

INCH-POUND
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MIL-DTL-9401C

12 May 2003

SUPERSEDING

MIL-C-9401B

9 January 1968

## DETAIL SPECIFICATION

## CANOPY, PARACHUTE, RING SLOT, GENERAL SPECIFICATION FOR

## CONSTRUCTION OF

This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers the general construction requirements of a parachute canopy which is characterized by concentric rings of cloth separated from each other by slots and designated as the ring slot parachute canopy.

1.2 Classification. The classification of parachute assemblies are defined as part numbers as specified in the acquisition requirements (see 6.2).

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are cited in sections 3 and 4 of this specification. These lists do not include documents cited in other sections of this specification or those recommended for additional information or as examples. While every effort has been made to ensure the completeness of these lists, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to: Natick Soldier Center ATTN: AMSSB-RAD-AD(N), Natick, MA 01760-5017, using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.
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AMSC N/A

FSC 1670

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## MIL-DTL-9401C

## SPECIFICATIONS

## FEDERAL

- A-A-59291 - Ink, Marking (For Parachutes and Other Textile Items)
- V-T-295 - Thread, Nylon

## STANDARDS

## DEPARTMENT OF DEFENSE

- MIL-STD-849 - Inspection Requirements, Definitions and Classification of Defects in Parachutes

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 40, Philadelphia, PA 19111-5094)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents that are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM D 737 Test Method for Air Permeability of Textile Fabrics
- ASTM D 6193 Standard Practice for Stitches and Seams

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to a first article inspection in accordance with 4.2.

3.2 Materials. Materials shall conform to the requirements of the applicable Technical Data Package (TDP), to subsidiary specifications and standards applicable thereto and as specified herein.

## MIL-DTL-9401C

3.2.1 Thread. Unless otherwise specified, the thread used in the construction of the canopy shall conform to types I, II or III, class A of V-T-295. The color and size of the thread shall be as specified in the TDP.

3.2.2 Color. The color of webbing and tapes in fully concealed seams shall be optional except the color red shall not be used.

3.2.3 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided the materials meet or exceed the operational requirements, and promote economically advantageous life cycle costs.

3.3 Construction. Details of construction shall be in accordance with the TDP and the additional requirements as specified herein.

3.3.1 Assembly aids. Drilling, notches, stapling, basting or any other such techniques used as aids in the manufacturing process shall be kept to a minimum and the use thereof shall be restricted to the same limitations as markings (see 3.3.1.2). All assembly aids, such as staples, shall be removed during or after assembly. For Navy procurements, hot glues are not authorized as an assembly aid.

3.3.1.1 Basting. Basting requirements shall be as specified in the TDP or be in accordance with common industry practices. Basting stitches shall not be seen in the finished seam or assembly. Contractors unfamiliar with commercial practices shall contact the contracting officer for specified details prior to assembly of the item.

3.3.1.2 Assembly markings. Markings on the canopy, riser and other components as an aid to assembly and to indicate stitching patterns shall be accomplished in a manner that will not adversely affect the utility, strength, or appearance of the parachute.

3.3.2 Warp direction. The warp direction of the canopy material shall be parallel to the skirt reinforcement band (seams) unless otherwise specified in the TDP.

3.3.3 Reinforcement bands. The ends of the reinforcement band shall overlap a minimum of 4 inches unless otherwise specified in the TDP. The rows of stitching shall be continuous across the overlap.

3.3.4 Skirt reinforcement. The ends of the skirt reinforcement shall overlap a minimum of 6 inches unless otherwise specified in the TDP. The rows of stitching shall be continuous across the overlap. When more than one piece is used, the shortest length shall cross a minimum of four gores.

3.3.5 Vent reinforcement. The ends of the vent reinforcement shall overlap a minimum of 4 inches unless otherwise specified in the TDP. The rows of stitching shall be continuous across the overlap. The lap joint shall be located so that the ends of the overlap will be secured by the

## MIL-DTL-9401C

stitching of at least two consecutive vent lines. The material for the vent reinforcement shall be one continuous piece.

3.3.5.1 Vent lines. Unless otherwise specified in the TDP, the vent lines shall be of the same material as the suspension lines.

3.3.6 Stitching. Stitching shall conform to ASTM D 6193. Unless otherwise specified, the stitch type shall be 301 of ASTM D 6193. The number of stitches per inch shall be as specified in table I.

Table I. Thread size and stitches per inch

Thread Size	Straight stitching		Zigzag stitching	
	Type 301	Type 401	Type 304 Single throw	Type 308 Double throw
E	<u>1</u> / 7 to 11	<u>1</u> / 7 to 11	2/ 12 to 16	<u>2</u> / 8 to 12
F	<u>1</u> / 7 to 11		2/ 12 to 14	<u>2</u> / 7 to 10
FF	<u>1</u> / 6 to 9	7 to 11	2/ 12 to 14	<u>2</u> / 7 to 10
3-cord	5 to 8		-	<u>2</u> / 4 to 6
5-cord	4 to 6		-	<u>2</u> / 3 to 5
6-cord	4 to 6		-	<u>2</u> / 3 to 5

1/ Stitches not exceeding 16 stitches per inch will be acceptable for a length not exceeding 2 inches in any one place with a minimum distance between locations of 12 inches. More than 16 stitches per inch will be cause for rejection. Where abrupt changes in material thickness occur, a variation of  $\pm 2$  stitches per inch beyond the specified number for a distance not exceeding  $\frac{3}{4}$  inch shall be acceptable.

2/ When the material thickness is more than doubled, the width of the zigzag stitching may vary  $\pm 50$  percent or the number of stitches may vary  $\pm 2$  stitches per inch beyond the number specified for a distance not exceeding  $\frac{3}{4}$  inch.

3.3.6.1 Tension. The tension of the bobbin and the needle threads shall be equal so that the thread locks will lie as close as possible in the center of the layers below the surface. Needles of multiple-needle machines shall be adjusted to provide the same tension from each needle insofar as practicable.

3.3.6.2 Straight stitching. Except for stitching made with stitch type 401, straight stitching shall be backstitched not less than  $\frac{1}{2}$  inch, unless turned under in a hem or held down by other stitching. Unless otherwise specified in the detail specification, the outside row of stitching made with a multiple-needle machine shall be  $\frac{1}{8} \pm \frac{1}{16}$  inch from the edge of the seam or the material. Multiple rows of straight stitching, when specified in the detail specification, shall be distributed equally across the seam when a single-needle machine is used. Stitching made with stitch type 401 shall be properly and carefully locked where the stitching ends.

## MIL-DTL-9401C

3.3.6.3 Zigzag stitching. Zigzag stitching that is parallel to straight stitching shall normally not overlap the straight stitching. When only one row of zigzag stitching is specified, it shall be centered. Unless otherwise specified, the tolerance for the length of the row of zigzag stitching shall be + ½ or – 0 inch. The distance between the nearest edge of the zigzag stitching and the edge of the material or seam and the distance between the adjacent edges of the rows of zigzag stitching on the drag surface shall be not less than 1/8 inch.

3.3.7 Automatic sewing machines. Automatic sewing machines may be used for sewing stitch patterns provided that the size of the pattern, the thread size, and the number of stitches per inch specified in the detail specification are maintained. A minimum of three tie-in, overlapping or back stitches shall be used to secure the ends.

3.3.8 Seams. Seams shall conform to ASTM D 6193. Seams shall be flat and smooth to preclude pleating, ragged edges, cloth edges not properly caught, and puffiness of fabric between. Every effort shall be made to produce a fully folded flat seam. Excessive puffiness in the seams shall not be acceptable, because it tends to reduce the fullness in the rows of the stitching gores causing stresses in the seams during canopy inflation which may cause damage or failure. Finished fell and hem seams showing raw edges shall be repaired. Seam margins that are less than 1/16 inch, but not beyond the edge of seam or material, will be acceptable for a distance of 2 inches spaced not less than 36 inches apart.

3.3.9 Splices. Splices of webbing tapes, and ribbons used in assembling the canopy, except the vent reinforcement web, shall be held to a minimum and shall not exceed the number specified in table II. Only one piece of webbing shall be used in the vent hem. When two or more layers of the same material are used in a seam, one layer shall be continuous across the splice of the other layer. Unless otherwise specified, the ends of the splice shall be made by overlapping the ends for a distance of not less than 4 inches.

Table II. Number of Splices

Length of seam (inches)	Number of splices permitted	Number of repairs permitted
0 to 2	0	0
2 to 12	0	1
12 to 72	0	2
72 to 240	1	3
240 to 360	2	4
360 to 480	3	5
480 to 600	4	6
Over 600	1 per 120 inches	1 per 100 inches

## MIL-DTL-9401C

### 3.3.10 Repairs.

3.3.10.1 Broken or skipped stitches. Broken or skipped stitches in stitch type 301 shall be repaired by adjacent stitching with the stitches extending a minimum of 3 inches ( $\pm 1$  inch) beyond the ends of the stitches being repaired. Broken or skipped stitches in stitch type 304 or 308 shall be repaired by adjacent stitching with the stitches extending a minimum of three stitches beyond the ends of the stitches being repaired. Broken or skipped stitches in stitch type 401 shall be repaired with stitch type 301 and as specified for broken or skipped stitches in stitch type 301. The frequency of the stitching repairs shall not exceed the number specified in table II.

3.3.10.2 Run-offs. A run-off shall be repaired by stitching within the seam margin tolerance with the stitches extending a minimum of 1 inch or three stitches, as applicable to the type of stitch, from the start and the end of the run-off.

3.3.10.3 Less than specified number of stitches per inch. Where the number of stitches per inch is less than the number specified, repairs shall be made by adjacent stitching, with the repair extending either 1 inch or three stitches, as applicable to the type of stitch, beyond the end of the repair.

3.3.10.4 Loose stitches. Loose stitching shall not be removed but shall be reinforced by adjacent stitching. Loose stitches shall be interpreted as those that do not lie smoothly on the fabric when the seam is put under tension.

3.3.10.5 Tight stitches. Tight stitches shall be removed and the section shall be restitched. Tight stitches shall be interpreted as those that cause the fabric under the stitches to gather or pucker when the seam is put under tension.

3.3.11 Darning tears and cuts. Darning shall be held to a minimum. Holes (see 6.4) not exceeding  $\frac{1}{4}$  inch in diameter and linear tears or cuts not exceeding  $\frac{1}{2}$  inch may be darned. The darned area of linear tears or cuts shall form a rectangular pattern extending  $\frac{1}{4}$  inch beyond each side and each end of the cut or tear. All darts shall be neat and flat and shall not pucker the canopy cloth. The darning thread shall be size A thread or yarns from the canopy and shall match the canopy cloth.

### 3.3.12 Measuring operations.

3.3.12.1 Cloth. All cloth shall be measured and cut while under substantially no tension. Tightly rolled material shall be relaxed by unrolling and, if necessary, relaxing it for 24 hours to permit the material to return to its original state. Section pattern shall be carefully placed on the cloth so that the small inequities of various cloth widths (within the tolerance specified) are evenly distributed on each side of the pattern. When multiple layers of cloth are cut at the same time, extreme care shall be taken to prevent the cloth from slipping during any part of the cutting operation.

3.3.12.2 Suspension and vent lines. The suspension and vent lines shall be measured under the tension specified in table III and marked to show the points of attachment to the drag surface and

## MIL-DTL-9401C

the load. Care shall be exercised in preparing proper line-measuring equipment. Equipment such as pulleys, guides, and reels, if used, shall not induce false loads on the material nor uneven load distribution on multiple line-measuring systems. Reasonable care shall be exercised to maintain uniformity in time control of load applications and control of large changes in temperature and humidity. Lines measured after attachment may have a variation in length of 1 percent in any one canopy when measured under tension in accordance with table III.

Table III. Tensile strength and tension

Tensile strength (pounds)	Tension (pounds)
100 to 500	$10 \pm 1/2$
500 to 1000	$20 \pm 1$
1000 and up	$40 \pm 2$

3.3.12.3 Webbings. Webbings, tapes, and ribbons used in assembling the drag surface shall be measured with no tension applied during the measuring operations. Very heavy webbings shall not be measured while in the stretched state. (The stretched state of webbing is caused by winding the webbing onto the spool while the webbing is under tension.) A uniform period of time shall be maintained between load applications and marking.

3.3.12.4 Drag surface. When finished dimensions are specified, proper allowance shall be provided for stitching take-up to obtain the finished dimensions when the specified tolerances under any condition of humidity. Unless otherwise specified in the detail specification, all finished dimensions shall be measured on the finished drag surface under nominal tension within 15 seconds after application of the nominal tension. See MIL-STD-849 for the definition of nominal tension.

3.3.13 Stitches. The number and the spacing of stitches shall be measured under a tension of not less than  $\frac{1}{2}$  pound nor more than 1 pound.

3.3.14 Tolerances. Unless otherwise specified, the tolerances for dimensions shall be as specified in table IV.

Table IV. Tolerances for dimensions

Dimension (inches)	Tolerances
$1/16$	$\pm 1/32$
Under 2 but over $1/16$	$\pm 1/16$
2 to 10	$\pm 1/8$
10 to 30	$\pm 1/4$
30 to 60	$\pm 3/8$
60 and up	$\frac{1}{\text{1/}}$

$\frac{1}{\text{1/}}$  The tolerance is 1 percent of the dimension.

## MIL-DTL-9401C

### 3.3.15 Finish

3.3.15.1 Ends. The ends of all materials which, in the final assembly, are not covered by other cloth, tapes, webbings, or ribbons shall be treated to prevent fraying. The exposed ends of nylon cords, webbings, tapes, and ribbons shall be cut and seared smoothly and evenly or dipped in a melted mixture of 50 percent beeswax and 50 percent paraffin at a temperature of  $180^{\circ} \pm 20^{\circ}$  F. The ends of the suspension lines shall be neatly trimmed back to the stitching, leaving an end which is not longer than  $\frac{1}{4}$  inch.

3.3.15.2 Searing. Searing shall not be permitted after stitching. Any searing permitted shall not leave sharp edges or points that may cause snagging of the canopy cloth. In general, searing shall not be used where the end of the material is sandwiched between two other pieces of material or where the stitching runs continuously over the exposed ends. All finishing shall be done neatly and shall not have any sharp edges or excess melted materials which could cause localized stresses. Whenever searing is used, the finished canopy shall be carefully examined for holes and snags caused by poorly seared materials. One broken warp thread will be allowed in a tape or webbing, provided that the strength of the material is not below specification strength.

3.4 Air permeability. When tested in accordance with 4.5, complete canopies shall have an average permeability of not more than 10 percent over the top limit or 10 percent below the lower limit of the fabric specification. The average air permeability reading for any one gore shall not exceed the upper limit, nor be less than the lower limit of the fabric specification by over 20 percent.

### 3.5 Identification of product

3.5.1 Marking. The ink used to mark the canopy shall conform to A-A-59291. Unless otherwise specified in the detail specification, contrasting colors shall be used for ease in identification.

3.5.2 Gore numbers. Each gore shall be numbered by stamping or stenciling the number of the gore in the right-hand corner of the outside of the lower sections on or adjacent to the skirt. The numbering sequence shall be clockwise when viewing the canopy from the top. The height of the numbers shall be a minimum of  $\frac{1}{2}$  inch.

3.5.3 Additional marking. Each parachute canopy designated for aircraft deceleration shall have the words THIS SIDE OUT stamped or stenciled near the skirt on the outside of the skirt section of each gore. Each extraction parachute canopy procured for Army use shall be stamped or stenciled THIS SIDE OUT on the top and bottom gores only near the skirt, on the outside of the skirt sections. The size of the characters shall be a minimum of 1 inch high.

3.6 Workmanship. The canopy, including all materials and accessories, shall be fabricated and finished in a workmanlike manner. Particular attention shall be given to freedom from blemishes and defects, accuracy of dimensions and markings, neatness and thoroughness of stitching, and proper assembly of component parts.



## MIL-DTL-9401C

## 4. VERIFICATION

4.1 Classification of Inspections. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall be performed on one complete parachute assembly, unless otherwise stated in the contract, when a first article sample is specified (see 3.1). The inspection shall include the tests and examinations of 4.3.1, 4.3.2, 4.4, and 4.5. Any defect or nonconformance shall be cause for rejection of the first article.

4.3 Conformance inspection. Conformance inspections shall include the examinations of 4.3.1, 4.3.2, 4.4 and 4.5. Sampling plans and acceptance/rejection criteria for 4.4 and 4.5 shall be as specified in the contract or purchase order. Parachute assemblies which fail the acceptance criteria shall be cause for rejection of the lot.

4.3.1 Component and material inspection. Components and materials shall be inspected in accordance with all of the requirements of referenced documents unless otherwise excluded, amended, modified, or qualified in this specification or applicable purchase document.

4.3.2 In-process inspection. Inspection of subassemblies shall be made to ascertain that construction details and dimensional requirements, which cannot be examined in the finished product, are in accordance with specified requirements. The Government reserves the right to exclude from consideration of acceptance any material or service for which in-process inspection has indicated nonconformance.

4.4 Examinations. The parachute assemblies shall conform to the visual and dimensional examinations as specified in the TDP for the associated item. Deviations from the TDP shall be classified in accordance with MIL-STD-849.

4.5 Tests.

4.5.1 Air Permeability. The number of completed canopies specified in Table I shall be selected at random from production and tested for air permeability. The cloth of completed parachute canopies shall be tested for air permeability to determine the compliance with the requirements of 3.4. The test shall be performed in accordance with ASTM D 737. The number of permeability readings shall be five in every fourth gore, excluding the top and bottom sections.

MIL-DTL-9401C

Table I. Canopies to be tested

Number of canopies produced per week	Number of canopies to be tested
0 - 10	1
11 - 25	2
26 - 50	3
51 and above	1 per day

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

(This section contains information of a general explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The ring slot parachute canopy covered by this specification is intended for application where high strength, low opening shock, and stability are of paramount importance, such as the deceleration of aircraft during approach and landing operation, the deceleration of missiles and target aircraft, and the aerial delivery of supplies and equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Part number (see 1.2).
- c. Issue of DoDISS to be cited in the solicitation and if required, the specification of individual documents referenced (see 2.2.1).
- d. When a first article is required (3.1).
- e. Sampling plan (see 4.3).
- f. Packing requirements (see 5.1).

MIL-DTL-9401C

6.3 Hole. A hole is defined as two or more broken yarns in the material in either the warp or the fill, or both.

6.4 Subject term (keyword) listing.

Aerodynamic  
Drag producing devices  
Decelerators

6.5 Changes from previous issue. Marginal notations are not used in this version to identify changes with respect to the previous issue due the extent of the changes.

Custodians:  
Army-GL2  
Navy-AS

Preparing Activity:  
Army-GL2  
  
(Project 1670-1018)

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

### I RECOMMEND A CHANGE:

1. **DOCUMENT NUMBER**  
MIL-DTL-9401C

2. **DOCUMENT DATE (YYYYMMDD)**  
20030512

### 3. DOCUMENT TITLE

Canopy, Parachute, Ring Slot, General Specification For Construction Of

### 4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

### 5. REASON FOR RECOMMENDATION

### 6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*

b. ORGANIZATION

c. ADDRESS *(Include Zip Code)*

d. TELEPHONE *(Include Area Code)*  
(1) Commercial  
(2) DSN  
*(if applicable)*

7. **DATE SUBMITTED**  
(YYYYMMDD)

### 8. PREPARING ACTIVITY

a. NAME

Natick Soldier Center

b. TELEPHONE *Include Area Code)*

(508) 233-4258

c. ADDRESS *(Include Zip Code)*

AMSSB-RAD-AD(N), Attn: J. Riley  
Natick, MA 01760-5017

**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:**