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SUPERSEDES
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MILITARY SPECIFICATION

WINDSHIELD SYSTEMS, FIXED WING AIRCRAFT - GENERAL SPECIFICATION FOR

This specification is approved for use within the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope - This specification establishes the general requirements for the design, performances, installations and acceptance of windshield systems in fixed wing aircraft,

2. APPLICABLE DOCUMENTS -

2.1 Government documents -

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, Systems Engineering and Standardization Department (SESD) Code 93, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

SPECIFICATIONS

MILITARY

MIL-G-5485	Glass, Laminated, Flat, Bullet-Resistant
MIL-T-5842	Transparent Areas, Anti-Icing, Defrosting and Defogging Systems, General Specification for
MIL-W-6729	Watertightness of Aircraft, Testing, General Specification for
MIL-P-8184	Plastic Sheet, Acrylic, Modified
MIL-I-8500	Interchangeability and Replaceability of Component Parts for Aircraft and Missiles
MIL-A-8860	Airplane Strength and Rigidity, General Specification for
MIL-A-8869	Airplane Strength and Rigidity Special Weapons Effects
MIL-I-18259	Installation of Window Anti--Icing, De-Greasing, and Washing Systems (General Specification for)
MIL-E-18927	Environmental Control Systems, Aircraft, General ‘Requirements for
MIL-P-25690	Plastic, Sheets and Parts, Modified Acrylic Base, Monolithic, Crack Propagation Resistant
MIL-R-81261	Rain Repellent, Glass Window and Windshield, for Inflight Application
MIL-R-81367	Rain Removal System, Aircraft Windshield, Jet Air Blast
MIL-R-81589	Rain Repellent Fluid Application System, Aircraft Windshield
MIL-P-83310	Plastic Sheet, Polycarbonate, Transparent

Naval Air Systems Command

SD-24	General Specification for Design and Construction of Aircraft Weapon Systems, Volume I - Fixed Wing Aircraft

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the Contracting Activity or as directed by the Contracting Activity.)

STANDARDS

Military

MIL-STD-143	Specifications and Standards, Order of Precedence for the Selection of
MIL-STD-210	Climatic Extremes for Military Equipment
MIL-STD-470	Maintainability Program Requirements (for Systems and Equipment)
MIL-STD-785	Reliability Program for Systems and Equipment, Development and Production
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-850	Aircrew Station Vision Requirements for Military Aircraft
MIL-STD-882	Systems Safety Program Requirements
MIL-STD-1333	Aircrew Station Geometry for Military Aircraft
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities
MIL-STD-2072	Survivability, Aircraft, Establishment and Conduct of Programs for

2.1.2 Other government documents and publications - The following other government documents and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitations.

FEDERAL TEST METHODS

FTM-406	Plastics, Method of Testing

PUBLICATIONS

MILITARY

MIL-BUL-544 List of Specifications and Standards (book form)

2.2 Other publications - The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

American Society for Testing and Materials (ASTM) Standards:

ASTM F-320	Hail Impact Resistance of Aerospace Transparent Enclosures
ASTM F-330	Bird Impact Testing of Aerospace Transparent Enclosures
ASTM F-428	Standard Test Method for Intensity of Scratches on Aerospace Glass Enclosures
ASTM F-733	Standard Practice for Distortion and Deviation of Transparent Parts Using the Double Exposure Method.
ASTM D-1003	Haze and Luminous Transmittance of Transparent Plastics
ASTM D-1925	Yellowness Index of Plastics

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Components

3.1.1 Selection of materials, parts and processes - The materials, parts, and processes used shall be selected primarily to accomplish the designated Performance requirements. Specifications and standards for all materials, parts, and processes which are not specifically designated herein, shall be selected in accordance with MIL-STD-143 and Military Bulletin 544 and shall require acquiring activity approval prior to use. Variations from designated items and the use of newly developed advanced materials shall require acquiring activity approval. Polycarbonate plastic shall not be used without an environmental protection layer.

3.1.1.1 Non-specification material - The contractor shall be required to develop specifications for materials for which no federal, military or industry specifications exist. The specifications shall cover technical requirements, test methods, qualification, and acceptance criteria by the acquiring activity.

3.1.2 Windshield - A fixed windshield shall be provided forward of the cockpit. The windshield shall be designed to provide clear vision for the pilot and to protect the cockpit and crew as defined both in this specification aid the airplane detail specification. For tandem cockpit arrangements, consideration shall be given to providing wind blast protection for each cockpit when the canopy is jettisoned.

3.2 Design ambient conditions

3.2.1 Operations - The design ambient conditions of the atmosphere under which equipment shall remain operational shall be in accordance with the operations criteria of MIL-STD-210.

3.2.1.1 Environmental conditions - The windshield system shall withstand environmental conditions in accordance with MIL-STD-810 as specified in 4.3.4 herein.

3.2.2 Performance - Unless otherwise specified in the contract (See 6.2.1), the design ambient conditions of the atmosphere for meeting the performance requirements of this specification shall be in accordance with the 10 percent risk criteria of MIL-STD-210. If a 10 percent risk criteria is not available for a given parameter, the highest risk factor provided shall be used.

3.2.2.1 Aerodynamic heating - In addition to the requirements of 3.2.1, the entire windshield system shall be designed to operate as prescribed when subjected to the effects of aerodynamic heating.

3.3 Aerodynamic shape - The exact shape of the windshield shall include an optimum combination of all design requirements, but in no case shall the normal angle of incidence to the surface exceed 60 degrees. The contour of the windshield shall not be so abrupt that it would create a distorted effect for binocular vision nor should there be abrupt changes in contour or thickness between adjacent transparent panels which would allow differences in angular deviation and subsequent image shift.

3.4 Structural arrangement

3.4.1 Structural frames - Structural frames which affect vision from the cockpit shall be arranged to avoid gunsight and optical landing aids viewing areas. Windshield structural frames shall also conform to the requirements of MIL-STD-850 with regard to size and vision impairment limitations.

3.4.1.1 Configuration - The use of a one piece wrap-around type windshield for fighter/attack aircraft using a single pilot configuration is desired to maximize external vision.

3.4.2 Joints - Detail design of joints between the windshield and the openable section shall insure that distortion due to crash loadings will not cause mechanical interlocking and hangup which will preclude forceable opening or jettisoning of the canopy for emergency escape or rescue.

3.4.3 Crew clearance - Crew clearance envelopes and equipment space requirements shall be coordinated with the aerodynamic shape of the windshield.

3.5 Structural design

3.5.1 Nonmagnetic material - All parts within 24 inches of the magnetic compass shall be of nonmagnetic material.

3.5.2 Windshield Material - Material selection for windshield transparencies will be based on a trade study that has evaluated, at a minimum, the following requirements as defined in the aircraft detail specification: flight envelope, cockpit arrangement, service life, ingress/egress/escape considerations, bird impact, survivability, reliability, and maintainability. When bullet resistant glass is used, it shall conform to the requirements of MIL-G-5485. When as-cast acrylic is used, it shall conform to the requirements of MIL-P-8184. When stretched acrylic is used, it shall conform to the requirements of MIL-P-25690. When polycarbonate material is used, it shall conform to the requirements of MIL-P-83310. The material(s) selected shall be submitted to the procuring activity for approval.

3.5.3 Edge attachments - Transparent plastic windshield elements may incorporate edge attachments of the laminated-type based on glass fabric or other suitable textile to reinforce the edges and restrain crack initiation.

3.5.4 Thermal effects - The transparent materials shall be securely anchored within the supports but, where feasible, shall be free to expand and contract with changes in temperature and aging without distorting the structure, impairing the efficiency of the joints, or impairing the optical qualities of the panel. Consideration shall be given to the interaction between transparent components and frame caused by thermal effects under extreme temperature conditions to insure that stress concentration in the transparent components is kept to a minimum.

3.5.5 Loads - The windshield system (transparent materials and support structure) shall be sufficiently rigid to withstand all flight loads combined with pressure differential loads from zero up to the maximum regulator tolerance. The windshield shall also withstand all landing and handling loads without permanent deformation. Elastic deformations shall be of magnitudes which wil1 not adversely affect proper functioning and operation.

3.5.6 Windshield attachments - Except for electrical heating elements of thermocouples, accessories or equipment shall not be attached to the transparent elements of the windshield.

3.5.7 Watertightness - The windshield assembly/system shall meet the watertightness requirements of MIL-W-6729 and the aircraft detail specification.

3.5.8 Airtightness - Windshield design shall consider that pressurized cockpits shall be airtight within the limits of MIL-E-18927 when the airplane is in flight or with engine(s) running.

3.5.9 Redundant load paths - To avoid catastrophic failures, the windshield design shall provide multiple load paths whenever practical. Each load path shall be capable of carrying the anticipated applied load such that failure or malfunction of one component will not be likely to cause a more serious failure. It may be necessary to permit elastic deflection in excess of that normally desired in the event the applied load is carried by a structural system in which one or more of the redundant load paths is inactive. The maximum amount of deflection occurring under these conditions shall not cause further failure or malfunction.

3.6 Strength requirements

3.6.1 General - The windshield system shall be designed to withstand the load Imposed by conditions specified in MIL-A-8860, in the detail specification of the airplane, and as modified herein.

3.6,2 Load factors - All structural designs shall be in accordance with MIL-A-8860, and the detail specification of the airplane. Transparent windshields and associated structure shall be designed to ensure structural continuity and compatibility between windshield and surrounding structure. Additional design load factors shall be used as required to ensure safety. Deflections which may cause glass breakage or stress crazing in plastic panels shall be avoided. The size, contour, and material of the transparent windshield shall be considered in establishing a valid design load factor.

3.6.3 Pressurization loads - The windshield system shall be designed to withstand the pressurization loads specified in MIL-A-8860. The design shall include the effects of continuous and cyclic pressurization loads, aerodynamic loads, and the effects of temperature and temperature differentials throughout the ground and flight envelope of the aircraft. In the event of cabin overpressurization due to a failure in the pressurization control system, the windshield system shall be designed to remain intact beyond the point where pressure is relieved by failure or deflection of some other less critical portion of the cockpit.

3.6.4 Airload distribution - The magnitude and distribution of the airloads used in the structural design shall be those determined by the use of acceptable analytic methods and reliable aerodynamic data applicable to the conditions encompassed by the aircraft design limit flight envelope. This data shall include, at a minimum, the effects of math number, aeroelasticity, and thermal effects.

3.6.5 Landing arrestment barrier/barricade - The windshield structure shall be designated to withstand loads imposed by contact with arrestment barrier/barricade cables during emergency landing. No failure shall be permitted which might result in injury to the pilot.

3.6.6 Crash and ditching - The windshield system design shall guard against failures which sight result in injury to the pilot during crash or ditching.

3.6.7 Underwater survival - When underwater escape provisions are required by the detail specification for the airplane, the windshield shall be designed such that excessive deflection or failure will not prevent canopy or hatch opening.

3.7 Windshield survivability

3.7.1 General - The survivability and vulnerability of the entire windshield system shall be designed in accordance with the requirements of MIL-STD-2072.

3.7.2 Bird impact - The windshield, all supporting structure, -and latching mechanisms that are positioned ahead of and protecting the pilot/crew shall be designed to withstand the impact of a four pound bird when the velocity of the aircraft (relative to the bird along the aircraft flight path) is equal to the maximum operational true airspeed achievable in level flight at altitudes up to 5000 feet. Structural damage which impairs operation of the aircraft is not permissible. In the event of a bird impact, the design of the windshield system shall not permit more than 50 percent of the aircrew's forward visibility to be lost. Head clearance shall be taken into account to preclude the possibility of pilot or crew injury from excessive deflection of the windshield during bird impact. Cockpit equipment clearances with the windshield shall be considered to preclude equipment damage from excessive deflection of the windshield during bird impact. Internal damage such as glass or plastic parts spalled off, structural members broken free, or lining panels torn loose which could injure the pilot or restrict performance of the pilots normal duties in the cockpit is not permissible.

3.7.3 Ballistic impact - When ballistic impact resistance is required by the mission requirements of the aircraft, the forward windshield, when made of bullet resistant glass, shall meet the requirements of MIL-G-5485. Ballistic impact requirements of other windshield material shall be as specified in the detail specification for the aircraft.

3.7.4 Nuclear detonation - The windshield and support structure shall survive a 2.0 psi overpressure load and any loads resulting from transient phenomena associated with the nuclear detonation as specified in MIL-A-8869.

3.7.5 Lasers/particle beam weapons. The windshield shall defeat threats from lasers and particle beam weapons as specified in the aircraft detail specification.

3.7.6 Radar Cross Section (RCS) - The windshield system shall be designed to minimize the RCS the requirements of the aircraft detail specification.

3.7.7 Nuclear, Biological, Chemical (NBC) contamination - The windshield shall resist the effects of NBC contamination as specified. in the aircraft detail specification. The windshild shall also withstand the detrimental effects of decontamination solutions/cleaners without degradation of windshield performance.

3.8 Human engineering

3.8.1 General - The design of the system shall conform to the requirements of MIL-STD-1472.

3.8.2 Safety - The windshield system shall be designed to preclude the incorporation of features which result in catastrophic hazards as specified in MIL-STD-882.

3.8.3 Cockpit space - The windshield system design shall provide adequate space In the cockpit for personnel and equipment specified in the detail specification for the airplane. There shall be no sharp corners or projections into the cockpit which might result in injury to the pilot during a crash.

3.8.4 Eye location envelope - The pilot's design eye position shall be located in accordance with the proposed cockpit geometry specified in the detail specification for the airplane. The envelope of permissible eye travel shall be as specified in the detail specification for the airplane and shall comply with MIL-STD-1333.

3.8.5 Vision

3.8.5.1 Envelope - The windshield, as part of the cockpit enclosure, shall be designed to provide vision from the cockpit as required by MIL-STD-850, as a minimum.

3.8.5.2 Tandem cockpit - For aircraft utilizing a tandem cockpit arrangement in which the pilot may occupy the rear cockpit, the vision requirements of 3.8.5.1 apply. If forward vision is limited by the person and seat in the front cockpit, effect of such obstruction shall be kept to an absolute minimum and shall be demonstrated by a mockup.

3.8.5.3 Night Vision Goggle (NVG) compatibility - When specified in the detail specifcation for the aircraft, the windshield shall be NVG compatible over the wavelength range of 600 to 900 nanometers.

3.8.5.4 Primary viewing zone - Zone I shall be considered the primary operational viewing zone of the windshield used by the pilot. Zone I definition dimensions shall be submitted to the procuring activity for approval (See 6.3.1).

3.8.6 Optics

3.8.6.1 General - The windshield shall be capable of meeting the optical requirements specified in 3.8.6 before and after a minimum of two lifetimes of pressure/temperature cycling as specified in the aircraft detail specification.

3.8.6.2 Luminous transmittance

3.8.6.2.1 Fighter/attack type aircraft - The average luminous transmittance of the transparent material shall be not less than 80 percent when measured at normal angles of incidence to the surface. The luminous transmittance shall be not less than 65 percent when measured at the design eye position along a horizontal line with zero azimuth and the windshield in the installed position.

3.8.6.2.2 Other aircraft - The average luminous transmittance of the transparent material shall be not less than 60 percent. The luminous transmittance shall be not less than 50 percent when measured at the observer's eye position along a horizontal line with zero azimuth and the windshield in the installed position.

3.8.6.2.3 Anti-icing coating - If an anti-icing conductive coating is used, the coating shall not reduce light transmittance by more than 5 percent.

3.8.6.3 Haze - The haze in the windshield shall be not greater than 3 percent at normal angles of Incidence.

3.8.6.4 Binocular disparity - The angular deviation between each eye from a point object shall be not greater than 10 minutes of arc in the horizontal plane and 2 minutes of arc in the vertical plane. If the aircraft is used for high altitude reconnaissance, the angular deviation shall be not greater than 3 minutes of arc in the horizontal plane and 2 minutes of are in the vertical plane.

3.8.6.5 Aniseikonia - Aniseikonia shall be not greater than 2 percent.

3.8.6.6 Monocular distortion

3.8.6.6.1 Fighter/attack type aircraft - The angular deviation of the windshield, when measured normal to the surface, shall be not greater than 3 minutes of arc. The change in direction shall be not greater than 180 degrees within any linear 36 inches. With the transparency in the installed position, not less than 60 points shall be selected for the determination of the apparent deviation in elevation and azimuth at each point. The apparent deviation at each point shall be not greater than 3 milliradians and the RMS value for all the points shall be less than 1 milliradian.

3.8.6.6.2 Other aircraft - The angular deviation of the windshield, when measured normal to the surface, shall be not greater than 3 minutes of arc. The change in direction shall be not greater than 180 degrees in any linear 36 inches. With the windshield in the installed position, 15 random points shall be selected for the determination of the apparent deviation in elevation and azimuth at each point. The apparent deviation shall be not greater than 10 minutes of arc at any single point, but the average deviation shall be not greater than 3 minutes of arc.

3.8.6.7 Distortion

3.8.6.7.1 Fighter/attack type aircraft - The maximum gridline slope for the windshield shall be 1:15 when the grid is photographed through the windshield in the installed position.

3.8.6.7.2 Other aircraft - The requirements of 3.8.6.7.1 apply. In addition, normal roll-off distortion of 1:1 in Zone III shall not be cause for rejection.

3.8.6.8 Magnification - The maximum magnification shall be not greater than ±8 percent and a minus value indicating a reduction in size shall be less than -8 percent.

3.8.6.9 Birefringency - The rainbow associated with internal stresses and variation of individual ply thickness and internal stress shall not be permitted when the windshield is photographed and visually inspected. A color photograph shall be taken from the left and right eye position at zero azimuth.

3.8.6.10 Visual performance - The windshield shall be inspected visually. There shall be no immediate apparent bending, blurring, divergency, convergency, or broken gridlines. Defects less than 0.035 inches in diameter shall be acceptable if not located or grouped in a manner to cause vision impairment. Any optical defect, regardless of size, which causes vision impairment shall be cause for rejection. Defects in Zone III are permitted if structural integrity of the windshield is not affected. The entire windshield, including Zone III, shall be free of bull's eye type distortion (See 6.3).

3.8.6.11 Scratches - Scratches shall be evaluated using ASTM F-428 Standards. There shall be no scratches more severe than F-428-3 in Zone I. There shall be no scratches more severe than F-428-4 in Zone II. There shall be no scratches more severe than F-428-6 in Zone III. Scratches that are equal to, or less severe than, the limits defined are acceptable, provided they are not of a length or density that impairs vision.

3.8.6.12 Color - When polycarbonate material is used in windshield construction, the yellowness of the core ply mill run prior to fusion bonding shall be determined. The yellowness index (YI) for a mill run ply of 0.25 inch thick polycarbonate shall be not greater than 8.5.

3.8.7 Cockpit reflections - Windshield and canopy configurations which produce objectionable patterns of reflections of cockpit and external lights shall be coordinated with locations of internal light sources, light baffles, and orientation of reflective surfaces for an optimum configuration. Proposed cockpit enclosure configuration. shall be verified by a lighting mockup. Point secure and distributed illumination effects shall be demonstrated.

3.8.8 - Rain removal - Windshield system design shall include provisions to insure visibility while flying through rain of 4 inches per hour in accordance with MIL-R-81367. System functioning shall be proven by test. The rain removal and repellent system shall provide clear vision for taxing, takeoff, approach, landing, inflight refueling, and level flight at 1.6 times the stall speed at maximum weight with flaps and gears retracted. For carrier-based aircraft, a clear view of landing aids shall be provided during the entire carrier approach operation.

3.8.8.1 - Windshield wipers - Specifications for electrically operated windshield wipers shall be provided by the prime aircraft contractor in accordance with 3.1.1.1 herein. Designs shall include provisions to prevent the possibility of damage to transparencies by aerodynamic buffeting, abrasion, and to eliminate vision obstruction by the wiper when stowed. Adequate strength and rigidity shall be provided to prevent possible loss of blades, arms, or other components during all flight conditions. Wipers shall not be used on panels in which the outer ply is susceptible to scratching. Hydraulic windshield wipers shall not be used.

3.8.8.1.1 - Wiper clearance envelope - The limits of the required clear area on the external surface of the windshield panel(s) shall be determined with respect to the pilot’s (co-pilot’s) design eye position. The minimum upper limit of the clear area shall be defined by the external intersection of the windshield panel(s) and a horizontal plane passing through the pilot’s (co-pilot’s) eye position with the aircraft at maximum expected nose-down attitude during approach and landing. The minimum transverse extent of the clear area shall be defined by the external intersection of the windshield panel(s) and two vertical planes passing through and measured from the pilot’s (co-pilot’s) eye position, one 13 degrees horizontally to the left and one 13 degrees horizontally to the right. The lower limit of the clear area shall be defined by the lower extent of the windshield panel(s) or the upper limit of intervening structure as viewed from the pilots (co-pilot’s) eye position.

3.3.8.2 Air Blast sytems - Designs utilizing air blast systems shall be in accordance with requirements of MIL-R-81367. A minimum flowrate of 7 pounds per minute per inch of nozzle length and sonic flow through nozzles shall be maintained at all conditions where rain removal is required. A tapered coverging slot type nozzle is preferred. A normally closed shutoff valve that will fail closed shall be provided in the air blast supply line to each cleared windshield. Airflows to both windshields in side by side cockpit aircraft must not be lost due to failure of a flow control or pressure regulating device.

3.8.8.3 - Rain repellent systems - Approved chemical rain replellent systems may be used as required to augment air blast or windshield wiper systems. Designs shall be in accordance with MIL-R-81261 and MIL-R-81589.

3.8.9 - Windshield heating elements - The use of heat sources to keep transparent areas of the windshield free of fog and ice shall not cause an uncomfortable temperature rise on the crew: Surface temperature shall be the minimum required to provide clear vision. Rate of onset and removal of heat shall be controlled to minimize the possibility of transparency damage due to thermal shock. Designs shall be in accordance with MIL-T-5842.

3.8.10 - Windshield washers - Windshield washers in accordance with MIL-I-18259 shall be provided on all seaplanes and on all other airplanes whose principle mission will involve low-level search over water or night carrier operations. The spray pattern shall cover the “clear area” requirement of 3.8.8.1.1 herein. The system shall be capable of removing salt water encrustations over the “clear area” of the windshield. The system shall have sufficient capacity to throughly clean the windshield a minimum of five times. For aircraft with extended mission times of greater than 4 hours, the system shall have sufficient capacity to provide for one thorough cleaning every 45 minutes of operation. When a fluid anti-icing system is incorporated, the spray distribution system should be common to the washing and anti-icing systems. (Rain repellent fluid is not compatible with water-based wash or anti-ice fluids and shall have a separate storage system.)

3.8.11 - Windshield decreasing - Windshield decreasing shall be provided in accordance with MIL-I-18259 for all airplanes having a reciprocating engine installed forward of the pilot s wind-shield.

3.8.12 - Windblast protection - Windblast protection shall be provided for rear seat occupants of aircraft utiltzing a tandem cockpit arrangement to permit operation of seat ejection controls or flight and landing from the rear seat subsequent to an inadvertent canopy loss.

3.9 - Maintainability

3.9.1 - General - The windshield system shall be designed in accordance with the qualitative and quantitative maintainability requirements of MIL-STD-470. Designs which require special tools for handling and installation shall be avoided as much as practicable.

3.9.2 - Interchangeability - Items which require frequent replacement such as transparent panels shall be designed to have interchangeable fit and attach hole patterns in accordance with MIL-I-8500 to permit replacement with minimum danger or damage during installation of the new part. Removal and re-installation shall be possible without affecting the entire system.

3.3.9 - Handling - Windshield systems shall be designed to prevent damage due to the strains imposed during ground handling, maintenance, removal, and servicing. Areas which are convenient for seating and stepping by maintenance personnel shall be designed to withstand such loads.

3.9.4 - Warpage - Parts, which are subject to warpage or distortion when not installed, shall be suitably protected and shall be placarded to forbid nesting, if applicable.

3.9.5 - Seals - Provisions shall be made to protect weather seals and cockpit pressurization system seals from damage as a result of normal maintenance activities and from normal entrance and egress by the crew. Designs of seals shall provide for simple replacement.

3.9.6 - Replacement - The design Mean Time To Remove And Replace (MTTRAR) at the organizational level, shall be furnished as part of the design approval report. The minimum MTTRAR shall be as specified by the procuring activity.

3.10 Reliabilty - Reliability shall be a basic consideration in the design of all components used in the system. A reliability program shall be established in accordance with MIL-STD-785. The design threshold reliability expressed quantitatively in MTBF shall be furnished as part of the design approval report. The minimum MTBF required shall be as specified in the contract (See 6.2.1).

3.11 - Design data - Prior to installation of a windshield assembly or system on an aircraft, the contractor shall prepare a report on the design of the system.

3.12 - Test plan - A report covering the proposed laboratory and flight tests required to prove the system design, shall be prepared prior to conducting of the final laboratory or flight test required to prove the system performance.

4. - QUALITY ASSURANCE PROVISIONS

4.1 - Responsibility for inspection - Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the-contract or purchase order, the contractor may utilize his own facilities or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must 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 assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 - Classification of tests - The inspection requirements specified herein are be classified as follows:

a. First article inspection (See 4.3)

b. Acceptance Tests (See 4.4)

4.3 - First article inspection - First article tests shall consist of the quality conformance tests herein and the additional tests specified in 4.3.1 and subparagraphs thereto.

4.3.1 - Strength testing - Tests shall be conducted to prove that adequate strength exists in all parts of the windshield system to meet the minimum strength and rigidity requirements imposed on the airplane. Airplanes designed in accordance with SD-24 shall be tested in accordance with MIL-A-8860 with the windshield installed.

4.3.1.1 - Test loads - The magnitude of the test loads shall include the factors of safety specified in MIL-A-8860, and as specified in 3.6.2 herein.

4.3.1.2 - Test setup - The windshield shall be tested as part of a complete airplane or on a test specimen, consisting of at least the cockpit portion of the fuselage together with the entire cockpit enclosure installed in operational condition.

4.3.1.3 - Windshield test - The windshield shall be tested in accordance with the applicable sections of MIL-A-8860 together with any additional tests which are dictated by peculiarities in the structure and which are deemed necessary to ‘insure windshield structural Integrity.

4.3.1.3.1 - Bird impact test - Bird impact resistance tests shall be conducted in accordance with the requirements of ASTM-F-330, The testing shall be conducted under the mist extreme temperature conditions likely to occur in flight below 5000 feet altitude. The testing shall use a four pound bird. Target locations on the windshield shall include:

a. Point of maximum structural stiffness

b. Point of minimum structural stiffness

c. Point of maximum deflection

d. A representative edge location

e. Center of each windshield support member

If the aircraft is equipped with a heads-up-display (HUD), the combiner portion of the HUD, or suitable mock-up, shall be installed in the test specimen during all bird impact testing.

4.3.1.3.2 - Ballistic testing - When specified in the contract (See 6.2.1), tests shall be conducted in accordance with MIL-G-5485 or as specified in the contract or purchase order.

4.3.1.3.3 - Electrical terminal test - When an electrical anti-icing system is used for the windshield, the electrical terminals shall be tested by applying a 100 pound tension load perpendicular to the panel surface followed by a 50 inch-pound torque load. Cracking, lossening of a terminal, or electrical non-continuity shall not be permitted.

4.3.2 - Functional testing

4.3.2.1 - General - The entire windshield system shall be tested for proper functioning and reliable operation of all components.

4.3.2.2 Windshield defogging system - The normal windshield defogging system shall be operated through not less than 1000 complete cycles. A cycle shall consist of cooling the windshield to -30 degrees F, filling the cockpit with ambient air at 70 degrees to 90 degrees F and relative humidity of not less than eighty percent and activating the defogging system. Ninety percent of the transparent area, useable for viewing from the design eye position, shall be free of condensation within 5-minutes after the defogging system is activate.

4.3.2.3 - Emergency defogging - The emergency windshield defogging shall be tested to prove proper functioning. Reduced clear vision area, as allowed by the detail specification for the airplane, shall be free of condensation within 5 minutes when tested in accordance with 4.3.2.2.

4.3.2.4 - Rain removal system - The windshield rain removal system, if applicable, shall be demonstrated as part of the airplane flight test program or in a suitable rain tunnel, in accordance with the requirements of MIL-R-81367 and MIL-R-81589. Landing approach visibility in a rainfall rate of four inches per hour shall be demonstrated.

4.3.2.5 - Anti-icing system - When applicable, the anti-icing system shall be demonstrated as part of the airplane flight test program or in a suitable climatic hanger as specified in the contract (see 6.2.1). Testing shall show conformity with the requirements of MIL-T-5842.

4.3.3 - Optical testing - Testing shall be conducted to prove compliance with all optical requirements herein. A test plan outlining the procedures of all optical testing shall be prepared.

4.3.3.1 - Luminous transmittance and haze - Luminous transmittance and haze testing shall be conducted in accordance with ASTM D-1003. Not less than one measurement shall be made on every 9 inches of surface area. Luminous transmission and haze shall be measured at the same location and shall be included as the average of the total measurements. The luminous transmission for the installed position shall be included separately and shall meet the requirements of 3.8.6.2 and 3.8.6.3 herein.

4.3.3.2 - Angular deviation - Grid board photographs shall be used to determine angular deviation and direction to show compliance with 3.8.6.6 herein.

4.3.3.3 - Distortion - Grid board photographs shall be used to determine optical distortion. The grid board shall consist of white lines 1/16 inch wide maximum on one inch centers, against a dull black background. The photographs shall be evaluated using the procedures of ASTM F-733-81 to assure compliance with 3.8.6.7 and 3.8.6.10 herein.

4.3.3.4 - Birefringency - Color photographs shall be taken through the windshield from each eye position at zero azimuth to show compliance with 3.8.6.9 herein. If windshield heating elements are used, color photographs shall also be taken with the heating element on and compared to those with the heating element off.

4.3.3.5 - Color - If polycarbonate material is used in windshield construction, color of the core ply mill run shall be tested in accordance with ASTM D-1925 to show conformance with 3.8.6.12 herein.

4.3.4 - Environmental tests of components - Components shall be subjected to the following environmental tsts specified in MIL-STD-810. Failure to pass specified tests shall be cause for rejection.

a. High temperature test, Method 501.1.

b. Temperature-altitude, Method 504.1.

c. Low temperature test, Method 502.1.

d. Temperature shock, Method 503.1

e. Humidity test, Method 507.1.

f. Solar radiation (sunshine), Method 505.1.

g. Altitude test, Method 500.1.

h. Rain, Method 506.1.

i. Salt spray test, Method 509.1.

j. Vibration test, Method 514.2.

k. Fungus resistance test, Method 508.1.

l. Sand and dust test, Method 510.1.

m. Acceleration test, Method 513.2.

n. Shock test, Method 516.2.

4.3.4.1 - Additional tests - The windshield transparency shall also be subjected to the following tests. Failure to pass specified tests shall be cause for rejection.

a. Crazing resistance tests in accordance with FTM-406 Method 6053. No crazing of the transparent material shall be allowed.

b. Hail impact tests per ASTM F-320.

4.4 - Acceptance tests

4.4.1 - General - The quality conformance tests for acceptance shall consist of those tests required by the detail specification of the aircraft and the following:

a. Examination (See 4.4.1.1)

b. Functional operation (See 4.4.1.2)

c. Optical Quality (See 4.4.1.3)

4.4.1.1 - Examination - The windshield system shall be inspected to determine compliance with the requirements specified herein with respect to materials, workmanship, and all other requirements not covered by the tests.

4.4.1.2 - Functional operation - The entire windshield system shall be tested for proper functioning and reliable operation of all moving parts. In addition, if the windshield system incorporates heating elements, tests shall be performed to show compliance with 3.8.9 herein.

4.4.1.3 - Optical quality - To determine compliance with the optical requirements specified herein, Optical Quality Tests shall be conducted in accordance with 4.3.3 through 4.3.3.5.

5. - PACKAGING - Not applicable to this specification.

6. - NOTES

6.1 - Intended use - The requirements of this specification are intended for use in designing windshield systems for fixed wing aircraft. The windshield system shall provide clear vision for the pilot(s) and provide protection from environmental and other threats. These requirements apply to the transparency materials, framing, support structure, attachments, and seals.

6.2 - Ordering data

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Performance, if other than specified in 3.2.2.
c. A reliability assurance program (See 3.10).
d. Reliability MTBF demonstration, if other than specified in 4.1.
e. Responsibility for Inspection, if other than specified in 4.1.
f. Test reports and distribution if required (see 4.2).
g. Environmental tests, if other than specified in 4.3.4.

h. Minimum MTBF required (See 3.10).
i. Ballistic testing (See 4.3.1.3.2).
j. Anti-icing system demonstration (See 4.3.2.5)

6.2.2 - Data requirements - When this specification is used in an acquisition which Incorporates a DD From 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DOD FAR Supplement, Part 27, Sub-Part 27.410-6 (DD form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirement. Deliverable data required by this specification is cited in the following paragraphs.

Paragraph No.	Data requirement title	Applicable DID no.	Option
3.1.1	Request for Deviation/Waiver	DI-E-3129	-
3.1.1.1	Material specification	DI-E-3131	-
3.8.5.4, 3.9.6, 3.10, 3.11, 4.1,	Report, technical	UDI-S-23272	-
3.8.6.12	Certification data/report	UDI-A-23264	-
3.12, 4.3.3	Test plan	DI-T-5204	-

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DOD 5010.12L, ANSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 - Definitions - Definitions listed herein pertain only to those items peculiar to this specification.

6.3.1 - Optical zones - The definitions for optical zones, for specified requirements establishes the critical and non-critical areas of the windshield.

6.3.1.1 - Zone I - Zone I is the primary operational viewing zone used by the pilot. For carrier based aircraft, Zone I also includes any area of the windshield that is used to view optical landing aids.

6.3.1.2 - Zone H - Zone II is the peripheral viewing zone required for scanning. Movement of the pilot's head from the design eye position should be considered scanning. Any part of the transparency that is not considered Zone I should be considered Zone II except for the boundary area which is designated Zone III.

6.3.1.3 - Zone III - Zone III is the boundary area of the transparency used for installation into an aircraft. Zone III can extend one inch from structural support members and the sill line of the fuselage.

6.4 Subject term (key word) listing

Windshield systems
Fixed wing aircraft
Optics
Fighter/attack type aircraft
Anti-static coating
Binocular disparity

6.5 - Changes from previous issues. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity
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