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PURCHASE DESCRIPTION
TRANSPARENT ARMOR

This specification is approved for use by the TACOM-LCMC, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense for the purchasing of Transparent Armor (TA).

Beneficial comments, suggestions, or questions on this document should be addressed to U.S. Army Tank-automotive and Armaments Command, 6501 E. 11 Mile Road, Warren, MI 48397-5000 or emailed to dami_standardization@conus.army.mil

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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 Army structures. 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. In the event of 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. That is, this specification makes careful definition of distance to edges and window size. Windows not conforming to these definitions must be individually ballistically qualified to the 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 (see 3.2.). Subsequent to First Article approval, no material or process changes shall be made without the procuring activity approval.

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 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 here.

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 issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto cited in the solicitation (see 6.2.).

SPECIFICATIONS:

FEDERAL

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

DEPARTMENT OF DEFENSE

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-DTL-62420	Detail Specification Periscope, Tank
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-L-85762	Lighting, Aircraft, Interior, Night Vision Imaging System (NVIS) Compatible
MIL-DTL-46593	Family of Fragment Simulating Projectiles
MIL-G-10924	Grease, Automotive, and Artillery
MIL-PRF-24139	Grease, Multipurpose Quiet Service
MIL-H-6083	Hydraulic Fluid, Petroleum Base
MIL-DTL-5624	U (Turbine Fuel Aviation, Grades JP-4 And JP-5)

STANDARDS

MIL-STD-129	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 Test Methods and Engineering Guidelines

HANDBOOKS DEPARTMENT OF DEFENSE

MIL-HDBK-722	Glass

GUIDES

AR 70-38 RD&E EVALUATION OF MATERIAL FOR EXTREME CLIMATIC CONDITIONS

SECURITY CLASSIFICATION GUIDE 6 April 2007
For COMBAT SUPPORT AND COMBAT
SERVICE SUPPORT ARMORING SYSTEMS

Program Executive Office, Combat Support and
Combat Service Support (CS&CSS)
ATTN: (SFAE-CSS-TV)
Warren, MI 48397-5000

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, or at http://assist.daps.dla.mil/quicksearch/).

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.

DRAWING

DTA184044	TACOM Protection Classes

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, U.S. Army TARDEC, RDTA-EN/STND/TRANS, MS 268, Warren, MI 48397-5000, dami_standardization@conus.army.mil

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. The issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Otherwise, the issues of documents are the most current issues of the documents (see 6.2.).

AMERICAN SOCEITY FOR TESTING AND MATERIALS (ASTM)

ASTM F428	Intensity of Scratches on Aerospace Glass Enclosures
ASTM F520	Environmental Resistance of Aerospace Transparencies
ASTM F521	Bond Integrity of Transparent Laminates
ASTM F548	Intensity of Scratches on Aerospace Transparent Plastics
ASTM F735	Abrasion Resistance of Transparent Plastics and Coatings Using the Oscillating Sand Method
ASTM F801-96	Standard Test Method for Measuring Optical Angular Deviation of Transparent Parts
ASTM D975	Oils, Diesel Fuel
ASTM D1003	Haze and Luminous Transmittance of Transparent Plastics (DoD adopted)
ASTM C1036	Flat Glass (DoD adopted)
ASTM D1044	Resistance of Transparent Plastics to Surface Abrasion (DoD adopted)
ASTM C1172	Standard Specification for Laminated Architectural Flat Glass
ASTM D1655	Aviation Turbine Fuels
ASTM D2156	Standard Test Method for Measuring Optical Distortion In Transparent Parts Using Grid Line Slope
ASTM D4093	Photo Elastic Measurements of Birefringence and Residual Strains in Transparent or Translucent Plastic Materials
ASTM D4169	Standard Practice for Performance Testing of Shipping Containers and Systems Description
ASTM D4814	Fuel, Automotive Spark-Ignition Engine

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

GAS PROCESSORS ASSOCIATION

GPA 2140	Liquefied Petroleum Gas Specifications and Test Methods

(Application for copies should be addressed to Gas Processors Association, 6526 East 60th Street, Tulsa, OK 74145, www.gasprocessors.com)

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
SAE J381	Windshield Defrosting Systems Test Procedure-Trucks, Buses, and Multipurpose Vehicles
ASME Y14.5M 1994	Dimensioning and Tolerancing

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 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 paragraph 4.1. Ballistic test requirements are intended to exploit the TA resistance to penetration. Therefore testing of conventional laminate TA is to be done at zero degrees obliquity using the specified multi-hit pattern. When other fabrication techniques such as 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 degrees and/or using tile interface seams and joints as the aim point for the multi-hit pattern.

3.2 Design and declarations. For new designs the TA cost and the cost to replace must be considered in addition to environmental sealing surety and ballistic performance. Parts of the TA assembly cannot be reclaimed to reduce total cost of ownership in most instances.

TA test and development may take many forms. Companies may use facilities of their own choosing with tests of their own design in the early stages. It is recommended that the Government test range be used for prequalification ballistic tests. Because of the munitions' variability, the tests are sometimes difficult for private ranges to control. Prequalification testing cannot be substituted for FAT (First Article Tests) testing unless the prequalification test was documented and qualified as a FAT test series. FAT testing requires that the vendor declare his construction geometries and methods, and that they are fixed and defined.

To meet declaration requirements, the fabricator must declare the material for each layer. (See 4.5. for marking of the declaration.) For example, the fabricator must declare that layer 1 is nylon, a methacrylate, a polycarbonate, a glass, a transparent ceramic, a urethane, or whatever class of material it happens to be; simply declaring a layer to be "Plastic" or "Adhesive," for example, is not sufficiently specific. The fabricator must also declare for each layer that the layer is of a certain nominal thickness, and give the thickness dimension. The data for each layer must be given separately. Note, for example, that two 6 mm layers do not equal one 12 mm layer. The data must also be given sequentially for each layer (an interlayer is a layer.) in order, with the strike face being layer number 1. A nominal thickness of the assembly of layers is also required. 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 that the process is capable and in control. The declaration must be submitted with the items submitted for FAT ballistic testing. The Government will keep the declaration data in confidence and will treat the data as proprietary to the data

provider if the supplied declaration is marked with confidential or proprietary statements per paragraph 4.5.

Production control testing samples (parts) must also be accompanied with declarations used for production.

Prequalification FAT testing and Production Control test reports without the composition and process control declarations are not compliant to this requirement. Ballistic testing shall not proceed until required declarations are received. If declarations are sent to the procuring agency, copy the Government ballistic test range.

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 ballistic Protection Class for the production lot or proposed TA design is UNCLASSIFIED when separated from the corresponding test projectile proofing velocity and/or the corresponding test obliquity; and 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.). CAUTION: some security classification guides may classify the Protection Class when associated with the vehicle system that uses the transparent armor as a component. Thus, current practice is to exclude all vehicle system information in ballistic test reports.

3.2.2 Construction and 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 specified in this document.

3.2.2.1 Materials Compatibility. Materials must be compatible with each other in all states that they may contact one another. Materials that cure and their out gassing components must be compatible with the spall liner, interlayer materials, edge seal materials, and so forth. The vendor must include in its quality control process an ongoing, proactive test series to assure that no materials induce failure nucleation processes such as embrittlement et cetera of another component of the TA.

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 C 1036. The outer ply shall be a material chosen for abrasion resistance and the inner ply shall be for spall resistance.

3.2.4 Edgework. For handling purposes flares shall be ground, glass edges shall have a light seam. All edges except for FAT ballistic coupons shall be sealed to ensure protection of the bond line(s) and underlying materials from the environmental (rain, ice, dust, etc.) conditions and other contaminates of 3.3.7.1. and 3.3.7.2. Debonding of the seal due to the tests of 4.3.7.1. or 4.3.7.2. shall be a failure to meet the requirements of this specification.

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 as 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.

3.2.6 De-icing. Transparent armor may have a built-in electric de-icing system when specified on the part drawing. The de-icing system shall be capable of clearing 80% of Area “C”, as shown in figure 1 at ambient temperatures down to *minus* 25° C per paragraph 4.2.6.

3.2.7 Allowable defects. Unless otherwise specified (see 6.2), minor imperfections that do not affect serviceability shall be permitted. Short interlayers no greater than 7mm from the edge shall be permitted and not recorded as a delamination. Maximum allowable defects shall conform to 4.2.3. and Table VII. See 4.3.1.3. The appearance of defects such as bubbles, blisters, or other indications of adhesive separation greater than allowed by Table VII shall be considered evidence of bond failure.

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

3.2.9 Tolerance. The part drawing dimensions controlling the overall size and shape of the TA assembly are considered major dimensions and shall be inspected.

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 exposure to the low temperature test. See Section 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. See Section 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.) and moisture buildup and bond separation requirements per Table VII following high temperature-humidity exposure. See Section 4.3.2.

3.3.3 Reserved

3.3.4 Temperature shock. The TA shall meet the optical requirements (see 3.4) after testing in accordance with Section 4.3.4. and shall show no evidence of delamination.

3.3.5 Sun exposure weathering. Transparent armor shall show no evidence of crazing, delamination, discoloration or other physical deterioration when tested per paragraph 4.3.5. and meeting the requirements of paragraphs 3.4.1., 3.4.1.1., and 3.4.2.

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 be tested per paragraph 4.3.6.1. and meet the requirements of Section 5.18.3 of the ANSI/SAE document referenced in 4.3.6.1.

3.3.6.2 Abrasion resistance–interior surface. The interior surface shall be tested per paragraph 4.3.6.2. and meet the requirements of Section 5.17.5. of the ANSI/SAE document referenced in 4.3.6.2.

3.3.7 Exposure to chemicals.

3.3.7.1 Cleaning spray. The inner and outer surfaces of the TA assembly shall meet the performance requirements of paragraph 3.4. (including sub paragraphs 3.4.1.1., 3.4.2., and 3.4.3.) and shall show no evidence of damage including clouding or cracking after the portion of the assembly within the edge sealing surface is tested per paragraph 4.3.7.1.

3.3.7.2 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 (see 4.3.7.2.1.) and no evidence of clouding or cracking shall be visually observable.

The outer surface of the TA assembly shall meet the performance requirements of paragraph 3.4. after exposure to vapors of or in direct contact with the materials shown in Table II (see 4.3.7.2.2.). Following this there shall be no evidence of clouding or cracking visually observable.

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	One of three aqueous solutions: A) isopropanol and glycol ether, B) isopropanol, glycol ether, and ammonium hydroxide, or C) ammonium hydroxide. The solutes shall be in the following concentrations: 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. These concentrations simulate commercial windshield cleaners.
5	Cleaning solvent Type I or Type II per MIL-PRF-680

Table II Chemical Exposure Requirement for Outer Surface	
Group	Exposure to one member of each of the following groups must be tested
1	One of the following: Fuel per A-A-52557 (DF-2, DF-1, or DF-A) or ASTM D975-81 (Commercial Diesel No. 1-D or No. 2-D); MIL-DTL-5624 (Grade JP-4 or JP-5), or ASTM D1655 (Commercial Turbine Jet-A or Jet A-1)
2	ASTM D4814 (MOGAS) or Regular Automotive Gasoline or Hydraulic fluid per MIL-H-6083
3	Anti-freeze per A-A-52624
4	Detergent, liquid Type I or Type II per MIL-D-16791
5	One of the following: Grease (molybdenum disulfide per MIL-G-21164) or Lubricant oil Grade 30 or NDO (per MIL-L-2104) or Grease, automotive/artillery (per MIL-G-10924) or Grease automotive MP (per MIL-PRF-24139)

3.4 Optical.

3.4.1 Luminous transmittance. The integrated luminous (photopic) transmittance of transparent armor shall be equal to or greater than 75% for Protection Classes 1 and 2, 60% for 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% 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% points.

3.4.1.1 NVG – weighted transmittance. The NVG-weighted integrated spectral transmission shall not be less than 50% for class 1 and 2, 30% for class 3, 20% for class 4 and 10% for 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%.

3.4.2 Haze. Haze shall be less than 3%. See paragraph 4.4.2.

3.4.3 Optical deviation. Unless otherwise specified by the acquisition activity, the optical deviation of 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 (IAW) paragraph 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.

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 agency shall specify the Protection Class as noted on each Part Drawing (see 6.2.). Parts that are too small for reliable 4-shot multi-hit patterns will be tested using coupons per Paragraph 4.5.a. See also 3.2.1. and 6.1.1. for other guidance on classification issues.
3.6 Reserved.

4. VERIFICATION.

4.1 Tests. The test program is a series of tests to satisfy the program objectives at minimum cost. Testing is performed by both the contractor and the Government to provide the verification data. Any contractor subcontracted laboratory or contractor in-house laboratory doing work to prove compliance to this document shall be accredited to ISO/IEC17025 (latest revision) by a recognized assessment agency such as A2LA or LAB (see 6.5.).

This section, Section 4, establishes the specific methods to be used to verify corresponding Section 3 requirements. Other sections may provide useful information not included in Section 4. The following paragraphs establish the formal tests, inspections, demonstrations, or analyses required for the demonstration and verification of the transparent armor performance.

The Government reserves the right to perform all ballistic tests. Thus, the ballistic acceptance definitions and criteria are presented below as information to the contractors. Conventional laminate TA shall be tested at zero degrees obliquity using a specified multi-hit pattern. When other fabrication techniques such as mosaic plies or laminate interface surfaces that are not parallel to the strike surface are submitted for testing the Test Engineer shall exploit its vulnerability by varying the shot obliquity and pattern aim point with the limitations of 3.1. The test plan shall be recorded in the Test Report.

FAT are performed as the initial stage of a new contract with the government. Usually these tests use coupons because production has not begun and no “parts” should be available. FAT ballistic test results shall not be made available to the general public. FAT ballistic test evaluations are paid-for by the TA supplier to the Government. See section 3.2. Results of the ballistic evaluations will not be released unless the supplier or manufacturer of the coupons or parts meets certain basic requirements including the restrictions of paragraphs 3.2.

Production Control Tests use production parts when possible. Transparent armor shall be subjected to the non-ballistic Production Control Tests as specified in Table V. This test assures the Government that the production items continue to be good TA

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. On contracts containing multiple part numbers of the same TA composition (see 3.2.), i.e. the same front-to-back recipe but differing lateral dimensions, FAT shall be done only for one part number (recipe) 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 ballistic test coupons required per Table IV (see 6.2.). The samples shall be examined for compliance with the requirements and verifications listed in Sections 3. and 4., except for the Ballistic acceptance coupons.

Subsequent to FAT approval, no material or process changes that may affect product performance shall be made without the Procuring Activity approval. See paragraph 3.2.

The number of samples and type of test result that is desired is given in Table III. Each non-ballistic requirement shall be tested with two samples unless noted and numerical results averaged; for pass/fail tests, the results of all samples must all be "pass" for acceptance. Sun exposure requirements 3.3.5. and abrasion requirements 3.3.6.1. and 3.3.6.2. shall be tested with three coupons. Non-ballistic tests may be done non-sequentially. That is, new coupons may be used for each test at the vendor's option except for part or coupon tests that measure the results of a prior test.

FAT Ballistic test coupons shall be identical in composition, stacking order and construction to the intended production lot samples submitted (see 3.2.) Ballistic testing shall be done using test coupons IAW paragraph 4.5. and in Table IV. The FAT acceptance criteria are found in 4.5. and in the Control FAT requirements and in Table IV. Re-worked TA shall be marked, with other required markings, "REWORKED" and shall be marked with the expiration date of the TA warranty.

4.1.2.1 Remediation of Failed First Article Testing. If the first article test(s) 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	Coupons 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	4.3.7.2	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)	Per Table IV	3.5	4.5	Coupons
Abrasion resistance – Threat surface	3 Avg.	3.3.6.1	4.3.6.1	Coupon, size determined by test facility
Abrasion resistance – Interior side	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

Table IV –Ballistic Test Articles Required and Pass-Fail Criteria			
	First Article Testing		Control Testing
Protection Class	ALLTEMP	AMBIENT	Ambient Only Testing
Designator	Class number, letter – ALLTEMP	Class number, letter – AMBIENT	Class Number, Letter – CONTROL
Contractor Provides	29 plus 5 spares Coupons	29 plus 5 spares Coupons	10 plus 2 spares No-Frame Samples
Test matrix: Ambient Hot Cold FSP	- 9 8 8 4	- 25 - - 4	- 8 - - 2
Pass Fraction* Ambient Hot Cold FSP**	- 8 of 9 6 of 8 6 of 8 4 of 4	- 21 of 25 - - 4 of 4	- 7 of 8 - - 2 of 2
*Patterns passed (no Complete Penetration results, CPs) of a maximum number of patterns tested. That is, 8 of 8 for Ambient ALLTEMP would be acceptable, but 8 of 10 is a fail result. Once testing indicates "fail", that is the number of patterns with a CP is greater than the Pass Fraction allows, testing will cease. **See 4.5.5.b.			

Table V–Production Quality Control Tests			
Title	Section 3	Section 4	Production Parts Unless Noted
Ballistic (ambient only)	3.5	4.5.2 and 4.5.5	Part*
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
* This test may be with or without a defrosting film being present.			

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 quality CONTROL ballistic tests. The Government reserves the right to conduct ballistic tests of production parts at any time during a production order as specified by the contracting agency.

For Protection Classes 1a through 4a, 5b and 6a, the minimum size TA that may be ballistically tested is 240mm x 365mm (9.5 inches x 14.4 inches) due to edge spacing. For Protection Class 5a the minimum size TA that may be tested is 320mm x 485mm (12.6 inches x 19.1 inches). If actual production parts are smaller than these dimensions, coupons sized in accordance with Paragraph 4.5.a. shall be submitted.

Eight multi-hit test patterns of the direct fire threat are to be shot. See Table IV. The sample lot shall be rejected if the test samples cannot successfully defeat seven patterns. A sample will fail if a target coupon has a complete penetration (CP) 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.

Two single FSPs will be shot at separate target samples. Both samples must pass. A test will fail if a CP is recorded. See Table IV.

Testing shall be performed with the target samples conditioned for at least 12 hours between 7 and 35ºC.

Parts which are ordered with a defrosting film may be tested with or without the film applied.

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 paragraph 4.5. Control ballistic tests are required only for each TA thickness i.e. each through thickness recipe on contracts containing multiple parts with lateral dimension variations but essentially the same through thickness recipe, and unless otherwise specified by the procuring activity.

Ballistic control acceptance tests shall occur every three months after production commences or 2000 production parts, whichever occurs first unless otherwise specified by the procuring activity, see 6.2. Changes to the frequency of control acceptance testing must be approved by the procuring agency.

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 on-site 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 ballistic failure with the initial samples submitted for any given control test such

as multi-hit or FSP, 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 IAW 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 done at TARDEC-Warren, RDTA-RS. Due to munitions variability and other uncertainties, the use of alternate ballistic test sites is not accepted. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable (See paragraphs 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 Section 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 First Article Testing approval, if the contractor makes any changes to the manufacturing process, 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 First Article Testing. 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. Inspect TA for visual defects per Table VII. Unless otherwise specified (see 6.2.), minor imperfections that do not affect serviceability shall be permitted. Short interlayers no greater than 7mm (about ¼") 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 50mm of

the concealed edges, and area C is the remaining central area. See Figure 1. Maximum allowable defects shall conform to Table VII.

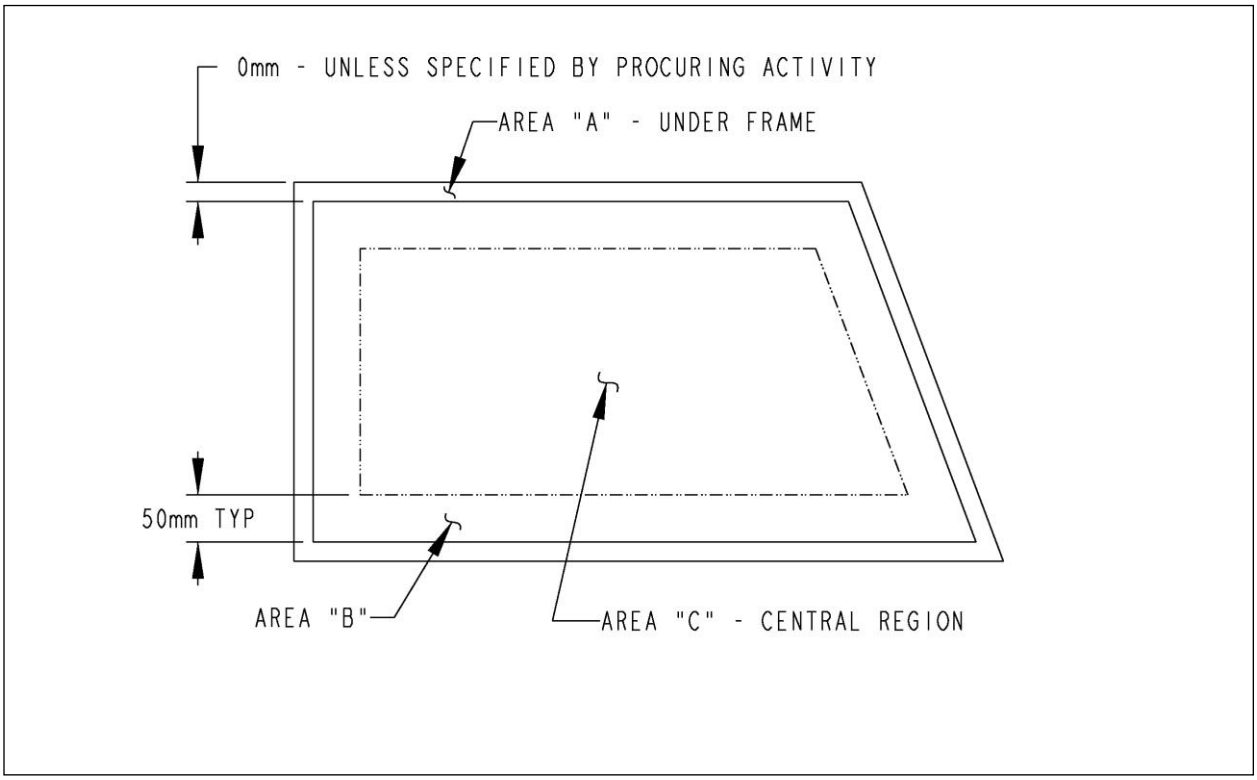


Figure 1: Definition of TA Areas

Table VII Maximum allowable defects		
Types of defects (See Appendix A GLOSSARY for definitions)	Allowable defects* Area C	Area B
Delamination or bond separations	Not allowed	Not allowed
Cracking, crazing, or clouding	Not allowed	Not allowed
Gaseous inclusions	.062 in. (1.6mm)	.093 in. (2.4mm)
Open gaseous inclusions	.045 in. (1.2mm)	.062 in. (1.6mm)
Stones and knots	.031 in. (.8mm)	.045 in. (1.2mm)
Digs	.062 in. (1.6mm)	.093 in. (2.4mm)
Inside dirt	.093 in. (2.4mm)	.093 in. (2.4mm)
Ream and string	Shall not be evident at an angle greater than 30 degrees 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 –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 inside surface are not permitted.	
Crush	Shall not be detectable at distances greater than 10 ft (3.0m), with indirect daylight.	
Lint and Hair	Area C, lint and hair barely noticeable at 3 ft (.9m) looking through the glass at a patterned background with indirect daylight. Area B, lint and hair may be noticeable under same conditions. Reference ASTM C1172-09	
Insects or other organic matter	Shall not be detectable at distances greater than 3 ft (.9m) looking through and perpendicular to the glass, with indirect daylight.	
Surface defects	Shall not be detectable at distances greater than 10 ft (3.0m).	
Interlayer striae	Shall not be detectable at distances greater than 10 ft (3.0m) looking perpendicular to the glass, with indirect daylight.	
Cracks	No cracks shall be allowed in area A, B, or C.	
Note 1. 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 C1036-06). 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. Visually verify that the TA laminates are marked in accordance with Section 3.2.8.

4.2.5 Tolerance. Verify that the TA meets the part drawing dimensional requirements.

4.2.6 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 *minus* 25°C ± 4°C for a 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 0.05mL of water per square centimeter of glass area applied by means of a spray gun with 345 kPa ± 35 kPa (50 psi± 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 250mm from the glass, 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 minus 25°C ± 4°C 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-1275D) 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 re-photographed. The clear de-iced area must be no less than 80 % of the "C" requirement of paragraph 3.2.6.

e. The windshield(s) shall then be returned to normal ambient temperature and subjected to the visual inspection of 3.2.7. and be subjected to 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 502.4, Procedure I. A temperature of *minus* 54°C ± 4°C shall be maintained for a period of 24 hours. The TA shall be returned to normal ambient temperature at the conclusion of this period. The TA shall show no indication of moisture buildup within the lamination, or bond separation per Table VII. The window shall then be examined per the requirements of paragraph 3.2.7. and be subjected to the optical requirements of 3.4.

4.3.1.2 High temperature. The TA shall be subjected to the conditions of MIL-STD-810 Method 501.5, Procedure I, A2, Induced. These conditions are summarized in Appendix B. The data in Appendix B may be used regardless of the version of MIL-STD-810 cited in the procurement documents. At the conclusion of three test cycles, the TA shall be stabilized at 23°C ± 2ºC and visually examined for moisture buildup or bond separation per Table VII. The TA shall then be returned to normal ambient temperature and subjected to the visual inspection of 3.2.7. and be subjected to the optical requirements of 3.4.

4.3.1.3 Window laminations. The laminations of the TA shall be visually examined for compliance with 3.2.7. The appearance of any bubbles, blisters, cracks or separations or any other defects exceeding that allowed by Table VII shall be considered evidence of bond failure (see 3.2.3.).

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-810G, Figure 507.5-7. The modified cycle is 48 hours duration. The required cycle profile is given in the table in Appendix C. After the test, the TA shall be conditioned at 23°C ± 10°C and 50% maximum relative humidity for 48 hours. After exposure, the TA shall exhibit no indication of moisture buildup, bond separation, or any other forms of image degradation per Table VII. The TA may then be allowed to return to normal ambient conditions and shall be subjected to the visual inspection of 3.2.7. and optical requirements of 3.4.

4.3.3 Reserved.

4.3.4 Temperature shock. The TA shall be tested by adapting Method 503.5, Procedure I-C of MIL-STD-810. The thermal cycle shall consist of an 18 hour period at *minus* 30°C ± 3°C followed by an 18 hour period at +60°C ± 3°C. The transfer time between temperature conditions shall be no longer than five minutes. The number of cycles shall be at least 5. No consideration will be given for passing more cycles. At the conclusion of the thermal shock test the TA shall meet the optical requirements of paragraph 3.4., and the TA shall show no evidence of bond separation (delamination), or any other physical damage exceeding that allowed by Table VII. Windows that have cracks as a result of this temperature shock test shall fail this test. Contractors producing windows with re-entrant (inside corners) corners must exercise best design practices to reduce the probability of failing this test.

4.3.5 Sun exposure weathering. The sample coupons for First Article Testing can be, but are not required to be, actual production parts. The key to using MIL-STD-810, Method 505, and Procedure II successfully is maintaining enough cooling air to prevent the test item from exceeding temperatures that would be attained under natural conditions. However, do not use so much cooling air that it produces unrealistic cooling. This implies that before this test can be performed, the maximum temperature response the material would experience under natural conditions (by using field/fleet data or as determined by running Procedure I) must be known. If Procedure I has not been performed previously on this TA recipe and no field/fleet data are available, a preliminary test must be carried out in accordance with Procedure I (absolute minimum of one complete cycle) to determine the approximate maximum response temperature of the test item. Samples submitted for first article acceptance testing shall be tested as follows:

a. Three pieces of TA shall be tested in accordance with the requirements of Section 3.3.5. Transparent armor shall show no evidence of crazing, delamination, discoloration or other physical deterioration when exposed to an irradiance level of 1120 W/m squared, per MIL-STD-810, Method 505, Procedure II for fifty-six 24-hour cycles and shall subsequently meet the requirements of paragraphs 3.4.1., 3.4.1.1., and 3.4.2. Irradiance shall be normal to the strike face of the TA. After exposure, the TA shall show no evidence of bond separation or any other physical damage exceeding that allowed by Table VII and shall be subjected to the optical requirements of 3.4.

b. Optionally, the components of the TA lamination may be tested per the procedure outlined in 4.3.5.a. using adhesive elements and bonded pairs, or coupons of TA, and show no evidence of bond separation or any other physical damage exceeding that allowed by Table VII. Test coupon laminations of 100mm x 100mm ± 5mm shall be used. Edge treatment is suggested but not required. All materials used in the TA recipe shall be tested (to include all adhesive materials and, if part of the deliverable requirements, the de-icing element). Three sets of the materials shall be tested. 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 ANSI/SAE Z26.1-1996 Section 5.18, and shall meet the light scattering requirement stated in Section 5.18.3 of the ANSI/SAE document.

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 ANSI/SAE Z26.1-1996 Section 5.17.4. and shall meet the scattering requirement stated in Section 5.17.5 of the ANSI/SAEZ26 document.

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 one foot or farther than two feet from the TA surface at a cleaning rate of one square foot per minute for a period of 10 minutes. The water jet shall be derived from a nozzle having an orifice diameter of .25 inch (6.35mm) and a nozzle pressure of 110 pounds per square inch gage (psig) (about 760 kPa). After the TA has been water rinsed and air dried, subject the TA to the optical requirements of 3.4.

4.3.7.2 Chemicals.

4.3.7.2.1 Exposure to chemicals inner surface. To determine conformance of the inner surface to 3.3.7.2, expose the assembly to the chemicals specified in Table I in accordance with ANSI/SAE Z26.1-1996 section 5.19 except for the requirement to immerse the specimen. The chemical shall be applied with a soft, 13mm 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, subject the assembly to allowable defects requirements of 3.2.7. and the optical requirements of 3.4.

4.3.7.2.2 Exposure to chemicals outer surface. To determine conformance to 3.3.7.2. for the outer surface, expose the assembly to the vapors (volatile chemicals) of or in direct contact (non-volatile chemicals) with the chemicals specified in 3.3.7.2. and Table II for a period of 48 hours minimum. Testing shall be done at 22°C to 24°C temperature and 50% ± 2% relative humidity. After exposure, subject the assembly to the allowable defects requirements of 3.2.7. and the optical requirements of 3.4.

4.4 Optical.

4.4.1 Luminous transmittance. Luminous (photopic) transmittance shall be determined in accordance with MIL-DTL-62420. Spectral transmittance shall be measured at wavelength intervals of 10nm or less over the 380 to 930nm 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 760nm 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 VIII below for the range necessary for photopic calculations. Transmittance shall be determined before and after the exposure of the Sun Exposure Weathering test, 4.3.5.

Table VIII – Relative Spectral Irradiance (Spectral Power Distribution) of CIE Standard 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 NVG-weighted transmittance. The NVG-weighted integrated spectral transmission is determined using the same procedure for determining the luminous transmission, 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 IX.

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

$$S_A(\lambda) = 100\left(\frac{560}{\lambda}\right)^5 \frac{\exp\frac{1.435\times10^7}{2848\times560} - 1}{\exp\frac{1.435\times10^7}{2848\lambda} - 1}$$

Table IX – 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. Haze shall be measured in accordance with ASTM D1003 (CIE Illuminant A; Method: Procedure B, Diffuse Illumination/Unidirectional Viewing) at locations representative for the central viewing area "C" and shall be less than 3%. See Paragraph 3.4.2.

4.4.3 Optical deviation. Optical deviation shall be determined using the methods specified in ASTM F801-96 or ASTM F2469-05. See Paragraph 3.4.3.

4.4.4 Optical distortion. Optical distortion shall be measured in accordance with ASTM F2156. See Paragraph 3.4.4.

4.5 Ballistic Qualification. The sample coupons for Ballistic Prequalification and for First Article Testing (AMBIENT or ALLTEMP) are not required or intended to be actual production parts; the samples for (Production) Control Testing are required to be production parts. See Paragraph 4.1.3 for Control Testing using the coupons exception. Ballistic coupons are not required to have a de-icing film applied. Coupons submitted for Prequalification shall be identified as to vendor, manufacturer, composition, and vendor's internal production code. See paragraph 3.2 sub paragraphs 2 and 3. 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 (number and type of layers including adhesives) as stated by the contractor. If the testing is done pursuant to a Government contract, submission documents containing the composition will be marked in accordance with DFARS 252.227-7013. Thus, documents whose content was developed entirely at private expense will be marked with a LIMITED RIGHTS legend as prescribed at DFARS 252.227-7013(f). Otherwise, if the testing is not done pursuant to a Government contract, the submission documents containing the composition will be marked with a company proprietary legend. Documents will be treated in accord with the aforementioned marking or legends. Documents that are not marked or legended will be treated as freely distributable consistent with UNLIMITED RIGHTS as defined in

DFARS 252.227-7013. The contractor shall certify that all TA produced during the production lot must use the same materials and construction as the ballistic coupons with the exception of de-icing elements. Photographs shall be taken of any coupon which contains a complete penetration. Samples submitted for ballistic acceptance testing shall be tested as follows:

a. The test ballistic coupons shall be of the following sizes, TACOM Classes 1 through 4, 5b, and 6a shall be 400mm x 400mm ± 5mm. Coupons submitted for TACOM Class 5a shall be 480mm x 480mm ± 5mm. The edges should have no protective coating applied, i.e. the glass edges shall be "raw". The coupons shall be packaged for shipping to TARDEC so that they are not damaged by moisture. Samples submitted for ballistic evaluation and having a protective edge coating applied, may have the coating partially or completely removed at the Government's option.

b. The ballistic acceptance tests for TA samples and coupons shall be conducted in accordance with the ballistic test procedures outlined in MIL-STD-662 for test set-up. Ballistic test coupons shall be received without gaskets or frames. The ballistic testing laboratory shall mount the coupons in a suitable frame which fully supports the full thickness of the TA on a shoulder 18 to 25mm wide behind the perimeter of the sample or coupon. The preferred frame material is wood. 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 25mm shoulder area is supported. The target samples shall be positioned at 0° obliquity ± 2°. The projectiles shall have no more than 5° of yaw angle. The witness system shall consist of aluminum foil, kitchen foil, or equivalent, .025mm 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 150mm ± 30mm 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 will be as mandated by drawing DTA184044 Protection Class. The multi-hit test pattern and location dimensions are shown as Figures 2 and 3. There shall be no multi-hit test required for TACOM Protection Class 1b, 5b, and 6a. A sample will fail if any target coupon has a complete penetration (CP) shot as determined by examination of the witness plates. A CP is recorded when light is observed to pass through the damage in the witness plate.

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 done using the requirements of 4.5. shall be reported as "tested in accordance with the requirements of ATPD 2352 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; the sample lot tested, and indicates the acceptance or rejection of the lot. The report may be classified SECRET based on the relevant SCG. The TA composition (see 3.2.) is to be considered proprietary information and is not to be released by the Government to other sources or contractors without written permission of the vendor. The test data of projectile weight, velocities, shot impact accuracy relative to the specified shot pattern, penetration observation, total weight, and thickness for each test sample will be available from the laboratory.

4.5.2 Ballistic test procedure, KE bullet threat, ambient ALLTEMP and AMBIENT temperature. Testing as specified on DTA184044 for the Protection Class shall be performed with the target samples conditioned for at least 12 hours between 7°C and 35°C. Unless otherwise specified by the procuring agency, nine test patterns (See Table IV, ALLTEMP) as shown in Figure 2 are to be shot for Protection

Classes 1a, 2a, 2b, 3a, and 4a. The pattern shown in Figure 3 is to be used for Protection Class 5a. The center of the specified pattern shall be located in the center of the coupon within a tolerance zone of 100mm see Figs 2 and 3. The requirement for Classes 1b, 5b, and 6a is a single shot centered on the coupon within a 100mm diameter tolerance zone. Photographs shall be taken of all complete penetrations. When the acquisition 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 AMBIENT) with the requirement that no more than four patterns with complete penetrations are allowed. TA which is tested at ambient temperature only shall be identified in test documents with the Protection Class number, the letter designation and the word AMBIENT must be included. An example would be for coupons tested to the 2b class at ambient temperature only, needs to be identified as 2b-AMBIENT. The acquisition 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. Vendor tests involving high and low temperature testing are required unless the acquisition activity specifically waives these tests or specifies "AMBIENT only" in the contract.

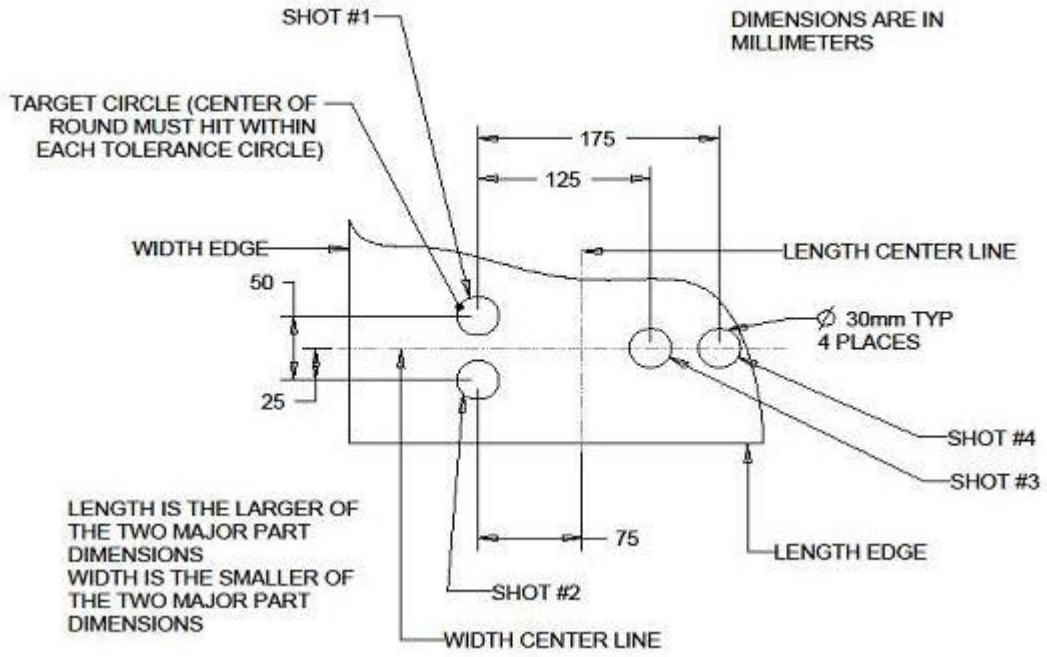


Figure 2: Multi-Hit Pattern for Classes 1 thru 4

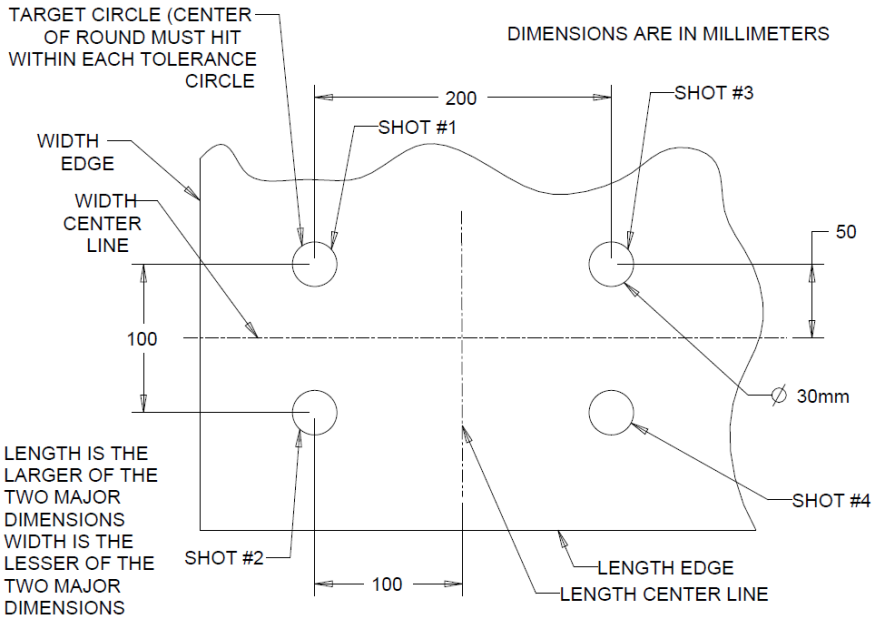


Figure 3: Multi-Hit Pattern for Class 5a Multi Round.

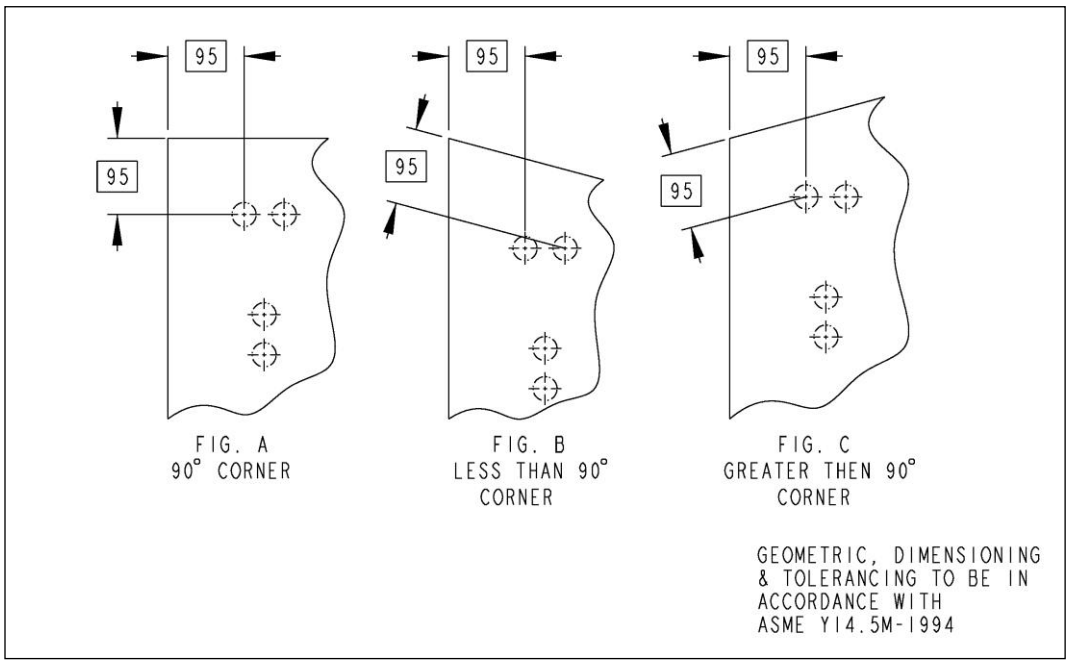


Figure 4: Protection Classes 1 thru 4, Minimum Clearances of Area "C" on Control Part Test Articles

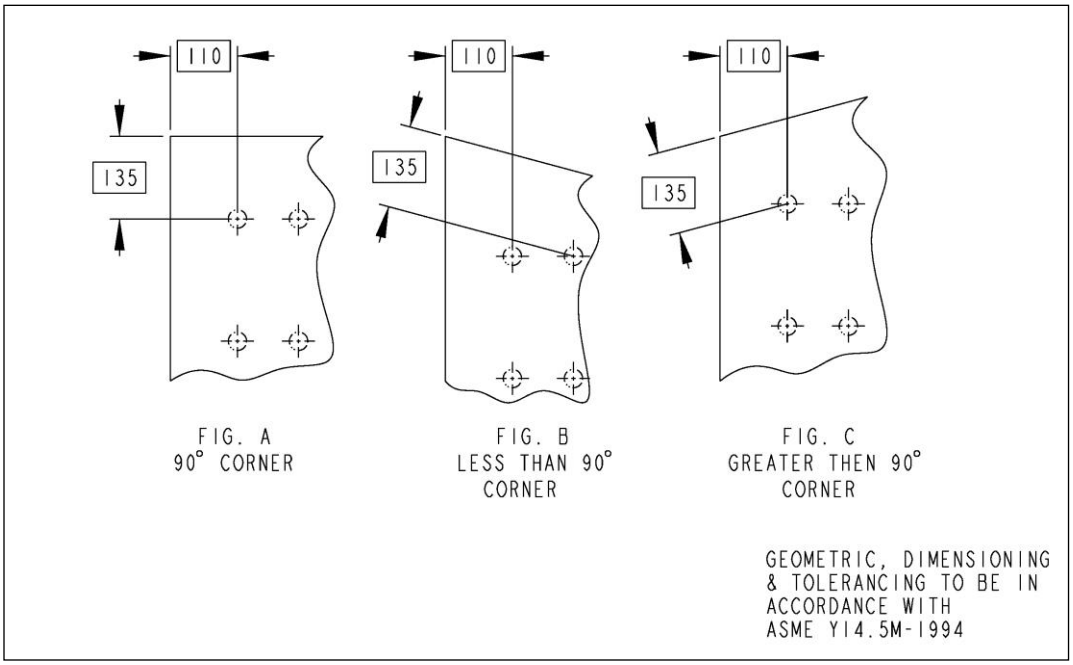


Figure 5: Protection Class 5, Minimum Clearances of Area "C" on Control Part Test Articles

4.5.3 Ballistic test procedure, KE bullet threat, ALLTEMP, high temperature. Testing as specified on DTA184044 for the Protection Class shall be performed with the target samples conditioned for a period of 12 hours minimum at 63°C± 5°C. Target samples 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 coupons must be re-conditioned for a minimum of 12 hours. Unless otherwise specified by the procuring agency, eight test patterns (Reference Table IV) as shown in Figure 2 are to be shot for Protection Classes 1a, 2a, 2b, 3a, and 4a. The pattern shown in Figure 3 is to be used for Protection Class 5a. The center of the specified pattern shall be located in the center of the coupon within a tolerance zone of 100mm. The requirement for Classes 1b, 5b, and 6a is a single shot centered on the coupon within a 100mm diameter tolerance zone. Photographs shall be taken of all complete penetrations.

4.5.4 Ballistic test procedure, KE bullet threat, ALLTEMP, low temperature. Testing as specified on DTA184044 for the Protection Class shall be performed with the target samples conditioned for at least 12 hours to *minus* 43°C ± 5°C. 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 coupons must be re-conditioned for a minimum of 12 hours. Unless otherwise specified by the procuring agency, eight test patterns (Reference Table IV) as shown in Figure 2 are to be shot for Protection Classes 1a, 2a, 2b, 3a, and 4a. The pattern shown in Figure 3 is to be used for Protection Class 5a. The center of the specified pattern shall be located in the center of the coupon within the tolerance zone of 100mm see Figs 2 and 3. The requirement for Classes 1b, 5b, and 6a is a single shot centered on the coupon within a 100mm diameter tolerance zone. Photographs shall be taken of all complete penetrations.

4.5.5 Ballistic test procedure, FSP threat, ALLTEMP. Protection Classes 1c, 2b, and 5b shall be conditioned for at least 12 hours between 7°C and 35°C.

a. The test requirement for all TACOM Protection Classes except 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 impact in the center of the sample within a 100mm diameter tolerance zone.

b. Protection class 1b does not require an FSP shot.

c. For TACOM Protection Class 5a only, three shots shall be placed in an equilateral triangular pattern centered on the coupon or sample. The true position of the shots, the triangle corners, shall be spaced 200mm apart. The positional tolerance of the actual hit locations shall be within a diameter of 60mm relative to the triangle corners. These samples, as noted in Table IV, shall be tested with no complete penetrations allowed.

d. High and Low Temperature requirements. Reserved. See DTA 184044.

4.5.6 Multi-hit ballistic test acceptance criteria KE bullet threat, AMBIENT only. The FAT acceptance requirement for "AMBIENT only testing" is that 25 coupons (patterns) be tested and there shall be 21 or more coupons with no penetrations. Testing may cease once 21 no-penetration patterns have been achieved. Testing will cease and the lot rejected once the number of CPs exceeds the difference. That is 25-21 or 4 is the maximum number of CPs that may occur or the test lot will be rejected and testing will cease. See Table IV.

4.5.6.1 Test acceptance criteria for FSP, AMBIENT only. The FAT acceptance requirement for "AMBIENT only testing" is that 4 coupons are each to be tested with a single FSP centered. All 4 tests must be partials. No CPs are permitted. See 4.5.2. and 4.5.5.

4.5.7 Ballistic Test Acceptance Criteria. Multi-hit ballistic test acceptance including low or high temperature coupons pass-fail criteria for low-ambient-high-temperature shall be per Table IV.

4.6 Rock strike resistance. Reserved.

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.

5. PACKAGING AND MARKING (not part of FAT).

5.1 Preservation, Packing and Marking. The preservation, packing, and marking requirements for this contract/order (See Section 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.

5.1.1.5 Unit Package. Unless otherwise specified, the unit package quantity shall be one (1) each. (See Section 6.2.)

5.1.1.6 Contractor Packaging Responsibility. Contractor shall perform packaging design validations in accordance with ASTM D 4169: "Standard Practice for Performance Testing of Shipping Containers and Systems", 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 (1) 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 D 4169: "Standard Practice for Performance Testing of Shipping Containers and Systems", 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 degrees Celsius 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 (2) foot intervals.

5.2 Packing.

5.2.1 Military Level A Packing. Protection required meeting the most severe worldwide shipment, handling, and storage conditions. A 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-2073-1D Appendix C, Table C.II).

5.2.2 Military Level B Packing. Protection required meeting moderate worldwide shipment, handling, and storage conditions. A 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-2073-1D 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 (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 IAW 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.

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 for tactical wheeled vehicles (TWV). The use of a TACOM Protection Class (number and letter) and the words PASS or FAIL is UNCLASSIFIED FOUO (For Official Use Only). The Protection Class identification (number and letter) with no reference to a specific projectile, or objective test velocity, or angle of impact is UNCLASSIFIED FOUO. When the Protection Class is isolated from specific TWV ballistic protection requirements; drawings, normalized ballistic test data, purchase documents, photographs, samples with associated witness plates, QC data, the FAT Report, and test results will be FOUO. The recommended method for reporting test results (normalizing) without revealing vulnerability is to isolate the Protection Class from the test velocity by using the term “Proof velocity difference.” Ballistic test results will not give the Proof or test velocity and state only the difference from the “Proof” velocity without identifying the threat projectile or other ballistic criteria. Questions regarding interpretation of the Security Class Guide should be made through SFAE-CSS-TV.

6.2 Acquisition requirements. Acquisition documents shall specify the following:

a. Title, number and date of this specification.

b. Title, number and date of the applicable acquisition drawing.
c. Issue of DODISS to be cited in the solicitation; and, if required, the specific issue of documents referenced (See 2.1.).
d. Quantity.
e. Unit quantity per package.
f. Whether FAT is required. (See 4.1.2.)
g. Marking requirement (See 3.2.8. or 5.3.).
h. 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.). Area to be concealed under frame at assembly (See 3.2.7. add Areas A and B of Figure 1.).
i. Minimum percent of TA to be defrosted and time requirement, Area C (See 3.2.6. and Figure 1) if different than Paragraph 3.2.6.
j. Whether specific requirements pertaining to minor imperfections are to be specified (See 3.2.7.).
k. Government reserves the right to conduct random ballistic testing to the requirements (See 4.1.3.).
l. 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. Commercial Packaging, 5.2.3. Commercial Packing, 5.3. Marking.
m. Levels of preservation/packaging (See Section 5.).
n. 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 requirement.

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 ATPD, 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 (latest revision) by the requirement that the laboratory be recognized by an assessment agency such as A2LA or LAB.

6.6 Subject term (key word) listing.

Glass
Protection Class
Windows
Transparent Armor
Ballistic Testing
Multi-Hit
Environmental Effects

Preparing Activity:
Army – AT

BALLISTIC TEST DECISION RULES FOR LOT ACCEPTANCE

The Protection classes used for evaluating TA performance represent actual military weapons. The class threat levels provide worst case test conditions (muzzle velocity, zero target obliquity) for the specific cartridge selected. TA meeting the requirements of ATPD 2352 should be used for design of new vehicle systems. There are sub-classes within this document which represent reduced threat levels for the specific projectile that are identified with letters after "a" such as class 2b. The reduced Protection classes are to be used for purchases of TA used in existing vehicle systems that were designed before ATPD 2352 was adopted by TACOM.

The sub-class reduced proof testing velocities listed in DTA184044 were determined as the 5% PROBIT estimate of "Probability of Penetration versus Velocity" by reverse engineering existing fielded TA.

ACCEPTANCE CRITERIA FOR FIRST ARTICLE TEST

"Good" TA has been defined as having a multi-hit resistance to penetration of 90% or better and should be accepted 90% of the time. "Bad" TA has been defined as having a resistance to penetration of 70% or less and should be rejected 90% of the time. The number of test coupons required to determine FAT acceptance or rejection was selected using a 90% confidence level. In order to meet these values it is necessary to test 25 samples. The decision rule for acceptance is that the TA configuration will be accepted if there are 21 or more coupons with no penetrations.

In order to minimize testing cost a decision rule for acceptance testing with the 20 mm FSP has been selected that does not define "good" or "bad" TA. Four coupons will be tested. The lot will be accepted if there are four coupons with no penetrations. The statistical properties of this test are that TA which has a resistance-to-penetration of 60% or less will be rejected 90% of the time.

ACCEPTANCE CRITERIA FOR PRODUCTION CONTROL TEST

"Good" TA has been defined as having a multi-hit resistance to penetration of 90% or better and should be accepted 81% of the time. "Bad" TA has been defined as having a resistance to penetration of 70% or less and should be rejected 74% of the time. The number of test coupons required to determine production control test acceptance or rejection was selected using a 90% confidence level. In order to meet these values it is necessary to test eight samples. The decision rule for lot acceptance is that the lot will be accepted if there are seven or more coupons with no penetrations.

In order to minimize testing cost a decision rule for acceptance testing with the 20 mm FSP has been selected that does not define "good" or "bad" TA. Two coupons will be tested. The lot will be accepted if there are two coupons with no penetrations. The statistical properties of this test are that TA which has a resistance-to-penetration of 42`% or less will be rejected 90% of the time.

GLOSSARY/DEFINITIONS:

Ballistic Qualification or Ballistic Prequalification: Tests may be performed at a vendor's cost prior to contract award. The TARDEC test facility will not represent these as FAT tests to the user. The vendor must petition the user to have initial tests considered as meeting particular FAT requirements. Changes in assembly schedules, interface materials, cleaning procedures, autoclave capacity, etc. may lead to Pretests being considered unacceptable as FAT testing.

Bond Separations: See Delaminations.

Bubble: See Gaseous inclusions.

Clouding: of interlayer materials results in a smoky or foggy appearance.

Control Tests: These tests occur during production. They occur at least every 2000 parts and may occur more often as required by contract.

Complete Penetration (CP): A complete penetration 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.

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. This information will be FOUO, Proprietary.

Confidence level: When estimating a parameter, a confidence interval is a gap around the estimator, within which the true (unknown) value of the estimated parameter have a given probability to lie. This probability is called 'confidence level' of the estimator. Accuracy of estimation is quantified by calculating the confidence interval, given a confidence level. Confidence levels $\geq 90\%$ are desirable for ballistic data.

Coupon: A transparent armor item 400mm square, or larger, having the necessary laminations and edge seal to represent a production part. See Test Coupon.

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

Crazing: Crazing or a craze is a network of microscopic surface cracks that are usually detected by a "rainbow" glint on transparent materials. In ceramics, when the effect is desired, it is called crackle.

Crush: Per ASTM C1036-06: lightly pitted condition with a dull gray appearance.

Delamination: The separation of the bonded transparent armor into visibly separated layers. Normally layers that are beginning to delaminate reveal themselves by a change in reflectivity. Often delaminations can be suppressed by allowing a fluid to be pulled into the space between the delaminated layers. That is, following a rain storm some delaminations seem to disappear. Per ASTM C1172-09: a condition in which one or two of the lites of glass loses the bond between the glass lite and the interlayer.

Digs: Per ASTM C1036-06: deep, short scratch.

Exterior Surface: See Strike Surface.

First Article Tests: Initial tests performed in response to a vendor having received a contract to produce a number of TA panels.

Fair impact: An impact that meets the specified conditions of velocity, angle of impact, yaw (total inclination angle between the projectile axis and the flight axis) and impact location, within the tolerances defined for each condition.

Fragment simulating projectile: A specific fragment simulator based on the MIL-P-46593 cylindrical projectile usually with a chisel nose.

Gaseous inclusions: Per ASTM C1172-09 this is called a boil (bubble) and in ASTM C1036-06 this is called a gas pocket in the interlayer material or between the glass and interlayer or an elongated bubble in the glass. See paragraph 3.2.3 of ASTM C1036-06.

Hair: See Lint and Hair.

IAW: In Accordance With…

Insects or other organic matter: Organic detritus trapped between layers.

Inside dirt: Per ASTM C1172-09: Foreign matter trapped inside the laminate.

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.

Interlayer striae: Per MIL-HDBK-722: An imperfection: a cord of low intensity of particular interest in optical glasses.

Kinetic energy penetrator: A gun launched penetrator made of lead, steel, tungsten, etc. which uses a combination of mass and velocity to generate interfacial pressures that penetrate or defeat a target.

Lint and Hair: Per ASTM C1172-09: *Lint:* short fibers of yarn or fabric trapped within the laminate. *Hair:* a slender pigmented filament from human or animal epidermis or other thread-like filament.

NVG: Night vision goggles.

Outside Surface: See Strike Surface.

Open bubble: See Open gaseous inclusion.

Open gaseous inclusion: Per ASTM C1172-09 and ASTM C1036-06: (Strike Face Only) a gaseous inclusion is a round or elongated bubble in the glass (Paragraph 3.2.18 from C1036) that is open to the surface. Compare with Gaseous inclusion.

Partial Penetration (PP): A projectile impact that does not result in light being visible through the witness plate. Note that there are other definitions of PP, but this definition is used in this purchase description.

Protection Class level: The Protection Class levels (or more usually Protection Classes) are a combination of a numeral and an alphabetic character to designate test projectiles combined with specific velocities and are defined on drawing DTA184044 Sheet 1.

Qualification Tests: See Ballistic Qualification.

Ream and String: Per ASTM C1036-06 and MIL-HDBK-722 *Ream:* linear distortion as a result of non-homogeneous layers of flat glass. An area of inhomogeneous glass incorporated in the sheet, producing a wavy appearance. *String:* straight or curled line, usually resulting from slow solution of a large grain of sand or foreign matter.

Rubs: See Scratches and rubs.

Sample: A production item (not laboratory) that is selected at random from a larger number of items intended for sale to the customer.

Scratches and Rubs: Per ASTM C1036-06: *Scratch:* damage on a glass surface in the form of a line caused by the movement of an object across and in contact with the glass surface. *Rub:* abrasion of a glass surface producing a frosted appearance. Also know as a scuff per ASTM C1172-09.

Shall: A word that when used makes an associated requirement mandatory.

Stones and knots: Per ASTM C1036-06 a stone is a crystalline inclusion in the glass while a knot is an inhomogeneity in the form of a vitreous lump.

Strike Surface: The strike surface is 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.

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

String: See Ream and string.

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.

Test Coupon: A coupon usually less than 400mm on a side and may not have an edge seal. Specially sized coupons not normally used for FAT or Production Control testing.

TA or Transparent Armor: Any protection system through which direct vision is possible.

Threat Surface: See Strike Surface.

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.

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

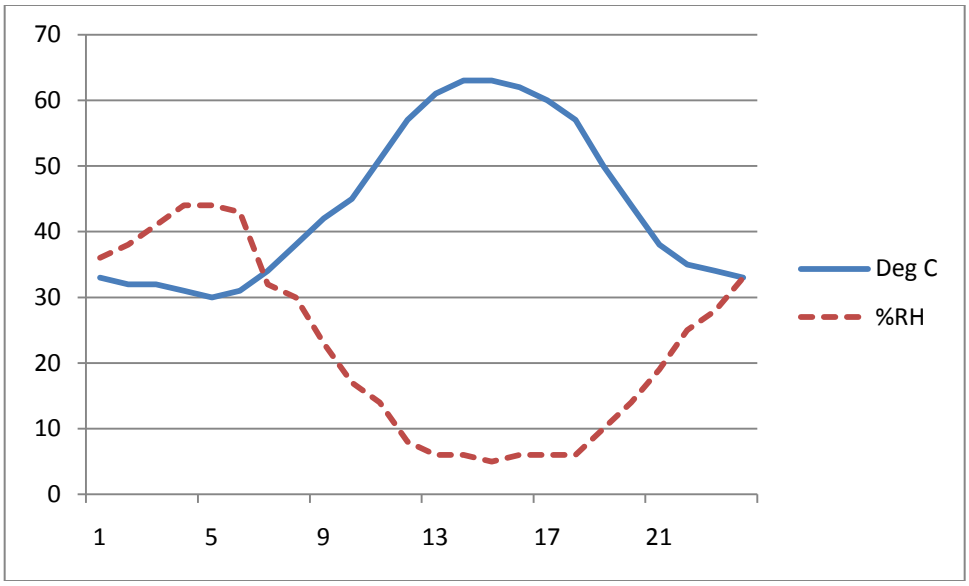
Yaw card: A material placed in the projectiles' line of flight whose perforation signature is used to determine the projectile yaw.

MIL-STD-810G Method 501.5, Procedure I, A2, Induced.

High Temperature Cycle for Use with ATPD Paragraph 4.3.1.2.

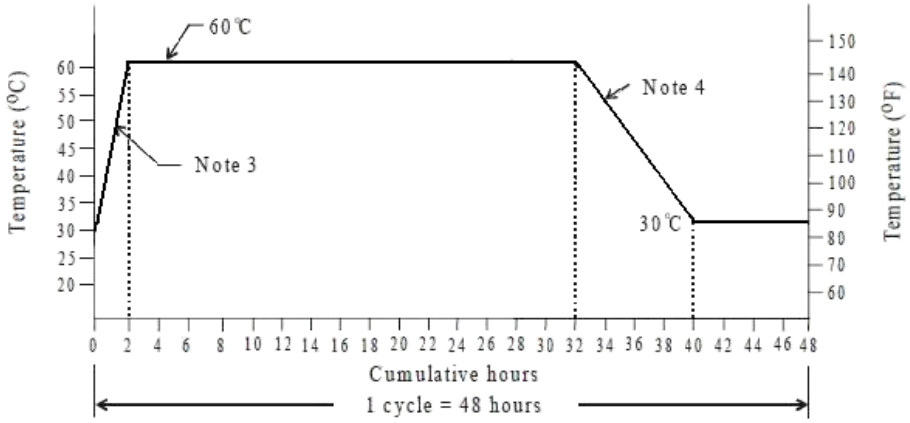
Hour	Celsius	% RH
1	33	36
2	32	38
3	32	41
4	31	44
5	30	44
6	31	43
7	34	32
8	38	30
9	42	23
10	45	17
11	51	14
12	57	8
13	61	6
14	63	6
15	63	5
16	62	6
17	60	6
18	57	6
19	50	10
20	44	14
21	38	19
22	35	25
23	34	28
24	33	33

Any hour may be the beginning point for the cycle. Linearly ramp the temperature to the beginning temperature. Do not heat at more than 8ºC per minute to reach the beginning point of the cycle. Do not cool the sample faster than 3ºC per minute to reach room temperature. Three cycles are required for the test. A graphical presentation of these data is given in the plot below. Note that the temperature is not completely smooth. Suggested temperature variability is ± 2ºC. Humidity variance should be noted and should be less than ±5%.



Plot of the data is taken (see previous page) from MIL-STD-810G, Method 501.5, Procedure I, A2, Induced which simulates storage conditions.

Hour	Temp ºC	RH%
0	30	95
2	60	95
32	60	95
40	30	95
48	30	95



NOTES:
1. Maintain the relative humidity at 95 ±4 percent at all times except that during the descending temperature periods the relative humidity may drop to as low as 85 percent.
2. A cycle is 48 hours.
3. Linearly increase the temperature between 0 and 2 hours.
4. Linearly decrease the temperature between 32 and 40 hours.

Procedure II – Aggravated Cycle (Figure 507.5-7 of MIL-STD-810G)
Modified for use with paragraph 4.3.2