1. SCOPE

1.1 Scope. This specification covers the Image Intensifier Assembly, 18 Millimetre Microchannel Wafer XX2540 (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

DRAWINGS : The applicable DEP drawing

3. REQUIREMENTS

3.1 Description. The Image Intensifiers Assembly, 18 Millimetre Microchannel Wafer XX2540, hereinafter referred to as the assembly, shall have a minimum useful diameter photocathode (see 6.3.1) and phosphor screen of no less than 17.5 millimetres (mm). The assembly shall employ a S25 photocathode with enhanced red response. The assembly shall include the auto-gated power supply and shall be encapsulated within a hard surface insulating sleeve. The assembly shall employ a microchannel electron multiplier plate with proximity focus on the input and output and shall contain an anti veiling glare input faceplate and an non-inverting fibre-optic output as an integral part of the tube envelope.

3.2 Construction. The assembly shall be fabricated in conformance to drawing as specified in the contract.

3.2.1 Weight. The weight of the assembly shall be not greater than 95 grams.

3.3 First article. When specified in the contract or purchase order, the contractor shall furnish first article units in accordance with 4.3.

3.4 Parts and materials. According to Bill of Material DEP.

3.4.1 Phosphor screen. The phosphor screen shall be P20 (see 6.3.2) or equal.

3.5 Components.

3.5.1 Fibre optics.

3.5.1.1 Shear distortion. The shear distortion (see 6.3.3) shall not exceed 30 micrometers.

3.5.1.2 Gross distortion. Gross distortion shall cause no point on the image of a straight line to be displaced by more than 50 micrometers relative to the straight line best fitted to the image.

3.5.1.2 Image inversion.
The fibre optic inverter shall perform a 180, ± 1 degrees image inversion. In cases where gross distortion is present, the line used to reference the degree of rotation of the inverter image shall be taken as that line passing through both end points of the inverter image, i.e., the best fit straight line.

3.5.1.3 Chicken wire. When the fibre optic is viewed under 10 power magnification perpendicular to the plane surface with the output in contact with the phosphor faceplate, which is excited by ultraviolet light, the fibre-optic shall meet the chicken wire (see 6.3.4) limits specified in table 1.

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

TABLE I. Fibre-optic inspection

No. of Allowable Incidences	Length	
	Minimum	Maximum
Chicken Wire (Zone 1)		
0	2.0 mm	or greater
2	1.0 mm	2.0 mm
6	0.5 mm	1.0 mm
Chicken Wire (zone 2)		
0	2.0 mm	or greater
6	1.0 mm	2.0 mm
12	0.5 mm	1.0 mm

Disregard those lengths which are 0.5 mm or less

Zone 1	7.5 mm diameter circle in centre of optic
Zone 2	7.5 mm – 17.5 mm annulus concentric with Zone 1

3.5.3 Power Source. The power source for operating the assembly shall be a power-source of 2.0 to 3.7 VDC.

3.6 Operational and environmental.

3.6.1 Photocathode sensitivity. Luminous sensitivity shall be no less than 700 µA/lm for radiation with a colour temperature of 2856 Kelvin (K), ± 50 K. Radiant sensitivity shall be no less than 65 mA/W at 800, ±1 nm, not less than 50 mA/Watt 850 ± 1nm.

3.6.2 Burn-in. The assembly shall undergo 50 continuous cycles. Each cycle shall consist of 55 minutes of operation and 5 minutes OFF time. Once during each operation cycle the photocathode shall be illuminated with 5×10^{-3} equivalent lux 2856K for 5 seconds and with 50 equivalent lux 2856K for 3 seconds. The remaining portion of the operating cycle shall be without photocathode illumination. The brightness gain setting shall not be changed during burn-in.

3.6.3 Vibration. The assembly with no operating voltage applied, shall not be damaged (see 6.3.9) or suffer degradation of performance when subjected to simple harmonic motion, parallel to and perpendicular to the optical axis over a frequency range of 10 to 3500 hertz (Hz) for a period of 1 hour in each plane.

3.6.4 Shock. The operating assembly with no radiation incident on the photocathode shall not be damaged and there shall be no evidence of arcing, flashing, flickering, corona, bright spots or other intermittent or continuous failure after the tube is subjected to 6 shocks 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 500 g's (see 6.3.5) and a duration of 1 millisecond, ± 0.2 milliseconds measured at the 10 per cent. amplitude points.

3.6.5 Temperature (moderate). The assembly shall not be damaged by storage or operation over the temperature profile specified in figure 2 and shall meet the following requirements at the temperature specified.

3.6.5.1 Temperature +38°C

a. Input current - Not greater than 40 mA

b. Gain at $2x10^{-5}$ lux - Not less than 4000 and not greater than 24000 cd/m^2/lx

c. Operational stability

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

(2) If random fluctuations greater than ± 10% but less than ± 15% 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.c(1) shall be met.

(3) If the output brightness drift is greater than ± 15% 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.c.(1) shall be met.

d. Rise time (see 6.3.6) - Shall be not greater than 5 seconds. Overshoot (see 6.3.18) shall be less than 40% of steady state output brightness.

3.6.5.2 Temperature -17.8°C

a. Input current - Not greater than 40 mA

b. Gain at $2x10^{-5}$ lux - Not less than 4000 and not greater than 24000 cd/m^2/lx.

c. Operational stability.

(1) The output brightness fluctuations shall not be greater than ± 10% from a steady state condition and drift shall not be greater than ± 15% 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% but less than ± 15% 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.c(1) shall be met.

(3) If the output brightness drift is greater than ± 15% 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.c(1) shall be met.

d. Rise time - shall be not greater than 7 seconds. Overshoot shall be less than 40% of steady state output brightness.

3.6.6 Temperature (extreme). The assembly shall not be damaged by storage, operation or thermal shock temperature profile, specified in figure 3a and shall meet the following requirements at the temperature specified.

3.6.6.1 Temperature +52°C

a. Input current - Not greater than 40 mA.

b. Gain at $2x10^{-5}$ lux - Not less than 4000 and not greater than 24000 cd/m^2/lx.

c. Operational stability.

(1) The output brightness fluctuations shall not be greater than ± 10% from a steady state condition and drift shall not be greater than ± 15% 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% but less than ± 15% occur in the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.6.1.c(1) shall be met.

(3) If the output brightness drift is greater than ± 15% during the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.6.1.c(1) shall be met.

d. Rise time - shall be not greater than 7 seconds. Overshoot shall be less than 50% of steady state output brightness.

3.6.6.2 Temperature -45°C

a. Input current - Not greater than 45 mA.

b. Gain at $2x10^{-5}$ lux - Not less than 4000 and not greater than 24000 cd/m^2/lx.

c. Operational stability.

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

(2) If random fluctuations greater than ± 10% but less than ± 15 per cent. occur in the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.6.2.c(1) shall be met.

(3) If the output brightness drift is greater than ± 15% during the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.6.2.c(1) shall be met.

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

f. After exposure of the assembly(s) to the profile of figure 3[a], the room temperature

(see 6.3.7) performance shall be as follows:

(1) Gain at $2x10^{-5}$ lux - Not less than 10.000 and not greater than 16.000 $cd/m^2/lx$.
(2) Operational stability.
(3) The output brightness fluctuations shall not be greater than ± 10% from a steady state condition and drift shall not be greater than ± 15% 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.

a. If random fluctuations greater than ± 10% but less than ± 15% occur in the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.6.2.f(2)(a) shall be met.

c. If the output brightness drift is greater than ± 15% during the original 2 minute time period, the test shall be continued an additional 2 minutes during which the requirements of 3.6.6.2.f(2)(a) shall be met.

3.6.6.3 Humidity
The assembly shall not be damaged when subjected to a humidity test specified in fig. 3a. A relative humidity of at least 95% at 45°C for a period of minimum 6 hours and a relative humidity of 15% at 65°C for a period of minimum 30 minutes.

3.6.6.4 Long time storage and operating
The assembly shall not be damaged by storage and operation specified in figure 3b.

3.6.7 Equivalent background input (EBI). The equivalent background input at room temperature shall not exceed 0.25 µlx.

3.6.8 Luminance gain. The assembly shall have a room temperature luminance gain and high level saturation characteristics as specified in table II and figure 4. The input current at room temperature shall not exceed 35 milliamperes at the light level specified.

TABLE II. Saturation requirements for luminance gain.

Nominal input light level (lux)	Minimum allowable gain (cd/m^2lx)	Minimum allowable output (cd/m^2)	Maximum allowable gain (cd/m^2lx)	Maximum allowable output (cd/m^2)	Input current (mA)
2×10^{-5}	10.000	N/A	16.000	N/A	35
10	N/A	4	N/A	8	-
200	N/A	4	N/A	8	-

3.6.9 Halo. The halo (see 6.3.8), produced by projecting (or butting) a spot of light onto the input of the assembly, shall be no greater than 0.8 mm in diameter.

3.6.10 Bright source protection. The assembly shall not be damaged when subjected to an input illumination of no less than 50 millilumens concentrated on the photocathode within an area no greater than 1 mm^2 for a time interval not less than 1 minute. There shall be no discernible damage after a non-operating period of not more than 24 hours, under the test conditions of 4.6.21.

3.6.11 Signal-to-noise ratio. The signal-to-noise ratio of the assembly shall be no less than 25.

3.6.12 Fixed pattern noise.

3.6.12.1 Multi-to-multi pattern variation (see 6.3.10). Multi-to-multi brightness deviations from mean value shall not exceed ± 8%.

3.6.12.2 Multi-boundary pattern noise (see 6.3.11). 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 ± 8%. The mean value shall be established from three adjacent multies containing the above multi-boundaries.

3.6.13 Output brightness uniformity. When the photocathode is uniformly illuminated with light at a colour temperature of 2856K, 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 830 ± 1 nm, the ratio shall not exceed 3:1. Under the same conditions, when the screen is viewed with a 10 power magnifier, the background shading shall be uniformly graded with no distinct line of demarcation between the light and dark areas.

3.6.14 Image alignment. A test reticle (pinhole) projected (or butted) on the photocathode of the assembly, concentric with the optical axis shall produce an image on the screen of the assembly such that the centre off the image shall fall within a circle of 0.15 mm.

3.6.15 Lens interface. The assembly shall show no evidence of intermittent operation, arcing, flashing, flickering, corona, or bright spots beyond that allowed in 3.6.21, and the input current of the operating assembly shall not increase when coupled with an objective lens mount assembly.
Objective lens mount assembly t.b.s.

3.6.16 Centre resolution. The centre resolution, referenced to the photocathode, shall be not less than 64 lp/mm.

3.6.16.1 Peripheral resolution. The peripheral resolution, referenced to the photocathode, shall be at least 64 lp/mm. This requirement shall be met at 2 points separated by 90 degrees spaced on a 14 mm diameter circle concentric with the optical axis (see 6.3.15).

3.6.16.2 High light level resolution. The centre resolution, referenced to the photocathode, shall be not less than 60 lp/mm.

3.6.17 Peripheral illumination stability. There shall be no flashing, flickering, or other intermittent operation when the input fibre optics is illuminated outside the 19.5 mm diameter with 200 lux for a period of 20 minutes. The input current deviation from the

steady state value shall be not greater than ± 3.0 mA.

3.6.18 Modulation transfer function (MTF). With an input illumination on the photocathode of not greater than 2 x 10^{-3} equivalent 2856K lux and a gain of 9000 cd/m^2/lx, the minimum assembly MTF (see 6.3.12) shall be as follows:
a. 90% modulation transfer at 2.5 lp/mm
b. 74% modulation transfer at 7.5 lp/mm
c. 54% modulation transfer at 15.0 lp/mm
d. 40% modulation transfer at 25.0 lp/mm
e. 30% modulation transfer at 30.0 lp/mm

3.6.19 Useful cathode diameter. The useful photocathode diameter shall be not less than 17.5 mm.

3.6.20 Reversed polarity. The assembly shall not be damaged when subjected to a reverse polarity of 3.7 volts direct current (Vdc) input voltage for a period of not less than 60 seconds.

3.6.21 Photocathode, microchannel plate and screen quality. When the screen is viewed with a 10 power magnifier with no light, then with 2 x 10^{-5} lux incident on the photocathode, there shall be no bright spots (see 6.3.4) or discernible field emission (see 6.3.13) brighter than the background scintillation (see 6.3.14) 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% 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 fibre-to-fibre transmission variations 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 this measurement disagreement concerning compliance at an input illumination performing a resolution test in the disputed area, measured at an input illumination of not greater than 1 x 10^{-3} lux incident to the photocathode. If the assembly passes the minimum resolution test in compliance with 3.6.16, the assembly shall be accepted.

TABLE III. Assembly dark spots

Size of spots	Number of spots within Ø5.6 mm diameter circle	Number of spots within annulus bounded by two circles,Ø5.6 Ø14.7 mm. diameter	Number of spots within annulus bounded by two circles Ø14.7 – & Ø17.5 diameter
> 150 µm	0	0	0
100 - 150 µm	0	2	1
70 - 100 µm	0	1	2
< 70 µm	minimal	minimal	minimal

NOTE: The 5.6 and 14.7 mm circles on the image screen shall be concentric with the optical axis of the assembly.

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

3.6.23 Veiling glare. The veiling glare of the image intensifier assembly when attached to the objective lens assembly shall not be greater than 2.35% on axis.

3.7 Reliability. The assembly shall have a mean time to failure of not less than 15000 hours when operated under the reliability tests conditions specified herein.

3.8 Operational life. The assembly shall be capable of a projected operation of no less than 15000 hours with the total photocathode illuminated at a level of no less than 108 10^{-6} lux. The signal-to-noise ratio at the projected completion of 15000 hours of operation shall not be less than 11.

3.9 Identification and marking. Each assembly shall be identified by a type and serial number.

3.10 Workmanship. The Image Intensifier shall be free from burrs, sharp edges, potting voids, defects, scratches which may affect the assembly performance. It shall also be free of grease, oil, dust, solder flux or any other conductive film.

3.11 Humidity: The Image Intensifier tube shall not deteriorate or being damaged after exposure to high relative humidity conditions as described in the MIL-STD-810E, method 507.3, Proc. II, for 10 days.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein.

4.1.1 Parts and materials inspection. The supplier is responsible for ensuring that the parts and materials used are manufactured, examined, and tested in accordance with referenced specification, standards, and as specified herein.

4.2 Classification of inspections. Inspections shall be classified as follows:
a. First article (4.3).
b. Quality conformance inspection (4.5).
c. Inspection of packaging (4.9).

4.3 First article. When specified in the contract or purchase order, the first article inspection shall be performed by the contractor.

4.3.1 Inspection. Each first article 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 the inspection. The first 10 tests in table V shall be run in the sequence specified.

TABLE IV. Inspection.

	Defects	Requirement paragraph
101.	Components and materials missing or not as specified	3.4, 3.5
102.	Weight not as specified	3.2.1
103.	Material not as specified	3.4
104.	Design not as specified	3.2
105.	Chemical and physical properties not as specified	3.2
106.	Dimensions not as specified	3.2
107.	Colour not as specified	3.2
108.	Finish not as specified	3.2
109.	Identification or special marking missing or illegible	3.9
110.	Workmanship	3.10

TABLE V. First article inspection

Inspection	Requirement paragraph	Test paragraph
Photocathode sensitivity	3.6.1	4.6.1
Operational life	3.8	4.8
Burn-in	3.6.2	4.6.2
Vibration	3.6.3	4.6.3
Shock	3.6.4	4.6.4
EBI	3.6.7	4.6.7
Luminance gain	3.6.8	4.6.8
Temperature (extreme)	3.6.6	4.6.6
Temperature (moderate)	3.6.5	4.6.5
Photocathode, mcp. and screen quality	3.6.21	4.6.21
Phosphor decay	3.6.22	4.6.22
Fixed pattern noise	3.6.12	4.6.12
Centre/Peripheral resolution	3.6.16	4.6.16
Peripheral illumination stab.	3.6.17	4.6.17
Modulation transfer function	3.6.18	4.6.18
Lens interface	3.6.15	4.6.15
Image alignment	3.6.14	4.6.14
Bright source protection	3.6.10	4.6.10
Output brightness uniformity	3.6.13	4.6.13
Useful cathode diameter	3.6.19	4.6.19
Halo	3.6.9	4.6.9
Reversed polarity	3.6.20	4.6.20
Signal-to-noise ratio	3.6.11	4.6.11
Reliability	3.7	4.7

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 radiation source used in the tests shall be a tungsten filament lamp operated at a colour temperature of 2856 K, ± 50K.
b. The photometer used for screen brightness measurements shall be a Pritchard Model 1970 PR or equal.
c. The photometer used for screen brightness measurements shall be calibrated against a standard source that has a tungsten filament lamp.
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 ± 25%.
e. Meters used for monitoring lamp current and voltage shall have and accuracy of ± 0.25%.
f. Tests shall be performed at room temperature (see 6.3.7).
g. Neutral density filters used in test equipment shall have transmission characteristics within ± 10% of the nominal filter transmission from 0.40 to 0.90 µm.
h. All tests on the assembly shall be performed with the input voltage at 2.7 Vdc.
i. All tests shall be performed with the assembly housing grounded.
j. Tolerances on applied nominal input voltages shall be ± 0.1 Vdc.

k. Test chambers used for environmental temperature tests shall maintain the temperature within ± 2 ℃ of the specified test temperature.
l. A night Vision Goggle Lens Assembly Eyepiece 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 unit on contract or purchase order shall be inspected for conformance to the inspections specified in tables IV and VI. Discrete lots shall be formed from units that pass this inspection. Factors of lot composition not defined herein, or in the contract or purchase order, shall be in accordance with MIL-STD-105. Each lot shall be subjected to sampling inspection, utilising the procedures of MIL-STD-105.

4.5.1.1 Order of inspection within Group A. Group A inspection shall be performed as listed in table VI.

TABLE VI. Group A inspection

Inspection	Requirement paragraph	Test paragraph
Photocathode sensitivity	3.6.1	4.6.1
Operational life	3.8	4.8
Burn-in	3.6.2	4.6.2
EBI	3.6.7	4.6.7
Luminance gain	3.6.8	4.6.8
Photocathode, mcp. and screen quality	3.6.21	4.6.21
Centre/Peripheral resolution	3.6.16. + 3.6.16.1	4.6.16 + 4.6.16.1
Signal-to-noise ratio	3.6.11	4.6.11

4.5.2 Group B inspection. Samples selected in accordance with 4.5.1 and which have passed the tests specified in 4.5.1.1 shall be subjected to the tests in table VII. Sample size shall be according to MIL STD 105. AQL shall be 1.5 percent defective, inspection level II.
Remarks: all tubes shall be visual inspected on fixed pattern noise and output brightness uniformity. Tubes which are visual border line will be measured according to the specification.

TABLE VII. Group B inspection

Inspection	Requirement paragraph	Test paragraph
Fixed pattern noise	3.6.12	4.6.12
Temperature (moderate)	3.6.5	4.6.5
Output brightness uniformity	3.6.13	4.6.13

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 or group A and B inspection. Sample units shall be selected in accordance with 4.5.3.1. Failure of any assembly of any test, shall constitute failure of the lot.

4.5.3.1 Sampling for group C inspection. Four sample tubes shall be selected random from a batch of 50-90 tubes. For batches less than 50 the sampling will be done in 2 or more batches till a number of $\geq$ 50 tubes is reached. The lens interface test shall be performed after the environmental test; the other tests may be performed in any sequence.

4.5.3.2 Shock and vibration tests shall be conducted in succession in any order under the group C inspection. Under 4.5.3.4, 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 For the purpose of 4.5.3.4, a failure at a given point in the environmental (extreme) test cycle shall be considered a failure of the given measurements 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 and shall not be subject to 4.5.3.4. In re-testing, the samples shall be cycled as shown in figure 3, 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 discussed with the purchaser.

TABLE VIII. Group C inspection

Inspection	Requirement paragraph	Test paragraph
Modulation transfer function	3.6.18	4.6.18
Vibration	3.6.3	4.6.3
Shock	3.6.4	4.6.4
Temperature (extreme)	3.6.6	4.6.6
Bright source protection	3.6.10	4.6.10
Lens interface	3.6.15	4.6.15
Useful cathode diameter	3.6.19	4.6.19
Image alignment	3.6.14	4.6.14
Halo	3.6.9	4.6.9
Peripheral illumination stability	3.6.17	4.6.17
High light-level resolution	3.6.16.2	4.6.16.2

4.5.4 Group D inspection. This inspection shall consist of the tests specified in table IX, except the phosphor decay inspection which shall only be performed when a new source or type of phosphor is utilised. At such time one unit shall be selected from the first 10 samples of assemblies that have been subjected to and passed group A inspection.

TABLE IX Group D Inspection.

Inspection	Requirement paragraph	Test paragraph
Phosphor decay	3.6.22	4.6.22
Reliability	3.7	4.7

4.5.4.1 Sampling for Group D inspection. At the beginning of a production batch of 600 assemblies, 2 assemblies will be put on reliability.

4.5.4.2 Group D failure. Not any failure shall constitute acceptance of the group D inspection.

4.5.4.3 Disposition of group D inspection assemblies. Disposition of assemblies subjected to group D inspection shall be discussed with the purchaser.

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 mm diameter circle with 1-5 mlm of a tungsten light source at 2856K radiation and with a maximum 200 volts dc on the photocathode.
The photocurrent in µA corrected for leakage and dark current divided by the actual lumens is the 2856 K photocathode sensitivity. With the same dc voltage applied as above, insert a 800 and 850 nm filter between the photocathode and the 2856 K tungsten source. The 16 mm diameter area on the photocathode shall be illuminated with 800 and 850 nm radiation at a level between 0.1×10^{-6} to 1.10^{-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 800 and 850 nm, in mA/W. The 800 and 850 nm 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 0.8000 ± 0.0030 micrometer.
c. Peak placement wavelength of 0.8500 ± 0.0030 micrometer.
d. Bandwith at the 10% points of 0.0125, ± 0.0015 micrometer.
e. Minimum peak transmission of 40%.

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

4.6.2 Burn-in. Each assembly shall be operated as specified in 3.6.2 for 50 continuous cycles. The brightness gain setting shall not be changed during the burn-in test. Evidence of damage 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 ± 10%. 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 10 to 3500 Hz. Vary the frequency from 10 to 2500 Hz and return to 10 Hz in a logarithmic sweep in 30 minutes. Repeat this frequency sweep 2 times. At the conclusion in the 2 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 2 frequency sweeps. Failure to meet the 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 breakdown. 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.
Apply the shock impacts in such a way as to generate nominal half sine wave pulses having a minimum peak amplitude of 500 g's. The duration of each shock pulse shall be 2 milliseconds, ± 0.4 milliseconds, measured between the 10% values of peak amplitudes. The after oscillations shall be not greater than 15% of peak amplitudes of the nominal half sine wave pulse.
Evidence of damage or failure to meet the requirements of 3.6.4 shall constitute failure of this test.

4.6.5 Temperature (moderate). Place the assembly(s) in a test chamber at room temperature (+20°C). Perform the room temperature tests specified in table X. A minimum 22 mm, ± 0.5 mm diameter area of the photocathode shall be illuminated by the specified input illuminations. The test procedure for gain shall be a relative method.
Remove the operating potential. Gradually, in no less than 30 minutes, raise the temperature of the test chamber to +38°C and hold at this temperature for a minimum of 1 hour. At the end of the 1 hour stabilising period, perform the +38°C performance tests specified in Table X. The assembly shall be off not less than 3 minutes prior to performance of rise time tests. 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.c. Adjust the vertical sensitivity to obtain a minimum of 80% deflection from a zero reference. Apply the required operating potential to the assembly and in no greater than 10 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% brightness. After the +38°C tests are completed, remove the operating potential. Gradually, in no less than 30 minutes, lower the temperature of the test chamber to -17.8°C. Hold at this temperature for a minimum of 1 hour. At the

end of the 1 hour stabilising period, perform the -17.8°C performance tests specified in table X. The test procedures for rise time, gain and operational stability shall be the same as those used at +38°C. At the conclusion of the -17.8°C tests, remove the operating potential and gradually return the test chamber to room temperature.

Compute +38°C high temperature luminance gain (G_{htji}) (+38°C), where (as defined in 6.3.17) the gain to brightness relationships are as follows:

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

Compute -17.8°C low temperature luminance gain (G_{ltji}) (-17.8°) where:

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

Failure to meet the requirements of 3.6.5 shall constitute failure of this test.

TABLE X.

ENVIRONMENTAL TEMPERATURE (MODERATE)

TEMP.	INPUT LIGHT	GAIN	INPUT CURRENT	RISE TIME		OPER STAB.	
°C	lux	2.7 vdc	2.7 vdc	2.2 vdc	2.0 vdc	2.0 vdc	2.7 vdc
+20	2×10^{-5}	*					
+38	2×10^{-5}	*	*	*			
	10					*	(*)
-17.8	2×10^{-5}	*	*		*		
	10					*	(*)

* and (*) applicable to first article.
* Group B Samples.

4.6.6 Temperature (extreme). The humidity portion of the environmental tests may be conducted separately from the entire environmental test cycle. If the humidity test (6 hours, 95% humidity at 45°C) is conducted separately, then 4.6.6.2 and 4.6.6.3 shall apply. If the humidity test is conducted at the same time, 4.6.6.1 shall apply.

4.6.6.1 Temperature (extreme) and humidity. Place the assembly(s) in a test chamber at room temperature (20°C). Perform the room temperature tests specified in table XI. A minimum 22 mm, ± 0.5 mm diameter area of the photocathode shall be illuminated by the specified input illuminations. The test procedure for gain shall be a relative method. Remove the operating potential. Raise the temperature of the test chamber to +65°C. and hold at this temperature for a minimum of 2 hours. At the end of the 2 hour stabilising period, lower the test chamber temperature to +45°C and adjust the relative humidity to not less than 95%. Hold at this temperature and humidity for 6 hours. At the end of this 6 hour period with the temperature at +45°C reduce the relative humidity to less than 15%. Maintain this condition for a period of 6 hours. At the end of this 6 hour period raise the temperature to +52°C. At the end of the 1 hour stabilising period, subject the assembly(s) to the high temperature +52°C performance tests, specified in table XI. The assembly shall be off not less than 3 minutes prior to performance of 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 3.6.6.1.c. Adjust the vertical sensitivity to obtain a minimum of 80% deflection from a zero reference. Apply the required operating 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% brightness. After the +52°C tests are completed, remove the operating potential. Raise the temperature of the test chamber to +65°C and remain at this temperature for not less than 30 minutes. Thermal shock the assembly(s) from +65°C to room temperature within 3 minutes or less. Lower the temperature for a minimum of 1 hour. At the end of the 1 hour stabilising period, subject the assembly(s) to the low temperature -45°C performance tests specified in table XI. The test procedures for rise time, gain and operational stability shall be the same as those used at +52°C. At the conclusion of the -45°C tests, remove the operating potential. Lower the temperature of the test chamber to -57°C and remain at this temperature for not less than 2 hours. At the end of the 2 hour stabilising period, thermal shock the assembly(s) from -57°C 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 XI. The test procedures for operational stability shall be the same as that used at +52°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.

TABLE XI.

ENVIRONMENTAL TEMPERATURE (EXTREME)

TEMP	INPUT LIGHT	GAIN			INPUT CURRENT			RISE TIME			OPER STAB.		
°C	lux	2.0 vdc	2.2 vdc	2.7 vdc	2.0 vdc	2.2 vdc	2.7 vdc	2.0 vdc	2.2 vdc	2.7 vdc	2.0 vdc	2.2 vdc	2.7 vdc
+20	2×10^{-5}			*			* (1)						
	10										* (1)		(*) (1)
+52	2×10^{-5}		*	*		*	(*)		*	(*)			
	10											*	(*)
-45	2×10^{-5}	*		*	*		(*)	*		(*)			
	10										*		(*)

* group C test.
* and (*) applicable to first article.
(1) post test after completion of environmental cycle.

Compute high temperature luminance gain (G_{htji}), where (as defined in 6.3.17) the gain to
brightness relationships are as follows:

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

Compute -17.8°C low temperature luminance gain (G_{ltji}) (-17.8°) where:

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

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

4.6.6.2 Temperature (extreme). Place the assembly(s) in a test chamber at room temperature (20°C). Perform the room temperature tests specified in table XI. A minimum 22 mm, ± 0.5 mm diameter area of the photocathode shall be illuminated by the specified input illuminations. The test procedure for gain shall be a relative method. Remove the operating potential. Raise the temperature of the test chamber to +65°C and hold at this temperature for a minimum of 2 hours. At the end of the 2 hour stabilising period, lower the test chamber temperature to +52°C and hold at this temperature for 1 hour. At the end of this period, subject the assembly(s) to the high temperature +52°C performance tests specified in Table XI. The assembly shall be off not less than 3 minutes prior to performance of 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 3.6.6.1.c. 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% brightness. After the +52°C tests are completed, remove the operating potential. Raise the temperature of the test chamber to +65°C and remain at this temperature for not less than 30 minutes. Thermal shock the assembly(s) from +65°C to room temperature within 3 minutes or less. Lower the temperature of the rest of the test chamber to -45°C and hold at this temperature for a minimum of 1 hour. At the end of the 1 hour stabilising period, subject the assembly(s) to the low temp. -45°C performance tests specified in table XI. The test procedures for rise time, gain and operational stability shall be the same as those used at +52°C.
At the conclusion of the -45°C tests, remove the operating potential. Lower the temperature of the test chamber to -57°C and remain at this temperature for not less than 2 hours. At the end of the 2 hour stabilising period, thermal shock the assembly(s) from -57°C 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 XI. The test procedures for operational stability shall be the same as that used at +52°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 (G_{htji}), where (as defined in 6.3.17) the gain to brightness relationships are as shown in 4.6.6.1. Failure to meet the requirements of 3.6.6 shall constitute failure of this test.

4.6.6.3 Humidity. Place the assembly without any protective covering inside the test chamber. Raise the temperature to +45°C and adjust the relative humidity to not less than 95%. Hold at this temperature and humidity for 6 hours. At the end of the 6 hour period, remove the tube from the test chamber to room temperature. Within 12 hours perform the room temperature post test measurements specified in Table XI. Failure to meet the requirements of 3.6.6 shall constitute failure of this test.

4.6.6.4 Long time storage and operation temperature (extreme).
Place the assemblies in a test chamber at room temperature (20°C).
Put 2.7V on the tubes and inspect visual if the tubes works well (no flickering and emission spots are allowed).
Remove the operating voltage. Raise the temperature of the test chamber to +65°C and hold at this temperature for a maximum of 8 hours. Lower the test chamber temperature to +52°C and hold at this temperature for a minimum of 8 hours.
At the end of the 8 hours put 2.7V on the tubes and inspect visual if the tubes works well (no flickering and emission spots are allowed).
Remove the operating voltage and lower the temperature chamber to -52°C and hold this temperature for a minimum of 8 hours.
After this period of 8 hours switch on the voltage of 2.7V for a period of minimal 8 hours.
After this period of 8 hours inspect visual if the tubes works will (no flickering and emission spots are allowed).
Raise the chamber to room temperature (+20°C).

After this test measure the tubes on gain, EBI and photocathode, micro channel plate and screen quality.
The measured gain must be within plus or minus 10% of the gain before this test.

4.6.7 Equivalent background input (EBI). With the operating potential applied to the assembly and no radiation incident on the photocathode, hold for a stabilising period of not more than 15 minutes. At the end of the stabilising period with no radiation incident on the photocathode, measure the screen brightness cd/m^2 with a photometer and record the photometer reading (R). Illuminate the photocathode at a level between 2 x 10^{-11} to 7 x 10^{-11} lumen per square centimetre uniformly distributed over the full useful diameter, centred on the photocathode faceplate.
Record the photometer reading (R_2). The photometer shall be positioned such that the acceptance angle covers Ø16 to Ø17 mm. Determine the equivalent background input (EBI) by the following formula:

$$EBI = \frac{R_1}{R_2 - R_1} \times \text{actual input illumination}$$

Equivalent background input (EBI) alternate method. With operating potential applied to the intensifier and no radiation incident on the photocathode, hold for a stabilising period of not less than one (1) minute nor more than 15 minutes. At the end of the stabilising period with no radiation incident on the photocathode, measure the screen brightness with a photometer. Divide this reading by the luminance gain, and multiply it by cd/m^2. An EBI greater than that in paragraph 3.6.6 shall constitute failure of this test.
Failure to meet the requirements of 3.6.7 shall constitute failure of this test.

4.6.8 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 3.6.8 in sequence. Measure the input current and measure the image screen luminance with the photometer for each condition. The accurance angle of the photometer shall be 10 degrees or less.

Position the photometer so that the acceptance angle subtends a 16 to 17 mm diameter area centred on the phosphor screen. Luminance gain is determined by dividing the screen luminance in cd/m^2 by the actual input illumination in lux. Failure to meet the requirements of 3.6.8 shall constitute failure of this test.

4.6.9 Halo. Uniformly illuminate the photocathode of the assembly. The aperture shall be so as to produce a spot of light 0.2, ±0.01 millimetre in diameter on the photocathode faceplate of the assembly. The illumination in the spot shall be not less than 5×10^{-3} lux. The illumination incident on the photocathode of the assembly in the region outside of the 0.2 millimetre spot shall not exceed
5×10^{-6} lux. Measure the diameter of the halo (see 6.3.8) 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 3.6.9 shall constitute failure of this test.

4.6.10 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 millimetre and having an intensity of at least 50 millilumens (2856K not required). Failure to meet the requirements of 3.6.10 shall constitute failure of this test.

4.6.11 Signal-to-noise ratio. Using a F=1.4 ± 5 per cent, objective lens, image a circular spot no larger than 0.2 millimetre in diameter onto the photocathode of the assembly. The circular spot shall uniformly illuminate the photocathode at a level no greater than 108×10^{-6}lx. Focus the signal that is emergent from the assembly on a pinhole 0.2 millimetre 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 equivalent. After suitable amplification, pass the signal to a digital signal analyser set and measure the dc content and the rms value of the signal over an electronic bandwidth of 10 hertz.

The signal-to-noise (S/N) ratio is the ratio of the dc signal to the rms noise:

$$S/N = \frac{(So - S_{bkd})}{K(N^2_o - N^2_{bkd})^{1/2}}$$

Where:

S = DC signal
N = RMS noise
S_o = DC signal output measured from signal analyse
S_{bkd} = DC background signal when the light input to the assembly is closed.
N_o = RMS noise output measured from signal analyser
N_{bkd} = RMS background noise as measured from signal analyser 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 10 hertz independent of the frequency response of the assembly. K = 1.09 for a P20 phosphor.

Failure to meet the requirements of 3.6.11 shall constitute failure of this test.

4.6.12 Fixed pattern noise. With the operating potential applied to the assembly, illuminate the entire photocathode uniformly at a level of 2 x 10^{-3} ± 25% lux. 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 screen where the multi-to-multi pattern appears most noticeable. Search this area for the most contrasting adjacent multi-bundles and measure each multi-bundle brightness using an aperture of effective diameter equal to 1.3 the dimension of a multi-bundle diameter or 1/3 the distance from flat-to-flat for hexagonal multies.
b. Choose an area of the image screen where the multi-boundary pattern noise is most noticeable. Scan three 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 3.6.12 shall constitute failure of this test.

4.6.13 Output brightness uniformity.

4.6.13.1 Evenly illuminate the photocathode of the tube under test with 5 x 10^{-5} ± 25% lux. Observe the phosphor screen with a 10x magnifier for shading. If shading is observed perform the following:
a. Make a linear scan over the observed shading and calculate the maximum and minimum output brightness values.

Failure to meet the requirements of 3.6.13 shall constitute failure of this test.

4.6.13.2 Evenly irradiate the photocathode of the tube under test with
3 x 10^{-10} ± 25% watt of 830 nm radiation. Observe the phosphor screen with a 10x magnifier for shading. If shading is observed repeat step 4.6.13.1 a. Calculate the maximum to minimum output brightness uniformity ratio. Failure to meet the requirements specified in 3.6.13 shall constitute failure of this test.

4.6.14 Image alignment. With the operating potential applied, butt or project the pinhole on the photocathode such that the centre dot falls on the optical axis of the photocathode. The photocathode shall be illuminated to provide a high contrast image of the pinhole. Observe the image of the pinhole, formed on the screen of the assembly, with a 10 power-measuring magnifier. When the image of the centre of the pinhole is butted or projected on the optical centre of the photocathode, the screen image of the centre of the pinhole shall be examined to verify that it falls within the specified circle.
The microscope shall be aligned with the optical axis of the assembly. Failure to meet the requirements of 3.6.14 shall constitute failure of this test.

4.6.15 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 requirements of 3.6.15 shall constitute failure of this test.

4.6.16 Centre resolution. Perform this test using:
a. A radiation source which illuminate an opal glass and the target.
b. The image from the resolving power target is projected to the tube input.
c. A resolving power target having 3 bars horizontal and vertical on the background (1951 Air Force Resolving Power Test Target).

The resolving power test target shall be focussed or butted on the photocathode such that the centre 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 target formed on the screen of the assembly shall be observed for limiting resolution (see 6.3.16). Failure to meet the requirements of 3.6.16 shall constitute failure of this test.

4.6.16.1 Peripheral resolution. Determine the peripheral resolution with the same or equivalent test equipment used in 4.6.16. The resolving power target shall be focussed on the photocathode such that the group and element representing 64 line pairs per millimetre of the target is positioned 7 mm from the optical centre of the photocathode. Input radiation shall be adjusted for best image contrast. Failure to meet the requirements of 3.6.16.1 shall constitute of this test.

4.6.16.2 High light level resolution. Determine the centre resolution with the same or equivalent test equipment used in 4.6.16 The resolving power test target shall be focussed or butted on the photocathode such that the centre of the target is aligned with the optical axis. The input radiation shall cover a minimum of 17.5 millimetre diameter area of the photocathode and shall be a minimum of 5,000 lx. The image of the resolving power target formed on the screen of the assembly shall be observed for limiting resolution (see 6.3.16). Failure to meet the requirements of 3.6.16.2 shall constitute failure of this test.

4.6.17 Peripheral illumination stability. Mask off the centre 19.5 millimetre 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 fibre optic with an input illumination of 200 lux for not less than 20 minutes. Failure to meet the requirements of 3.6.17 shall constitute failure of this test.

4.6.18 Modulation transfer function (MTF). Equipment used to measure modulation transfer function must satisfy the following:
a. A sine wave analyser capable of direct read-out at (but not limited to) spatial frequencies within one line pair of the following: 2.5 line pairs per millimetre, 7.5 lp/mm, 15 lp/mm, 25 lp/mm and 30 lp/mm. Its spatial frequency accuracy must be ± 3%, and accuracy of MTF at each frequency must be ± 2% of full scale.
b. The analysing slit must be 10 micrometers or less in width by 1 mm or more in length.
c. The limiting aperture in the plane of the test pattern shall be a minimum of 2.0 mm in width referred to the phosphor screen of the assembly.
d. The test system zero frequency shall be 0.2 lp/mm or less.
e. The test system MTF shall be greater than 95% at 2.5 lp/mm.
f. Input illumination measured at the assembly photocathode shall be less than 2 x 10^{-2} equivalent 2856K lux.

Assembly MTF is arrived at by dividing MTF of the measuring system with tube in place by MTF of the measuring system without assembly.

Failure to meet the requirements of 3.6.18 shall constitute failure of this test.

4.6.19 Useful cathode diameter. With the operating potential applied to the assembly, focus or butt the test pattern (figure 6 or equivalent) on the optical axis of the photocathode at unity magnification. Adjust the input radiation level for best image contrast. The image screen shall be viewed with a 10 power magnifier. Useful cathode diameter is determined by the number of millimetre graduations visible on the screen of the assembly and shall be determined in both a vertical and horizontal direction. Failure to meet the requirements of 3.6.19 in both the vertical and horizontal directions shall constitute failure of this test.

4.6.20 Reversed Polarity. With no light incident on the photocathode, the assembly shall be operated with a reversed polarity input voltage for a period of not less than 60 seconds. Failure to meet the requirements of 3.6.20 shall constitute failure of this test.

4.6.21 Photocathode, microchannel plate and screen quality. With the operating potential applied and no radiation incident on the photocathode, observe the image screen with a 10 power magnifier. With an input light level adjusted for best spot contrast, but not more than 10^{-2} lux 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^{-5} lux, observe the screen for field emission, bright spots and graininess. If chicken wire is present to a degree that it distracts from normal performance, refer to the requirements of 3.5.2. Failure to meet requirements of 3.6.21 shall constitute of this test.

4.6.22 Phosphor decay. The phosphor decay characteristics of the assembly shall be determined by illuminating uniformly within ± 25%, the entire photocathode with a pulsed light (2856 K colour temperature is not required). The dark to light transition shall be less than one millisecond, the light time shall be 125 milliseconds, ± 10 milliseconds, and the light to dark transition less than 100 microseconds. The dark light shall be less than 4×10^{-6} lux. The instrumentation for the analysis of the decay time shall consist of a signal (pickup) system and trigger system. The signal system shall detect the output light from the phosphor. The resulting signal shall go to a signal analysing device. The response time of the entire signal system shall be less than 300 microseconds. The trigger system shall provide a means to obtain an electronic pulse directly related to the input light pulse. This trigger pulse shall
be capable of triggering the signal analysing device with a repeatability of ± 300 microseconds in terms of trigger time versus actual start of decay. The signal analysing device shall be capable of looking at the decay in several sections so that the value read at a particular time from 10 milliseconds is not less than 20% of full scale. Full scale accuracy shall be ± 1.0%. Failure to meet the requirements of 3.6.22 shall constitute failure of this test.

4.7 Reliability. The reliability test shall be conducted on assembly(s) in a chamber from 45°C, ± 3°C. ON-OFF cycling shall consist of 55 minutes of operation (ON time) followed by 5 minutes OFF. Input voltage to the assembly shall be 2.7 Vdc. The initial brightness gain of each assembly shall be minimum 9000 cd/m^2/lx. Acceptable limits of brightness gain during and at the completion of the test shall be 3200 to 15000 cd/m^2/lx. No gain adjustments shall be allowed during the test or inspections. Signal/noise shall be not less than 12.0 during this test or any inspection.
During the operating each assembly shall be illuminated with not less than 1×10^{-4}

equivalent 2856K lux. Once during each hour of operation the illumination of each assembly shall be increased to $5x10^{-3}$ equivalent 2856K lux for 5 seconds and to 50 equivalent lux for 3 seconds. 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 not less than once each 800 hours of operating time. 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.

4.7.1 Failure definition. Failure shall be defined as inability of the assembly to meet the assembly parameter requirements specified in 3.7.

4.7.2 Accept/reject criteria.

4.7.2.1 First article inspection. The accept/reject determination shall be specified in the contract of purchase order.

4.7.2.2 Quality conformance Group D inspection. Each assembly on test shall be operated until a total operating "ON" time of 15000 hours is accumulated on each assembly. If an assembly fails before the accumulated 15000 hours, the failed assembly shall be counted as a failure. Actions required relative to group D failures shall be discussed with the purchaser.

4.7.3 Non-relevant failures. Any failure attributed directly and solely to overstress induced by the inspection procedure such as an assembly connecting wire breaking after the first 800 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 replacements of such image intensifier assembly(s). The time on the replacement shall begin at zero. The time on 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 operational life.

4.8.1 Test conditions. The tube element shall be operated under the following conditions:

a. Input illumination shall be 108×10^{-6} equivalent 2856K lux uniformly distributed over the useful cathode diameter. The absolute light level shall be accurate within ± 10% and shall stay constant within ± 3% over the test period.

b. Initial minimum brightness gain shall be 9,000 and shall not drop below 7,000 cd/m^2lx during the test.

c. Photocathode sensitivity (θ) shall be measured on the test-set. Luminous flux shall be accurate within ± 10% and shall stay constant within ± 3% over the test period. Total relative error in the measurement of photocathode sensitivity (0-) shall be less than 4% and shall be random in nature.

d. The signal-to-noise ratio shall be measured or calculated in accordance with 4.6.11 in the sequence called out in table VI or the test plan and this value shall be used in

predicting the assembly life.

e. The operating parameters including voltages shall be recorded.

4.8.2 Life test. The tube element shall be operated for 85 hours, exclusive of measurement and off time. Photocathode sensitivity (0-) shall be measured at least every 7.5 hours starting at 40 hours. A least square exponential fit shall be made using the measurements from 40 to 85 hours to determine for the equation:

$\theta- = b \exp - \alpha\varepsilon (t-40)$

Where: αε and b are constants determined by least squares fit.

The signal-to-noise ratio for t = 0 and t = 15000 hours shall be computed as follows:

$(S/N)_{t=0} = (S/N)_{t=85} \exp (\alpha\varepsilon / 2 \times 85)$

$(S/N)_{t=15000} = (S/N)_{t=85} \exp (-\alpha\varepsilon / 2 \times 14915)$

A signal-to-noise ratio projected to 15000 hours of operation $(S/N)_{t=\ 15000}$ shall not be less than 11.0 Failure to meet this requirement shall constitute failure of this test. This test can be carried out also in an accelerated way at 5.4. 10^{-4}lux instead of 108. 10^{-6} lux, the operating time shall be 17 hours instead of 85 hours.

4.9 Inspection of packaging. Packaging shall be in accordance with DEP-specification.

5. PACKAGING. Packaging shall be in accordance with DEP specification.

6. NOTES.

6.1 Intended use. The assembly covered by this specification is intended for use in 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 Ordering data. Procurement documents should specify the following:
a. Title, number and date of this specification.
b. Quantity and schedule for first article testing (see 4.3).
c. Production delivery schedule.

6.3 Definitions of terms.

6.3.1 Photocathode. The photocathode Anti veiling glare faceplate is herein referred to as the photocathode.

6.3.2 Phosphor. P20 or equal phosphor shall exhibit the decay characteristics shown on figure 5. The peak relative spectral response of the phosphor screen shall occur at a wavelength between 510 and 560 nm. The bandwidth shall be less than 200 nm measured at the 10% points of the spectral response curve.
Additionally, the relative response at 650 nm shall be less or equal to 10%.

6.3.3 Shear distortion. Is defined as the displacement or rotation of a small line segment with respect to a perfect straight line image.

6.3.4 Chicken wire. Defined as a predominate pattern of dead fibres which has a diameter equal to or less than 0.02 mm (2 single fibres) whose light transmission is so degraded that with light projected through the optic, single fibres in area of question can not be distinguished or identified as single fibres with the use of 50 power magnification.

6.3.5 "g". g is defined as an acceleration or deceleration of 9.8 m/sec^2.

6.3.6 Rise time and decay time. The rise time is the time required for the assembly to achieve 50% 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 x 10^{-2} lux after the voltage source is disconnected.

6.3.7 Room temperature. Room temperature shall be defined as + 20°C ± 3°C, for all tests except EBI, for which room temperature shall be defined as 20°C, ± 2°C.

6.3.8 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.

6.3.9. Damage. Damage shall be defined as:
a. Electrical failure or malfunctioning including arcing, corona, flashing, bright spots, flickering, blinking, or change in input current.
b. Cracks, breakage, deformation, corrosion, deterioration of any part or finish, missing or loose components.
c. Degradation of image quality including ion noise, dark spots, or shading.

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

6.3.11 Multi-boundary Pattern Noise. Discernible spatial gain variation between peripheral and interior channels of a multi-pattern or group of channels.

6.3.12 Modulation transfer. Modulation transfer is a measure of the degradation of a signal image as it appears at the output screen of the assembly as correlated to the input signal pattern which is normalised to 100% contrast at a spatial frequency equal to or less than 0.2 lp/mm.

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

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

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

6.3.16 Limiting resolution. Limiting resolution is defined as the smallest resolution pattern which the observer can see and distinguish between the lines and the area between the lines. The observer shall be able to determine the number of line pairs in both the

vertical and horizontal test patterns.

6.3.17 Environmental gain computations.

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

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

6.3.19 Degradation. Degradation is defined as a significant change in measurable characteristics which result in failure of the assembly to meet specified requirements or indicate that there is an inherent defect in the operating characteristics of the units.

6.4 International standardisation agreements. Not applicable

Fig.2 Environmental cycle moderate for 18 mm assembly

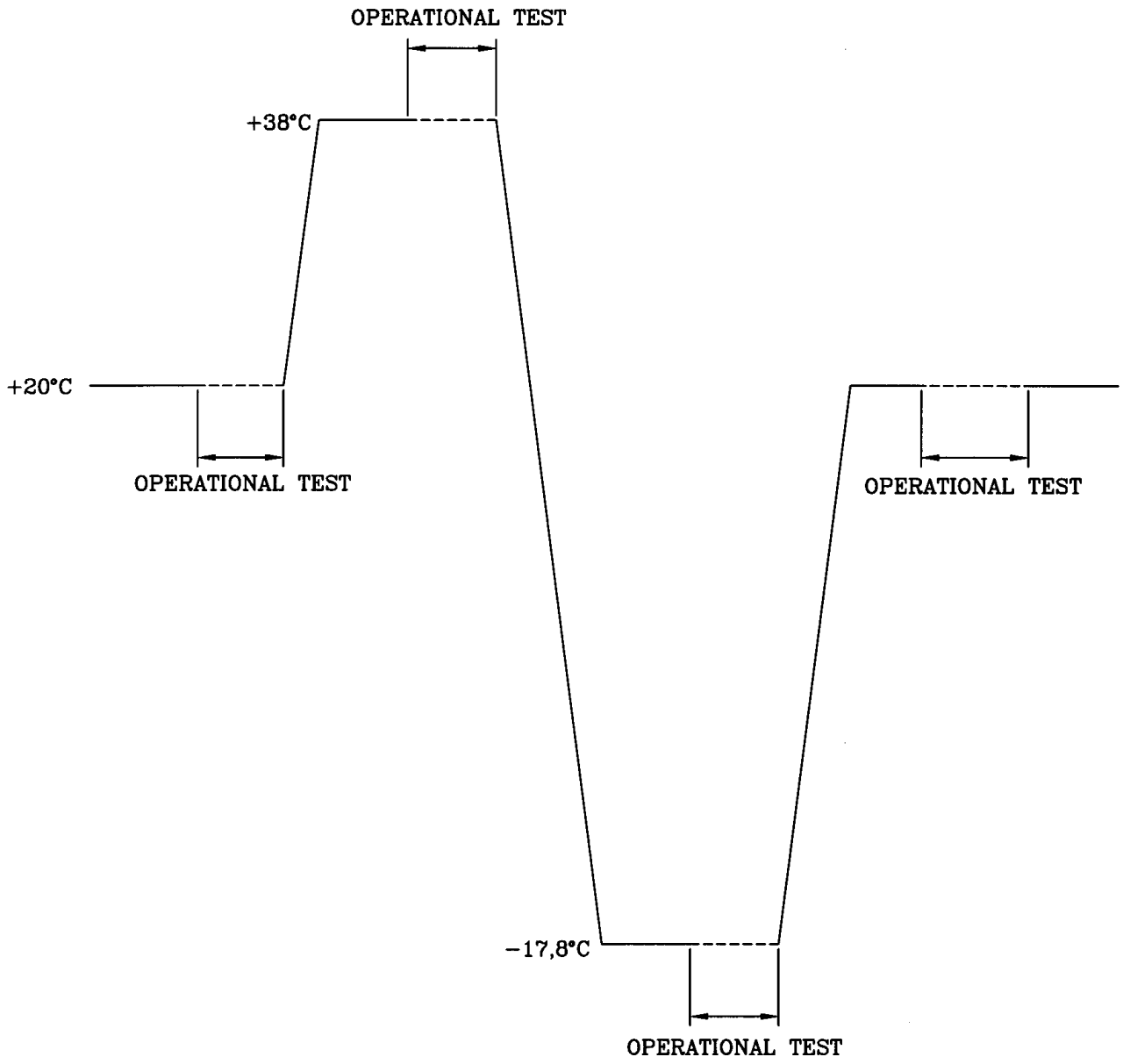


Fig.3a Environmental cycle extreme for 18 mm assembly

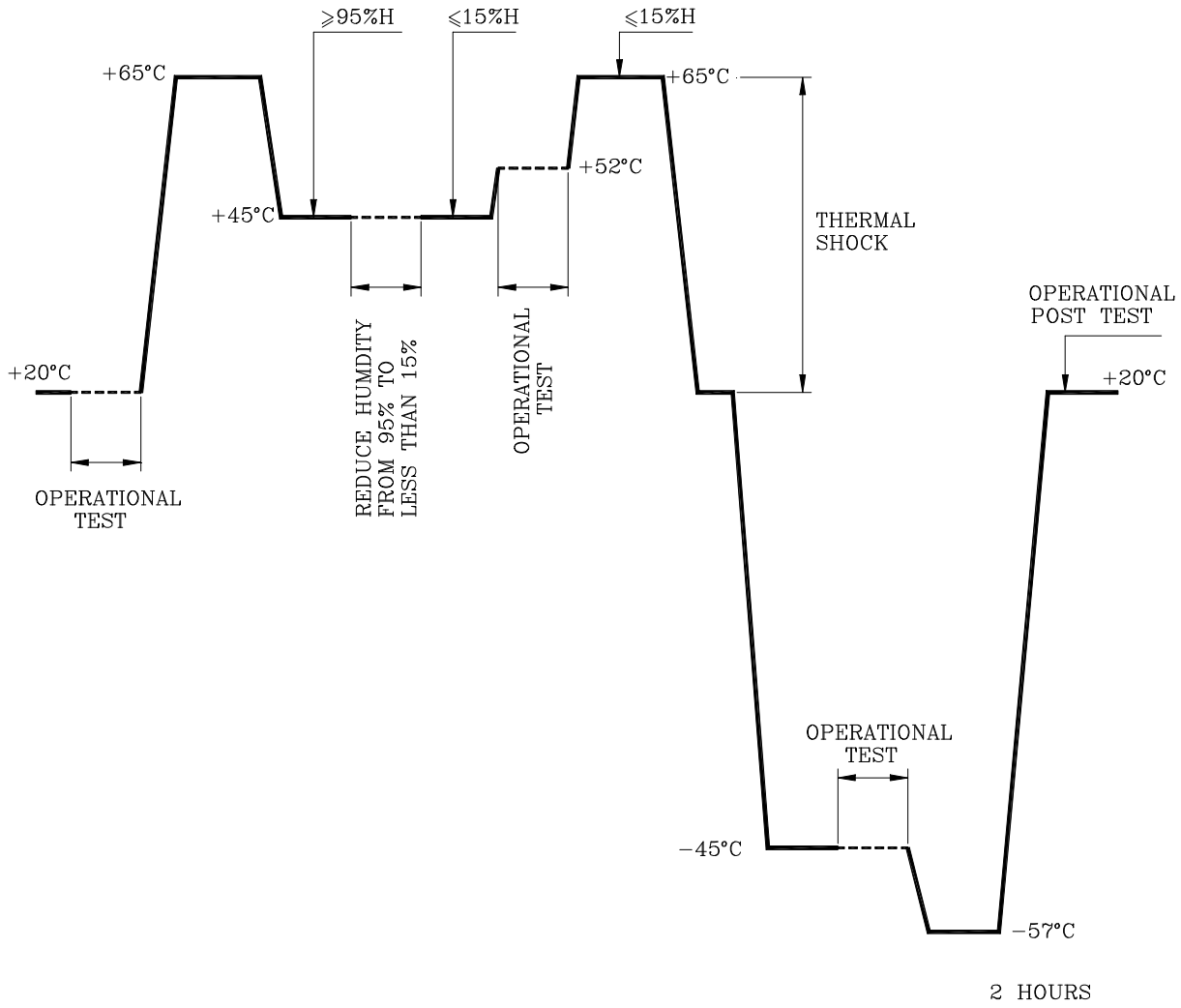


Fig.3b Environmental cycle extreme

Long time storage and operation for 18 mm assembly

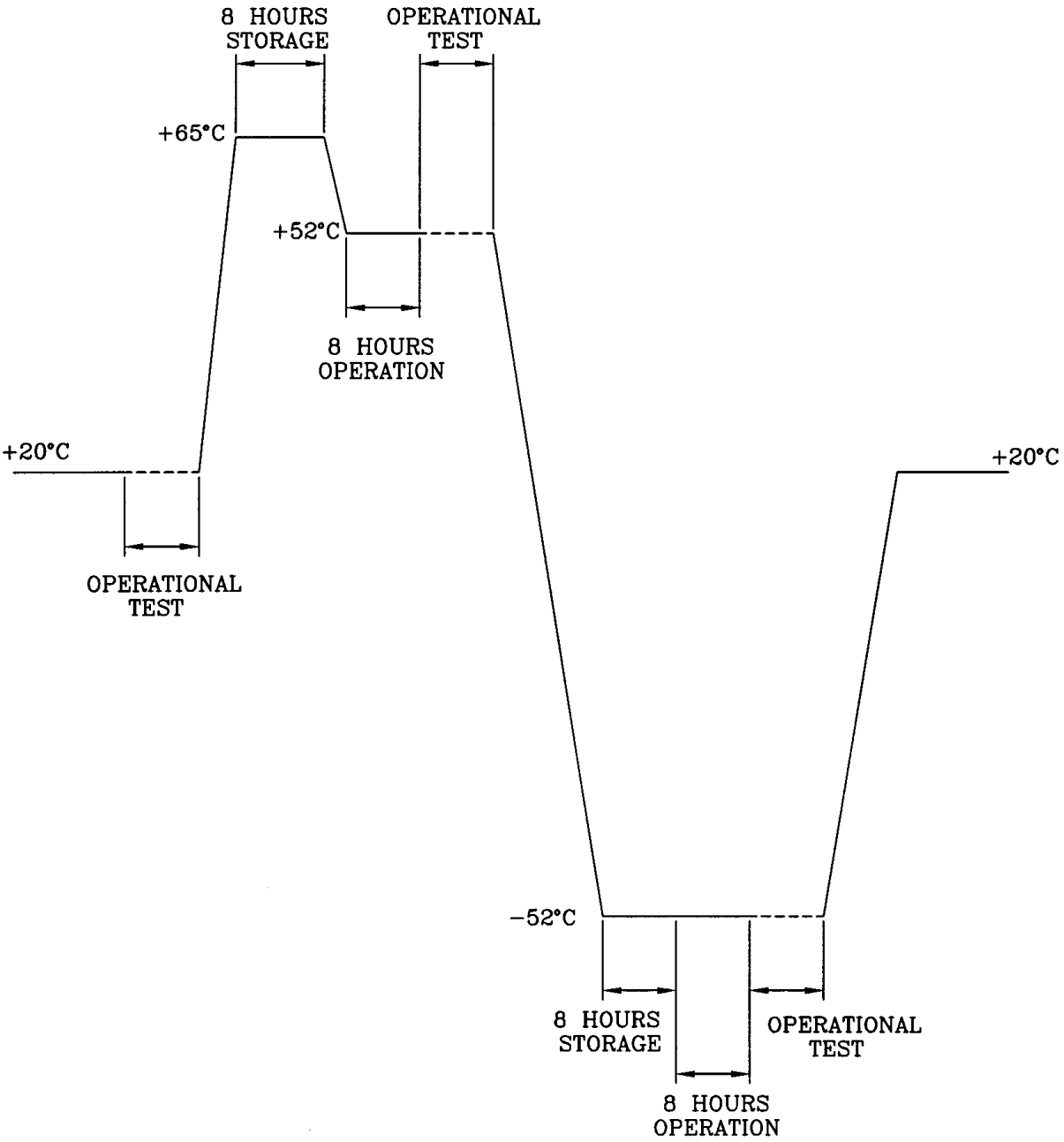


Fig.4 Gain/saturation requirement

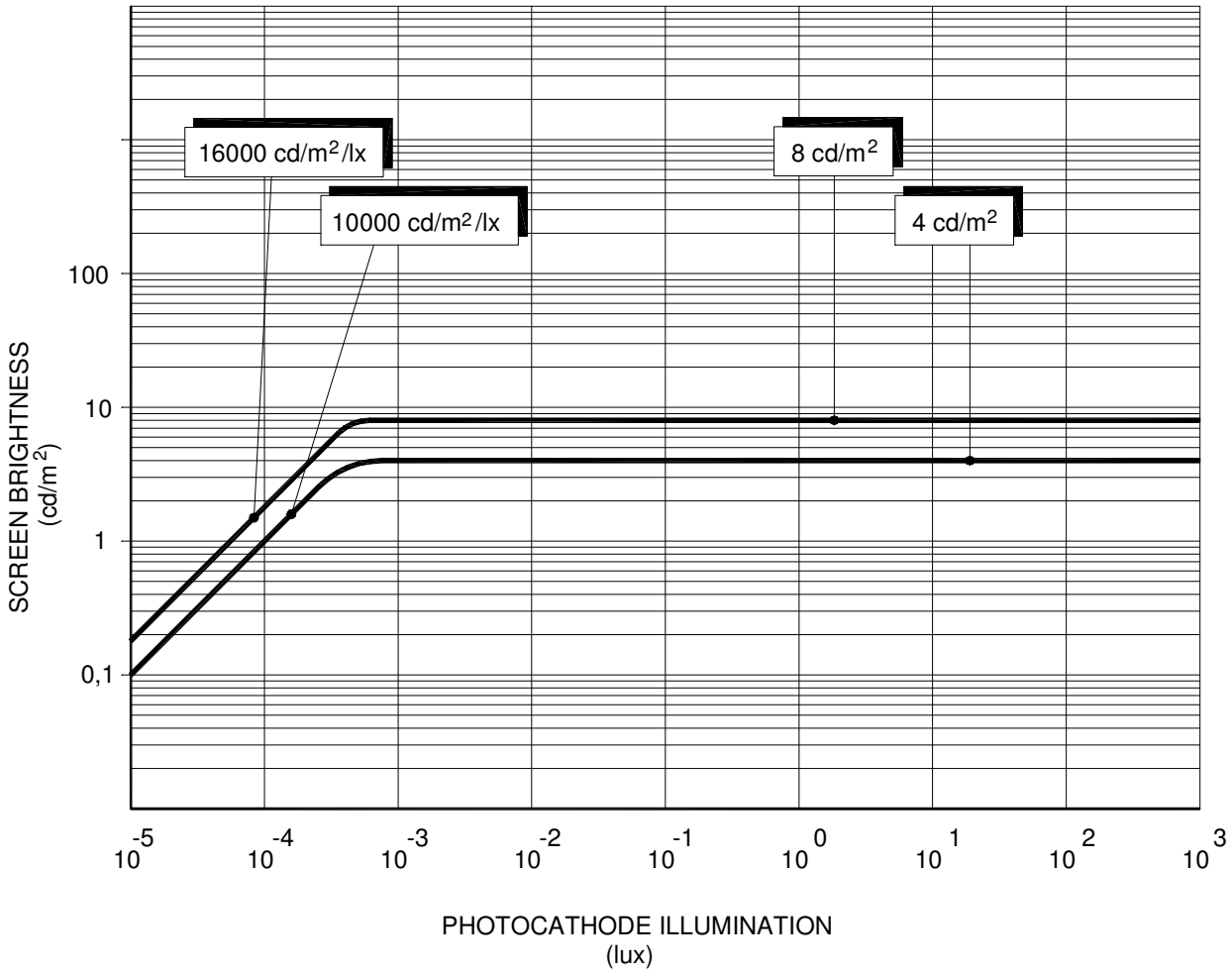


Fig. 5 Phosphor emission characteristic

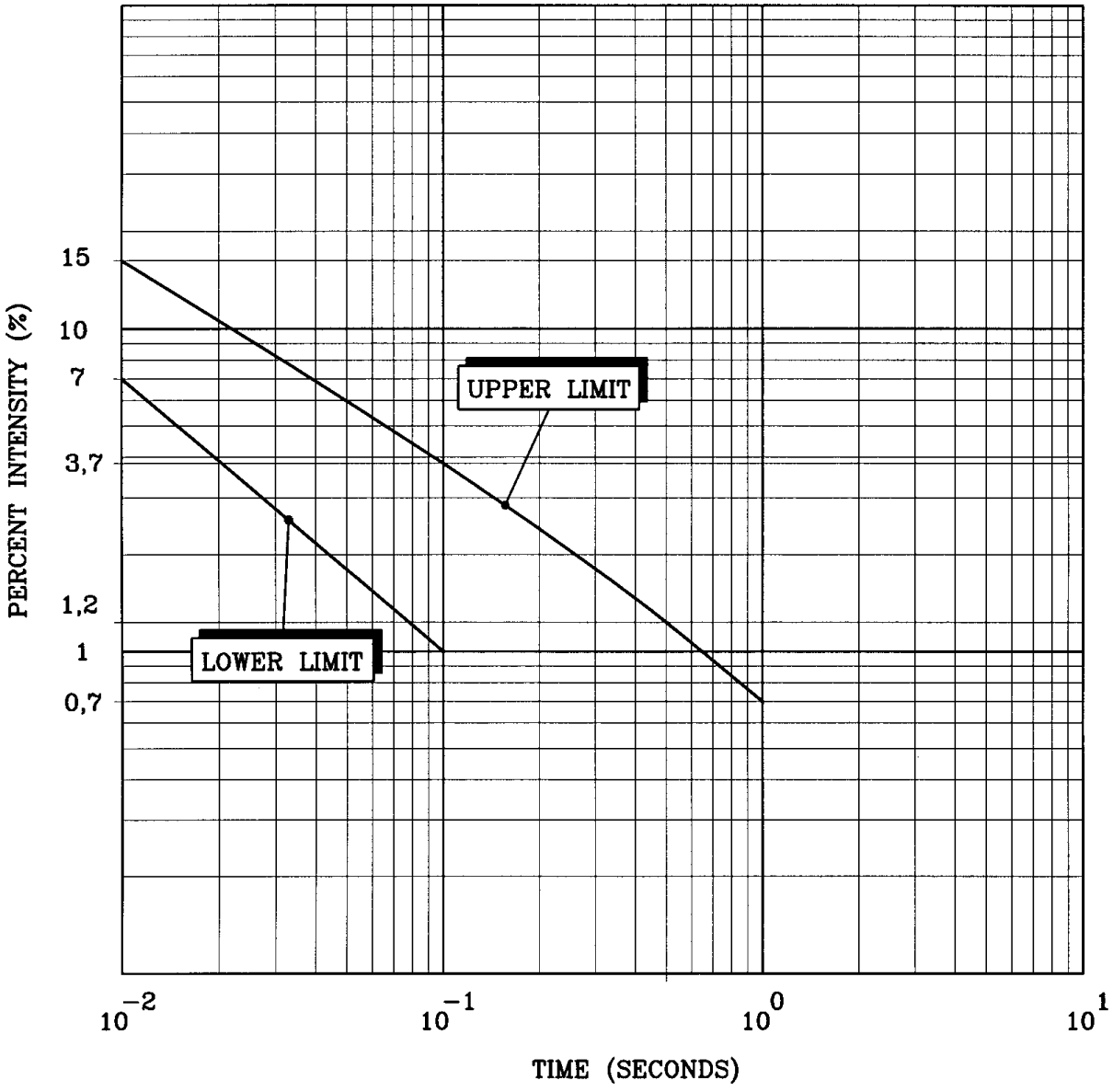
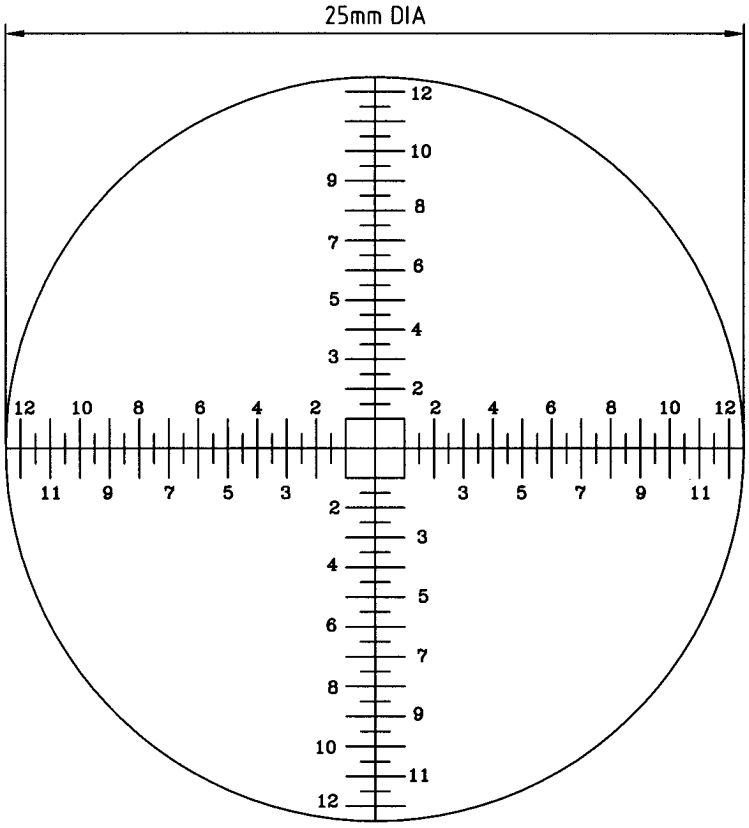


Fig.6 Test reticle, image alignment and useful cathode diameter



Note:
The test reticle shall consist of equally spaced lines from the centre of the 25 mm diameter circle to the edge of the circle in 4 directions 90° apart spacing between a large graduation and a small graduation shall be 0,5 millimetre ±0,03 millimetre, spacing between two large graduations shall be 1,0 millimetre ±0,03 millimetre. The centre of this reticle shall be a square 2 millimetre on a side.

Width of all lines to be 0,127 millimetre ±0,0254 millimetre.
All lines, letters and numbers shall be high contrast on a clear glass substrate.