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NCAMP Material Specification

High Temperature Consolidation, Medium Toughness PEEK Semipregs, Type 42, Class 2 and Class 3, Grade 284, Style 3K-5HS

Tenax-E TPWF/TPCL PEEK-HTA40 E13 3K 5HS

Prepared by: Kim-Leng Poon (NCAMP/NIAR), Royal Lovingfoss (NCAMP/NIAR), Vinsensius Tanoto (NCAMP/NIAR)

Reviewed by: Dr.José Maria Fernandes Marlet (Embraer), Joe Spangler (Teijin Carbon America), Brice Langston (Teijin Carbon), Jean-Philippe Canart (Teijin Carbon)

REVISIONS:

Rev	By	Date	Pages Revised or Added
-	Kim-Leng Poon	10/27/2022	Initial release
A	Kim-Leng Poon	3/8/2023	Added NCAMP Layup on product table
B	Kim-Leng Poon	7/26/2024	Revised notes for equivalency requirement in Table 3 & Table 4 equivalency test matrix.
	Kim-Leng Poon	11/25/2024	Revised equivalency test matrix with ETW tests.

1. SCOPE:

1.1 Form:

This detail specification along with the base material specification NMS 401 establishes the requirements for carbon fiber fabric powdered with a PEEK (Evonik Vestakeep 2000 FP) thermoplastic ("fabric Semipreg"). The semipreg is produced using a powdering process on both sides of the fabric and its consolidated laminate form.

1.2 Classification: Products qualified to this detail specification have the following classification: Type 42, Class 2, Grade 284, Style 3K-5HS – semi-preg or Type 42, Class 3, Grade 284, Style 3K-5HS – laminate

3. TECHNICAL REQUIREMENTS:

User Test Requirements: -
1.) Laminate (Class 3) and use as-is – Receiving inspection. (Table 2 & 3)
2.) Semipreg (Class 2) and consolidate – Receiving inspection (Table 1, 2 & 3) and equivalency (Table 4).
3.) Laminate (Class 3) and reconsolidate – Seek aviation authority/governing authority to approve process method, as this specification does not cover this process.

Table 1 – Semi-preg Physical and Chemical Properties (Class 2) (7)

Property	Test Method(1)	Number of Replicates	Requirements
Semi-preg Areal Weight	EN 2557 or ASTM D3776	Each Lot/Batch(2)	485±15 gsm (ind.) 485±12 gsm (avg.)
Fiber Areal Weight	EN2557 or ASTM D3529(4)	Each Lot/Batch(2)	284±6 gsm (ind.) 284±5 gsm (avg.)
TP Weight Content	EN 2559[3] or ASTM D3529(4)	Each Lot/Batch(2)	42±3 wt.% (ind.) 42±3 wt.% (avg.)
Thickness(6) (Optional)	ASTM D3171	10 Measurements Each Lot/Batch	0.0117 to 0.0129 inch, avg.
Differential Scanning Calorimetry (DSC)(5) Melting Temperature Degree of Crystallinity	DIN EN ISO 11357-7 or ASTM D3418	Each Lot/Batch	343 ± 5°C (avg.) 23 to 33 % (avg.)

(1) Specific procedures should be identical to those used in the original material qualification program.
(2) At a minimum, three specimens should be taken across the width of the semipreg from each batch/lot.
(3) (w1-w2)/w1*100, where w1 equals to semi-preg areal weight (PAW) and w2 fiber areal weight without sizing (FAW).
(4) Semipreg matrix digestion via ASTM D3171 Procedure B.
(5) Limit calculated with $\alpha = 0.01$
(6) Caliper for thickness measurements
(7) Teijin will provide information on Table 1 for each batch of material except for thickness measurement.

3.1 Constituent Material Requirements:

3.1.1 Reinforcement: The carbon fiber tow shall be qualified to NMS 818/22

3.2 Laminate (Consolidated Semipreg or TPCL) Requirements:

3.2.2 Consolidated Laminate Physical Properties:

TABLE 2 - Consolidated Laminate Physical Properties (Class 3)[5]

Property	Test Method	Requirements[2]
Differential Scanning Calorimetry DSC[1] [4] Melting Temperature Degree of Crystallinity	DIN EN ISO 11357-7 or ASTM D3418	 343 ± 7 °C (avg.) 23 to 33 % (avg.)
Visual	NMS 401 Base Material Spec (Section 9.1)	100%[3]
NDI Health Control	(ASTM E1316, ASTM E2580 & NAS 410) or 39.P02.040.04	100%[3]
Consolidated Ply Thickness, CPT	ASTM D3171 or PCD SQ.405.004.12	0.0117 to 0.0129 inch, avg.
Laminate Density[4]	ASTM D792	1.52 to 1.56 g/cc, avg.
Fiber Volume, by Volume[4]	ASTM D3171	48.0 to 55.0 %, avg.
Resin Content, by Weight[4]	ASTM D3171	38.0 to 44.0 %, avg.
Void Content, by Volume[4]	ASTM D3171	≤ 2%, avg.

[1] ΔHf for 100% crystallized PEEK = 130J/g.
[2] “avg.” refers to the average measurements per panel. Required only on one of the panels listed in Table 3.
[3] 100% refers to surface area inspected. A minimum of 75% of the laminate shall be defect free.
[4] Limits calculated with 1% α.
[5] All tests listed on Table 2 are required for semipreg (Class 2) user after consolidation, laminate obtained directly from Teijin, (Class 3) user will require Visual, NDI and CPT inspection and/or other applicable inspection.

3.2.3 Consolidated Laminate Mechanical Properties:

TABLE 3 - Required Consolidated Laminate Tests for Mechanical Properties[2]
(Class 2 “semi-preg” after consolidation and Class 3 “consolidated laminate”)

Property	Test Method[1]	Requirements[3]
0° (warp) Tension Strength and Modulus, Room Temperature NCAMP Layup: [0°]4s	ASTM D3039	Strength[2]: Min. Ind. $\geq$ 104.97 ksi Strength[2]: Average $\geq$ 121.04 ksi Modulus[2]: Between 7.83 and 9.30 msi, avg.
45° IPS Strength and Modulus Room Temperature NCAMP Layup: [45°]4s	ASTM D3518	Strength at 4%: Min. Ind. $\geq$ 7.62 ksi Strength at 4%: Average $\geq$ 8.70 ksi Modulus: Between 0.55 and 0.68 msi, avg.

[1] Specific procedures should be identical to those used in the original material qualification program.

[2] Normalize the properties to a consolidated ply thickness value of 0.01226" (Theoretical CPT).

[3] “ind.” refers to individual measurements. “avg.” refers to the average of 5 Replicates. Limits calculated with 1% α and Modified CV.

3.2.4 Equivalency Test Requirements:

TABLE 4- Equivalency Test Matrix

Layup (warp direction)	Test Type and Direction	Property	Number of Batches x Number of Panels x Number of Test Specimens			
			Test Temperature/Moisture Condition			
			CTD	RTD	ETD	ETW
[0/90°]4s	ASTM D3039 Warp Tension	Strength and Modulus		1x2x4		1x2x4
[0/90°]5s	ASTM D6641 Warp Compression	Strength and Modulus		1x2x4		1x2x4
[0/90°]4s	ASTM D3039 Fill Tension	Strength and Modulus		1x2x4		1x2x4
[0/90°]5s	ASTM D6641 Fill Compression	Strength and Modulus		1x2x4		1x2x4
[±45°]4s	ASTM D3518 In-Plane Shear	Strength and Modulus		1x2x4		1x2x4
[0/90°]10s	ASTM D2344 Short Beam	Strength		1x2x4		

Note: For equivalency testing, TPWF (Class 2 “semi-preg”) consolidated per the NPS 84013 (Section 4.3) guideline, shall meet the mechanical and physical requirements as defined in the equivalency test matrix listed in Table 4. Products derived from processes such as forming and/or machining from Class 3 (laminates) material should be verified by DSC, density, NDT inspection, and/or other applicable inspection methods.

QUALIFIED PRODUCTS LIST

Supplier Product Designation	Supplier Name and Production Location	Date Qualified	Specification Callout
Tenax™-E TPWF PEEK-4-40-HTA40 E13 3K DT-5HS-285 Semi-preg	Supplier Name: Teijin Carbon America, Inc. Teijin Carbon Europe GmbH Production Location: Porcher Industries Chemin des Chaumes 38690 Le Grand-Lemps France	March 8, 2023	NMS 401/3, Type 42 Class 2, Grade 284
Tenax™ -E TPCL PEEK-4-40-HTA40 E13 3K DT-5HS-285 Laminate		March 8, 2023	NMS 401/3, Type 42, Class 3, Grade 284

Class 2 Product Code:-

Name	TCA product code	TCE product code
Tenax™-E TPWF PEEK-4-40-HTA40 E13 3K DT-5HS-285	P30024N	6209

Class 3 Product Code:-

Tenax-E TPCL-HTA40 E13 3K 5HS (stacking sequence used in NCAMP Qualification:-

Name	Teijin Internal Layup	NCAMP Layup	Thickness (inch)	Plies	Product Code
NTP4013Q1-TTX-T40-E-P50040-XX-X-XX-1	[0/90°]4s	[0°]4s	0.098	8	P50040
NTP4013Q1-TTX-T40-E-P50041-XX-X-XX-1	[0/90°]5s	[0°]5s	0.123	10	P50041
NTP4013Q1-TTX-T40-E-P50042-XX-X-XX-1	[±45°]4s	[45°]4s	0.098	8	P50042
NTP4013Q1-TTX-T40-E-P50043-XX-X-XX-1	[(±45°)2,0/90°,(±45°)2]s	[(45°)2/0°/(45°)2]s	0.123	10	P50043
NTP4013Q1-TTX-T40-E-P50044-XX-X-XX-1	[0/90°,±45°]2s	[0°/45°]2s	0.098	8	P50044
NTP4013Q1-TTX-T40-E-P50045-XX-X-XX-1	[(0/90°)4,±45°]s	[(0°)4/45°]s	0.123	10	P50045
NTP4013Q1-TTX-T40-E-P50046-XX-X-XX-1	[0/90°,±45°]4s	[0°/45°]4s	0.196	16	P50046
NTP4013Q1-TTX-T40-E-P50047-XX-X-XX-1	[0/90°]10s	[0°]10s	0.245	20	P50047
NTP4013Q1-TTX-T40-E-P50048-XX-X-XX-1	[0/90°]7s	[0°]7s	0.172	14	P50048
NTP4013Q1-TTX-T40-E-P50049-XX-X-XX-1	[0/90°,±45°]3s	[0°/45°]3s	0.147	12	P50049

Class 3 Product Code (Continued):-

Other Teijin laminates product:- (not used in NCAMP Qualification)

Name:	Teijin internal layup	Thickness (inch)	Plies	Product Code
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/02AB	[(0,90)/(90,0)]	0.024	2	P50003
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/03BB	[(0,90)/(±45)/(0,90)]	0.036	3	P50037B
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/04AB	(0,90)4	0.048	4	P50035
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/05AB	[(0,90)/(±45)]2/(0,90)	0.061	5	P50036
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/06AB	[(0,90)/(±45)/(0,90)]s	0.073	6	P50004
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/07AB	[(0,90)/(±45)]3/(0,90)]	0.085	7	P50005
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/08AB	[[(0,90)/(±45]2]s	0.098	8	P50006
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/09AB	[(0,90)/(±45)]4/(0,90)]	0.110	9	P50007
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/10AB	[[(0,90)/(±45)]2/(0,90)]s	0.122	10	P50008
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/11AB	[(0,90)/(±45)]5/(0,90)]	0.134	11	P50009
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/11BB	[(±45)/(0,90)]5/(±45)	0.134	11	P50009B
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/12AB	[[(0,90)/(±45)]3]s	0.146	12	P50010
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/13AB	[(0,90)/(±45)]6/(0,90)	0.159	13	P50037
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/14AB	[[(0,90)/(±45)]3/(0,90)]s	0.171	14	P50011
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/15AB	[(0,90)/(±45)]7/(0,90)]	0.183	15	P50012
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/16AB	[[(0,90)/(±45)]4]s	0.195	16	P50034
TPCL PEEK-4-40-HTA E13 3K DT-5HS-285/16BB	[(0,90)/[(0/90)/(±45)]3/(0/90)]s	0.195	16	P50033

In accordance with NCAMP Standard Operating Procedures, NSP 100, this QPL shall not contain alternate materials/products. Additional production location may be included in the QPL only after successful equivalency demonstration and approval per NCAMP Prepreg Process Control Document (PCD) Preparation and Maintenance Guide, NRP 101.

The proper specification callout for material procurement purpose is “NMS 401/3.” This specification is developed based on the material properties that are available publicly. The purchaser may specify additional requirements beyond those specified in this specification, especially when the purchaser has generated additional material properties beyond those available publicly or when the application requires additional requirements. The additional requirements are subject to supplier review and approval.