#005

INCH-POUND
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PURCHASE DESCRIPTION

FRAGMENTATION HELMET, LIGHTWEIGHT, USMC

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

1. SCOPE

1.1 Scope. This specification covers the performance and verification requirements for the Lightweight Fragmentation Helmet. The Helmet (Lightweight Helmet or LWH) consists of an operationally finished helmet and suspension system that provides ballistic and non-ballistic protection for ground combat Marines. The LWH is compatible with, and is typically worn in conjunction with other components of infantry combat equipment such as Interceptor Body Armor, protective spectacles/goggles and/or prescription glasses, nightvision equipment and a camouflage fabric helmet cover. When properly equipped and adjusted, the LWH is safe and certifiable for use in airborne operations. The LWH is a replacement for the Helmet, Ground Troops-Parachutists (also known as PASGT or "Kevlar®") for the U.S. Marine Corps.
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1.2 Classification. The helmet will be of two types, each available in five sizes. Each helmet consists of a finished shell, suspension system, retention system with chinstrap, headband, and necessary attachment hardware (See Figure 1). Type II is derived from Type I and has the shape profile of the Army's Advanced Combat Helmet (ACH). The helmet assembly will be of the following types as specified in 6.2.

Type I:	Full PASGT Cut
Type II:	Tactical Cut

1.3 Schedule of sizes. The helmet will be available in the following sizes (see 6.2).

Extra-Small (XS)
Small (S)
Medium (M)
Large (L)
Extra-Large (XL)

Comments, suggestions, or questions on this document should be address to: U.S. Army Natick Soldier Research, Development & Engineering Center, Attn: AMSRD-NSC-WP-WI, Kansas Street, Natick, MA 01760, or via email michael.codega@us.army.mil. Since contract information can change, you may want to verify the currency of this address information using the ASSIST inline database at http://assist.daps.dla.mil.

AMSC N/A

FSC 8470

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 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 documents cited in sections 3 and 4 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 listed in the solicitation or contract (see 6.2).

FEDERAL STANDARDS

FED-STD-191	- Federal Standard for Textile Test Methods

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-32075	- Label: For Clothing, Equipage and Tentage (General Use)
MIL-H-6083	- Hydraulic Fluid, Petroleum Base, For Preservation and Operation
MIL-H-46170	- Hydraulic Fluid, Rust Inhibited, Fire Resistant, Synthetic Hydrocarbon Base, NATO Code No. H-544
MIL-P-46593	- Projectile, Calibers .22, 30, .50 and 20mm Fragment-Simulating

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-662	- V_{50} Ballistic Test for Armor
MIL-STD-810	- Environmental Engineering Considerations and Laboratory Tests

(Copies of documents are available online at http://assist.daps.dla.mil or from the Standardization Documents 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 are those cited in the solicitation or contract.

DRAWINGS

U.S. ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND, NATICK SOLDIER CENTER

2-1-2557	- Dimensions for Examination of Helmet Shell, Type I
2-1-2558	- Dimensions for Examination of Helmet Shell, Type II
2-1-2559	- Helmet Assy, USMC Lightweight, Type I (All Sizes)
2-1-2560	- Helmet Assy, USMC Lightweight, Type II (All Sizes)
2-1-2561	- Helmet Shell, USMC Lightweight, Type I (All Sizes)
2-1-2562	- Helmet Shell, USMC Lightweight, Type II (All Sizes)
2-1-2566	- Helmet Pads

(Copies of drawings, publications, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity.)

2.3 Non-Government standards and other publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents are those cited in the solicitation or contract (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE

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

(Copies of documents are available online at www.ansi.org or from the American National Standards Institute, 1819 L Street, 6th floor, Washington, DC.)

AMERICAN SOCIETY OF TESTING MATERIALS (ASTM)

ASTM D 76	- Specification for Tensile Testing Machines for Textiles
ASTM D 523-89	- Standard Test Method for Specular Gloss
ASTM D 782-82	- Standard Method of Testing Shipping Containers in Revolving Hexagonal Drum (re-approved 1987)
ASTM E 4	- Standard Practices for Force Verification of Testing Machines
ASTM F 1291	- Standard Test Method for Measuring Thermal Insulation of Clothing Using a Heated Manikin

(Copies of documents are available on line at www.astm.org or from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19426-2959.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 8	- Colorfastness to Crocking: AATCC Crocking Method
AATCC 15	- Colorfastness to Perspiration
AATCC 16	- Colorfastness to Light
AATCC 61	- Colorfastness to Laundering, Home and Commercial: Accelerated
AATCC 169	- Weather Resistance of Textiles: Xenon Lamp Exposure

(Copies of documents are available on line at www.aatcc.org or from the American Association of Textile Chemists and Colorists, P. O. Box 12215, Research Triangle Park, NC 27709-2215.)

NATIONAL INSTITUTE OF JUSTICE (NIJ)

NIJ 0101.03	- Ballistic Resistance of Police Body Armor
NIJ 0106.01	- Ballistic Helmets

(Copies of documents are available on line at www.nist.gov/oles/oles-standards-publications.html or from the National Institute of Standards, Office of Law Enforcement Standards, 100 Bureau Drive, M/S 8102, Gaithersburg, MD 20899-8102.)

DEPARTMENT OF TRANSPORTATION FEDERAL MOTOR VEHICLE SAFTEY

DOT FMVSS-218 - Department of Transportation Federal Motor Vehicle Safety Standard No. 218 Motorcycle Helmets

(Copies of documents are available on line at http://www.nhtsa.dot.gov/cars/rules/standards/safstan2.htm. The complete test of all Federal Motor Vehicle Safety Standards and the other

NHTSA regulations can be found in Title 49 of the Code of Federal Regulations (CFR). Title 49 of the CFR is published in seven volumes, the fifth volume (Parts 400-999) is where these regulations can be found. Copies of this volume can be obtained for a cost from the U.S. Government Printing Office. Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328.)

U.S. ARMY DEVELOPMENT TEST COMMAND, ABERDEEN PROVING GROUND, MD

USATECOM ITOP 4-2-805 - Projectile Velocity and Time-of-Flight Measurements

(Copies of documents are available by sending to Commander, US Army Test and Evaluation Command, Attn: AMSTE-TM-T, Aberdeen Proving Grounds, MD 21005-5055.)

DEFENSE SUPPLY CENTER, PHILADELPHIA

2005 Visual Guide of Colors Used in Military Items Color Card

(Copies of documents are available by sending to Defense Supply Center, Philadelphia, Attn: DSCP-FQSB (Contract Officer, 700 Robbins Ave., Philadelphia, PA 19111.)

PUBLICATIONS

Natick/TR-96/036 - Matched Anthropometric Database of U.S. Marine Corps Personnel: Summary Statistics.

(Copies of this report are available from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161, http://www.ntis.gov or Defense Technical Information Center, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218, http://www.dtic.dla.mil.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this specification takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless there is a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 4.3 and 6.3).

3.2 Recycled, recovered, or environmentally preferable materials. Recycled, recovered or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the requirements of this document and promotes economically advantageous life cycle costs.

3.3 Materials, design, and manufacturing processes. Unless otherwise specified, the materials, design, and manufacturing processes shall be at the discretion of the contractor provided all articles submitted to the government meet the requirements of this specification.

3.4 Design. The LWH assembly shall be in five sizes, X-Small, Small, Medium, Large, Extra-Large. A complete helmet assembly consists of the following components and shall be in accordance with drawings 2-1-2559 and 2-1-2560 (see Figure 1):

a. Helmet Shell
b. Suspension Hook Disks
c. Suspension Pads (3/4 or 1-inch thick)
d. Retention Assembly
e. Attaching Hardware
f. Edging, Finish, and Labels
g. Use and Care Manual

3.4.1 Interchangeability. Components shall be interchangeable and modular such that replacement of any component with another like-sized unit shall have no detrimental effect on any of the requirements herein. Not all parts need be size specific, and it is desired that the minimum number of unique parts/assemblies capable of meeting the requirements of this specification be used. When purchased as a separate component, the Helmet Shell shall be complete with edging, finish, hook disks and labels. Verification shall be in accordance with 4.10.2.

3.4.2 Weight. The maximum weight of the finished helmet assembly (shell, pad suspension system, retention system, paint, edging and attaching hardware) shall not exceed the weights listed in Table I. Lower weights capable of meeting requirements herein are desired. Verification shall be in accordance with paragraph 4.11.3.

TABLE I - Finished weights by size.

Size	Type I (lbs)	Type II (lbs)
Extra-Small (XS)	3.00	
Small (S)	3.13	2.94
Medium (M)	3.31	3.06
Large (L)	3.44	3.31
Extra-Large (XL)	3.94	3.88

3.4.3 Helmet shell. Prior to the application of any edging or finish, the helmet shell shall conform to drawings 2-1-2561 and 2-1-2562. The outside surface is defined by the inside surface plus the thickness (see 3.4.3.1). Verification shall be conducted in accordance with paragraph 4.11.4.

3.4.3.1 Shell thickness. The maximum thickness for the helmet shell shall not exceed 0.400 inch. The thickness shall be uniform within ± .050 inch, regardless of actual thickness. Verification shall be in accordance with paragraph 4.11.4.1.

3.4.3.2 Benchmarks. Benchmarks per drawings 2-1-2561and 2-1-2562 on both the inside and outside periphery of the shell shall extend past the helmet shell edge or edging (if used) 0.50 (± 0.30) inch. The benchmarks shall be clearly visible. Verification shall be in accordance with paragraph 4.11.4.2.

3.4.3.3 Deleted.

3.4.3.4 Paint adhesion. The helmet paint shall be adhered to the outer helmet shell surface so as to withstand operational use and typical abuse. Verification shall be in accordance with paragraph 4.11.4.4.

3.4.4 Edging. The helmet shell shall provide some means of ensuring that raw edges are not left exposed, which may lead to delamination, wear, cuts, and tears, or injury to the user. The edging itself shall not be susceptible to cutting, wear, or tear, or pose a hazard to the user. If the edging is not an integral component of the molded shell, then it shall consist of a one-piece molded construction or one piece cut to length, firmly bonded such that it protects the entire periphery of the shell and extends up the sides a minimum of 0.30 inch. If cut to length, the cut end shall be placed at the rear center of the shell and the butt ends shall be within 0.060 inch of each other. The edging shall be feathered at the top and rounded at the corners. The edging shall be colored the same color as the exterior of the shell (see 3.7.1). Verification shall be in accordance with paragraph 4.11.5.

3.4.4.1 Edging adhesion. If edging is used then it shall be capable of remaining firmly bonded to the shell. Verification shall be in accordance with paragraph 4.11.5.1.

3.4.4.2 Edging adhesion after heat aging. The edging (if used) shall not peel back more than 0.25 inch when tested as specified in paragraph 4.11.5.2.

3.4.5 Pad suspension and retention systems. The pad suspension system will attach to the helmet shell without the use of hardware or thru-holes. The retention system will attach to the helmet using the four side attachment holes shown on drawings 2-1-2557 and 2-1-2558.

3.4.6 Hook disks. The hook disks shall be permanently affixed to the inside of the helmet shell by means of a pressure sensitive adhesive. The opposite side of the disks shall consist of hook tape to engage the loop surface of the suspension pads. Testing shall be conducted in accordance with 4.12.1. The exterior color (side facing pad) of the hook disk shall be Black 357. Testing shall be conducted in accordance with 4.10.2.

3.4.6.1 Hook disk shape and coverage. Hook disk shape is at the discretion of the contractor; however shapes with square corners (i.e. rectangles or square cut tape strips) or pointed corners are unacceptable since they have demonstrated a tendency to peel at the corners. A circular shape 1-7/8-inch in diameter is been shown to be satisfactory. Alternatively, an oblong shown in Figure 3 may be acceptable and provide more coverage. Adequate number and size of hook disks shall be installed on the interior of the shell to allow movement of the pads into any position and to allow securing of the helmet cover. At a minimum, enough hook disk shall be installed to allow the smallest pad to be placed anywhere inside the shell and have at least 50% of the pad's surface in contract with hook disk(s). However, no hook disk shall cover any of the molded in markings. Testing shall be conducted in accordance with 4.12.1.

3.4.6.2 Hook disk durability. At no time shall removal of any helmet pad cause the hook material to become separated from the helmet shell. The adhesive shall firmly attach the disk to the inner surface of the helmets with no lifting of the hook disks on any contours within the helmets. Test in accordance with 4.12.2.1 and 4.12.2.2.

3.4.6.3 Hook/loop adhesion. The adhesion between the hook disk and the outer material on the pad shall be a minimum of 2.8 lbs/inch of width. Testing shall be in accordance with 4.12.2.2.

3.4.7 Attaching hardware. Unless otherwise approved, the retention components shall be attached to the helmet shell with four No. 10-32 TPI (threads-per-inch) slotted truss head shoulder screws. Each screw length will be selected based on helmet and retention component thickness to ensure threads fully engage nuts, but such that the screw does not protrude into the interior of the helmet. Backing nuts and all other hardware used on inside of the helmet (including the suspension/retention component itself) shall have a total thickness not greater than

0.25-inch when measured from the inside surface of the helmet shell. Hardware capable of withstanding and resisting impact from the 9mm FMJ RN is required.

3.4.8 Pad suspension system. The helmet shall utilize a modular pad suspension system consisting of a series of pads that act as the suspension system between the wearer's head and the helmet shell. The pads shall provide standoff, comfort, protection, and stability. The pads shall attach, remove, and reattach to the helmet shell via hook tape disks permanently adhered to the inside of the helmet shell. The pads shall remain firmly in place when attached. The ease of attachment of the pads and the ability to attach the pads where the wearer desires (i.e. in a variety of locations) shall permit accommodations among different size and shape heads. All pad suspension system and retention components system shall minimize liquid absorption and be capable of being cleaned with mild detergent and water. The pad suspension system and retention components shall be capable of being completely removed and installed in 30 minutes. Testing shall be conducted in accordance with 4.13. Mandatory source for this component shall be in accordance with 6.7.2.

3.4.8.1 Pad suspension design. Three different pad shapes-round, trapezoidal, and oblong-shall be utilized to form the suspension system (see 3.4.8.2). A complete pad suspension kit shall consist of seven pads as follows: one round pad (crown), two trapezoidal pads (front and back), and four oblong pads (distributed around the perimeter to achieve comfort and stability) (see 3.4.8.2). Testing shall be conducted in accordance with 4.13.

3.4.8.2 Pad dimensions and shape. Drawing 2-1-2566 shows the shapes and dimensions of the pads. All pads shall be 3/4-inch (nominal) thickness. In addition, the trapezoidal and oblong pads shall be available in 1-inch (nominal) thickness (see 3.4.8.1). The pads shall be uniform in thickness. Figure 2 shows pads installed in the standard pad configuration. Testing shall be conducted in accordance with 4.13.

3.4.9 Retention system. The retention system shall utilize four points of connection to the helmet shell in order to ensure stability side-to-side and front-to-back. The rear webs shall include a nape pad for comfort and stability. Each leg of the retention system, as well as the chinstrap shall be independently adjustable. The chinstrap buckle shall be capable of being mounted on the left or right sides. The chinstrap shall allow for quick and inexpensive replacement without tools. Verification shall be in accordance with paragraph 4.10.2. Mandatory source for this component shall be in accordance with 6.7.3.

3.4.9.1 Retention system static pull strength. The pull strength of the retention system shall be at least 200 lb., but less than 300 lb. Verification shall be in accordance with paragraph 4.15.4.

3.5 Construction

3.5.1 Helmet shell. The outer and inner surfaces of the shell, including the bottom edge, shall be finished smooth and even. If fabric construction is used, there shall be no exposed ends of the fabric fiber showing. Both the inside and outside surfaces of the shell shall be free from any hole, void, delamination, blister, cracking, crazing, dry spot, area of non-resin flow or pit greater than .125-inch diameter or greater than one ply deep. There shall be no raised fibers, pleats, wrinkles or creases on the inside or outside surfaces. Verification shall be conducted in accordance with paragraphs 4.10.2.

3.5.2 Helmet shell lay-up. Individual ply patterns ("pinwheels"), if used, shall be designed and applied so as to provide a uniform protection level around the entire helmet. All areas of the helmet shell must provide at minimum the protection levels as stated in paragraph 3.6.1, 3.6.2

and 3.6.3. The use of multiple materials in the helmet lay-up (i.e., hybrid construction) is permissible, provided all other requirements herein are met.

3.5.3 Molding. No patching, repairing, or remolding shall be performed after the shell has been molded, except that gaps and pits permissible under 3.5.1 shall be filled.

3.5.4 Drilled holes for suspension and retention components. Attachment holes in the helmet shell shall be cleanly drilled perpendicular to the helmet surface before application of the final finishing. There shall be no delamination of the shell material as a result of the drilling operation. Holes shall be in accordance with 2-1-2561.

3.5.5 Outer surface preparation. If required, prior to the application of any coating to the outer surface of the helmet, the material shall be appropriately prepared in order to meet the performance requirements for finish. If surface preparation includes abrading then the ballistic material shall show no signs of being visibly cut, gouged or raised. Before application of the final coating the surface shall be free of any contaminants including dust, oil, grease or any other foreign matter.

3.5.6 Texturing. The outer surface of the shell shall be textured with an aggregate prior to or in conjunction with the final coating. The aggregate shall be uniformly applied to the entire outer surface of the helmet shell down to and including the outer surfaces of the edging (if used). If walnut shell flour is used as the aggregate, it shall be 40/100 mesh and mixed at 10-12 ounces per gallon of coating. If sand is used as the texturing material, then it shall be mixed at 96 ounces per gallon prior to being reduced to spraying consistency, water washed and kiln dried, free of salts and deleterious matter, and containing not more than 1.5 percent of dirt or foreign matter. The coating-sand mixture shall contain 6 pounds of sand to one base gallon of coating and shall be reduced to spraying consistency, It shall conform to No. 70 with a screen analysis as follows:

Sieve No. (U.S. STD)	Cumulative Percent
No. 40	0.5 max.
No. 50	6.0 (±3)
No. 70	34.0 (± 5)
No. 100	82.0 (± 5)
No. 140	97.0 (+ 3, - 5)

3.5.7 Pad construction. The pad shall have at least three distinct layers or be designed in such a way as to function in three distinct ways as follows: An inner layer, padding layer, and an outer layer. The three layers shall be permanently joined around the perimeter to prevent disassembly. Testing shall be conducted in accordance with 4.13.

3.5.7.1 Inner layer material. The inner layer material shall contact the wearer's head, shall wick moisture away from the wearer's head and absorb it. The color shall be Foliage Green 504. Materials in this layer shall be comfortable and suitable for prolonged skin contact. Testing shall be conducted in accordance with 3.7.7 and 4.13.3.

3.5.7.2 Padding layer material. The padding layer material shall provide standoff, comfort, impact protection and stability. It shall not absorb or hold moisture when tested in accordance with 4.13.2. It may itself consist of multiple layers. Thickness of this layer shall provide for the bulk of the overall pad thickness required. Specific requirements and tests are contained elsewhere in this document. Testing shall be in accordance with 4.13.

3.5.7.3 Outer layer material. The outer material shall be made of a loop-type material to allow the pad to be attached to the hook disks on the inside of the helmet shell. The material shall have an average peel strength no less than 2.8 lbs per inch of width when tested in accordance with 4.11.2. The outer material shall interface with hook disc. The color shall be Foliage Green 504.

3.5.7.4 Pad compression durability. The pads shall be constructed such that they withstand multiple compressions without failing. The pads shall be subjected to repeated ¼-inch compressions and show no signs of degradation. Degradation includes but is not limited to the structure of the pad loosing its resiliency; not returning to its original shape or thickness. There shall be no physical damage to any of the pad components. Physical damage includes but it is not limited to breakage of threads (if used), seams or closures, damage to any of the components such that they do not return to original shape and thickness. Testing shall be in accordance with paragraph 4.13.1.

3.6 Ballistic requirements

3.6.1 V_{50} ballistic limits (fragmentation and handgun). The helmet shell shall meet minimum V_{50} ballistic limits of Table II for 0-degree obliquity. Testing at 45-degree obliquity will be conducted for Government Reference only. Performance at various conditions is required in paragraphs 3.8. Increased performance is desired. V_{50} ballistic limit testing shall be performed in accordance with paragraph 4.14.

TABLE II – V_{50} Ballistic Limits (Fragmentation and Handgun) in ft/sec.

Threat	V_{50} (ft/sec) 0-deg
2-gr RCC 1/	4200
4-gr RCC 1/	3475
16-gr RCC 1/	2475
64-gr RCC 1/	1750
17-gr FSP 2/	2,200
124-gr 9mm FMJ Bullet	1,650

1/ See Figure 4.
2/ MIL-P-46593A, Type 2

3.6.2 Resistance to penetration. The helmet shell shall resist penetration from the 124-gr 9mm FMJ bullet at 0-degree obliquity and 1400 (+ 50) ft/sec when tested in accordance with paragraph 4.14. Performance at various conditions is required in paragraphs 3.8.

3.6.3 Ballistic transient deformation. Ballistic transient deformation of the shell shall not exceed 0.63 inch (16 mm) against 9mm projectile at 1400 (+ 50 –0) ft/sec at 0° obliquity for shots made to the right side, left side, and crown. Ballistic transient deformation shall not exceed 1.0 inch (25 mm) for impacts to front and back. Testing shall be conducted in accordance with paragraph 4.14.

3.6.4 Low-velocity impact attenuation (bump protection). The finished helmet assembly shall provide non-ballistic protection to the wearer by reducing accelerations to a maximum of 150 G when tested in accordance with paragraph 4.14.6. Greater impact protection (i.e., lower G) is desired. Additionally, there shall be no physical damage such as delamination, ply separation, or shell fracture or indentation in excess of 0.15-inch present after impact testing.

3.7 Operating requirements

3.7.1 Color. The color of the outer surface of the helmet shell, edging and visible attachment hardware (if used) shall be Coyote Brown 498 (or Foliage Green 504) of 2005 Visual Guide of Colors Used in Military Items Color Card (see 6.2, 6.3 and 6.5). When the final exterior finish is applied after assembly, hardware will be painted with the helmet shell. However, when the helmet shell is finished before installation of the retention system, black hardware is permissible in lieu of Coyote Brown (or Foliage Green). The interior helmet shell and the remainder of the edging shall be the same shade as the exterior, unless approved otherwise. The retention components shall be Coyote Brown 498 (or Foliage Green 504) to match the helmet shell (see 6.2, 6.3 and 6.5). Verification shall be conducted in accordance with paragraph 4.15.1.

3.7.2 Infrared reflectance. The texturing and color coating (for the finished shell) and retention systems shall meet the spectral reflectance requirements of Table III when verified in accordance with paragraph 4.15.2.

TABLE III – Infrared reflectance requirements.

Wavelength(nm)	Coyote Brown 498 Reflectance (%)	
	Min	Max
600	8	20
620	8	20
640	8	22
660	8	24
680	10	24
700	14	24
720	16	28
740	20	34
760	30	44
780	40	50
800	45	56
820	42	-
840	42	-
860	42	-

3.7.3 Specular gloss. The outer surface of the helmet shell shall have a specular gloss as specified below. Verification shall be in accordance with ASTM D 523-89, Standard Test Method for Specular Gloss.

Angle	Min	Max
60 degree	-	1.0
85 degree	-	3.5

3.7.4 Colorfastness. All textile components used in the suspension and retention systems shall exhibit colorfastness to laundering, crocking, perspiration and light of Grade 3 or better when tested in accordance with paragraph 4.15.3.

3.7.5 Skin toxicity. The contractor shall show that finished materials are non-toxic when tested in accordance with:

a. Title 40, Code of Federal Regulations (CFR), Section 798.4100, Dermal Sensitization

b. Title 40, CFR, Section 798.4470, Primary Dermal Irritation
c. Title 40, CFR, Section 798.4500, Primary Eye Irritation
d. "Contact Allergy: Predictive Testing in Humans" Marzulli, F & H Maibach, Advances in Modern Toxicology, Volume 4, pp. 353-372, 1977.

An alternative to animal and human testing, the contractor may provide information which certifies that the materials are composed of chemicals which have been safely used commercially where prolonged skin contact has occurred. This would include Material Safety Data Sheets for the chemical finish/treatment, bonding agents and/or adhesive.

3.7.6 Hazardous materials. Hazardous material ~~exposure to~~ personnel shall be controlled to levels below the OSHA Permissible Exposure Limits. ~~The~~ helmet system shall not present any uncontrolled health hazard throughout the life-cycle of the item. Hazardous materials that can be exposed to personnel or the environment during any operational or maintenance procedures (to include transportation, assembly, repair or disposal), exposed as a result of damage to the helmet, or requiring special disposal procedures shall not be used. Environmentally acceptable materials shall be used whenever possible without degrading operational function and maintaining cost effectiveness.

3.8 Operating environment requirements

3.8.1 Flame resistance. The finished shell shall be flame resistant. The maximum after flame shall be 5 seconds and the maximum afterglow shall be 5 seconds. The helmet shell shall not exhibit melting or dripping when tested in accordance with paragraph 4.16.1. Flame resistance of the suspension components is desired.

3.8.2 Field agent resistance. The finished helmet shell shall be capable of meeting all performance and operating requirements, and show no evidence of softening, peeling, delamination, ply separation, or tackiness when exposed to the following agents. Verification shall be in accordance with paragraph 4.16.2.

a. DEET insect repellent (NSN: 6840-01-284-3982)
b. Fire resistant hydraulic fluid (MIL-H-46170)
c. Hydraulic fluid, petroleum base (MIL-H-6083)
d. Gasoline
e. Diesel fuel

3.8.3 Temperature extreme resistance. The finished helmet shell shall be capable of meeting all requirements herein when tested at high 160° F (± 10°F) and low minus 60° F (± 10°F) temperatures. The shell shall exhibit no cracking, delamination, separation of plies, distortion, softening, change in thickness greater than 2.5 percent, or other deterioration. Thickness measurements are to be taken at five random locations on the shell. The same five random data points shall be measured before and after testing. The 2.5 percent change criterion is based on a point-to-point comparison and not an average of the measurements. Verification shall be conducted in accordance with paragraph 4.16.3.

3.8.4 Helmet compression resistance (top to bottom). The finished helmet shell shall be capable of meeting all requirements herein after being subjected to repeated top-to-bottom compression. There shall be no height change greater than .0625 inch (absolute), nor any visible delamination, ply separation, distortion or paint ~~chipping after~~ the compressions. Verification shall be in accordance with paragraph 4.16.4.

3.8.5 Helmet compression resistance (side to side). The finished helmet shell shall be capable of meeting all requirements herein after being subjected to repeated side-to-side compression.

There shall be no width change greater than .125 in. (absolute), nor any visible delamination, ply separation, distortion or paint chipping after the compressions. The maximum displacement during testing shall not exceed 2.0 in. Verification shall be in accordance with paragraph 4.16.5.

3.8.6 Seawater resistance. The finished helmet shell shall be capable of meeting all requirements herein after immersion in seawater. The finished helmet shell and suspension system (excluding the headband and chinstrap) shall show no evidence of cracking, softening, peeling, blistering, delamination, increase in weight of more than 3% (± 0.1 ounce) over dry weight, or degradation of ballistic performance. Verification shall be in accordance with paragraph 4.16.6.

3.8.7 Weatherometer resistance. The finished helmet shell shall be capable of meeting all requirements herein after weathering. The finished helmet shall exhibit no evidence of cracking, blistering, delamination, ply separation, color change, separation of edging (if used) or degradation of ballistic performance after weatherometer exposure. Verification shall be in accordance with paragraph 4.16.7.

3.8.8 Temperature shock. The finished helmet shell shall be capable of meeting all requirements herein after exposure to temperature cycles. There shall be no visible damage to the finished helmet when subjected to the environmental extremes of minus 60°F and 160°F within a 5-minute period. The helmet and suspension system shall exhibit no cracking, delamination, separation of plies, distortion, softening of coating, increase or decrease in thickness greater than 2.5% or other deterioration. Thickness measurements are to be taken at five random locations on the shell. The same five random data points shall be measured before and after testing. The 2.5 percent change criterion is based on a point-to-point comparison and not an average of the measurements. Verification shall be in accordance with paragraph 4.16.8.

3.8.9 Altitude. The finished helmet shall be capable of meeting all requirements herein from sea level to 15,000 feet altitude. No damage or performance degradation shall occur when the helmet is exposed to a pressure change equivalent to a drop in altitude from 40,000 feet to 15,000 feet. The shell shall exhibit no cracking, delamination, separation of plies, distortion, softening, change in thickness greater than 2.5 percent, or other deterioration. Thickness measurements are to be taken at five random locations on the shell. The same five random data points shall be measured before and after testing. The 2.5 percent change criterion is based on a point-to-point comparison and not an average of the measurements. Testing shall be in accordance with section 4.16.9.

3.8.10 Impact resistance. The finished helmet shell shall be capable of meeting all requirements herein and shall show no signs of structural damage including delamination, separation of plies, or shell fracture when subjected to a 40 ft-lb impact in accordance with paragraph 4.16.11. The exterior finish shall show no signs of flaking, peeling, loss of adhesion, or other failure of the finish except within a 2.0-in. radius around the center point of impact. Indentation shall not exceed a depth of .150 inch from the original surface to the deepest point of the indentation.

3.8.11 Vibration. All helmet components including the shell, retention system, and hardware shall exhibit no structural, visible or operational degradation or physical damage when subjected vibration. There shall be no structural, visible or operational degradation to the finished helmet when subjected to vibration. Minor paint and edging scuffing, marring or wear marks are acceptable. No helmet parts shall become loose or disassembled when subject to vibration. "Loose" shall be defined as not meeting the original adhesion, tightness, or torque (as applicable) as when manufactured or assembled. Test in accordance with 4.16.11.

3.9 Ownership and support requirements

3.9.1 Marking of helmet shells. The helmet shell shall be marked on the inside crown surface area with the applicable size lettering XS, S, M, L, or XL as appropriate. The contractor's trademark or symbol, mold number and year of manufacture shall be marked in the inside crown area of the shell in a manner suitable to ensure legibility after storage and use. The inside shall also be labeled with nomenclature, contract number, national stock number, size, contractor's name, and traceability information. Metal materials shall not be used for identification marking purposes. Verification shall be in accordance with paragraph 4.17.1.

3.9.2 Marking of retention assemblies. Retention system and components must be suitably marked for identification so as to ensure legibility after storage and use. When part of the helmet system a visible area on the retention assembly shall be labeled in accordance with MIL-DTL-32075, Type IV, with the letters "LMCH" (Lightweight Marine Corps Helmet). It shall be clearly marked with the size (or abbreviation ~~letters X-S, S, M, L, X-L~~) as appropriate. When procured as an individual component the parts shall be placed in a snug fitting heat sealable plastic bag. Each bag shall have a paper label inserted into it, with the following information printed on it in accordance with MIL-DTL-32075, Type VII I, Class 5. If separable sub-components are intended to be used with more than one size, then all applicable sizes or range of sizes (or all sizes) shall be listed.

3.9.3 Marking of pad suspension system components. The pad suspension system shall be clearly marked by a permanent means. Each pad of the system shall be individually marked. Labeled shall conform to Type IV, Class 4 or Type VI, Class 4 of MIL-DTL-32075. The label shall indicate the item nomenclature, contract number, national stock number (NSN), contractor's name, size, and traceability information. If a Type IV label is used, it shall be located on the back side of the pad on the outer material. If a Type VI label is used, it shall be located in the seam of the pad or otherwise attached so as not to interfere with the attachment of the pad to the hook disks. Traceability information shall enable the manufacture to determine the date of pad manufacture and lot information on all materials used in the pad. The pad suspension system shall be permanently marked for identification regardless of use, maintenance or storage. Testing shall be conducted in accordance with paragraph 4.17.1. Each pad shall have a label with the thickness of the pad identified by a permanent means to each pad. Test in accordance with 4.10.2.

3.9.4 Barcode label. Each finished helmet or components of the finished helmet shall have a pressure sensitive bar-coded label attached to the outside package. The bar code elements shall be a 13 digit national stock number (NSN) and a twelve digit Universal Product Code (UPC) assigned for all NSNs by the Government. The initials "UPC" and "NSN" shall appear beneath the code. The bar codes for the NSN and UPC shall be medium to high density, clearly legible and readable by scanner. Testing shall be conducted in accordance with paragraph 4.10.2.

3.10 Shelf life. The helmet depot storage life shall be a minimum of 15 years under a direct maximum load of 20 lb. when tested in accordance with paragraph 4.17.2.

3.11 Repair/replacement kit. When required by purchasing activity (see paragraph 6.2), additional chinstraps or other repair parts shall be furnished with each helmet. A replacement kit, including parts that can be repaired at the individual level in the field, shall be available. The kit shall be provided in a durable, lightweight, re-sealable plastic bag.

3.12 Workmanship. The finished helmet shall conform to the quality of product established by this specification. Utmost care shall be taken during fabrication to ensure quality workmanship and safety of the service person using the item. Deviations in acceptable manufacturing procedures and/or quality of materials being used shall immediately be reported to the

contracting officer or his designee. Except as otherwise specified herein, repairs are not allowed to be made to the helmet.

3.13 Instruction booklet. Each finished helmet shall be supplied with one copy of a technical manual ™. The current TM is approximately 35 pages in 4.5-inch x 5.5-inch landscape format, printed on paper with tan card stock covers. Contents of the final TM will be provided to the contractor electronically in MS-Word® or Adobe® Portable Document Format (.pdf) as GFI prior to start of production.

4 VERIFICATION

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

1. First article inspection (see 4.3)
2. Quality conformance inspection (see 4.4)

Unless otherwise specified, the contractor is responsible for the performance of all inspection requirements specified herein. The government reserves the right to perform any of the inspections set forth where such inspections are deemed necessary to ensure the items conform to the specified requirements.

4.2 Responsibility for compliance. All items shall meet the requirements of section 3 and test methods of section 4 of this specification. The absence of any inspection requirement shall not relieve the contractor of the responsibility of ensuring that all items submitted to the government for acceptance comply with all requirements of the contract, including this specification. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements; however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the government to accept defective material. If there is a conflict between the stated requirements and the ANSI/ASQC Z1.4 standard, the more restrictive standard shall apply.

4.3 First article inspection. When specified (see 6.2), sample(s) shall be subjected to first article inspection in accordance with Table IV. Helmets used for first article testing shall be randomly selected from among the five sizes, unless otherwise stipulated in the contract.

4.4 Conformance inspection. The sampling inspection for conformance inspections (production lot inspections) shall be performed in accordance with ANSI/ASQC Z1.4, as defined by contract, except where otherwise indicated. Helmets used for conformance inspection testing shall be randomly selected from the sizes comprising the presented lot. Samples selected shall be examined for the defects specified in 4.10.2 and subjected to the tests indicated in the Conformance Lot inspection column in Table IV. Acceptance criteria shall be specified in the contract (see 6.4). Unless otherwise specified, a certificate of compliance will be acceptable as evidence that certain requirements are met (see note 1/ of Table IV). When certificates of compliance are submitted, the Government reserves the right to inspect such items to determine the validity of the certification.

4.4.1 Construction (in process) inspections and production data. A government-appointed quality assurance specialist will be responsible for conducting in-process inspections. Upon request, furnish production data as requested by the contracting officer or his designated representative.

4.5 Certificate of compliance. When certificates of compliance are submitted the government reserves the right to inspect or test such items to determine the validity of the certification.

4.6 Verification methods and alternatives. Acceptable verification methods included in this section are visual inspection, measurement, demonstration, tests, analysis, and similarity to previously approved, or previously qualified designs. In-process inspections are used to mitigate destructive end-item testing.

4.6.1 Verification alternatives. Contractors may propose alternative test methods, techniques, or equipment, including the application of statistical process control, tool control, or cost-effective sampling procedures to verify performance. See contract for alternatives that replace verification methods in this specification.

4.7. Requirements and verifications. The requirements and verifications cross reference is depicted in Table IV. The sequence of tests and examinations are at the discretion of the contractor unless otherwise specified. Typically, order of verifications will be in-process inspections, visual inspections, measurements, demonstrations, non-destructive tests, destructive tests and analysis. Unless otherwise specified, a single helmet may be used for multiple inspections, measurements and demonstrations, tests and analyses. A separate helmet may be used for each destructive test.

Table IV – Requirements and verifications.

Characteristic	Requirement paragraph	Verification paragraph	First article 1/	Lot acceptance 1/
Design	3.4	4.11.1	X	3/
Interchangeability	3.4.1	4.10.2	X	3/
Weight	3.4.2	4.11.3	X	X
Helmet shell	3.4.3	4.11.4	X	3/
Shell thickness	3.4.3.1	4.11.4.1	X	3/
Benchmarks	3.4.3.2	4.11.4.2	X	3/
Paint adhesion	3.4.3.4	4.11.4.4	X	2/
Edging	3.4.4	4.11.5	X	3/
Edging adhesion	3.4.4.1	4.11.5.1	X	2/
Edging adhesion after heat aging	3.4.4.2	4.11.5.2	X	3/
Pad suspension and retention systems	3.4.5	4.10.2	X	3/
Hook disks	3.4.6	4.12.1	X	3/
Hook disk shape and coverage	3.4.6.1	4.12.1	X	3/
Hook disk durability	3.4.6.2	4.12.2.1, 4.12.2.2	X	2/
Hook/loop adhesion	3.4.6.3	4.13.2.4	X	3/
Attaching hardware	3.4.7	4.10.2	X	3/
Pad suspension system	3.4.8	4.13	X	3/
Pad suspension design	3.4.8.1	4.13	X	3/
Pad dimensions and shape	3.4.8.2	4.13	X	3/
Retention system and chinstrap	3.4.9	4.10.2	X	3/
Static Pull Strength	3.4.9.1	4.15.4	X	3
Construction	3.5	4.10.2	X	3/
Helmet shell	3.5.1	4.10.2	X	3/
Helmet shell lay-up	3.5.2	4.10.2	X	3/
Molding	3.5.3	4.10.2	X	3/
Drilled holes for retention	3.5.4	4.10.2	X	3/

Characteristic	Requirement paragraph	Verification paragraph	First article 1/	Lot acceptance 1/
components				
Outer surface preparation	3.5.5	4.10.2	X	3/
Texturing	3.5.6	4.10.2	X	3/
Pad construction	3.5.7	4.13.1	X	3/
Inner layer material	3.5.7.1	4.13.2, 4.13.3	X	3/
Padding layer material	3.5.7.2	4.13.1	X	3/
Outer layer material	3.5.7.3	4.11.2	X	3/
Pad compression durability	3.5.7.4	4.13.1.1	X	3/
Ballistic requirements	3.6	4.14	X	2/
V_{50} ballistic limits 2-, 4-, 16-, 64-gr 17-gr FSP 124-gr 9mm	3.6.1	4.14	X X X	2/
Resistance to penetration	3.6.2	4.14	X	2/
Ballistic transient deformation	3.6.3	4.14	X	3/
Low-velocity impact attenuation	3.6.4	4.14.6	X	2/
Operating requirements	3.7	4.15	X	3/
Color	3.7.1	4.15.1	X	3/
Infrared reflectance	3.7.2	4.15.2	X	3/
Specular gloss	3.7.3	ASTM D 523	X	3/
Colorfastness	3.7.4	4.15.3	X	3/
Retention system static pull strength	3.7.5	4.15.4	X	3/
Thermal insulation	3.7.6	4.15.5	X	3/
Skin toxicity	3.7.7	4.10.2	X	3/
Hazardous materials	3.7.8	4.10.2	X	3/
Operating environment requirement	3.8	4.16	X	3/
Flame resistance	3.8.1	4.16.1	X	3/
Field agent resistance	3.8.2	4.16.2	X	3/
Temperature extreme resistance	3.8.3	4.16.3	X	3/
Helmet compression resistance (Top to bottom)	3.8.4	4.16.4	X	3/
Helmet compression resistance (Side to side)	3.8.5	4.16.5	X	3/
Seawater resistance	3.8.6	4.16.6	X	3/
Weatherometer resistance	3.8.7	4.16.7	X	3/
Temperature shock	3.8.8	4.16.8	X	3/
Altitude	3.8.9	4.16.9	X	3/
Impact resistance	3.8.10	4.16.10	X	3/
Vibration resistance	3.8.11	4.16.11	X	3/
Ownership and support requirement	3.9	4.10.2	X	3/
Marking of helmet shells	3.9.1	4.17.1	X	2/
Marking of retention assemblies	3.9.2	4.17.1	X	2/
Marking of pad suspension system components	3.9.3	4.17.1	X	2/
Barcode label	3.9.4	4.10.2	X	2/
Shelf life	3.10	4.17.2	X	3/
Workmanship	3.12	4.10.2	X	3/

1/ An "X" in the column designates that that test is performed. Sampling rate is specified in 4.4 for conformance lot testing unless otherwise specified in the contract.
2/ Sampling rate for these tests will be in accordance with contract.
3/ Documentation shall be provided certifying that the design, materials and processes have not changed since approval of FAT. The government reserves the right to inspect or test such items to verify validity of certification.

4.8 Responsibility for verification. Unless otherwise specified in the contract or purchase order (see paragraph 6.2), the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the purchase order or contract, with prior notification and approval the contractor may use any facilities suitable for the performance of the inspection requirements specified herein. The government reserves the right to witness all inspections and/or perform any of the inspections set forth in this document when such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.9 Responsibility for compliance. All items submitted to the government for acceptance shall meet all requirements of sections 3 and 5. The inspections set forth in this document shall become a part of the contractors overall quality program. The absence of any inspection method shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the government for acceptance comply with all requirements of the contract and this specification. Sampling in quality conformance does not authorize submission of defective material (either suspected, indicated or actual), nor does it commit the government to accept defective material based on the tested samples.

4.10. Methods of inspection

4.10.1 In-process inspections. Inspect process, raw materials, lower assemblies and/or certificates of conformance (CoC) to ensure that requirements are met and/or parts/materials meet the same standards as those used in the approved standard sample (see also paragraph 4.8).

4.10.2 Visual examination. The completed end item shall be examined for the defects listed in Table V.

TABLE V - End item visual defects.

Examination	Defect	Classification	
		Major	Minor
Helmet shell	Any fabric fibers visibly cut or raised on the shell body.		201
	Any surface dent, depression, or area not smooth.		202
	Any delamination or blister.	101	
	Any evidence of cracking.	102	
	Any evidence of dry spot, any area of nonresin flow or other molding deficiency.	103	
Helmet shell (cont.)	Any fabric gap, any pit except those specified as (see 3.5.1).	104	
	Any raised pleat or wrinkle, or any raised crease (groove) 1 inch or longer.		203
	Any permissible gap or pit not resin filled as specified (see 3.5.1 & 3.5.3) (exterior only).		204
	Any unauthorized patching, repair or reworking.	105	
	Any evidence of metallic fasteners.	106	
	Any benchmark omitted or obliterated. 1/		205

Examination	Defect	Classification	
		Major	Minor
	Any attaching hole exhibiting delamination, or other damage of the shell material.	107	
	Any attaching hole exhibiting fraying (uncut material attached at the edge of the hole).	108	
	Note: Criteria apply to interior and exterior of helmet except as noted. Shell is examined prior to coating.		
Edging	Not completely covering bottom periphery and sides as specified except for gap at rear of helmet if piece cut to length.		206
	Any cut, tear, or hole.		207
	Any area not adhered to shell.		208
	If piece cut to length		
	- ends overlapped		209
	- gap between ends in excess of 0.100 inch (if piece cut to length).		210
	Butt joint not in rear of helmet.		211
	Not correct color		212
	NOTE: Criteria apply to interior and exterior of helmet except as noted. Shell is examined prior to coating.		
Finish (coating) on exterior, Color on interior	Any scuffed area or scratch.		213
	Finish wet or tacky to the touch.	109	
	Coating furrows, flakes, or peels when scratched with fingernail.	110	
	Blemish, such as peeling, blistering, or flaking.	111	
	Not a smooth, uniform coating (i.e., run or sag affecting an area more than one square inch).		214
	Not completely and uniformly cover the shell surface and the outside of the edging.		215
	Not of specified thickness	112	
	Foreign matter embedded in or appearing on the finish, such as dirt, stain, oil, or grease.		216
	Color of exterior finish not as specified.	113	
	Interior color of shell not as specified.	114	
	Final coat not containing specified aggregate.	115	
	Texturing aggregate overrun extending beyond edge into interior surface of helmet.		217
Finish (coating) on exterior, Color on interior (cont.)	Not uniformly applied to the outside surface of the helmet shell including the outside of the edging.		218
	Hardware exposed on the exterior and interior of the shell, (e.g. screw heads) painted		219
	Evidence of cut blisters	116	
	Ballistic material showing signs of being visibly cut, gauged or raised	117	
	Any unauthorized repair.	118	
Pad suspension	Pads not as specified herein, damaged in any way, not		

Examination	Defect	Classification	
		Major	Minor
assembly	correct number and shape.	119	
	Any required component omitted.	120	
	Any component misplaced or not assembled.	121	
	Color of any component not as specified.	122	
	Any hole, cut, tear, or smash.	123	
	Any material not firmly or tightly woven, edges frayed or scalloped.		220
	Any material with multiple floats.		221
	Any material with abrasion mark, broken or missing yarns, slub, or broken end or pick, or multiple floats (if applicable).		222
	Any mend, yarn, or patch.		223
	Any raw edge (note that raw edge not securely caught in stitching shall be classified as open seams).		224
	Any open seam (note that a seam shall be classified as an open seam when one or more stitches joining a seam are broken or when two or more consecutive or runoff stitches occur).		225
	Stitch tension loose, resulting in loose bobbin or top thread.		226
	Stitch tension excessively tight, resulting in puckering material.		227
	Stitching ends not secured.		228
	Thread breaks, skipped stitches, or run-offs not overstitched.		229
	NOTE: Sewing defects apply only if item has sewing.		
Retention System	Any component incorrectly installed on helmet (e.g., wrong side or backwards).	124	
	Any required component omitted.	125	
	Any sharp edge or burr. 2/	126	
	Any hardware not secured in the orientation specified.	127	
	Any hardware component not finished as specified.	128	
	Any holes, cut, tear, or smash in webbing.	129	
	Webbing not firmly or tightly woven, edges frayed or scalloped.	130	
	Webbing possessing multiple floats.	131	
	Webbing possessing abrasion mark, broken or missing yarns, slub, or broken end or pick. Any holes, cut, tear, or smash.	132	
	Any mend, yarn, or patch.	133	
	Any raw edge (note that raw edge not securely caught in stitching shall be classified as open seams).		230
	Any open seam (note that a seam shall be classified as an open seam when one or more stitches joining a seam are broken or when two or more consecutive or runoff stitches occur).Stitch tension loose, resulting in loose bobbin or top thread.		231
	Stitch tension excessively tight, resulting in puckering		232

Examination	Defect	Classification	
		Major	Minor
	material. Stitching ends not secured. Thread breaks, skipped stitches, or run-offs not overstitched. Bartack or box-x, if any, omitted. Bartack or box-x, if any, not as specified or not in specified location.	134 135 136 137	
Marking	Shell: omitted, incorrect, illegible, or not as specified. Pads: omitted, incorrect, illegible, or not as specified. Retention System: omitted, incorrect, illegible, or not as specified. Barcode: omitted, incorrect, illegible, or not as specified.	138 139 140 141	
Manual	Omitted.	142	

1/ The helmet shall be examined from a distance of approximately 2 feet.
2/ A sharp edge shall be defined as something likely to cut skin if contracted.

4.11.1 Design. Inspect for conformance to the requirements in paragraph 3.4. Any non-conformance shall constitute a failure.

4.11.2 Pad dimensions and shape. The pads shall be examined for conformance to the thickness and shape requirements specified in 3.4.8.2. Each pad shall be measured to verify its thickness. The pad thickness shall be measured at five random locations and the results averaged. If the pad has a fabric material on either the pad inner material or the pad outer material, that material shall be removed prior to measurement. The average shall be within 0.0625-inch of the nominal thickness (3/4 or 1 inch). The shape of the pad shall meet shapes shown in 2-1-2566 within + 1/8-inch (i.e. the pads can exceed the shapes shown in 2-1-2566 by up to 1/8-inch, but shall be no smaller than the outline shown). Any nonconformance to the requirements specified in 3.4.8.2 shall be cause for test failure.

4.11.3 Weight. Individually weigh a minimum of five finished helmets of each size to the nearest 0.01 pounds. Any individual measurement above the requirements of paragraph 3.4.2 shall constitute a failure.

4.11.4 Shell. Examine at least one helmet shell of each size with appropriate measuring equipment accurate to within 0.01 in. to determine compliance with paragraph 3.4.3. Any non-conformance shall constitute a failure.

4.11.4.1 Thickness. Measure the helmet shell with appropriate measuring equipment accurate to 0.005 in. at five different locations. One dimension shall be taken at the approximate top center of the shell (but not on the top benchmark, if present) and the other four measurements shall be taken in the approximate center in each of the four lower sections not less than 3.50 in. from the top center. Inspect at least one helmet per size. Any measurement not within the tolerance specified in paragraph 3.4.3.1 shall constitute a failure.

4.11.4.2 Benchmarks. Measure the length of the benchmarks with appropriate measuring equipment accurate to 0.05 in. Any non-conformance with paragraph 3.4.3.2 shall constitute a failure.

4.11.4.3 Deleted.

4.11.4.4 Paint or coating adhesion. Cut 3 parallel, straight lines .0625 to .125 in. apart in any direction with a sharp scribe, razor, or knife held at 30 (± 5) degrees to the surface tangent. The cuts shall completely penetrate the paint or coating. These lines shall be crossed with 3 perpendicular lines .0625 to .125 inch apart. This procedure produces squares, which shall be inspected visually for any paint lifting. Any paint lifting in excess of 50% of a any square shall be cause for test failure. A slight unevenness of the edges of any square shall not be considered cause for test failure.

4.11.5 Edging. Inspect the helmet shell for raw edges left exposed. Measure the height of the edging (if used) with appropriate measuring equipment accurate to 0.05 in. at five different locations approximately equidistant from each other along the periphery of the shell. If a cut end is present, measure the gap to the nearest .01 in. Any individual measurement not in conformance to paragraph 3.4.4 shall constitute a failure.

4.11.5.1 Edging adhesion. Edging adhesion shall be determined by manually and visually inspecting the brim of the edging on both the inside and outside of the helmet. A section or area of the edging shall be considered un-bonded when the edge can be rolled back from the helmet by the ball of the thumb or finger. The specimen shall be tested after the edging has been applied for 24 hours. Any non-conformance to the requirement specified in paragraph 3.4.4.1 shall be considered a failure.

4.11.5.2 Edging adhesion after heat aging. Heat the shell in a chamber to 160 (± 5) degrees Fahrenheit for 4 hours (± 30 minutes), then allow to cool to room temperature. Using a sharp knife cut through the edging along the outer corner for a distance of approximately 2 inch. At one end of the cut, make another cut through and across the outer side of the edging and peel it back to form a tab approximately 0.50 in. in length. Attach a 1.5-lb. weight to the tab and arrange the shell and weight so that the pull is normal to the plane of the glue line under test. Make suitable gage marks on the specimen for the measurement of the amount of peeling during the test. Allow the weight to hang for 1 hour (±10) minutes and measure the amount of peeling back of the tab. The test shall be performed at two different locations on the shell and the two results shall be averaged. Any non-conformance to requirements of paragraph 3.4.4.2 shall constitute a failure.

4.12 Hook disk and loop

4.12.1 Hook disks. The finished helmet shall be visually inspected. Additionally, the smallest pad shape shall be placed at five random locations in the helmet while no other pads are inside the shell. The area of the pad that is in contact with the hook disk(s) shall be measured. The area of the hook disk(s) that are in contact with the pad shall be measured. Any nonconformance with the requirements of 3.4.6 shall be cause for test failure.

4.12.2 Hook disk adhesion. Using a finished shell without disks, apply a disk to the inside surface of a helmet per manufacturer's recommendations. Let disk and helmet sit for a period of 24 (± 1 hr) hours. After the required time frame, attempt to remove disk from helmet shell by peeling up using fingernail. Peeling up of the hook disk shall be cause for a test failure.

4.12.2.1 Self-stick adhesive hook tape helmet adhesion. Die cut a minimum of 5 self-stick hook disks and place on the inside of the finished shell, allowing a minimum of 15 hours or

overnight curing time at room temperature to set-up a maximum bond to the interior of the shell. Place 5 finished oblong/oval pads (or the smallest shape) with representative knit loop tape onto separate helmet hook disks. Press each pad firmly into each hook disk. Allow 2 hours engagement time and slowly pull each loop pad off each disk. Evidence of any hook disk lifting, curling or other disturbance of adhesive or paint used on the hook disk, or delamination of the shell shall be cause for test failure.

4.12.2.2 Hook/loop adhesion. With 2 inch wide by 6 inch long loop tape laying face-up on hard surface place a 1-inch wide by 5-inch long strip of hook tape face-down on top of loop tape such as to engage the tapes. Roll a 5 pound circular weight back and forth 5 times on top of hook tape. Use either calibrated push-pull scale ~~or testing machine~~ in accordance with ASTM D 76 in order to peel engaged hook and loop apart for 3-inches at a rate of 6-inches/min. Make five separate determinations, each using separate (new) hook and loop tape specimens. Record the maximum peel value registered by the push-pull scale or the D76 machine. Non-conformances with the requirements of 3.4.6.3 shall constitute test failure.

4.13 Pad construction. The pads shall be examined for conformance to the requirements specified in 3.5.7, 3.5.7.1, 3.5.7.2, 3.5.7.3 and 3.5.7.4. Any nonconformance to the specified requirements shall constitute test failure.

4.13.1 Pad compression durability test. The finished pad shall be subjected to cyclic compressions on a constant rate of extension (CRE) ~~machine~~ in accordance with ASTM D 76 except that the machine shall be used in the compression mode as follows: Position the pad on the base plate of the machine and orientated so that inner material will contact the moving top platen. The moving plate shall have a flat face surface large enough so that the entire face of the pad is compressed. Cycle the moving head such that the pad is compressed a minimum of 0.25-inch during each cycle at the rate of 12 (± 1-inch) inch/minute while the moving head is in contact with the pad. The cycle shall include a period of 15 seconds where the moving head is not in contact with the pad. Cycle the pad for 6570 cycles. Examine the pad and then carefully remove the fabric (if pad designed with fabric) from the coated foam. Examine the coating on the foam (if pad designed with coating). Failure of the pad to meet the requirements of 3.5.7.4 shall constitute failure of the tests.

4.13.2 Water absorbency. One pad of each shape ~~shall~~ have the inner and outer material carefully removed so as not to damage the padding material. The pad shall be weighed to the nearest centigram. The pad shall be completely immersed in salt water to a depth not exceeding six inches for a minimum of 12 hours. The salt water ~~shall~~ meet the composition specified in 4.16.6.1. Once the pad is removed from the water, shake it by hand for a minimum of 1 minute and maximum of 5 minutes in various orientations to remove bulk water. Alternately, one side of the pad may be placed on a dry paper towel for up to two minutes to blot. Each other side of the pad may be placed on another dry paper towel for up to 2 minutes. A side may be placed on the paper towel only once. The pad then shall be allowed to sir dry for a maximum of 24 hours in an ambient environment of 70°F (± 2°) and 65 % (± 2%) relative humidity on a screen rack or other device to allow drying off all sides of the padding. The rack may be angled to facilitate dripping of any bulk water. As an alternate, the inner and outer material may be left on the pad instead of removing. The pad (with or without the inner and outer material) may be rinsed with fresh water after removal from the salt water. If the pad has increased in weight more than 3% then the test shall constitute test failure.

4.13.3 Inner material absorbency. The contractor shall suitably demonstrate that the material used as the inner material meets the requirements of 3.5.7.1.

4.14 Ballistic verifications

4.14.1 Ballistic test information. For all ballistic tests, the minimum information below shall be required by the government to validate performance. In a situation where the V_{50} BL data sheet would compromise the Security Classified Guide for Armor Materials, the data sheet should exclude the specific projectile used during testing.

a. Contractor identification.
b. Test facility.
c. Contract number.
d. Lot numbers and quantities.
e. Item specification (name, number, date).
f. Armor description, including exact materials, thickness, sizes, weights of all components and areal density of armor system.
g. Identification number (serial number) of each test sample.
h. Test date.
i. Temperature and humidity measurements.
j. Personnel conducting and witnessing tests.
k. Weapon used.
l. Projectile used.
m. Projectile weight, in grains.
n. Type of propellent.
o. Weight of propellent for each shot, in grains.
p. Yaw angle.
q. Angles of target obliquity.
r. Velocity measurements of each test shot taken against the armor (regardless of whether that particular velocity was used in a determination). Strike velocities will be presented next to instrument velocities and velocity loss over base line.
s. PP (Partial Penetration) and CP (Complete Penetration) next to each shot velocity as determined by witness plate.
t. Calculated results, including (as appropriate) V_{50}, High Partial, Low Complete, Range of Results, Zone of Mixed Results, Backface Deformation.
u. Location of the shot on the test sample.

4.14.2 Ballistic test criteria. Unless otherwise stated all ballistic testing shall be performed using the following procedures:

4.14.2.1 Projectile velocity determination. Projectile velocity shall be determined to an accuracy of 1 ft/sec. Measurement methods may employ either high velocity lumiline screens or electrical contact screens that either open or close an electric circuit upon passage of the projectile. An electric counter type chronograph measuring to the nearest micro-second, or at most 10 microseconds, shall be used with these measuring devices. Alternatively, radiographic or radar equipment capable of calculating projectile velocity may be used. See USATECOM ITOP 4-2-805 for additional information.

4.14.2.2 Weapon mounting configuration. The spacing from the weapon muzzle to the first pair of triggering devices shall be sufficient to prevent damage from muzzle blast and obstruction from smoke in case optical devices are used. Recommended distances can be found in USATECOM ITOP 4-2-805.

4.14.2.3 Test area conditions. All ballistic tests shall be performed in a standard atmosphere of 68 (± 10)°F and 50 (± 20)% relatively humidity unless otherwise stated.

4.14.2.4 Projectile yaw determination. Projectile yaw shall be measured for each firing by yaw cards, flash radiograph or photography. The measurement system employed should be capable of measuring yaw to within an accuracy of 1.0 degree. Any round for which yaw is

determined to be greater than 5.0 degrees shall be disregarded in the calculation of the ballistic limit.

4.14.2.5 Witness plate for PP and CP determination. Complete and partial penetrations shall be determined based on the impressions left on an aluminum witness plate. The witness plate material shall be 0.020 in. (0.51 mm) thick sheets 2024-T3, 2024-T4 or 5052-H38 aluminum alloy. The witness plate shall be rigidly mounted inside the helmet approximately 3.0 in. behind the area of impact. The witness plates shall be of sufficient size to be impacted by all fragments resulting from projectile penetration.

4.14.2.6 Calculation of striking velocities. Strike velocities shall be calculated from instrument velocities by subtracting projectile drag from over the baseline. See USATECOM ITOP 4-2-805 for additional information.

4.14.2.7 Ballistic test sample mounting. For ballistic limit testing, the test sample shall be rigidly mounted on the test target mount with the impact side at the specified obliquity to the line-of-flight of the projectile. The clamps or securing fixture must be capable of retaining the sample and withstanding shock resulting from ballistic impact by the test projectiles. For resistance to penetration tests, the test samples shall be mounted on a headfrom conforming to NIJ 0106.01 (see paragraph 4.14.4 and 4.14.5).

4.14.2.8 Helmet sections. The helmet shall be divided into five sections with markings made on the outside surface of the shell. The sections shall be as described below with the 0-degree mark aligned with the center front benchmark, and arcs proceeding clockwise when viewed from above. The lower sections (sectors) shall be formed by lines extending from the helmet edge to the crown benchmark. The upper limit of each lower section shall be defined by a circle of 4-inch diameter about the center benchmark (i.e., TOP and other sections over lap by 1-inch). Unless otherwise specified, shot locations by section and position with each section shall be completely random.

Section	Location
TOP	5-in diameter, centered on top benchmark
FRONT	Sector from 315 to 45 degrees
RIGHT	Sector from 45 to 135 degrees
BACK	Sector from 135 to 225 degrees
LEFT	Sector from 225 to 315 degrees

4.14.2.9 Projectiles. Right Circular Cylinders (RCC) shall conform to Figure 4. Fragment Simulating Projectile (FSP) (17-grain only) shall conform to MIL-P-46593. The 124-grain 9mm projectile shall be Remington 9mm x19 Full Metal Jacketed (metal case) Round Nose (FMJ RN) bullet.

4.14.3 V_{50} Ballistic limits for fragmentation and handgun. Conduct a V_{50} Ballistic Limit (Protection Criteria) in accordance with MIL-STD-662 except as otherwise stated herein. Place two fair impacts (one for the 64-grain and 9mm projectiles), randomly into each section, except that one of the two fair impacts in the TOP section shall be within 1 inch of the center crown point. Any impact whose actual impact location is within a 0.5 inch radius of its original targeted locations shall be considered to meet the intended obliquity. If an impact is outside of the 0.5 inch radius shall be considered an unfair impact and not used. The 0.5 inch radius shall not apply if the actual impact location or the original targeted impact location is within 0.375 inch of the ear flap crease. An impact resulting in a complete penetration shall be considered unfair if it is within 1.5 inches of another impact, within 1.5 inches of the closest edge of any hole, within 1.0 inches of the edge of the helmet. If two fair impacts cannot be placed in a

section, the second impact shall be placed on another helmet but not in the same location as the first impact. If an impact, unfair because of location, results in a partial penetration, it may be considered a fair impact. The location of each shot on the helmet shall be reported. Calculate a V_{50} from 10 fair impacts within 125 ft/sec including an equal number of the lowest velocity complete penetrations (CP) and highest velocity partial penetrations (PP). If the range of results exceeds 125 ft/sec, then calculate a V_{50} based on 14 fair impacts within 150 ft/sec. If neither of these two requirements can be satisfied, the requirement shall be considered met by at least 14 impacts consisting of at least 7 PP above the V_{50} requirement, and no CP below the V_{50} requirement. If none of the above conditions can be met, the test shall be considered inconclusive.

4.14.4 Resistance to penetration tests. Demonstrate resistance to penetration by five partial penetrations on a finished helmet assembly with a set of seven 3/4-inch pads mounted in the standard configuration (Figure 2). Test in accordance with NIJ 0106.01, except as otherwise noted. Mount the helmet in an as-worn orientation on the headform, securing the retention system to the headform. Threats and velocities shall be those indicated in paragraph 3.6.2, and shall include transient deformation measurements (see 4.14.5). Complete penetration shall be defined as complete perforation of the shell by the projectile or fragment of the projectile as evidenced by the presence of that projectile, projectile fragment, or spall in the clay, or by a hole which passes thru the shell. In the case of the fastener test, any evidence of the projectile, fragment of the projectile, or fragment of the shell, projectile, or fastener, in the clay shall be considered a complete penetration. Any complete penetration shall constitute a test failure.

4.14.4.1 Shot locations for resistance to penetration tests. Five shots shall be placed into the sample as follows:

a. One shot shall be placed into the crown at the approximate intersection of the mid-saggital and coronal planes.

b. One shot shall be placed into each side, along the coronal plane approximately 2 inches above the ear flap.

c. One shot shall be placed into the front and rear sections along the mid-saggital plane, approximately 2 and 3 inches above the brim and rear edge of the helmet respectively.

d. In lieu of one impact (b) or (c) above, place one impact on one of the four retention system fasteners. For this impact, the helmet shall be rotated to align the impact with a slot in the headform, or an alternate headform made entirely of clay or one with an appropriately oriented slot may be used.

4.14.5 Ballistic transient deformation. Determine transient deformation a finished helmet assembly with a set of seven 3/4-inch pads mounted in the standard configuration (Figure 2) for the threats and velocities specified in paragraph 3.6.3 . Helmets shall be mounted on headforms conforming to NIJ 0106.01. A single headform with slots in both coronal and sagittal planes shall be used. A transient deformation in excess of those in 3.6.3 or a complete penetration shall constitute a test failure. Transient deformation testing may be combined with resistance to penetration.

4.14.5.1 Clay verification. Completely fill headforms with Roma Plastilina Number 1 clay such there are no voids and the resultant surfaces are smooth and continuous with the headform. Also fill a box measuring 12 in. x 12 in. x 4 in. Place both the headforms and the clay-filled box in the conditioning chamber for a minimum of 4 hours. Prior to start of testing, the drop verification sample shall be drop tested to confirm its plasticity. A 2.2 pound, 1.75-inch diameter steel cylinder with a hemispherical end shall be dropped from a vertical height of 78.7 inches to impact the clay surface at a zero degree obliquity, with its hemispherical end, at three locations whose center-to-center and center-to-edge of clay distance is not less than 3.0 inches. The depth of each of the three resultant depressions shall be 1.0 ($\pm$ 0.1) inch. If the depth of the

resultant depressions is outside the prescribed range, the conditioning temperature shall be adjusted as necessary to meet the above requirements.

4.14.5.2 Mounting. Mount the helmet on the headform in the as worn configuration. Only the helmet suspension/retention system shall be used to hold the helmet on the headform. Adjust the system to achieve a snug fit. Inspect the suspension system after each firing and readjust as needed. A failure of a suspension or retention system component shall not constitute a failure. Any failed component shall be replaced before continuing the test. For adjustable helmet suspension systems, the test agency will adjust suspension system strapping to the maximum allowable extent so as to achieve the minimum distance and airspace between the suspension crown and the interior helmet shell surface. A laser or other suitable means shall be used to locate the impact point on the helmet. The finished helmet shall be removed and a reference measurement made to determine the location of the front surface of the formed clay under the impact point. The finished helmet shall be remounted on the headform in the same location and manner as it was removed.

4.14.5.3 Impact locations for transient deformation measurement. Place one impact into each of the five helmet sections. Impacts used for resistance to penetration tests are suitable for transient deformation determinations. Additional shots within one or more of the defined sections may be necessitated as a result of the first shot being declared "unfair". Should one or more of those additional shots be declared a "penetration," those shots shall be declared "unfair" as well. If there has been no prior fair shot penetration, a penetration by a second shot at any location shall cause the testing of that helmet to be declared "inconclusive". Testing of any location declared "inconclusive" should be repeated with a new (untested) helmet sample. Once testing of a helmet sample has been initiated, testing shall continue until all required locations have been impacted, regardless of the pass/fail results of those shots.

4.14.5.4 Transient deformation measurement. The finished helmet shall be removed and a measurement made to determine the farthest extent of the clay depression (if any) as a result of the ballistic impact with respect to the original surface of the clay. The maximum depression shall be recorded. In making this determination, any clay surrounding the impression that has been raised above the original level of the surface (cratering) shall be ignored. Measurements of the magnitude of the resultant depression (if any) shall be made from a point originating from a radius flush and consistent with the contour of the pre-shot clay surface.

4.14.5.5 Alternate measurement techniques. Alternate means of measuring transient deformation, including multiple flash x-ray or photographic techniques, may be proposed.

4.14.6 Low-velocity impact attenuation. The impact attenuation of the complete helmet assembly shall be determined in accordance with DOT FMVSS 218 with the following exceptions:

1. Each helmet shall be tested with the pad suspension system arranged in the standard pad configuration (Figure 2).
2. Six helmet samples of each size shall be required" two each for testing after exposure to each of the three environmental conditions.
3. The environmental conditions shall be ambient, cold 14°F (± 5°F), and hot 130°F (± 5°F). Helmets shall be conditioned for minimum of 12 hours prior to test.
4. The hot and cold environmental impacts shall be conducted within 5 minutes after the helmets are removed from the environmental conditioning chamber. Helmets shall be returned to the conditioning chamber and exposed for at least 15 minutes before removal for another test.
5. Water immersion testing is not required.
6. The impact anvil used for all tests shall be the hemispherical anvil.

7. Helmets shall be fitted to the appropriate size DOT FMVSS 218 headform (sizes B, C, and D).
8. Each helmet shall be impacted two times at seven locations. These include the front, back, left side, right side, lower left rear, lower right rear, and the crown. The headform shall be oriented as described in Table IX for each particular impact site. Additionally, Figure 5 shows the orientation of all locations except the left and right nape.
9. Two successive impacts shall be made at each location between 1 to 2 minutes of each other.
10. The target impact velocity for all impacts shall be 10 feet per second with an allowable tolerance of ± 3%.

Failure of any one of the helmets to meet the requirements of 3.6.4 for any impact in any of the environments shall constitute failure of the test. Examine the shell for the defects in 3.6.4.

TABLE IX. – Headform orientation for impact testing.

Impact site	Headform base orientation
Front	25-45 degrees off vertical
Rear	5-30 degrees off vertical
Left/Right side	10-30 degrees off vertical
Crown	+/- 35 degrees off vertical
Left/Right nape	Zero degrees off vertical, rolled 15 to 30 degrees left or right

4.15 Operating verification

4.15.1 Color (shell and webbing). Verify that the helmet shell and webbings match the shade standard when viewed under filtered tungsten lamps that approximate artificial daylight and that have a correlated color temperature of 7500 (± 200) K, with illumination of 100 (± 20)-foot-candles. Verify that the helmet shell and webbings matches the standard sample under incandescent lamplight at 2300 (± 200) K. Any non-conformance to requirements of paragraph 3.7.1 shall constitute test failure. (See 6.5)

4.15.2 Infrared reflectance test. Obtain spectral reflectance data from 600 to 860 nm relative to a barium sulfate standard, the preferred white reference standard. Other white reference materials may be used, providing they are calibrated to absolute white. The spectral bandwidth at 860 nm shall be less than 26 nm. Reflectance measurements may be made by either the monochromatic or polychromatic mode of operation. When the polychromatic mode is used, the spectrophotometer shall operate with the specimen diffusely illuminated with the full emission of a source that simulates CIE Source A or CIE Source D65. View the specimen at an angle no greater than 10 degrees from normal, with specular component included. Photometric accuracy of the spectrophotometer shall be within 1% and wavelength accuracy within 2-nm. The standard aperture size used in the color measurement device shall be 1.0 to 1.25-in. in diameter. Take measurements on a minimum of three different areas and average the data. Any non-conformance to the requirements of paragraph 3.7.2 shall constitute a failure. (See 6.5)

4.15.3 Colorfastness. Perform the following tests to determine color fastness. Any non-conformance to the requirements of paragraph 3.7.4 shall constitute a failure.

Requirement	Test Method	Notes
Laundering, 3X	AATCC 61 IA	
Crocking	AATCC 8	
Perspiration	AATCC 15	Both acid and alkaline tests

Light	AATCC 16 Option A or E	Exposure shall be 40 hrs or 170 kilojoules

4.15.4 Retention strap static pull strength test

4.15.4.1 Test apparatus. A testing machine conforming to ASTM E 4, "Practices for Force Verification of Testing Machines" shall be used. The helmet shall be rigidly attached to the testing machine base with either a clamp or headform device. The headform and its orientation shall replicate the human head and face, and balance the load among the four points of attachment. The chin strap shall be attached to a grip that simulates the jaw. The grip shall consist of two cylinders of 0.25 in. diameter, rigidly spaced 3.0 in. apart with a length of approximately 1.50 in. to accommodate the chin strap.

4.15.4.2 Test procedure. Affix the helmet to the base of the test machine, and connect the simulated jaw to the chin strap. Apply a load at the rate of 1.0 in./minute until the strap fails. Failure shall consist of breakage or release of the retention system. Record the peak load as the pull strength. Record the mode of failure for information purposes only. Any non-conformance with paragraph 3.7.5 shall constitute a failure.

4.16 Operating environment verification. If ballistic testing is required to validate environmental performance requirements ~~then minimum acceptable~~ testing shall be V_{50} ballistic limit with the 16-grain RCC at 0 degrees obliquity in accordance with 4.9. Any non-conformance with the requirements of paragraph 3.8 shall constitute a failure.

4.16.1 Flame resistance. Determine flame resistance of the shell in accordance with FED-STD-191 test method 5903.1 with these exceptions: The shell shall be suspended in the chamber such that the burner flame impinges the outside surface of the helmet at the crown at a 90-degree angle to the flame. The approximate distance between the outer helmet shell surface and the top of the burner shall be 1.5 in. The flame shall be adjusted so that the tip of the inner cone of the flame impinges on the helmet surface. Any non-conformance with the requirements of paragraph 3.8.1 shall constitute failure.

4.16.2 Field agent resistance

4.16.2.1 Test conditions. Prior to testing, the shells shall be exposed to a temperature of 75 (± 5)°F and a relative humidity of 50 (± 5)% for a period of 24 (± 1) hours.

4.16.2.2 Test methods. More than one test may be done on any one shell providing the specified test agent does not come in contact or contaminate another agent during the test period. If more than one test is done on any one shell, the application of any agent shall be a minimum of 5 in. away from any other agent.

a. With a clean cloth remove any mold release, dirt, or foreign matter from the shell.
b. Scribe or mark a 2.5 sq. in. section ~~anywhere along the~~ periphery of the helmet shell including the edging.
c. Apply a liberal amount of the agent specified to the shell sufficient to cover the total marked area. The area shall remain wet with the agent for 24 (± 1) hours. If the agent dries during the test period, it shall be reapplied.
d. At the end of the test period, clean and remove any excess agent from the shell.
e. Visually examine the shell. Any non-conformance to the requirements of paragraph 3.8.2 shall constitute failure.

4.16.3 Temperature extreme resistance. Use separate helmet shells for high and low temperature conditioning. Condition a finished helmet shell in a chamber at 160 (± 10)°F or at

-60 (± 10)°F for 6 (± 0.25) hours. After temperature conditioning, remove each helmet from the conditioning chamber and visually inspect for damage. Perform ballistic testing within 30 minutes of removal. If testing is not completed within this time, measure the surface temperature of the shell prior to each shot to ensure the temperature is maintained within the range specified for each test condition. No individual shot shall be taken outside the conditions specified. If necessary, recondition for 1 hour minimum. Any non-conformance to the requirements of paragraph 3.8.3 constitutes a failure.

4.16.4 Compression resistance (top to bottom). The shell shall be tested on a constant rate of extension (CRE) machine in accordance with ASTM D 76 except that the machine shall be used in the compression mode. Failure to meet the requirements of paragraph 3.8.4 shall be a failure.

a. Position and center the helmet shell on the base platen so that the visor is fixed or resting in a horizontal plane.
b. Record and mark the maximum height reading of the shell at its apex to the nearest 0.01 in.
c. Using a 2.50-in. diameter flat anvil, compress the shell at its vertex at the rate of 12 in./minute until a compressive force of 400 lb is reached.
d. Release the applied force to 5 lb.
e. Repeat compression and release for testing for 24 additional cycles.
f. After the last cycle, release the load.
g. After a period of 11 to 24 hours has elapsed, record the height dimension in the same manner as step a. and b., above.

4.16.5 Compression resistance (side to side). The finished shells shall be tested on a constant rate of extension (CRE) machine in accordance with ASTM D 76, except that the machine shall be used in the compression mode. Failure to meet the requirements of paragraph 3.8.5 shall be a failure.

a. Record and mark the maximum shell width dimension of the shell to the nearest 0.01 in.
b. Using a clamping fixture with a 0.50 in. spindle (DE-STA-CO Model 207-4 or equal) clamp and position the helmet shell at the inside benchmark so that the highest width dimension is aligned with the center of the top anvil.
c. Compress the shell with a 2.50-in. diameter flat anvil at the rate of 12 in./minute until a force of 300 lb is reached. Record peak displacement.
d. Release the applied force to 5 lb.
e. Repeat compression and release for 24 additional cycles.
f. After the last cycle, release the load.
g. After a period of 11 to 24 hours has elapsed, record the width dimension in the same manner described in step a., above.

4.16.6 Seawater resistance. Conduct conditioning and testing below. Any non-conformance with the requirements of paragraph 3.8.6 shall constitute failure.

a. Finished helmet shells shall be clean and free of dirt or other foreign matter prior to testing.
b. Condition shell to a temperature of 75 (± 10)° F and a relative humidity of 55 (± 10)% for a 24 (± 1) hour period.
c. Weigh the shell to the nearest 0.5 ounce.
d. Immerse the shell in a laboratory seawater solution containing 3% sodium chloride and 0.5% magnesium chloride at 68 (± 10)° F for 16 (± 0.5) hours.
e. Remove the shell, wipe off excess moisture, and maintain at 75 (± 5)° F and a relative humidity of 55 (± 5)% for 12 (± 0.5) hours.

f. Weigh the shell again to the nearest 0.5 ounce. A weight increase in excess of that allowed in paragraph 3.8.6 shall constitute failure.
g. Visually inspect the shell for any evidence ~~of softening~~, peeling, blistering, or delamination.
h. Conduct ballistic testing within 2.0 hours after removal from the sea water solution.

4.16.6.1 Seawater immersion – weight and visual examination. The finished helmet shell, clean and free of dirt or other foreign matter, shall be exposed to standard ambient conditions for a minimum of 3 hours and then weighed to the nearest 0.5-ounce. The shell shall then be immersed in a laboratory seawater solution containing 3 percent sodium chloride and 0.5 percent magnesium chloride at standard ambient conditions for 16 (± 0.5) hours at a minimum depth of 3 feet. The shell shall be removed, wiped of excess moisture and kept at standard ambient conditions for 12 (± 0.5) hours and weighed again to the nearest 0.50-ounce. A weight increase in excess of that allowed in paragraph 3.8.6 shall constitute a failure. The shell shall be visually examined for the defects specified in 3.8.6 and any nonconformance with 3.8.6 shall be constitute test failure.

4.16.7 Weatherometer resistance. Cut helmet shell in half along the front-to-back axis. Mount test specimens on the outside of the rack. Test in accordance with AATCC 169 and modifications noted below. After the required exposure period, remove the specimen from the apparatus and allow to dry and condition at ambient. Visually inspect the helmet. Ballistic testing shall occur within 24 after exposure. Non-conformance with the requirements of paragraph 3.8.7 shall constitute a failure.

Modifications to AATCC 169:

a. The test apparatus shall be either a test chamber type 1A or 1B. Type 1B shall be equipped with a three-tiered inclined specimen rack. The apparatus shall be equipped with an automatic light monitor and shall be ~~capable of~~ automatically controlling irradiance, temperature, and humidity. The apparatus shall be maintained in accordance with manufacturer's recommendations.
b. The weathering test cycle shall be 40 minutes of light, 20 minutes of light with water spray on the specimen, 60 minutes of light, 60 minutes of darkness with no spray. The test cycle shall be repeated until the total energy exposure is equal to 100 kilojoules per square meter.
c. The irradiance level shall be 0.55 (± 0.01) watts/square meter/nanometer (W/sq. m/nm) bandpass at 340 nanometers.
d. The glass filter combination shall be quartz inner filter and a borosilicate type "S" outer filter.
e. The relative humidity shall be 50 (± 5) percent during the light cycle and not lower than 95 percent during the dark cycle.
f. The control set points shall be as follows:

Parameter	Dark Cycle	Light Cycle
Black panel	38°C	77°C
Conditioning Water	40°C	53°C
Wet bulb depression*	0°C (95% + RH)	10°C (50% RH)
* As a guide only; adjust to achieve required relatively humidity (see e. above).		

4.16.8 Temperature shock. Condition a helmet shell in a chamber at 160 (± 10) °F. Condition a second shell in a chamber operating at minus 60°F. After a period of 24 (± 1) hours, move the shells from one chamber to the other. At the end of the second 24-hour period, remove both helmet shells to ambient and allow too return to room temperature. Visually inspect the shells

and measure thickness in accordance with 4.11.4.1. Any non-conformance to the requirements of paragraph 3.8.8 shall constitute a failure.

4.16.9 Altitude test. Place the finished helmet in an ambient air pressure chamber at ambient temperature and pressure. Lower the pressure to simulate 40,000 (± 300) ft altitude, and hold for 1 hour. Raise the pressure at a rate of 1,500 to 2,000 ft./min so that the chamber simulates 15,000 (± 300) ft. altitude within 15 minutes. Hold for 1 hour. Raise pressure to ambient at a rate of 1,500 to 2,000 ft./min, then complete visual inspection and functional check. Any non-conformance with the requirements of paragraph 3.8.9 constitutes a failure. Thickness measurements are to be performed at five random locations, one in each section. Helmet sections are defined in 4.14.6. Suggested source for this test shall be in accordance with 6.7.1.

4.16.10 Impact resistance

4.16.10.1 Test apparatus. The test apparatus shall consist of a fixed ball release tester equipped with an electromagnetic device or similar apparatus for releasing an 8-lb iron sphere. The apparatus shall be designed such that the shell is subjected to only one impact.

4.16.10.2 Test procedure. Position the shell on a hard surface or fixture so that the visor of the helmet is fixed or resting in a horizontal plane, and the shell apex is aligned with the center of the impactor (sphere). Drop the impactor from a height of 5 ft (± 1 in). Visually inspect the shell for damage. Any non-conformance with the requirements of paragraph 3.8.10 shall constitute a failure.

4.16.11 Vibration test. Test in accordance with MIL-STD-810, Method 514.5 Procedure II. The vibration test shall approximate the various environments to which the helmet shall be subjected. Any non-conformance with requirements of paragraph 3.8.11 shall constitute a failure.

4.17 Ownership and support verification. If ballistic testing is required to validate environmental performance requirements then minimum acceptable testing shall be V_{50} ballistic limit with the 16-grain RCC at 0 degrees obliquity in accordance with 4.9. Any non-conformance with the requirements of paragraph 3.6.1 shall constitute a failure.

4.17.1 Marking of the helmet shell, pad suspension system and retention system. Visually inspect that all required labels are present, clear and legible. Verify that all markings are visible in low light levels (i.e. moon light and filtered red or blue light). Government Furnished Equipment (GFE) filtered flashlights will be provided for this demonstration. Verify that barcodes are machine-readable. Any non-conformance with the requirements of paragraph 3.9.1 shall constitute a failure.

4.17.2 Shelf life verification. Place two finished helmets in the chamber with the top of the helmet facing up. Place a representative 20 lb object on top of each helmet. Expose specimens in the aging chamber for a minimum of 7 days at 100 (± 10) psi, 100% oxygen atmosphere controlled to a temperature of 150 (± 5)°F. At the end of the test, depressurize the chamber over a period of at least 5 minutes. Place samples in ambient conditions for 16 to 96 hours with the 20-lb object on top of the helmet. Inspect the helmets for damage and subject to ballistic testing.

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 materiel 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 or Defense Agency's automated packaging files, CD-ROM products, or by contracting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The helmet when worn is to provide ballistic fragmentation and hand-gun protection. The helmet also provides non-ballistic protection to users. The helmet may be used at all times by individuals in combat situations requiring ballistic and trauma protection.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification and any amendments.
b. Type, size (see paragraph 1.2) and color (see paragraph 3.7.1) required.
c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced.
d. When a first article is required (see paragraph 3.1 and 4.1). If required, whether an initial production or a pre-production first article is required.
e. Packaging requirements (see paragraph 5.1).
f. Marking requirements (see paragraph 3.9.1).
g. Lot acceptance/conformance testing requirements.
h. Overpacked spares, if required.
i. Warranty provisions, if desired.

6.3 First article. When a first article is required, it will be inspected and approved under the appropriate provisions of FAR 52.209-4. The first article should be a pre-production 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 all acquisitions documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Conformance inspection. Acceptance criteria will be as specified in the contract or purchase order. Ballistic testing will be with the 17-gr FSP unless stated otherwise.

6.5 Standard color samples. Standard Color Samples are available from the Contracting Officer upon written request.

6.5.1 White standard. Barium sulfate of suitable quality for use as a white standard is available form the Eastman Kodak Company. The same source has magnesium oxide ribbon available. Suitable white tiles can be obtained from the instrument manufacturers.

6.5.2 Spectrophotometers. Suitable spectrophotometers for measuring spectral reflectance in the visible/near-infrared include the Diano-Hardy, the Diano Match Scan, Milton Roy Match Scan 2, Hunter D-54P-IR, Applied Color Systems Spectro Sensor I, II and CS-5, Hunter VIS/NIR Spectrocolorimeter and Macbeth 1500 with IR options.

6.6 Definitions. The following definitions are provided to assist in understanding the ballistic test procedures:

6.6.1 Complete penetration (CP). A complete penetration occurs when the impacting projectile or any fragment thereof, or any fragment of the test specimen perforates the witness

plate resulting in a crack or hole which permits light passage when a 60-watt, 110-volt light bulb is placed proximate to the witness plate. In cases where residual velocities are being measured and no witness plates are used, complete penetrations will be determined by projectile perforation.

6.6.2 Fair impact. A projectile that impacts the test sample at less than 3 degrees yaw and at sufficient distance from its edges, holes, and previous impacts and within the required velocity range. In addition, for an otherwise fair impact, if the distance from edges, holes, or previous impacts is insufficient, and/or if the velocity is in excess of that required, the impact is considered fair if the result is a partial penetration. Likewise, if the velocity is insufficient, but the result is a complete penetration, the impact is considered fair.

6.6.3 Instrument velocity. The projectile velocity at the moment and location measured by the velocity sensing instrument(s).

6.6.4 Lumiline screen. A photoelectric device used to activate/deactivate a chronograph upon the passage of a projectile.

6.6.5 Obliquity. A measure, normally in degrees, of the extent to which the impact of a projectile on an armor material deviates from a line normal to the target. Thus, a projectile fired perpendicular to an armor surface is at 0 degrees obliquity.

6.6.6 Partial penetration (PP). Any fair impact that is not a complete penetration shall be considered a partial penetration.

6.6.7 Strike velocity. The velocity of a projectile at the instant of impact (also known as impact velocity). This velocity is normally derived from the instrument velocity less predicted drag for the target base line.

6.6.8 Target base line. The distance from a point midway between the two velocities measuring, triggering devices to the test sample.

6.6.9 V_{50} ballistic limit (BL). In general, the velocity at which complete penetration is 50%.

6.6.10 Velocity spread. The velocity spread is computed by subtracting the lowest velocity used in the V_{50} BL (P) calculation from the highest velocity used in the calculation. Also known as "Range of results."

6.6.11 Witness plate. A thin sheet located behind and parallel to the ballistic test sample that is used to detect penetrating projectiles or spall.

6.6.12 Yaw. Projectile yaw is the angular deviation of the longitudinal axis of the projectile from the line of flight at a point as close to the impact point on the target as is practical to measure.

6.6.13 Zone of mixed results. The velocity difference between the highest velocity PP and the lowest velocity CP, when there is a PP at a higher velocity than a CP.

6.7 Suggested and Mandatory sources.

6.7.1 Suggested sources for 4.16.9:

Applied Technical Services (ATS)
1049 Triad Ct.

Marietta, GA
(770)-423-1400

Interteck Testing Services (ITS)
3933 US Rt. 11
Cortland NY
(607)-758-6388

SGS US Testing
291 Fairfield Ave.
Fairfield, NJ
(973)-575-5252

6.7.2 Mandatory source for 3.4.8:

National Industries for the Blind
1310 Braddock Place
Alexandria, VA 22314
POC – Mary Johnson (703)-310-0512

6.7.3 Mandatory source for 3.4.9:

National Industries for the Blind
1310 Braddock Place
Alexandria, VA 22314
POC – Mary Johnson (703)-310-0512

6.8 Subject term (key word) listing.

Body Armor
Headgear
Ballistic
Personnel Armor

MILITARY INTERESTS:

Custodians:
Navy - MC

Preparing activity:
DLA-CT

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 ASSIST online database at www.dodssp.daps.mil.

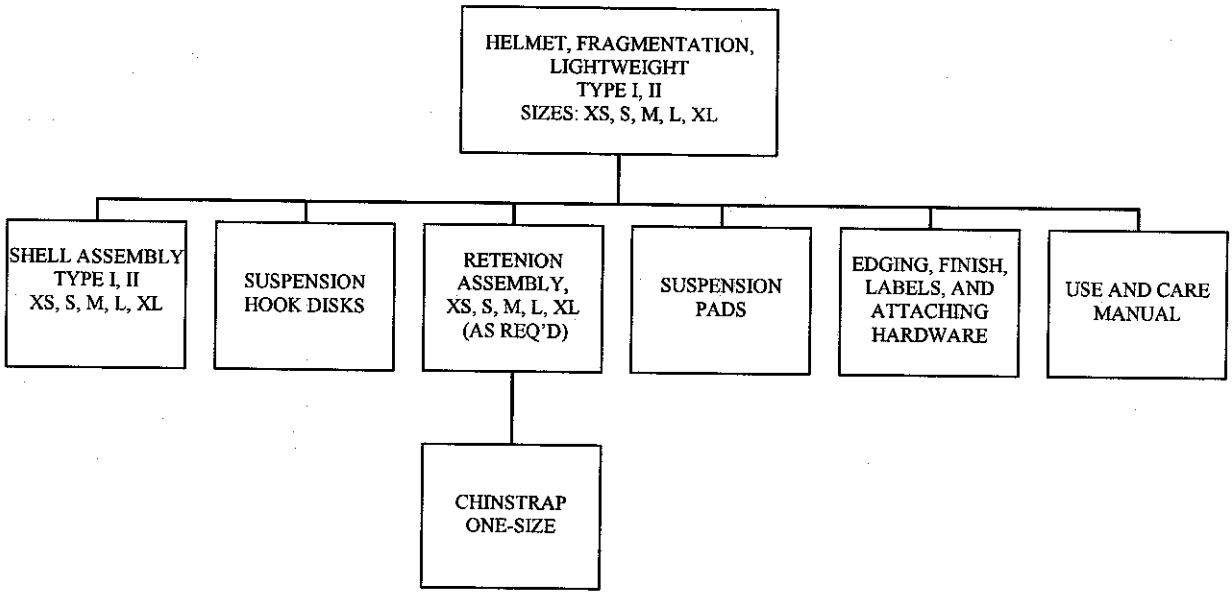


FIGURE 1.
LIGHTWEIGHT HELMET TOP LEVEL ASSEMBLY

STANDARD PAD CONFIGURATION

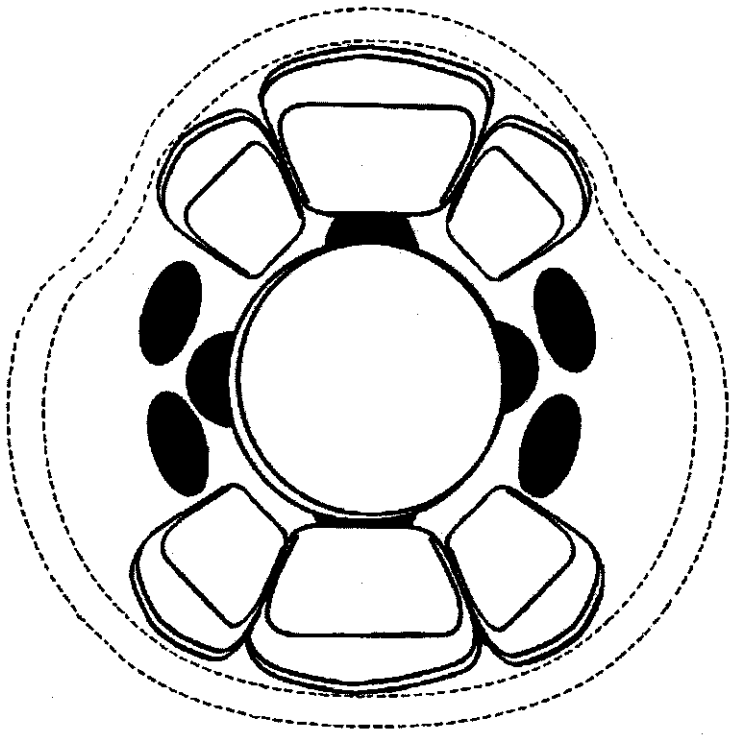


FIGURE 2.

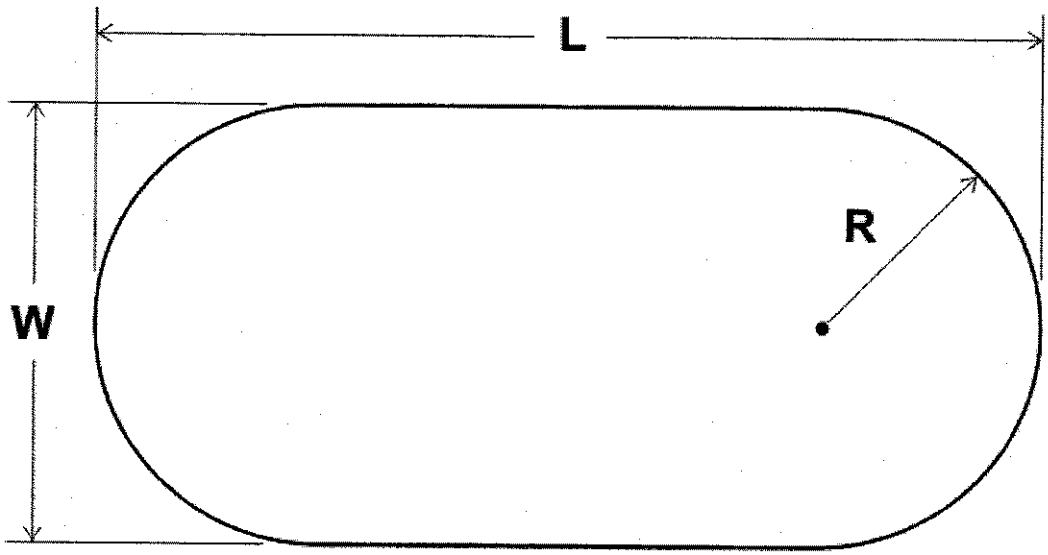
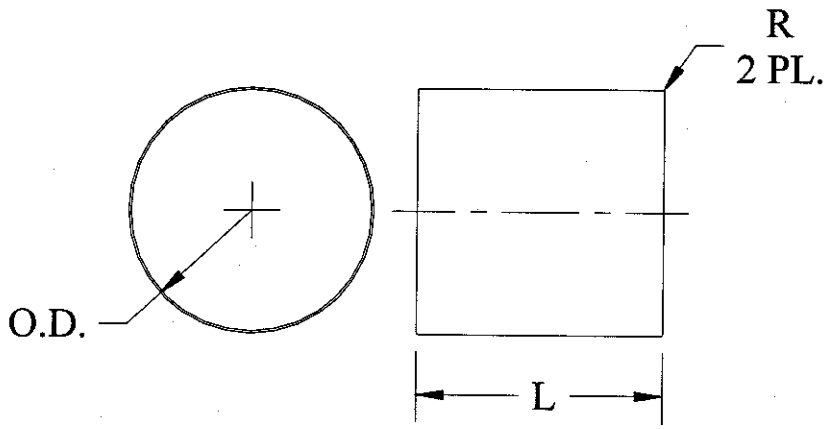


FIGURE 3.



Weight (grains)	Outside Diameter (OD)[1], (in.)	Length (L)[2] (in.)	R (in.)
2 ± 0.10	0.111 ± 0.001	0.111	.007 ± .003
4 ± 0.15	0.134 ± 0.001	0.147	007 ± .003
16 ± 0.5	0.219 ± 0.001	0.221	007 ± .003
64 ± 1.0	0.344 ± 0.001	0.355	007 ± .003

Notes:

1. O.D. is nominal diameter of drill rod as furnished.
2. Adjust Length (L) to meet the indicated weight (grains). Material is steel, 4340, heat treated, Rockwell "C" hardness of 29 (± 2). Finish all over 32 surface finishes.

FIGURE 4.