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NCAMP Material Specification

350°F Autoclave Cure, Toughened Epoxy Prepregs

Toray TC380

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

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REVISIONS:

Rev	By	Date	Description
-	Vinsensius Tanoto	3/4/2024	Initial Release
A	Vinsensius Tanoto	10/2/2025	Section 1.2: Applications temperature was revised from “225°F” to “275°F”. Section 3.3.1 Table 1: “extracted from prepreg” was added to FTIR. Section 3.4.2.1.1: “definition is in Section 8.1.1” was added for unwetted fibers. Section 3.4.2.3.1: “definition is in Section 8.1.1” was added for unwetted fibers. Section 3.6.1.1: “Paper or release film shall be used on the outside for Tape “ was revised to “Paper or release film shall be used on the inside, outside or both sides for Tape”. Section 3.6.1.2: “Test kits and precursor rolls for slitting that are 12 inches or narrower may have net width fiberboard tube supported by risers that suspend the roll vertically in the package.” Was added. Section 3.6.2.1.1: “maximum storage temperature of 0 °F. Temperature excursions up to 10°F, such as during shipping and freezer defrost cycles, for a cumulative maximum 7 days is permitted.” was revised to “maximum storage temperature of 10 °F.” Section 5.2.1: “The prepreg shall be maintained at or below 0°F during shipment by being packed in dry ice or by refrigeration. Temperature excursions up to 10°F for a cumulative maximum of 7 days are permitted per section 3.6.2.1.1.” was revised to “The prepreg shall be maintained at or below 10 °F during shipment by being packed in dry ice or by refrigeration.” Section 5.3.1: “Store material at or below 0°F.” was revised to “Store material at or below 10°F.” Section 8.1.1: Added unwetted fibers definition.

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1 SCOPE

1.1 Form

This specification and its associated detail specifications establish the requirements for continuous fiber unidirectional and fabric impregnated with a modified B-staged epoxy resin (“unidirectional tape and fabric prepreg”).

1.2 Application

These composite prepreg material systems are intended for use in the fabrication of aerospace structures and tooling substrate. The materials are designed specifically for vacuum-bag autoclave cure in accordance with NPS 83800 baseline cure cycle “C”. They are typically used in structural applications requiring high strength and stiffness in environments up to 275°F.

Material property data including statistically based material allowables are available publicly for the materials covered by this specification. Part fabricators that wish to utilize the material property data, allowables, and specifications may be able to do so by demonstrating the capability to reproduce the original material properties; a process known as equivalency. More information about this equivalency 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, participating in material change management activities, conducting statistical process control, and conducting regular supplier audits.

1.3 Classification

Each detail specification has a unique classification. Example specification callout is provided in the qualified products list of every detail specification. Prepregs shall be classified to the following Types, Classes, Grades and Styles.

1.3.1 Type shall specify nominal prepreg resin content. For example:

- Type 35 – Nominal resin content 35 percent by weight
- Type 37 – Nominal resin content 37 percent by weight
- Type 40 – Nominal resin content 40 percent by weight

1.3.2 Class shall specify prepreg product form. For example:

- Class 1 – Unidirectional carbon fiber prepreg tape
- Class 2 – Woven carbon fiber prepreg fabric

1.3.3 Form must specify prepreg specific product form. For example,

- Form 1 – Unidirectional carbon fiber prepreg tape (Hand Layup Applications)
- Form 2 – Unidirectional carbon fiber prepreg tape (Automated Tape Laying Equipment)
- Form 3 – Unidirectional carbon fiber prepreg tape (Automated Fiber Placement)
- Form 4 – Woven carbon fiber fabric prepreg (Hand Layup Applications)
- Form 5 – Woven carbon fiber fabric prepreg (Automated Tape Laying Equipment)

1.3.4 Grade shall specify nominal fiber areal weight in grams per square meter (gsm). For example:

- Grade 120 – 120 gsm nominal fiber areal weight
- Grade 145 – 145 gsm nominal fiber areal weight
- Grade 193 – 193 gsm nominal fiber areal weight
- Grade 200 – 200 gsm nominal fiber areal weight
- Grade 370 – 370 gsm nominal fiber areal weight

1.3.5 Style shall specify the woven fabric style (not applicable to Class 1). For example:

- Style 3K-PW – 3K yarn, plain weave
- Style 3K-8HS – 3K yarn, 8 harness satin weave
- Style 6K-2x2 – 6K yarn, 2x2 Twill

1.4 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.

1.5 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.

1.6 Qualified Products

This specification requires qualified products. Qualified products 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), weaver(s),

and the specific resin components and source(s) shall be qualified as a prepreg 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) as specified in 3.11.

1.7 Detail Specification

This base specification contains basic fiber reinforced epoxy prepreg material requirements that apply to every product. The detail specifications contain additional or superseding properties and requirements that apply to a specific product.

1.8 Change Control Approval

Prepreg product 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. In general, level 1 through level 3 changes per DOT/FAA/AR-06/10 and DOT/FAA/AR-07/3 are considered major changes. 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 prepreg material properties.

In general, FAA/DOT/AR-06/10 and DOT/FAA/AR-07/3 will be used as guidelines.

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	Carbon Fiber Tow
NRP 101	Prepreg Process Control Document (PCD) Preparation and Maintenance Guide
NPS 83800	Fabrication of NMS 380 Qualification, Equivalency, and Acceptance Test Panels

2.2 ASTM Publications

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

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 Methods 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 D3529	Standard Test Method for Matrix Solids Content and Matrix Content of Composite Prepreg
ASTM D3530	Standard Test Method for Volatiles Content of Composite Material Prepreg
ASTM D3531	Standard Test Method for Resin Flow of Carbon Fiber-Epoxy Prepreg
ASTM D3532	Standard Test Method for Gel Time of Carbon Fiber-Epoxy Prepreg
ASTM D3878	Standard Terminology Composite Materials
ASTM D7028	Standard Test Method for Glass Transition Temperature (DMA T _g) 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

2.3 SACMA Publications

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

SACMA SRM 1R-94	Compressive Properties of Oriented Fiber-Resin Composites
SACMA SRM 20R-94	High Performance Liquid Chromatography of Thermoset Resins

2.4 ISO Publications

AS9100 Quality Management System Standard

2.5 US Government Publications

29 CFR 1910.1200	Hazard Communication, Occupational Safety and Health Standards
CMH-17	Composite Materials Handbook (formerly MIL-HDBK-17)
DOT/FAA/AR-03/19	Material Qualification and Equivalency for Polymer Matrix
DOT/FAA/AR-06/10	Guidelines and Recommended Criteria for the Development of a Material Specification for Carbon Fiber/Epoxy Fabric Prepregs
DOT/FAA/AR-07/3	Guidelines and Recommended Criteria for the Development of a Material Specification for Carbon Fiber/Epoxy Unidirectional Prepregs Update
MIL-D-3464	Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification
MIL-PRF-131	Barrier Materials, Water vaporproof, Greaseproof, Flexible, Heat-Sealable

3 TECHNICAL REQUIREMENTS

3.1 Detail Specification

The requirements for a specific fiber reinforced unidirectional tape and fabric epoxy prepreg 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.

3.2 Constituent Material Requirements

Material supplied in accordance with this specification shall consist of epoxy resin and fiber. The definitions of fiber lot, resin batch, and prepreg batch are in accordance with DOT/FAA/AR-06/10 and DOT/FAA/AR-07/3.

3.2.1 Epoxy Resin System

The resin system shall be an epoxy-based resin that can meet the requirements of this specification; no separate specification exists for the resin system. Any changes to the epoxy resin system since qualification shall be re-approved by NCAMP. No more than one resin batch shall be included in any single prepreg batch unless allowed by the detail specification or accepted by the purchaser in the purchase order.

3.2.2 Reinforcement

The reinforcement requirements shall be specified in the applicable detail specifications.

3.3 Prepreg Physical and Chemical Property Requirements

3.3.1 Uncured prepreg physical and chemical properties

The uncured prepreg material shall meet the physical and chemical property requirements of Table 1 and as specified below. The material shall be capable of being cut without disarray of the filaments and without other visible damage.

Table 1 - Wide Prepreg Physical and Chemical Properties

Property	Product Form	Test Method ⁽¹⁾	Number of Replicates
Resin Content	Prepreg	ASTM D3529	Every roll ⁽²⁾
Fiber Areal Weight	Prepreg	ASTM D3529	Every roll ⁽²⁾
Volatile Content	Prepreg	ASTM D3530	First and last rolls of every batch ⁽²⁾
Flow	Prepreg	ASTM D3531	First and last rolls of every batch ⁽²⁾
Gel Time ⁽⁴⁾	Prepreg	ASTM D3532	First and last rolls of every batch ⁽²⁾
Tack	Prepreg	4.6.1	First and last rolls of every batch
Drape	Prepreg	4.6.2	First and last rolls of every batch
HPLC ⁽³⁾	Prepreg	SACMA SRM 20R-94	First and last rolls of a batch
FTIR ⁽³⁾⁽⁴⁾	Resin (extracted from prepreg)	ASTM E168 ASTM E1252	First and last rolls of a batch
Differential Scanning Calorimetry (DSC)	Resin ⁽³⁾⁽⁴⁾	ASTM D3418	Min. one per resin batch
exotherm peak temperature and total heat of reaction	Prepreg ⁽⁴⁾	ASTM D3418	First and last rolls of a batch

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

(2) Three specimens should be taken across the width of the prepreg; left, center, right.

(3) Not required for receiving inspection test.

(4) Optional for batch release test.

3.4 Visual and Dimensional Requirements

3.4.1 General

The prepreg shall be uniform in quality and shall not contain defects detrimental to handling, layup, cure, or structural properties.

3.4.2 Visual Requirements

3.4.2.1 Class 1 – Form 1 Material

3.4.2.1.1 The prepreg material shall be free from foreign material, cut or broken fibers, cured resin, unwetted fibers (definition is in Section 8.1.1), wrinkles, resin-rich areas, dry or boardy areas, and indications of moisture visible to the unaided eye.

3.4.2.1.2 Fuzz balls shall be acceptable provided:

- a. The fuzz balls cause no apparent fiber distortion. This shall be determined without removing the fuzz balls.
- b. Any fuzz ball shall not exceed 1.5 inches in any direction.
- c. The accumulated number of fuzz balls shall not exceed 6 in any 10 square feet of one side of prepreg material.
- d. The overall thickness change due to fuzz ball is no more than 50 percent of the prepreg material nominal thickness.

3.4.2.1.3 The edge of the prepreg tape shall not deviate from a straight line by more than 0.03 inch per foot of length and shall be flush with the separator paper.

3.4.2.1.4 All fiber tows shall be collimated and parallel, localized tow misalignment (resulting from crossovers, loose tows, etc.) is acceptable provided they are less than 3 inches in length and deviate by less than 20 degrees from the major tow axis.

3.4.2.1.5 The length of fiber gap, parallel to the 0° direction, shall not exceed 10 inches. The width of fiber gap, perpendicular to the 0° direction, shall not exceed 0.030 inch. Gaps in prepreg shall not exceed 0.030 inch in width or 10 inches cumulative in 10 square feet of prepreg.

3.4.2.1.6 The prepreg shall be free from crimped fibers and fiber tow crossovers visible to the unaided eye.

3.4.2.1.7 The following specifies the acceptance/reject criteria for puckers and/or pimples in the prepreg, as measured on the production machine.

Table 2 - Acceptance/Rejection Criteria for Puckers and/or Pimples

Largest Dimension	Frequency	Criteria
Greater than 0.50"	Any	Rejectable
0.25" - 0.50 "	3 or less per sq ft.	Acceptable
Less than 0.25"	All	Acceptable

3.4.2.2 Class 1 – Form 2 and Form 3 Material

Prepreg material shall be free of defects per Section 3.4.2.1 before slitting.

3.4.2.3 Class 2 – Form 4 Material

3.4.2.3.1 The prepreg material shall be free from foreign material, cut or broken fibers, folded selvages that overlap nonselvage areas, cured resin, unwetted fibers (definition is in Section 8.1.1), wrinkles, resin-rich areas, dry or boardy areas, and indications of moisture visible to the unaided eye.

3.4.2.3.2 The warp yarns shall be parallel to the warp direction within 1.0 inch over any 21.0 inches.

3.4.2.3.3 The fill yarns shall be perpendicular to the warp direction within 1.0 inch over any 21.0 inches.

3.4.2.4 Class 2 – Form 5 Material

Prepreg material shall be free of defects per Section 3.4.2.3 before slitting.

3.4.3 Roll Characteristics

The total weight or length of material shall be specified by the purchaser. Unless otherwise specified by the purchaser, individual roll net weight shall not exceed 70 lbs and 115 lbs for Class 1-Form 1 and Class 2-Form 4 materials, respectively.

Width shall be as specified by the purchaser. Unless otherwise specified by the purchaser, tolerances on the width of the prepreg shall be:

(a) Unidirectional tape (Class 1-Form 1) widths > 12.0 inches:	±0.060 inch
(b) Unidirectional tape (Class 1-Form 1) widths = 12.0 inches:	±0.030 inch
(c) Unidirectional tape (Class 1-Form 1) widths < 12.0 inches:	±0.020 inch
(d) Unidirectional tape (Class 1-Form 2 and Form 3):	±0.005 inch
(e) Woven fabric (Class 2-Form 4) (excluding the selvages):	±1.000 inch
(f) Woven fabric (Class 2-Form 5):	±0.020 inch

3.4.4 Material not conforming to the visible defect limitations and dimensional requirements.

3.4.4.1 In cases where foreign material or resin rich areas can be removed without causing any apparent deformation of the prepreg surface, they may be removed by spatula or adhesive tape. The spatula or adhesive tape shall not transfer any contaminants to the prepreg product.

3.4.4.2 Class 1 – Form 1 and Class 2 – Form 4 Materials

3.4.4.2.1 Areas not conforming to Section 3.4.1 and 3.4.2 shall be identified along the edge of the prepreg roll by markers. Markers shall be distinguishable from the prepreg and carrier release paper and removable without damaging the prepreg material.

3.4.4.2.2 For single-point defects, use a single marker.

3.4.4.2.3 Successive single-point defects 3 feet or less apart shall be considered as one

continuous defect. For continuous defective areas, markers shall be placed at the beginning, at each 2-foot maximum interval, and at the end of the continuous defect.

3.4.4.2.4 Prepreg material may be cut and spliced to remove defects. Splices shall be overlapped from 1.0 to 3.0 inches and marked as a single-point defect. The splicing technique must be easily identified by the end-user. Splices shall not be within 50 feet of the beginning or end of a roll. One (1.0) linear foot of additional material shall be supplied for each splice.

3.4.4.2.5 Prepreg material roll shall have a maximum defect content of 15 percent by weight or length. The defect weight limit shall be based on full-width weight.

3.4.4.2.6 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 prepreg material. Defect and splice locations shall be identified by markers on the prepreg roll edge.

3.4.4.2.7 Defective areas, considered as the length of the defect multiplied by the width of the roll, shall not be counted toward the amount of material purchased.

3.4.4.3 Class 1 - Form 2 and Form 3, and Class 2 - Form 5 Materials

3.4.4.3.1 Prepreg material shall be free of defects per Section 3.4.1 and 3.4.2 before slitting.

3.4.4.3.2 Prepreg material splicing must be in accordance with splicing procedure documented in the Toray TAC PCD 082.

3.5 Laminate (Cured Prepreg) Requirements

3.5.1 Test Laminate Fabrication and Baseline Cure Process:

The test laminate fabrication and baseline cure process shall be in accordance with the associated NCAMP Process Specification NPS 83800 Fabrication of NMS 380 Qualification, Equivalency, and Acceptance Test Panels as listed in the PCD and/or NCAMP test plan.

Minor changes in the process may be acceptable if it has been previously demonstrated to be equivalent and capable of producing test panels that meet the requirements of this specification. To facilitate individual specimen traceability, individual specimen numbering and/or skewed lines must be written or drawn across each sub-panel as shown in Figure 1.

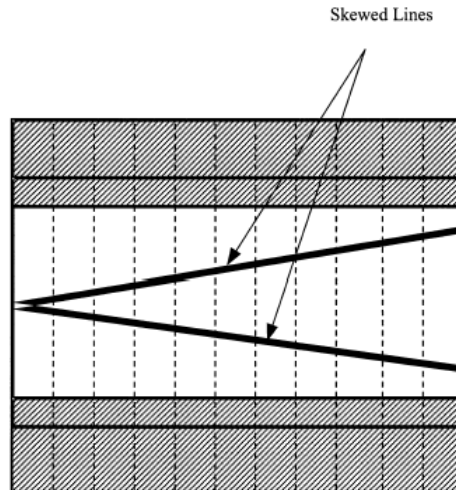


Figure 1 - Specimen Traceability Line

3.5.2 Cured Laminate Physical Properties:

The cured laminate physical properties listed in Table 3 shall conform to the values and limits listed on the corresponding detail specification.

Table 3 - Cured Laminate Physical Properties

Property	Test Method	Number of Replicates
Cured Ply Thickness	ASTM D3171 Section 14.3.6	10 measurements per panel
Glass Transition Temperature Dry, Tg by DMA	by flexural loading per ASTM D7028(1)	2 per batch

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

3.5.3 Cured Laminate Mechanical Properties

The cured laminate mechanical properties listed in Table 4 and 5 shall conform to the values and limits listed on the corresponding detail specification.

Table 4 - Required Cured Laminate Tests for Mechanical Properties (Class 1- Form 1, Form 2, and Form 3)

Property	Test Temperature	Test Method (1)	Number of Replicates
0° Tension (Tabbed) Strength and Modulus	RT, Ambient	ASTM D3039	5
90/0° Compression	RT, Ambient	ASTM D6641	5

Strength and Modulus			
0° Short Beam Strength	RT, Ambient	ASTM D2344	5
(1) Specific procedures should be identical to those used in the original material qualification program.			

Table 5 - Required Cured Laminate Tests for Mechanical Properties (Class 2 - Form 4 and Form 5)

Property	Test Temperature	Test Method (1)	Number of Replicates
90° (Fill) Tension Strength and Modulus	RT, Ambient	ASTM D3039	5
90° (Fill) Compression Strength and Modulus	RT, Ambient	ASTM D6641	5
0° (Warp) Short Beam Strength	RT, Ambient	ASTM D2344	5
(1) Specific procedures should be identical to those used in the original material qualification program.			

3.6 Storage and Handling Requirements

3.6.1 General Requirements

- 3.6.1.1 Release Paper/poly Film: A non-transferring separator paper with differential release may be used on the inside of the roll. Paper or release film shall be used on the inside, outside or both sides for Tape materials and on both sides for fabric materials of the roll to permit easy removal of the pre-impregnated material from the roll without loss of resin, tearing, shredding, fiber realignment, or other damage. The material shall be capable of being cut cleanly without other visible damage. The release paper shall not contaminate the prepreg.
- 3.6.1.2 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 prepreg wider than 12 inches shall extend a minimum of 2 inches past the separator film for this purpose. The material shall not be allowed to rest against any surface, and except for rolls of 12.0 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 prepreg 12 inches or narrower shall extend a minimum of 1 inch past the separator film. Test kits and precursor rolls for slitting that are 12 inches or narrower may have net width fiberboard tube supported by risers that suspend the roll vertically in the package.

- 3.6.1.3 Thawing Rolled Materials: Preimpregnated materials shall be allowed to warm at ambient temperature until moisture does not condense on the packaging (i.e. prepreg temperature is above dew point). The material out-time shall be recorded by the distributor and purchaser. The material out-time between manufacture and shipment at supplier location shall be in accordance with 5.2.3.

Note. No form of applied or direct heat shall be used to accelerate the thawing process.

- 3.6.2 Prepreg Life Requirements: Definitions for storage life, handling life, staging life, and out-time are shown in Figure 2.

- 3.6.2.1 Storage Life: The prepreg rolls shall be stored in sealed moisture-proof bags in a clean and dry area. The prepreg rolls shall be supported at all times by the ends of the internal fiberboard tube and kept horizontal and shall not have any objects resting on top of it.

- 3.6.2.1.1 The prepreg has a storage life of 12 months from the date of manufacture when stored in accordance with the conditions above at a maximum storage temperature of 10 °F. The material shall have a minimum of nine months remaining storage life at the time of shipment unless agreed upon by the purchaser.

- 3.6.2.1.2 For purposes of tracking the storage 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 storage life shall not be used until tests have been performed to extend the storage life as defined by 3.6.2.1.3 or the user's process specifications.

- 3.6.2.1.3 Storage Life Extension: Storage life may be extended by the purchaser. Storage life extension requirement is similar to receiving inspection requirement in 4.5. Each extension is for 6 months only. Storage life may be extended a maximum of one time only (refer to storage-life tests from qualification program).

- 3.6.2.2 Handling Life: The handling life of the material at 72+/-5°F and 0-65% relative humidity is 18 days. Handling life begins when the prepreg is removed from the freezer and ends when prepreg is laid onto the tool. Extension of handling life requires Material Review Board (MRB) approval, which should consider the intended application, handling characteristics (tack and drape), and mechanical properties of the material.

- 3.6.2.3 Staging Life: The staging life (or mechanical life) of the material when covered with vacuum bagging materials at 72+/-5°F and 0-65% relative humidity is 10 days. Staging life begins at placement of the ply on the tool and ends when the cure cycle begins. Extension of staging life requires MRB approval, which should consider the intended application and mechanical properties of the material.

3.6.2.4 Out-time: Out-time begins when the prepreg is removed from freezer storage and ends when the cure cycle begins. Total out-time is the summation of handling life and staging life.

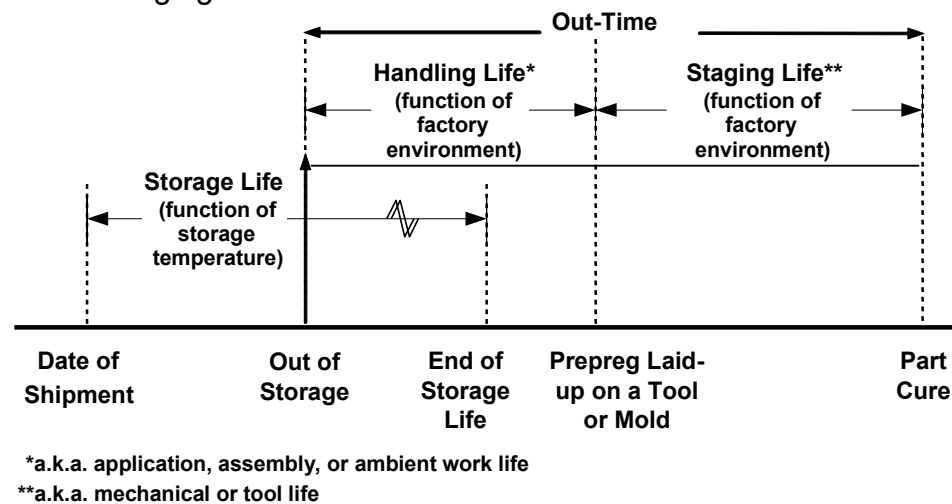


Figure 2 - Definitions of Storage, Handling, and Out-Time

3.6.3 Distributors

A material distributor shall perform the same documentation of storage life and handling life as the material supplier and purchaser. If the original packaging is to be opened to allow for re-spooling into smaller units, the prepreg shall be allowed to warm at ambient temperature in the unopened package until moisture does not condense on the packaging (i.e. prepreg temperature is above dew point). All out-time accumulated during warming, re-spooling, and repackaging shall be subtracted from the total handling life and documented for the purchaser(s). Distributors are not allowed to extend the storage life unless explicitly allowed by the purchaser.

3.7 Environmental, Health and Safety

- 3.7.1 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).
- 3.7.2 The delivered prepreg system shall fulfill the local requirements of the health and safety laws of the country of the purchaser. When processing the prepreg in the composite shop, there shall be no health hazards or emissions that require special measures to be taken to protect the environment.
- 3.7.3 The manufacturer shall inform the purchaser about the safe handling procedures of the material. The Material Safety Data Sheet (MSDS) shall be made available to the purchaser.

3.8 Defects During Usage

- 3.8.1 Defects, as defined by this specification, which are not marked by the supplier

but found in the prepreg material after acceptance shall be cause for rejection and the defective material may be returned to the supplier. Defects caused by user mishandling, improper storage, or expiration of storage or out-life are not the responsibility of the supplier and shall not be cause for rejection back to the supplier.

3.9 Qualification Requirements

Materials shall be qualified in accordance with an NCAMP test plan.

3.10 Material Re-Qualification and Equivalency

3.10.1 If any change occurs relevant to this specification or the PCD, NCAMP reserves the right to require a re-qualification or equivalency demonstration by the prepreg 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-06/10 and DOT/FAA/AR-07/3 provide guidance in this area.

3.10.2 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 prepreg material will require a full qualification program and a separate specification.

3.10.3 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.

3.11 Process Control Document

3.11.1 The supplier shall prepare and control a Process Control Document (PCD) in accordance with NRP 101. 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.

3.11.2 Changes to the PCD of a qualified material (as defined by DOT/FAA/AR-06/10, DOT/FAA/AR-07/3, and NRP 101) are subject to the written approval of NCAMP. Such changes may require substantial testing to demonstrate equivalency.

3.12 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.

3.13 Manufacturer's Responsibility

- 3.13.1 The manufacturer is responsible for the development and manufacture of any material submitted in accordance with this specification. Quality control by the manufacturer shall be in accordance with this specification.
- 3.13.2 Changes to the prepreg require review and approval by NCAMP in accordance with 1.8. Any testing required to validate the changes or adjustment of manufacturing materials, techniques and/or procedures is the manufacturer's responsibility.

3.14 Quality Management System

The manufacturer's quality system shall be approved as defined in AS9100 or equivalent.

4 QUALITY ASSURANCE

4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all batch release inspection and test requirements specified herein and the purchaser is responsible for the performance of all receiving inspection tests specified herein, except FTIR. The purchaser may reduce the frequency of testing if the reduced sampling plan is specifically approved by the original equipment manufacturer or the certifying agency. 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.

4.2 Classification of Tests and Inspections

4.2.1 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.

4.2.2 Batch Release Tests:

Batch release tests shall be those tests performed by the supplier on representative samples taken from each production batch of each type of material submitted by the supplier for acceptance under contract or purchase order. Specification limits are specified in the detail specification. Data and certification of data generated shall accompany each shipment of material.

4.2.2.1 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 roll of material may be examined by the purchaser for appearance, color uniformity, imperfections which would be detrimental for use in the fabrication of parts, and for quality of workmanship.

4.2.3 Receiving Inspection Tests:

The receiving inspection tests shall be those tests performed by the purchaser or approved test lab on representative samples taken from each production batch of each type of material delivered by the supplier.

4.3 Supplier Statistical Process Control

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 batch 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.

4.4 Product Certification

4.4.1 Batch Release Tests: The supplier shall perform batch release tests on each batch of prepreg as specified in this section and the detail specification.

4.4.1.1 Prepreg Physical and Chemical Properties: Test in accordance with the requirements of Table 1 and the detail specification.

4.4.1.2 Laminate Physical Properties: Test in accordance with the requirements of Table 3 and the detail specification.

4.4.1.3 Laminate Mechanical Properties: Each batch of prepreg shall be tested to verify compliance with the mechanical property requirements in Table 4 or 5 of the applicable detail specification, in accordance with Tables 6 and 7 sampling plans. This section is applicable to wide prepreg for hand layup applications (Class 1-Form 1 and Class 2-Form 4) and wide prepreg before it is slit (Class 1-Form 2 and Class 1-Form 3, and Class 2-Form 5).

Table 6 - Supplier Quality Control Sampling Plan for Laminate Mechanical Properties

Number of Pounds (net) in Batch	Test Frequency for Batches Shipped
1 to 250	One roll
251 to 800	first and last roll
801 +	first, last, and one roll for each additional 800 lbs or part thereof (sampled in the order of production)

sequence within approximately ± 100 lbs of each
additional 800 lbs)

- 4.4.2 Certification of Conformance: The supplier shall furnish with each shipment 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 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, type, roll numbers and results of batch release tests, including actual individual test data and average values.
 - f. Results of any retests.
 - g. Prepreg batch numbers.
 - h. Lot numbers of fiber, fabric, and resin used in the manufacturer of the prepreg materials.
 - i. Date of manufacture (date of impregnation).
 - j. Fiber lot certification test data and certificate of conformance
 - k. List of roll numbers for each batch and the quantity (length or weight) of each roll.
 - l. Roll defect logs for Class 1 - Form 1 and Class 2 - Form 4.
 - m. Slitting (continuous) width measurements for Class 1 - Form 2 and Form 3, and Class 2 - Form 5.
- 4.4.3 Records: The following records shall be available for inspection by NCAMP and purchasers.
- 4.4.3.1 The supplier shall keep on permanent file all records pertaining to the qualification of the candidate material.
- 4.4.3.2 The supplier shall keep the following records on file, for each prepreg batch, for a minimum period of 10 years:
- a. Full prepreg batch traceability. This traceability shall extend to the particular resin and resin component batches, and fiber yarn lot(s) 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.

4.5 Receiving Inspection

Before the prepreg material is accepted, the purchaser shall perform the following:

4.5.1 Verification: Material shall be inspected to ensure that:

- a. The material identification is correct.
- b. The quantity is correct.
- c. The required test data is received and meet the requirements of this specification.
- d. The Certificate of Conformance is received.
- e. Each shipment of prepreg meets the requirements for storage temperature between the point when the purchaser assumes ownership and the point when the material is received.
 - I. The purchaser shall document the procedure used to verify temperature exposure.
 - II. If any exposure exceeds the maximum handling and mechanical life conditions, the material shall be rejected.
 - III. For exposures that exceed the storage temperature and are less than the maximum handling exposure conditions the purchaser may reject the material. If the purchaser accepts the material the time exceeding the storage temperature shall be deducted from the handling life and mechanical life for the material in that shipment.

4.5.2 Testing: The purchaser shall repeat the supplier batch release test per 4.4.1 (except HPLC and FTIR) as part of the receiving inspection tests on each batch of prepreg. As use and confidence increase, the receiving inspection testing may be modified based on proven performance in cooperation with the material supplier, customer (if purchaser is supplying composite parts to another aircraft company), and appropriate certification agency.

4.5.2.1 Class 1-Form 2 and Class 1-Form 3, and Class 2-Form 5
Purchaser may perform receiving inspection test using Test Kit.

Test Kit is a small section of parent tape prepreg from the same batch with the slit tape material. A Test Kit is prepared and cut from parent tape prepreg (master roll) prior to slitting the material to slit tape form. Material supplier is to provide a Test Kit for every material batch of material in the shipment to the purchaser.

The Test Kit must be packaged and shipped to the purchaser in the same manner as the parent rolls for the slit tape material. The test kits may be shipped independently from the parent rolls for slitting. The purchaser shall replicate the recorded out-time and environmental conditions during the slitting process of the parent material for the test kit material according to the handling records provided prior to performing receiving inspection. Material supplier must provide enough material in the Test Kit or as requested in the purchase order.

Material supplier's Test Kit may be used for receiving inspection tests against the specification limits listed in the material supplier's Certificate of Conformance, this specification limits are for parent tape prepreg. However, this will be at risk because the material forms of receiving inspection and material's Certificate of Conformance are not identical, therefore NCAMP recommends for the purchaser to also perform mechanical tests using the material form listed in the material's Certificate of Conformance at some point, this can be conducted along with the actual part fabrications.

- 4.5.3 Re-Testing: One retest is allowed for each test property if the initial test result fails the requirement of this specification. Additional re-test(s) is allowed only when one or more of the following conditions exist:
- The initial test was performed in significant deviation to the appropriate procedure. Significant deviations are those expected to affect the measured response.
 - During layup, cure, machining, or testing, there was an occurrence known to cause or contribute to the observed test result(s).
 - 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.

4.6 Test Methods

- 4.6.1 Tack: The purpose of this test method is to determine the level of prepreg tack through its ability to adhere to itself and to a vertical surface. Equipment needed are (1) A corrosion resistant steel plate with a commercial 2D finish and (2) A squeegee or 1-inch diameter by 1-inch wide roller.

Procedure:

- This tack test shall be performed at $70^{\circ}\text{F} \pm 10^{\circ}\text{F}$ and 0-60% RH. Cut two 3-inch by 1-inch specimens from the prepreg. The 3-inch dimension shall be in the 0° or warp direction.
- Attach one piece of the prepreg specimen to the plate with light pressure using a squeegee or roller.
- Remove the backing and apply the next strip to the first one. Tack in a similar manner. Remove the backing from the second strip.
- Position the plate vertically.
- Determine the tack level as follows:

Tack level I – Low tack, prepreg is stiff and boardy.

Tack level II – Dry but slight drape.

Tack level III - Slight tack sticks to itself but not to a vertical surface.

Unable to adhere to the vertical tool surface for 30 minutes.

Tack level IV - Good tack, prepreg sticks to itself and vertical tool.
Adhered to the vertical tool surface for more than 30 minutes.

Tack level V – Sticks to hands or gloves but no resin transfer.

Tack level VI – High tack, wet, and sloppy with resin transfer.

- 4.6.2 Drape: The drape of the prepreg shall be determined at $70^{\circ}\text{F} \pm 10^{\circ}\text{F}$ and 0-60% RH as follows:
- Cut sufficient material to obtain three specimens that are a minimum of 2-inches long by a minimum of 3-inches wide, and remove any release paper or film.
 - Complete wrapping each specimen separately over a 0.25 inch diameter mandrel within 15 seconds of initiation, with fiber direction transverse to mandrel centerline.
 - Remove each specimen from the mandrel and inspect for evidence of cracks, wrinkles, folds, or tears on the surface of the material. Evidence of these defects in cut edges extending less than 0.13 inch inward maximum from the edge shall not be considered rejectable.

If no evidence of filament breakage can be visually observed, the specimen has met the requirements for drape. Report as pass or fail.

5 PREPARATION FOR DELIVERY

5.1 Packaging

- 5.1.1 The prepreg material shall be rolled onto a core suitable for use by the purchaser. Suppliers uncertain as to core suitability shall direct their inquiries through the purchaser prior to fabrication of material.
- 5.1.2 Each spool/roll of material shall be wrapped and sealed with a non-adherent, non-contaminating moisture-proof bag to prevent penetration of moisture. The bag material shall conform to MIL-PRF-131, Class 1 or 3 or equivalent.
- 5.1.3 Place a minimum of four units of MIL-D-3464, Type II desiccant in each bag prior to sealing.
- 5.1.4 The individual spool or roll shall be packed in a shipping container that will be acceptable for safe transportation by common carriers and shall include a packing list. The core shall be supported on ends to avoid damage to the prepreg. The container shall be of such design as to prevent damage or degradation to the prepreg during shipment.
- 5.1.5 The outside of each container and the inside of the roll core shall be clearly marked with the following information:
 - Title, number, and revision letter of this specification
 - Date of manufacture
 - Linear length

- d. Purchase order number and/or sales order number (not required on roll core)
 - e. Supplier's name
 - f. Supplier's prepreg batch and spool/roll number
 - g. The number of hours that the material has been exposed to temperatures above the storage temperature (may be documented in packing list - out-time log, or material certification instead).
 - h. A statement (not required on roll core) to indicate that:
 - I. The material shall be stored at a temperature not to exceed 10 °F, and
 - II. The container should not stand on end (for prepreg wider than 12 inches only)
 - i. All material labeling shall comply with OSHA Hazard Communication, 29 CFR 1910.1200.
- 5.1.6 If spools/rolls are reused, all information not applicable to the current shipment shall be removed.
- 5.1.7 Storage immediately after manufacture: The prepreg, sealed in a MIL-PRF-131, Class 1 or 3 film or equivalent, shall be stored at the storage temperature within 6 hours of manufacture.

5.2 Shipping Requirements

- 5.2.1 The prepreg shall be maintained at or below 10 °F during shipment by being packed in dry ice or by refrigeration.
- 5.2.2 Prepreg date of shipment to purchaser shall be within 90 days of the date of prepregging, unless explicitly approved by the purchaser for the batch to be shipped.
- 5.2.3 The out-of-storage time between point of manufacture and shipment from the supplier shall be a maximum of 48 hours, unless explicitly approved by the purchaser for the batch to be shipped.
- 5.2.4 Temperature Recorders: Temperature recorders shall be used as required herein to verify that the material was maintained at or below 10 °F during the entire time of shipping. If the material has been exposed to temperature between 10 °F and 77 °F, the material handling life and staging life must be subtracted accordingly. For shipping containers not large enough to hold the prepreg material and a temperature recorder, a separate container shall be used exclusively to contain the temperature recorder in a manner like the prepreg it represents.
- 5.2.5 For dry ice shipments, at least one temperature recorder shall be positioned within each shipping container. The shipping container shall be of such a construction to allow enough room for the prepreg, temperature recorder and dry ice. There shall be enough dry ice or additional dry ice shall be added during shipment to maintain the prepreg at the required shipping temperature. The shipping container shall also be insulated and have a partition of suitable material

to separate the temperature recorder and packaged prepreg from direct contact with the dry ice.

- 5.2.6 For refrigerated shipments, temperature recorders shall be positioned within the shipping containers as follows: The “shipping container” shall be defined as a box designated to hold one spool or one roll of prepreg material. Each refrigerated truck shipment requires two recorders, one per each of two randomly selected shipping containers. If the prepreg shipment has only one shipping container per truck, then both temperature recorders shall be placed in that shipping container. Identify each container having a temperature recorder for purposes of expediting receiving inspection.

5.3 Receipt at Purchaser

- 5.3.1 Store material at or below 10°F.
- 5.3.2 If requested by the supplier and documented on the purchase order, retain the shipping container, spools, and temperature recording instruments for return to the supplier.
- 5.3.3 For personnel safety when receiving shipments with dry ice, carbon dioxide concentration shall be below permissible level (typically 30,000 ppm for short-term exposure) before entering the truck bed. Consult Occupational Safety & Health Administration (OSHA) for more safety information.

6 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.

7 REJECTION

Prepreg rolls not conforming to this specification and the applicable detail specification, or to modifications authorized by purchaser, will be subject to rejection.

8 NOTES

8.1 Definitions

- 8.1.1 Unwetted fibers: Areas of the prepreg that contain no resin on the surface of the fiber/fabric and no resin impregnated into the fiber tows.

8.2 Additional Definitions

For definitions that are not provided in this specification or other applicable NCAMP specifications, the definitions in DOT/FAA/AR-06/10 and DOT/FAA/AR-07/3 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