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NCAMP Material Acceptance Specification

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Vacuum Assisted Resin Transfer Molded Laminates Using Dry Reinforcement Fabric and Resin

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REVISIONS

Revision	Date	Description
-	12/06/2022	Initial Release
-	06/30/2025	Updated Solvay to Syensqo

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1 SCOPE:

1.1 Form:

This specification and its associated detail specifications establish the requirements for laminates fabricated with dry reinforcements non-crimp and unidirectional woven fabric infused with resin via resin infusion process. The detail specification provides specific requirements for the fabricated laminate.

1.2 Application:

These composite materials are intended for use in fabrication of structures in support of the aerospace industry. The laminates are manufactured using an infusion process and raw materials procured to NCAMP Material Specification NMS 241R and NMS 241F series and shall be in processed with NCAMP Process Specification NPS 82401 Rev -.

Material property data including statistically based material allowables are available publicly for the material covered by this specification. Part fabricators that wish to utilize the material property data, allowables and specification may be able to do so by demonstrating the capability to reproduce the original material properties; the process known as equivalency. More information about this process including the test statistics and its limitations can be found in Section 6 of DOT/FAA/AR-03/19 and Section 8.4.1 of CMH-17-1G.

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 other requirements. The additional requirements are subject to supplier review and approval.

The use of this specification does not guarantee material or structural performance. Material users should be actively involved in evaluating material performance and quality including, but not limited to, performing regular purchaser quality control tests, performing periodic equivalency/additional testing, conducting statistical process control and conducting regular supplier audits if deemed relevant.

1.3 Safety – Hazardous Materials:

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 all 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.

1.4 Rounding of Values:

The following applies to all specified limits or requirements in this specification. For purposes of determining conformance with this specification, an observed value or a calculated value shall be rounded “to the nearest unit” in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of ASTM E29.

1.5 Qualified Products:

This specification requires qualified resin and reinforcements which are listed in the Qualified Products List (QPL) of each detail specification. In accordance with the requirements of this specification, the specific fiber material and source(s) and weaver(s) that make up the dry reinforcements and the specific components and source(s) that make up the resin shall be qualified as a combined cured material system. Any other combinations not listed on the QPL of the detail specification are not qualified. In addition, the production of the qualified products is controlled by an NCAMP approved process control document (PCD).

1.6 Detail Specification:

The base specification contains basic laminate material requirements that apply to every product. The detail specifications contain additional or superseding properties and requirements that apply to a specific combination of dry reinforcement fabric and resin product.

There shall be a base and detail specification for each class and style of reinforcement fabric and the reactive resin. The fabric and resin specifications are intended to be used together (with the referenced Process Specification) to produce the combined cured laminate. Use of non-referenced constituent materials are outside the scope of these specifications.

1.7 Change Control Approval:

The dry reinforcement and resin shall be produced in accordance with an NCAMP approved Process Control Document (PCD). See details in the resin or dry reinforcement material specification on how to process if there are changes made to the material. Changes shall be documented to ensure proper material change traceability.

2 APPLICABLE DOCUMENTS

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:

NPS 82401	Fabrication of NMS 241 Qualification, Equivalency, and Acceptance Test Panels for Vacuum Assisted Resin Transfer Molding of Carbon Fiber Reinforcements with Syensqo PRISM™ EP2400 toughened epoxy resin
NMS 241/1	NCAMP Material Acceptance Specification Oven Cure of VARTM Processed Tenax™ Dry Reinforcements with Toughened Epoxy Resin - Biaxial DRNF with NMS 241R/1 Syensqo PRISM™ EP2400
NMS 241/2	NCAMP Material Acceptance Specification Oven Cure of VARTM Processed Tenax™ Dry Reinforcements with Toughened Epoxy Resin - Bidiagonal DRNF with NMS 241R/1 Syensqo PRISM™ EP2400
NMS 241/3	NCAMP Material Acceptance Specification Oven Cure of VARTM Processed Tenax™ Dry Reinforcements with Toughened Epoxy Resin – UD Woven DRWF with NMS 241R/1 Syensqo PRISM™ EP2400
NMS 241F	NCAMP Material Procurement Specification. Fabric Specification: Tenax™ Dry Intermediate Modulus Carbon Fiber Reinforcement
NMS 241F/1	NCAMP Material Procurement Specification. Tenax™ Dry Reinforcement (Carbon Fiber) Class 1, Style BA, Grade 380
NMS 241F/2	NCAMP Material Procurement Specification. Tenax™ Dry Reinforcement (Carbon Fiber) Class 1, Style BD, Grade 380
NMS 241F/3	NCAMP Material Procurement Specification. Tenax™ Dry Reinforcement (Carbon Fiber) Class 2, Style UD, Grade 190
NMS 241R	NCAMP Material Procurement Specification. Resin Specification: Syensqo Toughened Epoxy Resin (formerly Solvay)
NMS 241R/1	NCAMP Material Procurement Specification Syensqo PRISM™ EP 2400 Toughened Epoxy Resin (formerly Solvay)

2.2 SACMA Publications

(available from American Composites Manufacturers Association, 1010 N Glebe Rd., Suite 450, Arlington, VA 22201, http://www.acmanet.org):

SACMA SRM 25R-94	Onset Temperature and Peak Temperature for Composite System Resins Using Differential Scanning Calorimetry (DSC)

2.3 ASTM Publications

(available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, http://www.astm.org)

ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D2344	Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM D3039	Tensile Properties of Polymeric Matrix Composite Materials
ASTM D3171	Standard Test Method for Constituent Content of Composite Materials
ASTM D3418	Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
ASTM D5379	Standard Test Method for Shear Properties of Composite Materials by the V-Notched Beam Method
ASTM D6641	Standard Test Method for Determining the Compressive Properties of Polymer Matrix Composite Laminates Using a Combined Loading Compression (CLC) Test Fixture
ASTM D7028	Standard Test Method for Glass Transition Temperature (DMA Tg) of Polymer Matrix Composites by Dynamic Mechanical Analysis (DMA)
ASTM E29	Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E168	General Techniques of Infrared Quantitative Analysis
ASTM E1252	Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis

2.4 ISO Publications:

ISO 9000	Quality Management Systems
ISO 9001	Quality Management Systems: Requirements
AS9100	Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations.

2.5 US Government Publications:

29 CFR 1910.1200	Hazard Communication, Occupational Safety and Health Standards

DOT/FAA/AR-06/25	Preliminary Guidelines and Recommendations for the Development of Material and Process Specifications for Carbon Fiber-Reinforced Liquid Resin Molded Materials
MIL–D–3464	Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification
CMH-17	Composite Materials Handbook (formerly MIL-HDBK-17)

3 Material Description

3.1 Material Classification:

Each detail specification has a unique classification. Example specification callout is provided in the qualified products list of every detail specification. The following reinforcement fabric shall be classified to the following Styles, Classes, and Grade. Additional details of the reinforcements' construction is described in the individual slash sheet governing the material.

3.1.1 Class shall specify product family. For example,

Class 1 – Dry reinforcement Non-Crimp Fabric
Class 2 – Dry reinforcement Woven Fabric (also known as Uni-Fabric)

3.1.2 Style shall specify product type. For example,

- Style Bidiagonal (BD) - Stitched textile with two orthogonal layers of carbon fiber, +45° and -45° (or -45°/+45°) – referenced to production direction
- Style Biaxial (BA) - Stitched textile with two orthogonal layers of carbon fiber, 0° and 90°(or 90°/0°) – referenced to production direction
- Style Unidirectional (UD)– One layer of Unidirectional carbon fiber woven with polymer yarn

3.1.3 Grade shall specify nominal carbon fiber areal weight of reinforcement fabric in grams per square meter (gsm). For example,

Grade 190 – 190 gsm nominal fiber areal weight
Grade 380 – 380 gsm nominal fiber areal weight

3.1.4 Level shall specify the nominal target fiber volume used to produce mechanical data. For example,

Level 57 – Nominal fiber volume is 57 percent by volume (pre-determined)

4 TECHNICAL REQUIREMENTS:

4.1 Detail Specification:

The requirements for a specific combination of reinforcement fabric and resin shall consist of all requirements specified herein in addition to requirements specified in the applicable detail specification. In case of conflict between requirements of this basic specification and an applicable detail specification, requirements of the detail specification shall govern.

4.2 Constituent Material Requirements:

Material acceptance criteria governed in this specification is a result of the use of reinforcement fabric and infusion resin using the specified process specification. The procurement specifications for the raw constituent materials (reinforcement and resin) are independent of this document and shall be used as referenced. The definition for material lot are in accordance with DOT/FAA/AR-06/25.

4.2.1 Reinforcement Fabric:

The reinforcement used is a dry reinforcement no-crimp and woven fabric and shall meet the requirements in the applicable material procurement specification. Any changes to the construction of the reinforcement fabric since qualification shall be re-approved by NCAMP. Specific details of the changes shall be documented.

4.2.2 Epoxy Resin System:

The resin system used shall be an epoxy-based resin for infusion that is capable of meeting the requirements of the applicable material procurement specification. Any changes to the epoxy resin system or the infusion method used since qualification shall be re-approved by NCAMP. Specific details of the changes shall be documented.

4.3 Laminate (Infused and Cured) Requirements:

4.3.1 Test Laminate Fabrication and Baseline Infusion Process:

The test laminate fabrication and baseline infusion and cure process shall be in accordance with NCAMP Process Specification NPS 82401 Fabrication of NMS 241 Qualification, Equivalency, and Acceptance Test Panels. Reference edge, reinforcement fabric production direction and panel ID shall be labeled on the panel to facilitate individual specimen traceability.

4.3.2 Cured Laminate Physical Properties:

The cured laminate physical properties listed in Table 1 shall conform to the values and requirements listed on the corresponding detail specification.

Table 1 - Cured Laminate Physical Properties

Property	Test Method (1)	Number of Replicates
Laminate Thickness	ASTM D3171	10 measurements per panel
Laminate Density	ASTM D792	5 per lot minimum
Fiber Volume, % by Volume	ASTM D3171	5 per lot minimum
Resin Content, % by Weight	ASTM D3171	5 per lot minimum
Void Content, % by Volume	ASTM D3171	5 per lot minimum
Dynamic Mechanical Analysis (DMA) Glass Transition Temperature	ASTM D7028	2 per lot minimum

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

4.3.3 Cured Laminate Mechanical Properties:

The molded laminate mechanical properties listed in Table 2, shall conform to the values and limits listed on the corresponding detail specification.

Table 2 - Required Cured Laminate Tests for Mechanical Properties (Class 1 only)

Property (2)	Test Temperature	Test Method(1)	Number of Replicates
0° Tension Strength and Modulus	RT	ASTM D3039	5
0° Compression Strength and Modulus	RT	ASTM D6641	5
0° Short Beam Strength	RT	ASTM D2344	5

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

(2) Use of 0° or 90° indicates the test direction with reference to the take up/production direction (this is similar to warp and weft direction in traditional plain weave woven fabric).

Table 3 - Required Cured Laminate Tests for Mechanical Properties
(Class 2 only)

Property[2]	Test Temperature	Test Method[1]	Number of Replicates
0° Tension Strength and Modulus	RT	ASTM D3039	5
0° Compression Strength and Modulus	RT	ASTM D6641	5
0° Short Beam Strength	RT	ASTM D2344	5

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

[2] Use of 0° indicates the test direction with reference to the take up/production direction (this is similar to warp direction in traditional plain weave woven fabric).

4.4 General laminate handling

Once infused and cured, the laminates may be stored at room temperature ambient conditions until ready for acceptance testing. If the testing is outsourced to a certified laboratory, the laminates shall be prepared and shipped in a manner that will not damage the fabricated panels or incur injury to the shipping or receiving personnel. Excess resin on the laminate edges may be trimmed to prevent/avoid sharp edges.

4.5 Environmental, Health, and Safety:

4.5.1 Equipment, materials, solutions, and emissions (if applicable) shall be controlled, handled, used, and disposed of in accordance with all local, State, and Federal Government Safety, Health, and Environmental Affairs (SHEA).

4.5.2 The delivered constituent materials (fabric and resin) shall fulfill the local requirements of the health and safety laws of the country of the purchaser. When processing the materials in the composite shop, there shall be no health hazards or emissions that require special measures to be taken to protect the environment.

4.5.3 The manufacturer shall inform the purchaser about the safe handling procedures of the material. The Material Safety Data Sheet (MSDS) or Product Information on Safe Handling (PISH) shall be made available to the purchaser.

4.6 Defects During Usage:

4.6.1 Undocumented defects or non-conformance in excess (observed in raw material), as defined by the procurement material specification, found in the materials after acceptance shall be discussed with the supplier and may be a cause for rejection. If rejected the defective material shall be returned to the supplier. Defects caused by the shipper/carrier and user mishandling or improper storage are not the responsibility of the supplier and shall not be cause for rejection back to the supplier. See appropriate resin or fiber/reinforcement specification.

4.7 Qualification Requirements:

Raw constituent materials supplied to fulfill this specification have been qualified in accordance with an NCAMP test plan.

4.8 Material Re-Qualification and Equivalency:

4.8.1 If any change occurs relevant to this acceptance specification, or the raw constituent procurement specification or the PCD, NCAMP reserves the right to require a re-qualification of the material in question to validate that the changes are equivalent to the material in the initial qualification. The extent of the re-qualification program will depend on the nature of the change of the material or the material processing. DOT/FAA/AR-06/25 provide guidance in this area.

4.8.2 Equivalency is limited to the evaluation of minor changes in a material’s constituents,

manufacturing process, or fabrication (e.g. curing) process used with a material. Significant changes to the material will require a full qualification program and a separate specification.

4.8.3 It is the responsibility of the material purchaser to conduct testing to meet acceptance properties in this specification to demonstrate that the chosen material combination, when processed to the baseline process specification, will generate composite properties statistically equivalent to the properties of the original materials.

4.9 Traceability:

Each individual material and its constituents as defined by the PCD shall be identifiable at all stages of manufacture and delivery. The material user shall present evidence of the material traceability upon request.

4.10 Quality Management System:

The manufacturer's quality system shall be approved as defined in ISO 9000, ISO 9001, AS 9100 or equivalent.

5 QUALITY ASSURANCE:

5.1 Responsibility for Inspection:

Unless otherwise specified in the contract or purchase order, the raw material supplier is responsible for the performance of all lot release inspection for the raw constituent materials. Requirements are detailed in the procurement specification slash sheets.

The purchaser/material user is responsible for the performance of all receiving inspection tests specified herein. Requirements are detailed in the acceptance specification slash sheets that govern the specific chosen material combination (i.e. non-crimp fabric and resin or woven fabric and resin).

The raw constituent supplier and the material user may use their own facilities or any commercial laboratory acceptable to NCAMP. The purchaser or NCAMP reserves the right to perform additional tests to assure that the material furnished conforms to the prescribed requirements.

5.2 Classification of Tests and Inspections:

5.2.1 Qualification Tests:

The preproduction tests performed for material qualification are those tests performed on representative samples of each specific form of material to establish a qualified product in accordance with this specification. Qualification testing shall be in accordance with an NCAMP test plan.

5.2.2 Material lot Release Tests:

Each incoming lot of material (resin or reinforcement) used in combination for VARTM laminates or parts fabricated per NPS 82401 shall meet their respective requirements that are detailed in the procurement specification. Lot release tests of the raw constituents shall be those tests performed by the supplier on representative samples taken from each production lot of each type of material submitted by the supplier for acceptance under contract or purchase order. Data and certification of data generated shall accompany each shipment of material. Lot release test of the raw constituents may be repeated by the purchaser if desired (optional).

Laminate acceptance testing shall be performed by the material purchaser and shall meet the specification requirements described herein. This shall be the responsibility of the user/purchaser of the materials. Laminate panel fabrication shall be performed by the user/purchaser; testing of specimens may be outsourced as necessary.

5.3 Certification of Conformance:

For details of CoC content, please refer to fabric acceptance specification and resin acceptance specification

5.3.1 Records:

The following records shall be available for inspection by NCAMP and purchasers upon request.

5.3.1.1 The purchaser/user shall keep on permanent file all records pertaining to the qualification of the candidate material.

5.3.1.2 The purchaser/user shall keep the following records on file, for each raw constituent material lot, for a minimum period of 7 years:

a. Full resin/fabric constituent traceability. This traceability shall extend to the particular resin component and resin lot; fiber construction components and reinforcement fabric lot, where applicable.
b. All records pertaining to raw constituent material receiving inspection and certification, in–process records, and product testing specified in the supplier PCD.
c. All records pertaining to the statistical process control (SPC) requirements which are specified in the supplier PCD.

5.3.2 Re-Testing:

One retest is allowed for each test property. Additional re-test(s) is allowed only when one or more of the following conditions exist:

a. The initial test was performed with significant deviation to the appropriate procedure. Significant deviations are those expected to affect the measured response.
b. In the course of layup, laminate consolidation, machining, or testing, there was an occurrence known to cause or contribute to the observed test result(s).
c. Standard statistical analysis procedures establish the suspect individual data point(s) as an outlier and there is a probable, if not provable, relationship to a deviation from required procedure.

6 Laminate Panel Shipping:

6.1 Packaging:

6.1.1 If shipment of the laminate to a test house is necessary, the laminates shall be wrapped with cushioning material (bubble wrap, heavy stock paper, etc.) and secured in a sturdy box. The box shall be closed to protect against damage or contaminants.

6.1.2 This shall be packed in a shipping container that will be acceptable for safe transportation by common carriers and shall include a packing list. The box shall be secured to prevent damage/unnecessary movement during shipment.

6.1.3 An external label or a suitable label accompanying the laminates to be tested shall be clearly marked with the following information:

a. Title, number and revision letter of this specification, (and the PCD if required by the detail specification).
b. Date of laminate manufacture (or date of shipment if specified by the detail specification)
c. Quantity of laminates and material identification
d. Purchase order number and/or sales order number
e. Test methods and properties to acquire
f. Laminate manufacturers name
g. All material labeling shall comply with OSHA Hazard Communication, 29 CFR 1910.1200 (if applicable).

6.1.4 Containers shall be closed properly and protected so that there is not excessive exposure to UV light and moisture.

6.1.5 Normal ground shipment temperature not exceeding 50°C (122°F).

7 ACKNOWLEDGEMENT:

A vendor shall mention this specification number and the applicable detail specification number and their revision letters, if any, in all quotations and when acknowledging purchase orders.

8 REJECTION:

Product not conforming to this specification and the applicable laminate slash sheet, or to modifications authorized by purchaser, will be subject to rejection.

9 NOTES:

This section of the specifications is reserved for explanatory and other notes.

9.1 Definitions:

For definitions that are not provided in this specification or other applicable NCAMP specifications, the definitions in DOT/FAA/AR-06/25 shall apply. For definitions not provided in DOT/FAA/AR-06/10 and DOT/FAA/AR-07/3, the definitions in ASTM D3878 shall apply. For definitions not provided in ASTM D3878, the definitions in CMH-17 (formerly MIL-HDBK-17) shall apply. The document listed may or may not be used in their entirety.