed providing a rough surface for adhesion on the next lay-up plies. Uniform sanding of the contact surface may be used in lieu of a peel ply.

TABLE III
CURING INSTRUCTIONS

Resin Classification	Curing Agent - Parts Per 100 Parts Resin	Cure Time & Temperature (See Note 1)	Remarks
Composition 1 - Polyester Resin			
Composition 1 Form (a) Category (1) (2) or (3)	Lupersol ATC - 2 Parts	1 Hour Minimum at 250°F	
Composition 1 Form (a) Category (1)	Luperox DDM-9 -1 Part Colbalt Naphthenate-0.1Part **(Caution: See Note 2)**	90 Minutes at (70° to 125°F)	- Use only for Grade B Laminates
Composition 1 Form (b) Category (1)	None	Heat to 170 F., hold 20 min. Heat to 200 F., hold 20 min. Heat to 275 F., hold 60 min.	
Composition 1 Form (b) Category (2)	None	Heat to 170 F., hold 20 min. Heat to 200 F., hold 20 min. Heat to 275 F., hold 60 min. Heat to 350 F., hold 120 min.	
Composition 2 - Epoxy Resin			
Composition 2 Form (a) Category (1)	Curing Agent U or T1-25 Parts or Diethylenetriamine - 10 Parts or Triethylenetetramine 14 Parts	7 Days at Room Temp. (70°F to 125°F) or 90 Minutes at 200°F	Cures Sufficiently For Mold Removal in 24 Hours Minimum
Composition 2 Form (a) Category (2)	Curing Agent Z-20 Parts	2 Hours at 175°F and Post Cure 2 Hours at 300°F	**See Note 3**
Composition 2 Form (a) Category (3)	Hardener 9816 – 15 Parts or Hardener 946 – 15 Parts Hardener 9449 –15 Parts	3 Days at Room Temp (70° to 125°F) or After Gel cure 2 Hours at 150° to 200°F	1 to 2 Hours Work Life, Sufficiently Cured in 16 to 24 Hours at 80°F for Removal From Mold
Composition 2 Form (b) Category (1) (3)	None	Heat to 170 F., hold 20 min. Heat to 200 F., hold 20 min. Heat to 260 F., hold 90 min.	
Composition 2 Form (b) Category (2)	None	Heat to 170 F., hold 20 min. Heat to 200 F., hold 20 min. Heat to 350 F., hold 180 min.	

Notes: 1. Time is measured after part reaches temperature (see paragraph 3.4.6.1.2). Temperatures shall be within ±10°F of specified temperature.
2. Cobalt Naphthenate should be mixed with resin first and then add DDM.
3. Parts shall be protected during post curing per paragraph 3.4.6.3.
4. Maximum part thickness to be six (6) plies.

TABLE III
CURING INSTRUCTIONS (CONTINUED)

Resin Classification	Curing Agent - Parts Per 100 Parts Resin	Cure Time & Temperature (See Note 1)	Remarks
Composition 3 - Phenolic Resin			
Composition 3 Form (a) & (b) Category (1)	None	Heat to 180 F., hold 90 min. Heat to 200 F., hold 30 min. Heat to 225 F., hold 30 min. Heat to 250 F., hold 60 min. Heat to 325 F., hold 60 min	
Composition 3 Form (b) Category (2)	None	Heat to 180 F., hold 90 min. Heat to 200 F., hold 30 min. Heat to 225 F., hold 30 min. Heat to 250 F., hold 60 min. Heat to 300 F., hold 60 min Heat to 350 F., hold 120 min.	
Composition 3 Form (b) Category (3)	None	Heat to 180 F., hold 90 min. Heat to 200 F., hold 30 min. Heat to 225 F., hold 30 min. Heat to 250 F., hold 60 min. Heat to 300 F., hold 60 min Heat to 350 F., hold 120 min. Let cool to Ambient remove from mold Post cure Heat to 250 F., hold 10 hrs. Heat to 300 F., hold 10 hrs. Heat to 350 F., hold 10 hrs. Heat to 400 F., hold 5 hrs	**See Note 3**
Composition 3 Form (b) Category (4)	None	Heat to 250 F., hold for 90 min.	**See Note 4**
Composition 4 - Silicone Resin			
Composition 4 Form (a) & (b)	XY-15 Catalyst - 0.17 Parts	1 Hour at 350°F, Post Cure 16 Hours at 200°F, 2 Hours at 250°F, 2 Hours at 300°F, 2 Hours at 400°F, 2 Hours at 450°F, and 16 Hours at 500°F	**See Note 3**
Composition 5 - Polyimide Resin			
Composition 5 Form (a) & (b) Category (1)	None	Cure by Placing in Cold Oven, raise Temperature to 240°F @ 2-4° per Minute, Hold for 30 Minutes, raise to 270°F @ 2-4° per minute, hold for 30 Minutes, raise to 350°F @ 2-4° per Minute, Cure at 350°F for 1 Hour	

Notes:
1. Time is measured after part reaches temperature (see paragraph 3.4.6.1.2). Temperatures shall be within ±10°F of specified temperature.
2. Cobalt Naphthenate should be mixed with resin first and then add DDM.
3. Parts shall be protected during post curing per paragraph 3.4.6.3.
4. Maximum part thickness to be six (6) plies.

TABLE III
CURING INSTRUCTIONS (CONTINUED)

Resin Classification	Curing Agent - Parts Per 100 Parts Resin	Cure Time & Temperature (See Note 1)	Remarks
Composition 5 - Polyimide Resin (Continued)			
Composition 5 Form (a) & (b) Category (2)	None	Cure as Listed for Category (1). Debag and Post Cure per the following Cure Cycle: ½ Hour at 200°F ½ Hour at 250°F ½ Hour at 300°F ½ Hour at 350°F 2 Hours at 400°F 3 Hours at 500°F 4 Hours at 550°F 4 Hours at 600°F	**See Note 3**

Notes:
1. Time is measured after part reaches temperature (see paragraph 3.4.6.1.2). Temperatures shall be within ±10°F of specified temperature.
2. Cobalt Naphthenate should be mixed with resin first and then add DDM.
3. Parts shall be protected during post curing per paragraph 3.4.6.3.
4. Maximum part thickness to be six (6) plies.

3.4.3 Laminate lay-up.

3.4.3.1 Number of plies. The number of plies shall be as called out on the Engineering drawing. In the event the plies are not called out, the number can be determined by dividing the part thickness by .010 inch, the approximate thickness of one ply of 7781 type glass or by the thickness of the specific type cloth in cases where other than 7781 cloth is used. (Reference AMS–C–9084 for other type cloth thicknesses.)

3.4.3.2 Warp direction. Warp direction of fiberglass plies shall be as specified on the Engineering drawing. In the event warp direction is not indicated, the direction is optional. In cases where warp direction is not defined on the engineering drawing, for parts with multiple curvatures it is recommended to alternate each layer 45° to facilitate draping of material during lay-up.

3.4.3.3 Ply Lay-up. The first ply of material shall be placed on the mold surface and worked until it lies smooth and flat. The mold may be preheated per 3.4.1.4 prior to the application of the first ply of prepreg. Hot air guns or smoothing irons can be used to smooth prepreg against the mold. Wrinkles, bridges, and gaps are to be eliminated. Additional plies are then applied in the same manner.

3.4.3.4 Splicing and overlap of plies. If it is necessary to lap two pieces of fabric for continuity of a ply, the pieces shall be laid up with an overlap width not less than 1/2 inch, with a minimum of 2 inches between splices on adjoining plies. The number of splices shall be held to a minimum. External parts exposed to high velocity air shall have no laps in the outside ply if such laps are at all avoidable. If the outside ply must be lapped, the lap shall be made to "tail" the airstream.

3.4.4 Bagging of parts.

3.4.4.1 Bagging of prepreg lay-ups.

a. Cover lay-up with 1 ply release fabric, (3.2.5.4) extending beyond edges of lay-up.

b. Cover with bleeder material, (3.2.5.3), extend flush with edges of release fabric. The amount of bleeder plies required will vary with the type and number of prepreg plies making up the lay-up. Unless determined by prior laminates, the ratio of resin bleeder plies to prepreg plies shall be as follows:

- 1 ply Airweave SS to 6 plies prepreg.
- 1 ply Burlflo 4822 (thin fabric) to 3 plies prepreg.
- 1 ply Burlflo 75051 (thick fabric) to 6 plies prepreg.
- 1 ply Style 1581 glass fabric to 4 plies prepreg.
- 1 ply Style 7500 glass fabric to 4 plies prepreg.

c. Cover lay-up with barrier film, (3.2.5.1) extending approximately 1 inch inside edges of bleeder and release materials.

d. Cover barrier film with 1 ply breather material, (3.2.7) which shall extend flush with edges of bleeder and release fabric.

e. The number of vacuum lines required per lay-up shall be a minimum of one line for each 15 square feet of part surface area. When more than one vacuum line is required they shall be positioned a minimum of four feet apart.

f. Position vacuum bag sealing compound (3.2.5.2) around the lay-up with no contact of breather, bleeder or release fabrics.

g. Cover lay-up with vacuum bagging film (3.2.5.1) extending approximately 2 inches past sealing compound.

3.4.4.1.1 De-bulk (prepreg). De-bulking is an in-process method of applying pressure (vacuum at greater than 22in. hg. for a minimum of 10 minutes) during ply lay-up to minimize voids in the laminate during fabrication. De-bulking may be performed at option of Manufacturing and is dependent upon the prepreg and configuration of the laminate. If the lay-up becomes bulky and loose, de-bulking will assist in compacting the plies and reduce bridging in radii as well as folds in the prepreg when bagged for curing. It is recommended to de-bulk approximately every six plies; i.e. a part consisting of 20 plies would require three de-bulking operations.

3.4.4.1.2 Shrink tape application. Shrink tape may be used on cylinderical parts (ducting etc.) to uniformly compress the prepreg plies prior to vacuum bagging per 3.4.4.1 to eliminate excessive wrinkles and folds as the vacuum bag contracts. The shrink tape may be used as the single source of applying pressure to thin laminate (ducting etc.) Grade "B" parts.

3.4.4.2 Bagging of wet resin lay-ups. Place a bleeder strip or spring around the periphery of the part approximately 2 inches from the part lay-up. This bleeder material shall be three–eighths inch or larger diameter hemp rope or

coil spring. Glass mat or a coarse woven fabric may be used in place of the rope or spring. Place a vacuum hose on the bleeder strip. Apply a strip of vacuum sealing compound (3.2.5.2) around the entire lay-up just outside the bleeder strip. Then cover the entire assembly with the vacuum bagging film and seal down along all edges and over and around the protruding vacuum line.

3.4.5 Compacting and excess resin removal.

3.4.5.1 Vacuum lines. It is recommended vacuum lines leading from the part shall have resin traps placed in the line to trap excess resin removed from the part. Portions of vacuum lines between the part and the resin trap that are in the oven or otherwise exposed to heat shall be covered with an insulating material to assure that the resin in the lines does not harden before the resin in the part, which could cut off the vacuum to the part.

3.4.5.2 Application of vacuum. Apply vacuum slowly, while removing or relocating bag wrinkles and folds as they develop. Draw a minimum of 26 inches of mercury and retain. Check and assure that no vacuum leaks. This is accomplished by listening very closely while pressing the bagging film firmly against the sealing compound. A drop in reading or failure to retain sufficient vacuum is an indication that the bag or line is leaking.

3.4.5.3 Excess resin and air removal (wet lay-up only). After applying full vacuum which results in atmospheric pressure being applied to the part, remove excess resin and allow air bubbles to flow ahead of the squeegee or roller and out the bleeder area. Lubricate the bag surface with glycerine to prevent tearing during squeegee operations. Continue the action until the fabric plies are closely packed and no air bubbles are visible. Warming of the part aids in resin removal. No squeegeeing or roll down of prepreg lay-ups is necessary for excess resin removal as the excess resin is absorbed in the bleeder material as pressure is applied to the part.

3.4.6 Curing procedure.

3.4.6.1 Cure temperature. The cure time and temperature shall be as specified in Table III for the specific resin system or prepreg material being used. If materials other than those specified herein are used, cure as recommended by the manufacturer or as specified on the engineering drawing. The time specified in Table III is the minimum cure time. A longer cure cycle may be necessary to permit an oven load of parts to be cured simultaneously. Parts may also be submitted to several cure cycles during secondary bonding or lay-up operations.

3.4.6.1.1 Heat curing. When heat curing of part is required, any convenient heating method may be used providing the following conditions are met:

a. Heat rise from room temperature to cure temperature at 2 to 4°F per minute unless otherwise approved in writing by Materials and Process Engineering.

b. Temperature is evenly distributed and controlled within 10°F of the temperature specified in Table III.

3.4.6.1.2 Temperature of part. The cure time shall not begin until the part reaches temperature. Thermocouples shall be placed within the vacuum bag, against the mold surface and insulated with the same amount of bleeder and breather material as the part. The number of thermocouples required to monitor part temperature shall be a minimum of one thermocouple for each 25 square feet of part surface area. When more than one thermocouple is required, they shall be positioned to best represent the entire part temperature.

3.4.6.2 Cure pressure. A minimum vacuum of 26 inches of mercury shall be maintained on all parts during the cure cycle. This vacuum shall be maintained on the parts following completion of the cure cycle until the

temperature of the laminate has cooled below 125°F. No vacuum or pressure is required during the post curing of parts except when the parts are bonded in a honeycomb sandwich assembly at the time of the post cure.

3.4.6.3 **Post curing.** When post curing is required (Table III) parts shall remain on the mold under vacuum if possible. If the post cure temperature exceeds the mold temperature capability, the part shall be removed from the mold but shall be protected from the direct hot air blast by placing in metal containers, wrapping in aluminum foil, high temperature bagging film or by similar means.

3.4.6.4 **Hardness of laminate.** For Grade A parts barcol hardness readings shall be taken on the production acceptance test panel after completion of the cure cycle. The average of ten readings taken per 4.5.5 shall meet the minimum hardness as specified in Table II for that resin system. Readings that are low due to voids in the laminate shall be disregarded. Representative test panels not meeting this Barcol hardness requirement shall require the panel and the parts it represents have their cure cycle repeated. Repositioning the production part in the mold is not necessary. If parts do not meet this hardness requirement after repeating their cure cycle, the Engineering Materials and Processes Unit should be contacted for additional instructions. For Grade B parts, hardness tests are not required.

3.4.7 **Removal from mold.**

3.4.7.1 Laminates shall be cooled below 125°F before removing from the mold. Post-curing by heating may be accomplished while the part is out of the mold.

3.4.7.2 Care shall be exercised in removing cured parts from the mold in order not to damage either the part or the mold. Rubber hammers or wooden paddles shall be used in tapping parts off of molds. Compressed air (shop air) applied along the edges between the part and the mold may also be used when parts are difficult to remove.

3.4.7.3 All release agents shall be removed from cured parts. Wax parting agents may be removed with a rag saturated in toluene. Cellophane and other type film may be removed with compressed air.

CAUTION Do not direct air pressure on unprotected portion of human skin.

3.4.8 **Trimming and finishing.**

3.4.8.1 **Protection from dust during trimming.** Air exhaust systems should be sufficient to remove dust accumulated during sanding, grinding and drilling operations or respiratory dust mask should be employed for protection during these operations.

3.4.8.2 **Trimming to dimensions.** Parts may be trimmed to dimension by sawing, grinding, sanding, milling or any other method provided all other requirements of this specification are met.

3.4.8.3 **Drilling and machining.** Drilling and machining shall be accomplished using sharp high speed steel or carbide tools. Work must be backed up at all times to prevent delamination. Procedures for the drilling and machining of fiberglass laminates listed in TPS 2–106 shall be followed.

3.4.8.4 **Finishing of rough surfaces.** Rough and sharp edges shall be sanded or otherwise smoothed down.

3.4.8.5 **Coating of edges.** Trimmed edges, areas that required grinding or excessive sanding and drilled holes, shall be coated to prevent moisture absorption. This coating shall be accomplished by brushing or wiping on a thin film of styrene thinned (up to 50%) room temperature catalyzed polyester resin (reference Table III). The coating mixture should not be applied excessively to areas previously trimmed to thickness dimensions.

3.4.8.6 **Secondary bonding or lay-up.** Parts requiring secondary bonding or lay-up shall have their mating surfaces abraded with sandpaper 80 grit or fine (ensuring no damage to fiber occurs), to remove any glaze or gloss or be laminated with a release ply (3.2.5.4), which shall be removed prior to the bonding or next lay up operation.

3.4.8.7 **Painting.** Surfaces requiring painting or erosion protection coating shall be sanded with a 320 or 400 grit sandpaper to remove the surface glaze and any parting agent still present. Following sanding, wipe the surface with a clean cloth dampened with solvent per 3.2.6.1 and fill surface pinholes as prescribed in the paint or coating specification. Epoxy or polyurethane paints are recommended for maximum adhesion and durability. Leading edges of aircraft exterior parts shall be protected from erosion by coating with a polyurethane rain erosion coating. Drawing shall specify paint and erosion protection coating requirements as applicable. All surfaces exposed to exterior environments shall be coated or painted to reduce surface porosity and moisture absorption.

3.5 **Workmanship.**

3.5.1 **Acceptability.** Except as otherwise specified in 3.5.3, all plastic laminates shall be uniform, smooth, and free from uncured or unbonded areas, gaps, cracks, holes, blisters, resin pockets, resin starved areas, tackiness, excess surface resin, incorrect laps, wrinkles, delamination, air or gas pockets, patches, porosity, and other similar defects as defined in MIL–P–9400. The laminate shall be essentially void free.

3.5.2 **Critical areas.** Critical areas, in relation to allowable defects and repair limitations, are considered as all areas of a plastic laminate that require signal transmission through the laminate and all areas with rigid dimensional tolerances and strength requirements, including all edge attachment areas, and other areas as indicated on the drawing. The highest standard of workmanship and uniformity is required for these areas.

3.5.3 **Allowable defects.** The limits stated herein are the maximum allowable defects permitted. Any laminates having defects which exceed the maximum allowable in nature, size or extent shall be rejected, pending repair or disposition as specified in 3.6.1.

3.5.3.1 **Uniformity.** The laminates shall be within the tolerances of the drawing and shall be of high quality workmanship.

3.5.3.2 **Voids.** Voids of less than 1/4 inch in diameter are acceptable provided they do not exceed 8% of the total surface of the part and there are no more than two such defects in any 6 inch diameter area. There shall be no voids within 4 hole diameters of a drilled hole.

3.5.3.3 **Hole defects.** There shall be no holes or punctures which penetrate through the first ply of glass fabric.

3.5.3.4 **Cracks.** Cracks or fissures which extend through the first ply of fabric are not allowed. Resin surface crazing (fine, shallow lines in a network pattern) is acceptable on Grade B parts.

3.5.3.5 **Resin starved areas.** There shall be no areas where the fabric is not uniformly impregnated with sufficient resin.

3.5.3.6 **Blisters.** Blisters are considered as air containing areas in which there is a lack of bond between any two plies of the laminate. There shall be no blisters within the three outer plies of a laminate. Small blisters l/4 inch or less in diameter are allowed within the remainder of the laminate. However, the total of such blisters shall not exceed an average of one for every 3 square feet and no two blisters shall be closer than 6 inches, edge to edge. There shall be no blisters within 4 hole diameters of a drilled hole.

3.5.3.7 **Foreign objects.** There shall be no foreign objects or substance in the laminate which might cause a loss of structural or electrical serviceability as determined by MRB or approving authority. Parts shall also be free of all forms of release agents and bleeder material prior to final inspection.

3.5.3.8 **Rough edges.** There shall be no flash or rough edges on completed parts.

3.5.3.9 **Uncured areas.** The entire laminate surface shall be fully cured and free of tackiness.

3.5.3.10 **Wrinkles.** A wrinkle is defined as a raised fold of fabric or resin which causes a greater thickness to the part than its maximum specified tolerance. Wrinkles are permitted on interior surfaces as specified in the following subparagraphs and immediately adjacent to any sharp change in contour on the outer surface, except in critical areas.

3.5.3.10.1 For Type 2 and 3 Grade A laminates, wrinkles not more than 1/32 inch high are permissible on the inner surface of the part. There shall not be more than three inches of wrinkles in any area encompassed by a six inch diameter circle. A total of twelve inches of wrinkles in any area encompassed by any three foot diameter circle shall be maximum allowable.

3.5.3.10.2 For Type 1 Grade A parts, wrinkles up to 1/32 inch in height shall be permitted up to a total length of 12 inches. Not more than six accumulated inches of wrinkle shall be allowed in any area encompassed by a six inch diameter circle.

3.5.3.10.3 External and internal wrinkles up to 1/32 inch in height are allowed on Grade B laminates, provided that the serviceability of the part is not affected.

3.6 **Rework.**

3.6.1 **Rework.** Rework is considered as working a nonconforming part back to the Engineering Drawing requirements. Damage requiring the removal of glass reinforcement on either side of the laminate shall be considered a repair. Sacrificial plies as part of the original construction shall be considered rework. Repairs shall be made as directed by MRB per the repair procedures in TPS 2-523.

3.6.1.1 **Limits of rework.** All rework shall meet the requirements of this specification. Rework shall not affect the serviceability of the part and the total of all rework made to the part shall not exceed 10% of the surface area.

3.6.1.2 **Rework resins.** Resins used for rework shall be per Table IV.

3.6.1.3 **Rework of defects.** Rework defects to reworked as follows:

3.6.1.3.1 **Blisters.** Blister defects shall be reworked as follows: Clean area with solvent (3.2.6.1). Using a No. 60 drill, drill holes on opposite sides of the blister (additional holes may be needed if air entrapment occurs when injecting resin. Slowly inject the applicable resin (3.6.1.2) until the blister is filled and resin flows out of the drilled holes. If necessary, as a Manufacturing option cover area with cellophane and apply vacuum bag and pressure. Work out any air entrapment. Cure as applicable for the resin used per Table II. After curing, sand the area lightly with #320 or #400 grit paper until smooth and evenly faired with adjacent area. Clean the area that was repaired with solvent (3.2.6.1).

3.6.1.3.2 **Resin starved areas.** Starved areas shall be reworked as follows: Clean area with solvent (3.2.6.1). Apply a brush coat of the applicable repair resin to the starved area. Cover the area with cellophane and apply vacuum bag and pressure. Work out any air entrapment. The resin used and curing of the resin shall be as listed in Table IV. The bleed spring, if located over a portion of the laminate, shall be placed over a 2 inch wide

waterproof film or cloth adhesive tape which shall be attached to the part to protect the part from excess resin buildup under the spring area.

3.6.1.3.3 Porosity. Defects of this nature shall be reworked by using the same method as in 3.6.1.3.2.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. Organizationally assigned personnel responsible for performing the requirements described herein are also primarily responsible for ensuring the quality of the process activities. Other personnel within the operating department, or others as deemed appropriate by management may be assigned to verify compliance with requirements listed herein. Quality Assurance departments may perform inspections or audits as necessary to provide adequate oversight of process controls.

Finished parts shall be examined for workmanship, uniformity, dimensional requirements and overall general quality. All Grade A Production Acceptance Panels shall be meet the mechanical strength property requirements specified in 3.3.2.1, 3.3.3, 4.3 and 4.5. If fiberglass parts fabricated per the requirements of this specification exhibit warpage in excess of drawing tolerances when unrestrained, the following method may be used to determine their acceptability, unless otherwise specified on the Engineering drawing:

a. Fit the part to its checking device, ten (10) pounds localized forces may be applied at 12 inch intervals along support attach edges, at attach points or along edges with no attach points, but which will be restrained in some other manner on a subsequent assembly. If the part conforms to the fit requirements under these pressures, it is acceptable.

b. Check devices may be surface plates, checking fixtures, process tooling, etc.

c. Any number of 10 pound force units may be used provided only one unit is applied at each load point and a 12 inch spacing (in any direction) is maintained between load points.

CAUTION: Do not apply loads to thin walled details (i.e., air ducts) which could be damaged by the pressure.

TABLE IV
REWORK RESINS FOR VARIOUS COMPOSITIONS OF LAMINATES

Required Repair	Composition of Laminates Rework Resin	Curing Agent and Parts Per 100 Parts Resin	Cure Cycle
Composition 1 - Polyester			
Ply Replacement Radar Transmission Surfaces	Composition 1, Form (a), Category (1) or (3), Type III, Grade A	Lupersol ATC - 2 Parts	1 Hour @ 250°F
Ply Replacement General Surfaces	Composition 2, Form (a), Category (1), Type I, Grade A	Curing Agent U or T1 - 25 Parts	24 Hours @ 70° to 125°F
Ply Replacement Flame Resistant Surfaces	Composition 1, Form (a), Category (3), Type I, II, and III, Grade A	Lupersol ATC - 2 Parts	1 Hour @ 250°F
Injection Application	Composition 1, Form (a), Category (1), Type I, Grade A (Epon 815)	Curing Agent U or T1 - 20 Parts or DETA - 10 Parts	24 Hours @ 70° to 125°F
Brush Applications and Seal Coat for Interior Surfaces	Composition 1, Form (a), Category (1), Type I, Grade A Thinned with Styrene	Lupersol DDM - 1 Part and 0.1 Part Cobalt Napthenate (see note 2)	90 Minutes @ 70° to 125°F
Composition 2 - Epoxy			
Ply Replacement General Surfaces	Composition 2, Form (a), Category (1), Type I, Grade A	Curing Agent U or T1 - 25 Parts	24 Hours @ 70° to 125°F
Ply Replacement Flame Resistant Surfaces	Composition 2, Form (a), Category (3), Type I, II, III, Grade A	Hardener 946 - 15 Parts or Hardener 9816 - 15 Parts Hardener 9449- 15 Parts	Same as Table I
Injection and Brush Applications	Composition 2, Form (a), Category (1), Type I, Grade A (Epon 815)	Curing Agent U or T1 - 20 Parts or DETA - 10 Parts or TETA – 14 Parts	24 Hours @ 70° to 125°F
Composition 3 - Phenolic			
All Applications	Composition 3, Form (a)	None	Cure Per Table I Per Category Laminate
Composition 4 - Silicone			
All Applications	Composition 4, Form (a)	XY-15 Catalyst - 0.17 Parts	1 Hour @ 250°F Followed by Same Post Cure as Shown in Table I
Composition 5 - Polyimide			
All Applications	Composition 5, Form (a)	None	Cure Per Table I

4.1.1 **Receiving Inspection of materials.** Upon receipt personnel shall check resins, curing agents, prepregs, and fiberglass for contamination and any visual noted evidence of deterioration. Prepregs shall be further checked by fabricating a test panel with that material and tested as specified in 4.5 unless a qualified supplier submits a certificate of conformance stating compliance to the material procuring specification. If a certificate of conformance is submitted, test panel fabrication and subsequent testing is not required. A qualified supplier is one whose material has been evaluated and approved for listing in the applicable material or process specification. The test panel shall be a flat 12 x 12 inch parallel lay up, 10 ply laminate for 1581, or 7781 type fabric or the number of plies as necessary to obtain a 0.100 ± .010 inch thickness panel for other type fabric. Fabrication of this panel shall be in accordance with procedures listed in this specification for that resin system. This panel shall be identified as to the type material, batch number and warp direction.

4.2 **Monitoring procedures for equipment used in process.** The process owner or department performing the process shall verify by process audits or inspection that all equipment used in this process are per the requirements specified herein. All ovens, vacuum gages, micrometers, test equipment and similar controlling equipment shall be calibrated periodically s specified by L-3/IS internal procedures.

4.3 **Monitoring procedures for materials used in process.** The process owner or department performing the process shall verify by process audits or inspection that all materials used in this process are per the requirements specified herein and are within any applicable shelf life limits. All resins, curing agents and preimpregnated fiberglass material shall be examined for their acceptance prior to their use. When it becomes necessary to prepare a test panel as determined by production in 3.3.2, test specimens shall be taken and tested per methods listed in 4.5. Test values shall meet the minimum values shown in Table II. In case of failure of the sample to meet the specific test values, an additional sample representative of the same lot or batch shall be laminated and tested. If this sample fails the specified tests, the entire lot of the sampled material shall be rejected and not used in the production of parts.

4.4 **Operator training.** Operators performing work to this specification shall be adequately trained. Qualification shall be conferred on trained operators by Production supervision, by successful demonstration of a knowledge of this process and the ability to produce parts meeting the requirements of this specification.

4.5 **Test methods.** Production acceptance test panel per 3.3.2 for Grade A production parts shall be tested as follows. The allowable test values of these tests are shown in Table II. Should the test values fall below the minimum acceptance level, the material or production part represented by this test panel shall be rejected. Quality shall maintain records of each test performed for a minimum period of five (5) years following the date of testing.

4.5.1 **Tensile strength.** A minimum of five (5) tensile strength test specimens shall be tested. Test in the 0° (parallel) warp direction at room temperature (72 ± 5°F). Test in accordance with ASTM D638. Conditioning of specimens not required.

4.5.2 **Compression strength.** A minimum of five (5) compression strength test specimens shall be tested. Test in the 0° (parallel) warp direction at room temperature (72 ± 5°F). Testing shall be accomplished using a set of holding fixtures as shown in photograph No. 1 and a spherical self leveling loading plate. Specimens shall be 1/2 inch in width and 1–1/2 inch in length. The ends of the specimen shall be cut smooth and parallel to each other. Loading rate and other test requirements, other than specimen size and the test fixture, shall be per ASTM D695. Conditioning of specimens not required.

4.5.3 **Specific gravity.** Specific gravity shall be determined on a test specimen taken from the test panel in accordance with ASTM D792. Conditioning of specimens not required. This test is required for material evaluation/qualification only unless otherwise specified.

4.5.4 **Resin content.** For determining resin content, a minimum of three specimens shall be taken from random areas of the test panel. Testing shall be accomplished in accordance with ASTM D2584, except the conditioning of specimens is optional. Only ignition loss (wt. %) shall be reported. This test is required for material evaluation/qualification only unless otherwise specified.

4.5.5 **Barcol hardness.** A minimum of 10 widely scattered hardness readings shall be taken with a Barcol Impressor (reference 3.1.5). Testing shall be accomplished in accordance with ASTM D2583, except the conditioning of specimens is optional. None of these readings shall be taken on a portion of the test panel that is later to be tested for tensile or compressive strength. Low values resulting from blisters, pores and similar defects shall be disregarded.

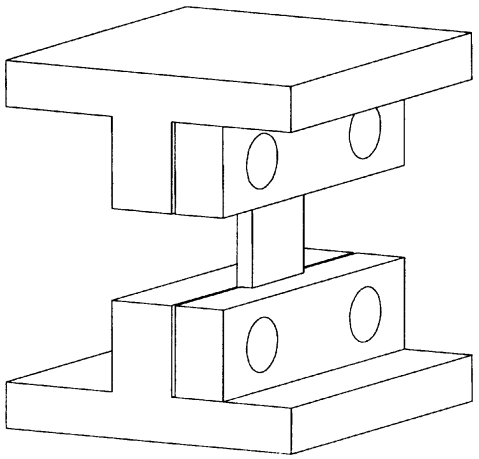

FIGURE 1
HOLDING FIXTURE FOR COMPRESSION TESTING

5. PREPARATION FOR DELIVERY.

This section is not applicable to this specification.

6. NOTES.

6.1 **Intended use.** The laminated plastic material fabricated by procedures contained in this specification are intended for use in aircraft and non–aircraft structural and nonstructural parts, such as radomes, antenna housing, fairing, etc. Consult the Materials and Process Specialist prior to specifying parts manufactured to this specification for use on any FAA-certified aircraft.

6.1.1 Specific information related to the selection and use of the various plastic resin systems designated by the group classification is as follows:

COMPOSITION 1 – POLYESTER–RESIN: Laminates made with this type resin have very good dielectric and microwave transmission efficiencies. Formability of the liquid resin systems are very good. They are available in flame resistant and moderately high temperature resistant categories (up to 350°F).

COMPOSITION 2 – EPOXY RESIN: This resin system offers higher strengths with slightly less desirable electrical properties than the polyester resins. Inter layer adhesion of laminates made with this type resin are the highest of any resin group. A high temperature category of this resin is available for short time (30 minutes) exposure up to 500°F; however, strengths and inter layer, ply, adhesion are somewhat lower on this resin category as compared to the lower temperature resistant category.

COMPOSITION 3 – PHENOLIC RESIN: The principle use of this somewhat lower strength resin system is for heat (up to 500°F continuous exposure), flame resistant applications, and applications requiring compliance to heat release. The 500°F continuous category material requires a very long cure cycle and laminates of this material are appreciably more porous than the epoxies or polyesters. Shrinkage during curing is also somewhat high.

COMPOSITION 4 – SILICONE RESIN: This resin is for very high temperature applications up to l000°F for short time exposure (30 minutes) and continuous exposure to temperatures up to 600°F. It is flame resistant and has good electrical and microwave transmission properties but lower mechanical strengths than any of the other resin group classifications, plus very long cure requirements and is appreciably more expensive than the other material compositions other than polyimide materials.

COMPOSITION 5 – POLYIMIDE RESIN: This system should be specified only when the electrical requirements and temperature resistance is critical. The resin system has temperature resistance in the 550°F – 600°F range. With quartz cloth, it has a dielectric constant of 2.9 – 3.0. This material is very expensive, and laminates are somewhat porous.

6.1.2 Representative mechanical properties of structural laminates for the various resins, type glass reinforcement and lay-up directions for the glass reinforcement are contained in MIL–HDBK–l7; however, material allowables for the laminate must be obtained from element tests using production shop facilities and techniques.

6.2 **Superseding data.** A cross reference of superseded specifications according to classification is listed in Table V.

TABLE V
CROSS REFERENCE OF SUPERSEDED SPECIFICATIONS

Superseded Classification	TPS 2-522 Classification
TPS 2-501	TPS 2-522, Composition 1 Form (a)
TPS 2-507	TPS 2-522, Composition 1 Form (b)
TPS 2-518	TPS 2-522, Composition 2
TPS 2-510	TPS 2-522, Composition 3
TPS 2-501, Type I TPS 2-507, Class 1 TPS 2-518, Class 1	TPS 2-522, Type I
TPS 2-501, Type II TPS 2-507, Class 2 TPS 2-518, Class 2	TPS 2-522, Type II
TPS 2-501, Type III TPS 2-507, Class 3 TPS 2-518, Class 3	TPS 2-522, Type III
TPS 2-501, Class A TPS 2-507, Class A TPS 2-510, Class A TPS 2-518, Class A	TPS 2-522, Grade A
TPS 2-501, Class B TPS 2-507, Class B TPS 2-510, Class B TPS 2-518, Class B	TPS 2-522, Grade B
TPS 2-501, Grade 1	TPS 2-522, Composition 1 Form (a), Category (2)
TPS 2-501, Grade 2	TPS 2-522, Composition 1 Form (a), Category (1)
TPS 2-501, Grade 3	TPS 2-522, Composition 1 Form (a), Category (3)
TPS 2-507, Type I	TPS 2-522, Composition 1 Form (b), Category (1)
TPS 2-507, Type II	TPS 2-522, Composition 1 Form (b), Category (2)
TPS 2-510, Type I	TPS 2-522, Composition 3 Form (b), Category (1)
TPS 2-510, Type II	TPS 2-522, Composition 3 Form (b), Category (2)
TPS 2-510, Type III	TPS 2-522, Composition 3 Form (b), Category (3)
TPS 2-518, Type I	TPS 2-522, Composition 2 Form (b), Category (1)
TPS 2-518, Type II	TPS 2-522, Composition 2 Form (b), Category (2)

6.3 **Waco Previous Engineering.** For previous design which specifies AC003006-002 or AC0M3006-002 contact Liaison Engineering for determination of the appropriate type, grade, composition, form and category per TPS 2-522.

6.4 **Drawing note.** When referenced on the Engineering drawing, the drawing note should read: "Fabricate per TPS 2-522, Type___, Grade___, Composition___, Form___, Category___."