

Document No.: NMS 818

NCAMP Material Specification

Carbon Fiber Tow

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1. SCOPE

1.1 Form

This base specification, together with its supplemental detail specifications, establishes the requirements for continuous multi-filament carbon fiber tow manufactured from polyacrylonitrile (PAN) precursor.

1.2 Application

This carbon fiber tow product is used typically in the manufacture of composite materials for aerospace structural applications, but its usage is not limited to such applications.

1.3 Classification: This specification consists of the following Styles and Grades

1.3.1 Style shall specify the carbon fiber tow twist. For example,

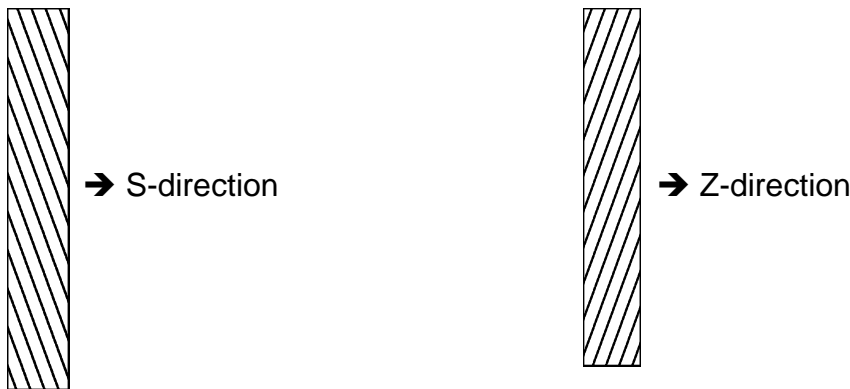
Style NT – Never Twisted Tow

Style UT – Untwisted Tow

Style TT or ST – Twisted Tow

NT is the default style. When style is not specified in purchase order, Style NT shall be supplied.

For Style TT only, specify the turns per meter and turn direction. S-direction and Z-directions are defined as:



Example: 10Z: 10 turns per meter in the Z-direction

1.3.2 Grade shall specify the carbon fiber tow size (i.e. the nominal number of filaments in a tow or nominal filament count), where 1K denotes 1,000 filaments. For example,

Grade 3K – 3,000 filaments in a tow

Grade 6K – 6,000 filaments in a tow

Grade 12K – 12,000 filaments in a tow

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 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 Significant Value

For purposes of determining conformance with this specification (specified limits or requirements contained within 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 E 29.

1.6 Detail Specification

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

1.7 Qualified Products

This specification requires qualified products. The carbon fiber tow product shall be qualified concurrently with a specific resin in a composite material form in accordance with 3.4. The carbon fiber tow product shall be produced in accordance with an NCAMP approved Process Control Document (PCD). The PCD shall be prepared in accordance with NCAMP’s NRP 102 Polyacrylonitrile-Based Carbon Fiber Process Control Document (PCD) Preparation and Maintenance Guide.

2. APPLICABLE DOCUMENTS

The following publications form a part of this specification to the extent specified herein. The latest issue of the NCAMP and SAE 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 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ASTM D 1423	Standard Test Method for Twist in Yarns by Direct-Counting
ASTM D 4018	Standard Test Methods for Properties of Continuous Filament Carbon and Graphite Fiber Tows
ASTM D 6156	Standard Practice for Use of Reversed-Phase High Performance Liquid Chromatographic Systems

ASTM E 29 Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 Occupational Safety and Health Administration (OSHA) Publications

Available from U.S. Department of Labor, Bureau of Labor Standards,

<http://www.osha.gov/>

29CFR-1910.1200 Hazard Communication

2.3 SACMA Publications:

Available from Composites Fabricators Association (CFA), 1010 North Glebe Road, Suite 450, Arlington, VA 22201 (<http://www.acmanet.org>).

SRM 12R-94 SACMA Recommended Method for Lot Acceptance of Carbon Fibers

SRM 14R-94 SACMA Recommended Method for Determination of Sizing Content on Carbon Fibers

2.4 American Society for Quality Publications:

Available from Quality Press, 600 N. Plankinton Avenue, Milwaukee, Wisconsin 53203 (www.asq.org).

ANSI/ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes

ANSI/ASQ Z1.9 Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming

2.5 NCAMP Publications:

NRP 102 Polyacrylonitrile-based Carbon Fiber Process Control Document (PCD) Preparation and Maintenance Guide

3. TECHNICAL REQUIREMENTS

3.1 Detail Specifications

The requirements for a specific 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 Material

3.2.1 Carbon Fiber Tow Composition

Carbon fiber tows shall be composed of carbon filaments manufactured from polyacrylonitrile (PAN) precursor. All raw material ingredients and auxiliary materials used in the manufacture of carbon fibers shall be controlled by material or procurement specifications. The carbon fiber manufacturer shall ensure that the PAN manufacturer produce uniform and consistent PAN fiber precursor within the PCD control limits. These controls shall include constituent ingredients and ratios, PAN lot definition, and

shelf life requirements. PAN lots blending requirements shall be provided in the applicable detail specifications.

3.2.2 Fiber Surface Treatment

Carbon fiber tow may be surface treated to enhance the fiber/matrix interface of the composite material. The surface treatment methods and levels, if used during material qualification program, shall be considered an integral part of the qualified product and can not be changed without prior approval from NCAMP.

3.2.3 Sizing

Sizing may be applied to the fiber during manufacture to improve the handling properties and adhesion to the matrix systems during subsequent processes. When applied, any sizing shall be applied in a continuous process throughout the carbon fiber lot production and shall be considered an integral part of the qualified product. Sizing type, sizing level, and drying methods cannot be changed without prior approval from NCAMP.

3.2.4 Twist

Carbon fiber tow twist shall be considered an integral part of the qualified product and cannot be changed without prior approval from NCAMP. Permissible level of twist for NT, TT, ST, and UT is specified in applicable detail specifications.

3.2.5 Splices

Carbon fiber tow splice requirements shall be given in the detail specification. If no requirement is given in the detail specification, no tow splicing shall be allowed. The tow splicing process and equipment shall be specified in the PCD.

3.2.6 Re-spooling

Carbon fiber tow re-spooling requirements shall be given the PCD. If no reference is made in the PCD, no re-spooling shall be allowed. Re-spooling procedures, equipment, additional tests, and inspection frequency shall be documented in the PCD. When creating a single spool from multiple spools, fibers from the same doff and fiber lot shall be used. Traceability to its parent spools, doffs, and fiber lot shall be maintained. Re-spooled carbon fiber tow shall not exhibit characteristics detrimental to handling, weaving, impregnation, or structural properties. In addition, re-spooling operation shall not change twist characteristics or sizing level.

3.2.7 Down Spooling

Carbon fiber tow down spooling requirements shall be given in the PCD. If no reference is made in the PCD, no down-spooling shall be allowed. Down spooling procedures, equipment, additional tests, and inspection frequency shall be documented in the PCD. Down spooled tow shall not exhibit characteristics detrimental to handling, weaving, impregnation, or structural properties. In addition, down spooling operation shall not change twist characteristics or sizing level.

3.2.8 Workmanship

Carbon fiber tows shall be uniform in quality and condition, and free from cut or broken fibers, foreign material, and defects. A small amount of broken filaments and fuzz is common and acceptable; however, the carbon fiber shall not exhibit characteristics detrimental to weaving, resin impregnation, or structural properties. Winding shall be uniform and provide for proper unreeling and twisting. Transition materials produced in non-steady-state conditions, such as those during start-ups or interruptions, shall be discarded; transition materials shall not be certified to this specification.

3.2.9 Storage Life (Sized Fiber Only)

Storage life and conditions (temperature and humidity) for sized fiber shall be as specified in the detail specification. Any deviations from the shelf life shall be included in the procuring organization purchase contract. Measurement of storage life begins on the date (or month) that the sizing is applied to the carbon fiber tow and ends on the date (or month) the fiber or woven fabric is impregnated with resin. Sized carbon fiber tow product that exceeds the storage life is subject to rejection. Storage life extension, if permitted, is specified in the applicable detail specifications.

3.2.10 Carbon Fiber Lot (definition)

Carbon fibers formed during one essentially continuous, uninterrupted production run under the same steady-state process conditions using one to three PAN precursor lots. An interruption in the process of up to 72 hours is permitted, provided that the production equipment settings are not modified or another material was not produced on the equipment during the interruption. Deviation from this definition, if any, shall be documented in applicable detail specification.

3.3 Properties

The carbon fiber tow product shall be tested as outlined in Table 1. Testing shall be performed on the carbon fiber lot supplied and in accordance with specified test methods. Specific product requirements such as those related to lot averages and individual spools shall be as specified in the applicable detail specification. Additional fiber tow properties such as thermal and electrical properties, if required, will be specified in the applicable detail specifications.

Table 1 – Carbon Fiber Tow Properties

Paragraph	Property	Test Method
3.3.1	Tow Tensile Strength	4.5.1
3.3.2	Tow Tensile Modulus	4.5.1
3.3.3	Percent Elongation	4.5.1

3.3.4	Density	4.5.2
3.3.5	Mass Per Unit Length	4.5.3
3.3.6	Twist (see Note 1)	4.5.4
3.3.7	Sizing Content	4.5.5

Note 1: Twist test is optional for NT tow in lot acceptance test.

3.4 Qualification

3.4.1 General

Manufacturers seeking qualification shall comply with the requirements of this base specification and the applicable detail specification. The carbon fiber tow product shall be qualified concurrently with a specific resin (usually in the form of a prepreg) in accordance with the applicable NCAMP prepreg qualification test plan and the applicable composite material specification. The manufacturer shall establish a PCD for the manufacture of qualification carbon fiber material and maintain the PCD under revision control thereafter in accordance with NRP 102. Manufacturers seeking qualification shall provide NCAMP with the following carbon fiber tow product information:

Manufacturer Name and Address

Carbon Fiber Manufacturing Plant Address and Manufacturing Line(s)

Carbon Fiber Distributor Name and Address (if different from manufacturer)

Product Designation

MSDS (Material Safety Data Sheet (MSDS) meeting OSHA requirements, or recognized equivalent requirements for deliveries in overseas regions such as EU Commission Regulation 2006/121/EC, ISO 11014-1 or JIS Z7250.

A documented quality plan shall be established and maintained by the carbon fiber manufacturer that encompasses the manufacturing process from raw material receiving to final product shipment.

3.4.2 Qualification Audit

A carbon fiber manufacturer seeking qualification to this specification shall submit to an audit of their associated product manufacturing operations, process records, quality and certification systems, raw material traceability, test procedures, and test data. NCAMP reserves the right to audit any or all follow-on production orders subsequent to product qualification. Access to the manufacturer's site and proprietary information may be subjected to a negotiated legal non-disclosure agreement.

3.4.3 Historical Data

Manufacturer shall provide a summary of historical fiber data as specified in Table 1 to demonstrate that the product being considered for qualification is an established product manufactured using a stable process. Such data should include the product properties variations between lots, between doffs of the same lot, and product(s) processes capability performance indices. These data along with the composite material qualification results will also be used to establish the acceptance limits of the fibers.

3.4.4 Baseline Carbon Fiber Tow Data

The manufacturer shall perform baseline carbon fiber tow tests to document the detailed characteristics of the carbon fiber being qualified. Ideally, one or more of the carbon fiber lots being qualified through the composite material qualification program should be used in the baseline carbon fiber tow tests. If such carbon fiber lot is no longer available, a different carbon fiber lot manufactured from the identical manufacturing line and process parameters that meet all the requirements of this specification and applicable detail specification may be used. The manufacturer shall keep a permanent record of the test results along with the specific test procedures used to obtain the test results. The record may be kept confidential by the manufacturer. The manufacturer need not perform these tests on regular basis. The tests need to be performed once only to “fingerprint” the material. Additional data may be added at a later date as funds and test methods become available. The results have been shown to be very useful when troubleshooting potential quality problems that might arise in the future. The results are also very useful when managing changes to the material or process (e.g. when the manufacturer wishes to qualify a new fiber production line or increase the line speed).

Suggested tests include:

- (a) Fiber diameter using a scanning electron microscope, an optical microscope fitted with image splitting eyepiece, a laser diffractometer, or an equivalent technique.
- (b) Fiber cross-sectional area and shape using an optical microscope, a scanning electron microscope, or an equivalent technique.
- (c) Fiber surface morphology using a scanning electron microscope or an equivalent technique on unsized fiber.
- (d) Molecular structure of the carbon fiber, which may include (1) the degree of crystallinity, (2) interlayer spacing, (3) coherent lengths perpendicular and parallel to the carbon layers, (4) orientation of the carbon layers with respect to the fiber axis, (5) the transverse and longitudinal radii of curvature of the carbon layers, (6) the domain structure, and (7) the percent, shape, and orientation of the voids; all using any appropriate techniques.
- (e) Chemical composition of the fiber sizing using high performance liquid chromatography in accordance with ASTM D6156 or an equivalent test method.

- (f) Chemical composition of the fiber sizing using infrared spectrometry in accordance with manufacturer's procedure.

3.4.5 Test Responsibility

Physical and mechanical property tests on carbon fiber tows identified by this specification shall be the responsibility of the carbon fiber manufacturer. The tests on higher level material forms such as prepreg, lamina, and laminate in accordance with an NCAMP test plan are not typically the responsibility of the carbon fiber manufacturer.

3.4.6 Qualification Approval

Qualification approval for a candidate carbon fiber tow product requires successful completion of both base and detail specification requirements, as well as approval of all specific manufacturing processes associated with the manufacture of the candidate fiber, including: raw material, production procedures, fiber line(s), manufacturing site, and testing as documented in the PCD and manufacturer's quality system. NCAMP will include the qualified carbon fiber tow in the Qualified Product List (QPL) of the applicable detail specification. The QPL will identify the following fiber product information:

- Detail specification, including fiber product requirements
- Manufacturer Name and Address
- Manufacturing Plant Address and Manufacturing Line(s)
- Distributor Name and Address (if different from manufacturer)
- Manufacturer product designation

Once a product is qualified, the PCD will be signed by NCAMP and the product shall not be changed without prior written approval of the change from NCAMP, in accordance with 4.4 below.

4. QUALITY ASSURANCE AND CERTIFICATION DOCUMENTATIONS

4.1 Responsibility for Inspection

The manufacturer of the carbon fiber tow product shall supply all samples and shall be responsible for all required tests.

4.2 Acceptance Tests

Tow tensile strength per 3.3.1, tow tensile modulus per 3.3.2, percent elongation per 3.3.3, density per 3.3.4, mass per unit length per 3.3.5, twist per 3.3.6, and sizing content per 3.3.7, or as specified in the applicable detail specification are classified as acceptance tests and shall be performed on each lot and doffs of the lot per sampling plan described in 4.3 below.

The applicable detail specifications contain the specification limits for each property. When setting specification limits (also known as acceptance limits) for tow tensile strength and tow tensile modulus, consideration shall be given to historical fiber tow properties, fiber tow properties used in the prepreg qualification program, and acceptance limits of the lamina tensile properties. When setting specification limits for other properties, consideration shall be given to historical fiber tow properties and fiber tow properties used in the prepreg qualification program.

4.3 Acceptance Sampling Plan

The samples must be taken to be representative of the width of the production line or taken randomly from various creel or winder positions, as specified in the PCD.

The samples must be taken to be representative of the entire time of the production lot run. For scheduled doffing, the number of samples per doff is usually determined by the estimated number of doffs for the production lot. For continuous doffing, samples are usually taken based on fixed time periods.

The sampling plan (e.g. sample size) for acceptance testing per 4.2 shall be on lot-by-lot basis in accordance with one of the following:

- a) SACMA SRM 12R-94, Level 1 – Certified Products (when production time exceeds 30 days, add one sample for every 14 hours of operation),
- b) One which conforms to ANSI/ASQ Z1.4 or ANSI/ASQ Z1.9 at Acceptable Quality Limit (AQL) of 1 percent with product unit as specified in PCD, or
- c) One which conforms to DIN ISO 3951 at Acceptable Quality Limit (AQL) of 1 percent with product unit as specified in PCD.

4.4 Change Control Approval

The carbon fiber tow product manufacturer shall establish control factors which will yield product meeting the technical requirements of this specification; these factors which are used in the production of fiber tow used in the prepreg material qualification shall constitute the approved factors, as documented in the PCD. They shall be used for manufacturing production carbon fiber tow product. Control factors are Controlled Process Equipment and Controlled Process Parameters for producing the product. Control factors include, but are not limited to, the following:

- PAN Precursor formulation (raw ingredients and ratios),
- PAN Precursor manufacturing process, equipment, line, or site,
- PAN Precursor acceptance requirements,
- Carbon fiber tow processing parameters (e.g. temperature and speed),
- Carbon fiber tow manufacturing equipment, line, or site,
- Carbon fiber tow acceptance requirements,
- Carbon fiber tow acceptance test methods,
- Carbon fiber tow acceptance sampling plan,

Carbon fiber tow surface treatment methods and levels,
Carbon fiber tow sizing formulation and sizing level, and
Carbon fiber tow sizing application and drying methods, including equipment.

If it is necessary to make any change in the above control factors, the carbon fiber tow product manufacturer shall submit for re-approval to NCAMP in accordance with NRP 102 Polyacrylonitrile-based Carbon Fiber Process Control Document (PCD) Preparation and Maintenance Guide. The change shall not be incorporated prior to the receipt of re-approval notice, typically in the form of a signed Advanced Change Notice (ACN).

4.5 Test Methods

4.5.1 Tow Tensile Properties

Tow tensile strength, modulus, and percent elongation shall be determined in accordance with ASTM D 4018, ISO 10618, JIS R7608, DIN 65382, or their equivalent methods. Specific specimen preparation and testing procedures such as resin name, impregnation method, tabbing method must be documented under revision control by the manufacturer.

4.5.2 Density

Tow density shall be determined in accordance with ASTM D 4018, ISO 10119, JIS R7603, DIN 65569, or their equivalent methods. Specific specimen preparation and testing procedures such as name of the immersion liquid must be documented under revision control by the manufacturer.

4.5.3 Mass per Unit Length

Tow Mass per Unit Length shall be determined in accordance with ASTM D 4018, ISO 1889, JIS R7605, DIN 53830, or their equivalent methods. Specific specimen preparation and testing procedures must be documented under revision control by the manufacturer.

4.5.4 Twist

Twist shall be determined in accordance with ASTM D 1423, ISO 1890, JIS R3912, or their equivalent test methods. Specific specimen preparation and testing procedures must be documented under revision control by the manufacturer. Never Twisted (NT) fiber need not be tested for twist.

4.5.5 Sizing Content

Sizing Content shall be determined in accordance with ASTM D 4018, SACMA SRM 14R-94, ISO 10548, JIS R7604, DIN 65566, or their equivalent test methods. Specific specimen preparation and testing procedures must be documented under revision control by the manufacturer.

4.6 Records

The manufacturer shall keep the following records on file, for each fiber lot, for a period of at least 7 years from the date of manufacture, unless otherwise specified on the purchase order.

- a) Full fiber lot traceability. This traceability shall extend to the PAN lot and doff numbers (where applicable) used in the carbon fiber lot manufacture.
- b) All records pertaining to raw material receiving inspection and certification, in-process records, and product testing specified in the manufacturer's Quality System and this specification.
- c) All records pertaining to the SPC requirements specified in the manufacturer's Quality System.

4.7 Criteria for Retesting/Obviation

Retesting and specimen obviation shall be in accordance with SACMA SRM 12.

4.8 Quality System

A documented quality system which encompasses the manufacturing process from raw materials receiving to final product shipment shall be established and kept current.

4.9 Product Key Characteristics and Statistical Process Control

The manufacturer shall establish and maintain procedures and requirements for a statistical process control (SPC) system based on key characteristics (KC). KC's of the carbon fiber to be monitored by SPC are as follows:

- a) Tensile strength
- b) Tensile modulus
- c) Mass per unit length
- d) Density

The manufacturer shall conduct SPC analysis of the KC based on sampling plan described in 4.3. If statistical analysis determines that a KC is out of control, the manufacturer shall:

- a) Investigate the cause(s),
- b) Eliminate special cause of variation and reestablish statistical control, and
- c) If a KC is not capable, as defined by a process capability ratio of less than 1.33, the manufacturer shall take corrective action to reestablish capability.

The manufacturer shall document all corrective actions affecting the process and assure the effectiveness of the actions. NCAMP and the purchaser reserve the right to review the results of all SPC analyses, capability calculations, and corrective actions.

5. PREPARATION FOR DELIVERY

Spool sizes must be in accordance with the purchase order.

5.1 Identification on Spool Core

The following information shall be permanently and legibly marked on each spool core of tow:

- a) Manufacturer name
- b) Manufacturer product designation, including filament count, surface treatment, and sizing designation, if any
- c) Net weight (optional to mark on the container only)
- d) Tow length (optional to mark on the container only)
- e) Spool and doff numbers, if applicable (optional to mark on the container only)
- f) Fiber lot number
- g) Any additional labeling as necessary in accordance with OSHA 29CFR-1910.1200 or recognized equivalent requirements for deliveries in overseas regions such as EU Commission Regulation 2006/121/EC or GHS (JIS Z 7251).

5.2 Identification on Packaging

Packaging shall be capable of protecting the product during shipment and storage and will retain the properties required by this specification. Each container shall be permanently and legibly marked with the following information:

- a) NMS 818/"X" Rev. "Y" (where "X" is the detail specification number and "Y" is the detail specification revision level)
- b) Purchase order number
- c) All the identifications in section 5.1, except individual spool and doff numbers are optional
- d) Date of manufacture and/or expiry date, which may be coded in the lot number.
- e) Any additional labeling as necessary in accordance with OSHA 29CFR-1910.1200 or recognized equivalent requirements for deliveries in overseas regions such as EU Commission Regulation 2006/121/EC or GHS (JIS Z 7251).

5.3 Certificate of Conformity and Test Results

The manufacturer shall provide a certificate of conformity with each shipment as follows:

- a) A statement that "This production lot was sampled, tested, and certified in accordance with NMS 818/"X" Rev. "Y" (where "X" is the detail specification number and "Y" is the detail specification revision level)
- b) Test results in accordance with 4.2.2, sampled in accordance with 4.3.

6. ACKNOWLEDGEMENT

A material manufacturer should mention this specification number and the applicable detail specification number in all quotations and when acknowledging purchase orders.

7. REJECTION

Carbon fiber tow product not conforming to this specification and the applicable detail specification, or to modifications authorized by purchaser, will be subject to rejection.

8. DEFINITIONS

- a. Base specification: A specification containing all basic PAN precursor and carbon fiber requirements that is used in combination with a detail specification to create the unique requirements for a fiber product.
- b. Carbon or graphite fiber: Interchangeable terms used for continuous filament strands produced in accordance with this specification. Typically, graphite fiber is processed at temperature above 2000°C, all standard and intermediate modulus carbon fiber is processed below 1600°C
- c. Carbon fiber lot: see section 3.2.10
- d. Carbon fiber tow: An untwisted, never twisted or twisted bundle of continuous carbon filaments.
- e. Controlled Process Equipment: Specific manufacturing equipment approved by NCAMP for production of the carbon fiber. Changes to the equipment may affect the quality of the carbon fiber.
- f. Controlled Process Parameters: Critical manufacturing process parameters approved by NCAMP for production of the carbon fiber. Changes to the parameters may affect the quality of the carbon fiber.
- g. Creel: A framework that holds spools (also known as cheeses) of precursor fiber on a carbon fiber production line.
- h. Date of impregnation: The first day tow or woven carbon fiber is coated with resin.
- i. Date of manufacture: The date (day or month) a lot of fiber (carbon or PAN) is manufactured. If the production run extends into the following month, the start date (day or month) is recorded.
- j. Detail specification: A specification containing requirements that is used in combination with a base specification to create the unique requirements for a fiber product.
- k. Doff (noun): All spools of fiber within a lot that are taken off the take-up winders within a given time period. A unique doff number is typically assigned to the spools. However, some manufacturers do not assign doff numbers because the spools are doffed independently when they reach the correct weight during production.
- l. Doff (verb): To remove spools of fiber from the take-up winders.

- m. Doff average: the average of test results for all specimens tested from the same doff sample.
- n. Doff sample: a fiber tow sample removed from the take-up winders in accordance with SACMA SRM 12. Doff sample zero (0) is the sample taken at start-up.
- o. Down spooling: A procedure that creates multiple spools from a single spool.
- p. Foreign materials: All materials not characteristic of the product, such as materials that are not carbon fiber or not PAN fiber.
- q. Never twisted tow: A tow that has never been twisted; denoted by the symbol "NT."
- r. Polyacrylonitrile (PAN): A polymer used as a precursor product for carbon fiber production.
- s. PAN Lot: PAN fiber manufactured in a single production run on the same equipment within a defined set of process parameters.
- t. Purchaser: Any organization that procures product in conformance to this basic specification and its associated detail specification.
- u. Qualified Product List: Qualified product list established for a given detail material specification.
- v. Re-spooling: A procedure that creates a single spool from multiple spools. Also a procedure that winds material from a single spool onto a different (sometimes smaller or larger diameter) spool.
- w. Run: (As used in fiber production) a continuous (uninterrupted) manufacturing process in which carbon fiber is produced.
- x. Sizing: A polymeric coating applied to carbon fiber tows to improve adhesion to resin systems and handling characteristics for subsequent processes (for example, weaving, or impregnation).
- y. Splice: A tow that has been cut or broken and subsequently had the ends rejoined.
- z. Manufacturer: The organization manufacturing and certifying production to this specification.
- aa. Manufacturer product designation: The identification or name given to the product by the manufacturer.
- bb. Surface treatment: A treatment applied to fiber to improve the bond between the fiber surface and the resin matrix in a composite material.
- cc. Tow: A strand of continuous fibers. Carbon fibers are supplied in the form of tows. A tow can nominally contain from 500 to 48,000 carbon fiber filaments. Typical tow counts (number of filaments within a tow) are 3,000 (or 3K), 6,000 (or 6K), 12,000 (or 12K), and 24,000 (or 24K). Larger tows are also available but not commonly used in aerospace applications.

- dd. Transition material: Material which is removed from the line during non-steady-state production because of process interruptions or start-up.
- ee. Twisted tow: Tow with intentional twist in its final form; denoted by the symbol "TT" or "ST"
- ff. Untwisted tow: Previously twisted tow that has had its twist removed in its final form; denoted by the symbol "UT."
- gg. Winders: Equipment used to collect the carbon fiber on the spool cores at the end of the carbon fiber conversion processes (end of the carbon fiber line). Also known as take-up winders.