INCH-POUND

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MILITARY SPECIFICATION

IMAGE INTENSIFIER ASSEMBLY 18 MM MICROCHANNEL WAFER MX-9916/UV

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

1. SCOPE

1.1 Scope. This specification covers the Image Intensifier Assembly, 18 Millimeter Microchannel Wafer, MX-9916/UV (see 6.1).

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 document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2.f).

SPECIFICATIONS

MILITARY

MIL-P-11268 - Parts, Materials, and Processes Used In Electronic Equipment

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving the document should be addressed to: HQ, USA Communications-Electronics Command, ATTN: AMSEL-ED-TM, Fort Monmouth, NJ 07703-5023 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A: FSC 5855

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

MIL-M-13231	-	Marking of Electronic Items
MIL-B-49030/6	-	Battery, Dry, Type BA-3058/U
MIL-P-49146	-	Power supply, 18 Millimeter Microchannel Wafer
MIL-B-49430/4	-	Battery, Primary, Lithium, Sulfur-Dioxide Type BA-5567/U

STANDARDS

MILITARY

MIL-STD-454	-	Standard General Requirements for Electronic Equipment
MIL-STD-461	-	Electromagnetic Interference Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	-	Electromagnetic Interference Characteristics, Measurements of
MIL-STD-781	-	Reliability Testing Engineering Development, Qualification, and Production
MIL-STD-810	-	Environmental Test Methods

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Bldg #4, Section D, Philadelphia, PA 19111-5094.)

2.1.2 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 are those cited in the solicitation(see 6.2.f).

DRAWINGS

SM-D-657310	-	Image Intensifier, Night Vision
SM-C-657375	-	Mount Assembly, Objective Lens
SM-C-804193	-	Night Vision Goggle Lens Assembly Eyepiece

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Description. The Image Intensifier Assembly, 18 Millimeter Microchannel Wafer, MX-9916/UV, hereinafter referred to as the assembly, shall have a minimum useful diameter photocathode (see 3.12.1) and phosphor screen diameter of no less than 17.5 millimeters (mm). The assembly shall employ an S-20 photocathode with extended red response. The assembly shall include the high voltage multiplier and oscillator and shall be encapsulated within a hard-surface insulating sleeve or boot and assembled into a metal housing. The assembly shall employ a microchannel electron multiplier plate with proximity focus on the input and output and shall contain a fiber optic input faceplate and fiber optics inverter as an integral part of the tube envelope.

3.2 Construction. The assembly shall be fabricated in conformance to SM-D-657310 and as specified herein.

3.2.1 Weight. The weight of the assembly shall be not greater than 126 grams.

3.3 Qualification. Unless otherwise specified by the contract or purchase order, assemblies furnished under this specification shall be products approved as qualified products (see 3.12.19 and 6.4).

3.3.1 Initial production testing (IPT). When specified in the contract or purchase order (see 6.2.b), the contractor shall furnish IPT units in accordance with 4.3.

3.4 Parts and Materials. Parts and materials shall be as specified herein and as shown on the applicable drawings. Material not specified shall be selected by the contractor, shall be subject to all provisions of this specification, and shall conform to MIL-P-11268. Nonstandard parts list are required for the power supply assembly, soldering material, wire, and noncorrosive potting materials.

3.4.1 Phosphor screen. The phosphor screen (see 3.12.2) shall be RCA F2126, type 10-52 or equivalent approved by the Government.

3.5 Components.

3.5.1 Power supply. The power supply shall be in conformance to MIL-P-49146. Power supply connections and voltage are shown in Figure 1.

3.5.2 Fiber optics inverter/faceplate.

3.5.2.1 Shear distortion. Shear distortion (see 3.12.3.1) shall not exceed 25 microns over the display area.

3.5.2.2 Gross distortion. Gross distortion (3.12.3.2) shall cause no point on the image of a straight line, through the axis, to be displaced more than ± 30 microns relative to the best-fit straight line (3.12.3.3). Displacement mesurements shall be rounded to nearest whole micron. The maximum slope of the straight line image shall be less than 15 microns per millimeter across the line image and less than 25 microns per any two millimeters across the best-fit straight line. Distortion shall be measured along 4 axes which are 45 degrees apart. Distortion measurements shall be initiated from an identifiable reference point located on the fiber optic inverter. The line image can not have more than two slope reversals. Slope reversals less than ± 5 microns shall not be considered as a change in slope.

3.5.2.3 Image inversion. The fiber optic inverter shall rotate a straight line image 180, ± 1 degree in a clockwise direction when viewed from the display side relative to the end points of the best-fit straight line (3.12.3.3). Image inversion measurements shall be rounded off to the nearest tenth of a degree.

3.5.2.4 Chicken wire. When the fiber optic inverter is viewed under 10-power magnification perpendicular to the plano surface with the output in contact with the phosphor faceplate, which is excited by ultraviolet light or with the output uniformly illuminated by a lambertian source the fiber optic inverter shall meet the chicken wire (see 3.12.4) limits specified in Table I.

NOTE: Those areas in question shall be inspected in such a manner that light is transmitted through the optic and areas in question can be observed and measured in accordance with 3.5.2.4 and Table I.

TABLE I. Fiber optic inspection.

Number of allowable incidences	(Length (inches) Minimum	Maximum
Chicken Wire (zone 1)		
0	0.090	or greater
2	0.041	0.089
6	0.020	0.040
Disregard those lengths which are 0.019 or less		
Chicken Wire (zone 2)		
0	0.250	or greater
5	0.125	0.249
Disregard those lengths which are 0.124 inch or less		
Zone 1 - 0.295 inch diameter circle in center of optic Zone 2 - 0.0295 to 0.710 inch annulus concentric with Zone 1.		

3.5.3 Power source. The power source for operating the assembly shall be a battery, BA-3058/U conforming to MIL-B-49030/6, or BA-5567/U conforming to MIL-B-49430/4.

3.6 Operational and environmental characteristics.

3.6.1 Photocathode sensitivity. Luminous sensitivity shall be no less than 260 microamperes per lumen for radiation with a color temperature of 2856 kelvin (K), ± 50 K. Radiant sensitivity shall be no less than .015 amperes per watt at 0.830, ± 0.001 micrometer.

3.6.2 Burn-in (ESS). The assembly shall undergo 50 continuous cycles. Each cycle shall consist of 55 minutes of operation and 5 minutes OFF time. Once during each operating cycle, the photocathode shall be illuminated with 5×10^{-4} footcandle (fc) for 5 seconds and with 5fc for 3 seconds. The remaining portion of the operating cycle shall be without photocathode illumination. The brightness gain setting shall not be changed during or subsequent to burn-in.

3.6.3 Vibration. The assembly with no operating voltage applied shall not be damaged (see 3.12.9) or suffer degradation of performance(see 3.12.22) after being subjected to simple harmonic motion parallel to and perpendicular to the optical axis over a frequency of 5 to 55 hertz (Hz) with an amplitude of not less than 0.10 inch total excursion for a period of 10 minutes in each plane.

3.6.4 Shock. The operating assembly with no radiation incident on the photocathode shall not be damaged (see 3.12.9) and there shall be no evidence of arcing, flashing, flickering, corona, bright spots, or other intermittent or continuous failure when subjected to 6 shock impacts parallel to the optical axis and 6 shock impacts perpendicular to the optical axis. Impacts shall be half sine wave with a minimum peak amplitude of 75 g's (see 3.12.5). and a duration of 6 milliseconds, ± 2 milliseconds measured at the 10 percent amplitude points.

3.6.5 Temperature (extreme). The assembly shall not be damaged (see 3.12.9) by storage, operation or the thermal shock temperature profile specified in Figure 2 and shall meet the following requirements at the temperature specified.

3.6.5.1 Temperature +45°C (+113°F).

a. Input current - not greater than 20 milliamperes.

b. Gain at 2×10^{-4} footcandle - not less than 3,000 and not greater than 15,000.

c. Gain at 2×10^{-4} footcandle - not less than 1,500 and not greater than 4,500.

d. Operational stability.

(1) The output brightness fluctuation shall not be greater than ± 10 percent from a steady state condition and drift shall not be greater than ± 15 percent from a steady state condition for a period of 2 minutes after an initial 2 seconds of operating time. All fluctuations shall be random after the initial 2 seconds.

(2) If random fluctuations greater than ± 10 percent but less than ± 15 percent occur in the original 2 minute time period, the test shall be continued an additional 2 minutes, during which the requirements of 3.6.5.1.d(1) shall be met.

(3) If the output brightness drift is greater than ± 15 percent during the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.5.1.d(1) shall be met.

e. Rise time (see 3.12.6) - shall be not greater than 7 seconds. Overshoot shall be less than 40 percent of steady state output brightness.

3.6.5.2 Temperature -51°C (-60°F).

a. Input current - not greater than 19 milliamperes.

b. Gain at 2 X 10-6 footcandle - not less than 7,500 and not greater than 30,000 (see 3.12.17).

c. Gain at 2 X 10^{-4} footcandle - not less than 1,500 and not greater than 7,500.

d. Operational stability.

(1) The output brightness fluctuation shall not be greater than ± 10 percent from a steady state condition and drift shall not be greater than ± 15 percent from a steady state condition for a period of 2 minutes after an initial 2 seconds of operating time. All fluctuations shall be random after the initial 2 seconds.

(2) If random fluctuations greater than ± 10 percent but less than ± 15 percent occur in the original 2 minute time period, the test shall be continued an additional 2 minutes, during which the requirements of 3.6.5.2.d(1) shall be met.

(3) If the output brightness drift is greater than ± 15 percent during the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.5.2.d(1) shall be met.

e. Rise time - shall be not greater than 10 seconds. Overshoot shall be less than 40 percent of steady state output brightness.

3.6.5.3 Room temperature, 23°C. After exposure of the assembly(s) to the profile of Figure 2, the room temperature (see 3.12.7) performance shall be as follows:

a. Gain at 2 X 10^{-6} footcandle - not less than 7,500 and not greater than 15,000.

b Gain at 2 X 10^{-4} footcandle - not less than 1,500 and not greater than 4,500.

c. Operational stability

(1) The output brightness fluctuation shall not be greater than ± 10 percent after a steady state condition and drift shall not be greater than ± 15 percent from a steady state condition for a period of 2 minutes after an initial 2 seconds of operating time. All fluctuations shall be random after the initial 2 seconds.

(2) If random fluctuations greater than ± 10 percent but not more than ± 15 percent occur in the original 2 minute time period, the test shall be continued an additional 2 minutes, during which the requirements of 3.6.5.3.c (1) shall be met.

(3) If the output brightness drift is greater than ± 15 percent during the original 2-minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.5.3.c(1) shall be met.

3.6.6 Equivalent background input (EBI). The equivalent background input at room temperature (see 3.12.7) shall not exceed 2.5 x 10^{-11} lumens per square centimeter.

3.6.7 Luminance gain. The assembly shall have a room temperature luminance gain and high light level saturation characteristics as specified in Table II and Figure 3. The input current at room temperature shall not exceed 16 milliamperes (mA) at the light level specified.

TABLE II. Saturation requirements for luminance gain.

Nominal input light level (fc)	Minimum allowable gain	Minimum allowable output (fl)	Maximum allowable gain	Maximum allowable output (fl)	Input current (mA)
2×10^{-6}	9,000	N/A	15,000	N/A	16
2×10^{-4}	1,500	N/A	4,500	N/A	16
1.0	N/A	0.3	N/A	0.9	N/A
20.0	N/A	0.3	N/A	0.9	N/A

3.6.8 Halo. The halo (see 3.12.8), produced by projecting a spot of light onto the input of the assembly shall be no greater than 1.37 millimeters (mm) in diameter.

3.6.9 Bright source protection. The assembly shall not be damaged (see 3.12.9) when subjected to an input illumination of no less than 50 millilumens concentrated on the photocathode within an area no greater than $1mm^2$ for a time interval not less than 1 minute. Additionally, the assembly shall have luminance gain saturation characteristics throughout the applied illumination period such that light output is no greater than 3 millilumens or no less than 0.37 millilumen. This requirement shall be met within 1 second after the input illumination is applied. There shall be no discernible damage after a non-operating period of not more than 24 hours, under the test conditions of 4.6.19.

3.6.10 Signal-to-noise ratio. The signal-to-noise ratio of the assembly shall be not less than 4.5.

3.6.11 Fixed pattern noise.

3.6.11.1 Multi-to-multi pattern variation (see 3.12.10). Multi-to-multi brightness deviations from mean value shall not exceed ± 10 percent.

3.6.11.2 Multi-boundary pattern noise (see 3.12.11). The average value of the brightness deviations of the multi-boundary intensities shall not deviate from the mean value of the adjacent multi intensities by more than ± 10 percent. The mean value shall be established from the three adjacent multies containing the above multi-boundaries.

3.6.12 Output brightness uniformity. When the photocathode is uniformly illuminated with light at a color temperature of 2856K, ± 50K, the output brightness uniformity shall be such that the ratio of the maximum to minimum brightness variation over the useful screen area shall not exceed 3:1. For input illumination of wavelength 0.830 ± 0.001 micrometers, the ratio shall not exceed 4:1. Under the same conditions, when the screen is viewed with a 10 power magnifier, the background shading shall be uniformly graded with no distinct lines of demarcation between the light and dark areas.

3.6.13 Image alignment. A test reticle projected on the photocathode of the assembly concentric with the optical axis shall produce an image on the screen of the assembly such that the center of the reticle's image shall fall within a ellipse of 0.012 inch major axis and 0.006 inch minor axis. The ellipse shall be concentric with the optical axis of the assembly and the major axis of the ellipse shall be horizontal when the alignment slot of the assembly is displaced 75, ± 0.5 degrees from the horizontal in a counterclockwise direction, when viewed from the screen end of the assembly.

3.6.14 Lens interface. The assembly shall show no evidence of intermittent operation, arcing, flashing, flickering, corona, or bright spots beyond that allowed in 3.6.19, and the input current of the operating assembly shall not increase when coupled with an objective lens mount assembly conforming to SM-C-657375.

3.6.15 Resolution.

3.6.15.1 Center resolution. The center resolution, referenced to the photocathode, shall be not less than 32 line pairs per millimeter (lp/mm). Disagreement concerning compliance shall be resolved by performing the Modulation Transfer Function Test in accordance with 3.6.17 and 4.6.17.

3.6.15.2 Peripheral resolution. The peripheral resolution, referenced to the photocathode, shall be no less than 32 lp/mm. This requirement shall be met at two points separated by 90 degrees spaced on a 14mm diameter circle concentric with the optical axis (see 3.12.15).

3.6.16 Peripheral illumination stability. There shall be no flashing, flickering, or other intermittent operation when the input fiber optics is illuminated outside the 19.5mm diameter with 20 footcandles for a period of 20 minutes. The input current deviation from the steady state value shall be not greater than ± 2.0mA.

3.6.17 Modulation transfer function (MTF). The minimum assembly MTF (see 3.12.12) shall be as follows:

a. 86 percent MTF at 2.5 lp/mm
b. 58 percent MTF at 7.5 lp/mm
c. 20 percent MTF at 15.0 lp/mm

3.6.18 Useful cathode diameter. The useful cathode diameter shall be not less than 17.5mm (see 3.12.20).

3.6.19 Photocathode, microchannel plate and screen quality. When the screen is viewed with a 10 power magnifier, with no light, then with 2 x 10^{-6} footcandle incident on the photocathode, there shall be no bright spots. There also shall be no discernible field emission (see 3.12.13) brighter or larger than the background scintillation (see 3.12.14) noise. When the screen is viewed with a 10 power magnifier and with the radiation level on the photocathode adjusted to obtain best spot contrast, the opaque or dark spots which exceed a contrast of 30 percent of their surrounding area shall not exceed the size and quantities specified in Table III. Size of non-circular

spots shall be determined on the basis of area equal to circular spots. When the distance between two spots is less than the maximum dimensions of either spot, the two spots shall be considered as one spot with a size equal to the sum of the maximum dimensions of the two spots plus the amount of separation between them. Graininess caused by grainy or "peppery" phosphor screen, channel-to-channel gain variations, or fiber-to-fiber transmission variatioon shall not be discernible over the useful diameter to the degree that it detracts from normal operation, when viewed with a 10 power magnifier and with the photocathode uniformly illuminated. Due to the subjectivity of these measurements, disagreement concerning compliance shall be resolved by performing a resolution test in the disputed area, measured at an input illumination of not greater than 1 X 10^{-4} footcandle incident to the photocathode. If the assembly passes the minimum resolution test in compliance with 3.6.15 and/or the visual requirements stated above, the assembly shall be accepted.

TABLE III. Assembly dark spots.

Size of spots	Number of spots within 0.22 in. diameter circle	Number of spots within annulus bounded by 2 circles, 0.22 & 0.58 in. diameter	Number of spots within annulus bounded by 2 circles 0.58 in diameter and total screen diameter
Greater than 0.015 in.	0	0	0
0.012 to and including 0.015	0	1	2
0.009 to and including 0.012	0	3	6
0.006 to and including 0.009	1	6	10
0.003 to and including 0.006	1	15	20

NOTE: The 0.22 and 0.58 inch circles on the image screen shall be concentric with the optical axis of the assembly.

3.6.20 Phosphor decay. With an input illumination of 1 to 5 x 10^{-5} footcandle, the decay due to the output phosphor screen response shall be within the limits specified in Figure 4 at 10 milliseconds, 100 milliseconds 500 milliseconds, and 1 second from the start of decay.

3.7 Reliability. The assembly shall have a mean time to failure of not less than 2000 hours when operated under the reliability test conditions specified herein.

3.8 Identification and marking. Each assembly shall be identified and serialized in accordance with MIL-M-13231. The markings shall include a coded acceptance date. The first two numbers shall be the last two digits of the year. The last two numbers of the code shall be two digits indicating the calendar week of the year (01 through 52). Reading from left to right or top to bottom, the code number shall indicate the year and week of acceptance in that order.

3.9 Humidity. The unprotected assembly pretest values for gain, and input current shall not change greater than ± 20 percent and the equivalent background input (EBI) shall not increase more than a factor of three and all parameters must remain in the specification limits when subjected to the Temperature/Humidity profile for MIL-STD-810, Method 507.1, Procedure II.

3.10 Workmanship. The assembly shall conform to MIL-STD-454, Requirement 9.

3.11 Electromagnetic interference (EMI). The assemblies manufactured under this procurement shall meet the same levels of EMI as those MX-9916/UV Image Intensifier tube assemblies employing government approved power supply assemblies and accepted by the U.S. Government.

The frequency to be tested under RE02 shall be 14KHz - 10GHz. The modified limitations during RE02 are as follows:

20.5 - 35.5KHz - 35dB
35.5 - 88.0KHz - 45dB
70.0 - 130.0KHz - 25dB
130.0 - 340KHz - 20dB

The radiated Susceptibility frequencies to be tested under RS03 are 10kHz to 40GHz.

3.12 Technical interpretations. The following technical interpretations are, when referenced in sections 3, 4, or 5, mandatory for this specification.

3.12.1 Photocathode. The photocathode fiber optic faceplate is herein referred to as the photocathode.

3.12.2 Phosphor. RCA F2126 (type No. 10-52) or equal phosphor shall exhibit the decay characteristics shown on Figure 4. The peak relative spectral response of the phosphor screen shall occur at a wavelength between 0.510 and 0.560 micrometers. The bandwidth shall be less than 0.200 micrometers measured at the 10 percent points of the spectral response curve. Additionally, the relative response at 0.650 micrometers shall be less than or equal to 10 percent.

3.12.3 Distortion. The two types of distortion that are important in imaging fiber optics are shear distortion and gross distortion.

3.12.3.1 Shear distortion. Shear distortion causes the image of a straight line to have a discrete, localized lateral displacement (break). Shear distortion is due to localized misalignment errors in the assembly of fibers or multifibers. Shear distortion in fiber bundles is sometimes referred to as incoherency.

3.12.3.2 Gross distortion. Gross distortion causes the image of a straight line to curve. Gross distortion is caused by a long-range deformation or flow of fibers during fabrication.

3.12.3.3 Best-fit straight line. A straight line intersecting the +8 and -8 millimeter points of the input straight line image. The +8 and -8 millimeter measurements are relative to the projected pattern center point.

3.12.4 Chicken wire. Chicken wire is defined as a predominant pattern of dead fibers which has a diameter equal to or less than 0.0009 inch (2 single fibers) and whose light transmission is so degraded that with light projected through the optic, single fibers in area of question can not be distinguished or identified as single fibers with the use of 50 power magnification.

3.12.5 "g". "g" is a unitless measure of the quantity of units of force associated with the earth gravity that a object is subjected to.

3.12.6 Rise time and decay time. The rise time is the time required for the assembly to achieve 50 percent of its steady state performance after the voltage source is applied to the assembly. The decay time is the time required for the assembly to achieve the screen brightness of less than 1×10^{-3} footlamberts after the voltage source is disconnected.

3.12.7 Room temperature. Room temperature shall be defined as +23°C, +10, -2°C for all tests except EBI, for which room temperature shall be defined as +23°C, ± 2°C.

3.12.8 Halo. A circular area of brightness evidenced on the assembly output imaging screen occurring as a result of a small bright source input and concentric with the input.

3.12.9 Damage. Damage is defined as:

a. Electrical failure or malfunctioning including arcing, corona, flashing, bright spots, flickering, blinking, or change in input current exceeding 1mA.

b. Cracks, breakage, deformation, corrosion, or deterioration of any part or finish, and missing or loose components.

c. Degradation of image quality including ion noise, dark spots, or shading.

3.12.10 Multi-multi pattern variation. Discernible spatial gain variation between individual multi-patterns or groups of multi-patterns.

3.12.11 Multi-boundary pattern noise. Discernible spatial gain variation between peripheral and interior channels of a multi-pattern or group channels.

3.12.12 Modulation transfer. Modulation transfer is a measure of the degradation of an image as it appears at the output screen of the assembly as correlated to the input pattern which is normalized to 100 percent contrast at a spatial frequency equal to or less than 0.2 lines per millimeter.

3.12.13 Field emission. Discernible field emission is voltage-dependent extraneous emission which appears as bright spots or a pattern that may flicker or appear intermittently on the image screen in one general area. Field emission is voltage-dependent and is best observed with a low intensity radiation incident on the photocathode.

3.12.14 Scintillations. Bright spots which occur on the image screen randomly in space and time.

3.12.15 Optical axis. The optical axis of the assembly is defined as the mean center line of that cylindrical portion of the assembly used to align the assembly in the system housing.

3.12.16 Limiting resolution. Limiting resolution is defined as the smallest resolution pattern which the observer can see and distinguish between the black lines and the clear area between the black lines. The observer shall be able to determine the number of line pairs in both the vertical and horizontal test patterns.

3.12.17 Environmental gain computations and formula.

a. G_{htji} - High temperature gain
b. G_{ltji} - Low temperature gain
c. B_{hji} - High temperature brightness output
d. B_{hoi} - High temperature background brightness output
e. B_{lji} - Low temperature brightness output
f. B_{loi} - Low temperature background brightness output
g. B_{rji} - Room temperature (chamber) brightness output
h. B_{roi} - Room temperature (chamber) background brightness output
i. Compute high temperature luminance gain (G_{htji}), where:

$$G_{htji} = \frac{B_{hji} - B_{hoi}}{B_{rji} - B_{roi}} \times \text{room temperature gain}$$

j. Compute low temperature luminance gain (G_{ltji}) where:

$$G_{ltji} = \frac{B_{lji} - B_{loi}}{B_{rji} - B_{roi}} \times \text{room temperature gain}$$

3.12.18 Overshoot. The amplitude of output brightness above a steady state condition at turn-on.

3.12.19 Qualified product. A product that has successfully met all the requirements of an IPT or First Article witnessed by the CECOM, Concurrent Engineering Directorate or its designated representative. Should the supplier make substantial changes in the process, personnel, location, or equipment used to produce a qualified product, or have not delivered the qualified product to the Federal Government within 12 months of contract award, an IPT shall be performed to the extent necessary to verify continued compliance to specification requirements for all characteristics of the product affected by the changes.

3.12.20 Useful area. The useful photocathode and phosphor screen area shall comprise a circle of diameter not less than 17.5 millimeters centered on the assembly optical axis.

3.12.21 Contrast. Contrast is defined as $\frac{B1 - B2}{B1 + B2}$

3.12.22 Degradation of performance. A significant change in measurable characteristics which results in failure of the assembly to meet specified requirements or indicates that there is an inherent defect in the operating characteristics of the unit.

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 specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own 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 ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet requirements of section 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Parts and material inspection. The contractor is responsible for ensuring that the parts and materials used are manufactured, examined, and tested in accordance with referenced specifications, standards, and as specified herein.

4.2 Classification of inspections. Inspections shall be classified as follows:

a. Initial production testing (IPT) (4.3)
b. Quality conformance inspection (4.5)
c. Inspection of packaging (4.11)

4.3 Initial production testing (IPT). Unless otherwise specified in the contract or purchase order (see 6.2.b), the initial production testing inspection shall be performed by the contractor. IPT samples shall be shipped to CECOM, Concurrent Engineering Directorate, ATTN: AMSEL-ED-IN, Fort Monmouth, NJ 07703 upon completion of all IPT testing.

4.3.1 Inspection. Each IPT assembly shall be inspected in accordance with Tables IV and V. Presence of one or more defects shall be cause for rejection of that assembly and may be cause for termination of IPT. The first 9 tests in Table V shall be run in the sequence specified.

TABLE IV. Inspection.

Defects	Requirement paragraph
Components and materials missing or not as specified	3.4, 3.5
Weight not as specified	3.2.1
Design not as specified	3.2
Chemical and physical properties not as specified	3.2
Dimensions not as specified	3.2
Color not as specified	3.2
Finish not as specified	3.2
Identification or special marking missing or illegible	3.8
Workmanship not as specified	3.10, 4.9

TABLE V. Initial production testing.

Inspection	Requirement paragraph	Test paragraph
Photocathode sensitivity	3.6.1	4.6.1
Burn-in (ESS)	3.6.2	4.6.2
EBI	3.6.6	4.6.6
Luminance gain	3.6.7	4.6.7
Photocathode, MCP, and screen quality	3.6.19	4.6.19
Resolution	3.6.15	4.6.15
Signal-to-noise ratio	3.6.10	4.6.10
Fixed pattern noise	3.6.11	4.6.11
Output brightness uniformity	3.6.12	4.6.12
Useful cathode diameter	3.6.18	4.6.18

TABLE V. Initial production testing - Continued.

Inspection	Requirement paragraph	Test paragraph
Halo	3.6.8	4.6.8
Modulation transfer function	3.6.17	4.6.17
Lens interface	3.6.14	4.6.14
Image alignment	3.6.13	4.6.13
Bright source protection	3.6.9	4.6.9
Peripheral illumination stability	3.6.16	4.6.16
Vibration	3.6.3	4.6.3
Shock	3.6.4	4.6.4
Temperature (extreme)	3.6.5	4.6.5
Humidity	3.9	4.8
EMI	3.11	4.10
Reliability	3.7	4.7
Phosphor decay	3.6.20	4.6.20

4.4 Inspection procedures. Tests shall be conducted in accordance with test procedures specified herein. Unless otherwise specified, the following conditions shall apply:

a. The color temperature of the radiation source shall fall within the following limits for the indicated tests:

Tolerance: 2856 ± 50K

Test paragraphs:

4.6.1	Photocathode sensitivity
4.6.6.1	Equivalent background input (EBI)
4.6.7	Luminance gain
4.6.10	Signal-to-noise ratio
4.6.12	Output brightness uniformity
4.7	Reliability

Tolerance: 2700K to 2900K

Test paragraphs:

4.6.2	Burn-in (ESS)
4.6.5	Temperature (extreme)
4.6.8	Halo
4.6.9	Bright source protection
4.6.11	Fixed pattern noise
4.6.13	Image alignment
4.6.15	Resolution
4.6.16	Peripheral illumination stability
4.6.17	Modulation transfer function

4.6.18 Useful cathode diameter
4.6.19 Photocathode, microchannel plate, and screen quality
4.6.20 Phosphor decay
4.10 Electromagnetic interference (EMI)

b. The photometer used for screen brightness measurements shall be a Pritchard Model 1980 PR or equal.

c. The photometer used for screen brightness measurements shall be calibrated against a standard source which has a tungsten filament lamp, opal glass or integrating sphere and filters as specified below:

(1) Tungsten filament lamp operated in connection with an opal glass or integrating sphere such that the color temperature of the radiation emitted from the opal glass or integrating sphere is 2856K, ± 50K.

(2) Opal glass or integrating sphere to produce a uniform, lambertian distribution.

(3) Corning Spectral Filters, Nos. 3-71 and 4-67, or equal at output of opal glass or integrating sphere.

(4) Output brightness to be 0.1 to 1.0 footlamberts uniformly distributed over an aperture of not less than 17 millimeters.

d. The amount of radiation from the source incident on the photocathode for each test shall be the amount specified in that test. Tolerances on specified radiation levels shall be ± 10 percent.

e. Meters used for monitoring lamp current and voltage shall have an accuracy of ± 0.25 percent.

f. Tests shall be performed at room temperature (see 3.12.7).

g. Neutral density filters used in test equipment shall have transmission characteristics within ± 10 percent of the nominal filter transmission from 0.35 to 1.0 micrometers.

h. All tests on the assembly shall be performed with the input voltage at not less than 2.7Vdc nor more than 3.0Vdc.

i. All tests shall be performed with the assembly housing grounded.

j. Tolerances on applied nominal input voltages shall be ± 0.05Vdc.

k. Test chambers used for environmental temperature tests shall maintain the temperature within ± 2°C (3.6°F) of the specified test temperature.

l. A Night Vision Goggle Lens Assembly Eyepiece (SM-C-804193) may be used in lieu of a 10X magnifier wherever such a magnifier is specified in this document.

4.5 Quality conformance inspection.

4.5.1 Group A inspection. Each assembly shall be inspected for conformance to the inspections specified in Table IV and Table VI.

4.5.1.1 Order of inspection within Group A. Group A inspection shall be performed in the order listed in Table VI. The signal-to-noise ratio testing referenced in Table VI shall be performed only on tubes that exhibit less than 275 microamperes per lumen referenced in the requirements of 3.6.1 and 4.6.1.

TABLE VI. Group A inspection.

Inspection	Requirement paragraph	Test paragraph
Photocathode sensitivity	3.6.1	4.6.1
Burn-in (ESS)	3.6.2	4.6.2
EBI	3.6.6	4.6.6
Luminance gain	3.6.7	4.6.7
Photocathode, MCP, and screen quality	3.6.19	4.6.19
Resolution	3.6.15	4.6.15
Signal-to-noise ratio	3.6.10	4.6.10

4.5.2 Group B inspection. Lots shall be established from assemblies which have passed Group A inspections. Lot size shall be determined by the contractor. Sampling plans shall be as specified in the contract or purchase order (see 6.2.e). Group B inspections shall be performed in accordance with Table VII and in any order.

TABLE VII. Group B inspection.

Inspection	Requirement paragraph	Test paragraph
Fixed pattern noise	3.6.11	4.6.11
Output brightness uniformity	3.6.12	4.6.12

4.5.3 Group C inspection. This inspection shall consist of the tests specified in Table VIII and shall be performed on units that have been subjected to and met Group A inspection. Sample units shall be selected in accordance with 4.5.3.1.

4.5.3.1 Sampling for Group C inspection. The sampling plans for Group C inspections shall be as specified in the contract or purchase order (see 6.2.e). Separate samples may be selected for subgroup testing.

4.5.3.2 Shock and vibration testing. Shock and vibration tests shall be conducted in succession in any order under the Group C inspection. A failure of the first of these two tests conducted shall be considered a failure of the attribute; a failure of the second of these two tests conducted shall be considered a failure of both attributes.

4.5.3.3 Temperature extreme testing. For the purpose of compliance with 4.5.3.4, a failure at a given point in the environmental (extreme) test cycle shall be considered a failure of the given measurement or inspection performed and the measurements and inspections yet to be performed in that test cycle. Measurements and inspections made before such failure shall be accepted. In retesting, the samples shall be cycled as shown in Figure 2 except that accepted measurements and inspections shall not be performed.

4.5.3.4 Group C failures. Actions required relative to Group C failures shall be as specified in the contract or purchase order (see 6.2.c).

4.5.3.5 Reinspection of conforming Group C samples. Unless otherwise specified, the samples which have been subjected to and passed Group C inspection shall be accepted on the contract provided all damages are repaired. Samples which were subjected to Humidity shall be baked at a minimum of 55°C and 400mm Hg maximum for a minimum of 24 hours.

TABLE VIII. Group C inspection.

Inspection	Requirement paragraph	Test paragraph
Subgroup I		
Modulation transfer function	3.6.17	4.6.17
Vibration	3.6.3	4.6.3
Shock	3.6.4	4.6.4
Temperature (extreme)	3.6.5	4.6.5
Bright source protection	3.6.9	4.6.9
Lens interface	3.6.14	4.6.14
Useful cathode diameter	3.6.18	4.6.18
Image alignment	3.6.13	4.6.13
Halo	3.6.8	4.6.8
Peripheral illumination stability	3.6.16	4.6.16
Subgroup II		
Humidity	3.9	4.8

4.5.4 Group D inspection. This inspection shall consist of the tests specified in Table IX. The phosphor decay inspection shall only be performed when a new source or type of phosphor is utilized. One unit shall be selected from the first 10 assemblies, representing the lot of phosphor, that have been subjected to and passed Group A inspection.

TABLE IX. Group D inspection.

Inspection	Requirement paragraph	Test paragraph
Phosphor decay Reliability	3.6.20 3.7	4.6.20 4.7

4.5.4.1 Sampling for Group D reliability inspection. Ten assemblies for IPT inspection shall be selected from the IPT units which have been subjected to and met the inspections in Table V. For subsequent quality conformance Group D inspection, 2 assemblies shall be selected at random from the first lot of each months' production from the assemblies which have passed Group A inspection. If the production quantity exceeds 200 assemblies in a given month, then an additional sample of two will be taken. Samples will be formed into groups of 4 for Group D testing. An additional sample of twenty (20) assemblies shall be randomly selected from the same lot that the Group D samples were selected from, identified as verification samples, and held until the Group D tests have been completed.

4.5.4.2 Group D reliability failure. Actions required relative to Group D failures shall be as specified in the contract or order (see 6.2.c).

4.5.4.3 Disposition of Group D reliability inspection assemblies. All Group D reliability samples shall be refurbished, pass Group A inspection and shipped as normal production.

4.6 Test methods.

4.6.1 Photocathode sensitivity. The photocathode current shall be measured on the tube element prior to assembly with the power supply and its housing. Corrections for leakage and dark current shall be made. The sensitivity shall be measured over a useful 16 millimeter diameter circle with 0.001 lumens of tungsten lamp radiation and with a maximum 200 volts dc on the photocathode. The photocurrent in microamperes corrected for leakage and dark current divided by the actual input lumens is the 2856K photocathode sensitivity. With the same dc voltage applied as above, insert a 0.83 micrometer filter between the photocathode and the 2856K tungsten source.

The 16 millimeter diameter area on the photocathode shall be illuminated with 0.83 micrometer radiation at a level between 1 X 10^{-6} to 1 X 10^{-4} watt. Measure total tube current and subtract the photocathode leakage and dark current. This photocurrent in microamperes divided by the actual input radiation in watts is the cathode radiant sensitivity at 0.83 micrometer, in microamperes per watt. The 0.83 micrometer filter shall have the following characteristics:

a. Far infrared blocking out to 4 micrometers and ultraviolet (UV) blocking out to 0.3 micrometer.
b. Peak placement wavelength of 0.8300, ± 0.0010 micrometer.
c. Bandwidth at the 10 percent points of 0.0125, ± 0.0015 micrometer.
d. Minimum peak transmission of 50 percent.

Failure to meet requirements of 3.6.1 shall constitute failure of this test.

4.6.2 Burn-in (ESS). Each assembly shall be operated as specified in 3.6.2 for 50 continuous cycles. The brightness gain setting shall not be changed during or subsequent to the burn-in test. Evidence of damage (see 3.12.9) shall constitute failure of this test.

4.6.3 Vibration. The operating potential shall not be applied to the assembly during vibration testing. Tolerance on specified frequencies shall be ± 2 Hz and tolerance on total excursion shall be ± 0.005 inch. Mount the assemblies rigidly, singly or in groups, with the photocathode end up. Subject the assembly to simple harmonic motion applied in a plane parallel to the optical axis of the tube assembly at a varying frequency of 5 to 55Hz. Vary the frequency from 5 to 55Hz and return to 5Hz in one minute. The amplitude of vibration shall be 0.05 inch (0.10 inch total excursion) in each plane. Repeat this frequency sweep 10 times. At the conclusion in the 10 frequency sweeps, apply the simple harmonic motion to the assembly in a plane perpendicular to the optical axis of the assembly and repeat the above 10 frequency sweeps. Failure to meet requirements of 3.6.3 shall constitute failure of this test.

4.6.4 Shock. This test is to be conducted in a darkened room with no light incident on the photocathode and the operating potential applied. Mount the assembly with the optical axis in a vertical plane and subject the assembly to 6 shock impacts with the direction of the force applied parallel to the optical axis. The image screen shall be observed with the unaided eye during the application of shock impacts for evidence of flashing, flickering, bright spots or electrical brakdown. If there is no evidence of flashing, flickering, bright spots or electrical breakdown during more than 2 shock impacts in this direction, continue the test by mounting the assembly with the optical axis in a horizontal plane. With the optical axis in a horizontal position, subject the assembly to 6 shock impacts with the direction of the force applied perpendicular to the optical axis and observe the image screen with the unaided eye for evidence of flashing, flickering, bright spots or electrical breakdown. There shall be no evidence of flashing, flickering, bright spots or electrical breakdown during more than 2 shock impacts. Apply

the shock impacts in such a way as to generate nominal half sine wave pulses having a minimum peak amplitude of 75 g's.The duration of each shock pulse shall be 6 milliseconds, ± 2 milliseconds, measured between the 10 percent values of peak amplitudes. The after oscillations shall be not greater than 15 percent of peak amplitudes of the nominal half sine wave pulse. Evidence of damage (see 3.12.9) or failure to meet the requirements of 3.6.4 shall constitute failure of this test.

4.6.5 Temperature (extreme). Place the assembly(s) in a test chamber at room temperature. Perform the room temperature tests specified in Table X. A minimum 22mm, ± 0.5mm diameter area of the photocathode shall be illuminated by the specified input illuminations. The test procedure for gain shall be the same as specified in 4.6.7. Remove the operating potential. Raise the temperature of the test chamber to +65°C (+149°F) and hold at this temperature for a minimum of 2 hours. At the end of the 2 hour stabilizing period, lower the test chamber temperature to +45°C (+113°F) and hold at this temperature for 1 hour. At the end of this period, subject the assembly(s) to the high temperature +45°C (+113°F) performance tests specified in Table X. Compute the low temperature luminance gain ($^{\circ}$ltji), with the gain to brightness relationships shown in 3.12.17. The assembly shall be off not less than 3 minutes prior to performance of the rise time test. The rise time shall be recorded on an X-Y recorder, or equivalent. The operational stability of the assembly shall be verified by viewing the output signal from the photometer with a device that will display the signal for the period required in paragraph 3.6.5.1.d. Adjust the vertical sensitivity to obtain a minimum of potential to the assembly and in no greater than 15 seconds illuminate the photocathode with the required step pulse of input illumination. The turn-on time of the input light pulse shall be less than 700 milliseconds from zero brightness to 100 percent brightness. After the +45°C (113°F) tests are completed, remove the operating potential. Raise the temperature of the test chamber to +65°C (+149°F) and remain at this temperature for not less than 30 minutes. Thermal shock the assembly(s) from +65°C (+149°F) to room temperature within 3 minutes or less. Lower the temperature of the test chamber to -51°C (-60°F) and hold at this temperature for a minimum of 1 hour. At the end of the 1 hour stabilizing period, subject the assembly(s) to the low temperature -51°C (-60°F) performance tests specified in Table X. The test procedures for rise time, gain, and operational stability shall be the same as those used at +45°C. At the conclusion of the -51°C (-60°F) tests, remove the operating potential. Lower the temperature of the test chamber to -57°C (-70°F) and remain at this temperature for not less than 2 hours. At the end of the 2 hour stabilizing period, thermal shock the assembly(s) from -57°C (-70°F) to room temperature within 3 minutes or less. Hold the assembly(s) at room temperature for a minimum of 1 hour. At the end of the 1 hour period, subject the assembly(s) to the room temperature tests specified in Table X. The test procedures for operational stability shall be the same as that used at +45°C, except that the light pulse for illuminating the photocathode shall be applied within 10 seconds after the operating potential has been applied to the assembly. Compute the high temperature luminance gain ($^{\circ}$htji), where the gain to brightness relationships are shown in 3.12.17. Failure to meet the requirements of 3.6.5 shall constitute failure of this test.

TABLE X. Environmental temperature (extreme).

Initial Production Testing

TEMP °C	INPUT LIGHT FC	GAIN			INPUT CURRENT			RISE TIME			OPER STABILITY		
		2.0 VDC	2.2 VDC	2.7-3.0 VDC	2.0 VDC	2.2 VDC	2.7-3.0 VDC	2.0 VDC	2.2 VDC	2.7-3.0 VDC	2.0 VDC	2.2 VDC	2.7-3.0 VDC
+23	2×10^{-6}			*			*(1)						
	2×10^{-4}			*							(1)		*(1)
	1										*(1)		*(1)
+45	2×10^{-6}		*	*		*	*		*	*			
	2×10^{-4}		*	*		*	*					*	*
	1											*	*
-51	2×10^{-6}	*		*	*		*	*		*			
	2×10^{-4}	*		*	*		*				*		*
	1										*		*

(1) On Completion of Temperature Profile Only.

TABLE X. Environmental temperature (extreme) - Continued.

Production Acceptance Testing

TEMP °C	INPUT LIGHT FC	GAIN 2.0 VDC	GAIN 2.2 VDC	GAIN 2.7-3.0 VDC	INPUT CURRENT 2.0 VDC	INPUT CURRENT 2.2 VDC	INPUT CURRENT 2.7-3.0 VDC	RISE TIME 2.0 VDC	RISE TIME 2.2 VDC	RISE TIME 2.7-3.0 VDC	OPER STABILITY 2.0 VDC	OPER STABILITY 2.2 VDC	OPER STABILITY 2.7-3.0 VDC
+23	2×10^{-6}			*			*						
	2×10^{-4}			*									
	1										(1)		
+45	2×10^{-6}		*	*		*			*		*(1)		
	2×10^{-4}		*										
	1											*	
-51	2×10^{-6}	*		*	*			*					
	2×10^{-4}	*											
	1										*		

* Group C Test

(1) On Completion of Temperature Profile Only.

4.6.6 Equivalent background input (EBI). With operating potential applied to the assembly and no radiation incident on the photocathode, hold for a stabilization period of not less than one minute nor more than 15 minutes. At the end of the stabilizing period with no radiation incident on the photocathode, measure the screen brightness (footlamberts) with a photometer, and record the photometer reading (R^1). Illuminate the photocathode at a level between 3.5 X 10^{-11} to 7 X 10^{-11} lumen per square centimeter uniformly distributed over the full useful diameter centered on the photocathode faceplate. Record photometer reading (R^2). The angle of incident flux shall not exceed 2 degrees from perpendicular and the photometer shall be positioned such that acceptance angle covers the full 17 millimeter diameter area centered on the phosphor screen. Determine the equivalent background input (EBI) by the following formula.

$$EBI = \frac{R'}{R_2 - R'} \times \text{actual input illumination}$$

Failure to meet requirements of 3.6.6 shall constitute failure of this test.

4.6.6.1 Equivalent background input (EBI) alternate method. With operating potential applied to the intensifier and no radiation incident on the photocathode, hold for a stabilizing period of not less than one (1) minute nor more than 15 minutes. At the end of the stabilizing period, with no radiation incident on the photocathode, measure the screen brightness (footlamberts) with a photometer. Divide this reading by the luminance gain, and multiply it by 1.08 X 10^{-3}. An EBI greater than that in paragraph 3.6.6 shall constiture failure of this test.

4.6.7 Luminance gain. Illuminate the photocathode of the operating assembly with an input light level, uniformly distributed over the full useful diameter area of the photocathode faceplate, in accordance with each of the conditions of 3.6.7 in sequence. Measure the input current and measure the image screen luminance with the photometer for each condition. The acceptance angle of the photometer shall be 2 degrees or less. Position the photometer so that the acceptance angle subtends a 17 mm diameter area centered on the phosphor screen. Luminance gain is determined by dividing the screen luminance in footlamberts by the actual input illumination in footcandles. Failure to meet requirements of 3.6.7 shall constitute failure of this test.

4.6.8 Halo. Uniformly illuminate the photocathode of the assembly through an aperture followed by a lens having a 40 degree field-of-view, an f-number equal to f/1.4, a focal length of 26.6, ± 0.2 millimeters, and a T-number equal to T-1.58. The aperture shall be so as to produce a spot of light 0.350, ± 0.020 millimeter in diameter on the photocathode faceplate of the assembly. The illumination in the spot shall be not less than 5 x 10^{-4} footcandle. The illumination incident on the photocathode of the assembly in the region outside of the 0.350 millimeter spot shall not exceed 5 x 10^{-7} footcandle. Measure the diameter of the halo (see 3.12.8) formed on the output image screen with no less than a 10 power measuring magnifier. Repeat the measurement 3 times and compute an average diameter. Failure to meet the requirements of 3.6.8 shall constitute failure of this test.

4.6.9 Bright source protection. Apply the input potential to the assembly. Illuminate the photocathode with a spot of light having an area not greater than 1.0 square millimeter and having an intensity of at least 50 millilumens. Measure the luminous output from the screen with an integrating cone designed to collect at least 95 percent of the light. Make the measurements between 1 second and at least 1.0 minute after the light illumination is turn ON. The measuring equipment shall have a response time and calibration sufficiently accurate to reflect the true reading of the output light within 10 percent at 1 second and 1 minute. Failure to meet the requirements of 3.6.9 shall constitute failure of this test.

4.6.10 Signal-to-noise ratio. Using a T - 1.45, ± 5 percent objective lens, image a circular spot no larger than 0.200 millimeter in diameter onto the photocathode of the assembly. The circular spot shall uniformly illuminate the photocathode at a level no greater than 1.2×10^{-6} footcandle. Focus the signal which is emergent from the assembly on a pinhole 0.200 millimeter or larger in diameter. Align to obtain a maximum signal through the pinhole. Measure the light passing through the pinhole with a low dark current photomultiplier tube, EMR Model 541E or equal. After suitable amplification, pass the signal to a Melpar or equivalent, signal-to-noise measurement set and measure the dc content and the rms value of the signal over an electronic bandwidth of 10 Hz. The signal-to-noise (S/N) ratio is the ratio of the dc signal to the rms noise:

$$SN = \frac{S_o - S_{bkd}}{K\,(N_o^2 - N_{bkd}^2)^{\frac{1}{2}}}$$

WHERE:

S	-	dc signal
N	-	rms noise
S_o	-	signal output from a Melpar type S/N test set
S_{bkd}	-	background signal when the light input to the assembly is closed
N_o	-	noise output measured from a Melpar type test set rms meter
N_{bkd}	-	background noise as measured by a Melpar type S/N test set rms meter when the light input to the assembly is closed
K	-	a correction factor to obtain a signal-to-noise ratio over an equivalent bandwidth of 10Hz independent of the frequency response of the assembly. K - 1.09 for a phosphor having temporal decay characteristic as specified in Figure 4.

Failure to meet requirements of 3.6.10 shall constitute failure of this test.

Note: Signal-to-noise measurements shall be performed on all units with a photo response of less than 275 microamperes per lumen as stated in the requirements of paragraph 3.6.1 and 4.6.1.

4.6.11 Fixed pattern noise. With the operating potential applied to the assembly, illuminate the entire photocathode uniformly at a level of 1 to 2 x 10^{-4} footcandle. Observe the phosphor screen with a 10 power magnifier for multi-to-multi pattern variation and multi-boundary noise (webbing). If multi-to-multi pattern variations or multi-boundary pattern noise are observed, perform the following:

a. Choose an area of the image where the multi-to-multi patterns appears most noticeable. Search this area for the most contrasting adjacent multi-bundles and measure each multi-bundle brightness using a diameter equal to 1/3 the dimension from flat-to-flat for hexagonal multies. Failure to meet the requirements of 3.6.11.1 shall constitute failure of this test.

b. Choose an area of the image screen where the multi-boundary pattern noise is most noticeable. Scan 3 multies and the corresponding multi-boundaries in this area of the screen with a photometering aperture of 25 micrometers effective diameter. Failure to meet the requirements of 3.6.11.2 shall constitute failure of this test.

4.6.12 Output brightness uniformity.

4.6.12.1 Illumination with 2856 color temperature light. Uniformly illuminate the photocathode of the assembly under test at a level between 5 x 10^{-6} and 1 x 10^{-5} footcandle of 2856K light. Observe the phosphor screen with a 10-power magnifier for shading. If shading is observed, perform the follow: Using a photometer whose effective aperture at the output image plane of the assembly is not greater than 2.5mm, make four scans completely across the assembly useful area. Each scan shall pass over the assembly optical axis and shall be rotated 45 degrees from the two adjacent scans. The axis of the scanning aperture shall be parallel to the assembly optical axis for all points along each scan. The brightness of the output image plane shall be measured to within ± 10 percent over each scan, and the brightness values shall be recorded in a suitable storage device. There shall be no compensation made for nonuniformity caused by the output fiber optic. The four scans shall then be examined as a group, from which the maximum and minimum values shall be obtained to compute the maximum-to-minimum output brightness uniformity ratio. Failure to meet requirements of 3.6.12 shall constitute failure of this test.

4.6.12.2 Illumination with 0.83mm radiation. Uniformly irradiate the photocathode of the assembly under test with 1 to 3 x 10^{-10} watt of 0.83 micrometer radiation. Observe the phosphor screen with a 10-power magnifier for shading. If shading is observed repeat the scan procedure in 4.6.12.1. Failure to meet requirements of 3.6.12 shall constitute failure of this test.

4.6.13 Image alignment. Perform this test with the same equipment used in 4.6.18 "Useful Cathode Diameter". With the operating potential applied, focus the test reticle on the photocathode such that the center dot falls on the optical axis of the photocathode. The photocathode shall be illuminated to provide a high contrast image of the test reticle. Observe the image of the test reticle formed on the screen of the assembly with a 10 power measuring magnifier containing an elliptical pattern of 0.012 inch apparent major axis and 0.006 inch apparent minor axis. When the image of the center of the test reticle is focused on the optical axis of the photocathode, the screen image of the center of the reticle shall be examined to verify that it falls within the elliptical pattern. The pattern shall be aligned such that the major axis makes an angle of 75, ± 0.5 degrees with the assembly alignment slot. The alignment slot shall be located in the first quadrant when the major axis is in the horizontal plane and is parallel with the assembly transverse mounting flange. The microscope shall be aligned with the optical axis of the assembly such that the center of the elliptical pattern falls on the optical axis. Failure to meet the requirements of 3.6.13 shall constitute failure of this test.

4.6.14 Lens interface. With the operating voltage applied, monitor the input current and observe the output phosphor screen with a 10 power magnifier. Adjust the objective lens through its focus range. Failure to meet the requiremetns of 3.6.14 shall constitute failure of this test.

4.6.15 Resolution.

4.6.15.1 Center resolution. Perform this test using:

a. A radiation source as specified in 4.4.

b. A projection system having an f-number not greater than f/1.4 to project the test pattern. If the pattern is butted to the tube input faceplate, the illuminating light shall have a convergence equivalent to an f/1.4 projection lens.

c. A resolving power target having black bars on a clear background (1951 Air Force Resolving Power Test Target).

d. A 10 power viewing system.

The resolving power test target shall be focused on the photocathode such that the center of the target is aligned with the optical axis. The input radiation shall be adjusted for best image contrast. The image of the resolving power test target formed on the screen of the assembly shall be observed for limiting resolution (see 3.12.16). Failure to meet the requirements of 3.6.15 shall constitute failure of this test.

4.6.15.2 Peripheral resolution. Determine the peripheral resolution with the same or equivalent test equipment used in 4.6.15.1. The resolving power target shall be focused on the photocathode such that the group and element representing 28 line pairs per millimeter of the target is positioned 7 mm from the optical center of the photocathode. Input radiation shall be adjusted for the best image contrast. Failure to meet the requirements of 3.6.15 shall constitute failure of this test.

4.6.16 Peripheral illumination stability. Mask off the center 19.5 millimeter diameter area of the photocathode. With the input current and the output brightness continuously monitored with a strip chart recorder or equivalent, illuminate the total input fiber optic with an input illumination of 20 footcandles for not less than 20 minutes. Failure to meet the requirements of 3.6.16 shall constitute failure of this test.

4.6.17 Modulation transfer function (MTF). Equipment used to measure modulation transfer function must satisfy the following or equivalent, subject to Government approval.

a. A sine wave analyzer capable of direct readout at (but not limited to) spatial frequencies within one line pair of the following: 2.5 line pairs per millimeter, 7.5 lp/mm, and 15 lp/mm. Its spatial frequency accuracy must be ± 3 percent of the value.

b. The analyzing slit must be 10 micrometers or less in width by 1mm or more in length.

c. The limiting aperture in the plane of the test pattern shall be a minimum of 2.5mm in width referred to the phosphor screen of the assembly.

d. The test system calibration frequency shall be 0.2 lp/mm or less.

e. The test system MTF shall be greater than 95 percent at 2.5 lp/mm.

f. Input illumination measured at the assembly photocathode shall be not greater than 2×10^{-3} footcandle.

The zero MTF level shall be determined by blocking the light from the phosphor screen while the system is running at calibration frequency. When unblocked, the calibration reading is normalized to 100 percent MTF. Assembly MTF is arrived at by dividing MTF of the measuring system with tube in place by MTF of the measuring system without the assembly. Failure to meet the requirements of 3.6.17 shall constitute failure of this test.

4.6.18 Useful cathode diameter. With the operating potential applied to the assembly, focus the test reticle on the photocathode such that it is centered on the assembly's optical axis. The test reticle shall consist of equally spaced lines from the center to the edge of the reticle in four directions 90° apart. Spacing between a large graduation and a small graduation shall be 0.5 millimeter ± 0.03 millimeter, and spacing between two large graduations shall be 1.0 millimeters ± 0.03 millimeter. All lines, letters and numbers shall be high contrast black on a clear glass substrate. Adjust the input radiation level for best image contrast. The output screen shall be viewed with a 10-power magnifier. Useful cathode diameter is determined by the number of millimeter graduations visible on the screen of the assembly and shall be determined in both vertical and horizontal directions. Failure to meet requirements of 3.6.18 in both vertical and horizontal directions shall constitute failure of this test.

4.6.19 Photocathode, microchannel plate, and screen quality. With the operating potential applied and no radiation incident of the photocathode, observe image screen with a 10 power magnifier. With an input light level adjusted for best spot contrast, the image screen shall be observed for opaque or dark spots that exceed the size or quantity specified in Table III. With an input light level of 2×10^{-6} footcandle, observe the screen for field emission, bright spots, and graininess. If chicken wire is present to a degree that it detracts from normal performance, refer to the requirements of 3.5.2. Failure to meet requirements of 3.6.19 shall constitute failure of this test.

4.6.20 Phosphor decay. The phosphor decay characteristics of the assembly shall be determined by illuminating uniformly, within ± 25 percent, the entire photocathode with a pulsed light. The dark to light transition shall be less than one millisecond, 125 milliseconds, ± 10 millseconds, and the light to dark transition less than 100 milliseconds. The dark light level shall be less than 4×10^{-7} footcandle. The instrumentation for the analysis of the decay time shall consist of a signal (pickup) system and a trigger system. The signal system shall detect the output light from the phosphor. The resulting signal shall go to a signal analyzing device. The response time of the entire signal systems shall be less than 300 microseconds. The trigger system shall provide means to obtain an electronic pulse directly related to the input light pulse. This trigger pulse shall be capable of triggering the signal analyzing device with a repeatability of ± 300 microseconds in terms of trigger time versus actual start of decay. The signal analyzing device shall be capable of looking at the decay in several section so that the value read at a particular time from 10 milliseconds is not less than 20 percent of full scale. Full scale accuracy shall be ± 0.5 percent. Values shall be taken at 10 milliseocnds, 100 milliseconds, 500 milliseconds, and 1 second. Failure to meet the requirements of 3.6.20 shall constitute failure of this test.

4.7 Reliability. The test shall be in accordance with a Government approved reliability test demonstration and evaluation plan which incorporates the test condition specified herein and as required in the contract. The reliability test shall be conducted on assembly(s) in the monocular configuration, in accordance with Table XI. ON-OFF cycling shall consist of 55 minutes of operating (ON time) followed by 5 minutes OFF. Input voltage to the assembly shall be not less than 2.7 Vdc nor more than 3.0 Vdc. The initial brightness gain of each assembly shall be between 7,500 and 15,000. Acceptable limits of brightness gain during and at the completion of the test shall be 5,000 to 20,000. No gain adjustment shall be allowed during the test or inspections. Signal/noise shall be not less than 3.5 during this test or any inspection. Operation shall be with a target located 20 inches from the front of the objective lens with the monocular focused on the target. The target shall have a color temperature of 2856K and completely fill the field-of-view of the monocular under test. The target brightness shall be 1 X 10^{-4} footlambert, which shall be raised to 5 X 10^{-3} footlambert for 5 seconds and to 50 footlambert for 3 seconds once during each "ON" period. Sufficient instrumentation shall be provided to ensure immediate recognition of a catastrophic failure as well as a change in relative output brightness. The assembly parameters: luminance gain, EBI, signal-to-noise, photocathode microchannel plate, screen quality, output brightness uniformity, and useful cathode diameter shall be tested at room temperature as specified herein once each 200 ± 50 hours of operating time. Reliability test assemblies shall be removed from test condition for not more than 15 hours for measurement of assembly parameters. At other times, assemblies shall be cycled continuously on a 24 hour basis. A failure shall be presumed to have occurred immediately after the last successful measurement or inspection unless acceptable continuous monitoring instrumentation records the actual time of failure. Failed assemblies which have been removed from the test shall not be replaced. A failed assembly repaired and returned to the test shall be used for information only. Each assembly on test at the completion of the test shall be submitted to at least the Group A and B inspections performed during the test. The requirements of MIL-STD-781 shall apply.

NOTE: THE TARGET BRIGHTNESS SHALL BE ADJUSTED TO ACHIEVE AN EQUIVALENT PHOTOCATHODE ILLUMINATION OF AN F1.4 OBJECTIVE LENS WHEN THE F1.1 OBJECTIVE LENS IS USED.

NOTE: An alternative reliability test method may be chosen, in which the tube photocathode is directly illuminated by a radiation source without using an assembly monocular. If this method is chosen, the entire tube assembly useful area shall be uniformly illuminated at levels corresponding to what would be provided by a T-1.58 objective lens for the brightness levels specified in 4.7 above.

TABLE XI. Reliability test environmental conditions.

Parameter	Environmental conditions
Temperature	40°C, ± 5°C
Temperature cycling	Not applicable
Vibration	2.2g, ± 10 percent peak acceleration at any nonresonant frequency between 20 and 60Hz, measured at mounting points on the equipment. The duration of vibration shall be at least 10 minutes during each period of equipment ON time.

4.7.1 Failure definition. Failure shall be defined as inability of the assembly to meet the assembly parameter requirements specified in 4.7. Failures attributable to the power supply shall be considered relevant.

4.7.2 Accept/reject criteria.

4.7.2.1 Initial production test reliability inspection. For IPT reliability inspection, ten (10) assemblies shall be subjected to the MTTF test specified herein. The accept/reject determination shall be made on either the accumulation of 2000 hours operating time on each of the ten assemblies or the occurrence of four assembly failures. Four or more assembly failures shall constitute failure of the equipment to meet the reliability inspection requirement. Three or less assembly failure shall constitute acceptance of the reliability requirement.

4.7.2.2 Quality conformance reliability test inspection. For quality conformance testing, four assemblies shall be subjected to the MTTF specified herein. The accept/reject determination shall be made on either the accumulation of 2000 hours on each of the four assemblies or the occurrence of two assembly failures. Failure of two or more assemblies to pass the tests shall constitute failure of the equipment to meet the reliability inspection and be cause for rejection of the represented lots. One or less assembly failures shall constitute acceptance of the reliability inspection requirement.

4.7.3 Non-relevant failures. Any failure attributed and solely to overstress induced by the inspection procedure such as an assembly connecting wire breaking after the first 200 hour inspection point, shall be neither regarded as relevant in the accept/reject determination, nor cause for removal from the test, if the failure is repairable. Any non-relevant failure which is non-repairable shall require the replacement of such image intensifier assembly(s). The time on the replacement shall begin at zero. The time of the removed assembly(s) shall not be used in the accept/reject determination of the image intensifier assemblies. The contractor shall have the option to reclassify any non-relevant failure as a relevant failure.

4.8 Humidity. Subject the unprotected assemblies to the temperature/humidity profile of MIL-STD-810, Method 507.1, Procedure II as modified below. Failure to meet the requirements of paragraph 3.9 constitutes a failure of this test.

Procedure II - Ground and airborne electronic equipment.

Step 1 - delete
Step 2 - delete
Step 3 - delete
Step 4 - Take initial measurements of gain, input current, center resolution and EBI. Gain shall be run at 2 X 10 -6 fc

NOTE: No readjustment shall be permitted throughout the test period and no repairs or replacement of parts shall be permitted.

Step 5 - Change 30°C to 21°C
Step 6 - Subject the test items to five continuous 48 hour cycles in accordance with Figure 507.1-2 with a modified baseline of 21°C instead of 20°C and 30°C. Take measurements in accordance with Step 4 at the last four hour period of the third (3rd) cycle (sixth day). Prior to measurement, accumulated moisture may be removed. Wiping is permitted.
Step 7 - At the end of five continuous 48 hour cycles, cool the assemblies to room temperature and hold at room temperature for a minimum of four hours.
Step 8 - At the end of the room temperature holding period, subject the assemblies to the measurements specified in Step 4.
Step 9 - Bake samples at a minimum of 55°C and 400mm Hg max for a period of not less than 24 hours.

4.9 Workmanship. The assembly shall be inspected under suitable lighting by visually assuring that there are no cracks, broken parts, deformation, corrosion, deterioration of parts or finishes, missing parts, loose parts, chipping or scratches. Failure to meet the requirements of paragraph 3.10 constitutes failure of the assembly.

4.10 Electromagnetic interference (EMI). The EMI shall be tested in accordance with the requirements of MIL-STD-462 using assemblies incorporated into a AN/PVS-5B or 5C system. Failure to comply with requirements of paragraph 3.11 shall constitute failure of this test.

4.11 Inspection for packaging. Inspection of packaging shall be performed to assure compliance to the requirements of section 5.

5. PACKAGING

5.1 Packaging. The packaging requirements for the desired level(s) of protection shall be as specified by the acquisition activity (see 6.2.h).

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 assembly covered by this specification is intended for use in the AN/PVS-5( ) Night Vision Goggles, an electro-optical viewing device capable of intensifying low light levels such that a visible image is presented for viewing and sighting purposes.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number and date of this specification.
b. Time frame required for submission of IPT and number of assemblies required.
c. Necessary action by contractor in event of Group C or D failures.
d. Qualification - If product is not qualified at time of award the contract must require qualification prior to first delivery.
e. Sampling plans for Group B and Group C inspections, for guidance, unless otherwise specified, all sampling plans shall be in accordance with MIL-STD-105.
f. Issue of DODISS to be cited in the solicitation, and if required, the specified issue of individual documents referenced (see 2.1.1 and 2.1.2).
g. MIL-STD-810C shall be used for all environmental tests of section 4.
h. Levels of preservation and packaging (see section 5),

6.3 Definitions. See 3.12.

6.4 Qualification. With respect to products requiring qualification, unless otherwise specified by the contract or purchase order, if a product is not qualified at time of award, the contract shall require qualification prior to first delivery. The activity responsible for approving qualified products is the CECOM, Concurrent Engineering Directorate, ATTN: AMSEL-ED-IN, Fort Monmouth, NJ 07703. Information pertaining to qualification of products may be obtained from the above activity.

6.5 International standardization agreement. Certain provisions of this sepcification are the subject of international standardization agreement (QSTAG 468). When amendment, revision, or cancellation of this specification is proposed which will affect or violate the international agreement concerned, the preparing activity will take appropriate reconcillation action through international standardization channels including departmental standardization office, if required.

6.6 Subject term keyword listing.
Night Vision Assembly
Tube

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

CUSTODIAN:
Army - CR
Navy - AS

PREPARING ACTIVITY:
Army - CR

Project No. 5855-0022

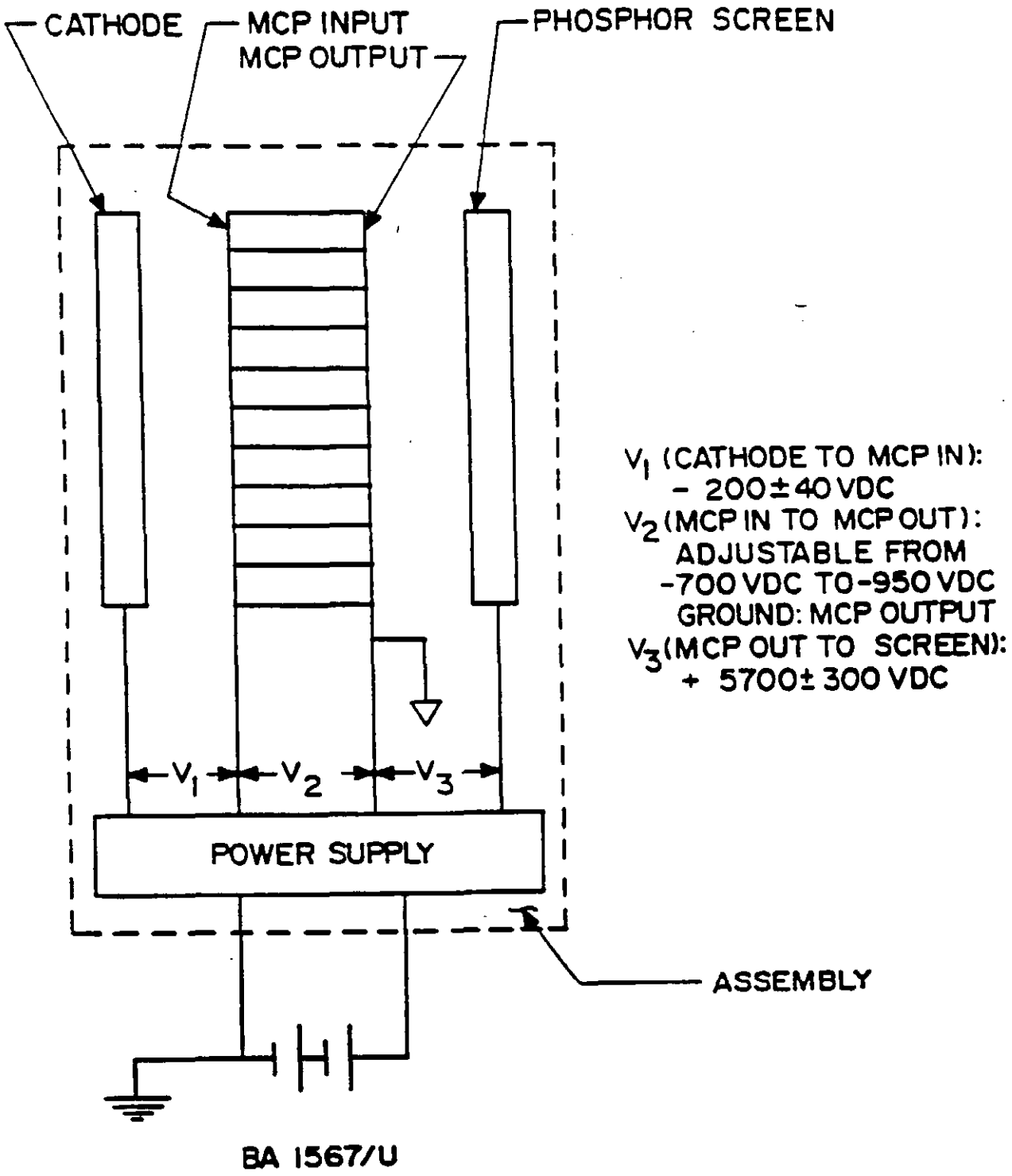
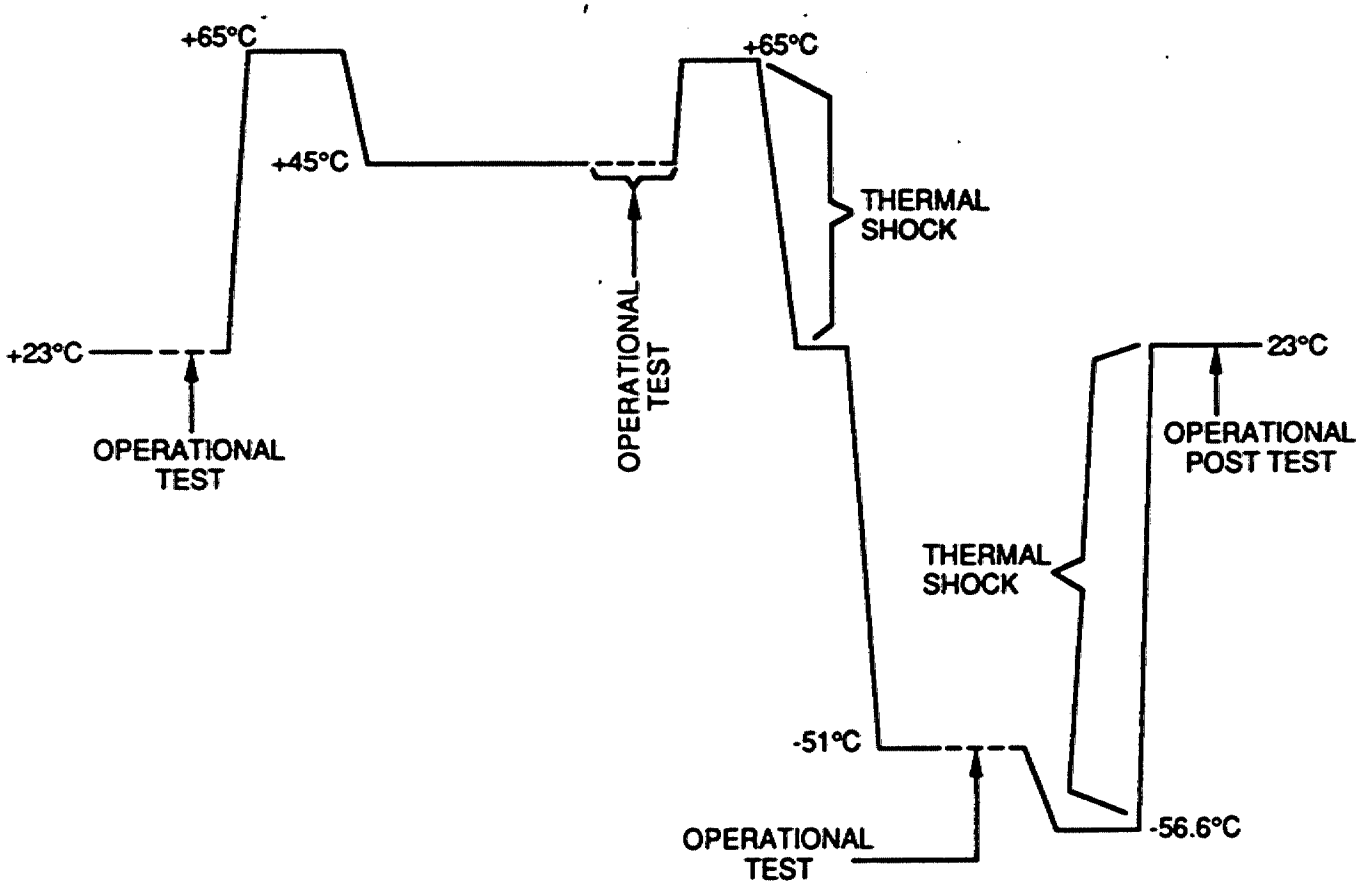


FIGURE 1. Power supply voltage.



REFERENCE ONLY

FIGURE 2. Temperature extreme cycle

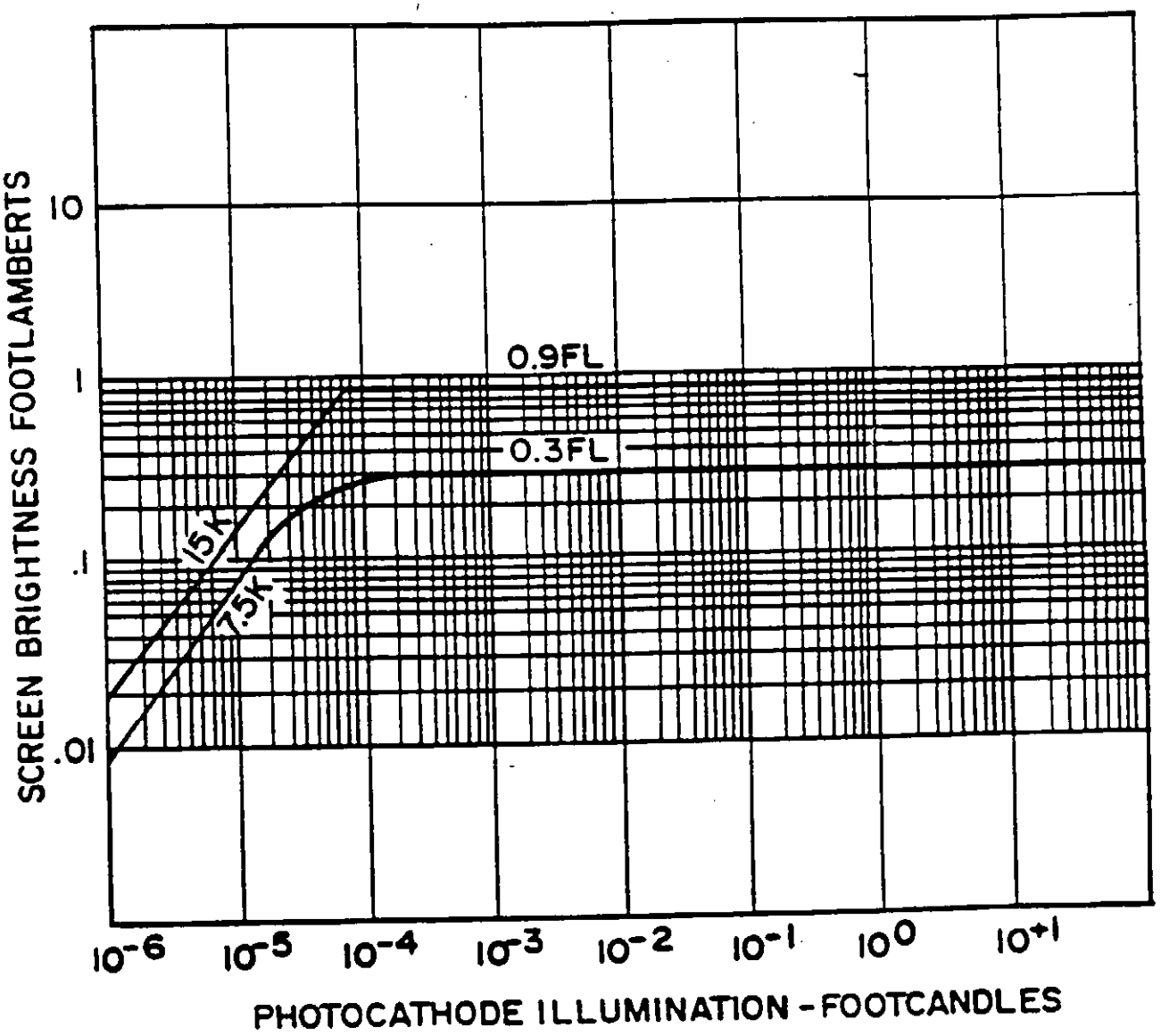


FIGURE 3. Gain/saturation requirement.

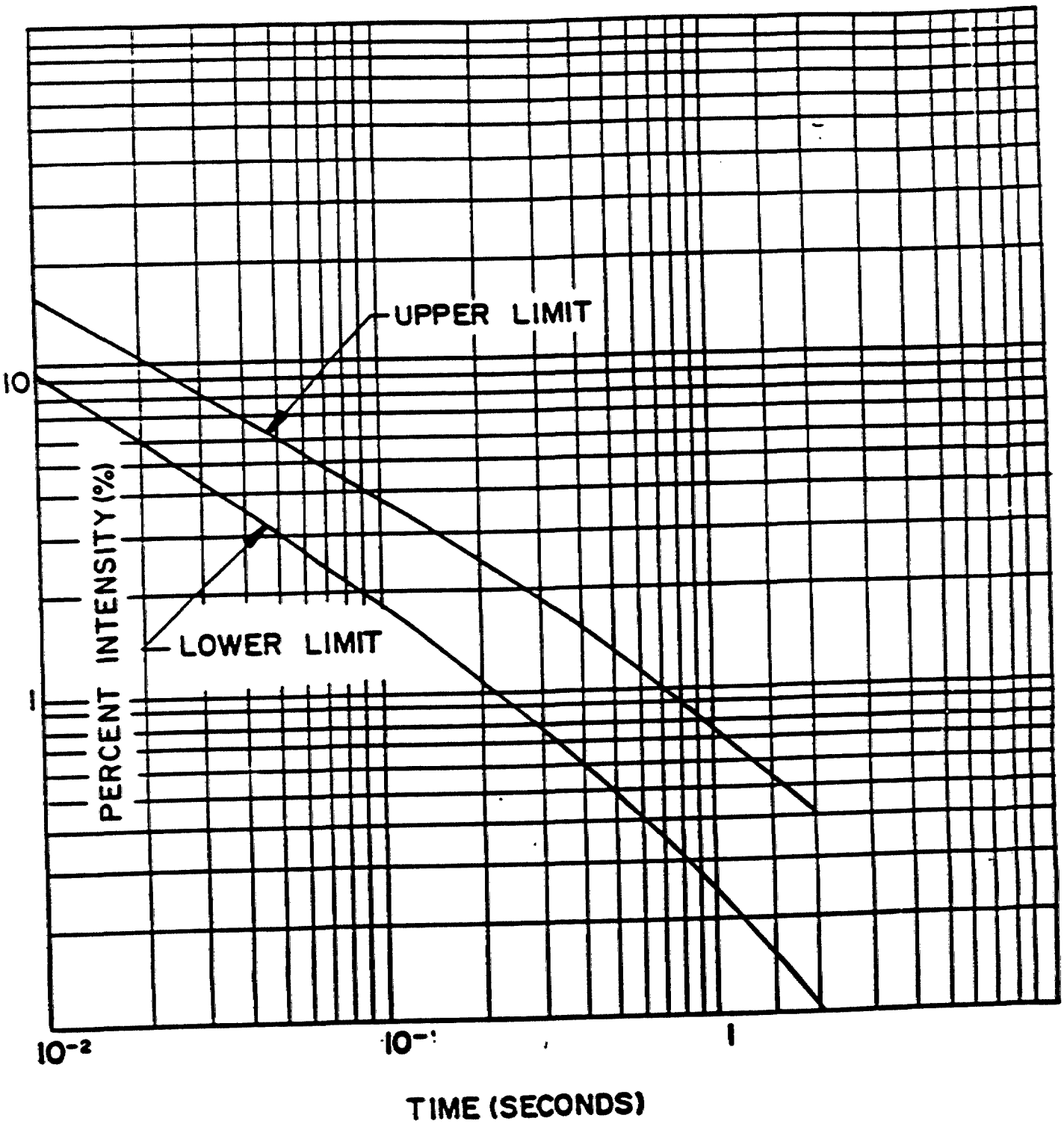


FIGURE 4. Phosphor decay characteristic.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-I-49052F	

3. DOCUMENT TITLE
IMAGE INTENSIFIER ASSEMBLY, 18 MM MICROCHANNEL WAFER MX-9916/UV

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial	(2) AUTOVON
CECOM	(908) 532-5851	992-5851
c. ADDRESS (Include Zip Code) AMSEL-ED-TM Fort Monmouth, NJ 07703-5023	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340. AUTOVON 289-2340	

DD Form 1426, OCT 89 — Previous editions are obsolete.