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NCAMP Process Specification

Fabrication of NMS E765 Equivalency and Acceptance Test Panels

Park Aerospace Corp. E765 Prepregs

This specification is generated and maintained in accordance with NCAMP Standard Operating Procedures, NSP 100

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REVISIONS

Rev	By	Date	Description
-	Vinsensius Tanoto	2/9/2024	Initial Release

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1. SCOPE

This process specification describes the methods of fabricating test panels using NMS 765 prepregs. Specifically, this specification covers prepreg cutting, layup, vacuum bagging, and curing process with either a forced-air convection oven equipped with vacuum ports or an autoclave. In addition to the instructions contained in this specification, users are advised to obtain hands-on guidance directly from the prepreg manufacturer.

This specification does not contain all the necessary information typically required in a composite process specification for the fabrication of composite structures, such as personnel qualification and layup room requirements. Users should refer to their existing company process specification. DOT/FAA/AR-02/110 provides guidance for the development of composite process specifications.

NCAMP process specification, NPS 81765 is written based on Park Aerospace Corporation E-765 PS1000 Rev 6, 11/22/22 process specification for E-765 materials in AGATE database.

AGATE-WP3.3-033051-103	B – Basis Design Allowables for Epoxy – Based Prepreg FiberCote Graphite Fabric T300 3KPW / E765
AGATE-WP3.3-033051-104	B – Basis Design Allowables for Epoxy – Based Prepreg FiberCote Graphite Unitape T700 24K / E765
AGATE-WP3.3-033051-105	B – Basis Design Allowables for Epoxy – Based Prepreg FiberCote E-Glass Fabric 7781 / E765
AGATE-WP3.3-033051-109	Laminate Design Allowables for Epoxy – Based Prepreg FiberCote Graphite Fabric T300 3KPW / E765
AGATE-WP3.3-033051-110	Laminate Design Allowables for Epoxy – Based Prepreg FiberCote Graphite Fabric E765/T300 6K 5HS
NIAR Report # 02-2 Rev. 1	B – Basis Design Allowables for Epoxy – Based Prepreg FiberCote Graphite Fabric T300 6K 5HS / E765

1.1 Purpose

The purpose of this process specification is to provide processing information for the fabrication of test panels for use in material equivalency and acceptance testing. This process specification may also be used as a baseline by material users to develop a process specification for the fabrication of aerospace composite parts.

1.2 Health and Safety

While the materials, methods, applications, and processes described or referenced in this

specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2 APPLICABLE DOCUMENTS

The following publications form a part of this specification to the extent specified herein. The latest issue of the NCAMP publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order unless otherwise specified. When a referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 NCAMP Publications

NMS 765	NCAMP Material Specification, Vacuum-Bag-Only or Autoclave Cure Epoxy Prepregs, Type 38, Class 2, Grade 293, Style 7781, Park Aerospace Corp. E765 7781 Glass

2.2 ISO Publications:

ISO 9000	Quality Management Systems

2.3 US Government Publications:

DOT/FAA/AR-02/110	Guidelines for the Development of Process Specifications, Instructions, and Controls for the Fabrication of Fiber-Reinforced Polymer Composites

3 MATERIALS

Item	Part No. or Specification	Supplier
Acetone	Open Source	Sun Chemical, Dow, Ashland, Union Carbide or equivalent
Denatured Alcohol	Open Source	Ashland, Sofecia*, Union Carbide, Eastman Chemical
Release Film	WL4600 (non-porous) WL5200 (non-porous) A4000R (non-porous)	Airtech International Airtech International Airtech International

	200TFP (porous) A5000 (non-porous) 234TFP (porous) or equivalent	Richmond* Richmond* Airtech International or equivalent
Release Agent	Frekote 700 RAM 225 or equivalent	Frekote* Lilly* or equivalent
Breather	A-3000 Airweave N10 or equivalent	Richmond Products* Airtech International or equivalent
Bleeder	7781 woven fiberglass cloth E-765 MS 1001 or equivalent	JPS Industries Inc., BGF Industries Inc., Hexcel-Schwebel* or equivalent
Peel Ply	56030 Release Ply B or equivalent	Performance Fabrics* Airtech International or equivalent
Sealant Tape	GS 100 SM5126 or equivalent	Circuit Supply * Scnee-Morehead* or equivalent
Expanding adhesive (core splice)	AF 3024 or equivalent	3M or equivalent
Bagging Sheet Film	HS6262 WL7400 WL8400 or equivalent	Richmond Products* Airtech International Airtech International or equivalent

* Supplier may no longer exist.

4 TEST LAMINATE FABRICATION

4.1 Prepreg Cutting

Wear non-contaminating gloves disposable powder-free nitrile gloves when handling the prepreg. The prepreg may be cut using conventional method (i.e. on a polyurethane table top with utility knife) or automated method. The method of cutting must not contaminate the prepreg. Fiber orientation (e.g. warp versus fill directions) must be maintained during the cutting process. Each ply is marked to identify warp direction. The test panel dimensions shall be sufficient to allow a minimum trim allowance of 1” on all sides.

If prepreg laminations are pre-cut and grouped into kits for future lay-up and cure, the poly-film backing provided by Park Aerospace Corp. shall not be removed until each ply is ready to be placed in the lay-up mold. Kits shall be stored in sealed, moisture-proof containers until ready for lay-up.

Before lay-up, the prepreg material shall be near ambient temperature. Upon removal from storage, the prepreg materials shall be allowed to warm to room temperature inside the

sealed moisture-proof bag for at least 3 1/2 hours or until visible moisture has vanished from the outside of the bag.

4.2 Debulking

Debulking shall be performed in order to achieve appropriate compaction. Debulking according to the following procedure is required no less frequently than every six (6) plies of woven fabric or every eight (8) plies of unidirectional tape, except 12K 2x2 Twill which shall be debulked every second ply.

a. Apply one layer of porous release fabric over the prepreg lay-up.

b. Apply one layer of breather on top of the porous release film. If the breather is not contaminated with resin or other foreign material, the breather may be re-used.

c. Install nylon bagging film over the laminate or form-fit a silicone rubber bag and edge seal to the tool with vacuum bag sealant; install the vacuum connector through the bag. Use multiple vacuum connectors so that no point on the part is more than 60 inches from a vacuum source. Install the vacuum connectors on the tool surface outside the perimeter of the laminate wherever possible. Placing the connector in a bag pleat is an acceptable alternate.

d. Note: Install the vacuum connectors on the tool surface outside the perimeter of the laminate wherever possible. Placing the connector in a bag pleat is an acceptable alternate.

e. Apply vacuum of at least 18 inches Hg for at least 15 minutes at a rate that does not cause the prepreg to shift. When specified by the applicable shop traveler, the laminate may be heated to 100°F maximum and held for 10-15 minutes during vacuum application but there shall be no more than six (6) debulks at 100°F on any lay-up. The final debulk shall be for 30 minutes minimum.

4.3 Prepreg Layup

Wear non-contaminating gloves such as disposable powder-free nitrile gloves when handling the prepreg. The panel layups (stacking sequences) for equivalency purposes should be in accordance with appropriate test plans. For material acceptance purpose, the panel layups should be in accordance with NMS 765.

In the case of materials which are not mid-plane symmetric, such as satin weave fabrics, plies must be orientated such as to give a mid-plane symmetric laminate as best as possible, as shown in Figure 1.

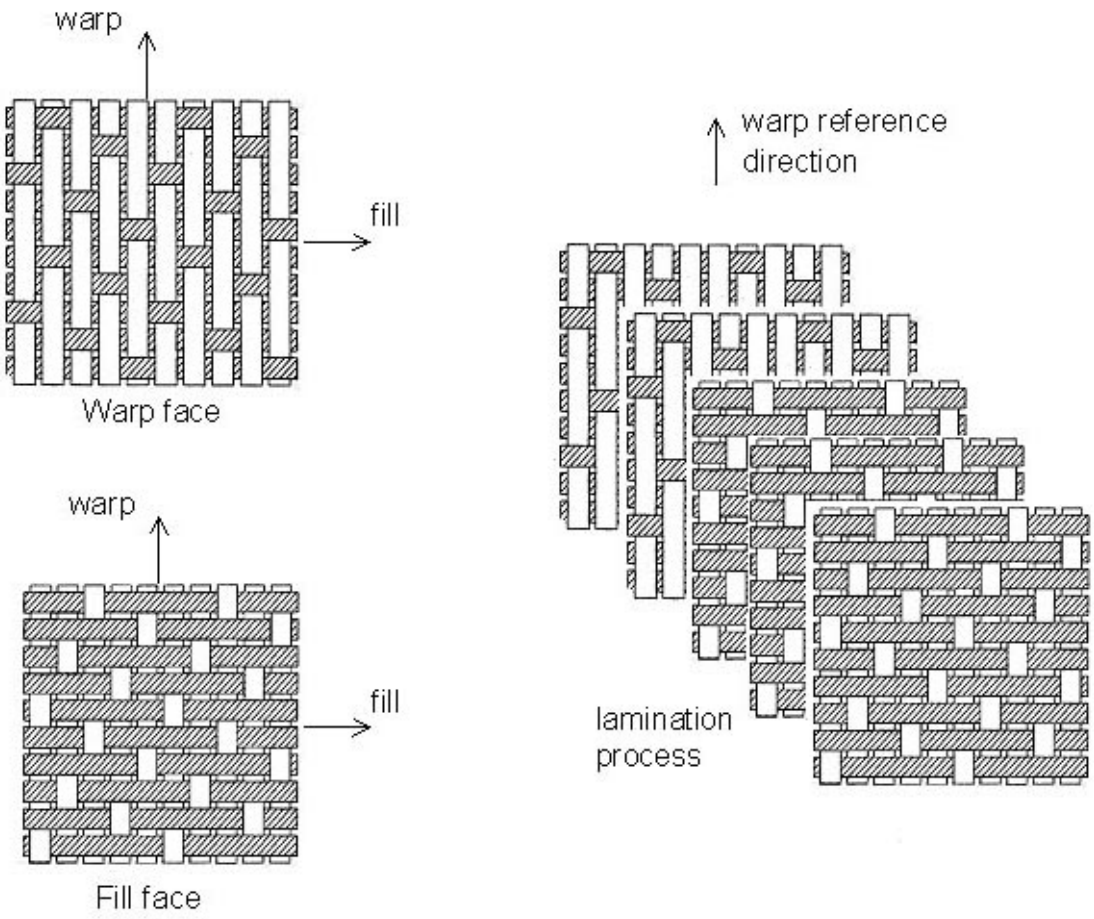

Figure 1 – Example Satin Weave Showing Warp and Fill Faces Used for Ply Collation

In order to maintain the fiber orientation, a reference edge should be created on each panel. The reference edge making needs to be at least 1” from the edge to allow for panel edge trim. During the layup process, each ply must be laid up within ±5° for fabric, and ±3° for tape of the reference edge. The edge dams around the layup/prepreg will form a straight edge on the cured panel. In the layup of unidirectional prepreg, plies may be butt spliced in the 90° direction; ply splicing is not allowed in the 0° direction. Ply splicing is not allowed in the layup of woven fabric prepreg in any direction.

In equivalency programs, for panel identification purpose, place a label with 0.5” from the prepreg edge with the following information:

0° direction → – Test Plan Document Number – Prepregger ID – Material Code – Fabricator ID – Test Type – Batch ID – Cure Cycle ID – Test Panel ID

Make sure that the “0° direction →” actually points in the 0° direction or warp direction.

4.4 Bagging Procedure

4.4.1 Bagging Option 1

This bagging option was used to fabricate AGATE Qualification panels.

1. Apply one layer of porous release fabric over the prepreg lay-up.
2. Apply bleeder cloth the same size as the laminate over the release film. Smooth out all wrinkles.
   Note: For laminates of six (6) plies or greater, two (2) to four (4) bleeder plies may be added to aid in volatiles removal from the relatively tight weaves of E-765 6K 5HS and E-765 7781 materials.
3. Apply breather strings from each corner of the part to contact the breather fabric.
4. Apply one layer of non-porous release film over the lay-up; extending at least ½ inch past the edge of part.
5. Apply one layer of breather fabric over the lay-up ensuring that is forms a path to the vacuum source.
6. Vacuum sources should not be on the surface of the part. There should be at least two (2) sources for any part larger than four (4) square ft. For larger parts, at least one vacuum connection should be provided for every 18 square ft. of laminate surface. Where possible, the maximum distance to any point on the laminate surface should not exceed 60 inches. Protect against clogging with resin by applying extra breather under the vacuum port.
7. Apply the nylon bagging film and edge seal to tool with vacuum bag sealant.
8. Evacuate the bag to at least 18 inches Hg and adjust the bag to eliminate wrinkles and bridging.
9. Install a vacuum gauge at the vacuum probe connector. Allow the bagged assembly to stand for at least 15 minutes with an applied vacuum of at least 18 inches Hg. Remove the vacuum source and monitor the bag vacuum. Leakage may not exceed three (3) inches Hg in the first five (5) minutes after removing the vacuum source.

4.4.2 Bagging Option 2

1. The final debulk for cure preparation should be held under vacuum for no less than 16 hours.
2. Apply one layer of porous release fabric over the prepreg lay-up. In order to reduce resin bleed the use of edge dams are permitted around the periphery of the lay-up. Ensure the dams are the proper height to prevent seal-off.
3. Apply bleeder cloth the same size as the laminate over the release film. Smooth out all wrinkles.
   Note: For laminates of six (6) plies or greater, two (2) to four (4) bleeder plies may be added to aid in volatiles removal from the relatively tight weaves of E-765 6K 5HS and E-765 7781 materials.
4. Apply one layer on non-porous release film over the lay-up; extending at least 1/2 inch past each edge of the part.
5. When appropriate, the use of a pressure intensifier is permitted to aid in void reduction for vacuum only cure cycles.
6. Apply at least one layer of breather fabric over the lay-up ensuring that it forms a path to the vacuum source. It may be necessary to apply strips of perimeter breather outside the edge/resin dams to ensure seal-off does not occur.
7. Vacuum sources should not be on the surface of the part. There should be at least

two (2) sources for any part larger than four (4) square ft. For larger parts, at least one vacuum connection should be provided for every 18 square ft. of laminate surface. Where possible, the maximum distance to any point on the laminate surface should not exceed 60 inches. Protect against clogging with resin by applying extra breather under the vacuum port.

8. Apply the nylon bagging film and edge seal to tool with vacuum bag sealant.
9. Evacuate the bag to at least 18 inches Hg and adjust the bag to eliminate wrinkles and bridging.
10. Install a vacuum gauge at the vacuum probe connector. Allow the bagged assembly to stand for at least 15 minutes with an applied vacuum of at least 18 inches Hg. Remove the vacuum source and monitor the bag vacuum. Leakage may not exceed three (3) inches Hg in the first five (5) minutes after removing the vacuum source.

4.5 Cure Cycle

4.5.1 Vacuum-Bag-Only Cure Cycle “O”

This cure cycle option was used to fabricate AGATE Qualification panels.

All prepreg materials are to be cured according to tightly controlled time, temperature and pressure requirements as shown in Table 1. Time, temperature, and pressure must be continuously recorded and monitored during the cure process. All temperatures are panel temperatures based on the lagging thermocouple.

Temperature Ramp rate °F/Min.	Cure Temperature °F (as defined by slowest heating part)	Pressure In. Hg	Cooling Rate °F/Min.	Dwell Time At Cure Minutes
1 - 6	270 - 280	20 - 28	3 - 10	110 - 130

Table 1 – Vacuum-Bag-Only Cure Cycle

4.5.2 Autoclave Cure Cycle “A”

All prepreg materials are to be cured according to tightly controlled time, temperature and pressure requirements as shown in Table 2. Time, temperature, and pressure must be continuously recorded and monitored during the cure process. All temperatures are panel temperatures based on the lagging thermocouple.

Temperature Ramp rate °F/Min.	Cure Temperature °F (as defined by slowest heating part)	Pressure Psig.	Cooling Rate °F/Min.	Dwell Time At Cure Minutes
1 - 6	250 - 280	40 - 50	3 - 10	110 - 130

Table 2 – Autoclave Cure Cycle

4.6 Cured Panels

The reference edge created in Section 4.3. should be clearly marked on each panel. This reference edge will be used as datum for subsequent machining process. Sharp edges should be removed from cured panels so that they can be handled and packaged safely.

5 QUALITY ASSURANCE

5.1 Process Control

In-process monitoring data such as part temperature, oven temperature, vacuum, and part vacuum readings through the cycle should be in accordance with user's applicable company process specification or an approved shop practice. For material equivalency purposes, the in-process monitoring data should be provided to the appropriate organizations in accordance with the applicable test plan. Process control testing is not required for the fabrication of test panels.

5.2 Ultrasonic Non-Destructive Inspection

Panel fabricator need not perform ultrasonic non-destructive inspection on the test panels. For material equivalency purposes, the panels may be ultrasonically inspected by the testing lab in accordance with the applicable test plan.

5.3 Visual Inspection

Verify that there are no obvious defects such as warpage or dry spots. Panels for material equivalency purposes should be labeled in accordance with the applicable test plan for identification purposes.

6 SHIPPING

For material equivalency purposes, it may be necessary to send the panels to a designated test lab. The panel shipping instruction is typically included in the applicable test plan.