

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS 3904B

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Superseding AMS 3904A

(R) **Organic Fiber (Para-Aramid), Yarn and Roving
Intermediate Modulus
For Cables, Cordage, and Woven Goods**

1. SCOPE:

1.1 Form:

This specification and its supplementary detail specifications cover intermediate modulus para-aramid organic fibers in the form of continuous, multifilament yarn and roving.

1.2 Application:

These products have been used typically as primary elements in cables, cordage, and woven goods, but usage is not limited to such applications. Each application should be considered individually.

1.3 Classification:

The fibers shall be as specified in the applicable detail specification, wherein each product is defined by form, denier, and finish. An example is shown in 8.2. The product covered by each detail specification appears as part of the title.

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.

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2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

2.1 ASTM Publications:

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

ASTM D 885 Testing Tire Cords, Tire Cord Fabrics, and Industrial Filament Yarns Made from Man-Made Organic-Base Fibers

ASTM D 1505 Density of Plastics by the Density-Gradient Technique

ASTM D 1907 Yarn Number by the Skein Method

2.2 ANSI Publications:

Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

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

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 Construction: Shall consist of parallel, unidirectional, continuous, organic filaments characterized by flexibility and fineness.

3.2.2 Finish: A finish or treatment shall be applied to the fibers to promote internal abrasion resistance. The amount of finish shall be as specified in the applicable detail specification.

3.2.3 Color: Shall be essentially yellow.

3.3 Properties:

The product shall conform to the requirements of this specification and the applicable detail specification. Tests shall be performed on the product supplied and in accordance with specified methods, insofar as practicable.

3.4 Quality:

The product, as received by purchaser, shall be uniform in quality and condition, as free from foreign materials as commercially practicable, and free from imperfections detrimental to usage of the product.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The manufacturer of the product shall supply all samples and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Construction (3.2.1), property testing in accordance with 3.3 or as specified in the applicable detail specification, and quality (3.4) are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction of Tests: All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of a product by the manufacturer, when a change in material and/or processing requires reapproval as in 4.4.1, and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

4.3.1 Sampling Schedule: Shall be in accordance with Single Sampling for Normal Inspection, General Inspection Level II, with an Acceptance Quality Level (AQL) of 1.5 specified in ANSI/ASQ Z1.4. Test specimens shall be taken from spools selected at random throughout the lot.

4.3.1.1 If the number of inspection units to be sampled equals or exceeds the lot size, inspect each unit.

4.3.2 A lot of roving shall be all product produced in a single 24-hour production run or a single production run under the same fixed conditions and presented for manufacturer's inspection at one time.

4.3.3 A lot of yarn shall be all product produced in a single 24-hour production run from the same batch of raw materials and presented for manufacturer's inspection at one time.

4.3.4 An inspection unit shall be each individual package.

4.3.5 For Tensile Strength and Modulus of Elasticity: A minimum of five specimens form each inspection unit.

4.3.6 For Linear Density, Fiber Finish, and Fiber Density: One specimen from each inspection unit.

4.3.7 For Catenary: One specimen from each four inspection units of roving; none required for yarn.

4.4 Approval:

4.4.1 Sample product shall be approved by purchaser before product for production use is supplied, unless such approval is waived by purchaser. Results of tests on production product shall be essentially equivalent to those on the approved sample. Production product made by a revised procedure shall not be shipped prior to receipt of reapproval. If necessary to make any change in parameters for the process control factors, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample product.

4.4.2 Manufacturer of the product shall make no significant change in material, processes, or control factors from those on which the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, could affect the properties or performance of the product.

4.5 Test Methods:

4.5.1 Tensile Strength and Modulus of Elasticity: Shall be determined in accordance with ASTM D 885.

4.5.2 Fiber Density: Shall be determined in accordance with ASTM D 1505.

4.5.3 Linear Density: Shall be determined in accordance with ASTM D 1907 or as follows:

4.5.3.1 Measure a 45-m length of yarn or a 18-m length of roving. Dry fiber at 300 °C ± 3 (572 °F ± 5) for 20 to 30 minutes. Cool in a conditioned atmosphere for 10 minutes ± 2.

4.5.3.2 Immediately weigh the fiber sample to the nearest milligram.

4.5.3.3 Calculate the linear density as shown in Equation 1 and Equation 2:

$$\text{Yarn Linear Density} = (45\text{-m sample weight}) \times C_y \times \text{finish factor} \quad (\text{Eq. 1})$$

$$\text{Roving Linear Density} = (18\text{-m sample weight}) \times C_R \times \text{finish factor} \quad (\text{Eq. 2})$$

where:

C_y = 200 for denier units and 222 for dtex units

C_R = 500 for denier units and 556 for dtex units

finish factor is:

0.9300 for 7.0% finish

0.9900 for 1.0% finish

0.9910 for 0.9% finish, and

1.0000 for 0.0% finish.

4.5.3.4 If linear density is determined using ASTM D 1907, report the measurement option used.

4.5.4 Fiber Finish Content: Shall be determined by either of the two methods as follows:

4.5.4.1 Method 1: Nuclear Magnetic Resonance (NMR):

4.5.4.1.1 Reel a sample skein to approximately the length specified in Table 1.

TABLE 1 - Sample Lengths

Linear Density, den	Linear Density, dtex	Sample Length, yd	Sample Length, m
200	220	88.6	81
400	440	44.3	40.5
1000	1110	17.2	15.75
1500	1670	11.1	10.125
3000	3300	5.0	4.5
4500	5000	3.7	3.375
15,000	16,700	1.1	1.0

4.5.4.1.2 Dry the sample at $100\text{ }^{\circ}\text{C} \pm 2$ ($212\text{ }^{\circ}\text{F} \pm 4$) for 15 minutes ± 1 .

4.5.4.1.3 Remove skein from oven and weigh immediately to the nearest 0.001 gram.

4.5.4.1.4 After weighing, put skein into a clear sample tube. Cap the open end of the tube. Sample must be weighed, placed in the sample tube, and capped within 30 minutes of removal from the oven.

4.5.4.1.5 Place the sample tube in a Nuclear Magnetic Resonance (NMR) test instrument and measure the finish level in percent by weight.

4.5.4.2 Method 2: Soak and Blow Method:

4.5.4.2.1 Weigh approximately 10 grams of oven-dried fiber to the nearest 0.001 gram. Fiber drying can be done in a moisture teller or by oven drying as in 4.5.3.1.

4.5.4.2.2 For each specimen, tare a balance with a clean aluminum dish that has been rinsed with a solvent suitable for removal of fiber finish and oven-dried at $105\text{ }^{\circ}\text{C} \pm 2$ ($221\text{ }^{\circ}\text{F} \pm 4$) for 10 minutes ± 2 .

4.5.4.2.3 Remove fiber finish as follows:

4.5.4.2.3.1 Place fiber sample into an extraction funnel. Close stop cock and introduce 65 mL of solvent. Funnel should be sized so that this volume of solvent covers fiber sample to a depth of approximately 0.25 inch (6.4 mm).

4.5.4.2.3.2 Soak samples for not less than 10 minutes, stirring each sample occasionally with a different rod.

- 4.5.4.2.3.3 Open stop cock to drain solvent into tared dish (See 4.5.4.2.2).
- 4.5.4.2.3.4 Using a rubber stopper fitted to a 2 to 3 psi (140 to 200 mbar) air line, blow solvent residue into dish.
- 4.5.4.2.3.5 Repeat 4.5.4.2.3.1 through 4.5.4.2.3.4 two additional times.
- 4.5.4.2.4 Prepare a solvent blank sample using the same volume of solvent as used in the analysis with each series of samples.
- 4.5.4.2.5 Evaporate sample cups to dryness on a steam bath.
- 4.5.4.2.6 Wipe cup bottoms and dry in an oven at $105\text{ }^{\circ}\text{C} \pm 2$ ($221\text{ }^{\circ}\text{F} \pm 4$) for 10 minutes ± 2 .
- 4.5.4.2.7 Remove cups to desiccator to cool.
- 4.5.4.2.8 Reweigh cups with finish residue to nearest 0.0001 gram.
- 4.5.4.2.9 Calculations: Shall be in accordance with Equation 3.

$$\text{Percent Finish on Yarn} = \frac{(C - B) - D}{A} \times 100 \quad (\text{Eq. 3})$$

where:

- A = Weight of yarn sample (See 4.5.4.2.1)
- B = Weight of empty cup (See 4.5.4.2.2)
- C = Weight of cup with finish residue (See 4.5.4.2.8)
- D = Weight of residue in blank (See 4.5.4.2.8)
- 100 = Percent conversion factor

4.5.5 Catenary of Roving: Shall be determined as follows:

- 4.5.5.1 Place roving ball on a horizontal spindle so that the ball will unwind in the counterclockwise direction when the yarn is pulled. Strip off a minimum of 12 feet (4 m) of the threadline from outside of the ball.
- 4.5.5.2 With the yarn in the center of the package, tie an overhand knot approximately 1 foot (300 mm) from the roving ball while keeping the threadline tight.
- 4.5.5.3 Tie a loop with a slip knot formation between the overhand knot and the end of the threadline. Both knots must be pulled tight.
- 4.5.5.4 Pull the threadline until the knot is approximately 50 feet (15 m) from the package.

- 4.5.5.5 Attach a two-pound (one kg) weight into the loop formed above. Shake the threadline several times to separate threadlines before lowering the weight.
- 4.5.5.6 Lower the weight until the threadline is coming off the center of the ball.
- 4.5.5.7 Tap the threadline firmly four times with a ruler to separate threadlines. The yarn should be tapped in the middle of the 50-foot (15-m) span.
- 4.5.5.8 Measure the separation between the top threadline and the lowest threadline. Do not include the threadline thickness in the catenary measurement. Record the catenary results to the closest 0.1 inch (2.5 mm).

4.6 Reports:

The supplier of the product shall furnish with each shipment a report from the manufacturer showing the results of tests to determine conformance to the acceptance test requirements and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, AMS 3904B and the applicable detail specification number and its revision letter, if any, manufacturer's identification number, lot number, and quantity.

4.7 Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

- 5.1.1 The product shall be supplied in continuous lengths wound on spools with cores having an OD not less than 1 inch (25 mm). Winding shall be uniform and provide for proper unreeling. Ends shall be secured.
- 5.1.2 Each package shall be legibly identified in a way that traceability is ensured.
- 5.1.3 The packages shall be wrapped in a material which will ensure protection from damage that may result from handling, shipping, and storage.