Document No.: NMS 241F Revision A, October 20, 2025

NCAMP Material Procurement Specification

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

Fabric Specification:
Tenax™ Dry Intermediate Modulus Carbon Fiber Reinforcements

Prepared by: Michelle Man (NCAMP), Alfonso Lopez (Teijin Carbon), Elisabeth Boeck (Teijin Carbon)

Reviewed by: Rachael Andrulonis (NIAR), Royal Lovingfoss (NIAR), John Tomblin (NCAMP/NIAR), Joe Spangler (Teijin Carbon), Patrick Kistner (Teijin Carbon), Vera Richter (Teijin Carbon), Gary Kidd (Syensqo), Steve Ward (Collins Aerospace), Curtis Davies (FAA), Ed Hooper (NCAMP AER)

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

REVISIONS

Revision	Date	Description
-	12/20/2022	Initial Release
A	06/30/2025	Updated Solvay to Syensqo, typographical and editorial changes, Section 4.3.1 on physical property requirements and addition of sampling guide, Section 4.4.2 and 4.4.3 updates to requirement criteria tables
A	10/20/2025	Updated trademark symbol for Syensqo material callout

TABLE OF CONTENTS

LIST OF TABLES

1. SCOPE:

1.1 Form:

This specification and its associated detail specifications establish the requirements for dry reinforcement non-crimp and unidirectional woven fabric (DRNF and DRWF respectively). The DRNF fabric consists of carbon fiber, a binder and veil stitched together with a copolymer yarn to produce a textile while the DRWF consists of unidirectional carbon fiber woven with a copolymer yarn, with possible application of a binder and/or veil. The detail specification shall provide specific requirements for these fabrics. For simplicity and clarity, both reinforcements shall be referenced as reinforcement fabric (RF).

1.2 Application:

The reinforcement fabrics are intended for use in fabrication of structures in support of the aerospace industry. The materials are designed specifically for resin infusion. The reinforcement fabric may be used alongside qualified NCAMP Resin Material Specification and approved NCAMP Process Specification to produce laminates that will meet laminate acceptance specification.

Laminate panels produced using the materials governed herein in conjunction with the process specification referenced is used to generate material property data including statistically based material allowables that are available publicly. 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 Vol 1 (latest release).

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 products 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 shall be considered qualified materials. Any materials 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:

This base specification contains basic unprocessed/uncured dry reinforcement material requirements that apply to every product. The detail specifications contain additional or superseding properties and requirements that apply to a specific material form of the dry reinforcement fabric.

There shall be a base and detail specification for the reactive resin and a combined cured laminate with resulting specification limits. 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 reinforcements shall be produced in accordance with an NCAMP approved Process Control Document (PCD). Formal change notification and approval is required before a change may be implemented. DOT/FAA/AR-06/25 can be used as a guide to determine changes that require change notification. In general, Level 0 and level 1 are minor changes and level 2 through level 4 are considered major changes. Minor changes should be communicated to NCAMP using a change notice to ensure proper material change traceability. NCAMP approval is required for major changes, and is granted through Advance Change Notices (ACN). Prior to implementing a major change, the material supplier shall contact NCAMP with the following information:

a. A detailed description of the change,
b. A draft test plan to substantiate that the change will not affect the material properties, and
c. A list of material users

NCAMP staff will communicate the proposed change(s) and obtain necessary suggestions and/or approvals from the material users and certification agencies. In general, DOT/FAA/AR-06/25 will be used as guidelines. The ACN along with test results will be reviewed by the material users and certification agencies. NCAMP staff will sign the ACN when a consensus is reached.

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:

NMS 818/15	NCAMP Material Specification. Carbon Fiber Tow Tenax-E IMS65 E23 24K (E-Europe)
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 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 241	NCAMP Material Acceptance Specification. Vacuum Assisted Resin Transfer Molded Laminates Using Dry Reinforcement Fabric with Resin
NMS 241/1	NCAMP Material Acceptance Specification Oven Cure of VARTM Processed Dry Reinforcements with Toughened Epoxy Resin - Tenax™ Biaxial DRNF with Syensqo PRISM® EP2400
NMS 241/2	NCAMP Material Procurement Specification Oven Cure of VARTM Processed Dry Reinforcements with Toughened Epoxy Resin - Tenax™ Bidiagonal DRNF with Syensqo PRISM® EP2400
NMS 241/3	NCAMP Material Procurement Specification Oven Cure of VARTM Processed Dry Reinforcements with Toughened Epoxy Resin – Tenax™ UD Woven DRWF with Syensqo PRISM® EP2400

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 D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
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 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 European Standards and ISO Publications:

ISO 3951	Sampling procedures for inspection by variables - Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL
ISO 9001	Quality Management Systems: Requirements
AS9100	Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations.

DIN EN 12127	Textile fabrics - Determination of mass per unit area using small samples
DIN EN 1773:1996	Textiles - Fabrics - Determination of width and length
EN 13473-1	Reinforcement - Specifications for multi-axial multi-ply fabrics - Part 1: Designation

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 Reinforcement Fabric 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

3.2 Reinforcement Fabric Construction:

The dry reinforcement fabric consists of multiple layers of material stitched together with a polymer yarn. The dry reinforcements can be identified as non-crimp fabric and woven fabric. Specific construction is detailed in the material slash sheet governing the specific material. Properties of the individual layers are controlled within the NCAMP approved PCD, unless otherwise specified. The following describes the various material layers in the dry reinforcement fabric.

3.2.1 Carbon fiber

Tenax™ - E IMS65 E23 24K 830 tex fibers are used in this material construction. Carbon fibers used for the reinforcement fabric shall be in accordance with NMS 818/15.

3.2.2 Powder Binder (PB)

The quantity and parameters of the binder shall be controlled by the NCAMP approved PCD. For the construction of this material Westlake EPIKOTE 05311 binder resin shall be used. The binder improves material cutting and handling and aids in preforming and tacking two layers of textile together.

3.2.3 Toughening Veil (V)

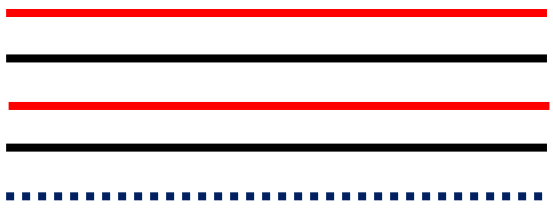
The quantity and parameters of the veil shall be controlled by the NCAMP approved PCD. For the construction of this material TA1903s, a polyamide veil shall be used. The veil improves material toughness.

3.2.4 Stitching Yarn and Weft Yarn

The non-crimp fabric (NCF) shall be stitched together with K-203 (EP1390) 33 dtex a co-polyamide yarn. Various stitching patterns are used depending on the product and details are provided in material specific slash sheet.
The UD woven fabric (Uni-Fabric) textile shall be woven together with a polyester and co-polyamide Z-85 combi-fuseable bonding yarn, 200 dtex.

3.2.5 Reinforcement Construction

The BA and BD NCF shall consists of 5 constituent layers: veil, carbon fiber, veil, carbon fiber, ending with a layer of applied powder binder. These layers are held together by the stitching yarn. A common terminology used to describe this construction is abbreviated to PB/-45°/V/+45°/V. The following illustration describes the layered construction of a bidiagonal (BD) material.



Veil (V) – Top layer
Carbon fiber (+45°)
Veil (V)
Carbon fiber (-45°)
Powder Binder (PB) – Bottom/first layer

4 TECHNICAL REQUIREMENTS:

4.1 Detail Specification:

The requirements for a specific reinforcement fabric product 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 Other Material Requirements:

The definition for material lot can be described as a quantity of material produced at the same time and under the same conditions from a well-defined collection of raw materials. The quantity of material must have minimal variation in properties throughout to be considered a unique lot. For additional details see section 4.8.2 of the same document. Constituent raw ingredients that are sourced to produce the reinforcements shall be controlled within an NCAMP approved PCD. 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.

4.3 Physical Property Requirements:

4.3.1 Physical properties:

Each lot of reinforcement fabric (RF) shall meet the physical property requirements of Table 1 or Table 2 as specified below. Specific requirement values can be found in the respective NMS 241F slash sheet. Testing shall be the responsibility of the material supplier and performed on every lot of material (see also Table 3). The material shall be capable of being cut without disarray of the filaments and without other visible damage. A sharp-edged tool (not serrated or blunt) shall be used to cut the fabric to ensure that it does not fray during cutting.

Table 1 – Reinforcement Fabric Physical Properties
(Class 1 Only)

Property	**Test Method(1)**	**Number of Replicates per lot(2)**
Product Areal Weight (without Binder)	DIN EN 12127 (TAV DRNF 2302-002)	3
Binder Areal Weight	TAV DRNF-PB 2303-002	3
Material Width	DIN EN 1773:1993:1996 (TAV DRNF-WS 2304-002)	3

(1) Specific procedures should be identical to those used in the original material qualification program. Tests are performed according to Teijin internal test methods (TAV) in reference to official ISO test standards. Teijin internal standards (TAV) may be requested from Teijin. Only product areal weight is reported in certificate of conformance.

(2) The sampling interval in Table 3 shall be used.

Table 2 – Reinforcement Fabric Physical Properties
(Class 2 Only)

Property	Test Method[1]	Number of Replicates per lot[2]
Product Areal Weight	DIN EN 12127 (Cramer-Method No. U02.1-01-02)	3
Setting Weft	Cramer-Method No. U02.1-01-03	1
Material Width	Cramer-Method No. U02.1-01-05	3

[1] Specific procedures should be identical to those used in the original material qualification program. Cramer internal standards may be requested from the supplier. Only product areal weight is reported in certificate of conformance.
[2] The sampling interval in Table 3 shall be used.

Table 3 – Sampling Guide

The following sampling Interval shall be used:

A standard unit of reinforcement fabric (RF) is defined to an area of 175 m², independent of the width and weight of the RF and the actual size of the produced units.

The number of units to be tested in relation to the number of units in a production lot is given in the following table.

The first ten production lots of a newly qualified material shall be tested according to statistical distribution. Further production lots shall be tested in accordance with the normal distributions unless otherwise agreed between the supplier and purchaser.

Number of Standard Units in a production lot (n)	Number of standard units to be tested (x)	
	Normal	Statistical
01 – 03 (0 m² – 525 m²)	1	Each Unit
04 – 15 (525 m² - 2.625 m²)	2	3
16 – 25 (2.625 m² - 4.375 m²)	4	4
26 – 40 (4.375 m² - 7.000 m²)	5	5
>= 41 (>= 7.000 m²)	7	7

The unit number to be sampled shall be in accordance with the following:
Two units sampled: First and last produced roll
More than two units sampled: First and every n / (x-1) unit to be tested (to the lowest number)

4.4 Dry Reinforcements Visual and Dimensional Requirements:

4.4.1 General:

The reinforcement fabric shall be uniform in quality and shall not contain defects detrimental to handling, layup, infusion process or structural properties. The definition of defects is defined in the defect catalogue TD34128 for NCF materials and the Cramer defect catalogue for woven materials.

4.4.2 Requirements for dry reinforcement non-crimp fabric:

All observed defects will be Flagged by the supplier and removal of the defect shall be done by the user. Removal of flagged defects is recommended but it is at the discretion of the user to determine if some defects may be acceptable for use and not be detrimental to their application.

For removal of defects, cuts shall be made before and after the defect, removed, and discarded. The remainder of the material may be used.

Defects are marked with a defect number and corresponds to the defect type in the table below.

Table 4 Requirement Criteria for Class 1 (DRNF)

Defect number	Flagged Defect type	Significant defect size	Action
10	Contamination, foreign material	Any	Do not use section
13	Smash, cut, hole	Any	Do not use section
14	Winding stripe, crease	Any	Do not use section
15	Veil with a crease	Critical if width > 10 mm	Recommended not to use section, user discretion
		Critical if veil overlap (for example during change of veil roll; independent of width)	Do not use section
33	Missing stitch yarn	Size > length 30 mm and width 15 mm	Recommended not to use section, user discretion
		Size ≤ length 30 mm, width 15 mm and > 10 of these areas per m^2	Recommended not to use section, user discretion
		Distance between two missing stitch areas < 100 mm (width and production direction)	Recommended not to use section, user discretion
		if filaments are not held in place	Do not use section
34	Yarn splice, hard piece	Any	Do not use section
35	Damaged carbon fiber	> 3 cm length	Do not use section

Table 5 Requirement Criteria for Class 1 (DRNF) (continued)

44	Misalignment (skewed fabric, weft waviness)	For 90° layer: For 127 cm width: maximum permissible skew: 38.1 mm (perpendicular distance between the point at which one yarn meets one selvage, and the corresponding point at which the same yarn meets the opposing selvage) For all other widths: Maximum permissible skew : 3 % of fabric width	Do not use section
		For +45° and -45° layer Maximum permissible skew : 3 % of fabric width	Do not use section
51	Fuzz balls	if significant change in thickness (visible or between the layers)	Do not use section
		If >4 cm^2 (independent of thickness)	Recommended not to use section, user discretion
		accumulated surface area per 15 linear meters: > 8 cm^2	Recommended not to use section, user discretion
73	Gap	if 1.5 to 2.0 mm	Recommended not to use section, user discretion
74	Gap	if > 2 mm	Do not use section

Table 6 Requirement Criteria for Class 1 (DRNF) (continued)

81	Scattered/excess of powder application	> 100 mm²	Do not use section
82	Area without powder	>100 mm²	Do not use section
83	Incomplete fixation of the coating	Any	Do not use section
91	Lack of veil	>100 mm²	Do not use section
Edge Defects:			
20	Damaged selvedge / damaged selvedge yarn	if edges not straight and parallel to the direction of the fabrication	Do not use section; user discretion
23	Frayed edge	Any visually recognized	Do not use section; user discretion
24	Veil is missing at the selvedge	Any visually recognized	Do not use section; user discretion
	Missing edge yarn	Any visually recognized	Do not use section (see Note in section 4.4.2)

4.4.3 Requirements for dry reinforcement woven fabric (Uni-Fabric):

Table 7 Requirement Criteria for Class 2 (DRWF)

Defect number	Flagged Defect Type	Significant defect size	Action
Direction independent defects			
10	Contamination, foreign material	Any	Do not use section
13	Smash, cut, hole	Any	Do not use section
15	Fold/overlap in veil	Any	Do not use section
51	Fuzz ball with significant change in thickness	Any	Do not use section
	Fuzz balls	> 3 x 3 cm	Do not use section; user discretion
55	Loose fiber accumulation	Any	Do not use section; user discretion
56	Winding stripe, crease	Any	Do not use section
81	Excess of binder with significant change in thickness (Note 1)	solids > 3 mm diameter	Do not use section
81	Lack of Binder (Note 1)	≥ 3 cm	Do not use section; user discretion
86	Lack of toughening veil	> 3 x 3 cm (900 mm^2)	Do not use section; user discretion
Warp direction			
30	Tight warp ends	Any	Do not use section; user discretion
34	Yarn splice, hard piece	Any	Do not use section
35	Broken warp end (damaged carbon fiber)	> 3 cm length	Do not use section
70 / 71	Gaps in material	> 2 mm	Do not use section

Table 8 Requirement Criteria for Class 2 (DRWF) (continued)

Weft direction			
40	Missing weft yarn (missing pick)	Any	Do not use section; user discretion
41	Broken weft end	Any	Do not use section; user discretion
42	Double filling weft yarn	Any	Do not use section; user discretion
44	Missalignment (skewed fabric, weft waviness)	Any	Do not use section; user discretion
72	Weft end not fixed, glued	Any	Do not use section; user discretion
Edge defects:			
20	Damaged edge, rewind quality, frayed edge	Any	Do not use section; user discretion

Note 1: Not all Class 2 have a binder in its construction (see specific material slash sheet). These defect requirements are applicable only when it is present.

4.4.3.1 The reinforcement material shall be free from foreign material, (unintended) cut or broken fibers, wrinkles, loosely adhered veils and indications of moisture or contaminants visible to the unaided eye. Where defects may be present, they shall be marked on the roll and documented.

4.4.3.2 Accumulations of short fiber / dust leading to localized fuzz balls shall be acceptable provided:

a. The fuzz balls cause no apparent textile distortion. This shall be determined without removing the fuzz balls.
b. Any fuzz ball shall not exceed 4 cm^2 in size
Experience suggest that fuzz balls smaller than 4 cm^2 can typically be removed without damaging the reinforcement, while removal of larger accumulation may cause disruption in binder coverage or stitching patterns.

4.4.3.3 Weft spacing in Class 2 materials may be visible in the reinforcement from the stitching of the weft yarn. Large gaps shall not be present. The material shall appear closely stitched and have uniform spacing throughout the roll.

Uneven spacing of the weft yarn is permitted provided that

a. The uneven spacing does not cause apparent fiber distortion during processing.
b. It does not lead to uneven thickness when infusion begins.
c. Defects causing yarn distortion are not permitted in the production direction of the material.

4.4.3.4 Where veil is present, it shall be securely adhered to the reinforcement fabric. If the veil has separated from the reinforcement fabric, first inspect if this may be a localized defect or caused by poor handling. If it appears to be a manufacturing anomaly, see section 4.4.5.

4.4.3.5 The powder binder shall appear uniformly distributed on the surface of the textile. Uneven binder coverage may be present but shall not exceed limits described in Table 4 and Table 7. If the binder coverage appears inconsistent or uneven, see Section 4.4.5.

4.4.4 Roll Characteristics:

The total weight or length of material may be specified by the purchaser. Larger quantities are available upon request. Unless otherwise specified by the purchaser, individual roll net weight shall not exceed 60 kg (130 lbs) for typical size of Class 1 non-crimp material and 32 kg (39.6 lbs) for a typical size of Class 2 UD woven material. Width of Class 1 shall not exceed 2540 mm (100 in.). Typical width and length of the rolls are as follows:

a. Typical Width for Class 1 and Class 2 are 1.270 m (50 in.)
b. Typical Length for Class 1 and Class 2 are 100m (328 ft)

4.4.5 Material not conforming to the visible defect limitations and dimensional requirements:

4.4.5.1 In cases where foreign material is present but can be removed without causing any apparent deformation to the reinforcement material or the distribution of the veil and binder, they may be removed by spatula, forceps, suitable tool, or adhesive tape. The instrument or adhesive tape shall not transfer any contaminants to the product. In cases where foreign material is present but cannot be removed, they shall be marked and logged in the defect report.

4.4.5.2 Areas not conforming to 4.4.2 and 4.4.3 shall be identified along the edge of the reinforcement material role using either markers or suitable tags. Markers shall be non-contaminating and tags shall not leave any residual contaminants. Single point defects may be marked, or cut and discarded if possible.

4.4.5.3 The type, location, and length (for continuous defect) of each marked defect, and the location of the splices shall be indicated on a defect log accompanying each roll of product. Defect locations shall be identified by markers on the reinforcement fabric roll edge.

4.5 Storage and Handling Requirements for Dry Reinforcements:

4.5.1 General Requirements:

4.5.1.1 Material Handling:

All rolled material greater than 12 inches wide shall be supported at all times by the ends of the internal fiberboard tube and kept horizontal. Unless otherwise specified by the purchaser, the fiberboard tube of reinforcement fabric wider than 12 inches shall extend a minimum of 2 inches past the edge of the textile for this purpose. The material shall not be allowed to rest against any surface, and except for rolls of 12 inches or less in width, shall not be allowed to rest in a vertical position. Wider width rolled material may be momentarily rested against a surface or in a vertical position only while being transferred to or from storage. The fiberboard tube of textiles 12 inches or narrower shall extend a minimum of 1 inch past the edge of the textile.

4.5.2 Reinforcement Life Requirements:

4.5.2.1 Storage Conditions: The reinforcement fabric shall be placed in a poly -foil, and then placed within a suitable box to prevent UV light degradation in a clean and dry area. The material shall be kept in a cool and dry environment until ready for use. The spool the material is supplied on should be labeled with appropriate material lot information and date of manufacture.

4.5.2.2 Shelf Life of raw constituent materials: The carbon fiber shall have a shelf life of 3 years from the date of production when stored according to storage conditions recommended by the manufacturer. The binder shall have a shelf life of 2.5 years after its application to the reinforcement fabric when stored according to the storage conditions recommended by the manufacturer.

Shelf life of reinforcement fabric: The supplier shall define the shelf life of the reinforcement fabric (final product) for each lot of material supplied and it shall be labeled with date of manufacture and expiry. Minimum shelf life upon shipment shall be defined with the individual customer. It must be stored in a manner to prevent exposure to UV light sources in an environment 10-38°C (50-100°F) and less than 85% relative humidity. Direct exposure to sunlight or rain shall also be avoided to prevent loss in performance.

4.5.2.3 The material does not require any special environmental conditioning prior use; normal shop floor conditions 10-38°C (50-100°F), and less than 85% relative humidity are acceptable.

4.5.2.4 For purposes of tracking the shelf life, the time shall be measured from the date of manufacture, unless otherwise specified in the purchase order. Material that has been stored for a time period longer than the maximum shelf life shall not be used. There is no shelf life extension for dry textiles.

4.5.3 Distributors:

A material distributor shall perform the same documentation of storage/shelf life and handling life as the purchaser. The Material Safety Data Sheet (MSDS) or Product Information on Safe Handling (PISH) shall be made available to the purchaser.

4.6 Environmental, Health, and Safety:

4.6.1 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).

4.6.2 The delivered constituent materials 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.

4.6.3 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.

4.7 Defects During Usage:

4.7.1 Undocumented defects or non-conformance in excess, as defined by this 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.

4.8 Qualification Requirements:

Materials supplied against this specification have been qualified in accordance with an NCAMP test plan which includes testing of cured laminate panels using various reinforcement materials.

4.9 Material Re-Qualification and Equivalency:

4.9.1 If any change occurs relevant to this specification or the PCD, NCAMP reserves the right to require a re-qualification by the dry reinforcements manufacturer to validate that the changed material is 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.

4.9.2 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.

4.9.3 It is the responsibility of the material supplier to conduct testing to demonstrate that the current material, when processed to the baseline process specification, will generate composite properties statistically equivalent to the properties of the original materials.

4.10 Process Control Document:

4.10.1 The supplier shall prepare and control a Process Control Document (PCD) for the qualified materials. The PCD shall be considered proprietary and shall be protected in accordance with disclosure agreements signed by the supplier and NCAMP. The established Process Control Document (PCD) shall be presented to NCAMP upon request. NCAMP shall treat any information contained in the PCD as proprietary.

4.10.2 Changes to the PCD of a qualified material are subject to the written approval of NCAMP. Such changes may require substantial testing.

4.11 Traceability:

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

4.12 Manufacturer's Responsibility:

4.12.1 The manufacturer is responsible for the development and manufacture of the constituent material submitted in accordance with this specification. Quality control by the manufacturer shall be in accordance with this specification.

4.12.2 Changes to the dry reinforcements supplied against this specification require review and approval by NCAMP in accordance with the NCAMP ACN process. Any testing required to validate the changes or adjustment of manufacturing materials, techniques and/or procedures is the manufacturer's responsibility.

4.13 Quality Management System:

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

5 QUALITY ASSURANCE:

5.1 Responsibility for Inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all lot release test requirements of the reinforcement fabric. Requirements are detailed in the procurement specification slash sheets.

The supplier 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 Lot Release Tests:

Lot release tests 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).

5.2.3 Additional Testing:

The purchaser reserves the right to perform additional testing to confirm the supplier's certification data, and to approve incoming material for use in the fabrication of production parts. Each lot of reinforcement fabric may be examined by the purchaser for appearance, imperfections which would be detrimental for use in the fabrication of parts, and for quality of workmanship.

5.2.4 Laminate Inspection Tests:

The laminate inspection tests shall be those tests performed by the purchaser or approved test lab on representative samples taken from each production lot of each type of material delivered by the supplier. Fabric is accepted if it meets the physical and chemical property requirements specified in Section 4.3.

Prior to use/application of the material, the purchaser shall be responsible for the specification limits specified in the laminate material slash sheet. This shall be conducted on the cured laminates produced when the reinforcement fabric are processed with the specified resin (detailed in a separate specification) in accordance with the NCAMP Process Specification.

5.3 Supplier Statistical Process Control (SPC):

The supplier shall establish and maintain procedures and requirements for an SPC system based on Key Characteristics (KC) and Controlled Process Parameters (CPP). The KC are the material properties required for lot release per 4.4.1. The KC monitoring, typically using control charts, must be provided to material users, certification agencies, and NCAMP staff upon request. The CPP monitoring must also be provided to material users, certification agencies, and NCAMP staff upon request, but proprietary information may be coded or normalized. Alternatively, supplier may send the KC data to NCAMP for inclusion in the NCAMP's control charts which are available to the public.

5.4 Product Certification:

5.4.1 Lot Release Tests:

The following lot release tests shall be performed on each lot of the reinforcement fabric as specified in this section and the detail specification.

5.4.1.1 Reinforcement fabric Physical Properties: Test in accordance with the requirements of Table 1 and the detail specification. Tests shall be performed by the supplier.

5.4.2 Certification of Conformance

The supplier shall furnish with each material shipment supplied against this specification one copy of a Certification of Conformance including certified test reports, confirming that all the material in the shipment complies with the requirements of this specification. The Certificate of Conformance is generated according to DIN EN 10204 and shall include the following information:

a. Manufacturer's identification.
b. Manufacturer's material designation.
c. Specification number, title, revision.
d. Purchase order number.
e. Date, material classification (section 3.1), roll numbers and results of lot release tests, including actual individual test data and average values.
f. Results of any retests.
g. Lot numbers of reinforcement fabric.
h. Date of reinforcement fabric manufacture.
i. Yarn lot certification test data and certificate of conformance.

j. List of roll numbers for each lot and the quantity (length or area) of each roll. (may be a separate document accompanying the shipment)
k. Textile defect logs (available upon request only).

5.4.3 Records:

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

5.4.3.1 The supplier shall keep on permanent file all records pertaining to the qualification of the candidate material.

5.4.3.2 The supplier shall keep the following records on file, for each material lot, for a minimum period of 7 years:

a. Full reinforcement fabric raw material constituent traceability. This traceability shall extend to the particular fiber, binder, veil and polymer yarn component lots employed, where applicable.
b. All records pertaining to raw material receiving inspection and certification, in–process records, and product testing specified in the supplier PCD.
c. All records pertaining to the SPC requirements which are specified in the supplier PCD.

5.5 Receiving Inspection:

Before the materials are accepted, the purchaser shall perform the following:

5.5.1 Verification: Material shall be inspected to assure that:

a. The material identification is correct.
b. The quantity is correct.
c. The required test data is received.
d. The Certificate of Conformance is received.

5.5.2 Reinforcement Fabric Material Testing:

The purchaser may choose to repeat the supplier lot release tests on the materials as part of the receiving inspection tests of each material lot. As use and confidence increase, the receiving inspection testing may be modified based on proven performance in cooperation with the material supplier, customer, and appropriate certification agency.

5.5.3 Cured Laminate Material Testing:

Upon verification and receipt of the reinforcement fabric, the purchaser shall process the materials in accordance with the applicable NCAMP process specification to fabricate the panels defined in NMS 241.

This shall be the sole responsibility of the purchaser and resulting data shall be reviewed internally or with the appropriate certification agency. Conformance of processed laminate panel shall be in accordance with the appropriate NCAMP Material Acceptance Specification.

5.5.4 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 sample preparation, 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 Material Shipping/Delivery:

6.1 Packaging:

6.1.1 The material shall be rolled onto a core capable of supporting the material. Standard core used is 152 mm (6 in.) in diameter.

6.1.2 Each roll of material shall be wrapped and closed to protect the roll against damage, dust, and contaminants.

6.1.3 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 roll shall be secured to prevent damage/unnecessary movement during shipment. Each roll shall be packaged such that it is protected from UV light and moisture (<85% RH).

6.1.4 Either the core of the reinforcement fabric or a suitable label accompanying the material that is supplied 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 manufacture
c. Quantity of material/product
d. Purchase order number and/or sales order number (not required on roll core)
e. Supplier’s name
f. Supplier’s lot number
g. Roll number
h. Material expiry
i. All material labeling shall comply with OSHA Hazard Communication, 29 CFR 1910.1200 and European Unions Registration, Evaluation, Authorization, and Restriction of Chemical Substances (REACH).

6.1.5 If core of the rolls are reused, all information not applicable to the current shipment shall

be removed.

6.2 Shipping Requirements:

6.2.1 All materials shall be properly secured to prevent damage during shipment. Temperature and humidity limits of the recommended storage parameters shall be maintained.

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

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

6.3 Receipt at Purchaser:

6.3.1 Store material at recommended storage temperature and humidity. The product shall be stored in a manner to prevent exposure to UV light sources in an environment 10 to 38°C (50 to 100°F) and less than a 85% relative humidity. Direct exposure to sunlight or moisture shall also be avoided to prevent loss in performance.

6.3.2 If requested by the supplier and documented on the purchase order, retain the shipping container, spools, and temperature recording instruments (if used) for return to the supplier.

7 ACKNOWLEDGEMENT:

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

8 REJECTION:

Product not conforming to this specification and the applicable detail specification, 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-06/25 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.