Document No.: NPS 81250 Revision A, November 18, 2022

NCAMP Process Specification

Fabrication of NMS 125 Qualification, Equivalency, and Acceptance Test Panels

High Performance Polyaryletherketone (PAEK) Thermoplastics
VICTREX AE™ 250 Low Melt (LM) Polyaryletherketone (PAEK)

Prepared by: Royal Lovingfoss (NCAMP/NIAR), Michelle Man (NCAMP/NIAR), Claire Steggall-Murphy (TxV Aero), Kalon Lasater (TxV Aero)

Reviewed by: Rachael Andrulonis (NCAMP/NIAR), John Tomblin (NCAMP/NIAR), Peter Levesque (TxV Aero), Kalon Lasater (TxV Aero), Chris Myslinski (Victrex), Robert Mazzella (Victrex), James Myers (Victrex), Stuart Green (Victrex)

REVISIONS

Rev	By	Date	Description
-	Michelle Man	10/07/2020	Initial Release
A	Michelle Man	11/18/2022	Section 4.3 edited; section title, minimum time for Tm and Tc were updated.

Table of Contents

1 SCOPE

This process specification describes the methods of fabricating test panels using VICTREX AE™ 250 Polyaryletherketone (PAEK) reinforced with unidirectional carbon fibers (AE 250 UD Tape). These composite prepreg material systems are intended for use in the fabrication of aerospace structures and tooling substrate using various consolidation techniques. Specifically, this specification covers prepreg cutting, layup and consolidation process with a static press.

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 125	High Performance Polyaryletherketone (PAEK) Thermoplastics VICTREX AE™ 250 Low Melt (LM) Polyaryletherketone (PAEK)
NMS 125/1	High Performance Polyaryletherketone (PAEK) Thermoplastics VICTREX AE™ 250 Low Melt (LM) Polyaryletherketone (PAEK) Hexcel AS4 12k Unidirectional Tape 143 gsm 34% RC

2.2 ISO Publications:

AS 9100 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:

3.1 Polyimide Film

- Upilex 50S qualified for use at 800 ºF or above
  UBE Americas Inc, 28345 Beck Road, Wixom, MI 48393
- Or equivalent

3.2 Caul Plates

- Top/bottom tool, steel, flat and smooth, or equivalent.
- Open source
- L-Shaped tool should have similar thickness and surface finish (ILT only)

3.3 Kapton Tape

- Open source

4 TEST LAMINATE FABRICATION

4.1 Prepreg cutting and layup

Wear non-contaminating gloves such as powder-free nitrile gloves when handling the prepreg and layups. The panel layups (stacking sequences) for qualification and equivalency should be in accordance with appropriate test plans. For material acceptance purpose, the panel layups should be in accordance with NMS 125.

Layups shall be produced using an automated tape laying process with optional hand placement of tape segments (also known as courses). Equipment shall be capable of ±3° angular alignment of tape and ±0.100” tape edge distance (gap/overlap). Discrete tack welding of courses shall be ultrasonic, heated type or equivalent. Manual welders, if heated type, shall not exceed 1000 °F. End splice for tape segments (courses) shall be excluded from the test sample areas. For the purpose of equivalency and qualification, the parameters used shall be traceable to the fabricated test panel.

Prior to removing panel from layup tooling surface, identify orientation with reference line, rosette and label according to the test plan with white/silver marker within 0.5” of the panel edge.

If ply splicing is identifiable at C-Scan, it shall be marked and specimens shall not span a ply splice. This may be prevalent on 45-degree plies only.

In material qualification and equivalency programs, for panel identification purpose, place a label or mark the consolidated panel with white/silver marker within ½-inch from the prepreg edge with the following information: “0º 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 “0º direction →” actually points in the 0º direction or warp direction. Appendix 2 of the test plan contains the panel identification information.

Drying (optional)

Users are recommended to dry panel layups to remove moisture prior to consolidation. Drying process should be in accordance with user’s applicable process specification or approved practice. For the purpose of the Qualification program, panel layups were dried at 250 – 300F for a minimum of 8 hours.

4.2 Preparation/Setup Procedure:

Place the panel package in between the caul sheet tooling. Consolidate the test panels as specified below. Each batch of prepreg shall be traceable to the consolidation cycle used to fabricate the test panel.

4.3 Press Consolidation

Panels shall be processed within the parameters given in Table 1 below. Process parameters may be adjusted to improve rate and panel quality. For the purpose of equivalency and qualification, the parameters used shall be traceable to the fabricated test panel and any deviations shall be recorded. All temperatures below are panel temperatures based on lagging thermocouple. Users should follow applicable thermal cycle validation process or approved practice to ensure press heating system parameters achieve the panel temperature requirements.

Table 1

T_m Temperature Range	T_m Minimum Time	T_m Minimum Pressure	T_c Temperature Range	T_c Minimum Time	T_c Minimum Pressure
660-750 ºF	450 s	50 psi	392-572 ºF	330 s	100 psi

T_m = Melting Temperature
T_c = Crystallization Temperature

1. Place layup in caul plate/picture frame assembly
2. Shuttle assembly to high temperature platens
3. Apply low to moderate pressure while heating layup to the melt range (660 to 750 °F)
4. Increase pressure to 50 psi minimum
5. Hold within melt range for 450 s minimum
6. Shuttle assembly to low temperature platens (panel must remain in melt range during shuttle period)
7. Increase pressure to 100 psi minimum
8. Hold within cooling range (392 to 572 °F) to for 330 s minimum
9. Remove pressure and open press after panel is below 428 °F
10. Remove panel from assembly

Ensure panel markings created at layup step are visible and recreate with silver/white marker as needed. Panels may be supplied as molded with reference edge indicated with marking or trimmed with reference line marked for specimen machining alignment.

4.4 Heat Forming

(For ASTM D6415 testing only)

Users should follow applicable heat forming process to form specified geometry in accordance with the applicable test plan. The panel to be consolidated using this process shall be traceable to the consolidation process specified above.
Formed parts shall be processed within the parameters given below. Panel drying is recommended to remove moisture prior to heat forming (see Section 4.1). Process parameters may be adjusted to improve rate and panel quality. For the purpose of equivalency and qualification, the parameters used shall be traceable to the fabricated test sample and any deviations shall be recorded. All temperatures below are part temperatures based on lagging thermocouple. User's should follow applicable thermal cycle validation process or approved practice to ensure heating system and tooling parameters achieve the part temperature requirements.

1. Heat part to melt range (660 to 750 °F)
2. Hold part within melt range for 60 s minimum
3. Transfer part to forming tool, maintaining part within melt range

4. Close forming tool to minimum recommended pressure of 300 psi
5. Hold within cooling temperature range (392 to 572 °F) for 120 s minimum
6. Cool part to below 490 °F.
7. Remove pressure, open press and remove part

5 QUALITY ASSURANCE

5.1 Process Control

In-process monitoring data such as platen temperature (heating rate, dwell, cooling rate, etc.), pressure readings through the consolidation 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 Ultrasonic Non-Destructive Inspection

Panel fabricator need not perform ultrasonic non-destructive inspection on the test panels. For material qualification and 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:-

1. Warpage
2. Dry spots
3. Gaps
4. Broken Yarn/Fiber
5. Damaged Edge
6. Brown Stain
7. White Mark
8. Delamination

Panels for material qualification and equivalency purposes should be labeled in accordance with the applicable test plan for identification purposes.

6 SHIPPING

For material qualification and 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.