Document No.: NMS 241/3 Revision A, June 30, 2025

NCAMP Material Acceptance Specification

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

Oven Cure of VARTM Processed Dry Reinforcements with Toughened Epoxy Resin
Class 2, Style UD, Grade 190, Level 57
(Tenax™ UD Woven DRWF with Syensqo PRISM™ EP2400)

Prepared by: Michelle Man (NCAMP), Royal Lovingfoss (NIAR),

Reviewed by: Rachael Andrulonis (NIAR), John Tomblin (NIAR), Ed Hooper (NCAMP AER), Elisabeth Schäfer (Teijin Carbon), Patrick Kistner (Teijin Carbon), Martin Linder (Teijin Carbon), Joe Spangler (Teijin Carbon), Alfonso Lopez (Teijin Carbon), Gary Kidd (Syensqo)

National Center for Advanced Materials Performance
Wichita State University – NIAR
1845 Fairmount Ave., Wichita, KS 67260-0093, USA

REVISIONS:

Rev	By	Date	Pages Revised or Added
N/C	Michelle Man	12/06/2022	Document Initial Release
A	Michelle Man	06/30/2025	Updated Solvay to Syensqo, and Specification Limits

1 SCOPE:

1.1 Form:

NMS 241 applies in its entirety and this specification supplements that document with details specified below. This specification provides requirements for laminates produced with NPS 82401 using fabric specification NMS 241F/3 and resin specification NMS 241R/1. This detail specification is intended to be used with specifications listed in Section 0.

This detail specification provide specific material properties called out in the base specification and may contain additional or superseding requirements. The base specification shall govern where no additional requirement is specified; in such cases, the applicable sections are omitted from this detail specification.

This material is intended to be used in combination with Class 1 (Non-crimp Fabric) materials in order to provide additional laminate stiffness.

1.2 Classification:

All products qualified to this detail specification have the following classification: Class 2, Style UD, Grade 190, Level 57; unidirectional dry reinforcement woven fabric.

2 Constituent Material Requirements:

Reinforcement: The reinforcement fabric shall be procured to NMS 241F/3. The qualified product list can be found in the detailed fabrics specification.

Resin: The resin shall be procured to NMS 241R/1. The qualified product list can be found in the detailed resin specification.

Both the constituents shall be processed in accordance with NPS 82401.

3 Cured Laminate Requirements:

Acceptance testing to meet the requirements detailed in this specification shall be the responsibility of the material user/purchaser. Individual lots of dry reinforcement or resin shall not be accepted for use/application until laminates are fabricated and tested showing compliance to the requirements of this specification. The user may elect to do in-process coupon or part level testing in lieu of laminate testing.

3.1 Cured Laminate Physical Properties:

Table 3-1 - Cured Laminate Physical Properties

Property	Test Method[1]	Requirements[2]
Cured Ply Thickness [3]	ASTM D3171	0.16 to 0.19 mm, avg 0.0066 to 0.0074 inch, avg.
Laminate Density[4]	ASTM D792	1.53 to 1.56 g/cc, avg.
Fiber Volume, by Volume	ASTM D3171	57 ± 3 %, avg.
Resin Content, by Weight[4]	ASTM D3171	29.0 to 33.3 %, avg.
Void Content, by Volume	ASTM D3171	≤ 2%, avg.
Dynamic Mechanical Analysis (DMA) [5] Glass Transition Temperature	ASTM D7028	154 to 174 ºC, ind. [310 to 346 ºF, ind]

[1] Specific procedures should be identical to those used in the original material qualification program.
[2] “ind.” refers to individual measurements. “avg.” refers to the average measurements per panel.
[3] Computed from actual qualification panel thicknesses using α=0.01 and modified CV. Panel FV is 57 ±3%
[4] Computed from actual qualification panel properties using α=0.01.
[5] Limits computed from average qualification data ±18°F. Onset Storage Modulus, RTA.

3.2 Cured Laminate Mechanical Properties:

Table 3-2 - Required Cured Laminate Tests for Mechanical Properties

Property[4]	Test Method[1]	Requirements[3]
Tabbed Tension Strength and Modulus Room Temperature, Dry Layup: $[0°]_8$	ASTM D3039	Strength[2]: Min. Ind. $\geq$ 2316 MPa (336 ksi) Strength[2]: Average $\geq$ 2712 MPa (393 ksi) Modulus[2]: 145 to 173 MPa (21.0 to 25.1 msi), avg
Compression Strength and Modulus Room Temperature, Dry Layup: $[0°/90°]_{4s}$	ASTM D6641	Strength[2]: Min. Ind. $\geq$ 549 MPa (79.7 ksi) Strength[2]: Average $\geq$ 637 MPa (92.4 ksi) Modulus[2]: 69.6 to 82.7 MPa (10.1 to 12.0 msi), avg
Short Beam Strength Room Temperature, Dry Layup: $[0°]_{32}$	ASTM D2344	Strength: Min. Ind. ≥ 65.7 MPa (9.53 ksi) Strength: Average ≥ 75.0 MPa (10.9 ksi)

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

(2) Normalize the properties to a cured ply thickness value of 0.007 inch, based on theoretical nominal CPT, using the following equation:
Normalized_Value = Measured_Value x Measured_CPT / Nominal_CPT

(3) “ind.” refers to individual measurements. “avg.” refers to the average of 5 replicates. Limits computed at α=0.01 and modified CV.

(4) Test in 0° test direction. This indicates the take up/production direction (similar to warp and weft direction in traditional plain weave woven fabric).

4 Related Specifications

The following are NCAMP qualified materials and process specifications that may be used to produce laminates to conform to the limits in this specification.

Document type	Specification Number	Document Name
Process Specification	NPS 82401	Fabrication of NMS 241 Qualification, Equivalency, and Acceptance Test Panels for Vacuum Assisted Resin Transfer Molding of Carbon Fiber Reinforcement with Syensqo PRISM™ EP2400 toughened epoxy resin
Resin **Procurement** Specification	NMS 241R/1	Resin Specification: Syensqo PRISM™ EP 2400 Toughened Epoxy Resin (formerly Solvay)
Fabric **Procurement** Specification	NMS 241F/3	Tenax™ Dry Carbon Fiber Reinforcement Class 2, Style UD, Grade 190

QUALIFIED PRODUCTS LIST

Supplier Product Designation	Supplier Name and Production Location	Date Qualified	Specification Callout(1)
DRWF IM UD 0190 720004	**Fiber Supplier Name**: Teijin **Production Location**: C. Cramer & Co. GmbH Eper Straße 45-47 48619 Heek Germany Reinforcement Production Line: 231x	May 2025	NMS 241F/3 Material QPL: See procurement spec
PRISM ™ EP2400 Resin System	**Resin Supplier Name**: Syensqo (formerly Solvay) **Production Location**: Wrexham Industrial Estate Abenbury Way Wrexham Clwyd LL13 9UZ Resin Mixer Vessel ID: Myers 1	May 2025	NMS 241R/1 Material QPL: See procurement spec

(1) 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 Process Control Document (PCD) Preparation and Maintenance Guide, NRP 101.

(1) **The proper specification callout for material acceptance purpose is "NMS 241/3".** 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.