INCH-POUND

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6 February 2009
SUPERSEDING
MIL-C-44050A
18 August 1987

DETAILED SPECIFICATION

CLOTH, BALLISTIC, ARAMID

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

1. SCOPE

1.1 Scope. This document covers untreated, scoured, water-repellent treated, and adhesion modified aramid ballistic cloth.

1.2 Classification. This specification covers the following Types and Classes (see 6.2).

1.2.1 Types. The values listed are nominal, see Table I for acceptable range limits.

Type I	-	8.25 oz/sq. yd. (fragmentation protection)
Type IA	-	8.25 oz/sq. yd. (bullet protection)
Type II	-	14.0 oz/sq. yd.
Type III	-	6.8 oz/sq. yd.
Type IV	-	13.2 oz/sq. yd.
Type V	-	5.7 oz/sq. yd.

1.2.2 Classes.

Class 1	-	Untreated – (scoured)
Class 2	-	Water-repellent treated
Class 3	-	Adhesion modified
Class 4	-	Greige fabric (unfinished, loom-state, no slashing)

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center Philadelphia, Clothing and Textiles Directorate, ATTN: DSCP Standardization Team, 700 Robbins Avenue, Philadelphia, PA 19111-5096. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil/.

AMSC N/A FSC 8305

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

V-T-295	-	Thread, Nylon

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-32072	-	Thread, Polyester
MIL-DTL-46593	-	Projectile, Calibers .22, .30, .50, and 20MM Fragment-Simulating

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-662	-	V_{50} Ballistic Test for Armor

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL TRADE COMMISSION

Rules and Regulations under the Trade Fiber Products Identifications Act

(Copies of this document are available online at http://www.ftc.gov/ or from the Federal Trade Commission, Pennsylvania Avenue at Sixth Street, N.W, Washington, DC 20580.)

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 these documents are those cited in the solicitation or contract.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC Test Method 20A	-	Fiber Analysis: Quantitative
AATCC Test Method 22	-	Water Repellency: Spray test
AATCC Test Method 70	-	Water Repellency: Tumble Jar Dynamic Absorption Test
AATCC Test Method 96	-	Dimensional Changes in Commercial Laundering of Woven and Knitted Fabrics except Wool

(Copies of these documents are available from www.aatcc.org or American Association of Textile Chemists and Colorists (AATCC), PO Box 12215, Triangle Park, NC 27709-2215)

ASTM INTERNATIONAL

ASTM D885	-	Standard Test Methods for Tire Cords, Tire Cord Fabrics, and Industrial Filament Yarns Made From Manufactured Organic-Base Fibers.
ASTM D1422	-	Standard Test Method for Twist in Single Spun Yarns by the Untwist-Retwist Method
ASTM D1423	-	Standard Test Method for Twist in Yarns by Direct-Counting
ASTM D1907	-	Standard Test Method for Linear Density of Yarn (Yard Number) by the Skein Method
ASTM D3775	-	Standard Test Method for Warp (End) and Filling Count of Woven Fabrics
ASTM D3776	-	Standard Test Method for Mass Per Unit Area (Weight) of Fabric
ASTM D6193	-	Standard Practice for Stitches and Seams
ASTM E805	-	Standard Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials

(Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.)

NATIONAL INSTITUTE OF JUSTICE

NIJ Standard 0101.06	-	Ballistic Resistance of Body Armor

(Publications are available from http://www.nlectc.org or National Law Enforcement and Corrections Technology Center, P.O. Box 1160, Rockville, MD 20849–1160)

OTHER PUBLICATIONS

Repeat Insult Patch Test – Modified Draize Procedure
Principle and Methods of Toxicology, (fourth edition), A Wallace Hayes (editor), pp 1057-1060, 2001.

(Copies are available online at http://www.taylorandfrancis.co./uk or from Taylor and Francis, 325 Chestnut Street, Suite 8000, Philadelphia PA 19106.)

US ENVIRONMENTAL PROTECTION AGENCY NATIONAL LIBRARY NETWORK

(Laws and Regulations may be found on-line at http://www.epa.gov/libraries/index.html)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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 in the contract or purchase order (see 6.2), a sample shall be subjected to first article inspection (see 6. 3) in accordance with 4.3.

3.2 Material.

3.2.1 Fiber. All types of cloth shall be made from virgin para-aramid fiber (see 6.3).

3.2.2 Yarn. Minimum yarn tenacities and elongations to break required below are on the as-spun yarn.

3.2.2.1 Type I and IA. The warp and filling yarns shall be continuous filament, 1000 denier (nominal) and shall have a minimum average yarn breaking tenacity of 20.0 grams per denier. No individual yarn tenacity value shall be less than 19 grams per denier. The warp yarns shall have a minimum nominal twist of 1.5 turns per inch.

3.2.2.2 Type II. The warp and filling yarns shall be continuous filament 1500 denier (nominal) and shall have a minimum average yarn breaking tenacity of 20.0 grams per denier. No individual yarn tenacity value shall be less than 19 grams per denier. The warp yarns shall have a minimum nominal twist of 1.5 turns per inch.

3.2.2.3 Type III. The warp and filling yarns shall be continuous filament, 850 denier (nominal) and shall have a minimum average yarn breaking tenacity of 24.0 grams per denier and a minimum average elongation to break of 3.6 percent. No individual yarn tenacity value of the yarn shall be less than 22.5 grams per denier. The yarns shall be untwisted.

3.2.2.4 Type IV. The warp and filling yarns shall be continuous filament 3000 denier (nominal) and shall have a minimum average yarn breaking tenacity of 20.0 grams per denier. No

individual yarn tenacity value shall be less than 19 grams per denier. The yarns shall be untwisted.

3.2.2.5 Type V. The warp and filling yarns shall be continuous filament 600 denier (nominal) and shall have a minimum average yarn breaking tenacity of 24.0 grams per denier and a minimum elongation to break of 3.4 percent. No individual yarn breaking tenacity shall be less than 22.5 grams per denier. The yarns shall be untwisted.

3.3 Color. The color of the cloth shall be as produced from the fiber provided by the manufacturer. No bleach or color modifier shall be used.

3.4 Physical requirements. The physical requirements for the finished cloth shall be as specified in Table I when tested as specified in 4.4.3.

TABLE I. Physical requirements

CHARACTERISTICS	REQUIREMENTS									
	TYPE I & IA		TYPE II		TYPE III		TYPE IV		TYPE V	
	min	max	min	max	min	max	min	max	min	max
Weight (oz / yd^2) 1/	8	8.5	13.5	14.5	6.6	7.2	12.5	14.2	5.1	5.7
Yarns per inch:										
Warp	30	---	35	---	30	---	16	18	32	36
Filling	30	---	35	---	30	---	16	18	32	36
Yarn Break Force (lbf) 2/										
Warp	30	---	55	---	24	---	105	---	22	---
Filling	30	---	55	---	24	---	110	---	24	---
Water repellency (Class 2), Dynamic Absorption (% weight increase)										
Initial	---	15%	---	15%	---	15%	---	15%	---	15%
After one laundering	---	15%	---	15%	---	15%	---	15%	---	15%
Adhesion modified, Water repellency (Class 3), Dynamic Absorption (% weight increase)										
Initial	---	---	---	---	9%	15%	9%	15%	9%	15%

NOTES:

1/ Weight shall be determined on bone dry unfinished fabric.

2/ Test specimen shall be taken from scoured fabric for Class 1 fabrics, from finished fabric for Class 2 and Class 3 fabrics, and Greige fabric for Class 4.

3.5 Width. The minimum acceptable width shall be as specified in the contract or purchase order (see 6.2) and shall be inclusive of the woven selvage when fly shuttle looms are used and exclusive of the lock-in selvage when shuttleless looms are used.

3.6 Weave.

3.6.1 Types I, IA, III, IV, and V. The cloth shall be woven using a plain weave.

3.6.2 Type II. The cloth shall be woven using a 2 by 2 basket weave.

3.7 Finish.

3.7.1 Class 1. The cloth shall be scoured open width and dried following guidelines supplied by the fiber producer.

3.7.2 Class 2 (all types). The cloth shall be scoured (see 3.7.1) and water-repellent treated. The water-repellent treatment shall be fluorochemical based combined with a melamine extender and meet the requirements specified in Table I, 3.8, 3.9, (see 6.4) and 3.10.

3.7.3 Class 3 (Types III, IV and V). The cloth shall be scoured (see 3.7.1) and treated with an approved emulsified fluorochemical combined with a melamine extender in order to meet the requirements specified in Table I (see 6.4) and 3.10, for a controlled maximum treatment or minimum dynamic absorption.

3.7.4 Class 4 (all types). The fabric shall be delivered directly from the loom without scouring. Any finish to include slashing shall require the fabric to be scoured and classified as Class 1 material.

3.8 Spray rating (Class 2). The results of three individual determinations on the sample unit for spray rating shall be equal to or better than 100, 100, 90 initially and 90, 90, 80 after one laundering when tested as specified in 4.4.3.

3.9 Resistance to organic liquid (Class 2). The finished cloth shall show no wetting by n-dodecane initially, and after one laundering when tested as specified in 4.4.3.

3.10 Ballistic resistance.

3.10.1 Ballistic limit (Type I). The ballistic limit V_{50} for eight layers of unbonded cloth shall be not less than 1200 feet per second when tested as specified in 4.4.3, when using a 10 shot V_{50} with a maximum spread of 125 feet per second.

3.10.2 Bullet resistance (Type IA). Panels made up of eight plies of cloth shall defeat the 22 caliber, 40 grain long rifle (high velocity), lead bullets at 1050 + 50, -0 feet per second and the 38 caliber, 158 grain special round nose lead bullets at 850 + 50, -0 feet per second when tested as specified in 4.4.3.

3.10.3 Ballistic limit (Type II). The ballistic Limit V_{50} for 12 layers of unbonded cloth shall be not less than 1550 feet per second when tested as specified in 4.4.3 when using a 10 shot V_{50} with a maximum spread of 125 feet per second.

3.10.4 Ballistic limit (Type III). The ballistic limit V_{50} for 10 layers of unbonded cloth shall be not less than 1250 feet per second when tested as specified in 4.4.3 when using a 10 shot V_{50} with a maximum spread of 125 feet per second.

3.10.5 Ballistic limit (Type IV). The ballistic limit V_{50} for 10 layers of unbonded cloth shall be not less than 1300 feet per second when tested as specified in 4.4.3 when using a 10 shot V_{50} with a maximum spread of 125 feet per second.

3.10.6 Ballistic limit (Type V). The ballistic limit V_{50} for 28 layers of unbonded cloth shall be not less than 1775 feet per second when tested as specified in 4.4.3 when using a 10 shot V_{50} with a maximum spread of 125 feet per second.

3.11 Length and put-up. For Government procurements only, unless otherwise specified in the contract or purchase order (see 6.2), the cloth shall be furnished in rolls of 80 to 120 yards each. Each roll shall contain not more than two pieces and no single piece shall be less than 40 yards in length. Each length shall be put-up in full width rolls as specified.

3.12 Fiber Identification. Each roll of cloth shall be labeled and ticketed for fiber content in accordance with the Rules and Regulations under the Textile Fiber Products Identification Act.

3.13 Workmanship. The finished cloth shall conform to the quality of product established by this specification, and the occurrence of defects shall not exceed the specified quality level as specified in the contract or purchase order (see 6.2).

3.14 Toxicity. The finished cloth shall not present a health hazard and shall show compatibility with prolonged, direct skin contact when tested as specified in 4.5.7. Chemicals recognized by the Environmental Protection Agency (EPA) as human carcinogens shall not be used.

3.15 Lot Size The lot size shall be determined by the vendor and shall be specified in the contract or purchase order (see 6.2 and 6.6).

4. VERIFICATION

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

a. First article inspection (see 4.3).
b. Conformance inspection (see 4.4).

4.2 Testing facilities. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all the requirements as specified herein. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor may use his own or any other facilities suitable for the performance of the requirements specified herein, except ballistic tests (see 4.2.1), unless disapproved by the Government. The contracting officer shall include specific instructions in the contract or purchase order (see 6.2) regarding arrangement for examination, quantity and testing and approval. The Government reserves the right to perform or check any of the inspections set forth in this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements and to determine the validity of the certifications.

4.2.1 Ballistic testing facility. Unless otherwise specified in the contract or purchase order (see 6.2), the ballistic test panels shall be forwarded to the Commander, USA ATC, ATTN: CSTE-

DTC-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059 for ballistic testing for first article or production acceptance.

4.3 First article inspection. First article sample size shall be as specified in the contract or purchase order (see 6.2). First article inspection, except as otherwise indicated in this specification, shall utilize the same requirements and test methods as the conformance inspection shown in 4.4.

4.4 Conformance inspection. Conformance inspection shall include the examination of 4.4.2, the tests of 4.4.3, and the methods of inspection of 4.5.

4.4.1 In process examination. Visual and dimensional examinations shall be made at any point or during any phase of the manufacturing process to determine whether components which cannot be examined in the finished product are in accordance with requirements specified in Section 3. Materials and components which can be classified as having a defect in accordance with Table II shall be removed from production.

4.4.2 End item visual examination.

4.4.2.1 Yard-by-yard examination. Each roll in the sample shall be examined on the face side only for the defects listed below. The entire yardage of every roll shall be examined. All defects which are clearly noticeable at normal inspection distance (3 feet) shall be marked so as to remain visible and indicate the defect position upon unrolling. All defects, except for continuous defects, shall be marked regardless of frequency of appearance. A continuous defect shall be marked as one defect for each linear 1/4 yard in which it appears except that multiple continuous defects within the same linear 1/4 yard shall be marked as one defect. Any roll containing more than 15 strung defects per hundred linear yards shall be rejected.

Hard crease or wrinkle
Cut, hole, or tear
Broken or missing yarn
Smash
Multiple floats, mispick, harness skip, or other misweave
Jerked-in filling
Open or thin place, crack (warp or filling)
Loose, slack yarn
Fine yarn
Mixed yarn
Spot or stain through fabric
Woven-in waste 1/8 inch or larger in diameter
Abrasion mark
Baggy or wavy cloth
Any mend or darn
Width less than minimum specified

TABLE II. Component and end item tests.

CHARACTERISTICS		REQUIREMENT PARAGRAPH	TEST METHOD
Fiber identification		3.2.1	AATCC 20A
Yarn denier		3.2.2	ASTM D1907
Yarn breaking tenacity			
Types I and IA	Warp	3.2.2.1	ASTM D885
	Filling	3.2.2.1	ASTM D885
	Yarn twist	3.2.2.1	ASTM D1423 or D1422
Types II	Warp	3.2.2.2	ASTM D885
	Filling	3.2.2.2	ASTM D885
	Yarn twist	3.2.2.2	ASTM D1423 or D1422
Types III	Warp	3.2.2.3	ASTM D885
	Filling	3.2.2.3	ASTM D885
	Yarn twist	3.2.2.3	ASTM D1423 or D1422
Types IV	Warp	3.2.2.4	ASTM D885
	Filling	3.2.2.4	ASTM D885
	Yarn twist	3.2.2.4	ASTM D1423 or D1422
Types V	Warp	3.2.2.5	ASTM D885
	Filling	3.2.2.5	ASTM D885
	Yarn twist	3.2.2.5	ASTM D1423 or D1422
Color		3.3	ASTM E805 or Visual 1/
Weight		3.4	ASTM D3776
Yarns per inch	Warp	3.4	ASTM D3775
	Filling	3.4	ASTM D3775
Yarn break force (lbf)	Warp	3.4	ASTM D885 2/
	Filling	3.4	ASTM D885 2/
Water repellency (Class 2), Dynamic Absorption	Initial	3.4	AATCC 70
	After one laundering	3.4	AATCC 96 and AATCC 70
Adhesion modified, Water repellency (Class 3), Dynamic Absorption (% weight increase)	Initial	3.4	AATCC 70
	Weave	3.6	Visual 1/
	Finish (all Classes)	3.7	3/
Spray rating (Class 2)	Initial	3.8	AATCC 22
	After one laundering	3.8	AATCC 96 and AATCC 22
Resistance to organic liquid (Class 2)	Initial	3.9	4.5.1
	After one laundering	3.9	AATCC 96 and 4.5.1
Ballistic limit (Type I)		3.10.1	4.5.2
Bullet resistance (Type IA)		3.10.2	4.5.3
Ballistic limit (Type II)		3.10.3	4.5.4
Ballistic limit (Type III)		3.10.4	4.5.4
Ballistic limit (Type IV)		3.10.5	4.5.4
Ballistic limit (Type V)		3.10.6	4.5.4
Toxicity		3.14	4.5.7

1/ One determination shall be made from each sample unit and the results reported as "pass" or "fail". Visual inspection of the delivered fabric compared to manufacturer's standard product shall be determined.

2/ For the Type I and IA cloth, clamps with flat-grip type jaws may be used. For Type II cloth, the yarn shall be tested using a constant rate of extension (CRE) tensile testing machine set with a 10 ± 0.05 inch gage length and operated at 5 inches per minute speed. The yarn shall be tested at 1.5 turns per inch twist for Types I, IA and II cloth, 1.5 turns per inch for Type IV cloth, 2.8 turns per inch Z twist for Type III, and 3.3 turns per inch twist for Type V cloth. Twist may be added or removed as appropriate, but care must be taken to handle the yarn in such a manner that the twist does not deviate from the required twist level per inch prior to closing the jaws of the clamps on the specimen.

3/ Documentation shall be provided for all Classes stating the finish or lack of finish present.

4.4.2.2 Overall examination. Any roll containing any of the following defects shall be rejected.

More than two pieces in roll
Single piece less than 40 yards in length
Length of roll less than specified or less than indicated on ticket
Not labeled in accordance with Textile Fiber Products Identification Act

4.4.3 End item testing. The cloth shall be tested for the characteristics listed in Table II. The methods of testing specified/listed in Table II shall be followed. Except for ballistic resistance, the physical and chemical values specified in Section 3 apply to the results of the determinations made on a sample unit for test purposes as specified in the applicable test method. For fragmentation ballistic resistance, the V_{50} limit for the lot shall be reported as the average of all panels tested from the lot. The lot shall be unacceptable if the average V_{50} limit is less than 1200 feet per second for the Type I cloth, less than 1550 feet per second for the Type II cloth, less than 1250 feet per second for the Type III cloth, or less than 1300 feet per second for Type IV, or less than 1775 feet per second for the Type V cloth. For bullet resistance, the lot shall be unacceptable if any one of the test missiles penetrates any test panel.

The sample unit for test purpose shall be as follows:

(a) Ballistic tests.

1. Types I and IA. For fragmentation resistance testing (Type I), three cuts of 15 inches full width of the cloth with each cut originating from a different roll. For bullet resistance testing (Type IA), six cuts of 15 inches full width of the cloth with no more than two cuts originating from any one roll.

2. Type II. Five cuts at 15 inches full width of the cloth with each cut originating from a different roll.

3. Types III and IV. Three cuts of 15 inches full width of cloth with each cut originating from a different roll.

4. Type V. Seven cuts of 15 inches full width of the cloth with no more than two cuts originating from any one roll.

(b) All end item tests excluding ballistic tests. One cut 3 yards long full width of the finished cloth originating from one of the rolls from which the sample unit for ballistic testing was drawn. Each individual cut comprising the sample unit shall be marked to indicate contractor's piece, lot and roll number, and the Government lot number. The lot size shall be expressed in units of linear yards. The sample size (number of sample units) shall be as shown in Table III. The lot shall be unacceptable if one or more sample units fail to meet any requirement specified in Section 3.

TABLE III. Sample size.

Lot size (yards)	Sample size (units)
800 or less	2
801 up to and including 22,000	3
22,001 and over	5

4.5 Methods of Inspection.

4.5.1 Organic resistance test. Place a small specimen of the cloth on a smooth horizontal surface, face up, using a pipette or eye dropper, gently deposit one drop of n-dodecane on the surface of the specimen. After 1 minute, examine the specimen under light at an angle. Absence of light reflectance at the fabric drop interface shall be taken as evidence of wetting. Three specimens taken at various locations across the sample shall be tested. Evidence of wetting on any specimen shall be cause for rejection of the lot.

4.5.2 Ballistic resistance test (Type I). The test panels shall be made up of cut pieces taken from the sample unit. The size of each layer in the panels shall be approximately 15 inches by 15 inches. Each test panel shall contain 8 layers of cloth. The specimens shall be tested in accordance with the procedure in 4.5.6. Prior to conducting the test, the panels shall be preconditioned in the ballistic test area for at least 24 hours with air freely circulating on all sides of the layers. All test panels shall be sewn in accordance with 4.5.5.

4.5.3 Bullet resistance test (Type IA). The test panels shall be made up of cut pieces taken from the sample unit. The size of each layer in the panels shall be approximately 15 inches by 15 inches. Each test panel shall contain 8 layers of cloth. Prior to conducting the test, the panels shall be preconditioned in the ballistic test area for at least 24 hours with air freely circulating on all sides of the layers. All test panels shall be sewn in accordance with 4.5.5. The 8-layer panels being tested for bullet resistance shall be tested separately against the 22 and 38 caliber bullets and at the velocities specified in 3.10.2. Only dry panels shall be tested. The test procedures shall be in accordance with those specified for the Type I armor in NIJ Standard 0101.06.

4.5.4 Ballistic resistance test (Types II, III, IV, and V). The test panels shall be made up of cut pieces taken from the sample unit. The size of each layer in the panels shall be approximately 15 inches by 15 inches. Each test panel shall contain the appropriate number of plies of cloth as defined in section 3.10.1 – 3.10.6. The specimens shall be tested in accordance with the procedure in 4.5.6. Prior to conducting the test, the panels shall be preconditioned in the ballistic test area for at least 24 hours with air freely circulating on all sides of the layers. All test panels shall be sewn in accordance with 4.5.5.

4.5.5 Sewing of ballistic test panels (all Types). All ballistic test panels (all Types) shall be sewn around the periphery 1/2 inch ± 1/8 inch from the edges. The sewing shall be accomplished in accordance with the following:

a. Thread-Nylon, conforming to Type I, Class B of V-T-295, or Polyester conforming to Type I, Class 1, Subclass B of MIL-DTL-32072. Thread size shall be Tex size 70 (Government size "E"). Color shall be optional unless otherwise specified in the contract or purchase order (see 6.2).

b. The stitching shall be 9 stitches ± 1 stitch per inch.

c. The Seam type shall be SSa-1 in accordance with ASTM D6193.

d. The stitch type shall be 301 in accordance with ASTM D6193

4.5.6 Ballistic resistance V_{50} procedure. The ballistic resistance test for Type I, Type II, Type III, Type IV, and Type V cloth shall be conducted in accordance with MIL-STD-662 with the following exceptions:

a. The fragment-simulating projectile. The test projectile shall be the 22 caliber fragment-simulating projectile as specified in MIL-DTL-46593 except the fragment-simulating projectile weight shall be 17 grains ± 0.25 grains and the configuration of the fragment-simulating projectile shall conform to Figure 1 of this document for body armor in lieu of Figure l of MIL-DTL-46593A.

b. Barrel. The barrel shall be a .30 caliber rifled barrel with a one-in-sixteen twist. The barrel length shall be 28 inches. The barrel shall be chambered to accommodate firing the specified sabot as specified in the solicitation and/or contract (see 6.2).

c. Yaw card measurement system. A yaw card shall be used to determine yaw. The following procedure shall be employed.

1. Place the yaw card directly in front of the test sample with the emulsion side facing the sample. (The yaw card shall be devoid of any markings. Kodak photographic paper, single weight, Kodabromide, or equal may be used for the yaw card.)

2. After the test, carefully measure the yaw card to determine the largest dimension of the hole caused by penetration of the projectile. An optical magnification device with a magnification between 5X and 10X shall be used for making this measurement.

3. The firing shall be considered invalid if the determined degree of yaw is more than 5 degrees.

d. Test sample mount. The armor test sample shall be secured with impact sites perpendicular to the line-of-flight of the projectile. The frame supports and clamps or mounting fixtures must be capable of retaining the sample and withstanding shock resulting from ballistic impact by the test projectiles. The frame support shall have a flat surface without teeth. The test sample mount shall be capable of adjustment for moving the sample in the vertical or horizontal directions so that the point of impact can be located anywhere on the sample, and rotation on the vertical axis so that zero degree obliquity impacts can be achieved anywhere on the sample. The test sample mount shall be able to rotate on the vertical or horizontal axis so that various obliquity attack angles can be achieved. The test samples shall be mounted with rigidity equal to or greater than the actual installation of the part. The test panel shall be mounted between an inner and

outer metal frame. The frame shall be designed to capture the entire periphery of the test panel to a depth of 1-1/2 inches to 2 inches. The frame shall also be designed to provide a minimum available test area of 121 square inches. The mounting frame will be clamped, at a minimum, in eight locations around its periphery, i.e. at each corner and at the mid-point of each side. (NOTE: vise-grip type pliers or equal have been found to be acceptable for clamping.) The test panel shall be mounted with the expressed intent of providing for uniform tension throughout and to provide for a minimum of deflection at projectile impact.

e. Measurement of yaw. Yaw shall be determined using the system specified in 4.5.6. Yaw may be examined at any time deemed necessary. However, in any event, yaw shall be measured at intervals no less than those indicated below. When the barrel is new, a minimum of 25 shots shall be fired to "break-in" the barrel. Measurement of yaw shall be five successive shots at each interval.

Measurement interval

1. After "break-in" period.
2. After 250 shots.
3. After 500 shots.
4. After 750 shots.
5. After 1000 shots.

In the event the shots fired indicate yaw, the barrel shall be rechecked for affect on yaw as follows: Fire five shots, if three or more shots exhibit yaw, discard the barrel. If one or two shots exhibit yaw, investigate cause and correct. If no yaw is indicated at the 1,000 - shot interval, measurement for yaw shall be made at 100 shot intervals thereafter until such time as yaw is indicated. In the case of a dispute concerning a particular barrel, yaw shall be measured by a photographic measurement system using a multi-flash light source to determine projectile velocity and yaw. Yaw shall be measured by the system to an accuracy of 0.5 degree.

f. Fair Impact. The impact shall be considered fair when an unyawed test projectile strikes an unsupported area of the test panel at least 2 inches from a supported area of the test panel and at least 2 inches from any previous impact, and shall not involve the same warp or filling yarns of any previous impact.

4.5.7 Toxicity test. When specified in the contract or purchase order (see 6.2), an acute dermal irritation study and a skin sensitization study shall be conducted on laboratory animals. When the results of these studies indicate the (item) is not a sensitizer of irritant, a Repeat Insult Patch Test shall be performed in accordance with the Modified Draize Procedure (See 2.3). If the toxicity requirement (see 3.14) can be demonstrated with historical use data, toxicity testing may not be required and shall be specified in the contract or purchase order (see 6.2).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2 and 6.5). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. 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 or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Types I, II, and III cloth are intended for use in fragmentation protective garments. Type IA cloth is intended for use in bullet (handgun) protective garments. Type IV cloth are intended for use in fragmentation protective curtains. Type V fabrics are intended for use in fragmentation protective garments and curtains, and in bullet (handgun) protective garments and curtains.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Type and Class required (see 1.2).
c. When first article sample is required (see 3.1, 4.3, and 6.3).
d. Minimum acceptable width required (see 3.5).
e. Length and put up required if other than that specified (see 3.11).
f. Quality level of the occurrence of defeats (see 3.13).
g. Lot size (see 3.15).
h. If someone other than the contractor is responsible for the performance of all the requirements specified (see 4.2).
i. Characteristics testing facilities used (see 4.2).
j. Specific testing instructions (see 4.2).
k. Ballistic testing facility if other than specified (see 4.2.1) .
l. Sample size for first article (see 4.3).
m. If a color is required for the thread (see 4.5.5 a).
n. The specified sabot (see 4.5.6 b).
o. When toxicity testing is required (see 4.5.7).
p. Toxicity testing may not be required if the toxicity requirement can be demonstrated with historical use data (see 4.5.7).
p. Packaging requirements (see 5.1).

6.3 First article. When a first article inspection is required (see 3.1), it will be inspected and approved under the appropriate provisions of FAR 52.209-4. The first article should be a preproduction sample. The contracting officer should specify the appropriate type of first article

and the number of units to be furnished. The contracting officer should include specific instructions in acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Sources of supply for Types I, IA, II, III, IV and V fiber and yarn. Types I, IA, II and IV cloths described in this document reflect Kevlar® 29, and Types III and V reflect Kevlar KM2®. Possible sources of suppliers are E.I. DuPont & Co., Wilmington, DE, and Teijin Aramid.

6.5 Packaging. Packaging requirements, such as put-up and preservation, should be specified in the contract or purchase order. As a guide the wording specified in the cancelled standard, FED-STD-802, entitled: “Packaging of Synthetic Fiber Fabrics”, dated 19 April 1991 can be used.

6.6 Lot size. One recommendation is for the amount of fabric woven on one loom in one whole day of production. Regardless of the specification of lot size, the Table III in 4.4.3 calls out the number of test samplings required per quantity of fabric (measured in linear yards) identified as a particular lot.

6.7 Subject term (key word) listing.

Basket weave
Bullet protection
Fiber
Fragmentation protection
Fragment-simulating projectile
Looms
Pusher plate
Sabot
Virgin fiber
Water-repellent
Yarns

6.8 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

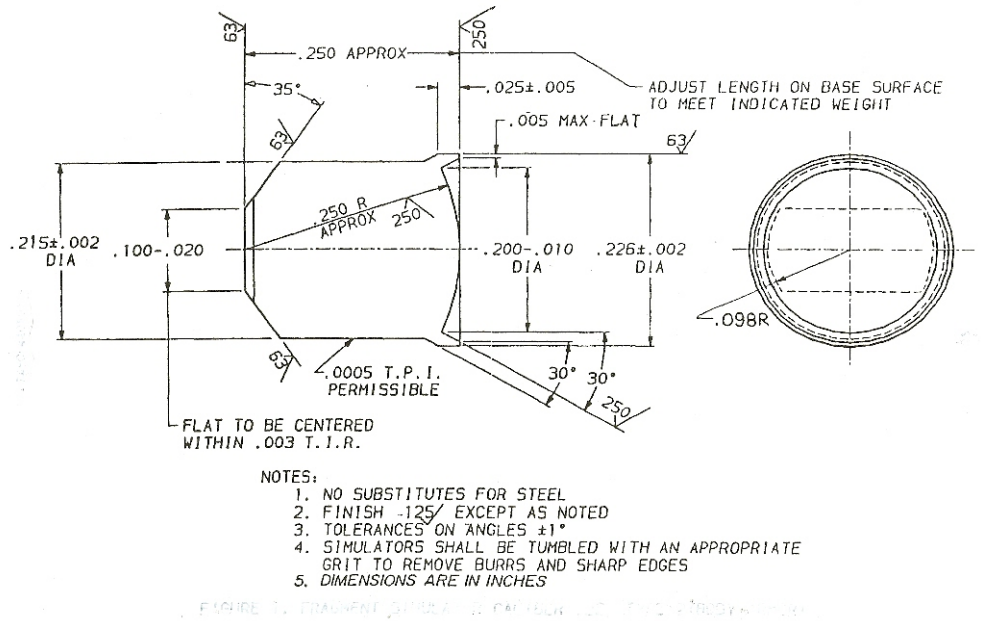

FIGURE 1. Fragment Simulator Caliber .22, Type 2 for Body Armor.

CONCLUDING MATERIAL

Custodians.
Army – GL
Navy - NU
Air Force – 11

Preparing activity:
DLA -CT

Project No. 8305-2008-001

Review activities:
Army – MD, MR
Navy – MC, AS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.