MAIN TYPES OF MATERIALS USED IN PARACHUTE MANUFACTURING

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REZUMAT. Tesaturile folosite pentru obtinerea parasutelor trebuie sa aiba urmatoarele carcteristici de calitate: masa unitatii de suprafata cat mai redusa in conditiile in care valorile caracteristicilor fizico-mecanice (sarcina la rupere pe directie axiala, alungirea relativa si absoluta, rezistenta la sfasiere a tesaturii si a asamblarilor, permeabilitatea la aer) trebuie sa fie maxime. Nu in ultimul rand materialele trebuie sa corepunda calitativ pe metraje foarte mari si din aceasta cauza reglementarile si standardizarile trebuie sa fie foarte riguroase. Pe plan global nivelul cel mai inalt de standardizare, in domeniul materialelor pentru parasute, a fost cel folosit de armata statelor unite, drept urmare acesta ramane o referinta pentru orice material folosit in prezent chiar daca organismele de standardizare se numesc acum PIA, CEN, ISO si nu MIL. O consecinta a acestui lucru ramane si adoptia unitatiilor de masura imperiale pentru definirea dimensiunilor, fortelor si a altor marimi. Lucrarea enumereaza sintetic materialele de baza folosite in constructia parasutelor, materiale sub forma de tesaturi, chingi, benzi si suspante.

Cuvinte cheie: tesaturi pentru parasute, chingi pentru parasute, suspante pentru parasuta, textile tehnice.

ABSTRACT. The fabrics used to make parachutes must have the following characteristics: the mass of fabric per unit of surface must be low while the other physical-mechanical characteristics (the axial breaking strength load, the relative and absolute elongation, the tear resistance of the fabric and the assemblies, air permeability) must be at a maximum. On a global scale, the highest level of standardization, in the field of parachute materials, was the one used by the United States Army, so it remains a reference for any material used today, even though the standardization bodies are now called PIA, CEN, ISO and not MIL. A consequence of this remains the adoption of imperial units for measurements of dimensions, forces and other specifications. The paper summarizes the basic materials used in the construction of parachutes, materials in the form of fabrics, webbing, tapes and lines.

Keywords: parachute fabric, parachute webbing, parachute lines, technical textiles.

1. INTRODUCTION

All certificated parachute systems built under government approval programs require most, if not all, materials used in their construction to have some form of specification approval. The most common of these systems is the military specification (MIL-SPEC) system. In addition, there are other Government specifications, such as Federal Standards, and commercial specifications in use. The MIL-SPEC system is the one with which most riggers are familiar. Contrary to popular perception, not all materials for use in parachute manufacturing must be MIL-SPEC. Any specification may be used, providing the manufacturer can prove compliance with this specification, and that the specification is acceptable to the FAA or EASA for use in the parachute system. As a rule, the MIL-SPEC system has proven the most readily available and accepted method.

In 2002, the Parachute Industry Association (PIA) adopted approximately 270 parachute related specifications, drawings, standards, and test methods. The PIA takes responsibility for the continued maintenance and revision of these specifications. As the specifications are revised, they keep their original identification number, but the PIA prefix precedes them. For instance, MIL-W-4088 webbing becomes PIA-W-4088. Through the involvement of the PIA Specifications Committee,

the revised specifications, including new digital drawings, are made available to the industry.

The MIL-SPEC or PIA-SPEC system of identification consists of the initial letters MIL or PIA with a middle letter such as W for webbing or wire, then the identification or serial number of the specification. In addition, there may be a revision letter such as A, B, C, D, etc. In the case of PIA-W-4088D, this is the fourth revision.

To promote the latest specifications, the PIA nomenclature is called out unless otherwise noted. In the past, the common method to denote the various types of webbings, cords, etc., was to use the Roman numeral for the type (i.e., Type VIII for Ty-8, Type XVII for Ty-17, etc.).

Fabrics for use in the manufacturing of parachutes are predominately nylon. The major differences include the weave, weight, and finish. The various types of materials include canopy fabric, pack cloths, mesh, elastic fabrics, stiffener materials, and foams.

2. PARACHUTE FABRICS

Fabric properties

Tear strength: Woven textiles possess certain unique mechanical properties unlike other sheet materials such as paper or film. The great improvement in the tear strength is due to the geometry of the matrix into which the fibers have been formed; the yarns are sometimes twisted and then they have been interwoven at right angles into a material sheet. The crossing yarns are free to slide over one another. When a tear is started, the threads move and the stress is distributed around the end of the tear. The threads of a piece of paper, on the other hand, cannot move and continuing a tear is relatively easy. Any treatment or coating of the fabric which reduces this deformability will reduce the tear strength. Therefore, it is normally inadvisable to coat canopy fabrics though sometimes very light coatings will reduce permeability with minimum reductions in tear strength. New coatings are being developed that may even increase tear strength.

Most round personnel parachutes were designed to use 36" bolts so that the selvage edges of the cloth would be caught in the diagonal seams. When the fabric weavers switched to wider 72" looms, only one selvage edge could be utilized. The Air Force Flight Test Center at Edwards AFB ran tests on parachutes and found no reduction in structural integrity when constructing diagonal seams of selvage to non-selvage or non-selvage to non-selvage edge material.

Weight: Nylon cloth is weighed in ounces per square yard, i.e., 1.1 ripstop is a ripstop weave fabric, one square yard of which weighs no more than 1.1 ounces. Note: the weight of the cloth has nothing to do with its permeability.

Finishing: After weaving, the nylon cloth is sometimes scoured, dyed and dried. It is then calendered.

This is a rolling process using pressure and heat (temperature in excess of 200F) to force the fibers closer together and to spread them out. This process determines the permeability.

Permeability: Permeability is defined as the number of cubic feet of air which will pass through a square foot of cloth in one minute under .5" of water pressure. Nylon threads are not fuzzy and the fabric must be woven quite tightly to restrict the air flow. Permeability is very difficult to control, hence the wide range (e.g. 80-120 cfm for Type I in MIL-C-7020) which is acceptable. In Great Britain, measurements are taken under 10" of water pressure.

Material: The nylon yarn used in the manufacture of canopy fabric is a bright, high tenacity, multifilament polyamide prepared from hex methylene diamine and adipic acid or its derivatives. It has a melting point of 482F, plus or minus 10.

Treatment: Military nylon canopy fabric may be treated with 0.3% to 0.5% silicon oil based on the weight of the dry cloth. One type is Dow Chemical Company's Silicon Emulsion ET 112A. Low permeability (0-3 cfm) fabric may be treated with fluorocarbon finishes such as Zepel®.

Manufacturer’s Identification: The colored threads woven into the selvage edge of some fabrics identifies the manufacturer. Identification colors are listed in ANA Bulletin No. 195 and MIL-STD-851.

Visual identification of parachute materials

Canopy fabrics are primarily ripstop nylon 6.6. Ripstop weave is a plain weave with heavier threads woven into the material resulting in a boxlike pattern. The heavier thread inhibits the tearing process and results in stronger fabrics. [Figures 1 through 4]

The composition of most containers is from either nylon duck (para-pak) for military systems or Cordura® for sport systems. Most sport containers also utilize a thin foam lining on the inside of the flaps to smooth out the fabric and absorb wear and tear. Other fabrics, such as mesh, Spandex®, and ballistic fabric, serve specialized purposes. [Figures 5 through 8].

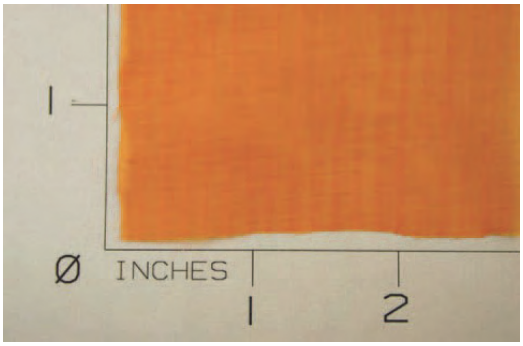

Figure 1. Cloth, parachute, nylon, Ty-1.
Specification: PIA-C-7020, 1.1 oz
Tear/breaking strength: 5 lb. /42 lb.
Identification: 120 x 120 balanced weave Common use: 24', 26', 28' military canopies Comment: Standard colors: white, orange, olive green, sand

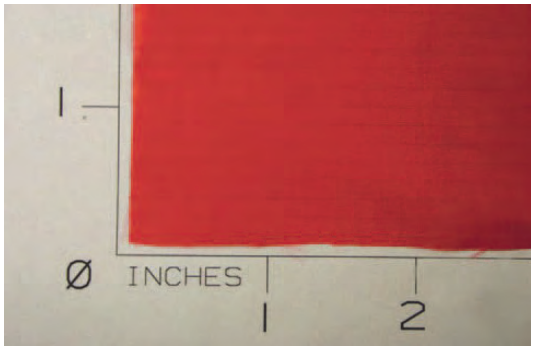

Figure 2. Cloth, parachute, nylon, Ty-3, 30-50 cfm.
Specification: PIA-C-44378, 1.2 oz
Tear/strength: 5 lb./45 lb.
Identification: Ripstop nylon
Common use: LoPo reserve canopies
Comment: N/A

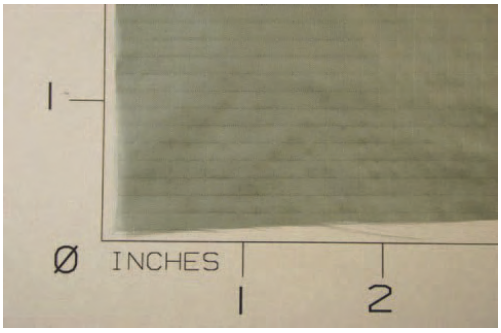

Figure 3. Cloth, parachute, nylon, Ty-1, Lo-Po, .5-3 cfm.
Specification: PIA-C-44378, 1.12 oz
Tear/breaking strength: 5 lb./45 lb.
Identification: Ripstop nylon
Common use: Ram-air canopies and some round reserves
Comment: F-111™, Exacta-chute™

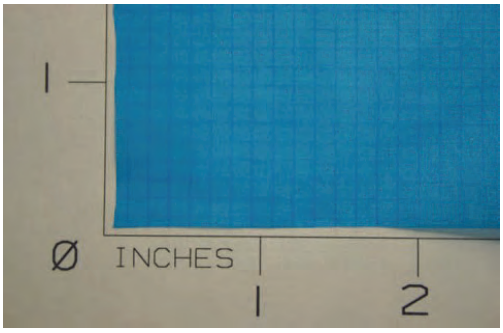

Figure 4. Cloth, parachute, nylon, Ty-1, zero porosity.
Specification: Commercial, 1.13 oz, 0 cfm, silicone coated
Tear/breaking strength: 12.6 lb./43 lb.
Identification: Ripstop nylon
Common use: Sport main canopies and some reserves
Comment: Trade names include Zero P3™, Soar-Coat™.

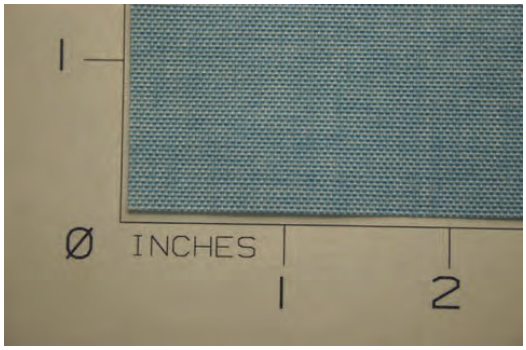

Figure 5. Cloth, nylon, Cordura®.
Specification: MIL-C-43734
Strength: 500 denier
Identification: N/A
Common use: Sport container systems
Comment: N/A

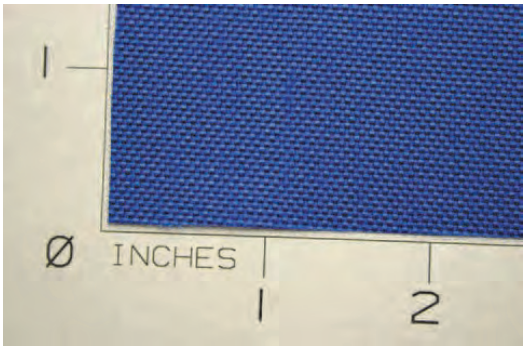

Figure 6. Cloth, nylon, Cordura®.
Specification: MIL-C-43734, class 3
Strength: 1000 denier
Identification: N/A
Common use: Sport and military container systems
Comment: Has a urethane coating on the inside.

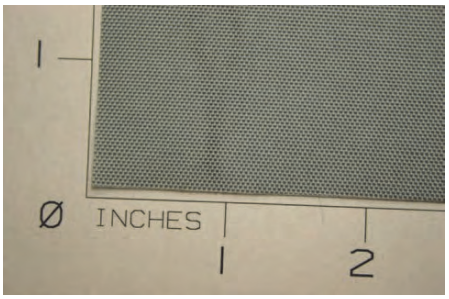

Figure 7. Cloth, duck, nylon (para-pak).
Specification: PIA-C-7219 class 3, 7.25 oz, 420 denier
Tear/breaking strength: 20 lb./275-325 lb.
Identification: 1-1 plain weave
Common use: Military containers
Comment: Commercial para-pak is 400 denier with a urethane coating on the inside.

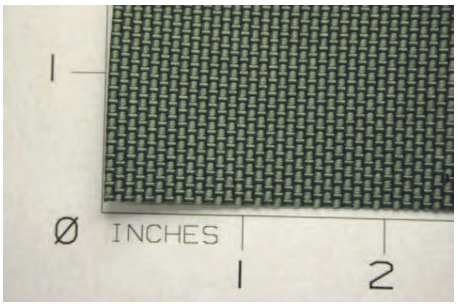

Figure 8. Cloth, duck, nylon, ballistic.
Specification: PIA-C-3953, class 2
Strength: 1100 lb., 20 oz/yd
Identification: 3 x 4 basket weave
Common use: Stiffening material for containers
Comment: Uses a melamine resin for stiffness.

While many webbing and tapes have the same specifications, they still have different designations. The difference is a common rule of thumb where anything 1" or wider and over 1000-lb. strength is webbing. Anything less is a tape. There are, however, some examples that fall outside of this criterion.

The primary use for webbing is for load bearing purposes such as harnesses and risers. Tapes are for use as support and reinforcing for canopies and containers. Most web- bing and tapes, when manufactured, are left in their natural, untreated condition (condition U), or treated with a synthetic resin named Merlon, for stiffness (condition R). A newer treatment, called "Ecco," is similar to a light condition R. This is a newer treatment that is ecologically friendlier than using Merlon. It also results in a medium stiffness that is easier to sew. This is for use primarily in the lighter weight tapes such as 3/4" Ty-3. [Figures 9 through 14]

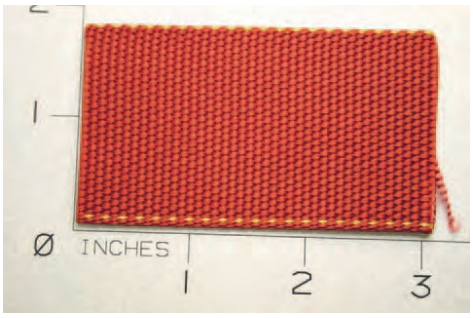

Figure 9. Ty-7 Webbing.
Specification: PIA-W-4088
Strength: 6000 lb.
Identification: Double plain weave, 1 23/32" width, with yellow lines at each selvage edge
Common use: Modern sport harness, risers
Comment: More widely used than Ty-13 and more colors available.

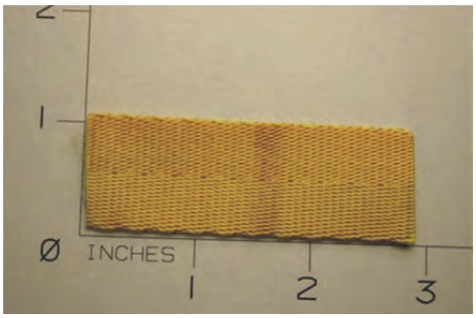

Figure 10. Ty-17 Webbing.
Specification: PIA-W-4088
Strength: 2500 lb.
Identification: 2/2 HB twill, 1" width, no color code
Common use: Sport main risers, chest straps, carry handles
Comment: N/A

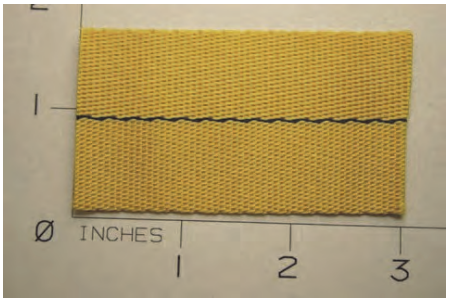

Figure 11. Ty-8 Webbing.
Specification: PIA-W-4088
Strength: 4000 lb.
Identification: 2/2 HB twill, 1 23/32" width, black centerline
Common use: Main risers, harness construction
Comment: One of the most common webbings in use today.

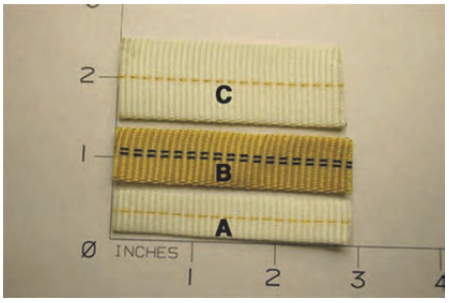

Figure 12. Tubular webbing.
Specification: PIA-W-5625
Strength: A. 1/2", 1000 lb.; B. 5/8", 2250 lb.; C. 1", 4000 lb.
Identification: Various widths, yellow or black lines at the center or edges
Common use: Bridles, static lines

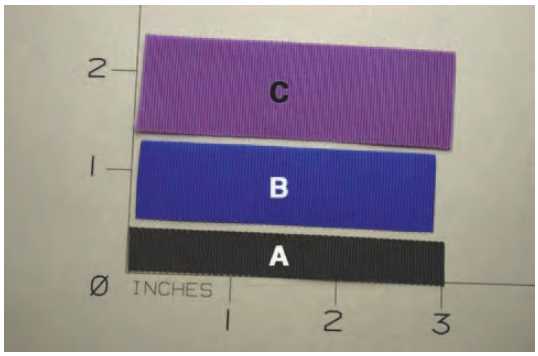

Figure 13. Ty-3 Tape.
Specification: PIA-T-5038
Strength: A. 3/8", 200 lb.; B. 3/4", 400 lb.; C. 1", 525 lb.
Identification: Ribbon weave, various widths as above
Common use: Binding tape, canopy-reinforcing tapes, and line attachment tapes
Comment: One of the most common tapes in use; condition U, R, and Ecco are the cur- rent treatments.

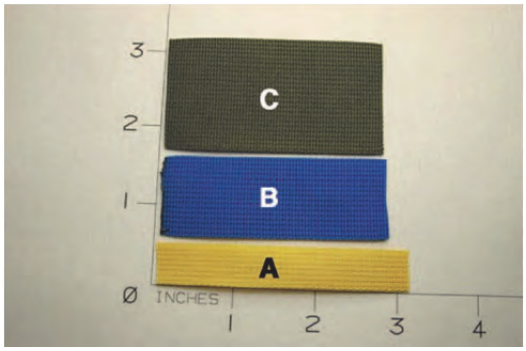

Figure 14. Ty-4 Tape.
Specification: PIA-T-5038
Strength: A. 1/2", 550 lb.; B. 1", 1000 lb..; C. 1 1/2", 1500 lb.
Identification: Plain weave, various widths Common use: Bridles, reinforcing, buffers Comment: One of the most versatile tapes available, called “square weave.”

The most common uses of cord and lines are the suspension lines of the canopy. There are many different types in use. Today, the most common are nylon, Dacron, and Spectra®. Each may have special techniques to work with them. [Figures 15 through 20]

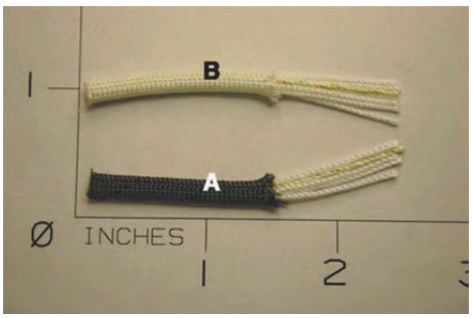

Figure 15. Cord, nylon, Ty-2 and Ty-3.
Specification: PIA-C-5040
Strength: A. 400 lb.; B. 550 lb.
Identification: Sheath and core construction
Common use: Ty-2 used on T-10 canopies; Ty-3 used on 24" and 28" canopies
Comment: A. Ty-2; B. Ty-3

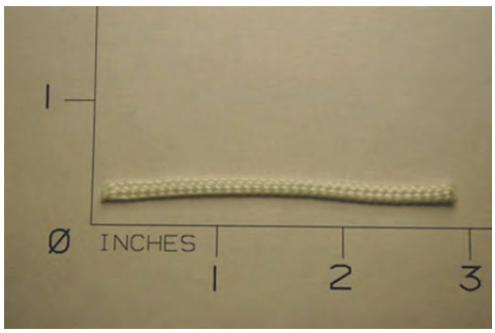

Figure 16. Cord, nylon, Ty-1a.
Specification: PIA-C-7515
Strength: 400 lb.
Identification: Braided line
Common use: Several sport round reserves

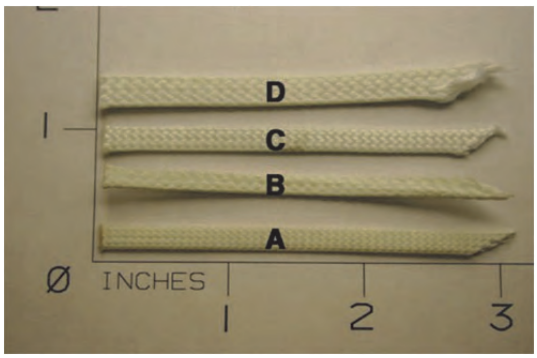

Figure 17. Cord, Dacron.
Specification: Commercial
Strength: A. 400 lb.; B. 500 lb.; C. 600 lb.; D. 900 lb.
Identification: Braided hollow line
Common use: Ram-air canopies

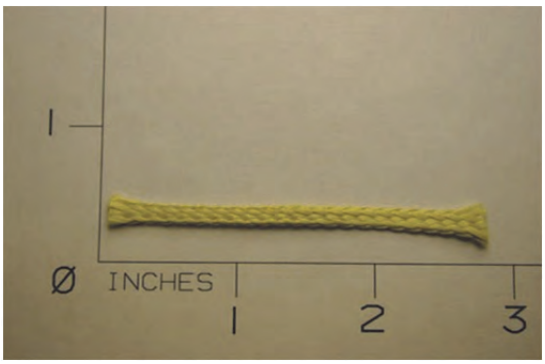

Figure 18. Cord, Kevlar®.
Specification: PIA-C-87129
Strength: 700 lb.
Identification: Braided, untreated
Common use: Early ram-air canopies

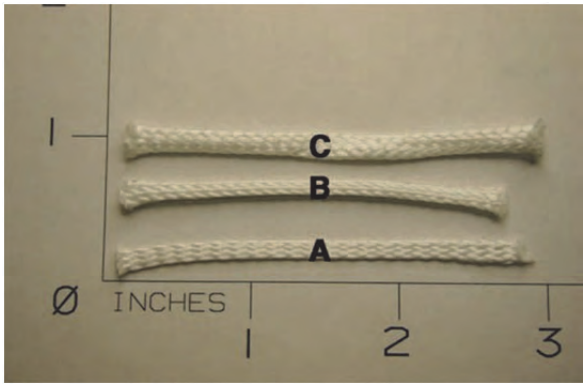

Figure 19. Cord, Spectra®.
Specification: Commercial
Strength: A. 725 lb.; B. 940 lb.; C. 1800 lb.
Identification: Braided line
Common use: Modern ram-air canopies

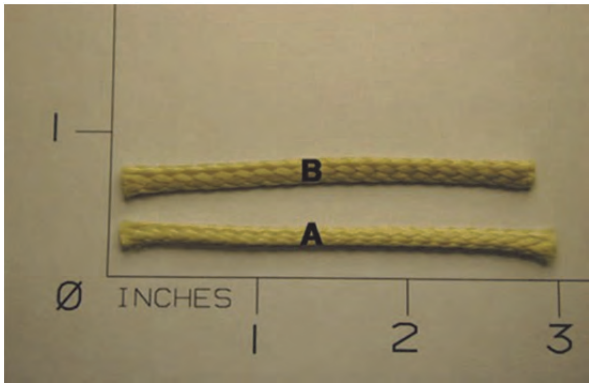

Figure 20. Cord, Vectran® LCP.
Specification: Commercial
Strength: A. 1000 lb.; B. 1600 lb.
Identification: Braided
Common use: Strong tandem main canopies

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