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NCAMP Process Specification

Fabrication of NMS 401 Qualification, Equivalency, and Acceptance Test Panels
Teijin Tenax™-E TPWF/TPCL PEEK

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1. SCOPE

This process specification describes the methods of fabricating test panels using Tenax™-E TPWF PEEK (Evonik Vestakeep 2000 FP). Specifically, this specification covers semipreg cutting, layup and consolidation process with both static and multi-press. The ILT panels were formed in the secondary consolidation process from the TPCL panel.

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 for such information. DOT/FAA/AR-02/110 provides guidance for the development of composite process specifications.

1.1 Purpose

The purpose of this process specification is to provide processing information for the fabrication of test panels for use in material qualification, 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 401	High Temperature Consolidation, Medium Toughness PEEK thermoplastic, Teijin Tenax™-E TPWF/TPCL PEEK
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2.2 ISO Publications:

ISO 9000	Quality Management Systems
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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:

- 3.1 **Polyimide Film**, equivalent to Vac-Pak UHT 750 qualified for use at 800°F or above.
- Airtech International, Inc., 5700 Skylab Road, Huntington Beach, CA 92647
 - Polyimide film has an ending identifier of RCBS (release coated both sides) manufactured by Airtech.
 - Or equivalent

- 3.2 **Release Agent**, ZYVAX CompositeShield
- Or equivalent

- 3.3 **Consolidate Plates** (top/middle/bottom tool), minimum 0.250 inches thick aluminum, flat and smooth, or equivalent
- Open source

4. TEST LAMINATE FABRICATION

4.1 Semipreg cutting

Wear non-contaminating gloves such as disposable powder-free nitrile gloves when handling the semipreg. The semipreg 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 semipreg. 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.

4.2 Semipreg layup

Wear non-contaminating gloves such as disposable powder-free nitrile gloves when handling the semipreg. The panel layups (stacking sequences) for qualification and equivalency purposes should be in accordance with appropriate test plans. For material acceptance purpose, the Tf1) for qualification and

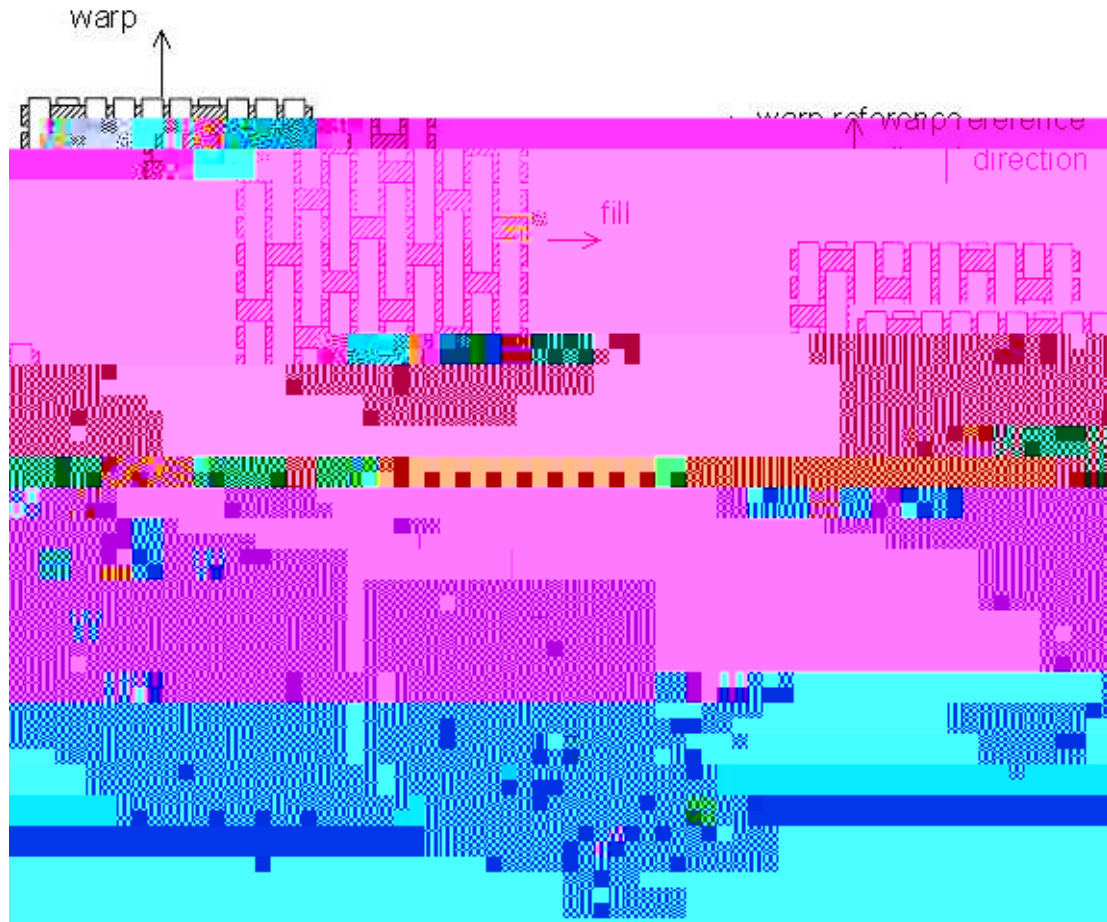


Figure 1 - Example Satin Weave Showing Warp and Fill Faces Used for Ply Collation

In order to maintain the fiber orientation, a reference edge should be created on each panel. The reference edge marking 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 $\pm 5^\circ$ for fabric, and $\pm 3^\circ$ for tape of the reference edge. The edge dams around the layup will form a straight edge on the consolidated panel. Ply splicing shall be identified at C-Scan of the TPCL and specimens shall not span a ply splice. This may be prevalent on 45-degree plies only. (Note: This is for qualification or equivalency panels only)

In material qualification and equivalency programs, for panel identification purpose, place a label or mark the consolidated TPCL with white/silver marker within $\frac{1}{2}$ -inch from the semipreg edge with the following information: "0° direction , Test Plan Document Number -Company ID - Material Code - Fabricator ID - Test Type - Batch ID - Consolidating Cycle ID -Test Panel ID." Make sure that the "0° direction " actually points in the 0° direction or warp direction. Appendix 2 of the test plan contains the panel identification information.

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g. Repeat Step (a to f) if there is another stack/layup of semipreg.

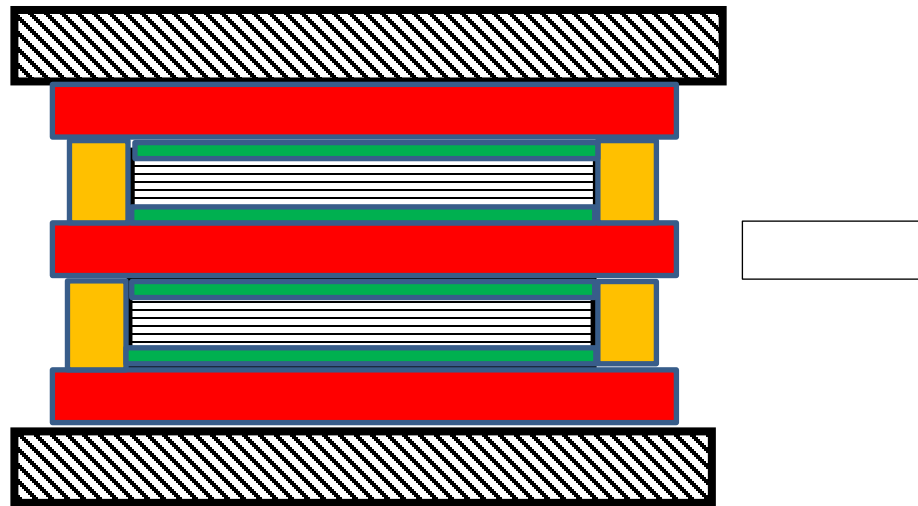


Figure 2 - Molding Technique for Tenax®-E TPWF PEEK (Forming of TPCL)

4.5 ILT Consolidation Cycle from flat laminate²

²This cure cycle may not show a successful equivalency demonstration to the Qualification processing baseline.

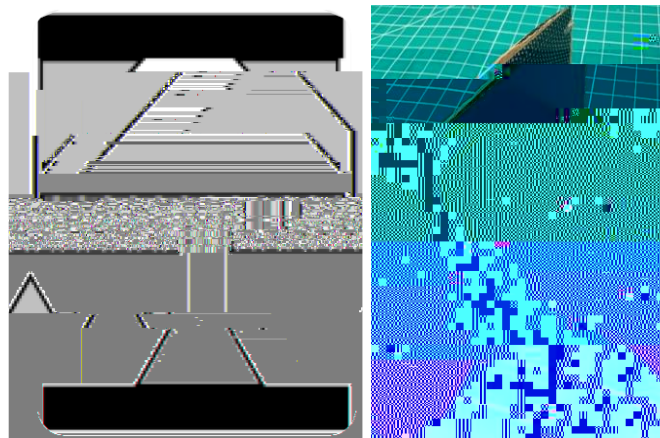


Figure 3 - Molding Technique for Tenax®-E TPCL PEEK (Forming of ILT panel from flat laminate)

- 1.) The heated shape/blank with the minimum temperature of 360°C (680°F), but the maximum temperature not exceeding 440°C (824°F) is transported into the press, institute and hold pressure at 30-50 Bar (435-725 psi). At the same time the tool temperature in the press shall be maintained between 230-250°C (446- 482°F).
- 2.) Cooling rate shall be up to 120°C (248°F) per minute. Maximum release temperature from the press shall be 140°C (284°F), but it is recommended to maintain pressure restraint to room temperature in a restraining fixture if shuttled from the press zone. See **Figure 4- Mold Cycle** below. NOTE: Due to the complex nature of part molding a polyimide film cannot be used on the molding tool. In this instance the tool shall be coated with a water-based (liquid) release agent (similar to Zyvax Composite Shield) suitable for polymers up to 420°C (750°F).

**Figure 4 – Mold Cycle Tenax®-E TPCL PEEK
(Forming of ILT Panel)**

4.6 Consolidated Panels

The reference edge created in section 4.2 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 consolidated 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 qualification and 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 Visual Inspection (Refer to NMS 401 section 9.1)

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