INCH POUND

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DETAIL SPECIFICATION

VISORS, FLYER'S HELMET, POLYCARBONATE

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

1. SCOPE

1.1 Scope. This specification covers general and performance requirements for curved polycarbonate flyer's helmet visors worn by aircrew personnel.

1.2 Classification. The visors will be of the following classes as specified (see 6.2).

Class 1	-	Clear
Class 2	-	Neutral Gray
Class 3	-	Neutral Gray Gradient (Air Force)

2. APPLICABLE DOCUMENTS

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

Comments, suggestions, or questions on this document should be addressed to the Commander, Defense Supply Center Philadelphia, ATTN: DSCP-FQSE, 700 Robbins Avenue, Philadelphia, PA 19111-5092 or e-mailed to Kathleen.Gullifer@dla.mil. Since contract information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

AMSC N/A FSC 8415

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-E-12397	Eraser, Rubber-Pumice (for Testing Coated Optical Elements)

DEPARTMENT OF DEFENSE STANDARDS

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

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

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

DRAWING

7680606	Tester, Abrasion, Optical Coating

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z87.1	Occupational and Educational Personal Eye And Face Protection Devices

(Copies of this document are available from www.ansi.org<BLOCKED::http://www.ansi.org/> or the American National Standards Institute, 25 West 43rd St., 4th Floor, New York, NY 10036.)

ASTM International

ASTM F 735	Standard Test Method for Abrasion Resistance of Transparent Plastics and Coatings Using the Oscillating Sand Method
ASTM D 1003	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics

ASTM D 1044	Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion
ASTM D 3935	Standard Specification for Polycarbonate (PC) Unfilled and Reinforced Material
ASTM D 3359	Standard Test Method for Measuring Adhesion by Tape Test

(Copies of these documents are available from www.astm.org<BLOCKED::http://www.astm.org/> or the ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AMERICAN SOCIETY FOR QUALITY

ANSI/ASQ Z1.4	Sampling Procedures and Tables For Inspection by Attributes (DoD adopted)

(Copies of this document are available from www.asq.org<BLOCKED::http://www.asq.org/> or the American Society for Quality, 600North Plankinton Ave., Milwaukee, WI 53203-2914 or www.ansi.org<BLOCKED::http://www.ansi.org/> or the American National Standards Institute, 25 West 43rd St., 4th Floor, New York, NY 10036.)

INTERNATIONAL COMMISSION ON ILLUMINATION (CIE)

CIE 1924 Standard

(Copies of these documents are available from www.cie-usnc.org<BLOCKED::http://www.cie-usnc.org> or the CIE/USA Publications Office, c/o TLA-Lighting Consultants, Inc., 7 Pond St., Salem, MA 01970.)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Design and dimensions. The design and dimensions of the visor shall be as specified in the end item specification, drawing or contract as applicable.

3.3 Materials and components. Unless otherwise specified in the end item specification, drawing, or contract as applicable, the visor shall be fabricated from bisphenol type polycarbonate plastic molding material conforming to ASTM D 3935. All other material and components used in the construction of the visor shall be as specified in the end item specification, drawing, or contract, as applicable.

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

3.4 Areas of vision. Unless otherwise specified, the visor shall have three areas of vision which are identified as: outside the area of vision (no optical requirement), non-critical area of vision, and critical area of vision. The center point for the right and left optics shall be identified as point "C". The location of point "C" and the location and size of the three areas of the visor identified above shall be as specified in the end item specification, drawing, or contract as applicable. The critical area is approximately a 50 degree radius field of view from the primary line of sight intercept point on the visor for the designed right and left eye locations. The areas within 1 mm (1/16") of the edges of the visor are non-critical areas. Regions that rest against the helmet shell are outside the area of vision. Figure 1 shows a typical layout of a visor and is intended to serve as a guide only for use by Government agencies to develop their detailed requirements. Unless otherwise specified in the end item specification, drawing, or contract as applicable, the numbered circles within the critical areas are designated as points of choice for prismatic and distortion tests. Points bearing the same number, for example 5R and 5L, shall be compared with each other, except points 2R and 2L (outermost points on left and right sides of visor) shall be compared with point 3 (center point of visor) when measuring refractive power or prismatic deviations.

3.5 Performance.

3.5.1 Prismatic deviation. Prismatic deviation stated herein includes the inherent prismatic power resulting from nonparallel surfaces of the material and dissimilar curvature between the critical areas. The vertical and horizontal prismatic deviations shall be tested as specified in 4.3.5.

3.5.1.1 Vertical prismatic deviation. The vertical prismatic deviation through point "C" for the left and right eyes shall be no more than 0.18 prism diopters. The vertical prism along any individual line of sight through the critical area shall not exceed 0.25 prism diopters.

3.5.1.2 Horizontal prismatic deviation. The horizontal prismatic deviation through point "C" for the left and right eyes shall be no more than 0.18 prism diopters BASE IN and no more than 0.25 diopters BASE OUT. The horizontal prism along any individual line of sight through the critical area shall not exceed 0.25 prism diopters.

3.5.2 Refractive power. The refractive power shall not exceed plus or minus 0.125 diopters at point "C" and at all other points of choice for the left and right optics, when tested as specified in 4.3.5.

3.5.3 Luminous transmittance (see 6.5)

3.5.3.1 Class 1 visor. The luminous transmittance of class 1 visor shall be not less than 85 percent throughout the critical area when tested as specified in 4.3.5.

3.5.3.2 Class 2 visor. The luminous transmittance of class 2 visor shall be within 12 to 18 percent when measured at point "C", left and right optics. The total visible transmittance of the visor shall not vary more than 3.0 percentage points. Tests shall be as specified in 4.3.5.

3.5.4 Optical density.

3.5.4.1 Class 3 visor. The optical density (OD) of the class 3 visor shall be between 0.83 and 0.60 OD when measured at point "C" left and right optics. The OD at any point in a horizontal meridian of a given visor shall not vary by more than 0.1 OD from other points on the same meridian. The class 3 visor shall consist of a class 1 visor with a gradient tint, darker at the top, conforming to an OD gradient of 0.4 OD/inch $\pm$ 0.06 OD when measured at point "C" to a

vertical distance of 1-inch above or below point "C". The resultant gradient shall be smooth and uniform when tested as specified in 4.3.5.

3.5.5 Optical distortion of critical areas. The optical distortion within the critical vision areas shall conform to the acceptable standards shown on figure 2 when tested as specified in 4.3.5.

3.5.6 Haze. The haze value of the visor shall not exceed 2.0 percent when tested as specified in 4.3.5.

3.5.7 Ultraviolet transmittance. The erythemal ultraviolet transmittance shall not be more than 1.00 percent, when computed as the average spectral transmittance at wavelengths of 290, 300, 310, and 320 nm when tested as specified in 4.3.5.

3.5.8 Neutrality of class 2 and 3 visors. The spectral transmittance (see 6.6) of the class 2 visor may vary with wavelengths between 430 and 730 nm, the average percentage deviation within nine spectral bands shall be less than 12 when tested as specified in 4.3.5. The spectral distribution curve shall show a reasonable even distribution throughout the visible spectrum to insure that color distortion will not be excessive. The neutrality of the class 3 visor shall conform to the requirements specified for the class 2 visor except that the average percentage deviation shall be less than 20 when tested as specified in 4.3.5.

3.5.9 Chromaticity of class 2 and 3 visors. The chromaticity coordinates x and y of the classes 2 and 3 visors shall be within the limits indicated on figure 3 when computed as described in 4.3.5.

3.5.10 Ballistic resistance. The ballistic resistance of the lenses shall be such that they will pass a V_0 test using a 0.22 caliber, 17.0 $\pm$ 0.5 grain, T37 shaped projectile at a velocity of 550 to 560 feet per second when tested as specified in 4.3.5.

3.5.11 Abrasion resistant coating . After being subjected to the abrasion tests specified in 4.3.5 , the increase in haze shall not exceed 2 percent and the decrease in transmittance shall not exceed 2 percent.

3.5.12 Bayer abrasion resistance. After being subject to the Bayer abrasion test the Bayer ratio shall exceed a value of 4.0 or higher as specified in 4.3.5.

3.5.13 Coating adhesion. Before and after humidity exposure, the visor shall show no loss of coating when tested in accordance with 4.3.5.

3.5.14 Weathering resistance. The coated visors shall show no yellowing or other changes, nor show loss of coating when tested as specified in 4.3.5.

3.5.15 Chemical resistance. When tested in accordance with 4.3.5 the visor shall not increase more than 2% for transmittance and haze.

3.6 Workmanship. The visors shall be free from all defects which would affect proper functioning in service. The visors shall conform to the quality and grade of product established by this specification.

4. VERIFICATION

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

a. First article inspection (see 4.2)

b. Conformance inspection (see 4.3)

4.2 First article inspection. When a first article is required (see 3.1), it shall be examined as specified in 4.3.3 and 4.3.4 and tested for the characteristics specified in 4.3.5. Any nonconformance shall be cause for the rejection of the first article. The number of units to be inspected shall be specified in the contract.

4.3 Conformance inspection. Unless otherwise specified, sampling for inspection shall be performed in accordance with ASQ-Z1.4. Items shall be examined as specified in 4.3.3 and 4.3.4 and tested for the characteristics specified in 4.3.5.

4.3.1 Inspection lots. For purposes of sampling, a lot shall consist of visors produced from a single batch of resin during one continuous injection molding operation. Any shutdown of the molding operation shall be considered as the termination of that operation and lot.

4.3.2 Component and material inspection. Components and materials shall be inspected in accordance with all the requirements of referenced documents unless otherwise excluded, amended, modified, or qualified in this specification or applicable purchase document.

4.3.3 End item visual examination. The end item shall be examined for the defects listed in Table I. The lot size shall be expressed in units of visors. The sample unit shall be one visor.

TABLE I. End item visual defects

Examine	Defect	Classification		
		Critical	Major	Minor
Appearance	Pit, bubble, scratch, foreign matter, void, inclusions or blister:			
	- Critical area of vision	1		
	- Non-critical area of vision		101	
	- Area outside area of vision			201
	Cloudiness:			
	- Critical area of vision	2		
	- Non-critical area of vision		102	
	Crack, hole, chip, or break:			
	- Any area	3		
	- Evidence of warpage	4		
	Visible striae or waviness:			
	- Critical area of vision	5		
	- Non-critical area of vision		103	
	Surface abraded, dulled, or not smooth:			
	- Critical area of vision	6		
	- Non-critical area of vision		104	

TABLE I. End item visual defects (continued)

Examine	Defect	Classification Critical	Major	Minor
	Stain or discoloration not readily removed with water:			
	- Critical area of vision	7		
	- Non-critical area of vision		105	
	Sharp edge or burr:			
	- Affecting serviceability		106	
	- Not affecting serviceability			202
	Transmittance gradient not smooth and uniform (class 3 visor)	8		
Design	Not as specified	9		

4.3.4 End item dimensional examination. The visors shall be examined for conformance to the dimensions specified in the end item specification, drawings, or contract. Any dimension not within the specified tolerance shall be classified as a critical defect.

4.3.5 End item testing. The visors shall be tested for the characteristics listed in Table II.

TABLE II. End item tests

Characteristic	Requirement paragraph	Test method	Number of determinations	Results to nearest
Prismatic deviation	3.5.1	4.4.1	1/unit	0.01 diopter
Refractive Power	3.5.2	4.4.2	2/unit	0.01 diopter
Luminous transmittance	3.5.3	4.4.3	1/unit for class 1 2/unit for class 2	1 percent
Optical density	3.5.4	4.4.4	2/unit for class 3	1 percent
Optical distortion of critical areas	3.5.5	4.4.5	1/unit	Pass or fail
Haze	3.5.6	4.4.6	1/unit	0.1 percent
Ultraviolet transmittance 1/	3.5.7	4.4.7	1/unit	1 percent

TABLE II. End item tests (continued)

Characteristic	Requirement paragraph	Test method	Number of determinations	Results to nearest
Neutrality of class 2 and 3	3.5.8	4.4.8	1/unit	1 percent
Chromaticity of class 2 and 3	3.5.9	4.4.9	1/unit	1 percent
Ballistic resistance	3.5.10	4.4.10	2/	Pass or fail
Abrasion resistance	3.5.11	4.4.11	2/unit	<2 percent
Bayer abrasion resistance	3.5.12	4.4.12	2/unit	ratio >4
Coating adhesion	3.5.13	4.4.13	2/unit	Pass or fail
Weathering Resistance	3.5.14	4.4.14	1/unit	Pass or fail
Chemical resistance	3.5.14	4.4.15	2/unit	<2 percent

1/ The test for ultraviolet transmittance shall be performed only on the first lot of visors from each batch of molding material.

2/ A minimum of three articles.

4.4 End item performance test methods.

4.4.1 Prismatic deviation test. Prismatic deviation shall be measured in accordance with ANSI Z87.1. Telescope, lensometer or optical beam deviation along the selected line of sight may be used. Error shall be less than 0.03 prism diopters.

4.4.1.1 Vertical prismatic deviation. BASE UP prism shall be designated positive (+) while BASE DOWN prism shall be designated negative (-). The vertical prismatic imbalance shall be defined as the absolute value of the difference between the prism through point “C” of the right and left eyes. Vertical prismatic imbalance shall meet the requirements as specified in 3.5.1.1. This calculation can also be applied to other opposing points as stated in 3.4.

4.4.1.2 Horizontal prismatic deviation. BASE OUT prism shall be designated positive (+) while BASE IN prism shall be designated negative (-). The horizontal prismatic imbalance shall be defined as the absolute value of the sum of prism at the design eye point of the right and left lenses. Horizontal prismatic imbalance shall meet the requirements specified in 3.5.1.2. This calculation can also be applied to other opposing points as stated in 3.4.

4.4.2 Refractive power test. The refractive power shall be determined with any suitable instrument with increments of 0.01 diopters for spherical and cylindrical powers. The aperture over the test items shall not exceed 1 centimeter. If the instrument used cannot measure astigmatic components, then the target pattern shall be a fixed spoke wheel, with a minimum of 24 spokes.

4.4.3 Luminous transmittance test. The transmittance shall be measured through point "C" (see 3.4) for left and right eye, using a calibrated National Institute of Standards and Technology (NIST) traceable spectrophotometer with a spectral bandwidth ≤ 10 nm. Table III shows an example calculation of the photopic and scotopic luminous transmittance.

TABLE III. Sample calculation for luminous transmittance 1/ 2/ 3/ 4/ 5/

Wavelength (nm)	V(λ)	V(λ′)	Sample T	V(λ)*T	V(λ′)*T
380	0.00004	0.00059	0.00003	0.00000	0.00000
390	0.00012	0.00221	0.12361	0.00001	0.00027
400	0.00040	0.00929	0.65772	0.00026	0.00611
410	0.00120	0.03484	0.83508	0.00100	0.02909
420	0.00400	0.09660	0.86258	0.00345	0.08333
430	0.01160	0.19980	0.87339	0.01013	0.17450
440	0.02300	0.32810	0.87927	0.02022	0.28849
450	0.03800	0.45500	0.88191	0.03351	0.40127
460	0.06000	0.56720	0.88449	0.05307	0.50169
470	0.09100	0.67560	0.88644	0.08067	0.59888
480	0.13900	0.79300	0.88830	0.12347	0.70442
490	0.20800	0.90430	0.88673	0.18444	0.80187
500	0.32300	0.98170	0.88690	0.28647	0.87067
510	0.50300	0.99660	0.89154	0.44844	0.88851
520	0.71000	0.93520	0.89110	0.63268	0.83336
530	0.86200	0.81100	0.88666	0.76430	0.71908
540	0.95400	0.64970	0.88772	0.84689	0.57675
550	0.99500	0.48080	0.88991	0.88546	0.42787
560	0.99500	0.32880	0.88619	0.88176	0.29138
570	0.95200	0.20760	0.89049	0.84775	0.18487
580	0.87000	0.12100	0.88132	0.76675	0.10664
590	0.75700	0.06550	0.88939	0.67327	0.05826
600	0.63100	0.03325	0.88914	0.56105	0.02956
610	0.50300	0.01593	0.89237	0.44886	0.01422
620	0.38100	0.00737	0.89093	0.33944	0.00657
630	0.26500	0.00334	0.89280	0.23659	0.00298
640	0.17500	0.00150	0.88936	0.15564	0.00133
650	0.10700	0.00068	0.90356	0.09668	0.00061
660	0.06100	0.00031	0.89687	0.05471	0.00028
670	0.03200	0.00015	0.91225	0.02919	0.00014
680	0.01700	0.00007	0.90045	0.01531	0.00006
690	0.00820	0.00004	0.90968	0.00746	0.00004
700	0.00410	0.00002	0.91164	0.00374	0.00002
710	0.00210	0.00000	0.90284	0.00190	0.00000
720	0.00100	0.00000	0.91709	0.00092	0.00000
730	0.00050	0.00000	0.91137	0.00046	0.00000
740	0.00030	0.00000	0.90570	0.00027	0.00000
750	0.00010	0.00000	0.92346	0.00009	0.00000
760	0.00010	0.00000	0.91446	0.00009	0.00000
TOTALS	10.686	9.707	32.905	9.496	8.603

$$T_{photopic} = \frac{\sum_{\lambda=380}^{760} T * V_{\lambda}}{\sum_{\lambda=380}^{760} V_{\lambda}} = \frac{9.496}{10.686} = 88.87 \qquad T_{scotopic} = \frac{\sum_{\lambda=380}^{760} T * V_{\lambda'}}{\sum_{\lambda=380}^{760} V_{\lambda'}} = \frac{8.603}{9.707} = 88.63$$

1/ V(λ) = the photopic relative luminous efficiency (CIE 1924 Standard)
2/ V(λ′) = the scotopic relative luminosity (CIE 1925 Standard)
3/ T = transmittance of the sample under test (here a Class 1 sample)
4/ T/photopic = Percent photopic transmittance
5/ T/scotopic = Percent scotopic transmittance

4.4.4 Optical density of class 3 test. The optical density of the class 3 visors shall be calculated by first determining the luminous transmittance in accordance with ASTM D 1003. The optical density shall be calculated by the formula:

$$\text{Optical Density} = \text{Log}\ \frac{1}{\text{Transmittance}}$$

4.4.5 Optical distortion of critical areas test. The optical distortion of the critical area of the visors shall be determined by inserting the visor with its surface normal to the line of sight into the apparatus described on figure 4. The degree of off-parallelism shall constitute the amount of distortion. The visor shall be compared with the plates on figure 2.

4.4.6 Haze test. The haze shall be determined in accordance with ASTM D 1003.

4.4.7 Ultraviolet transmittance test. The erythemal ultraviolet transmittance shall be measured by a spectrophotometer.

4.4.8 Neutrality of class 2 and 3 visors test. The spectral transmittance of the class 2 or 3 visor, as applicable, shall be measured by a spectrophotometer having a monochromator band width of 10 nm or less and a reproduction of plus or minus 1 percent. The neutrality shall be calculated by the Judd Daylight Duplication Method. Table IV shows an example for the calculation of spectral transmittance deviations.

TABLE IV. Example for calculation of spectral transmittance deviation. 1/ 2/ 3/ 4/ 5/

Wave length (nm)	T	Band N	Wave length range	Average Trans-mittance Tn	Percent deviation 100(1-Tn/Tc)	x Weight	= Product
430	0.114						
440	0.118						
450	0.127						
460	0.137	1	430-490	0.133	14.25	5	71.2
470	0.142						
480	0.144						
490	0.145	2	460-520	0.145	6.34	10	63.4
500	0.147						
510	0.149						
520	0.151	3	490-550	0.151	2.80	10	28.0
530	0.153						
540	0.154						

TABLE IV. Example for calculation of spectral transmittance deviation. (cont.) 1/ 2/ 3/ 4/ 5/

Wave length (nm)	T	Band N	Wave length range	Average Trans-mittance Tn	Percent deviation 100(1-Tn/Tc)	x Weight	= Product
550	0.155	4	520-580	0.155	0.22	10	2.2
560	0.157						
570	0.158						
580	0.159	5	550-610	0.159	2.31	10	23.1
590	0.160						
600	0.160						
610	0.160	6	580-640	0.160	3.39	10	33.9
620	0.161						
630	0.161						
640	0.160	7	610-670	0.160	3.12	10	31.2
650	0.159						
660	0.159						
670	0.158	8	640-700	0.158	1.67	5	8.3
680	0.157						
690	0.156						
700	0.153	9	670-730	0.153	1.18	1	1.2
710	0.151						
720	0.149						
730	0.148						
					Totals	71	262.5

Notes:

1/ Tc = Total visible transmittance of sample visor, which is 0.155.
2/ T = Transmittance at 10 nm intervals.
3/ Tn = Average transmittance of 60 nm band. The Tn for a given band is the average of the seven tabulated values within that band except that the first and last values are divided by 2 and the average computed by dividing the sum of the values by 6.
4/ Average percentage deviation of spectral transmittance within nine spectral bands. (Average deviation – 262.5/71 = (3.7%)
5/ This table is based on illuminant “C”.

4.4.9 Chromaticity of class 2 and 3 visors test. The chromaticity coordinates x and y shall be calculated from spectrophotometric data. Table V illustrates a sample calculation.

TABLE V. Sample computation table of coordinates 1/ 2/ 3/ 4/ 5/

Wavelength (nm)	$\bar{x}$	$\bar{y}$	$\bar{z}$	T	$\bar{x}T$	$\bar{y}T$	$\bar{z}T$
380	4		20	0.104	0	0	2
390	19		89	0.240	5	0	21
400	85	2	404	0.301	26	1	122
410	329	9	1,570	0.275	90	2	432
420	1,238	37	5,949	0.174	215	6	1,035
430	2,997	122	14,628	0.110	330	13	1,609
440	3,975	262	19,938	0.093	370	24	1,854

TABLE V. Sample computation table of coordinates (cont.) 1/ 2/ 3/ 4/ 5/

Wavelength (nm)	$\bar{x}$	$\bar{y}$	$\bar{z}$	T	$\bar{x}T$	$\bar{y}T$	$\bar{z}T$
450	3,915	443	20,638	0.092	360	41	1,899
460	3,362	694	19,299	0.100	336	69	1,930
470	2,272	1,058	14,972	0.110	250	116	1,647
480	1,112	1,618	9,461	0.122	136	197	1,154
490	363	2,358	5,274	0.132	48	311	696
500	52	3,401	2,864	0.140	7	476	401
510	89	4,833	1,520	0.142	13	686	216
520	576	6,462	712	0.142	82	918	101
530	1,523	7,934	388	0.141	215	1,119	55
540	2,785	9,149	195	0.141	393	1,290	27
550	4,282	9,832	86	0.155	664	1,524	13
560	5,880	9,841	39	0.170	1,000	1,673	7
570	7,322	9,147	20	0.167	1,223	1,528	3
580	8,417	7,992	16	0.153	1,288	1,223	2
590	8,984	6,627	10	0.142	1,276	941	1
600	8,949	5,316	7	0.136	1,217	723	1
610	8,325	4,176	2	0.136	1,312	568	0
620	7,070	3,153	2	0.137	969	432	
630	5,309	2,190		0.137	727	300	
640	3,693	1,443		0.138	510	199	
650	2,349	886		0.150	352	133	
660	1,361	504		0.199	256	94	
670	708	259		0.270	191	70	
680	369	134		0.368	136	49	
690	171	62		0.475	81	29	
700	82	29		0.576	47	17	
710	39	14		0.620	24	9	
720	19	6		0.636	12	4	
730	8	3		0.643	5	2	
740	4	2		0.642	3	1	
750	2	1		0.632	1	1	
760	1	1		0.630	1	1	
770	1			0.600	1	0	
				Totals	13,992 (X)	14,790 (Y)	13,228 (Z)

NOTES:

1/ $X = \sum \bar{x}T$, $Y = \sum \bar{y}T$, $Z = \sum \bar{z}T$

2/ Spectral transmittance , Tc = Y/1,000 = 14.8 percent

3/ Chromaticity coordinates:

$x = X/(X + Y + Z) = 13{,}992/(13{,}992 + 14{,}790 + 13{,}228) = 0.3331$

$y = Y/(X + Y + Z) = 14{,}790/(13{,}992 + 14{,}790 + 13{,}228) = 0.3521$

4/ Spectral transmittance, Tc, and chromaticity coordinates, x and y, for standard illuminant “C”

5/ The symbol “T” represents the transmittance, the ratio of transmitted to homogeneous radiant flux.

4.4.10 Ballistic resistance test. Ballistic resistance testing shall be in accordance with either method 1 or method 2 cited in paragraph 4.4.10.1 or 4.4.10.2. Method shall be as determined by the military service and specified in the applicable contract or purchase order.

4.4.10.1 Ballistic resistance test method 1 (for Army visors). The ballistic test at the V_0 point shall be conducted in accordance with MIL-STD-662 using a 0.22 caliber, 17 $\pm$ 0.5 grain, T37 shaped projectile with the following exceptions: electronic velocity detection devices (light beam or acoustic type) may be used to determine the velocity of the projectile, such devices placed no less than 8 inches and no more than 24 inches from the target; compressed gas propulsion of the projectile may be used. The sample shall be mounted on an Alderson 50th percentile male headform in the as worn position. The 0.002 inch thick aluminum foil witness sheet shall be mounted within 2 inches behind the area of impact. Three valid impacts shall be made on the lens; one in the center and one in each vision area. The sample shall be considered a failure if the aluminum foil witness sheet is punctured or if the sample is cracked. An impact shall be considered valid only if it meets any of the following:

a. The impact velocity of the projectile is between 550 feet per second and 560 feet per second.
b. The impact velocity of the projectile is less than 550 feet per second and the impact fails to meet the requirements in 3.5.10.
c. The impact velocity of the projectile is more than 560 feet per second and the impact meets the requirements in 3.5.10.

4.4.10.2 Ballistic resistance test method 2 (for Air Force and Navy visors). The impact test shall be conducted in accordance with MIL-STD-662 and using a caliber .22 T37 fragment simulating projectile. The visor shall be rigidly mounted with the area to be impacted normal to the line of fire. An aluminum foil witness sheet, 2 mils thick, shall be mounted 2 inches behind the area of impact. Three valid impacts shall be made on the visor; one in the center and one in each vision area. An impact shall be considered valid only if it meets any of the following:

a. The impact velocity of the projectile is between 550 feet per second and 560 feet per second.
b. The impact velocity of the projectile is less than 550 feet per second and the impact fails to meet the requirements in 3.5.10.
c. The impact velocity of the projectile is more than 560 feet per second and the impact meets the requirements in 3.5.10.

The visor containing the three valid impacts and the witness sheet shall be examined for conformance to the requirements in 3.5.10. Any penetration on the witness sheet shall be considered evidence of spall.

4.4.11 Abrasion resistance coating test. Before and after the abrasion tests, haze and luminous transmittance of the coated specimens and visors shall be calculated as specified in ASTM D 1003. The abrasion test, as specified in ASTM D 1044, using an abrasion of 500 cycles with a 500 gram load, shall be performed on flat panels which are coated by the same process as the visors. Additionally, visors shall be tested using the eraser test. The eraser test shall be performed by rubbing with a specially standardized eraser mounted as illustrated on figure 5 and held approximately normal to the visor. The device and eraser material indicated on figure 5 shall be used for this test. The areas of the visor where the eraser test is to be performed shall be identified and shall include at least three areas in the critical area of vision. The eraser shall be rubbed across the surface of the coated visor from one point to another, over the same path, for 20 complete cycles (motion of the eraser up and back is one cycle) with a force of 2.0 to 2.5 pounds continuously applied. Wherever possible, rubs of about 1 inch length are preferred. After the rubbing has been completed, the lens shall be thoroughly cleaned to remove dirt, film, finger marks and grease marks using a mild detergent and water followed by drying with a soft cloth or lens tissue. The visor shall meet the requirements in 3.5.11.

4.4.12 Bayer abrasion resistance. The visor / or 6 curve lenses shall be tested using the oscillating sand method. The abrasion test will be performed in accordance with ASTM F 735 using 500 grams Alundum® Norton ZF #12 (Saint-Cobain) for 600 cycles. A CR-39 reference lens or equivalent of same diopter will be tested in parallel to the coated specimen. The resulting ratio will be the change in haze, tested using ASTM D 1003, of the reference specimen divided by the change in haze of the coated specimen.

4.4.13 Coating adhesion. The tape test adhesion shall be performed using ASTM D 3359. The coated visor shall be subject to a crosshatch (cross hatch cutter with a 1.0 mm spacing) and then subject to 3 consecutive tape pulls. A tape having an adhesion to steel of 45-55 oz per inch shall be applied to the cross hatched area and firmly pressed down. Tape shall be cut to a length of approximately three inches long and firmly applied to the visor. To ensure good contact with the visor, rub the tape firmly with an eraser. Within 90 $\pm$ 30 seconds of application, remove the tape by seizing the free end and rapidly (not jerked) back upon itself at as close to an angle of 180° as possible. This adhesion test shall be repeated after the visor is subjected to the humidity test, as specified in MIL-STD-810, Method 507, Procedure III, for 120 hours (5 cycles).

4.4.14 Weathering resistance. Visors shall be exposed in a weatherometer in accordance with MIL-STD-810, method 505.3, procedure II. For visors which contain external coatings, the coating adhesion test shall be performed after weather resistance tests have been completed.

4.4.15 Chemical resistance. The visors shall be exposed to the following chemicals:

a. Insect repellent, controlled release (DEET)
b. JP4 aircraft turbine fuel
c. JP8 aircraft turbine fuel, kerosene type
d. Aircraft lube oil, turbine engine, synthetic base
e. Aircraft hydraulic fluid, fire-resistant, synthetic base
f. Degreasing solvent, type I (mineral spirits)
g. Cleaning compound, turbine engine gas path, 20 % solution

The chemical exposure will be tested for a 10 hour period at ambient room temperature conditions. The chemicals shall be contained by sealing an o-ring (0.5 inch or 0.75 inch diameter) to either the concave or convex surface of the visor. At the end of the test, the surface shall be thoroughly cleaned using a mild detergent and water followed by drying with a soft cloth or lens tissue. The visor shall then be visually inspected for visible damage and shall pass the requirements of 3.5.3 and 3.5.6 ensuring the same areas that were exposed to the chemicals are tested for these requirements. The haze and transmittance shall be measured before and after the exposure to the chemicals. Each visor shall have two (2) locations tested for each chemical type (i.e. left and right side of the visor).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service’s system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The class 1, class 2, and class 3 visors are intended to be used on flight helmets used by aircrew personnel.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.
b. Class of visor required (see 1.2)
c. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3)
d. When first article is required (see 3.1)
e. When abrasion resistant coating is required (see 3.5.11)
f. Packaging requirements (see 5.1).

6.3 First article. When a first article is required, it will be inspected and approved under the appropriate provisions of FAR 52.209. The first article should be a preproduction sample. The contracting officer should specify the appropriate type of first article and the number of units to be furnished. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Coatings. All requirements for abrasion resisting coatings applied to polycarbonate visors are included in this document.

6.5 Luminous transmittance. For the purpose of this specification, luminous transmittance is defined as the ratio of the luminous flux transmitted by the visor to the luminous flux incident on the visor. It is measured with a sensor corrected to compare with the photopic sensitivity of the human eye without regard to specific wavelengths. ASTM D 1003 or a specified modification thereof is a way of determining luminous transmittance. A CIE C source (average daylight) is used to make the luminous transmittance measurements.

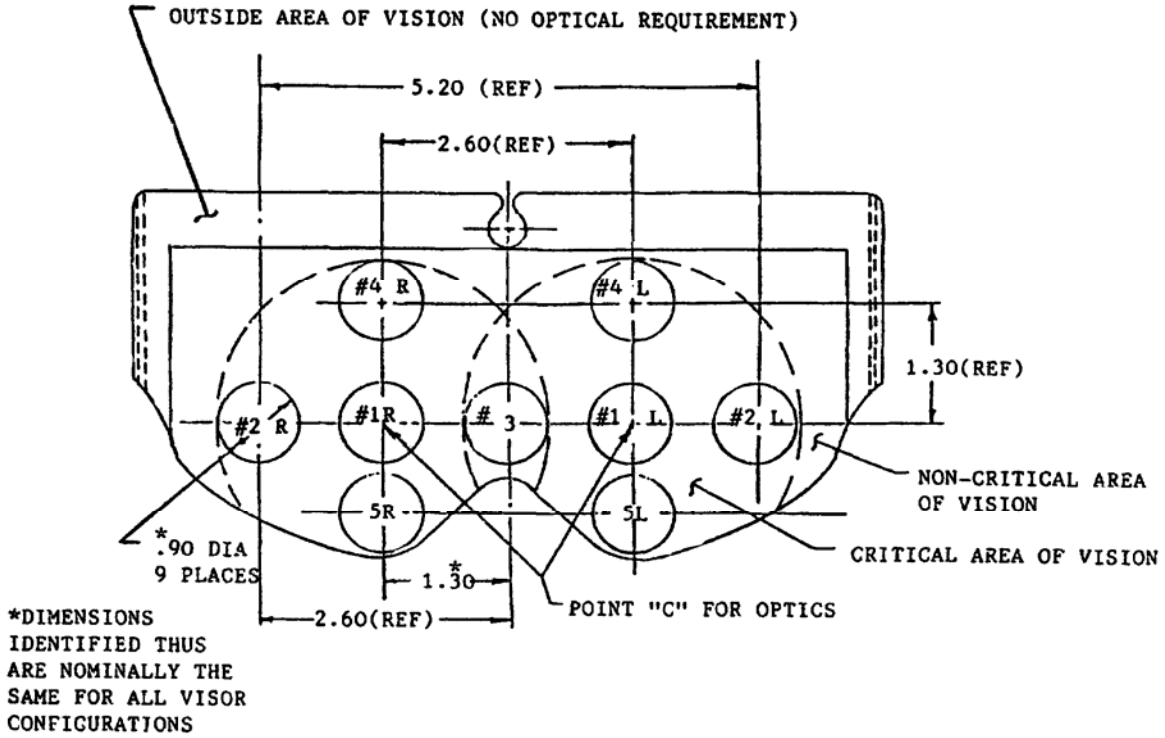
6.6 Spectral transmittance. For the purpose of this specification, spectral transmittance is defined as radiant transmittance evaluated for a specific range of wavelengths of incident energy. It is desirable that it be measured with an automatic recording spectrophotometer of the required range of sensitivity and evaluated according to the applicable instructions.

6.7 Suggested source of supply. Navy has determined that Gentex Corporation is an acceptable source for visors meeting the requirements stated in this document.

6.8 Subject term (key word) listing

Aircrew personnel
Armor
Eye protection
Flight
Shield

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



CRITICAL AREAS ARE LOCATED WITHIN THE DOTTED SEGMENTS, NONCRITICAL AREAS ARE LOCATED OUTSIDE DOTTED SEGMENTS. NUMBERED CIRCLES WITHIN THE CRITICAL AREAS ARE DESIGNATED AS POINTS OF CHOICE FOR PRISMATIC AND DISTORTION TESTS. POINTS BEARING THE SAME NUMBER, FOR EXAMPLE 5R AND 5L, SHOULD BE COMPARED WITH EACH OTHER, EXCEPT THAT POINTS NO. 2R AND 2L SHOULD BE COMPARED WITH POINT NO. 3 WHEN MEASURING REFRACTIVE POWER OR PRISMATIC DEVIATIONS. THIS FIGURE COVERS ONE SPECIFIC VISOR AND IS INTENDED TO SERVE ONLY AS A GUIDE SINCE VISOR CONFIGURATIONS DIFFER AMONG DIFFERENT HELMETS. CRITICAL AREA SUBTENDS APPROXIMATELY A 50 DEGREE FIELD OF VIEW RADIUS MEASURED ALONG THE PRIMARY LINE OF SIGHT OF THE DESIGNED RIGHT AND LEFT EYE LOCATIONS.

FIGURE 1. Typical visor configuration.

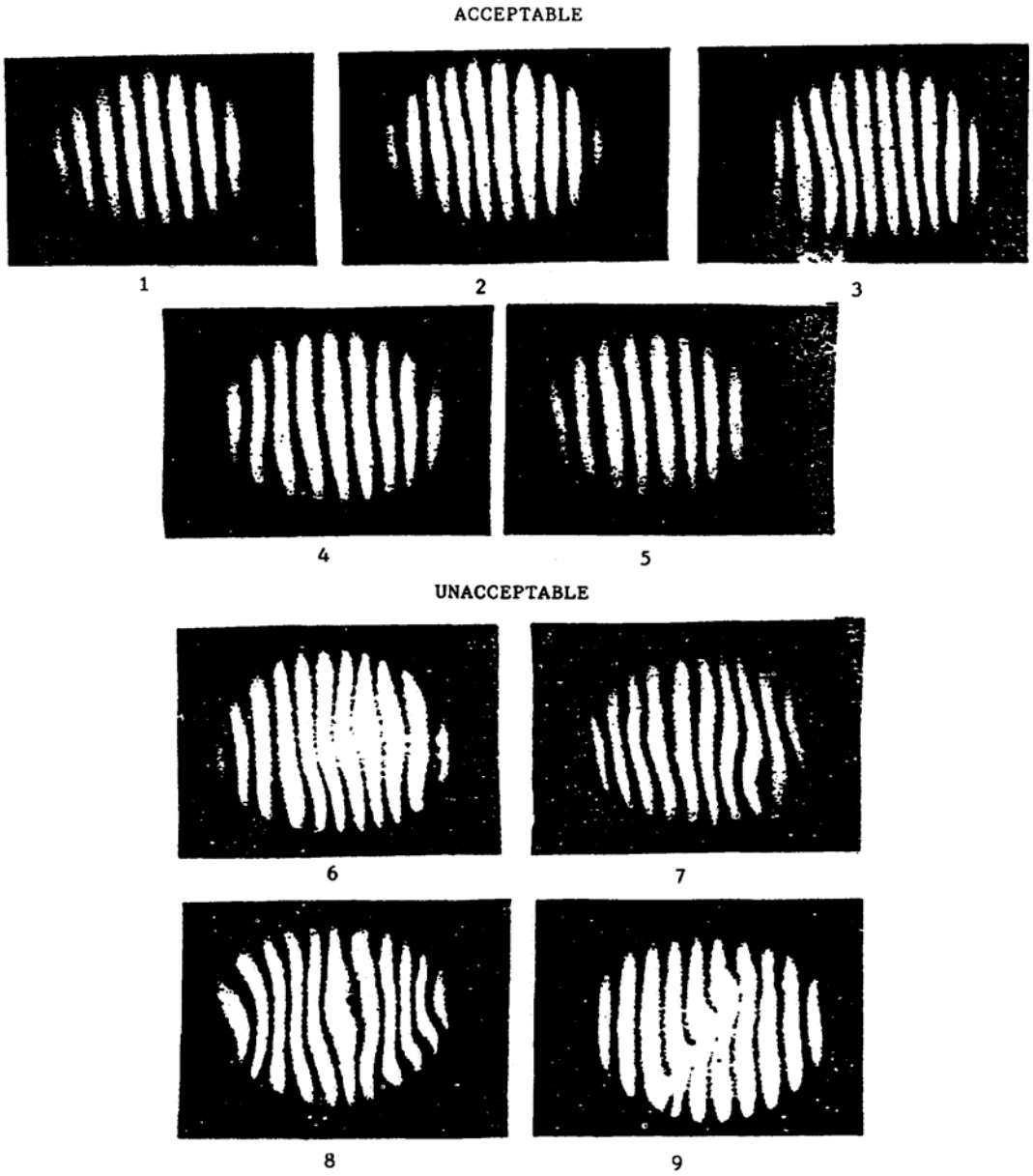


FIGURE 2. Visors optical distortion standards.

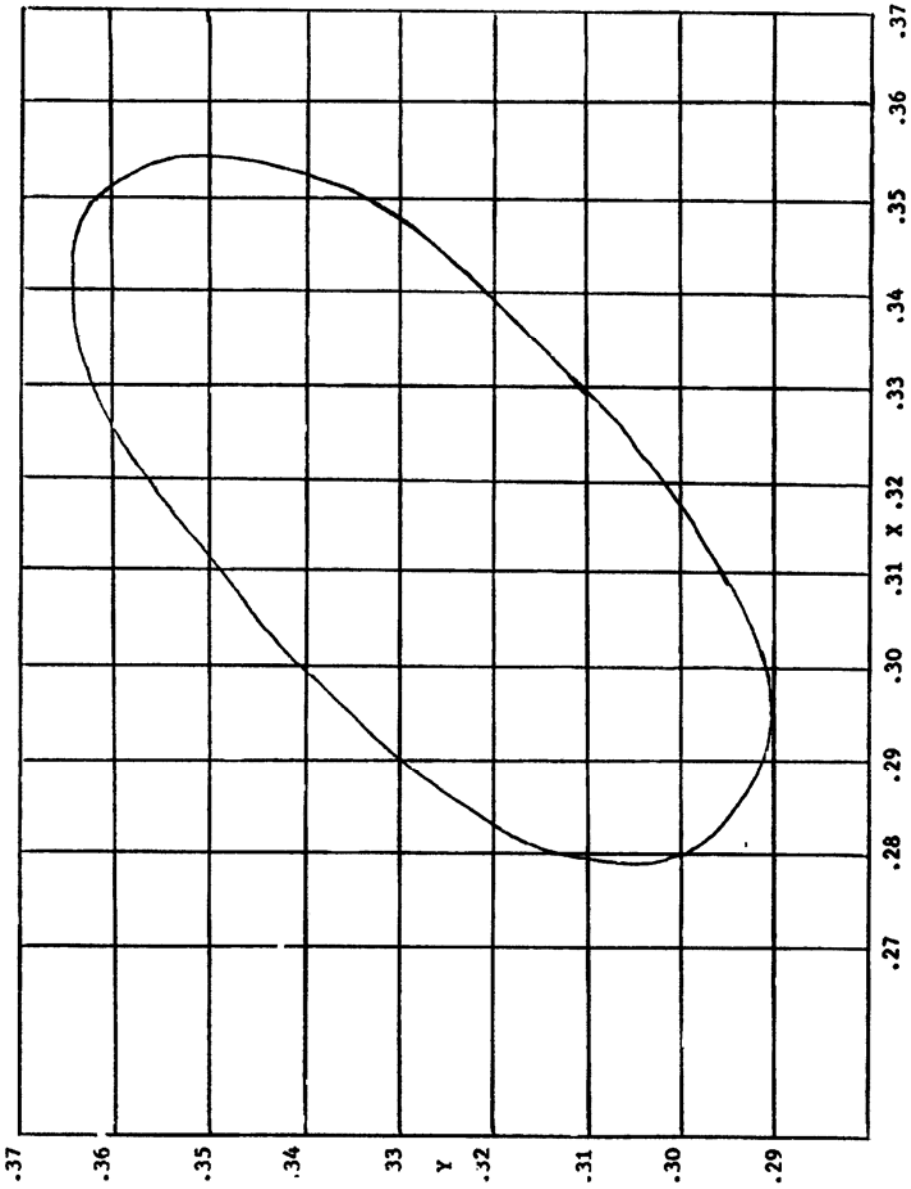
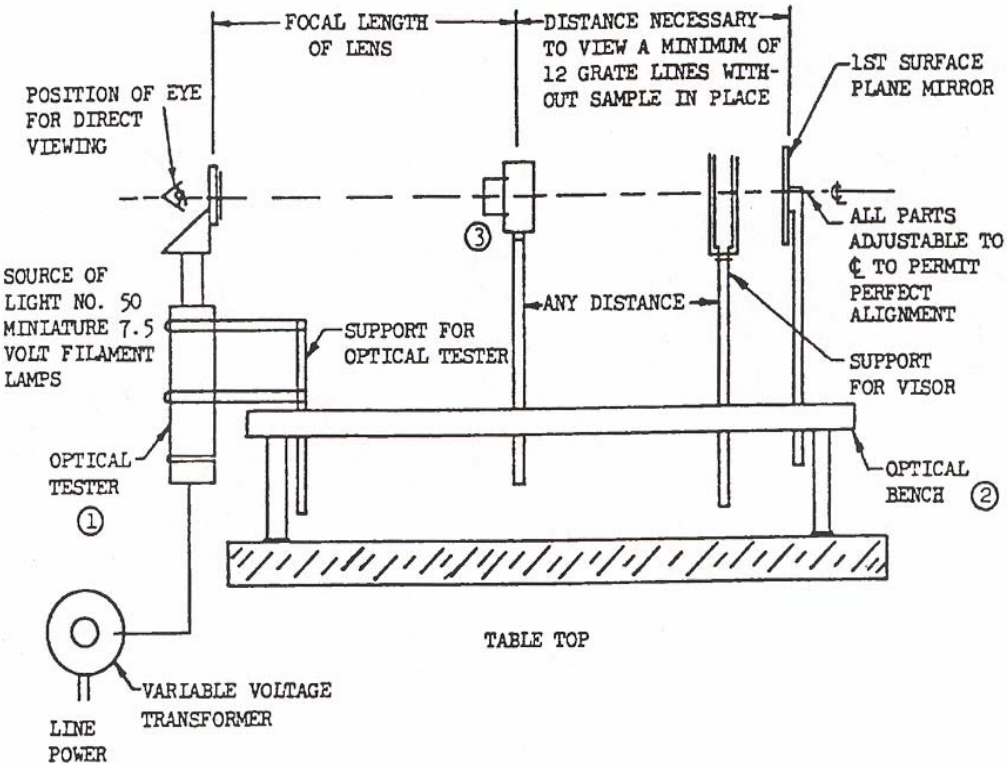


FIGURE 3. Chromaticity coordinates.



1 MODEL "B" OR EQUIVALENT OPTICAL TESTER WITH A 50 to 60-LINE GRATING, WITH OPTICAL BENCH ADAPTER OR EQUIVALENT.

2 THE COMPLETE TEST ASSEMBLY, OR COMPONENTS, DEPICTED IN THIS FIGURE MAY BE OBTAINED AS THE MODEL E DISTORTION TESTER FROM DATA OPTICS INC., 115 HOLMES ROAD, YPSILANTI, MICHIGAN 48198-3020, PHONE 800-321-9026 OR 734-483-8288.

FIGURE 4. Distortion tester.

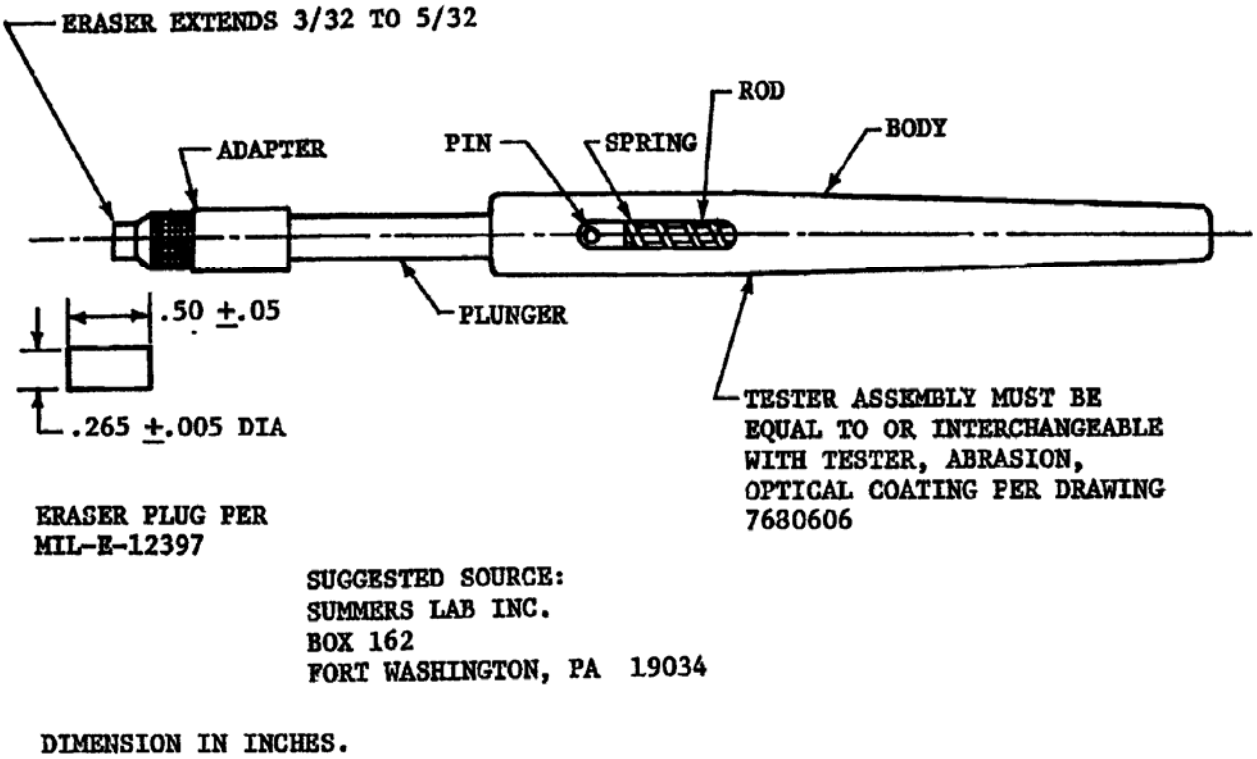


FIGURE 5. Eraser abrasion tester assembly and eraser plug.

Custodians:
Army - GL
Air Force – 11
Navy - AS

Review activities:
Army – MD, AV
Navy - NU

Preparing activity:
DLA - CT
(Project 8415-0183)

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