METRIC

2013-006
MARCORSYSCOM
13 APRIL 2016

DESIGN SPECIFICATION

FOR

TRANSPARENT ARMOR

FOR THE

MINE RESISTANT AMBUSH PROTECTED (MRAP) FAMILY OF VEHICLES

NSN 2355-1-581-2392 Cougar CAT I A1 ISS (TAMCN D0025)
NSN 2355-1-579-8929 Cougar CAT I A2 ISS (TAMCN D0025)
NSN 2355-1-579-8931 Cougar CAT II A1 ISS (TAMCN D0027)
NSN 2355-1-579-8920 Cougar CAT II A2 ISS (TAMCN D0027)
NSN 2355-1-583-1029 Cougar Ambulance (TAMCN D0023)
NSN 2355-1-589-1279 Cougar TOW (TAMCN D0040)
NSN 2355-1-575-9632 M-ATV (TAMCN D0036)
NSN 2355-1-596-1330 M-ATV UIK (TAMCN D0036)
NSN 2355-1-531-6425 Buffalo (TAMCN B0035)

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REVISION	DATE	CHANGED BY	DESCRIPTION OF CHANGES
R0.1	18Apr16	J. Gablin	Added immersion (3.3.8/4.3.8), reliability (3.7/4.8), and frame construction (2.2.2/3.8/4.9) requirements, modified temperature shock requirement (3.3.4/4.3.4)
R0.2	21Apr16	J. Gablin	Included fresh/salt water testing for immersion requirement (3.3.8/4.3.8), modified packaging requirement (5.1.1.4)
R0.3	29Apr16	J. Gablin	Added highly accelerated lifecycle testing (HALT) requirement (3.9/4.10) and relevant TOP documentation reference
R0.4	3May16	J. Gablin	Corrected Table IX (Humidity Test Profile), added shock and vibration (3.10/4.11), and adhesion and bonding (3.11/4.12) requirements
R0.5	9May16	J. Gablin	Modified adhesion and bonding requirement (3.11/4.12) to include testing for frame to TA adhesion (3.11.1/4.12.1) and TA inter-layer adhesion (3.11.2/4.12.2)
R0.6	31May16	J. Gablin	Modified title to reflect design specification of document, further definition of TA part (3.2.2), and other general requirement clarifications
R0.7	7Jun16	J. Gablin	Further language clean-up, additional chemical exposure requirement detail, document control number, vehicle applicability, and Cougar A1 drawing references
R0.8	13Jun16	J. Gablin	Updated drawing numbers and nomenclature
R0.9	30Jun16	J. Gablin	Updated CS&CSS and added Armor Materials and Technology security classification guides

CONTENTS

FIGURES

TABLES

1. SCOPE

1.1 Scope. This specification covers the performance requirements for transparent armor (TA) used for windows of armored ground military vehicles and other U.S. Marine Corps vehicles. The requirements of this document are applicable when specified on the part drawing or by the procuring activity. Transparent armor is the technical term for protective transparencies also commonly known as ballistic resistant windows. Unless otherwise specified, TA refers to an entire assembled item to include glass stack, frame, and any bonding material(s), representative of a production end item. Specific TA ballistic threats are noted in a classified drawing not included in this specification. In the event of a conflict between this document and the procurement documents, the procurement documents shall take precedence.

Caution: The ballistic tests mandated by this document are defined by statistical requirements for consistency. They do not guarantee that all windows of all configurations will survive ballistic impacts not defined by this specification. This specification makes careful definition of distance to edges and window size. Windows not conforming to these definitions must be individually qualified to the ballistic requirements of the system for which the specific windows are being purchased.

1.2 Material Selection. This document does not intend to restrict the use of the many materials and processes used in the design and manufacture of transparent armor; it is important to note that their proper selection is required in order to achieve the performance, reliability and longevity requirements of this document.

2. APPLICABLE DOCUMENTS

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

2.2 Government Documents.

2.2.1 Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract (see 6.2).

COMMERCIAL ITEM DESCRIPTIONS

A-A-52557	-	Fuel Oil, Diesel; for Posts, Camps and Stations
A-A-52624	-	Antifreeze, Multi-Engine Type
A-A-59133	-	Cleaning Compound, High Pressure (Steam) Cleaner

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-680	-	Degreasing Solvent
MIL-PRF-2104	-	Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service
MIL-DTL-5624	-	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-PRF-6083	-	Hydraulic Fluid, Petroleum Base, for Preservation and Operation
MIL-PRF-10924	-	Grease, Automotive and Artillery
MIL-D-16791	-	Detergents, General Purpose (Liquid, Nonionic)
MIL-G-21164	-	Grease, Molybdenum Disulfide, for Low and High Temperatures, NATO Code Number G-353
MIL-PRF-24139	-	Grease, Multipurpose, Water Resistant
MIL-DTL-62420	-	Periscope, Tank

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-129	-	Military Marking for Shipment and Storage
MIL-STD-130	-	Identification Marking of U.S. Military Property

MIL-STD-662	-	V50 Ballistic Test for Armor
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-1275	-	Characteristics of 28 Volt DC Electrical Systems in Military Vehicles

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-722	-	Glass

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

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

SECURITY CLASSIFICATION GUIDES

Security Classification Guide For Combat Support and Combat Service Support Armoring Systems, 21 August 2012

Security Classification Guide For Armor Materials and Technology, 31 May 2016

(Copies of these documents are available from Marine Corps Systems Command (MARCORSYSCOM), 2200 Lester St., Quantico, VA 22134-6050)

PM MRAP PROGRAMMATIC DOCUMENTS

Capability Production Document for Mine Resistant Ambush Protected (MRAP) Family of Vehicles (FoV), Version 1.1, 7 July 2009

MRAP Performance Baseline, 26 March 2012

Interface Control Document for the Mine Resistant Ambush Protected Cougar A1 Family of Vehicles

Transparent Armor Frame Drawings

4003549	-	WINDSHIELD, 50 CAL 1700 X 400 X 140
10038992	-	FRAME, 1700 X 400 X 140
4002834	-	GLASS, WINDSHIELD 50 CAL
10003116	-	WINDOW, CLEAR 300 X 400 X 140
4002826	-	FRAME, 300 X 400 X 140 REAR
10002515	-	GLASS, CLEAR 300 X 400 X 140
10003118	-	WINDOW, CLEAR 400 X 700 X 140 LS

10002504	-	GLASS, CLEAR 400 X 700 X 140 LEFT
4002827	-	FRAME, 400 X 700 X 140 PENTA LEFT
10003119	-	WINDOW, CLEAR 400 X 700 X 14 RS
4002828	-	FRAME, 400 X 700 X 140 PENTA RIGHT
10002510	-	GLASS, CLEAR 700 X 400 X 140 RS
10003114	-	WINDOW, CLEAR 800 X 300 X 140
4002825	-	FRAME, 800 X 300 X 140
10002526	-	GLASS, CLEAR 800 X 300 X 140

(Copies of these documents can be obtained from USMC Program Executive Office-Land Systems (PEO LS)—PM MRAP (PMM 207), 2200 Lester Street, Quantico, VA 22134-6050)

U.S. ARMY TACOM DRAWINGS

DTA184044 - TACOM Protection Classes

NOTE: DTA184044 is classified SECRET. Unless specified by the procuring agency, the latest revision of this drawing will apply. Proof of proper authorization and security clearance shall be required to obtain copies.

(Copies of this drawing can be obtained from the Standardization Office, Tank Automotive Research, Development and Engineering Center, ATTN: RDTA-EN/STND/TRANS MS #268, 6501 E. 11 Mile Road, Warren, MI 48397-5000 or can be requested by sending an email to usarmy.detroit.rdecom.mbx.tardec-standardization@mail.mil)

U.S. ARMY TEST AND EVALUATION COMMAND TEST OPERATIONS PROCEDURES (TOP)

TOP 01-1-065 - Accelerated Corrosion Durability

(Copies of this document are available from http://itops.dtc.army.mil/RequestForDocuments.aspx or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218)

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

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

ASTM F428	-	Intensity of Scratches on Aerospace Glass Enclosures
ASTM F548	-	Intensity of Scratches on Aerospace Transparent Plastics

ASTM F801	-	Measuring Optical Angular Deviation of Transparent Parts
ASTM D975	-	Diesel Fuel Oils
ASTM D1003	-	Haze and Luminous Transmittance of Transparent Plastics (DoD adopted)
ASTM C1036	-	Flat Glass (DoD adopted)
ASTM C1172	-	Laminated Architectural Flat Glass
ASTM D1655	-	Aviation Turbine Fuels
ASTM F2156	-	Measuring Optical Distortion in Transparent Parts Using Grid Line Slope
ASTM D4169	-	Performance Testing of Shipping Containers and Systems
ASTM D4814	-	Automotive Spark-Ignition Engine Fuel
ASTM D3363	-	Film Hardness by Pencil Test
ASTM E1575	-	Standard Practice for Pressure Water Cleaning and Cutting

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

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	-	Structural Welding Code (Steel)
AWS B2.1	-	Specification for Welding Procedure and Performance Qualification
AWS A5.18	-	Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding

(Copies of this document are available from www.aws.org or AWS Customer Service, 8669 NW 36 Street #130, Miami, Florida 33166-6672)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME Y14.100	-	Engineering Drawing and Related Documentation Practices

(Copies of this document are available from www.asme.org or ASME Customer Service, Two Park Avenue, New York, NY 10016-5990)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 3290-2	-	Rolling bearings - Balls - Part 2: Ceramic balls

(Copies of this document are available from www.iso.org or www.ansi.org or ANSI Customer Service Department, 25 W. 43rd Street, 4th Floor, New York, NY 10036)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

ANSI/SAE Z26.1-1996	-	American National Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways - Safety Standard

(Copies of this document are available from www.sae.org or SAE Customer Service, 400 Commonwealth Drive, Warrendale, PA 15096-0001)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/IEC 60529-2004	-	Degrees of Protection Provided by Enclosures (IP Code)

(Copies of this document are available from www.nema.org or NEMA Customer Service, 1300 North 17th Street, Suite 1847, Rosslyn, VA, 22209)

2.4 Order of Precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Tests. Unless otherwise specified by the part drawing or the procuring agency (see 6.2), samples of production parts or coupons shall be subjected to testing and inspection in accordance with section 4.

3.2 Design and Declarations. First article and production control tests must be accompanied by a declaration of TA composition. The contractor's declaration must declare the material type (materials such as but not limited to glass, transparent ceramic, polyurethane, or polycarbonate) and nominal thickness for each layer and interlayer. Stating a layer to be a plastic or adhesive is insufficient. Layers must be listed individually and sequentially, beginning with the strike surface. The nominal thickness of the laminated TA must also be provided. Coatings and surface treatments such as hard coatings and washes need to be declared though not specifically defined. However, the declaration must list an identifier or code that is traceable to company process control specifications, and declarations must indicate that the process control specification for the supplied transparent armor is fixed and in control. After FAT approval, no material or process changes that may affect product performance, including ballistic integrity and environmental durability, shall be made without the procuring activity approval.

3.2.1 Ballistic Protection Classes. TACOM has established protection classes based on threat munitions. The protection classes and their corresponding test projectiles with proofing test velocities are listed on drawing DTA184044. The drawing is classified SECRET. The protection class shall be used in place of describing the threat munitions and their specific performance objectives in the contract or detailed specification for the particular transparent armor system (see 6.2). See 6.1.1 for further guidance.

3.2.2 Materials. The contractor shall select the methodology of construction and the materials, provided these methods and materials are capable of yielding uniform and reproducible test properties, as well as a consistent end product as specified in this document. All references to TA, 'part', or 'parts' shall refer to a fully assembled and integrated glass stack, frame, and bonding material(s), representative of a production item unless otherwise specified.

3.2.2.1 Materials Compatibility. Materials must be compatible with each other in all states that they may contact one another. Materials shall be selected such that interfaces of two materials do not induce failure chemically or physically.

3.2.3 Transparent Plies. The transparent plies used in the lamination shall be specially selected transparencies conforming to Type I or Type II, Class 1, quality–q3 of ASTM C1036. The outer ply shall be a material chosen for abrasion resistance and the inner ply shall be chosen for spall resistance.

3.2.4 Edgework. For handling purposes, flares shall be ground and glass edges shall have a light seam. All edges except for FAT ballistic coupons shall protect the bond line(s) and underlying materials from the environmental (rain, ice, dust, etc.) conditions and other contaminants of 3.3.7.1, 3.3.7.2, and 3.3.7.3, utilizing a sealant or other relevant process to shield the TA from debris and moisture. All edgework shall meet immersion requirements as stated in section 3.3.8.

3.2.5 Areal Density. The armor shall be of the minimum practicable density, except where the product drawing specifies the TA thickness, while meeting the ballistic and performance requirements specified by the part drawing or the procuring agency (see 6.2). When the procuring agency specifies the weight of the TA assembly, weight variations greater than 3% shall be cause for rejection of the part. TA part shall be in accordance with specific vehicle frame drawings at stated in section 2.2.2.

3.2.6 De-icing. Transparent armor may have a built-in electric de-icing system when specified on the vehicle drawing(s) (see 2.2.2 & 6.2). The de-icing system shall be capable of clearing 80% of Area C, as shown on figure 1, at ambient temperatures down to -25°C/-13°F (see 4.2.6), or as required by the vehicle specification.

3.2.7 Allowable Defects. Defects shall not exceed allowable limits indicated in table VII (see 4.2.3).

3.2.8 Marking. Individual TA shall be clearly and permanently marked in accordance with MIL-STD-130 and shall include the marking "STRIKE FACE" and the TA vendor identification (CAGE code) and production date (see 6.2). Marking shall be readable from the vehicle exterior (see 4.2.4).

3.3 Environmental.

3.3.1 Temperature Extremes.

3.3.1.1 Low Temperature. The TA shall meet allowable defects requirements (see 3.2.7) and optical requirements (see 3.4) after prolonged exposure, in accordance with MIL-STD-810 Method 502, Procedure I (Storage), to temperatures of -54±4°C/-65±7°F (see 4.3.1.1).

3.3.1.2 High Temperature. The TA shall meet allowable defects requirements (see 3.2.7) and optical requirements (see 3.4) after exposure to three 24 hour cycles from MIL-STD-810 Method 501, Procedure I (Storage), climatic category A2 (Basic Hot) Induced conditions with a maximum temperature of 63°C/145°F (see 4.3.1.2).

3.3.2 Humidity. The TA shall meet allowable defects requirements (see 3.2.7) and optical requirements (see 3.4) without moisture buildup following high temperature-humidity exposure modified from MIL-STD-810 Method 507, Procedure II (Aggravated) (see 4.3.2).

3.3.3 Reserved.

3.3.4 Temperature Shock. The TA shall withstand sudden changes in surrounding air temperature and shall not be damaged when surrounding air temperature changes from between -30±3°C/-22±5°F and 60±3°C/140±5°F in less than 1 minute in accordance with MIL-STD-810 Method 503, Procedure I-C (Multi-cycle shocks from constant extreme temperature). After experiencing temperature shock, the TA shall meet the allowable defects requirements of 3.2.7, immersion requirements of 3.3.8, and optical requirements of 3.4 (see 4.3.4).

3.3.5 Sun Exposure Weathering. Transparent armor shall show no evidence of crazing, delamination, discoloration or other physical deterioration when exposed to an irradiance level of 1120 W/m² per MIL-STD-810 Method 505, Procedure II (Steady State (actinic effects)) for fifty-six (56) 24-hour cycles. Irradiance shall be normal to the strike face of the TA. After exposure, the TA shall meet the allowable defects requirements of 3.2.7 and the requirements of 3.4.1, 3.4.1.1, and 3.4.2 (see 4.3.5).

3.3.6 Abrasion Resistance.

3.3.6.1 Abrasion Resistance – Threat Surface. The threat surface (also called strike face or exterior surface) material shall satisfy the light scattering requirement described in ANSI/SAE Z26.1 for safety glazing material after undergoing the safety glazing material abrasion resistance test of ANSI/SAE Z26.1 (see 4.3.6.1).

3.3.6.2 Abrasion Resistance – Interior Surface. The interior surface shall satisfy the light scattering requirements described in ANSI/SAE Z26.1 for Item 4A (rigid plastics) after undergoing the rigid plastics abrasion resistance test of ANSI/SAE Z26.1 (see 4.3.6.2).

3.3.7 Exposure to Chemicals.

3.3.7.1 Cleaning Spray. The entire TA part shall meet the performance requirements of 3.4 and shall show no evidence of damage, including clouding or cracking, after the portion of the assembly within the edge sealing surface is exposed to agents conforming to A-A-59133 (see 4.3.7.1).

3.3.7.2 Inner Surface Exposure to Chemicals. The inner surface of the TA assembly shall meet the performance requirements of 3.4 after exposure to the materials shown in table I. After exposure, no evidence of clouding or cracking shall be visually observable (see 4.3.7.2).

Table I. Chemical Exposure Requirement for Inner Surface.

Group	Exposure to one member of each of the following groups must be tested
1	• One percent solution of nonabrasive soap in deionized water (i.e., potassium oleate or equivalent)
2	• Kerosene No. K-1 or K-2
3	• Undiluted denatured alcohol (Formula SD No. 30)
4	• Isopropanol and glycol ether (concentrations no greater than 10% or less than 5% by weight) • Isopropanol, glycol ether, and ammonium hydroxide (isopropanol and glycol ether solvents in concentrations no greater than 10% or less than 5% by weight each or/and ammonium hydroxide no greater than 5% or less than 1% by weight) • Ammonium hydroxide (concentrations no greater than 5% or less than 1% by weight) These concentrations simulate commercial windshield cleaners.
5	• Cleaning solvent Type I or Type II per MIL-PRF-680

3.3.7.3 Outer Surface Exposure to Chemicals. The outer surface of the TA assembly shall meet the performance requirements of 3.4 after exposure to vapors of, or being placed in direct contact with, the materials shown in table II. After exposure, no evidence of clouding or cracking shall be visually observable (see 4.3.7.3).

Table II. Chemical Exposure Requirement for Outer Surface.

Group	Exposure to one member of each of the following groups must be tested
1	• Fuel per A-A-52557 (DF-2, DF-1, or DF-A) • Fuel per ASTM D975 (Commercial Diesel No. 1-D or No. 2-D) • Fuel per MIL-DTL-5624 (Grade JP-4 or JP-5) • Fuel per ASTM D1655 (Commercial Turbine Jet-A or Jet A-1) • Fuel per MIL-DTL-83133 (Grade JP-8) • Fuel per NATO AFLP-3747 (Grade F-24)
2	• ASTM D4814 (MOGAS) • Regular Automotive Gasoline or Hydraulic fluid per MIL-PRF-6083
3	• Anti-freeze per A-A-52624
4	• Detergent, liquid Type I or Type II per MIL-D-16791
5	• Grease (molybdenum disulfide per MIL-G-21164) • Lubricant oil Grade 30 or NDO (per MIL-PRF-2104) • Grease, automotive/artillery (per MIL-PRF-10924) • Grease, automotive MP (per MIL-PRF-24139)

3.3.8 Immersion. The TA shall show no evidence of moisture permeation between any interfaces of the frame or TA itself. The TA and frame shall be adhered or sealed in such a way to eliminate fresh and salt water ingression (see 4.3.8).

3.4 Optical.

3.4.1 Luminous Transmittance. The integrated luminous (photopic) transmittance of transparent armor shall not be less than 75% for Protection Classes 1 and 2, 60% for Protection Class 3, 50% for Protection Class 4, and 20% for Protection Classes 5 and 6. When TA with a de-icing system is tested, the requirement values shall be reduced by 5 percentage points. When testing the luminous transmission of a single element (or bonded pair) before and after other tests, the luminous transmission shall not change by more than 3 percentage points (see 4.4.1).

3.4.1.1 Night Vision Goggles – Weighted Transmittance. The night vision goggles (NVG)-weighted integrated spectral transmission shall not be less than 50% for Protection Classes 1 and 2, 30% for Protection Class 3, 20% for Protection Class 4, and 10% for Protection Classes 5 and 6. When testing the NVG-weighted transmittance of a single element (or bonded pair) before and after other tests, the NVG-weighted transmittance shall not change by more than 3 percentage points (see 4.4.1.1).

3.4.2 Haze. Haze shall be less than 3% (see 4.4.2).

3.4.3 Optical Deviation. Unless otherwise specified by the procuring activity, the optical deviation of a parallel light at normal incidence to the glass shall not exceed 5 minutes of arc over the Area C (see figure 1) when tested in accordance with 4.4.3.

3.4.4 Optical Distortion. Optical distortion shall be no worse than that indicated by a line slope ratio of 1:20 over Area C (see figure 1) when tested in accordance with ASTM F2156 (see 4.4.4).

3.5 Ballistic Protection. The TA shall, at a minimum, provide protection from the threat rounds corresponding to the protection class specified in the purchase document (see 6.2). Each multi-hit pattern shall be on a single coupon. The protection class threat specifications are found on drawing DTA184044, which is classified SECRET. The multi-hit patterns and location are not classified and are shown as figures 2 and 3 in this document. Figures 4 and 5 may be used by the ballistic test facility when recommending multi-hit patterns for undersized parts (samples). The procuring activity shall specify the protection class as noted on each part drawing (see 6.2) or in the system performance specification. Parts that are too small for reliable four-shot multi-hit patterns will be tested using coupons per 4.5.a. See 3.2.1 and 6.1.1 for other guidance on classification issues (see 4.5).

3.6 Rock Strike and Scratch Resistance. The TA shall provide resistance to scratch and low velocity impact damage and propagation (see 4.6).

3.7 Reliability. The TA and frame assembly shall demonstrate 95% reliability at 45000 hours of useful life with 95% confidence. Failure shall be defined as not meeting production requirements set forth in tables V and VI (see 4.8).

3.8 Construction. The TA frame shall be fabricated IAW drawings referenced in section 2.2.2, including dimensioning, tolerances, welding, surface preparation, finishes, priming, painting, marking, and packaging (see 4.9).

3.9 Highly Accelerated Lifecycle Testing (HALT). The TA and frame assembly shall demonstrate the ability to endure HALT events representative of 45000 hours (see 4.10).

3.10 Shock and Vibration. The TA and frame assembly shall demonstrate the ability to endure shock and vibration testing for 350 hours (see 4.11).

3.11 Adhesion and Bonding.

3.11.1 Frame to TA. The TA and frame assembly shall demonstrate the ability to adhere and remain bonded as a single part following testing set forth in Table III (see 4.12).

3.11.2 TA Inter-layer. The TA layers shall demonstrate the ability to adhere and remain bonded following testing (see 4.12).

4. VERIFICATION

4.1 Tests. This program is a series of tests to satisfy the requirements at minimum cost. Testing is performed by both the contractor and the Government to provide the verification data. Any subcontracted laboratory or contractor in-house laboratory doing work to prove compliance to this document shall be accredited to ISO/IEC 17025 (latest revision) by a recognized assessment agency such as A2LA or LAB (see 6.5).

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

a. Ballistic qualification (see 4.5)

b. First article test (see 4.1.2)

c. Production control test (see 4.1.3)

d. Production conformance inspection (see 4.1.4)

4.1.2 First Article Test (FAT). All new contracts are required to perform a FAT, unless otherwise specified by the procuring activity (see 6.2). On contracts containing multiple part numbers of the same TA composition (see 3.2), meaning the same front-to-back recipe but differing lateral dimensions, FAT shall be conducted only for one part number unless otherwise specified by the procuring activity. Test items conforming to the product drawings of items of the size and type shall be provided for non-ballistic testing and shall be submitted for FAT in addition to the standardized ballistic test coupons required per table IV. The number of samples required for each test is given in table III. Non-ballistic tests may be completed sequentially using the same parts or coupons or may be completed concurrently using different parts or coupons. Coupons may not be used for a test which explicitly requires a part (see table III). For a TA design to pass the non-ballistic tests, either all samples must meet the requirement or the average measurement of the specified number of samples must meet the requirement (see table III). FAT ballistic test coupons shall be identical in composition, stacking order, and construction to the intended production lot (see 3.2 and 4.5). The FAT ballistic acceptance criteria are found in 4.5. Tests that are performed on samples prior to contract award will not be used as a substitute for FAT unless the tests were performed and documented to all FAT requirements, including the design and declaration (see 3.2).

4.1.2.1 Remediation of Failed First Article Testing. If the first article test is disapproved for not meeting requirements, the contractor, upon Government request, shall submit additional first article samples and support, in the same level and manner as the original FAT. Before resubmitting, the contractor shall make any necessary changes or modifications to the TA. Before resubmitting additional FAT samples, the contractor shall furnish the Government information concerning previous rejection, and the action taken to correct the failures. All costs related to the first article tests or building additional FAT samples are to be borne by the contractor. Production shall not begin until the approval of the FAT samples has been obtained.

Table III. First Article Tests.

Title	Samples Required (Pass/Fail unless noted)	Section 3	Section 4	Pre-Production Parts (unless noted)
Design	Documented	3.2	4.2	Part
Allowable Defects	2/2	3.2.7	4.2.3	Part
Marking	Inspection	3.2.8	4.2.4	Part
Luminous Transmittance	2/2	3.4.1, 3.4.1.1	4.4.1, 4.4.1.1	Part or Coupon
Haze	2 Avg.	3.4.2	4.4.2	Part or Coupon
Optical Deviation	2/2	3.4.3	4.4.3	Part
Optical Distortion	2/2	3.4.4	4.4.4	Part
Chemical	2/2	3.3.7	4.3.7	Part
De-icing	2/2	3.2.6	4.2.6	Part
Low Temperature	2/2	3.3.1.1	4.3.1.1	Part
High Temperature	2/2	3.3.1.2	4.3.1.2	Part
Humidity Resistance	2/2	3.3.2	4.3.2	Part
Temperature Shock	2/2	3.3.4	4.3.4	Part
Tolerance	Inspection	3.2.9	4.2.5	Part
Ballistic (cold, ambient, and hot)	34 (per table IV)	3.5	4.5	Coupon
Rock Strike and Scratch Resistance	4 (per 4.6)	3.6	4.6	Coupon
Abrasion Resistance – Threat Surface	3 Avg.	3.3.6.1	4.3.6.1	Coupon, size determined by test facility
Abrasion Resistance – Interior Surface	3 Avg.	3.3.6.2	4.3.6.2	Coupon, size determined by test facility
Sun Exposure Weathering	3/3	3.3.5	4.3.5	Part or Coupon, size determined by test facility
Immersion	2/2	3.3.8	4.3.8	Part
Highly Accelerated Lifecycle Testing (HALT)	2/2	3.9	4.10	Part
Shock and Vibration	2/2	3.10	4.11	Part

Table IV. Ballistic Test Articles Required and Acceptance Criteria.

Protection Class	First Article Testing		Control Testing
	ALLTEMP	Ambient Temperature Only	Ambient Temperature Only
Samples Required	29 plus 5 spares, Coupons	29 plus 5 spares, Coupons	10 plus 2 spares, No-Frame Samples

Test Matrix			
KE bullet, ambient	9	25	8
KE bullet, hot	8	-	-
KE bullet, cold	8	-	-
FSP	4	4	2
Pass Fraction[1]			
KE bullet, ambient	8 of 9	21 of 25	7 of 8
KE bullet, hot	6 of 8	-	-
KE bullet, cold	6 of 8	-	-
FSP	4 of 4	4 of 4	2 of 2

[1]The pass fraction is the number of samples that must pass the ballistic test by receiving no complete penetrations.

Table V. Production Quality Control Tests.

Title	Section 3	Section 4	Production Parts (unless noted)
Ballistic (ambient only)	3.5	4.5.2, 4.5.5	Part[1]
Luminous Transmittance	3.4.1, 3.4.1.1	4.4.1, 4.4.1.1	Part or Coupon
Haze	3.4.2	4.4.2	Part or Coupon
Optical Deviation	3.4.3	4.4.3	Part
Optical Distortion	3.4.4	4.4.4	Part
Abrasion Resistance	3.3.6	4.3.6	Coupon
Immersion	3.3.8	4.3.8	Part
Highly Accelerated Lifecycle Testing (HALT)	3.9	4.10	Part
Shock and Vibration	3.10	4.11	Part

[1]A defrosting film is not required for the ballistic test.

Table VI. Production Inspection.

Title	Section 3	Section 4	Production Parts (unless noted)
Allowable Defects	3.2.7	4.2.3	
Marking	3.2.8	4.2.4	
Tolerance	3.2.9	4.2.5	

4.1.3 Production Control Test. Transparent armor shall be subjected to the production control tests as specified in table V. Control tests shall occur for every production order and shall be carried out by the contractor under Government surveillance, except for ballistic tests which are conducted by the Government (see 4.5). Unless otherwise specified by the procuring activity, contracts containing multiple part numbers of the same recipe, neglecting the presence of de-icing elements, with different lateral dimensions must only conduct control testing on one part number. Ballistic production control tests shall occur every three months or 2000 production parts, whichever occurs first. Changes to the frequency of production control testing must be approved by the procuring agency. The Government reserves the right to conduct ballistic tests of production parts at any time during a production order (see 6.2). For ballistic testing, actual production parts shall be submitted unless the production part is smaller than 240 mm x 365 mm for Protection Classes 1 through 4, 5b and 6a, or 320 mm x 485 mm for Protection Class 5a. If actual production parts are smaller than these dimensions, coupons sized in accordance with 4.5a shall be submitted.

4.1.3.1 Control Test Deficiencies. Control test deficiencies (ballistic and non-ballistic) shall be evidence that end items produced since the last acceptable control test and end items produced after the selection of the control test items may be similarly defective. The contractor may provide evidence satisfactory to the Government Quality Assurance Representative that previously produced end items and units representing the control test are not similarly defective. In the event that the defect(s) exists beyond the control test lot, the contractor shall correct all defective items at no additional cost to the Government. The contractor shall not provide additional product for acceptance until the control test is successfully completed. If there is a failure with the initial samples submitted for a ballistic control test, one additional test sequence for the failed test shall be required to determine if there was a ballistic test anomaly or if there is a quality assurance deficiency in the product. Additional samples shall be submitted to retest the failed threat. Failure of the initial control test and the additional test shall constitute failure of the control test. Parts produced since the previous control test or FAT shall be quarantined and isolated until the reason for test failure is identified and the decision of the procuring activity is obtained.

4.1.4 Production Inspection. Production inspection (control inspections) of TA shall be conducted by the contactor in accordance with table VI. The emphasis shall be on measurement and interface/visual criteria. The number of samples required for a production inspection and frequency of inspections is at the contractor's discretion. No matter what method or frequency of inspection is used, it is the producer's responsibility to ensure that all parts meet the requirements.

4.1.5 Responsibility for Tests. Unless otherwise specified in the contract or purchase order, the contractor is responsible for performing FAT, control testing and inspections (examinations and tests) except for the ballistic testing which will be performed at TARDEC-Warren, RDTA-RS. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable (see 4.1 and 6.5) for the performance of the non-ballistic tests and inspections specified herein, unless disapproved by the Government. The Government reserves the right to witness or perform any of the inspections or tests set forth in this specification where such inspections or tests are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.6 Responsibility for Compliance. All items shall meet all requirements of Sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance also comply with all requirements of the contract. 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.

4.2 Design. The TA shall be visually examined for compliance with the requirements for design and serviceability (see 3.2.2, 3.2.3, 3.2.4, and 3.2.7).

4.2.1 Construction and Materials Process Changes. Following FAT approval, if any changes are made to the manufacturing process, place of manufacture, form, fit, supplier, source of materials, reliability, durability, performance, or components of the TA, the contractor shall notify the procuring activity. The items produced under the changed process may be subject to FAT. The contractor's quality program must control the lots of interlayer materials used, and the program must provide assurance to the Government that as the lot changes, the interlayer materials are functionally the same or the Government may require FAT for the subsequently produced parts.

4.2.2 Reserved.

4.2.3 Allowable Defects. Conformance to 3.2.7 shall be verified by visual inspection for the defects specified in table VII. Unless otherwise specified (see 6.2), minor imperfections that do not affect serviceability shall be permitted. Short interlayers no greater than 7 mm (approximately 0.25 in.) from the edge shall be permitted. For inspection purposes, the TA is divided into three zones or grading areas. Area A is the edge to be concealed at assembly by the frame or gasket and is zero unless specified by the procuring activity (see 6.2). Area B is the area within 50 mm of the concealed edges, and Area C is the remaining central area (see figure 1). Observation of defects exceeding what is allowable, as indicated in table VII, shall constitute failure.

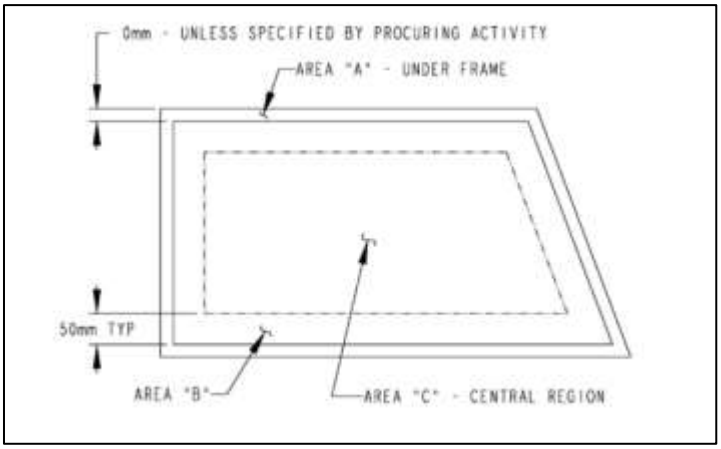

Figure 1. Definition of TA Areas.

Table VII. Maximum Allowable Defects.

Types of Defects (See Section 6 for definitions)	Maximum Allowable Area C	Maximum Allowable Area B
Delamination or Bond Separations	Not allowed	Not allowed
Cracking, Crazing, or Clouding	Not allowed	Not allowed
Gaseous Inclusions	.062 in. (1.6 mm)	.093 in. (2.4 mm)
Open Gaseous Inclusions	.045 in. (1.2 mm)	.062 in. (1.6 mm)
Stones and Knots	.031 in. (0.8 mm)	.045 in. (1.2 mm)
Digs	.062 in. (1.6 mm)	.093 in. (2.4 mm)
Inside Dirt	.093 in. (2.4 mm)	.093 in. (2.4 mm)
Ream and String	Shall not be evident at an angle greater than 30° between line of sight and the glass surface, with indirect daylight.	
Scratches and Rubs	Use ASTM F548 for plastics and ASTM F428 for glass. Scratches meeting F428-level 6 are acceptable but level 7 are unacceptable. Scratches in Area B shall be less than 2 inches long. Scratches in Area C shall be less than 1 inch long. Scratches on the safe side are not permitted.	
Crush	Shall not be detectable at distances greater than 10 ft (3.0 m), with indirect daylight.	
Lint and Hair	Area C, lint and hair barely noticeable at 3 ft (0.9 m) looking through the glass at a patterned background with indirect daylight. Area B, lint and hair may be noticeable under same conditions. Reference ASTM C1172.	
Insects or Other Organic Matter	Shall not be detectable at distances greater than 3 ft (0.9 m) looking through and perpendicular to the glass, with indirect daylight.	
Surface Defects	Shall not be detectable at distances greater than 10 ft (3.0 m).	
Interlayer Striae	Shall not be detectable at distances greater than 10 ft (3.0 m) looking perpendicular to the glass, with indirect daylight.	
Cracks	No cracks shall be allowed in area A, B, or C.	

Note 1: Defects or imperfections not specifically mentioned shall be compared to the imperfection they most closely resemble. Imperfection(s) include any related distortion to the area surrounding the imperfection.

Note 2: Areas of concentrated imperfections shall be no larger or more detectable than individual imperfections.

Note 3: Windows shall be examined while in the vertical position looking from the safe side through to the strike face (as viewed from the inside of the vehicle) in front of a patterned background where the light measured at the strike face shall be 160 foot candles (per ASTM C1036). The window shall be evaluated at a distance of 3 feet, perpendicular to the surface for 10 seconds. It is important that the observer look at the background rather than looking at the window surface.

4.2.4 Marking. Conformance to 3.2.8 shall be verified by visual examination. Observation of marking that does not include all required information, is not permanent or that is not readable from the exterior of the vehicle shall constitute failure.

4.2.5 De-icing. To determine conformance to 3.2.6, the TA shall be subjected to the following conditions:

a. The TA shall be placed in a temperature chamber and conditioned at a temperature of -25°C/-13°F for a minimum period of 12 hours.

b. A coating of ice shall be formed on the threat surface of the windshield(s) as follows: The windshield(s) shall be sprayed with 0.05 mL of water per square centimeter of threat surface area applied by means of a spray gun with 345±35 kPa (50±5 psi) air pressure at the device, measured while spraying to form an even coating of ice over the entire glass surface. The spray nozzle (adjusted to full fan pattern and maximum flow) is held perpendicular to and 200 to 250 mm from the strike face, and stroked back and forth evenly in horizontal overlapping layers until the specified quantity of water is applied. Upon completion of the icing process, wait 25±5 minutes before the start of the de-icing test. The windshield(s) shall remain in the temperature chamber at -25°C/-13°F until the test is completed.

c. With the coupon or part vertical, apply 26±1 V DC for 60 minutes (steady state voltage limit per MIL-STD-1275) to the de-icing element. An ice removal tool may be used on the exterior face of the TA to remove ice that is floating (not frozen) onto the glass surface. The tool may not be used to chisel ice still frozen to the exterior surface to meet this requirement.

d. At the end of the 60 minute test period the de-iced pattern is photographed, the TA gently wiped with a cotton rag, and the TA photographed. The clear de-iced area must be no less than 80% of Area C (see 3.2.6).

e. The windshield(s) shall then be returned to standard ambient temperature and visually inspected for conformance to the allowable defects requirements of 3.2.7 and the optical requirements of 3.4.

4.3 Environmental Conditions. The environmental capabilities of the TA shall be verified through analysis and testing for discrete environments.

4.3.1 Temperature Extremes.

4.3.1.1 Low Temperature. The TA shall be placed in a temperature chamber and subjected to the conditions adapted from MIL-STD-810 Method 502, Procedure I (Storage). A temperature of -54±4°C/-65±7°F shall be maintained for a period of 24 hours. The TA shall be returned to standard ambient temperature at the conclusion of this period. The TA shall then be inspected for conformance to the allowable defects requirements of 3.2.7 and the optical requirements of 3.4.

4.3.1.2 High Temperature. The TA shall be subjected to the conditions adapted from MIL-STD-810 Method 501, Procedure I (Storage), climatic category A2 (Basic Hot) Induced. Three cycles of the profile in table VIII shall be used. The suggested temperature and relative humidity variability are ±2°C/±4°F and ±5%, respectively. At the conclusion of three test cycles, the TA shall be returned to standard ambient temperature and visually inspected for moisture buildup. The TA shall be inspected for conformance to the allowable defects requirements of 3.2.7 and the optical requirements of 3.4.

Table VIII. High Temperature Test Profile.

Time (Hours)	Temperature (°C/°F)	Relative Humidity (%)	Time (Hours)	Temperature (°C/°F)	Relative Humidity (%)
0100	33/91	36	1300	61/142	6
0200	32/90	38	1400	63/145	6
0300	32/90	41	1500	63/145	5
0400	31/88	44	1600	62/144	6
0500	30/86	44	1700	60/140	6
0600	31/88	43	1800	57/134	6
0700	34/93	32	1900	50/122	10
0800	38/101	30	2000	44/111	14
0900	42/107	23	2100	38/101	19
1000	45/113	17	2200	35/95	25
1100	51/124	14	2300	34/93	28
1200	57/134	8	2400	33/91	33

4.3.2 Humidity. To determine conformance to 3.3.2, the TA shall be exposed to five modified cycles of the profile of MIL-STD-810 Method 507, Procedure II (Aggravated). The profile for the modified cycle is given in table IX. The TA shall then be allowed to return to standard ambient conditions and shall be visually inspected for moisture buildup. The TA shall be inspected for conformance to the allowable defects requirements of 3.2.7 and the optical requirements of 3.4.

Table IX. Humidity Test Profile.

Time (Hours)	Temperature (°C/°F)	Relative Humidity (%)
0	30/86	95
2	60/140	95
32	60/140	95
40	30/86	95
48	30/86	95

4.3.3 Reserved.

4.3.4 Temperature Shock. Conformance to 3.3.4 shall be verified by subjecting TA to the testing described in MIL-STD-810 Method 503, Procedure I-C (Multi-cycle shocks from constant extreme temperature). The temperature extremes used for the test shall be -30±3°C/-22±5°F and 60±3°C/140±5°F. Temperature stabilization period shall be bound by TA temperature reaching within 5±1°C/9±2°F of air temperature at each temperature extreme. The test cycle shall begin at either temperature extreme, and the transfer time between temperature conditions shall be no longer than 1 minute. The TA shall be subjected to 730 thermal cycles. After completion of the temperature shock test, nonconformance with the optical requirements of 3.4, immersion requirements of 3.3.8, or the allowable defects requirements of 3.2.7 as a result of the test shall constitute failure.

4.3.5 Sun Exposure Weathering. Conformance to 3.3.5 shall be verified by conducting sun exposure testing on TA in one of the following conditions:

a. 3 pieces of TA in the form of actual production parts (see 6.2)

b. 3 sets of each combination of bonded pair and adhesive or full thickness test coupon laminations of 100±5 mm x 100±5 mm. All materials and substrate-adhesive combinations used in the TA recipe shall be tested (to include all adhesive materials and, if part of the deliverable requirements, the de-icing element). Edge treatment or sealing to be used on the production parts is suggested but not required.

Transparent armor production parts or sample coupons shall be exposed to an irradiance level of 1120 W/m2 in accordance with MIL-STD-810 Method 505, Procedure II (Steady State (actinic effects)) for fifty-six (56) 24-hour cycles. Irradiance shall be normal to the strike face of the TA. Airflow shall be applied as described in the test procedure to maintain the thermal response or peak response temperature that would be attained under natural conditions. After exposure, nonconformance to the allowable defects requirements of 3.2.7 or nonconformance with the optical requirements of 3.4.1, 3.4.1.1, and 3.4.2 shall constitute failure. Luminous transmittance shall be determined before and after testing. In the event that the acquisition activity waives the requirement for the sun exposure testing, then the contractor shall certify that no material that degrades when subjected to solar exposure for a minimum period of five years was used for this production lot.

4.3.6 Abrasion Resistance.

4.3.6.1 Abrasion Resistance – Threat Surface. Three sample coupons of the threat surface material shall be tested in accordance with the safety glazing material abrasion resistance test (Test 18) of ANSI/SAE Z26.1. Noncompliance with the light scattering requirement stated in the ANSI/SAE Z26.1 test procedure after test completion shall constitute failure.

4.3.6.2 Abrasion Resistance – Interior Surface. Three sample coupons of the interior or spall liner surface material shall be tested in accordance with the plastics abrasion resistance test (Test 17) of ANSI/SAE Z26.1, including the modified procedure for Item 4A rigid plastics. Non-compliance with the light scattering requirements stated in ANSI/SAE Z26.1 test procedure for Item 4A rigid plastics after test completion shall constitute failure.

4.3.7 Exposure to Chemicals.

4.3.7.1 Cleaning Spray. To determine conformance to 3.3.7.1, the portion of the TA assembly within the sealing surface (see figure 1) shall be exposed to a water jet or steam spray using agents conforming to A-A-59133. The jet shall be applied perpendicular to the TA at a distance no less than 1 ft (0.305 m) or farther than 2 ft (0.610 m) from the TA surface at a cleaning rate of 1 ft^2/min (0.0929 m^2/min) for a period of 10 minutes. The water jet shall be derived from a nozzle having an orifice diameter of 0.25 inch (6.35mm) and a nozzle pressure of 110 lb/in^2 gage (about 760 kPa). After the TA has been water rinsed and air dried, nonconformance to the optical requirements of 3.4 or debonding of the seal due to the tests of 4.3.7 shall constitute failure.

4.3.7.2 Inner Surface Exposure to Chemicals. To determine conformance to 3.3.7.2, expose the assembly to the chemicals specified in table I in accordance with the chemical resistance (non-stressed) test (Test 19) of ANSI/SAE Z26.1 except for the requirement to immerse the specimen. The chemical shall be applied with a soft, 13 mm wide brush, wet brush before each stroke. Coat the entire surface for a period of one minute. The edges of the specimen may be wiped after the chemical has been applied to the surface. The chemical shall remain on the specimen for one hour; reapply if necessary to keep the surface wetted. After the one hour exposure, wipe with absorbent cotton. After exposure, nonconformance to the allowable defects requirements of 3.2.7, nonconformance to the optical requirements of 3.4, or debonding of the seal due to the tests of 4.3.7 shall constitute failure.

4.3.7.3 Outer Surface Exposure to Chemicals. To determine conformance to 3.3.7.3, expose the assembly to the vapors (volatile chemicals) of or in direct contact (non-volatile chemicals) with the chemicals specified in table II for a minimum period of 48 hours. Testing shall be done at a temperature between 22°C/72°F and 24°C/75°F and at 50±2% relative humidity. After exposure, nonconformance to the allowable defects requirements of 3.2.7, nonconformance to the optical requirements of 3.4, or debonding of the seal due to the tests of 4.3.7 shall constitute failure.

4.3.8 Immersion. To determine conformance to 3.3.8, the assembly shall be attached to a closed mock windshield plate, representative of production vehicle attachment dimensions and methods, and completely immersed in both fresh and salt water consecutively, IAW MIL-STD-810 Method 512, Procedure I, following the prescribed conditioning temperature, to a depth of 1±0.1m for a minimum period of 30 minutes for each water type. An 8 inch x10 inch chlorophenol red test sheet attached to inside of windshield plate shall be used throughout the test. Evidence of water ingression shall constitute failure.

4.4 Optical.

4.4.1 Luminous Transmittance. Conformance to 3.4.1 shall be verified by determining luminous (photopic) transmittance in accordance with MIL-DTL-62420. Spectral transmittance shall be measured at wavelength intervals of 10 nm or less over the 380 to 930 nm band at normal incidence. Luminous visible light transmittance corresponding to daylight vision is determined by integration of individual photopic transmission values in the 380 to 760 nm range, as discussed in MIL-DTL-62420. To aid in these calculations, the relative spectral irradiance (spectral power distribution) of CIE Standard Illuminant A is tabulated in table X for the range necessary for photopic calculations. Integrated luminous (photopic) transmittance values lower than the levels specified in 3.4.1 for each protection class shall constitute failure.

Table X. Relative Spectral Irradiance (Spectral Power Distribution) of CIE Illuminant A.[1]

Wavelength (nm)	CIE Illuminant A Relative SPD	Wavelength (nm)	CIE Illuminant A Relative SPD	Wavelength (nm)	CIE Illuminant A Relative SPD
380	9.795	570	107.184	760	232.115
390	12.085	580	114.436	770	237.008
400	14.708	590	121.731	780	241.675
410	17.675	600	129.043	790	246.116
420	20.995	610	136.346	800	250.329
430	24.671	620	143.618	810	254.314
440	28.703	630	150.836	820	258.071
450	33.086	640	157.979	830	261.602
460	37.812	650	165.028	840	264.909
470	42.869	660	171.963	850	267.994
480	48.242	670	178.769	860	270.861
490	53.913	680	185.429	870	273.511
500	59.861	690	191.931	880	275.950
510	66.063	700	198.261	890	278.182
520	72.496	710	204.409	900	280.210
530	79.133	720	210.365	910	282.039
540	85.947	730	216.120	920	283.676
550	92.912	740	221.667	930	285.123
560	100.000	750	227.000	940	286.388

4.4.1.1 Night Vision Goggles – Weighted Transmittance. Conformance to 3.4.1.1 shall be verified by using the same procedure for determining the luminous transmission (see 4.4.1), except that the photopic visibility response function is replaced by the NVG response function and the integration is over the 400-930 nm band width. The NVG response function for the Gen III goggle can be found in table XI. NVG-weighted integrated spectral transmission values lower than the levels specified in 3.4.1.1 for each protection class shall constitute failure.

[1]The spectral power distribution of CIE Standard Illuminant A may be calculated directly for any wavelength (in nanometers) according to the following equation:

$$S_A(\lambda) = 100\left(\frac{560}{\lambda}\right)^5 \cdot \frac{\exp\left(\frac{1.435 \cdot 10^7}{2848 \cdot 560}\right) - 1}{\exp\left(\frac{1.435 \cdot 10^7}{2848\lambda}\right) - 1}$$

Table XI. Night Vision Goggle Response Function (Gen III with PVS14 Lens).

Wavelength (nm)	NVG response function	Wavelength (nm)	NVG response function	Wavelength (nm)	NVG response function
400	0.435303	580	139.1584	760	228.2707
410	0.553184	590	147.6375	770	231.5246
420	0.622804	600	154.7995	780	232.9495
430	0.720327	610	158.2172	790	230.6198
440	0.774597	620	163.9736	800	229.8749
450	0.95592	630	171.2335	810	230.8247
460	1.498751	640	177.1857	820	230.5731
470	2.733931	650	180.9362	830	232.4454
480	5.062586	660	183.9411	840	232.9500
490	8.980719	670	188.3174	850	230.5399
500	16.73018	680	193.6995	860	222.8937
510	33.157	690	198.8604	870	206.3682
520	59.38454	700	204.6688	880	174.7238
530	88.01918	710	207.1154	890	117.5446
540	104.2107	720	210.3207	900	60.17207
550	114.4304	730	213.5381	910	20.50749
560	125.9235	740	218.2106	920	5.212234
570	132.2722	750	223.1936	930	0

4.4.2 Haze. Conformance to 3.4.2 shall be determined by measuring haze in accordance with ASTM D1003 at locations representative for Area C. Haze greater than 3% shall constitute failure.

4.4.3 Optical Deviation. Conformance to 3.4.3 shall be determined by measuring optical deviation using the methods specified in ASTM F801 or ASTM F2469. Unless otherwise specified, optical deviation greater than 5 minutes of arc over Area C (see figure 1) for a parallel light at normal incidence to the glass shall constitute failure.

4.4.4 Optical Distortion. Conformance to 3.4.4 shall be determined by measuring optical distortion in accordance with ASTM F2156. Optical distortion worse than that indicated by a line slope of 1:20 over Area C (see figure 1) shall constitute failure.

4.5 Ballistic Qualification. The sample coupons for ballistic testing prior to FAT, also called prequalification, and for FAT are not required or intended to be actual production parts; the samples for production control testing are required to be production parts, except as noted by 4.1.3. Ballistic coupons are not required to have a de-icing film applied. Coupons and samples submitted for FAT and production control ballistic testing shall be identified before testing as to contractor, contract number, manufacturer, date of manufacture and/or production lot, and composition as stated by the contractor (see 3.2). The contractor shall certify, through submission of a declaration that all TA produced during the production lot uses the same materials and construction as the ballistic coupons with the exception of de-icing elements. First article and production control ballistic testing shall not proceed until the required declarations are received. If declarations are sent to the procuring agency, copy the Government ballistic test range. Samples submitted for ballistic acceptance testing shall be tested as follows:

a. The ballistic test coupons submitted for Protection Classes 1 through 4, 5b, and 6a shall be 400±5 mm x 400±5 mm. Coupons submitted for Protection Class 5a shall be 480±5 mm x 480±5 mm. In order to verify the contractor's construction declaration (see 3.2), the coupon edges shall have no wrap or seal applied that prohibits viewing of the stacking sequence. The coupons shall be packaged for shipping to the test laboratory so that they are not damaged by moisture.

b. Reference MIL-STD-662 for general procedures and guidelines for setting up and conducting a ballistic test. Ballistic test coupons shall be received without gaskets or frames. The ballistic testing laboratory shall mount the coupons in a suitable frame, preferably wood, that fully supports the full thickness of the TA on a shoulder 18 to 25 mm wide behind the perimeter of the sample or coupon. Non-metallic (stress distributing) pads shall be used on the clamp feet to protect the TA strike face. The frame shall be mounted to a rigid target fixture so that the 18 to 25 mm shoulder area is supported. For conventional laminate TA, the target samples shall be positioned at 0±2° obliquity. When other fabrication techniques such as, but not limited to, mosaic plies or laminate interface surfaces that are not parallel to the strike surface are submitted for testing, the TA shall be tested to exploit its vulnerability. The exploitation shall be accomplished by varying the angle of shot obliquity up to 45° and/or using tile interface seams and joints as the aim point for the multi-hit pattern. The projectiles shall have no more than 5° of yaw. Yaw shall be verified at the beginning of the test and at any time during the test when the test director sees indications of yawed impacts. The witness system shall consist of aluminum foil, kitchen foil, or equivalent, 0.025 mm thick. Alloy may be 8111 or 1100, "0" temper. (The Government purchases foil to A-A-1676 Type I, Grade A.) It shall be placed at a standoff distance of 150±30 mm behind and parallel to the back face surface of the target at the aim point. The witness system shall extend over a sufficient area (equal to or greater than the target area) such that all significant projectile or target debris can be detected. The witness system foil should be protected on the sides and rear so that debris from the front surface impact does not ricochet off surfaces in the impact chamber and cause false failure holes.

c. The threat projectile and proof velocity shall be mandated by drawing DTA184044 for the required protection class. The multi-hit test patterns and location dimensions are shown as figures 2 and 3. Protection classes shall have a multi-hit requirement except as noted on DTA184044. A sample will fail if any target coupon has a complete penetration (CP) shot as determined by examination of the witness plate. A CP is recorded when light is observed to pass through the damage in the witness plate. Photographs shall be taken of any sample that contains a complete penetration.

d. Material Safety Data Sheets shall be provided to the ballistic test laboratory for all materials in the TA sample.

4.5.1 Ballistic Test Report. The results of ballistic testing conducted using the requirements of 4.5 shall be reported as "tested in accordance with the requirements of MRAP specifications, Class XY" (Protection Class number, alpha character, and ALLTEMP, AMBIENT, or CONTROL per table IV). The ballistic test report for FAT and production control shall identify the contractor and lot tested and shall indicate the acceptance or rejection of the lot. The report may be classified SECRET based on the relevant SCG. The test data of projectile weight, impact velocity, shot impact accuracy relative to the specified shot pattern, penetration observation, and total weight and thickness for each test sample will be available from the laboratory.

4.5.2 Ballistic Test Procedure, KE Bullet, Ambient Temperature. Testing as specified on DTA184044 for the protection class shall be performed with the target samples conditioned for a minimum period of 12 hours between 7°C/45°F and 35°C/95°F. Unless otherwise specified by the procuring activity, nine test patterns (see table IV, ALLTEMP) as shown on figure 2 are to be shot for the multi-hit requirements of Protection Classes 1 through 4. The pattern shown on figure 3 is to be used for the multi-hit requirement of Protection Class 5. The center of the specified pattern shall be located in the center of the coupon within a tolerance zone of 100 mm. Protection classes with a single shot requirement shall have the shot centered on the coupon within a 100 mm diameter tolerance zone. When the procuring activity waives the requirements for ballistic testing ALLTEMP at high and/or low temperature during FAT, then the number of ambient temperature test coupons shall be 25 (per table IV). TA that is tested at ambient temperature only shall include AMBIENT in test documents (see 4.5.1). The procuring activity may specify "AMBIENT only" in the contract to reduce the contract risk. In this case, no high or low temperature ballistic tests will be performed or required and the coupons required are given in the table IV AMBIENT column. Ballistic tests involving high and low temperature testing are required unless the acquisition activity specifically waives these tests or specifies "AMBIENT only" in the contract.

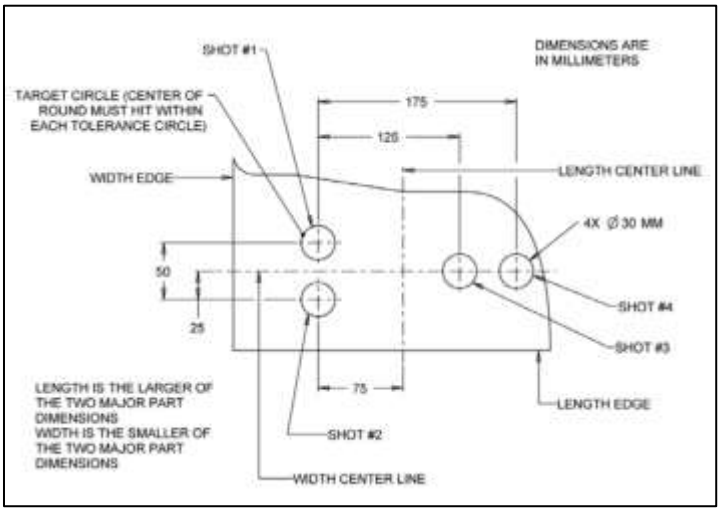

Figure 2. Multi-hit Pattern, Protection Classes 1 thru 4.

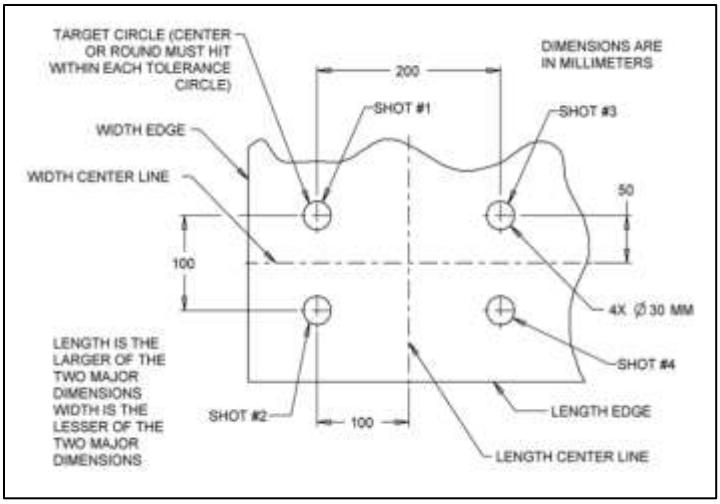

Figure 3. Multi-hit Pattern, Protection Class 5.

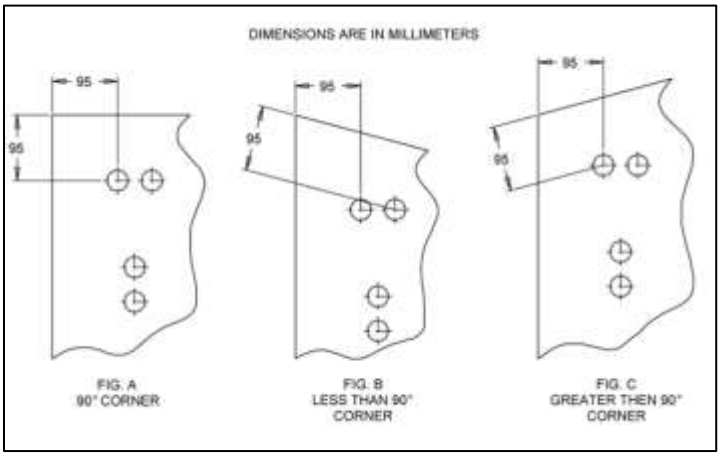

Figure 4. Multi-hit Pattern Location on Production Part, Protection Classes 1 thru 4.

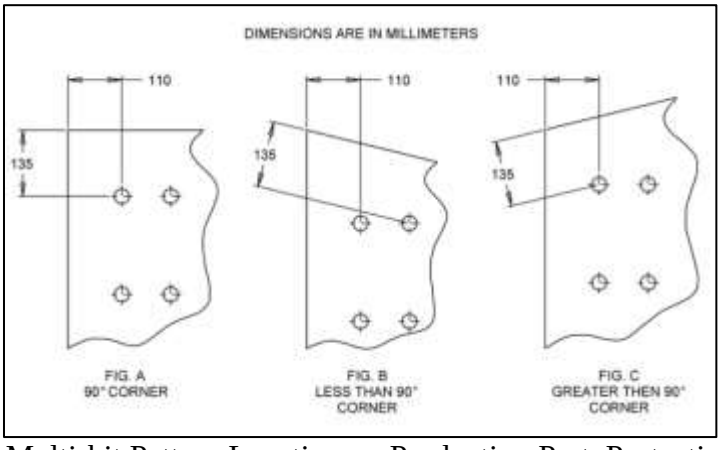

Figure 5. Multi-hit Pattern Location on Production Part, Protection Class 5.

4.5.3 Ballistic Test Procedure, KE Bullet, High Temperature. Testing as specified on DTA184044 for the protection class shall be performed with the target samples conditioned for a minimum period of 12 hours at 63±5°C/145±9°F. The target sample shall be removed from the conditioning chamber and the test pattern shot within 25 minutes. If the shot pattern is not completed within 25 minutes, the coupon must be re-conditioned for a minimum of 12 hours. Unless otherwise specified by the procuring activity, eight test patterns (see table IV) as shown on figure 2 are to be shot for the multi-hit requirements of Protection Classes 1 through 4. The pattern shown on figure 3 is to be used for the multi-hit requirement of Protection Class 5. The center of the specified pattern shall be located in the center of the coupon within a tolerance zone of 100mm. Protection classes with a single shot requirement shall have the shot centered on the coupon within a 100 mm diameter tolerance zone.

4.5.4 Ballistic Test Procedure, KE Bullet, Low Temperature. Testing as specified on DTA184044 for the protection class shall be performed with the target samples conditioned for a minimum period of12 hours at -43±5°C/-45±9°F. The target sample shall be removed from the conditioning chamber and the test pattern shot within 25 minutes. If the shot pattern is not completed within 25 minutes, the coupon must be re-conditioned for a minimum of 12 hours. Unless otherwise specified by the procuring agency, eight test patterns (see table IV) as shown on figure 2 are to be shot for the multi-hit requirements of Protection Classes 1 through 4. The pattern shown on figure 3 is to be used for the multi-hit requirement of Protection Class 5. The center of the specified pattern shall be located in the center of the coupon within the tolerance zone of 100mm. Protection classes with a single shot requirement shall have the shot centered on the coupon within a 100 mm diameter tolerance zone.

4.5.5 Ballistic Test Procedure, FSP. Testing as specified on DTA184044 for the protection class shall be performed with the target samples conditioned for a minimum period of 12 hours between 7°C/45°F and 35°C/95°F. The tests shall be as follows:

a. The test requirement for all protection classes, except Protection Class 5a, is that these samples, as noted in table IV, shall each be shot with a single FSP as specified in DTA184044 at the velocity specified for the requested protection class with the shot centered on the coupon within a 100 mm diameter tolerance zone. No complete penetrations are allowed (see table IV).

b. For Protection Class 5a only, three shots shall be placed in an equilateral triangle pattern. The center of this pattern will be located within 70 mm of the coupon center. The spacing between the vertices of the triangle, the impact locations, shall be 200 mm. The position of the actual hit locations relative to the vertices shall be within a 60 mm diameter tolerance zone. No complete penetrations are allowed (see table IV).

c. High and Low Temperature requirements. Reserved (see DTA184044).

4.5.6 Ballistic Test Acceptance Criteria. Acceptance criteria are given in the pass fraction section of table IV. If the required pass fraction is attained or the allowable number of failed samples is surpassed before all coupons have been tested at one temperature condition, the test at that temperature condition may be stopped.

4.6 Rock Strike and Scratch Resistance. Testing shall be performed on 400±5 mm x 400±5 mm coupons that have been conditioned for a minimum period of twelve hours between 15°C/59°F and 35°C/95°F. Two impact tests (see 4.6.1) and one scratch test (see 4.6.2) shall be performed. Prior to testing, the strike side of the coupons shall be dry and clean.

4.6.1 Low Velocity Impact Resistance. Coupons shall be mounted at an obliquity of 0±2°. Each sample shall be impacted four times as shown on figure 6 with a 12 mm diameter silicon nitride ball conforming to ISO 3290-2 grade 10 or better. Impact velocity shall be measured less than 1 m from the coupon strike face.

a. One sample shall be tested with four impacts on the strike face at 18.3±1.53 m/s (60±5 ft/s). After four impacts, the maximum linear distance across the strike side between the ends of the damaged or fractured region at each impact location shall be measured and recorded. The maximum distance from end to end of damage or fracture, including subsurface damage, at each location shall not exceed 50 mm. All four impacts shall meet this requirement.

b. Two coupons shall be tested with four impacts on the strike face at 30.5±1.53 m/s (100±5 ft/s). Immediately after each impact, the extent of the visible surface or subsurface damaged area, including the leading tips of cracks, shall be marked with a fine point permanent marker. If no damage is visible, the approximate location of the impact will be marked for reference. After testing and marking, the coupons shall be placed in a chamber with an air temperature that is linearly cooled from ambient temperature to -43±5°C/-45±9°F in twelve hours and then held at -43±5°C/-45±9°F for six hours. The air temperature shall then be linearly raised to ambient temperature in six hours. The coupons may be held at ambient temperature longer to stabilize if necessary. The coupons shall be inspected after stabilization. An impact site with cracks that have reached the sample edges prior to marking or that have visually propagated past the marked lines shall fail. Five of eight impacts shall meet this requirement.

4.6.2 Scratch Propagation Resistance. One coupon shall be scratched in the coupon center within a 100 mm diameter tolerance zone. The scratch shall be 10±1 mm in length and shall be created by applying a 10±1 Newton load to a pencil hardness tester equipped with a cone hand file with 0.125-in. shank and 120 grit diamond on the taper (Starlite Industries part number 105025 hand file or equal) as a stylus. The angle and direction of travel of the stylus are specified in ASTM D3363. The scratch shall be formed in a manner such that the indenter does not bounce or skip along the coupon. The extent of the scratch and resulting damage shall be marked with a fine point permanent marker. After scratching and marking, the coupons will be placed in a chamber with an air temperature that is linearly cooled from ambient temperature to -43±5°C/-45±9°F in twelve hours and then held at -43±5°C/-45±9°F for six hours. After the test, the air temperature shall be linearly raised to ambient temperature in six hours. The coupon may be held at ambient temperature longer to stabilize if necessary. Visual observance of cracks propagating past the marked lines or other damage resulting from the scratch shall constitute failure.

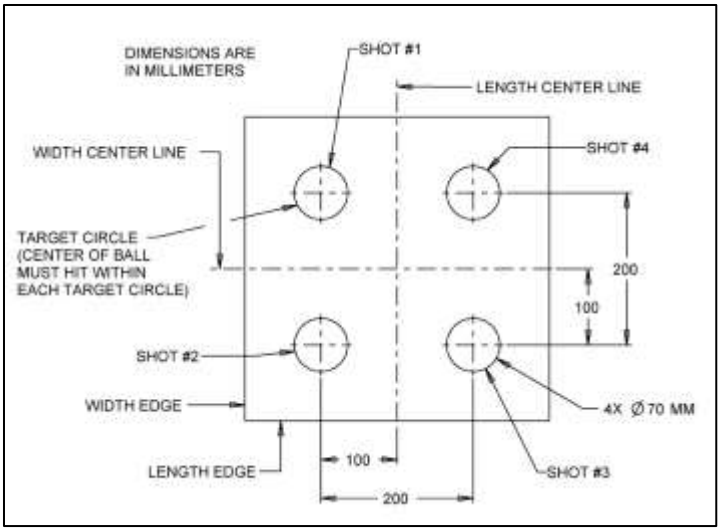

Figure 6. Pattern for Low Velocity Impact Tests.

4.7 Ballistic Testing Facility. Unless otherwise specified in the contract or purchase order (see 6.2), the ballistic test coupons shall be forwarded to the Commander, USA TARDEC-WARREN, Attn: RDTA-RS, MS 263, Bldg 219 Ballistic Lab, Warren, MI 48397-5000.

4.8 Reliability. Conformance to 3.7 shall be verified by statistical analysis of performance WRT production requirements listed in tables V and VI.

4.9 Frame Construction. Conformance to 3.8 shall be verified by inspection as to the following of drawings provided as referenced in section 2.2.2.

4.10 Highly Accelerated Lifecycle Testing (HALT). Conformance to 3.9 shall be verified by testing IAW TOP 01-1-065. Inability to fulfill any requirements listed in tables V and VI following HALT events shall constitute failure.

4.11 Shock and Vibration. Conformance to 3.10 shall be verified by testing IAW MIL-STD-810 Method 514, Procedure I (General Vibration), using vibration environment category 4 (Transportation, Trucks and Trailers, Secured Cargo). Inability to fulfill any requirements listed in tables V and VI following HALT events shall constitute failure.

4.12 Adhesion and Bonding.

4.12.1 Frame to TA. Conformance to 3.11.1 for all parts shall be verified via conformance to sections 3.3.2 (Humidity), 3.3.8 (Immersion), all sections under 3.4 (Optical), and section 3.10 (Shock and Vibration).

4.12.2 TA Inter-layer. Conformance to 3.11.1 for all TA shall be verified via testing IAW ANSI/SAE Z26.1-1996, Test 29 (5.29: Impact, Ball Drop).

5. PACKAGING AND MARKING

The following section 5 is not part of FAT.

5.1 Preservation, Packing and Marking. The preservation, packing, and marking requirements for this contract/order (see 6.2) shall be accomplished in accordance with the performance requirements defined herein.

5.1.1 Military Requirements. Preservation designed to protect an item during shipment, handling, indeterminate storage, and distribution to consignees worldwide.

5.1.1.1 Dirt and Contaminants. Items shall be free of dirt and contaminants.

5.1.1.2 Deterioration Protection. Items susceptible to corrosion or deterioration shall be protected by means of preservative coatings, volatile corrosion inhibitors, desiccants, water proof and/or water vapor proof barriers. Coatings and preservatives shall not cause damage to the end item.

5.1.1.3 Physical Damage Protection. Items requiring protection from physical and mechanical damage (e.g., fragile, sensitive, material critical) shall be protected by wrapping, cushioning, pack compartmentalization, or other means to mitigate shock and vibration to prevent damage during handing and shipment.

5.1.1.4 Packaging. A unit package shall be designed and constructed to contain the contents with no damage to the item(s) including minimal damage to the unit pack during shipment and storage and will allow subsequent handling. The outermost component of a unit package shall be a container. All containers shall be rated IP68 IAW ANSI/IEC 60529-2004 for dust and water ingression, and shall be used at all times prior to installation of TA.

5.1.1.5 Unit Package. Unless otherwise specified, the unit package quantity shall be one each (see 6.2).

5.1.1.6 Contractor Packaging Responsibility. Contractor shall perform packaging design validations in accordance with ASTM D4169, Acceptance Criteria 1, Distribution Cycle 18, Assurance Level I. Replicate testing and climatic conditioning is not required.

5.1.2 Commercial Packaging Requirements. Preservation, packaging, packing and marking of the item or items furnished by the supplier and limited to CONUS. Immediate use shipments shall provide protection for a minimum of one year, be free of dirt and contaminants, protected from corrosion or deterioration if required, wrapped and cushioned to mitigate shock and vibration, placed into a unit container with a quantity per unit pack equaling one each and provide multiple handling, redistribution and shipment by any mode.

5.1.2.1 Contractor Packing Responsibility, Commercial Packing. Contractor shall perform packaging design validations in accordance with ASTM D4169, Acceptance Criteria 1, Distribution Cycle 14, and Assurance Level II. Replicate testing and climatic conditioning is not required.

5.1.3 Wood Heat Treating. Boxes/pallets and any wood used as inner packaging made of non-manufactured wood shall be heat-treated. All non-manufactured wood used in packaging shall be heat treated to a core temperature of 56°C/133°F for a minimum of 30 minutes. The box/pallet manufacturer and the manufacturer of wood used as inner packaging shall be affiliated with an inspection agency accredited by the board of review of the American Lumber Standard Committee. The box/pallet manufacturer and the manufacturer of wood used as inner packaging shall ensure traceability to the original source of heat treatment. In addition, wood used as dunnage for blocking and bracing shall be ordered with ALSC certified marking for dunnage or the markings may be applied locally at two foot intervals.

5.2 Packing.

5.2.1 Military Level A Packing. Protection required meeting the most severe worldwide shipment, handling, and storage conditions. Level A pack must, in tandem with the applied preservation, be capable of protecting material from the effects of direct exposure to extremes of climate, terrain, and operational and transportation environments. (ref: MIL-STD-2073-1E Appendix C, Table C-II).

5.2.2 Military Level B Packing. Protection required meeting moderate worldwide shipment, handling, and storage conditions. Level B pack must, in tandem with the applied preservation, be capable of protecting material not directly exposed to extremes of climate, terrain, and operational and transportation environments. (ref: MIL-STD-2073-1E Appendix C, Table C-II).

5.2.3 Commercial Packing. Unit packages and intermediate packages not meeting the requirements for a shipping container shall be packed in shipping containers. All shipping containers shall be the most cost effective and shall be of minimum cube to contain and protect the items.

5.2.4 Shipping Containers. The shipping container (including any necessary blocking, bracing, cushioning, or waterproofing) shall comply with the regulations of the carrier used and shall provide safe delivery to the destination at the lowest tariff cost. The shipping container shall be capable of multiple handling, stacking at least ten feet high, and storage under favorable conditions (such as enclosed facilities) for a minimum of one year.

5.2.4.1 Unitization. Shipments of identical items going to the same destination shall be palletized if they have a total cubic displacement of 50 cubic feet or more unless skids or other forklift handling features are included on the containers. Pallet loads must be stable, and to the greatest extent possible, provide a level top for ease of stacking. A palletized load shall be of a size to allow for placement of two loads high and wide in a conveyance. The weight capacity of the pallet must be adequate for the load. The preferred commercial expendable pallet is a 40 x 48 inch, 4-way entry pallet although variations may be permitted as dictated by the characteristics of the items being unitized. The load shall be contained in a manner that will permit safe handling during shipment and storage.

5.3 Marking. Marking shall be per the purchase agreement.

5.3.1 Marking Limitations. All unit packages, intermediate packs, exterior shipping containers, and, as applicable, unitized loads shall be marked in accordance with the most current version of MIL-STD-129 and in accordance with contract requirements. The contractor is responsible for application of special markings as discussed in the Military Standard regardless of whether specified in the contract/order or not. Special markings include, but are not limited to, shelf-life markings, structural markings, and transportation special handling markings. The marking of pilferable and sensitive materiel will not identify the nature of the materiel.

6. NOTES

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

6.1 Intended Use. Laminated bullet resistant glass laminates covered by this specification are intended for use in ground tactical vehicle windscreens, windows, and gun shields.

6.1.1 Security Requirements. The "Security Classification Guide for CS & CSS Armoring Systems" will govern actions for all transparent armor purchased according to this specification, unless a classification guide exists specifically for the vehicle for which the transparent armor is being purchased. The use of a referenced protection class and the words pass or fail is UNCLASSIFIED//FOUO (For Official Use Only). The protection class identification with no reference to a specific projectile, test velocity, or angle of impact is UNCLASSIFIED//FOUO. The recommended method for reporting test results without revealing vulnerability is to isolate the protection class from the test velocity by reporting the difference between the test velocity and the class proof velocity. Ballistic test results will not give the proof or test velocity, threat projectile, angle of impact, or other ballistic criteria. Compilation of purchase orders, test data, test reports, or drawings may result in compiled data which is classified SECRET, and caution must be exercised to avoid this situation. Changes to the applicable Security Classification Guide supersede statements made in this paragraph. Questions regarding interpretation of the Security Classification Guide should be made through SFAE-CSS-TV.

6.2 Acquisition Requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. Title, number and date of the applicable acquisition drawing.

c. If required, the specific issue of documents referenced (see 2.2.1 and 2.3).

d. Quantity.

e. Test and inspection requirements (see 3.1)

f. Protection Class required including the word AMBIENT if the coupons are to be tested only at ambient temperature (see 3.2.1 and 4.5.2).

g. Ballistic and performance requirements (see 3.2.5 and 3.5).

h. Minimum percent of TA to be defrosted and time requirement, Area C (see 3.2.6 and figure 1) if different than 3.2.6.

i. If allowable defects are other than as specified herein (see 3.2.7).

j. Marking requirement (see 3.2.8 or 5.3).

k. Whether first article test is required (see 4.1.2).

l. Government reserves the right to conduct random ballistic testing to the requirements (see 4.1.3).

m. Items to be used for sun exposure weathering tests (see 4.3.5).

n. Ballistic testing facility (see 4.7).

o. Packaging requirements (see Section 5). Packaging, packing, and marking requirements are recommended to be commercial best practices unless otherwise specified in the solicitation. The following paragraphs would apply: 5.1.2, 5.2.3, and 5.3.

p. Levels of preservation/packaging (see Section 5).

q. Unit quantity per package (see 5.1.1.5).

r. Area to be concealed under frame at assembly (see 3.2.7 and Areas A and B of figure 1).

s. Warranty settlement procedure.

6.3 Structural Integrity. The TA shall maintain its structural integrity without damage or unacceptable ageing (clouding or yellowing) as a function of storage, installation/removal in a vehicle and use of the vehicle during the life of five years or the period defined by the procuring activity. Stone chip damage and cleaning damage of the interior surface is excluded from this paragraph.

6.4 Alternate Ballistic Testing Facility. Request for approval for an alternate ballistic testing facility shall be forwarded by the procuring activity to the Associate Director, Survivability, TARDEC-WARREN Attn: RDTA-RS, MS 263 Warren, MI 48397-5000 and shall be obtained prior to the contract award.

6.5 Laboratory Accreditation. Laboratory accreditation is defined as formal recognition of an organization's technical competency to perform specific tests, types of tests, or calibrations. It is desirable for laboratories used in the execution of requirements for this specification, to participate in proficiency testing on a regular basis to demonstrate their competency. The general requirements for laboratory accreditation are contained in ISO/IEC 17025. This standard contains quality system requirements and technical requirements that the laboratories must meet. Laboratory accreditation requirements, however, go beyond the requirements of ISO/IEC 17025 by the requirement that the laboratory be recognized by an assessment agency such as A2LA or LAB.

6.6 Definitions.

6.6.1 Definitions from ASTM C1036. Unless otherwise specified or as modified herein, definitions from ASTM C1036 shall apply for the following terms:

Crush
Dig
Gaseous Inclusion
Knot
Ream
Rub
Scratch
Stone
String

6.6.2 Definitions from ASTM C1172. Unless otherwise specified or as modified herein, definitions from ASTM C1172 shall apply for the following terms:

Boil
Delamination
Inside Dirt
Hair
Lint

6.6.3 Clouding. Smoky or foggy appearance when viewing through the TA.

6.6.4 Complete Penetration. A complete penetration (CP) has occurred when an impacting projectile, a piece of the projectile, or target debris passes through the witness plate causing light to be visible through the witness plate.

6.6.5 Composition. The thickness, stacking order, and kinds of materials that make-up the transparent armor. It also includes the lateral seal materials and any other materials that the vendor would supply to communicate the MSDS information. It does not include the cleaning methods, autoclave timing, or other production information.

6.6.6 Coupon. A transparent armor item having the necessary laminations to represent a production part.

6.6.7 Crack. A break in the glass, ceramic, or plastic that is oriented in the thickness direction of any layer of the laminate.

6.6.8 Crazing. Crazing or a craze is a network of microscopic surface cracks that are usually detected by a “rainbow” glint or whitening.

6.6.9 Delamination. The separation of the bonded transparent armor into visibly separated layers.

6.6.10 Fair Impact. An impact that meets the specified conditions of velocity, angle of impact, yaw, and impact location, within the tolerances defined for each condition.

6.6.11 Fragment Simulating Projectile. A specific fragment simulator based on the MIL-DTL-46593 cylindrical projectile, usually with a chisel nose.

6.6.12 Insects or Other Organic Matter. Organic detritus trapped between layers.

6.6.13 Interlayer. For the purposes of this purchase description, an interlayer is any layer that is not principally present for projectile defeat. The interlayers may be adhesives, weatherproofing materials, spacers, de-icing films, sun-shades, etc.

6.6.14 Interlayer Striae. Per MIL-HDBK-722, an imperfection; a cord of low intensity of particular interest in optical glasses.

6.6.15 Open Gaseous Inclusion. A gaseous inclusion or boil that is open to the surface. This definition only applies to the strike face.

6.6.16 Partial Penetration. A partial penetration (PP) is a projectile impact that does not result in light being visible through the witness plate.

6.6.17 Protection Class. The protection class levels are a combination of numbers and letters used to designate test projectiles combined with specific velocities and are defined on drawing DTA184044.

6.6.18 Ream. Per MIL-HDBK-722, an area of inhomogeneous glass incorporated in the sheet, producing a wavy appearance.

6.6.19 Strike Surface. The surface of the transparent armor being struck first by an attacking item. The strike surface must be the surface on the exterior of the vehicle. Strike face is also known as the threat side, strike face, strike side, or exterior surface.

6.6.20 Striking or Impact Velocity. The velocity of the projectile upon impact with the target face. This velocity may be measured at any point within 2.5 m of the target face and corrected for the velocity loss between the measurement point and the target face if necessary.

6.6.21 Surface Defects. Defects other than inclusions in the glass such as stones, knots, dirt, reams, strings, scratches, rubs, lint, or hair that hinder vision through the system.

6.6.22 Transparent Armor. Transparent armor (TA) is any protection system through which direct vision is possible.

6.6.23 Unfair Impact. A shot not conforming to one or more of the specified conditions of velocity, angle of impact, yaw, or impact location. A shot with a velocity exceeding the maximum value allowed will be judged a “fair shot” if a partial penetration is produced.

6.6.24 Yaw Angle. The maximum resultant angle between the main axis of the projectile and its trajectory vector irrespective of plane.

6.6.25 Yaw Card. A material placed in the projectile's line of flight whose perforation signature is used to determine the projectile yaw.

6.7 Subject Term Listing.

Glass
Protection Class
Windows
Ballistic Testing
Multi-Hit
Environmental Effects

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