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Report Title

Laser Filter Unit

ABSTRACT

Matrix of Laser Filter Unit design activities.

	Title	Requirement	Verification	Testing	Specification	Responsibility
		<u>MIL-DTL-62422D</u>				
	Materials	3.2	4.4.2, 4.4.3	inspect contractor records		Design Team
	Glass	3.2.1	4.4.2	inspect contractor records		Design Team
	Construction	3.3		Drawing 12357797		Design Team
	Environmental weathering	3.4	4.5.2	1120 W/m ² and meet	No detonation or other pl	QC
	Optical Characteristics	3.5				
Filter Specifications	Optical Density (first article)	3.5.1	4.5.3.1	Laser Test	Table I	3rd party
	Optical density	3.5.1	4.5.3.2		Row A, Table I	
	Optical density scan	3.5.1	4.5.3.3		Row A, Table I	
	Ruby coating characterization	3.5.1.1	4.5.4	Laser Test	680-880 > 2 OD	3rd party
	Photopic transmission	3.5.2	4.5.5	Lambda 950 (III A)	> 65%	QC
				Lambda 950 (III A)	> 40% @ 50°	QC
	Chromaticity	3.5.3	4.5.6	Lambda 950	ASTM E308 CIE x,y chart	QC
	Resolution	3.5.4	4.5.7	Dioptometer, Resolvir	< 1 arcmin	Metrology Lab
	Filter coating durability	3.5.5	4.5.8	MIL-C-48497	No evidence of flaking, peeling, cracking, or blistering a	
	Surface quality	3.5.6				QC
	Substrate	3.5.6.1	4.5.9	MIL-PRF-13830	80-50	QC
Coating	3.5.6.2	4.5.9	MIL-PRF-13830	80-50	QC	
Laser damage resistance	3.5.7	4.5.10	Table V	no delamination or other	3rd party	
Temperature stability	3.5.8	4.5.11	-40±5 °F to +140±5 °F	Row A, Table I	QC	

and free of blemishes such as stains, smears, discolorations, streaks, and cloudiness.

Table I: Optical density (OD)

	Wavelength (nm)	OD with angle (0 to 80) +/-1.5 °	Unity device w/filter
A	694	3.4	3.5
B	1048-1068	3.4	3.5
C	1064	3.4	3.5

Table V: Laser damage test parameters

Wavelength (nm)	Energy density (mJ/cm2)	Repetition rate (Hz)
694	≥ 500	0.2+10%
1064	≥ 650	2.5+10%

*M1 Periscope Requirements

Periscope	Nomenclature	PLT
12357840	Commander's Side	29%
12357841	Commander's Front	24%
12357846	Driver's Side	33%
12357848	Driver's Front	33%

‡ Exposure to vapors of and in direct contact with the following materials

Diesel fuel grade 1
Diesel fuel grade 2
Aviation turbine fuels grade JP-4 (or JP-5)
Regular automotive leaded gasoline
Hydraulic fluid per MIL-PRF-6083 (or equivalent)
Hydraulic fluid per MIL-H-46170 (or equivalent)

TABLE I. Maximum Permissible Inclusions.

Periscope	Diameter in inches (mm)				
	0.04 (1)	0.03 (0.8)	0.02 (0.5)	0.01 (0.3)	0.005 (0.1)
M1 driver (all)	3	10	12	48	92
M1 commander (all)	3	10	12	48	92
15° uplook	3	10	12	48	92
20° uplook	3	10	12	48	92
12357918	3	10	12	48	92
12357792, 12357794	5	10	21	81	332
12357850, 12370033					

^

M1 short driver - 0.75 in. (19 mm)

M1 wide driver - 1.35 in. (34.3 mm)

M1 tall commander - 1.35 in.

M1 short commander - 0.75 in.

12357908, 12357909, 12357918 - 0.75 in.

12357792, 12357794, 12357850, 12370033, 12370322, 12370393 - 1.35 in.

TABLE II. Hot climatic temperature test
(<10% RH)

Time	°F (°C)
100	95 (35)
200	94 (34)
300	94
400	92 (33)
500	92
600	91 (33)
700	97 (36)
800	104 (40)
900	111 (44)
1000	124 (51)
1100	133 (56)
1200	145 (63)
1300	156 (69)
1400	158 (70)
1500	160 (70)
1600	158
1700	153 (68)
1800	145
1900	131 (55)
2000	118 (48)
2100	105 (41)
2200	103 (39)
2300	99 (37)
2400	95

Weathering Tests

- a. No less than 350 hours of simulated sunshine. Heat intensity shall be $160 \pm 5^\circ\text{F}$ ($71 \pm 2^\circ\text{C}$) at the geometric center of the periscope. The spectral energy distribution of simulated sunshine shall be in accordance with method 505.3 of MIL-STD-810.
- b. No less than 420 hours steady state hot-humid exposure at $110 \pm 10^\circ\text{F}$ ($43 \pm 6^\circ\text{C}$) relative humidity $70 \pm 10\%$.

- c. No less than 420 hours of cold exposure at $20 \pm 5^{\circ}\text{F}$ ($-7 \pm 4^{\circ}\text{C}$).
- d. Simulated sunshine shall include ultraviolet and be cycled in accordance with Method 505.3, Procedure 1 of MIL-STD-810 except the diurnal cycle hot-dry temperature shall have a peak temperature of $160 \pm 5^{\circ}\text{F}$ at the geometric center of the periscope. Heat intensity shall be controlled by adjustment of the light source to periscope distance and shall not be achieved by varying voltage to the source.
- e. Environmental conditions a and b shall be cycled so that conditions shall not exceed 10 hours duration, and condition c shall be maintained for minimum of 72 continuous hours.
- f. No test exposure shall be followed by a like exposure. For the duration of the test, the periscope shall be exposed to air, the test chamber, ozone and shall not be purged with any inert gas.

	Title	Requirement	Inspection	Testing	Specification	Responsibility
		<u>MIL-DTL-62420B</u>				
	Operational requirements	3.4	4.7			
	Optical characteristics:	3.4.1	4.7.1			
	Resolution	3.4.1.1	4.7.1.1	Dioptometer, Resolving chart, Holding fixture	≤ 1 arcmin	Metrology Lab
	Spherical power	3.4.1.2	4.7.1.2	Dioptometer, Resolving chart, Holding fixture	-0.5-+0.25 diopter	Metrology Lab
	Astigmatism	3.4.1.3	4.7.1.3	Dioptometer, Resolving chart, Holding fixture	< 0.25 diopter	Metrology Lab
	Photopic transmission	3.4.1.4	4.7.1.4	Lambda 950 (III A)	> 36% (M1*)	QC
	Optical density	3.4.1.5	4.7.1.5	as above		
	Angular deviation	3.4.1.6	4.7.1.6	Dioptometer, Resolving chart, Holding fixture	@normal < +1°	Metrology Lab
	Cleaning spray	3.4.2	4.7.2			
	Vehicle exterior	3.4.2.1	4.7.2.1	alkali steam solution & cold water rinse	Repeat Optical Characteristic Testing	
	Vehicle interior	3.4.2.2	4.7.2.2	jet spray of tap water	Repeat Optical Characteristic Testing	
	Chemicals	3.4.3	4.7.3	48 hr exposure _¥	Repeat Optical Characteristic Testing	
	Interface requirements	3.5	4.8	-----	-----	-----
	Support and ownership requirement	3.6	4.9			
System Requirements	Bubbles and inclusions	3.6.1	4.9.1	Inspection	< 0.040" (Table I)	QC
	Lint	3.6.2	4.9.2	Inspection	< 0.25" (clear aperture), < 0.125" [^]	QC
	Cleanliness	3.6.3	4.9.3	Inspection		QC
	Identification marking	3.6.4	4.9.4		MIL-STD-130 (Reinspect after environmental testing)	
	Safety Inspection	3.6.5	4.9.5	Inspection	Inspect periscopes for hazardous burrs, nicks, sharp edges, foreign materials, or other imper	
	Operating environment requirements	3.7	4.1	Repeat 3.4.1.1, 3.4.1.4, 3.4.1.5, 3.4.1.6 (no indication of moisture buildup, bond separation, or other forms of image degradation)		
	Temperature:	3.7.1	4.10.1			
	Low temperature	3.7.1.1	4.10.1.1	24 hrs at -65°F (MIL-STD-810, method 502.3, procedure I)		
	High temperature	3.7.1.2	4.10.1.2	3 - 24 hr cycles	TABLE II	
	Mirror and window laminations	3.7.1.3	4.10.1.3	No evidence of bond failure after exposure to 3.7.1.1 and 3.7.1.2		
Humidity	3.7.2	4.10.2	2 - 24hr cycles 50% RH			
Salt fog	3.7.3	4.10.3	Salt fog test Method 509.3 (MIL-STD-810)			
Vibration	3.7.4	4.10.4	3 hrs at 140°F			
Shock	3.7.5	4.10.5				
Basic shock	3.7.5.1	4.10.5.1			3rd party	
Gunfire shock	3.7.5.2	4.10.5.2			3rd party	

Submergence	3.7.6	4.10.6	No water leakage	Depth of 3 +0.75/-0 " for 5 minutes	
Fungus	3.7.7	4.10.7	MIL-STD-810, Method 508.4		3rd party
Weathering	3.7.8 - 3.7.8.3	4.10.8	Pass 3.4.1.5, 3.7.1.3	Weathering Test Table	
Resolution (Modified)	3.7.8.1			< 75 arcsec	
Spherical power (modified)	3.7.8.2			-0.60 to +0.30 diopter	
Astigmatism and light transmission (mo	3.7.8.3			degraded < 20% of the value prior to weathering tests	

fections that pose physical danger to an installer/operator.

Notes	Testing	Specification	Responsibility
Dimensions & Tolerancing	ANSI Y14 5M-1982	<u>DWG 12357796</u>	Molding
Material Type	MIL-P-46144C	Plastic Polycarbonate Sheet, Type II, Class I	Molding
Window Element	MIL-O-13830		
Parallel	Dioptometer, Resolving chart	30 arc minutes	Metrology Lab
Remove sharp edges			Molding
Clear aperature 0.12 from all edges			
Abrasion Resistant Coating	MIL-C-83409, 3.3.2 and 3.6		Coating
Luminous Transmittance	ASTM D1003	> 84%	QC
Haze	ASTM D1003	< 3%	QC

Title	Requirement	Testing	Specification	Responsibility
101 Optical Density	MIL-F-62422	para 3.5.1		QC
201 0.040" + 0.020/-0.040"		Length Gage		Molding
202 Parallel	MIL-O-13830	para 4.2.8	< 15 arc minutes	Metrology Lab
203 Surface Quality	MIL-F-62422	para 4.2.2	80-50	QC
301 ABC Dimensions	2 places = +.00/-.04", 3 places = ±.010"	Length Gage		Molding

QAP 12357797

Part No.	Dimension A (in)	Dimension B (in)	Dimension C (in)
12357797-1	7.62	2.65	0.125
12357797-2	6.65	2.62	0.125
12357797-3	7.80	2.42	0.125
12357797-4	7.80	4.98	0.125
12357797-5	6.50	2.12	0.125
12357797-6	0.50	2.62	0.125
12357797-7	7.62	2.65	0.125
12357797-8	4.62	2.69	0.125
12357797-9	7.62	2.65	0.125
12357797-10	8.69	3.00	0.125
12357797-11	7.62	2.65	0.125
12357797-12	7.04	2.63	0.125

Design Phase	Verification		Validation	
	insp/testing	Reference/Procedure	insp/testing	Reference/Procedure
Filter Design	Materials - MIL-DTL-62422D - 3.2	inspect records	---	---
Filter Design	Glass - MIL-DTL-62422D - 3.2.1	inspect records	---	---
Filter Design	Construction - MIL-DTL-62422D - 3.3	Drawing 12357797	---	---
Filter Testing	Environmental weathering - MIL-DTL-62422D - 3.4	UV Chamber Weathering	---	---
Filter Testing	Optical Characteristics - MIL-DTL-62422D - 3.5		---	---
Filter Testing	Optical Density (first article) - MIL-DTL-62422D - 3.5.1		---	---
Filter Testing	Optical density - MIL-DTL-62422D - 3.5.1		---	---
Filter Testing	Optical density scan - MIL-DTL-62422D - 3.5.1		---	---
Filter Testing	Ruby coating characterization - MIL-DTL-62422D - 3.5.1.1		---	---
Filter Testing	Photopic transmission - MIL-DTL-62422D - 3.5.2	Spectrophotometer	---	---
Filter Testing	Chromaticity - MIL-DTL-62422D - 3.5.3	Spectrophotometer	---	---
Filter Testing	Resolution - MIL-DTL-62422D - 3.5.4	PD732300000	---	---
Filter Testing	Filter coating durability - MIL-DTL-62422D - 3.5.5	MIL-C-48497	---	---
Filter Testing	Surface quality - MIL-DTL-62422D - 3.5.6		---	---
Filter Testing	Substrate - MIL-DTL-62422D - 3.5.6.1	MIL-PRF-13830	---	---
Filter Testing	Coating - MIL-DTL-62422D - 3.5.6.2	MIL-PRF-13830	---	---
Filter Testing	Laser damage resistance - MIL-DTL-62422D - 3.5.7		---	---
Filter Testing	Temperature stability - MIL-DTL-62422D - 3.5.8		---	---
System Design	Interface requirements - MIL-DTL-62420B - 3.5	MIL-DTL-62420B	---	---
System Design	Mirror and window laminations - MIL-DTL-62420B - 3.7.1.3	MIL-DTL-62420B	---	---
System Optical Testing	---	---	Resolution - MIL-DTL-62420B - 3.4.1.1	PD732300000
System Optical Testing	---	---	Spherical power - MIL-DTL-62420B - 3.4.1.2	PD732300000
System Optical Testing	---	---	Astigmatism - MIL-DTL-62420B - 3.4.1.3	
System Optical Testing	---	---	Photopic transmission - MIL-DTL-62420B - 3.4.1.4	Spectrophotometer
System Optical Testing	---	---	Optical density - MIL-DTL-62420B - 3.4.1.5	Spectrophotometer
System Optical Testing	---	---	Angular deviation - MIL-DTL-62420B - 3.4.1.6	
System Testing	---	---	Cleaning spray: Exterior - MIL-DTL-62422D - 3.4.2.1	MIL-DTL-62420B
System Testing	---	---	Cleaning spray: Interior - MIL-DTL-62422D - 3.4.2.2	MIL-DTL-62420B
System Testing	---	---	Chemicals - MIL-DTL-62422D - 3.4.3	MIL-DTL-62420B
System Testing	---	---	Bubbles and inclusions - MIL-DTL-62420B - 3.6.1	MIL-DTL-62420B
System Testing	---	---	Lint - MIL-DTL-62420B - 3.6.2	MIL-DTL-62420B
System Testing	---	---	Cleanliness - MIL-DTL-62420B - 3.6.3	MIL-DTL-62420B
System Testing	---	---	Identification marking - MIL-DTL-62420B - 3.6.4	MIL-DTL-62420B
System Testing	---	---	Safety Inspection - MIL-DTL-62420B - 3.6.5	MIL-DTL-62420B
System Testing	---	---	Low temperature - MIL-DTL-62420B - 3.7.1.1	MIL-STD-810, method 502.3, procedure I
System Testing	---	---	High temperature - MIL-DTL-62420B - 3.7.1.2	MIL-DTL-62420B
System Testing	---	---	Humidity - MIL-DTL-62420B - 3.7.2	MIL-DTL-62420B
System Testing	---	---	Salt fog - MIL-DTL-62420B - 3.7.3	Method 509.3 (MIL-STD-810)
System Testing	---	---	Vibration - MIL-DTL-62420B - 3.7.4	MIL-DTL-62420B
System Testing	---	---	Basic shock - MIL-DTL-62420B - 3.7.5.1	MIL-DTL-62420B
System Testing	---	---	Gunfire shock - MIL-DTL-62420B - 3.7.5.2	MIL-DTL-62420B
System Testing	---	---	Submergence - MIL-DTL-62420B - 3.7.6	MIL-DTL-62420B
System Testing	---	---	Fungus - MIL-DTL-62420B - 3.7.7	MIL-STD-810, Method 508.4

System Testing	---	---	Weathering - MIL-DTL-62420B - 3.7.8	Weathering Test Table
	Window Element - DWG 12357796-3	MIL-O-13830	---	---
	QAP 12357796 - DWG 12357796-10	QAP 12357796	---	---
PC Design	Dimensions & Tolerancing - DWG 12357796-1	MAT75103	---	---
PC Design	Material Type - DWG 12357796-2	MAT75103	---	---
PC Design	Clear aperature 0.12 from all edges - DWG 12357796-6	MAT75103	---	---
PC Design	Abrasion Resistant Coating - DWG 12357796-7	MIL-C-83409, 3.3.2 and 3.6	---	---
PC Testing	Parallel - DWG 12357796-4	PD732300000		
PC Testing	Luminous Transmittance - DWG 12357796-8	Spectrophotometer		
PC Testing	Haze - DWG 12357796-9	ASTM D1003		
PC Production	---	---	Remove sharp edges - DWG 12357796-5	MAT75103
Filter Testing	Optical Density - QAP 12357797 - 101	Spectrophotometer		
Filter Testing	Parallel - QAP 12357797 - 202	PD732300000		
Filter Testing	Surface Quality - QAP 12357797 - 203			
Production	---	---	0.040" + 0.020/-0.040" - QAP 12357797 - 201	MAT75103
Production	---	---	ABC Dimensions - QAP 12357797 - 301	MAT75103

Project Name: ARO - Unity Power Periscope

QC

Molding

Molding

Molding

Coating

Metrology Lab

QC

QC

Molding

QC

Metrology

QC

Molding

Molding

101 Laser Rejection Coatings	401 DWG 13010597
102 Absolute Optical Density	501 OD ≥ OD1 @ L1-L2 @ normal, @ 10o
103 Optical Density	501 OD ≥ OD2 @ L3 @ normal, @ 10o
104 Normal Incidence	501 OD ≥ OD3 @ L4-L7 @ normal and OD4 @
105 Photopic Transmission	501 PLT ≥ 35% (425-875nm)
106 Scotopic Transmission	501 SLT ≥ 30% (410-610nm)
107 Resistance to Laser Damage	502 No physical damage
108 Collimated Laser of Lambda 1	502 L1 or L2
109 Collimated Laser of Lambda 3	502 L3
110 Collimated Laser of Lambda 8 or 9	502 L8 or L9
111 Humidity	503 120o for 4 hrs @90-100% RH - no delam
112 Temperature	504 -40o - +160o for 2 hrs each - no delamin
201 Workmanship	Visual
202 Completeness of machining and finish	505

∅ L5-L6

ination, edge separation or feathering
ation, edge separation or feathering