



Document No.: NMS 241/2 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 1, Style BD, Grade 380, Level 57
(Tenax™ Bidiagonal DRNF with Syensqo PRISM™ EP2400)

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Distribution Statement A. Approved for public release; distribution is unlimited.

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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/2 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.

1.2 Classification:

All products qualified to this detail specification have the following classification: Class 1, Style BD, Grade 380, Level 57; Bidiagonal 45°/-45° and Bidiagonal -45°/45°, dry reinforcement non-crimp fabric.

2 Constituent Material Requirements:

Reinforcement: The reinforcement fabric shall be procured to NMS 241F/2. 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 batches 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	0.34 to 0.39 mm, avg 0.0134 to 0.0152 inch, avg.
Laminate Density ⁽⁴⁾	ASTM D792	1.52 to 1.56 g/cc, avg.
Fiber Volume, by Volume	ASTM D3171	57 ± 3 %, avg.
Resin Content, by Weight ⁽⁴⁾	ASTM D3171	30.7 to 35.5 %, avg.
Void Content, by Volume	ASTM D3171	≤ 2%, avg.
Dynamic Mechanical Analysis (DMA) ⁽⁵⁾	ASTM D7028	146 to 166 °C, ind. [296 to 332 °F, ind]
Glass Transition Temperature		

⁽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 $\alpha=0.01$ and modified CV. Panel FV is 57 ±3%

⁽⁴⁾ Computed from actual qualification panel properties using $\alpha=0.01$.

⁽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⁾
Tension Strength and Modulus Room Temperature, Dry Layup: [0°/90°] _{4s}	ASTM D3039	Strength ⁽²⁾ : Min. Ind. \geq 1186 MPa (172 ksi) Strength ⁽²⁾ : Average \geq 1366 MPa (198 ksi) Modulus ⁽²⁾ : 76.9 to 91.3 MPa (11.1 to 13.2 msi), avg
Compression Strength and Modulus Room Temperature, Dry Layup: [0°/90°] _{4s}	ASTM D6641	Strength ⁽²⁾ : Min. Ind. \geq 576 kPa (83.6 ksi) Strength ⁽²⁾ : Average \geq 668 MPa (96.9 ksi) Modulus ⁽²⁾ : 72.0 to 85.5 MPa (10.4 to 12.4 msi), avg
Short Beam Strength Room Temperature, Dry Layup: [0°/90°] _{8s}	ASTM D2344	Strength: Min. Ind. \geq 60.3 MPa (8.74 ksi) Strength: Average \geq 68.8 MPa (9.98 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 0.014 inch, based on theoretical nominal CPT, using the following equation:

$$\text{Normalized_Value} = \text{Measured_Value} \times \text{Measured_CPT} / \text{Nominal_CPT}$$

⁽³⁾ “ind.” refers to individual measurements. “avg.” refers to the average of 5 replicates. Limits computed at $\alpha=0.01$ 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). **Layup is obtained by rotating BD reinforcements 45°.**

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/2	Tenax™ Dry Carbon Fiber Reinforcement Class 1, Style BD, Grade 380

QUALIFIED PRODUCTS LIST

Supplier Product Designation	Supplier Name and Production Location	Date Qualified	Specification Callout ⁽¹⁾
DRNF IM BD 0380 710089 And DRNF IM BD 0380 710090	Fiber Supplier Name: Teijin Production Location: Teijin Carbon Europe GmbH Vitsstrasse 2 52525 Heinsberg Germany Reinforcement Production Line: 2303	May 2025	NMS 241F/2 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 241/2”.** 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.