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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Night Vision System	Electro-optical
Night Vision Goggles	Low Light Level
Night Vision Devices	LLL Binoculars
Image Intensifiers	
Starlight Scopes	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The test operations procedure (TOP) delineates general test and specific subtest procedures required to measure the technical performance of Night Vision Goggles (NVG). Comparison of test results with criteria and technical specifications permits evaluation of their suitability for an intended use.

The NVG is a self-contained, night vision viewing system worn on your head or hand-held. It provides the operator with improved night vision capabilities using available light from the sky allowing the operator to see and (cont)

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(Item 20 continued)

move in the night and perform such manual tasks as map reading, vehicle maintenance, short-range surveillance, etc. The NVG is used only at night. It is not used as a substitute for daytime vision.

This TOP is limited to tests outlined herein, which are applicable only to night vision goggles.

The following test will measure:

a. Physical Characteristics
b. Field of View
c. Magnification/Linear Distortion
d. Interpupillary Distance
e. Focus Adjustment
f. Resolution
g. Brightness Gain
h. Visual Acuity
i. Depth Perception
j. Depth of Field
k. Radioactive Materials
l. Forward Projection
m. Center of Gravity
n. Objective lens f number
o. Objective lens T number
p. Veiling Glare
q. Flange Focal Distance
r. Relative Illumination
s. Field Flatness/Field Tilt
t. Exit Pupil Eye Relief
u. Diopter Adjustment
v. Transmission

The ability to perform radio tasks, map reading, and drive cross-country while wearing the goggles will also be investigated.

US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

11 July 1985

AMSTE-RP-702-105
Test Operations Procedure 6-2-603
AD No. ______

IMAGE INTENSIFIERS, NIGHT VISION (AN/PVS-7 GOGGLES)

1. SCOPE. This test operations procedure (TOP) describes methods of evaluating the technical characteristics of Night Vision Goggles (NVG) (see fig. 1) relative to criteria specified in the Required Operational Capability (ROC). Letter Requirements, and/or Purchase Description. The types of NVG covered by this TOP are passive or active, binocular and monocular, hand-held or rigid-mounted devices which provide individual monocular focusing. Both contractor and Government testing will be addressed.

Requirements exist for a lightweight head-mounted self-contained night vision system. A night vision device is an electro-optical viewing instrument that images and amplifies the available illumination from a scene by means of a low-light-level, image-intensifier tube energized by an electronic power supply.

Night vision devices may be either passive or active, depending upon their source of illumination. Passive devices use only the light available from the moon or stars (10^{-2} to 10^{-5} footcandles) as a light source. This light is amplified by means of the image intensifier tube to produce a visible picture of the scene being observed. Active devices depend on an artificial source of light which may or may not be visible to the unaided eye. When the light rays of the source are reflected back from the scene and focused on the image intensifier tube, the light is amplified to produce the visible picture. It will permit the user to view distant objects or events, under conditions of

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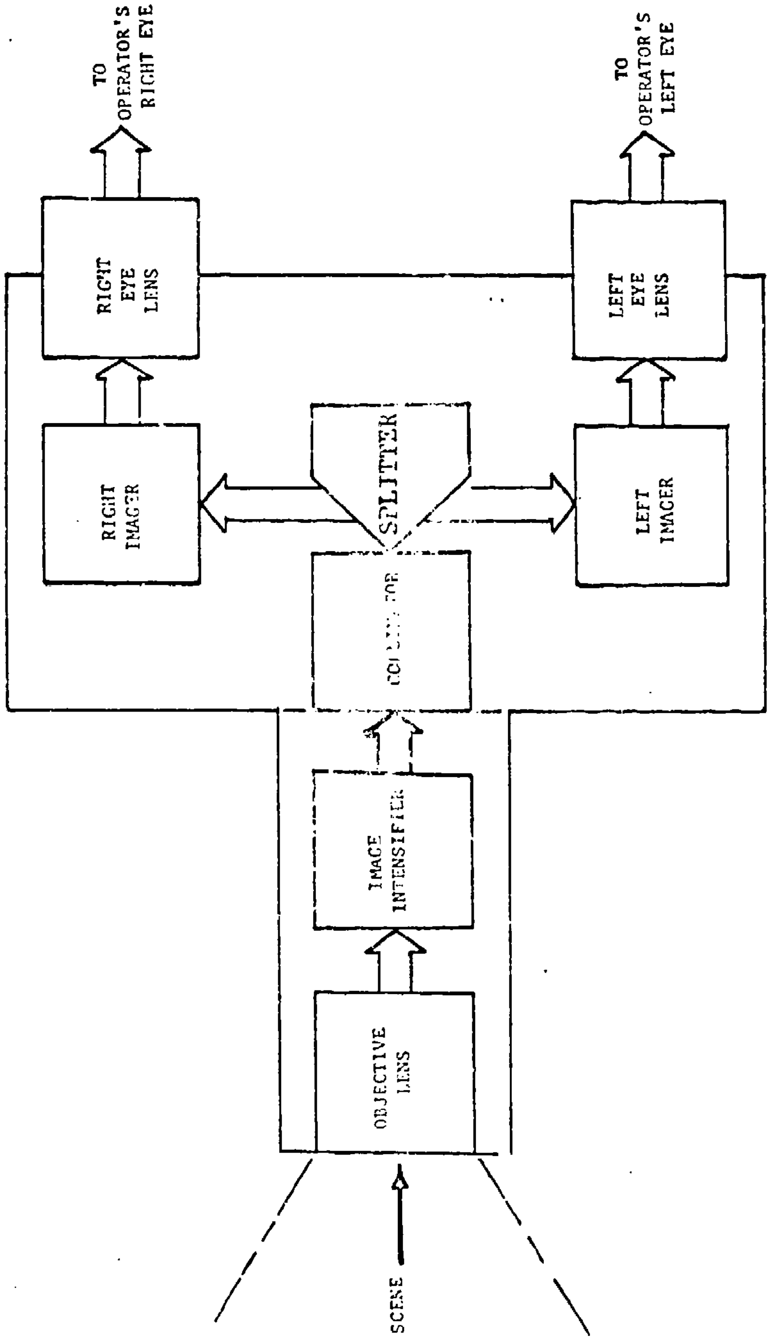


Figure 1. Functional diagram night vision goggles.

starlight, less than starlight, and moonlight, that would not otherwise be discernible to the unaided eye under those conditions. The NVG would also be used by the individual user for walking, driving vehicles, short-range surveillance, and such manual tasks as map reading, vehicle maintenance, and administering medical aid.

Common Engineering Tests. Not included in this TOP are the following Common Engineering Tests which apply to this commodity.

a. TOP 1-2-609, Instructional Material Adequacy Guide and Evaluation Standard (IMAGES), Jan 81.

b. TOP 1-2-610, Human Factors Engineering, 30 Nov 83, AD Nos. 140343 and 140391.

c. TOP 6-2-503, Reliability, 23 Mar 70, AD No. 869926.

d. TOP 6-2-504, Maintenance/Maintainability, 25 Mar 70, AD No. 871133.

e. TOP 6-2-507, Safety and Health Evaluation - Communication/Electronic Equipment, 15 Jun 81, AD No. A103808.

f. TOP 6-2-542, Electromagnetic Interference Tests for Electronic Equipment, 1 Feb 74, AD No. 775446.

g. MIL-STD-810D, Environmental Test Methods, 19 Jul 83.

2. FACILITIES AND INSTRUMENTATION

2.1 Facilities

a. The performance tests will be conducted in a large fully equipped darkroom or similar facility where the light conditions can be carefully controlled and verified by measurement. Light conditions should be established to approximate less than starlight, starlight, and moonlight levels.

b. The facility must have the capability of conducting all the required electrical/performance bench tests and environmental tests.

c. A complex cross-country course, including a figure eight and a three-point turn, will be used for vehicle driving. The course will be on flat terrain.

2.2 Instrumentation and Equipment

Luminance Standard
Calibrated Light Level Meter (photometer)
Boresight Collimator
Text Fixture compound Rotary table, 10 inch and 5 inch, calibrated in degrees
Goggle Holder
Diopter Scope

Test Paddle containing (2) 5-mm pupils located 51 mm apart
and (2) 5-mm pupils located 72 mm apart
The standard visual acuity target-the Landolt C Target Ring uniform density
Detector Assembly
Vibrating Reed Electrometer Amplifier
Optical Transfer Function (OTF) test set
Test Set TS-3895 (GFE item)
Recorder
Standard NBS Optical Resolution Charts
Howard-Dahlman type depth perception apparatus
Vernier scales of 0.1-mm accuracy
Fulcrum - contractor fabricated
Scale - mm increments
Collimator - 101.6-mm fl with mm reticle - contractor fabricated
Traveling Microscope
Objective Holding Fixture - contractor fabricated
Optical Bench
Integrating Sphere - contractor fabricated with detector holder and iris
Aperture - contractor fabricated
Collimator - 2856°K $\pm$50°K source
Silicon Detector System - Microamp Meter Readout Spectral Blocking Filters - contractor fabricated
Veiling Glare Test Fixture - contractor fabricated
Photometer - 250 Extended Rad tube.
Microspectra Lens
XYZ Traverse Stage
Microscope - (20x) Numerical aperture $\geq$0.65
Microscope Adapter - Containing a piece of tube face plate glass of known thickness point source - contractor fabricated
Rotary Table - 5 inches - with objective holder - contractor fabricated
Neon Laser
Dummy Image Tube with mask containing 1-mm apertures on axis at $\pm$18° field - contractor fabricated
Viewing screen - mm grid - contractor fabricated
Eyepiece assembly holding fixture - contractor fabricated
Diopter Scope - contractor fabricated - +2 to -6 diopters
Dummy Image Tube - contractor fabricated
Illumination Source
Transmission Test Plate Assembly - contractor fabricated
5-mm pupil - contractor fabricated
Gallium Arsenide Detector
PMT Preamp
Data Acquisition System
Power Supply
Oscilloscope - Monitor
Decwriter
High Voltage Power Supply
Weight Scale - accurate to 1 gram
Dr. Kronenberg's Eye Equivalent Nuclear Sensing Device, 0.5 percent by weight (500 ppm)

2.3 Characteristics/Requirements. Select test equipment accuracy of at least ten times that of the function to be measured. The above listed major facilities, instrumentation, and equipment will provide the necessary characteristics and setups required to perform the following subtest procedures which will measure system:

a. Physical Characteristics
b. Field of View
c. Magnification/Distortion
d. Interpupillary Distance Adjustment
e. Focus Adjustment
f. Resolution
g. Brightness Gain
h. Visual Acuity
i. Depth Perception
j. Depth of Field
k. Radioactive Materials
l. Forward Projection
m. Center of Gravity
n. Objective lens f number
o. Objective lens t number
p. Veiling Glare
q. Flange Focal Distance
r. Relative Illumination
s. Field Flatness Field Tilt
t. Exit Pupil Eye relief
u. Diopter Adjustment
v. Transmission

The ability to perform radio tasks, map reading, and drive a cross country course while wearing the goggles will also be investigated.

3. REQUIRED TEST CONDITIONS

a. Review TECOM Pamphlet 70-3, Research, Development, and Acquisition and Project Engineer's Handbook, 16 Jun 78, for guidance on test planning, execution, reporting, and post-test activities.

b. Establish and/or continually maintain a readily accessible project log and project file.

c. Review local installation project officer's handbook, standing operating procedures (SOP), and implementing directives which govern the administrative processes of preparing test plans, conducting tests, preparing reports, reporting to the Test Resource Management System (TRMS), and budgeting.

d. Acquire and review all specifications and other descriptive and instructional material on the test items issued by the Government and Contractor(s) for checking the test plan instrumentation requirements.

e. Prior to monitoring Contractor testing, a pretest inspection of the Contractor facility is required to determine if the test instrumentation has proper calibration dates and the environmental chambers are adequate.

f. The developer will be notified of acceptability or nonacceptability of Contractor test facilities.

g. The raw data collected at the Contractor facility will not be condensed, but will be a complete presentation of all collected and recorded values/observations.

h. Identify, for each type of data, the source documents containing the methods or procedures which were followed during data acquisition.

i. Provide the contractor test plan to the Government within 45 days after contract award so that a review of the plan is accomplished before start of test witnessing.

j. Testing conducted by contractors must meet appropriate minimum standards in order for the data to be used in lieu of Government testing.

k. Determine the scheduled availability of the test item.

l. Ensure availability of appropriate facilities and coordinate the test support requirements including personnel, equipment, maintenance, spare parts, and instrumentation.

m. Review the detailed test plan.

n. Record as a minimum, the following data:

(1) Nomenclature, serial number(s), manufacturer's name, and function of the item(s) under test.

(2) Nomenclature, serial number, calibration requirements, and last calibration date of test equipment selected for the tests.

(3) Damage to the test item(s) incurred during transit and/or manufacturing defects.

(4) Test item photographs.

o. Establish instrumentation or measurement system mean error and standard deviation of error.

p. Determine test item sample size.

q. Organize test item and establish responsibilities for test conduct, reporting, and data control according to TECOM Supplement 1 to AMC Regulation 310-6, 24 Oct 80.

r. Select test equipment having an accuracy at least ten times greater than that of the function to be measured.

s. Familiarize all test personnel with the test item instructional material.

t. Prepare adequate safety precautions to provide safety for personnel and equipment and ensure all safety requlations are observed throughout the test.

u. Inspect the test item thoroughly for obvious physical and electrical defects. Note and correct all defects before proceeding with testing.

v. Prepare, disseminate, and continually review record forms for systematic entry of data, chronology of tests, and analysis in final evaluation of the test item.

w. Prepare and monitor a test item sample plan sufficient to ensure that enough samples of all measurements are taken to provide statistical confidence of final data in accordance with TOP 3-1-002.

x. Perform such preliminary tests as necessary to ensure the test item(s) is in satisfactory condition. Perform warm-up time for instrumentation and test items, check battery status, i.e., check cabling for shorts and opens, etc.

y. Illuminate those performance tests which require collimators with tungsten filament lamps operated at a correlated color temperature of 2856° $\pm$50° Kelvin as their radiation source.

z. Purge the viewer assembly anytime the image intensifier is removed for any reason. Accomplish the purging by the Contractor or Government tester anytime it is deemed necessary during testing of the night vision goggles. The procedure in Appendix F will be followed.

aa. Test conditions for objective:

1. GaAs photocathode (3rd Gen) for all photometric measurements.

2. 2856 $\pm$ 200°K white light source.

3. MTF scan area 0.5 mm.

4. Off-axis MTF meaurements must be performed in same focal plane as on-axis.

ab. Test conditions for Eyepiece

1. S-11 photocathode
2. Simulated phospher source
3. MTF scan area 0.5 mm

4. TEST PROCEDURES

NOTE: Modification of these procedures shall be made as required by technical design of the night vision goggles and availability of test equipment, but only to the extent that such modified procedures will not affect the validity of test results.

4.1 Test Methods (Government)

4.1.1 Physical Characteristics

a. Weight. Weigh the night vision goggles and mask assemblies and all ancillary equipment on a scale accurate to at least 1 gram.

b. Size. Repeat measurements (dimensions) on all of the test items received.

4.1.2 Field of View

a. Install batteries into the goggle assembly and mount in goggle holder on 10-inch rotary table. (See fig. 2.)

b. Conduct this test in a darkened room, 2.5×10^{-4} footcandle (FC).

c. Turn collimator on and turn goggles on.

d. Adjust goggle objective to "infinity" and eyepiece diopter rings for corrected vision.

e. Rotate 10-inch rotary table clockwise while viewing through eyepieces until the beam of light is located at the edge of field of view. Record the angle from the rotary table in degrees.

f. Rotate the 10-inch rotary table counter clockwise while viewing through eyepieces until the beam is located at the edge of the field of view. Record the angle from the rotary table.

g. Take the algebraic difference of the readings recorded in steps e and f. Record on data sheet.

4.1.3 Magnification/Distortion

a. Conduct this test in a darkened room, 2.5×10^{-4} FC.

b. Install batteries into the goggle assembly and mount in goggle holder on the 10-inch rotary table. (See Fig. 2.)

c. Turn collimator and goggles on.

d. Adjust goggles' objective to infinity.

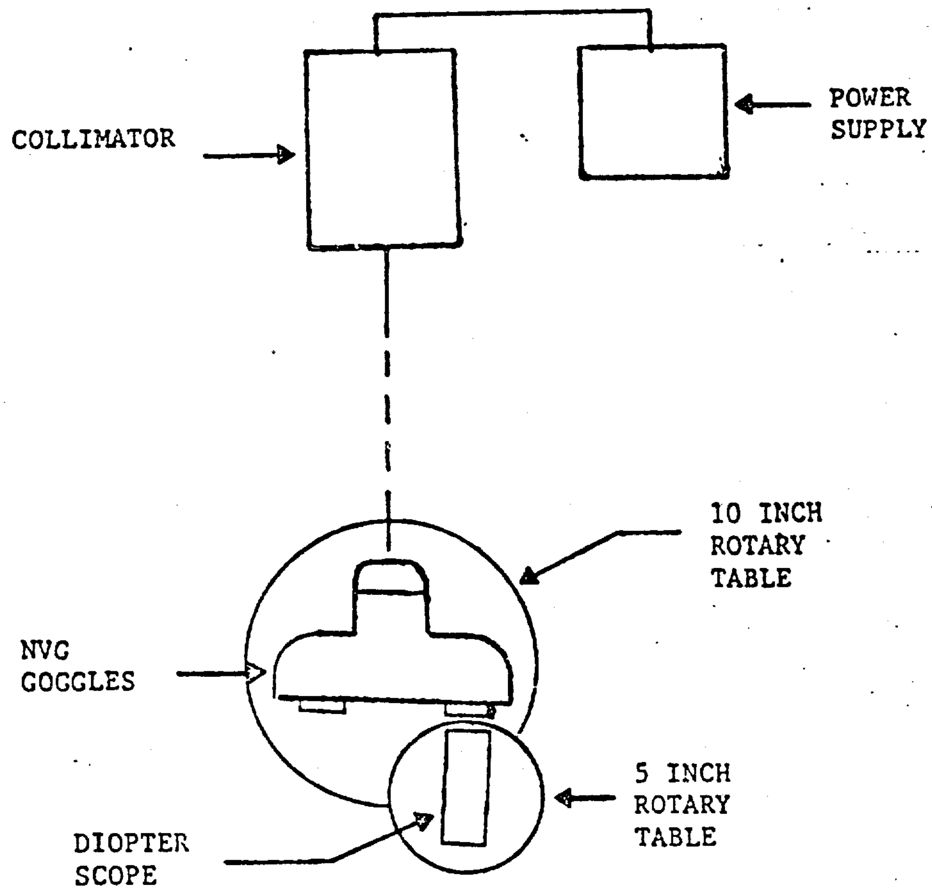


Figure 2. Test setup for FOV, magnification/distortion.

e. Rotate the 10-inch rotary table clockwise while viewing through eyepieces until the beam of light is located at the edge of the field of view.

f. Record the angle from the rotary table on data sheet.

g. Rotate the 10-inch rotary table counterclockwise while viewing through eyepieces until the beam is located at the opposite edge of the field of view.

h. Record the angle from the rotary table on data sheet.

i. Take the algebraic difference of the reading recorded in steps f and h and divide by two.

j. Establish the center of the field from the angle obtained in step i.

k. Take readings at ±5°, ±10°, ±15°, and ±20° from the center of the field. Determine the 10-inch rotary table settings for each required angle.

l. Mount diopter scope holder on 5-inch rotary table.

m. Rotate the 10-inch table while viewing through scope until crosshair is aligned with beam coming out of the eyepiece.

n. Record the angle in degrees from the 5-inch rotary table, and record on data sheet.

o. Continue by rotating the 10-inch table to desired angles +20°, +15°, +10°, +5°, -5, -10°, -15°, and -20° respectively, and rotating the 5-inch table while viewing through scope to align with each respective angle. Record readings from 5-inch table at each position on data sheet.

p. Determine the algebraic difference of the readings obtained on the 5-inch rotary table at ±5°, ±10°, ±15°, and ±20°. Record angles on data sheet.

q. Calculate the magnification of the goggles under test as follows:

$$\text{Magnification (M)} = \frac{\tan \theta_1}{\tan 5^\circ}.$$

where θ_1 is equal to algebraic difference of the readings in degrees obtained at +5° and -5° divided by two.

r. Record magnification (M) on data sheet.

s. Calculate the linear distortion across the field at ±20°, ±15°, and ±10° as follows:

$$\text{Distortion (D\%)} = \frac{\tan \theta_2}{(M)\tan x} - 1 \times 100\%.$$

where:

$x = 20°$ and θ_2 = the algebraic difference of the readings in degrees obtained at $\pm 20°$ divided by two.

$x = 15°$ and θ_2 = the algebraic difference of the readings in degrees obtained at $\pm 15°$ divided by two.

$x = 10°$ and θ_2 = the algebraic difference of the readings in degrees obtained at $\pm 10°$ divided by two.

(M) = the magnification previously calculated in step q.

t. Record the three calculated distortions on the data sheet.

u. Remove the goggle from the holder, and reverse it in the fixture to allow taking measurements through the other eyepiece.

v. Repeat steps b through s and record magnification and linear distortions obtained on the data sheet.

4.1.4 Interpupillary Distance (IPD) Adjustment

a. Conduct this test in a darkened room, 2.5×10^{-4} FC light level.

b. Locate test paddle axially with objective of goggles and at 15-mm eye relief distance. (See fig. 3.) Record maximum and minimum distances between exit pupils. (Eye relief is the maximum distance from the vertex of the eye to the vertex of the nearest eyepiece optical element along the optical axis.)

c. Turn goggle on and set IPD adjustment to 51-mm position.

d. View through each 5-mm pupil located 51 mm apart and verify the whole field can be seen through each pupil. Record operator comments on data sheet.

e. Adjust the IPD to 72-mm position.

f. View through each 5-mm pupil located 72 mm apart and verify the whole field can be seen through each pupil. Record operator comments on data sheet.

4.1.5 Focus Adjustment

a. Conduct this test in a darkened room, at 2.5×10^{-4} FC light level.

b. Install batteries in goggles and mount on rotary table. Turn goggles on.

c. Adjust eyepieces to accommodate vision.

d. Adjust objective focus while viewing target in collimator. Set at infinity. (See fig. 4.)

e. Ascertain the image to be sharp and focused.

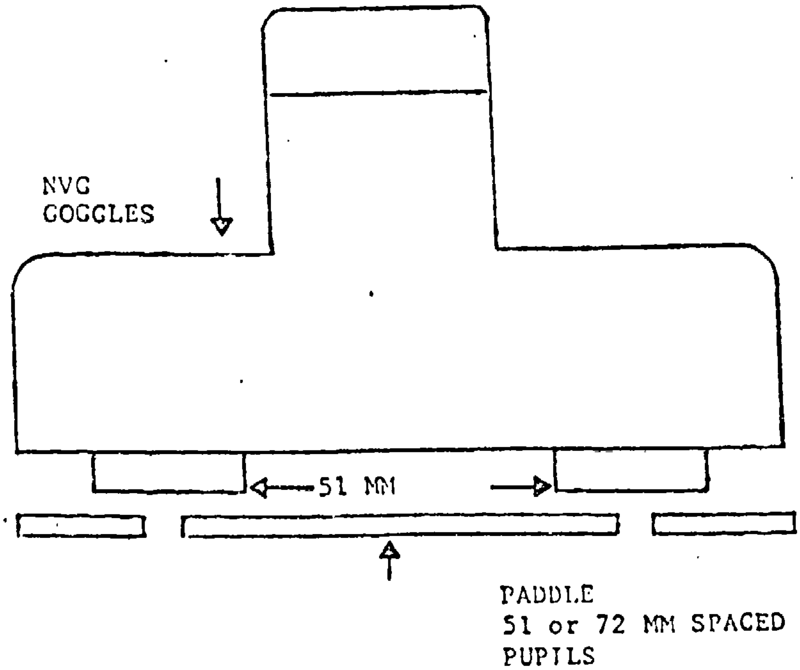


Figure 3. Test setup for interpupillary adjustment.

f. Rotate the table to view target on light box which is 25 cm away from front of objective. Rotate the objective counterclockwise until the image is sharp and focused.

g. Record results on data sheet.

4.1.6 Resolution

a. Install standard resolution charts (obtained from the National Bureau of Standards) in a darkened room, at the chart specified distances at which resolution is to be measured. A commonly used chart is the Large Size Resolution Test Object RT-2-72 Type AB, which is a standard 3-bar black-on-white chart. Refer to MIL-HNBK-141 "Optical Design".

b. Illuminate the resolution chart with a background light level of $< 2.5 \times 10^{-4}$ FC.

c. Install batteries in the night vision device, turn the goggles on, and adjust eyepieces to accommodate vision.

d. Observe the set of chart resolution lines that are just discernible as distinctly separated lines while viewing the chart through the night vision device.

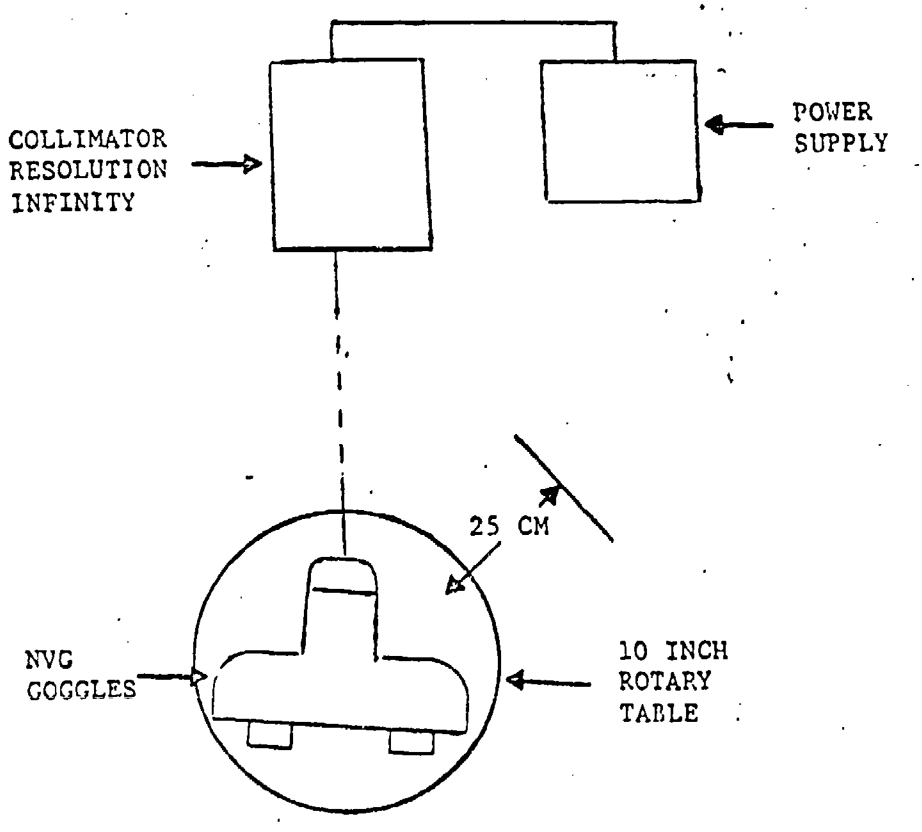


Figure 4. Test setup for focus adjustment.

e. Record the numerical resolution of the night vision goggles as indicated by the chart for the set of lines observed in step d above.

f. Repeat steps c, d, and e above illuminating the resolution charts with background light levels of 2.5 to 3.0 x 10^{-3} FC and > 3.0 x 10^{-3}.

4.1.7 Brightness Gain

a. Conduct this test in a darkened room and the test setup will be as shown in figure 5.

b. Adjust the light source with the night vision goggles omitted from the test setup to the desired level by varying the attenuation and the slit size.

c. Record the light level in footcandles and correct for the photometer sensitivity.

d. Turn on the night vision goggles, focus to infinity, position in the optical path, and check for proper alignment.

e. Position the photometer head to read the light level from each eyepiece of the goggles.

f. Adjust the photometer head for maximum reading. Record the light level reading on the data sheet.

g. Unfilter the light source 2854°K (white light).

h. Repeat the test procedure described in steps d through f with the light source turned off to determine the light level from the ambient background of the darkened laboratory.

4.1.8 Visual Acuity

a. Conduct the test in a darkened room whose light conditions can be carefully controlled.

b. Establish light conditions as: low, <2.5 x 10^{-4} foot candles; medium, 2.5 x 10^{-4} FC, to 3.0 x 10^{-3} FC, and high, >3.0 x 10^{-3} FC.

c. Select the personnel to be thoroughly trained in the use of the night vision device.

d. Assess the visual acuity using the standard visual acuity target -- the Landolt C ring. (See Appendix C.)

e. Mount the target on a moveable carriage over a measured course. (A steel measuring tape secured to the floor can be used.) The subject wearing the night vision device will be seated directly in front of the target with his eyes at zero position.

f. Instruct the subject to say STOP as soon as he can determine the orientation (left, right, up, or down) of the Landolt C gap. Move the target outside the user's visual range and then slowly move it towards the subject until STOP is indicated.

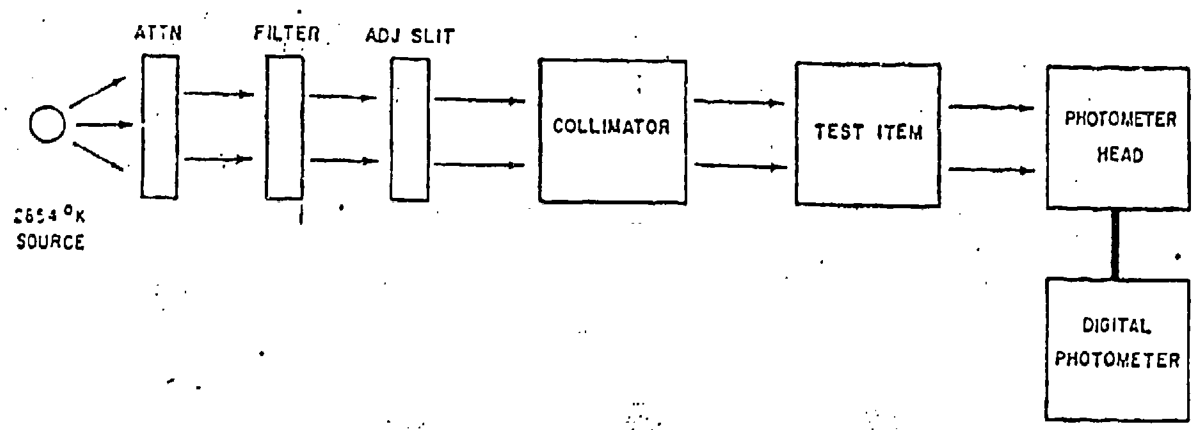


Figure 5. Test setup for brightness gain.

g. Ask the subject to indicate the gap orientation. If the subject is correct, record the distance. If an incorrect gap orientation is reported, slowly move the target closer until the subject indicates the correct gap orientation. Then record the distance.

h. Take measurements from each point of stoppage to the subject's eyes.

i. Allot to each subject 20 trials for each test condition (subject, light intensity, and goggle type).

j. Vary target sizes and gap orientation randomly throughout the trials.

k. Express the visual angle as the angle θ where:

$$\tan \theta = S/R.$$

where

S = gap size

R = range of observer to target.

4.1.9 Depth Perception

a. Set up a Howard-Dahlman (H-D) depth perception apparatus in a darkened room. The apparatus consists of two horizontal rods, one with a stationary upright and one with a moving upright.

b. Seat the subject wearing the night vision device a distance of 15 feet in front of the window of the H-D apparatus.

c. Place the movable upright randomly at various distances in front of or behind the stationary upright. Cover the window in the apparatus while the uprights are positioned to preclude any cues to the subject.

d. Open the window and ask the subject to manipulate the movable upright until both uprights appear even.

e. Measure the amount of error between the uprights and record it.

f. Control for eye dominance by giving each subject 10 trials with the moveable upright on the left and 10 trials with the moveable upright on the right.

g. Control light conditions to be low, $<2.5 \times 10^{-4}$ FC; medium, 2.5×10^{-4} to 3.0×10^{-3} FC; and high, $>3.0 \times 10^{-3}$ FC.

h. Perform the test for each of the light levels in step g.

4.1.10 Depth of Field

a. Conduct this test in a darkened room at low, $<2.5 \times 10^{-4}$ FC and medium, 2.5×10^{-4} FC to 3.0×10^{-4} FC light levels.

b. Seat the subject wearing the night vision device in front of the Howard-Dahlman depth perception test apparatus resting his/her chin in a fixed position.

c. Hold the legibility specimen perpendicular to the line of sight on a calibrated track along which it may be moved with respect to a fixed viewer's head position with the test apparatus.

d. Measure the depth of field at 15 and 30 inches from the face by first obtaining optimal focus at the indicated range and then measure the near and far limits at which a page of printed material, originally legible, becomes significantly blurred or illegible.

e. Perform at least six trials per distance and light level with each participant.

4.1.11 Radioactive Materials

a. Survey each lens prior to testing by use of Dr. Kronenberg's eye equivalent nuclear tester to determine the level of thorium emitted from the lens.

b. Clamp the test item to a tripod to ensure no movement during test run. Remove rubber eyecups prior to test to allow the lens to be located 1 centimeter from mylar window of the detector. (See fig. 6.)

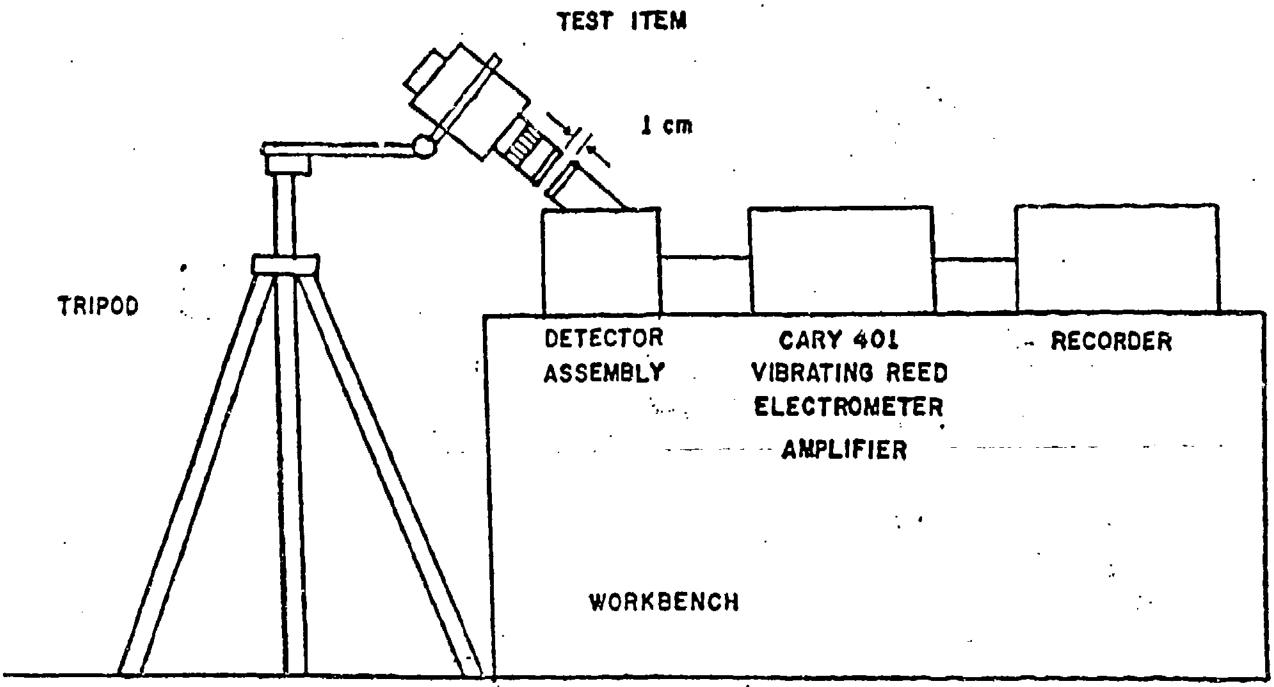


Figure 6. Test setup to check for thorium material.

c. Ensure maximum accuracy at the beginning of each day's runs by running a background and standard reference lens. (The background will be subtracted from each test item lens, and the reference lens will be used to calibrate the measuring system.)

d. Examine each recorder trace for any indication of radiation from the lens upon completion of the runs.

4.1.12 Field Tasks

4.1.12.1 Radio Task

a. Perform this test under low light level, $<2.5 \times 10^{-4}$ FC by a qualified radio repairman.

b. Make the test participant wear the night vision goggles during the conduct of the test.

c. Turn on the goggles and adjust the eyepieces to accommodate vision.

d. Make participants disassemble, assemble, and operate a portable tactical radio with and without light emitting diodes (LEDs).

e. Make the operator receive and record by hand five random five-letter groups of messages composed from the NATO standard word spelling alphabet while the radio is in operation with and without LEDs.

f. Retransmit the handwritten message after a 1-minute pause.

g. Record the difficulty of writing and reading the message by commentary and observed errors.

h. Conduct three trials per participant.

4.1.12.2 Map Reading

a. Perform this test under a low light level of $<2.5 \times 10^{-4}$ FC, by a trained map reader.

b. Make the test participant wear the night vision goggles during the conduct of the test.

c. Turn on the goggles and adjust the eyepieces to accommodate vision.

d. Turned on the infrared (IR) LED and have the operator locate designated standard features by grid reference and read selected information.

e. Record difficulties in identification of standard features and time to complete the task.

f. Conduct three trials per participant.

g. Repeat the test procedure described in steps d, e, and f with the IR LED turned off.

4.1.12.3 Cross Country Vehicular Driving

a. Perform this test under a low light level of $<2.5 \times 10^{-4}$ FC by a licensed driver familiar with the vehicle being driven.

b. Make the test participant wear the night vision goggles; turn them on and adjust the eyepieces to accommodate vision.

c. Use a gentle but complex cross-country course including a figure eight and a three-point turn. Use pylons to set up the figure eight and three-point turns.

d. Hold speed to safe limits and equip an assistant driver with a night vision device for safety (e.g., if for some reason the driver's goggles fail to operate properly).

e. Record the time for completion of the course and number of pylons hit for one trial per participant. Solicit comments after each trial.

4.2 Test Methods (Contractor, Government Witnessing).

4.2.1 Forward Projection

a. Set the goggle objective focus to the near focus position.

b. Set the goggle eyepiece diopter rings to the +2 diopter position. (accurate to 0.1 mm)

c. Measure the distance from the front of the objective housing to the eyepiece lens using the Vernier scale (accurate to 0.1 mm).

d. Add 15 mm eye relief distance (maximum) to measurement obtained in step c.

e. Record the total measurement of forward projection on data sheet.

4.2.2 Center of Gravity

a. Install the battery into the goggle and place the goggle without mask on a fulcrum.

b. Move the goggle back and forth on the fulcrum until the point of balance is determined.

c. Measure the distance from the edge of the fulcrum to 15 mm behind the eyepieces.

d. Record the distance on the data sheet.

e. Remove the battery. If more than one type of battery can be used in the goggles (e.g., lithium, "AA" or mercury) install the other type.

f. Repeat steps b through d.

4.2.3 Objective Lens f Number

a. Mount objective assembly into objective holding fixture and position holder to measure focal length of number (fig. 7).

b. Slide objective lens holder along optical bench until reticle assembly of collimator is in sharp focus while viewing through eyepiece of traveling microscope.

c. Measure the apparent image height of central 4 mm of the collimator reticle using the traveling microscope.

d. Calculate the effective focal length (EFL) of the objective lens under test using the formula:

$$\text{EFL (objective)} = \text{Image Height (measured)} \times \frac{101.6\text{mm}}{4\text{ mm}}.$$

(40 inches equals 101.6-mm, which provides a factor of 25.4 in the EFL formula.)

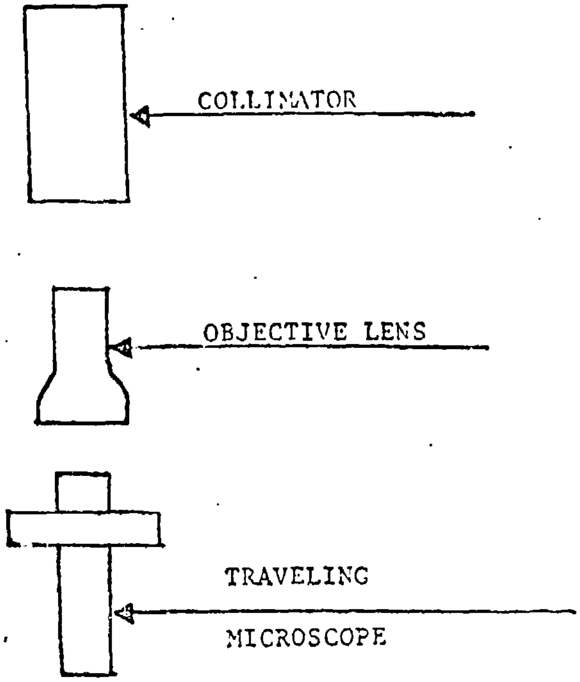


Figure 7. Test setup for f number.

e. Record on data sheet.

f. Rotate the objective lens holder 180°, and using the traveling microscope, measure the effective aperture of the objective under test (Aperture I).

g. Record on data sheet.

h. Calculate the f number of the objective using the formula:

$$\text{f number} = \frac{\text{EFL (Step e)}}{\text{Effective aperture (Step g)}} \;;\; f = \frac{\text{EFL}}{\text{Aperture I}}$$

4.2.4 <u>Objective Lens t Number</u>

a. Mount objective assembly into objective holding fixture (fig. 8).

b. Open iris on integration sphere to its full open position.

c. Position the collimator and aperture to illuminate the objective, and read the available energy shown on the microamp meter.

d. Record the reading from the microamp meter on the data sheet.

e. Remove the objective lens tested from holder.

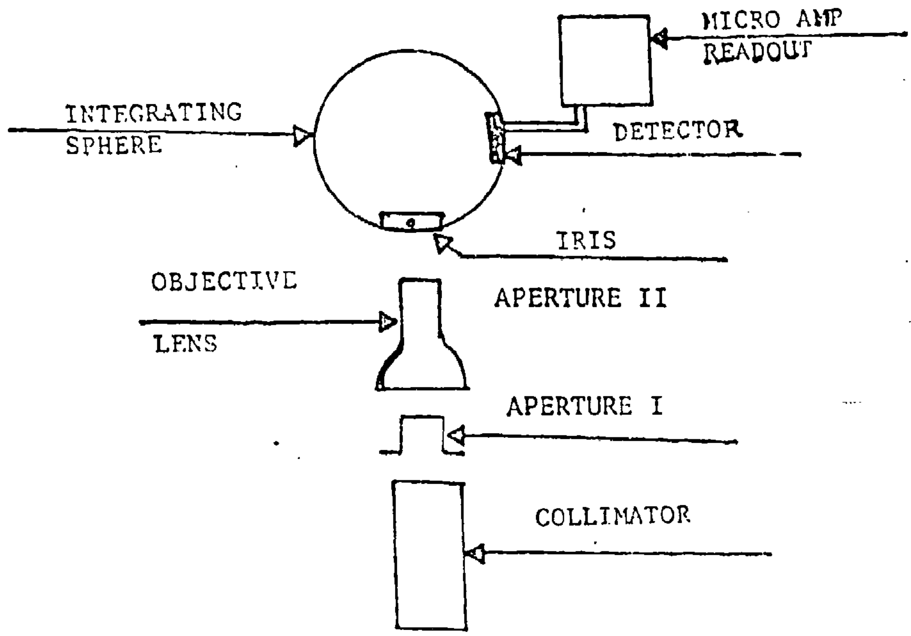


Figure 8. Test setup for t number.

f. Close the iris of integrating sphere down until the same reading as recorded in step d is obtained while watching the microamp meter.

g. Read the aperture size from the iris and divide this aperture size by the input aperture to determine percent transmission.

$$T\% = \frac{\text{Aperture II}}{\text{Aperture I}}.$$

h. Record transmission on data sheet.

i. Calculate t number using formula.

$$\text{T number} = \frac{\text{f number}}{\sqrt{\text{transmission (t)}}} \; ; \; t = \frac{(\text{f no.})^2}{(\text{T no.})^2}.$$

Where: f number - previously calculated for objective transmission from step h of paragraph 5.2.3.

j. Record results on data sheet.

4.2.5 Veiling Glare

a. Conduct this test according to MIL-STD-150A in a darkened room, 2.5 x 10^{-4} FC.

b. Turn veiling glare test fixture on.

c. Turn on the photometer and allow to warm up.

d. Calibrate photometer in accordance with manufacturer's instructions.

e. Slide photometer holder to position one, and focus on the black hole (Fig. 9).

f. Record reading of photometer on data sheet.

g. Slide photometer to position two.

h. Record reading on data sheet.

i. Divide reading recorded in step f by reading recorded in step h, and record results on data sheet.

j. Screw micro-spectra lens onto photometer and place in position one.

k. Install objective lens in holder of veiling glare fixture making sure it is fully seated.

l. Refocus photometer on rear of objective assembly.

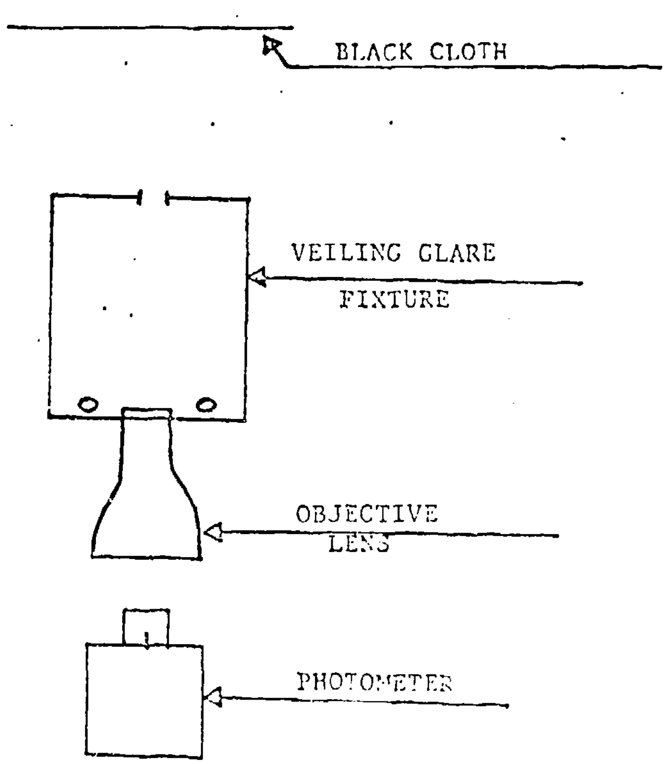


Figure 9. Test setup for veiling glare.

m. Read the output of the black holes on the photometer, and record on data sheet.

n. Slide photometer to position two.

o. Record the reading on data sheet.

p. Divide reading obtained in step m by reading recorded in step o.

q. Veiling glare for the objective lens assembly is computed as follows:

$$\frac{\text{Reading in step m}}{\text{Reading in step o}} - \frac{\text{Reading in step f}}{\text{Reading in step h}} \times 100\% = \text{veiling glare.}$$

r. Record results on data sheet.

4.2.6 Flange Focal Distance

a. Mount objective lens under test onto objective holder (fig. 10).

b. Place microscope adapter on microscope. Turn collimator on.

c. Adjust microscope objective, using XYZ stage, so it is aligned with the optical axis of the objective lens.

d. Move the objective, using Z stage, until the front of the microscope adapter face plate glass touches the flange in the objective.

e. Record reading from Z stage micrometer on data sheet.

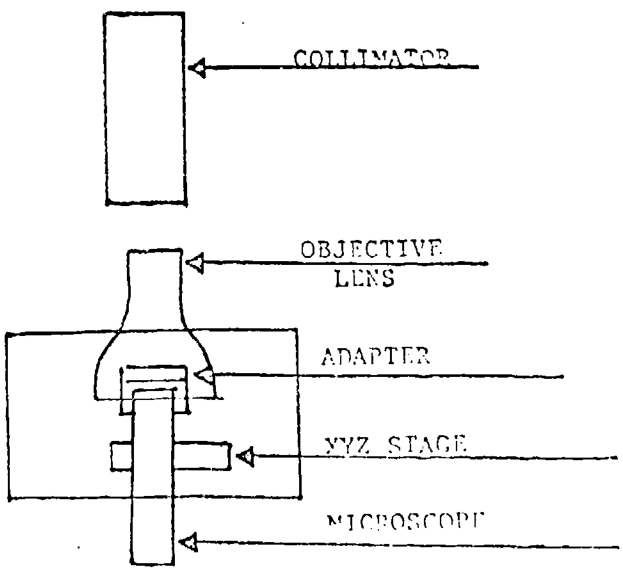


Figure 10. Test setup for flange focal distance.

f. Move Z stage micrometer, while viewing through eyepiece of microscope, until the infinity spot is in focus.

g. Record reading from Z stage micrometer.

h. Subtract micrometer readings obtained in step e and step g; add known face plate dimension to this reading. See manufacturer's specifications (dimensions).

i. Record the flange focal distance on data sheet.

j. There is no requirement or procedure to insure the flange is parallel to the X,Y stages.

4.2.7 Relative Illumination

a. Install the objective lens in holder, position collimator and aperture to illuminate objective lens under test (fig. 11). The collimator projects a forty degree field of view.

b. Position paddle so that the 2-mm aperture is located axially with objective and between the integrating spheres entrance port and the objective output.

c. Read from the microamp meter the energy level obtained and record on the data sheet.

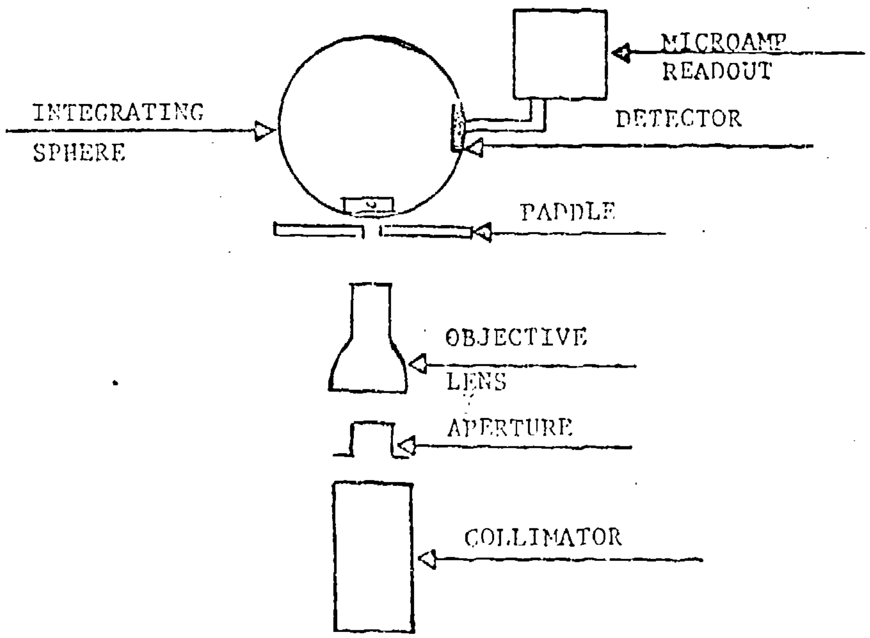


Figure 11. Test setup for relative illumination.

d. Slide the 2-mm aperture sideways until it is located at the edge of the objective field. If not the lens aperature, the integrating sphere must be rotated.

e. Read and record the energy level read on the microampmeter.

f. Calculate the relative illumination as follows:

$$\text{Rel Illum} = \frac{\text{Reading step e}}{\text{Reading step c}} \times 100\%.$$

g. Record results on the data sheet.

4.2.8 Field Flatness Field Tilt

a. Position the microscope adapter on front of the microscope objective (fig. 12).

b. Install the objective under test in the objective holder and turn collimator on.

c. Align the objective lens axially with the collimator, using the rotary table, and record the rotary table reading.

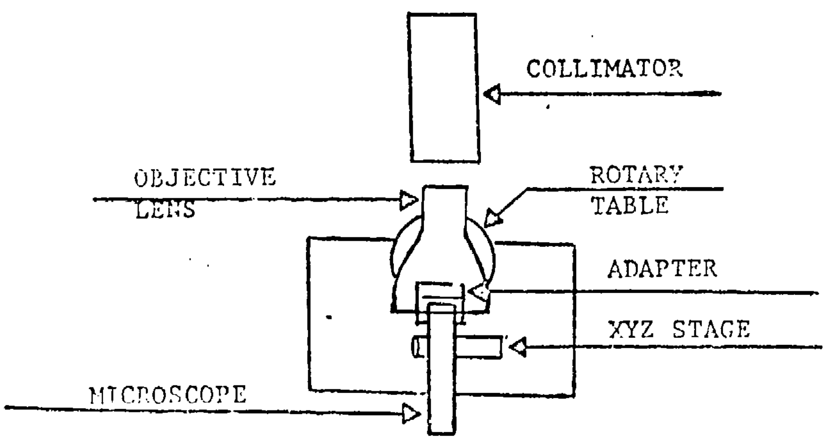


Figure 12. Test setup for field flatness - field tilt.

d. Focus on the resolution target using the XYZ traverse stages. Record Z stage reading at focus.

e. Rotate the rotary table 4 degrees from position recorded in step c.

f. Translate X stage to align microscope with target and use Z stage to obtain best focus. Record Z stage micrometer reading.

g. Determine algebraically the difference between the readings obtained in step d and step f. Record on data sheet.

h. Repeat steps e through g but rotate the rotary table 8, 12, and 18 degrees from the axial position. Record readings on data sheet.

i. Repeat steps e through g but rotate the rotary table -4, -8, -12, and -18 degrees from the axial position. Record readings on data sheet.

j. Rotate objective assembly 90 degrees in holder and repeat steps c through i. Record all readings on data sheet.

k. Pick up this test when measuring the off-axis MTF.

4.2.9 Exit Pupil Eye Relief

a. Install the dummy tube into eyepiece assembly under test and mount on eyepiece holding fixture (fig. 13).

b. Position viewing screen in holder at 15 mm eye relief distance from the last eyepiece element.

c. Position the neon laser beam axially with the holding fixture so that the beam passes through the axial 1-mm aperture in the dummy image tubes mask.

d. Measure exit pupil size on millimeter grid, and record on data sheet.

e. Reposition the laser to +18 degrees field position.

f. Measure exit pupil at +18 degrees field position and record on data sheet.

g. Reposition the laser to -18 degrees field position.

h. Measure the exit pupil at -18 degrees field position and record on data sheet.

i. Perform this measurement both in the azimuth and elevation directions.

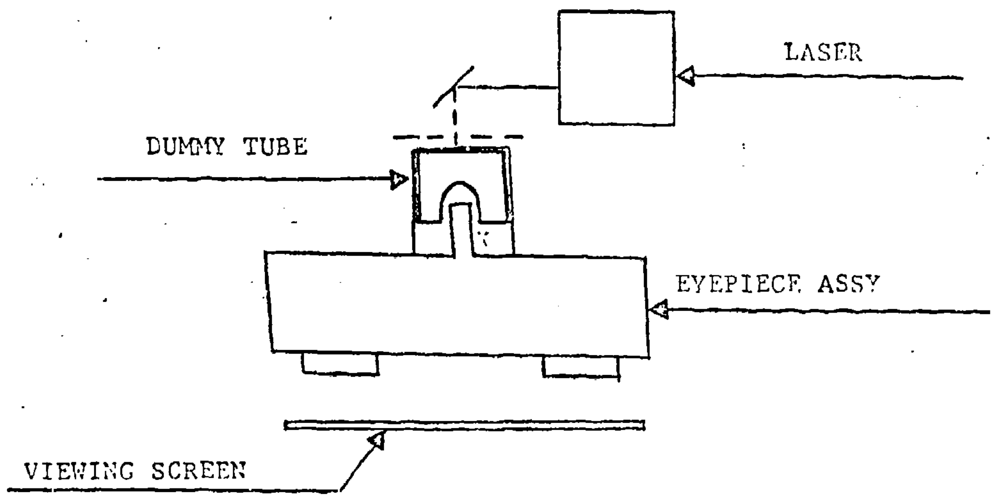


Figure 13. Test setup for exit pupil eye relief.

4.2.10 Diopter Adjustment

a. Install dummy tube into eyepiece assembly under test, and mount on eyepiece holding fixture (fig. 14).

b. Position Diopter Scope at eye relief distance of 15 mm.

c. Measure diopter range with diopter adjustment in both extremes.

d. Record results of diopters read at both extremes of diopter adjustment on data sheet.

e. Repeat test measuring the diopter range of the other eyepiece, and record results on data sheet.

4.2.11 Transmission

a. Conduct this test in a darkened room, 2.5×10^{-4} FC.

b. Turn on transmission tester's light source.

c. Mount the photometer to transmission tester's photometer holding fixture, turn on photometer, and allow it to warm up.

d. Calibrate photometer utilizing attached procedures.

e. Position photometer holder in position one.

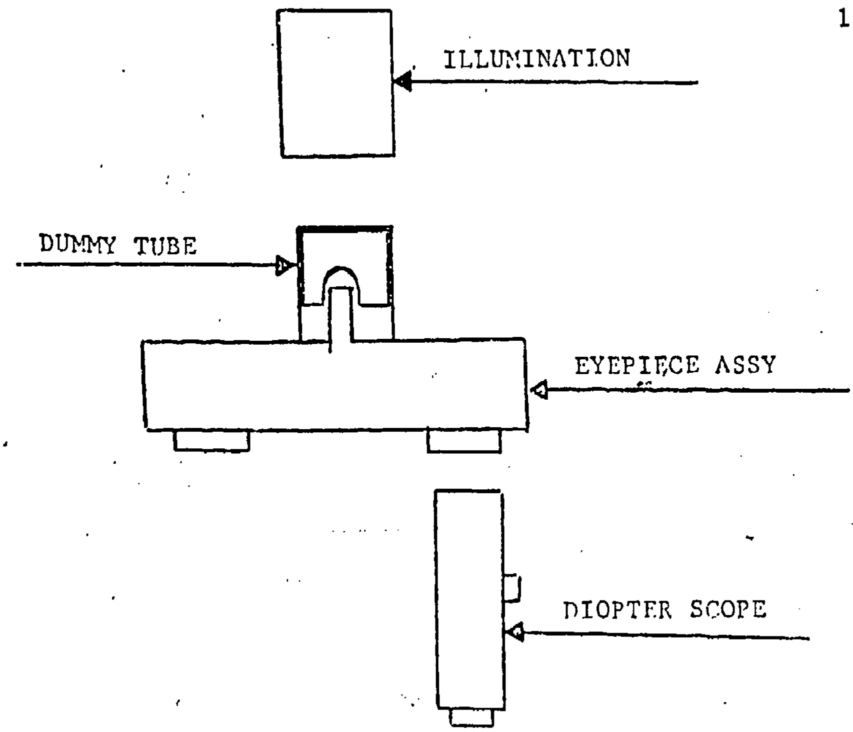


Figure 14. Test setup for diopter adjustment.

f. Mount dummy tube in front of source and place pupil in front of the dummy tube.

g. While viewing through photometer, focus on the pupil to establish light available through the tube.

h. Read level from photometer and record on data sheet.

i. Clamp eyepiece holder assembly on transmission tester plate.

j. Mount eyepiece assembly onto eyepiece holder.

k. Mount dummy tube in eyepiece assembly and mount pupil at eye relief.

l. Reposition photometer holder to position two.

m. Refocus on pupil in front of eyepiece front lens while viewing through photometer.

n. Read level from photometer and record on data sheet.

o. Calculate transmission as follows:

$$T\% = \frac{\text{Reading step n}}{\text{Reading step h}} \times 100\%.$$

p. Record results on data sheet.

q. Place a stop in photometer that is considerably smaller than the exit pupil size. This is required because one photometer will not be correctly calibrated for both situations (e.g., lens in/lense out).

4.2.12 Modulation Transfer Function (MTF)

a. MTF for the objective lens.

(1) Conduct this test in a darkened room, 2.5×10^{-4} FC (fig. 15).

(2) Measure the MTF for the objective lens for pupil positions of on-axis 14 and 18 degrees.

(3) Use an optical transfer function (OTF) test set with a gallium arsenide detector as shown in figure 15 for this test.

(4) Turn the Decwriter power switch on.

(5) Lock the 300 Baud rate key and Caps lock key down, then push the carriage return.

(6) Turn the oscilloscope monitor on and allow it to warm up.

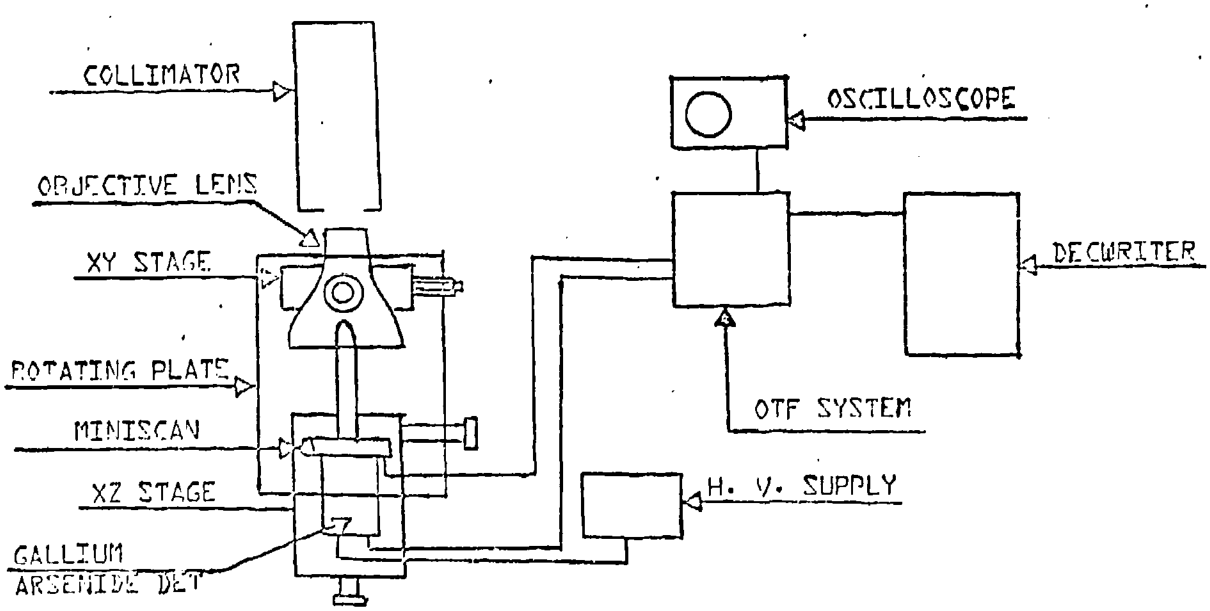


Figure 15. Test setup for objective lens MTF.

(7) Check to ensure that the High Voltage power switch on the H.V. supply is off.

(8) Turn the main power switch of the OTF test set on. The run light should illuminate and the computer should respond by typing the following message on the Decwriter:

"TROPEL OTF SYSTEM"
"LEVEL SEVEN, VERSION I"

(9) Turn the power supply for the collimator lamp on. Adjust the voltage to 6.5 Vdc. After adjusting for 6.5 Vdc, turn the DC supply switch on.

(10) Operation of the OTF 2000 system requires entry of four constants into the computer. These will vary depending on whether you are using the primary or secondary scan technique, the speed of the synchronous motor being used with the miniscan, the number of data points you desire to observe, and the required frequency increments.

(11) The MTF of the objective must be performed in a primary scan with a knife edge of "fish-tail" on the second surface of window simulating one photocathode glass. The scan length should be set up such that increasing the length by a factor of two does not reduce the measured MTF. This scan length has to be set up in an off-axis field position.

b. MTF for the eyepiece

(1) Conduct this test in a darkened room, 2.5×10^{-4} FC.

(2) Measure the MTF of the eyepiece assembly using a 5-mm exit pupil at 15-mm eye relief distance as shown in figure 16.

(3) Repeat procedure a(4) through a(10).

(4) Collimate a point source (P-20 type) limited by a 4-mm aperture and aimed through the eye lens.

(5) Measure the image of this point source by the secondary scan of the Tropel at the object plane of the collimater assembly.

(6) Run the eyepiece assembly backwards in this test to minimize the complexity of the test re-imaging optics.

(7) The Tropel OTF cannot accommodate the large angular ray bundle at the focal plane of the primary and secondary scans. Place a four micron lambertion source in the focal plane of the eyepiece. Use a relay lens (AN/PVS-5) with a 5-mm stop to relay the imagery on to the primary scan position.

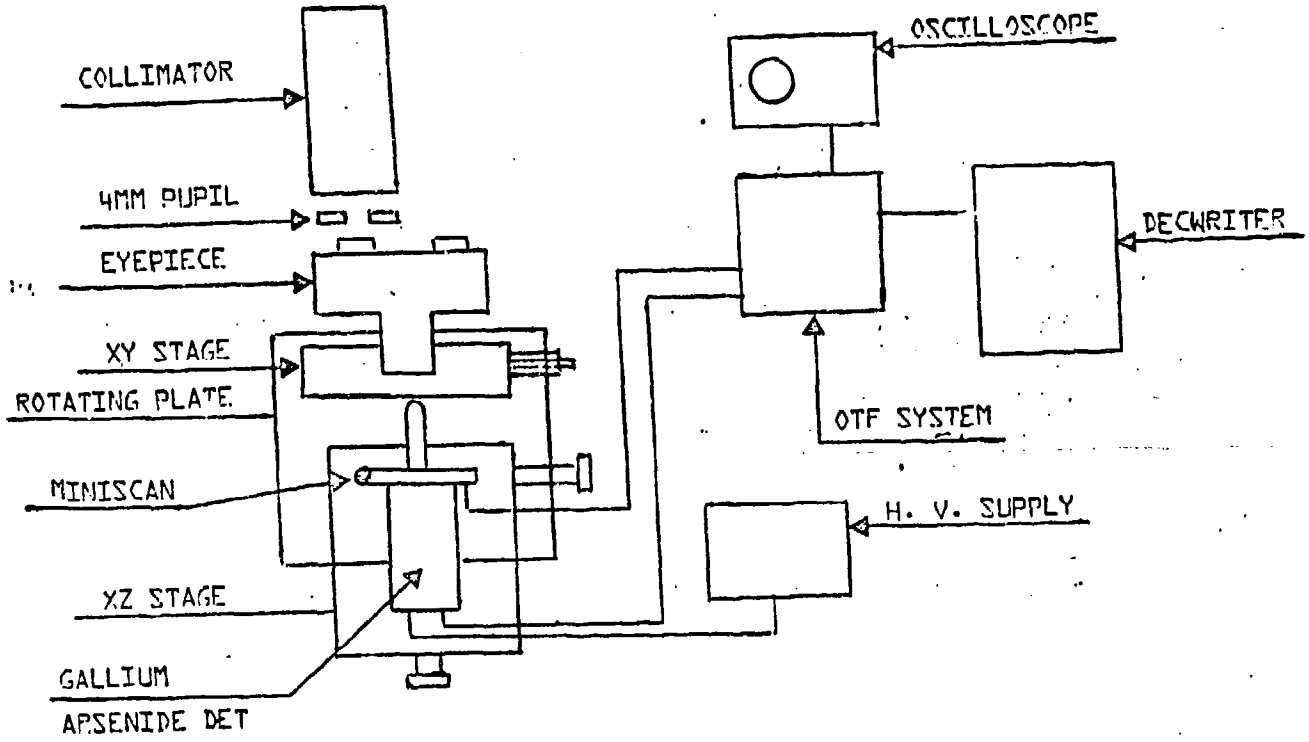


Figure 16. Test setup for eyepiece MTF.

4.3 Data Required

4.3.1 Preparation. Assemble records of the following data prior to testing:

a. Nomenclature, serial number(s), manufacturer's name, and function of item(s) under test.

b. Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

c. Appropriate photographs of the test item.

4.3.2 Test Data

a. Record throughout the test in the project log book in chronological order pertinent remarks and observations which will augment test data and support engineering evaluation and analysis of the technical performance of the test item.

b. Acquire supporting photographs, calibration records, and recordings of test anomalies and note deviations from the test plan found necessary throughout the test.

4.3.2.1 Physical Characteristics Data

a. Weight of storage case.

b. Weight of carrying bag.

c. Weight of night vision goggles with batteries and without batteries.

d. Weight of face mask assembly.

e. Weight of storage case with all the components packed inside.

4.3.2.2 Field of View Data

a. Illumination level.

b. Angular measurement to edge of field clockwise direction.

c. Angular measurement to edge of field counterclockwise direction.

4.3.2.3 Magnification and Distortion Data

a. Illumination level.

b. Magnification

(1) Actual image dimension (degrees).

(2) Apparent image dimension, measured at the eye relief of the goggles.

(3) Magnification in percent.

c. Distortion

(1) Apparent field dimension (degrees).

(2) Actual field dimension (degrees).

(3) Magnification from b(3) above.

(4) Distortion in percent.

4.3.2.4 Interpupillary Distance Data

a. Minimum distance between exit pupils to nearest millimeter.

b. Maximum distance between exit pupils to nearest millimeter.

c. Illumination level.

d. Operator comments on adjustment characteristics.

4.3.2.5 <u>Focus Adjustment Data</u>

a. Illumination level.

b. Target range in centimeters.

c. Ability of operator to focus goggles at each range.

d. Operator comments pertaining to ease or difficulty of adjustment.

4.3.2.6 <u>Resolution Data</u>

a. Target description.

b. Illumination level.

c. Target distance from goggles.

d. Smallest pattern which can be resolved.

4.3.2.7 <u>Brightness Gain Data</u>

a. Source light level.

b. Output meter level for goggles.

c. Output meter reference level.

4.3.2.8 <u>Visual Acuity Data</u>

a. Target illumination.

b. Target contrast.

c. Target size.

d. Distance from target to goggles.

e. Background light level.

f. Results of each test participant's eye examination.

g. Any problems encountered by test participants who wear corrective lenses.

4.3.2.9 <u>Depth Perception Data</u>

a. Illumination level.

b. Error distance between stationary upright and moveable upright in millimeters.

4.3.2.10 Depth of Field Data

a. Illumination level.

b. Distance in millimeters for near and far focus starting at 15 inches from goggle.

c. Distance in millimeters for near and far focus starting at 30 inches from goggle.

4.3.2.11 Radioactive Material Data. Record excess thorium radiation.

4.3.2.12.1 Radio Task Data

a. Illumination level.

b. Time to disassemble radio.

c. Time to assemble radio.

d. Test message received by operator.

e. Test message transmitted by operator.

f. Number of errors between message received and message transmitted.

g. Difficulty of writing and reading the message will be recorded by commentary of operator.

4.3.2.12.2 Map Reading Data

a. Illumination level.

b. Status of IR LED.

c. Difficulties in identification of standard map features.

d. Time to complete task.

e. Difficulties in reading the map will be recorded by commentary of operator.

4.3.2.12.3 Cross-country Vehicular Driving Data

a. Illumination level.

b. Time to complete course.

c. Number of pylons hit.

d. Operator comments on difficulty in driving with goggles.

e. Speed of vehicle.

4.3.2.13 Forward Projection Data. Record dimension (in mm) from the exit pupil to the most forward projection on the goggles.

4.3.2.14 Center of Gravity Data. Record distance (in mm) from pivot point to the exit pupil.

4.3.2.15 Objective Lens f Number Data

a. Effective focal length.

b. Effective aperture.

4.3.2.16 Objective Lens t Number Data

a. f number of objective lens.

b. Transmission percent.

4.3.2.17 Veiling Glare Data

a. Image illuminance produced by the glare light.

b. Image illuminance produced by the image light plus glare light.

4.3.2.18 Flange Focal Distance Data. Record flange focal distance in millimeters.

4.3.2.19 Relative Illumination Data

a. Flux through the objective lens on axis.

b. Flux through the objective lens at edge of field.

c. Relative illumination in percent.

4.3.2.20 Field Flatness/Field Tilt Data. Record reading at best focus positions.

4.3.2.21 Exit Pupil Eye Relief Data

a. Exit pupil size on axis in millimeters.

b. Exit pupil size off axis in millimeters.

4.3.2.22 Diopter Adjustment Data. Record diopter values at each extreme of the diopter adjustment.

4.3.2.23 Transmission Data

a. Light coming from an extended source located at the focal plane of the collimator assembly.

b. Light measured through the collimator, mirrors, and eyepiece cell.

4.3.2.24 Modulation Transfer Function (MTF) Data

a. MTF for the objective lens. MTF values for pupil positions of on-axis 14 and 18 degrees.

b. MTF for the eyepiece assembly. Values for on-axis and 2/3 field position radial and tangential MTF.

5. DATA PRESENTATION

5.1 General. Process raw test data, to include but not be limited to the following steps:

a. Mark test data for identification and correlation according to subtest.

b. Organize data into tabular and graphical form. (See app D, Data Presentation Tables and Graphs.)

c. Determine the statistical variation of the results in terms of the average value and standard deviation of the particular quantities and the correlation among two or more quantities.

NOTE: The test directive (or specification) itself serves to define the types and characteristics of the raw test data, and the ultimate objective of the test program defines the form of the test data desired. Specific instructions for the reduction and presentation of individual subtest data are outlined in subsequent paragraphs.

5.2 Subtest Data

a. Compare the recorded data of subtest 4.1.1 with specified requirements to determine if any variations exist. Evaluate any difference for the effect on system performance.

b. Compare the recorded data of subtests 4.1.2, 4.1.4, 4.1.5, 4.1.6, 4.1.7, 4.1.9, 4.1.10, 4.1.11, 4.1.12, and 4.1.13 with specified requirements to determine if any variations exist. Analyze any malfunction or unacceptable performance to determine if it is characteristic of the test item or an isolated case. If the incident is found to be characteristic of the test item, an evaluation will be made to determine the input on the overall system performance and what corrective actions are required.

c. Record subtest 4.1.3 magnification and distortion data as follows:

(1) Calculate the magnification utilizing the ratio of actual image height to apparent image height, measured at the design eye relief of the goggles.

(2) Calculate the distortion on a ratio of the apparent incremental field height to the actual field height times the measured magnification in 5.2c(1) above.

(3) Provide verification of the differential distortion between channels from the difference in the calculated results for each eyepiece.

(4) Evaluate any difference between test item data and specifications for its effect on system performance.

d. Present subtest 4.1.8, Visual acuity data in tabular form as degrees of visual angle. This, however, may have little meaning to an evaluator. A more meaningful presentation involves converting the distance at which the Landolt C gap can be resolved to the distance at which a 42 centimeter width can be resolved. Forty-two centimeters is the approximate width of a male soldier. Thus the data will roughly express the limits beyond which the resolution capability of the device would prevent detection of a human-size target. Evaluate any difference between test item data and specifications for its effect on overall system performance.

e. Compare the recorded data of subtests 4.2.1 through 4.2.11 with specific requirements to determine if any variations exist. Any malfunction or unacceptable performance will be analyzed by the contractor and corrected before continuing test. If any previous test was compromised by the fix, a retest in that area will also be accomplished.

f. Accompany all test data with a written report that consists of conclusions and recommendations drawn from tests results. Include, in addition, equipment specifications that will serve as the model for a comparison of the actual test results. Equipment evaluation usually will be limited to comparing the actual test results to the equipment specifications and the requirements as imposed by the intended usage. Compare the results also to data gathered from previous tests of similar equipment.

g. Review a written report by the contractor and the government testing agency data covering the performance, environmental, and electromagnetic interference tests. Use all acceptable data from these tests in the formal final government report.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: AMSTE-TC-M Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Commander, US Army Electronic Proving Ground, ATTN: STEEP-MT-T, Fort Huachuca, AZ 85613-7110. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22304-6145. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A. PERFORMANCE TEST CHECKLIST

	YES	NO	N/A	DATE
1. Test item documentation received				
2. Test item availability schedule determined				
3. Test procedures defined				
Subtest 1				
Subtest 2				
Subtest 3				
4. Required facilities determined and scheduled				
Subtest 1				
Subtest 2				
Subtest 3				
5. Required instrumentation determined and scheduled				
Subtest 1				
Subtest 2				
Subtest 3				
6. Required test personnel determined and scheduled				
Subtest 1				
Subtest 2				
Subtest 3				
7. Conduct necessary aspects of safety checklist.				
8. Conduct necessary aspects of MTSP checklist.				
9. Conduct necessary aspects of photographic checklist.				
10. Conduct necessary aspects of contractor monitoring checklist.				

	YES	NO	N/A	DATE
11. Review testing priority checklist.				
a. All items received				
b. Test schedules				
(1) Prepared				
(2) Coordinated				
(3) Submitted				
c. Procedure developed for each operation				
d. Test site(s) inspected				
e. Safety hazards or critical problems solved				
f. All pretest operations completed				
g. Item prepared for test				
h. SOPs and checklist posted at site(s)				
i. Test team briefed				
j. Required capabilities on hand				
12. Initiate testing per approved test plan and schedule established.				
13. Use testing checklist developed for each subtest.				
14. Submit equipment performance reports.				
15. Prepare memoranda for record to document changes in test plans, directives, or procedures resulting from conferences, telephone calls or conversations.				
16. Ensure that found changes in or out of the project have documented authorization.				Ongoing
17 Receive internal reports written by supporting organizations.				Ongoing
18. Begin early preparation of report paragraphs including subtest-by-subtest writings while subsequent subtests are in progress.				

		YES	NO	N/A	DATE
19.	Monitor expenditure of funds using ITRMS and work planning and control reports. Request additional funds as required.				Ongoing
20.	Begin data reduction early and continue reduction and inspection continuously throughout the test.				
21.	Make notes during the conduct of tests regarding inadequacies in test techniques, facilities, or instrumentation which serve to delay test completion, increase costs or compromise test results.				Ongoing
22.	Submit delays when schedule cannot be met.				Ongoing
23.	If funds are becoming exhausted suspend test program.				Ongoing
24.	Report problem areas on a daily basis to supervisor.				Ongoing
25.	Make entries to project file and project log as appropriate.				Ongoing
26.	Conduct test activity EPR review as necessary.				
27.	Determine all subtests to be complete.				
28.	Analyze data.				
29.	Prepare test report.				

APPENDIX B. DATA COLLECTION SHEETS
(Revise as required)

A. PHYSICAL CHARACTERISTICS

Equip Type ____________________ Date __________ ________
Equip Serial Number ______________
Weight: Storage case ____________ grams
Carrying bag ____________ grams
Night Vision Goggles ______ grams
Face Mask ______________ grams
System packed in storage case __________ grams

Forward Projection ______________ mm
Center of Gravity _______________ mm

B. FOV, MAGNIFICATION, INTERPUPILLARY DISTANCE, FOCUS ADJUSTMENT, RESOLUTION

Equip Type ____________________ Date ____________________
Equip Serial Number ______________ Light Level __________ FC

	Results	
Field of View	______________	degrees
Magnification	______________	1 $\pm$ .03
Distortion	______________	percent
Interpupillary Adjustment	______________	mm
Focus Adjustment	______________	infinity
	______________	25 cm
Resolution	______________	infinity
	______________	close focus

C. BRIGHTNESS GAIN

Equip Type ____________________ Date ____________________
Equip Serial Number ______________ Light Level __________ FC

Source light level ______________________
Output meter reference level ______________
Output meter goggle - right eyepiece __________
- left eyepiece __________

D. VISUAL ACUITY

Visual Acuity Performance by Subject

Equip Type ______________ Date ______________

	Subject	Ser. No. ____ (meters)	Ser. No. ____ (meters)	Ser. No. ____ (meters)
Low Light	1			
	2			
	3			
	4			
	5			
Medium Light	1			
	2			
	3			
	4			
	5			
High Light	1			
	2			
	3			
	4			
	5			

NOTE: Low light $< 2.5 \times 10^{-4}$ FC, medium 2.5×10^{-4} to 3×10^{-3} FC, high $> 3 \times 10^{-3}$ FC.

E. DEPTH PERCEPTION

Depth Perception Error

Equip Type ______________ Date ______________

Subject	Ser. No. ____ (cm)	Ser. No. ____ (cm)	Ser. No. ____ (cm)
1.			
2.			
3.			
4.			
5.			

F. DEPTH OF FIELD

Depth of Field

Equip Type ____________________ Date ____________________
Equip Ser No. ________________ Light Level ______________ FC

Distance in Centimeters

Subject	Minimum	Maximum	Average
1.			
2.			
3.			
4.			
5.			

G. RADIO TASK

Radio Task

Equip Type ____________________ Date ____________________
Equip Ser. No. ________________ Light Level ______________ FC

Without LED

Subject	Assembly Time (seconds) Average	Range	Operation Time (seconds) Average	Range	Writing Errors	Reading Errors
1.						
2.						
3.						
4.						
5.						

With LED

Subject	Assembly Time (seconds) Average	Range	Operation Time (seconds) Average	Range	Writing Errors	Reading Errors
1.						
2.						
3.						
4.						
5.						

H. MAP READING

Map Reading

Equip Type ____________ Date ____________
Equip Ser No. ____________ Light Level ________ FC
Subject Name ____________

	With LED				Without LED			
Map Legibility	%	Trials (number)	Average Time (seconds)	Range (seconds)	%	Trials (number)	Average Time (seconds)	Range (seconds)
Nothing								
Coordinates Only								
Some of Place Name								
All of Place Name								

I. CROSS COUNTRY DRIVING

Cross-country Driving

Equip Type ____________ Date ____________
Equip Ser No ____________ Light Level ________ FC
Subject Name ____________ Type Vehicle ____________
Time Start ____________ Time End ____________

Run No.	Total Time (seconds)	No. Pylons Hit: Figure 8	No. Pylons Hit: 3-Point Turn
1			
2			
3			
4			
5			

J. Objective lens f number, T number

Equip Type ____________________ Date ____________________
Equip Ser No. ________________

f Number	Results	
Image height	________	millimeters
Effective focal length	________	millimeters
Effective aperture	________	millimeters
f number $= \frac{EFL}{EA}$	________	f number
T Number		
Aperture I microamp meter reading	________	microamps
Aperture II microamp meter reading	________	microamps
T % $= \frac{\text{Aperture II}}{\text{Aperture I}}$	________	transmission %
T Number $= \frac{\text{f number}}{\text{transmission}}$	________	T number

K. Veiling Glare, Flange Focal Distance, Relative Illumination, Field Flatness/Field Tilt, Diopter Adjustment and Transmission

Equip Type ____________________ Date ____________________
Equip Ser No. ________________ Light level ______________ FC

Veiling Glare	____________________	%
Flange Focal Distance	____________________	mm
Relative Illumination	____________________	%
Field Flatness/Field Tilt	____________________	mm
Diopter Adjustment	+ _____ diopter − _____	diopter
Transmission	____________________	%

L. Exit Pupil/Eye Relief

Equip Type ____________________ Date ____________________
Equip Ser No. ____________________ Light level ______________ FC

On-axis pupil size	____________________	millimeter
+ 18° field position pupil size	____________________	millimeter
− 18° field position	____________________	millimeter

M. Modulation Transfer Function

Equip Type ____________________ Date ____________________
Equip Ser No. ____________________

Objective Lens

On-axis 4mm pupil	________	MTF
14 degrees Tangential	________	MTF
Radial	________	MTF
18 degrees Tangential	________	MTF
Radial	________	MTF

Eyepiece Assembly

On-axis Vertical	________	MTF
Horizontal	________	MTF
2/3 field position	________	MTF
Vertical	________	MTF
Horizontal	________	MTF

N. Forward Projection

Equip Type ____________________ Date ____________________
Equip Ser No. ____________________

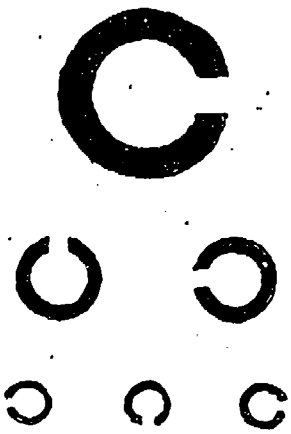
Distance from the front objective housing to eyepiece lens
(accurate to 0.1-mm) ______________________________

O. Center of Gravity

Equip Type ____________________ Date ____________________
Equip Ser No. ____________________

Determine the point of balance and measure the distance from the edge of the the fulcrum to 15-mm behind the eyepieces.

APPENDIX C. LANDOLT C TARGET RING



Acuity is defined as the reciprocal of the critical dimension (width of line, gap, or other) subtended at the eye.

The Landolt ring consists of a line whose thickness is one-fifth the outer diameter. The gap width is also one-fifth the outer diameter.

Paragraph 4.1.8. Visual Acuity. This procedure was used to acquire valid data in the fewest possible trials, to minimize the number of responses based on chance alone, and to ensure simple data taking. Although the forced-choice procedure is a more sensitive and reliable procedure in that it eliminates behavior of the subject as a variable, it would require more trials and complicate data taking. Of more importance, Army testing is interested in the system, which includes the user. Data including the decision processes of the user as well as the actual resolution of the optical device are believed to be most useful. If the optical device has a higher resolution than is demonstrated, that has little meaning if the user does not take advantage of it. Although some subjects might hesitate to respond until they are completely confident, careful instructions can minimize this inclination. The following changes on pages 14 and 15 are recommended to clarify the procedure.

APPENDIX D. DATA PRESENTATION TABLES AND GRAPHS

a. BRIGHTNESS GAIN DATA

	DEVICE NAME			
	Serial No.			
Log (L)*	001	002	003	Avg
R				
L				
R				
L				

*L = light level in fc

A chart of LOG [L(fc)] vs LOG (GAIN) will display the data in an easily understandable manner. (See example below.)

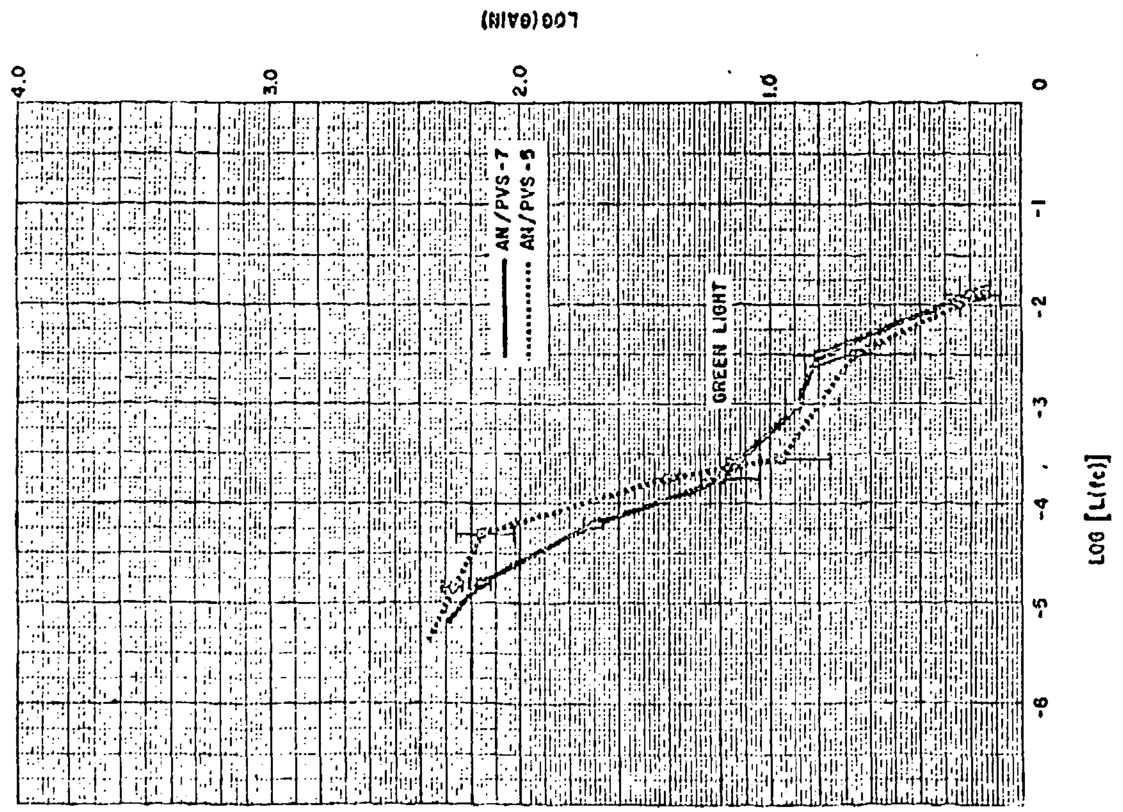


Figure 30. Brightness gain versus light level for green light.

b. VISUAL ACUITY DATA EXPRESSED AS DISTANCE IN METERS AT WHICH A HUMAN WIDTH (42 cm) TARGET COULD BE DETECTED

		Serial No.		
	Subject	001	002	003
	1			
	2			
LOW LIGHT	3			
	4			
	5			
Range				
Median				
Mean				
Standard dev				
	1			
	2			
MEDIUM LIGHT	3			
	4			
	5			
Range				
Median				
Mean				
Standard dev				
	1			
	2			
HIGH LIGHT	3			
	4			
	5			
Range				
Median				
Mean				
Standard dev				

c. A visual acuity performance whisker chart of range for detection of a 42 centimeter (human width) target will display the data in a more easily understandable manner. (See example below.)

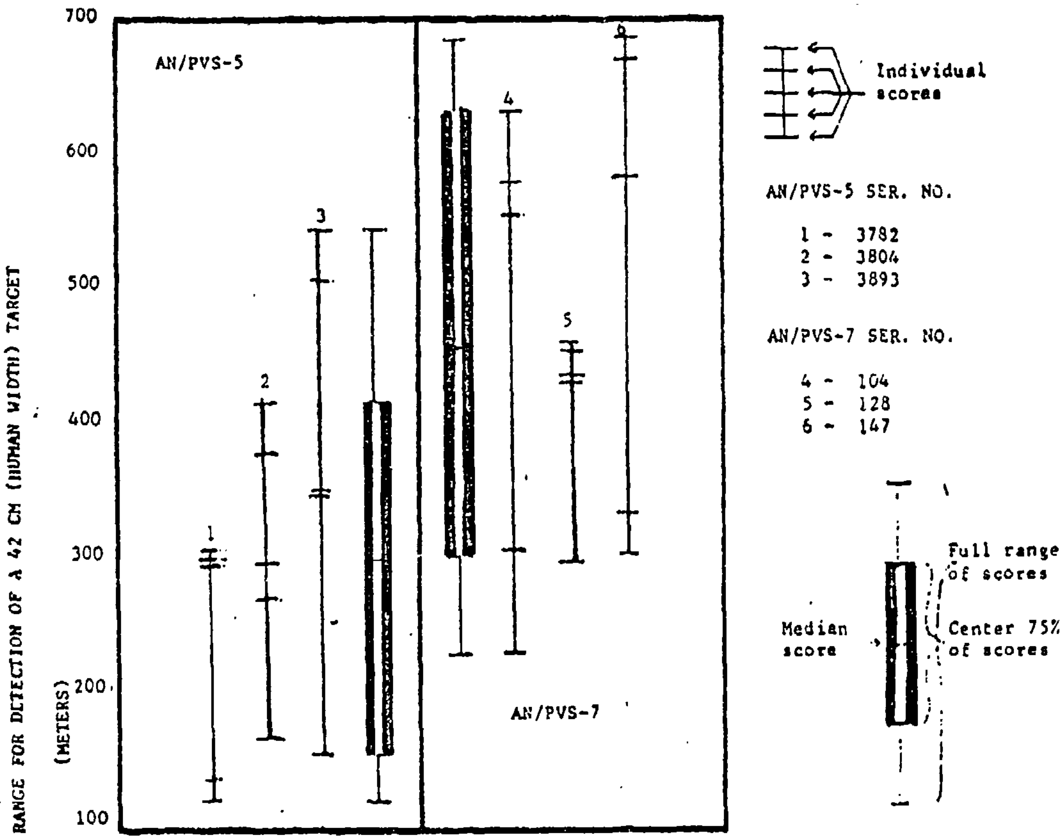


Figure 5. Visual acuity performance under low light conditions.

d. VISUAL ACUITY DATA IN DEGREES OF VISUAL ANGLE

		DEVICE NAME Serial No.		
		001	002	003
	Subject			
LOW LIGHT	1			
	2			
	3			
	4			
	5			
MEDIUM LIGHT	1			
	2			
	3			
	4			
	5			
HIGH LIGHT	1			
	2			
	3			
	4			
	5			

e. DEPTH OF FIELD

	DISTANCE (CM)		
SUBJECT	MINIMUM	MAXIMUM	AVERAGE
1			
2			
3			
4			
ALL			

f. MAP READING

WITHOUT LED

Map Legibility	Trials % (Number)	Average Time (Seconds)	Range (Seconds)
Nothing			
Coordinates Only			
Some of Place Names			
All of Place Names			

WITH LED

Map Legibility	Trials % (Number)	Average Time (Seconds)	Range (Seconds)
Nothing			
Coordiantes Only			
Some of Place Names			
All of Place Names			

g. OBSTACLE COURSE

Time in Seconds	Without NBC Gear	With NBC Gear
Av...age		
Range		

h. CROSS COUNTRY DRIVING

Time to Complete Course (Seconds)		Pylons Hit	
Average	Range	Figure 8	3-Point Turn

i. EYE-HAND COORDINATION

Time to Complete Task	(Seconds)
Average	Range

j. RADIO TASK

Without LED					
Assembly Time (Seconds)		Operation Time (Seconds)		Writing	Reading
Average	Range	Average	Range	Errors	Errors

With LED					
Assembly Time (Seconds)		Operation Time (Seconds)		Writing	Reading
Average	Range	Average	Range	Errors	Errors

APPENDIX E. REFERENCES

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APPENDIX F. ABBREVIATIONS

cm	centimeter
D	distortion
EA	effective aperture
EFL	effective focal length
FC	foot candle
FOV	field of view
IMAGES	Instructional Material Adequacy Guide and Evaluation Standards
IPD	interpupillary distance
IR	infrared
LED	light emitting diode
M	magnification
mm	millimeter
MTF	Modulation Transfer Function
NVG	Night Vision Goggles
OTF	optical transfer function
PSI	pounds per square inch
ROC	required operational capability
SOP	standing operating procedures
TOP	test operations procedure
TRMS	Test Resources Management Systems

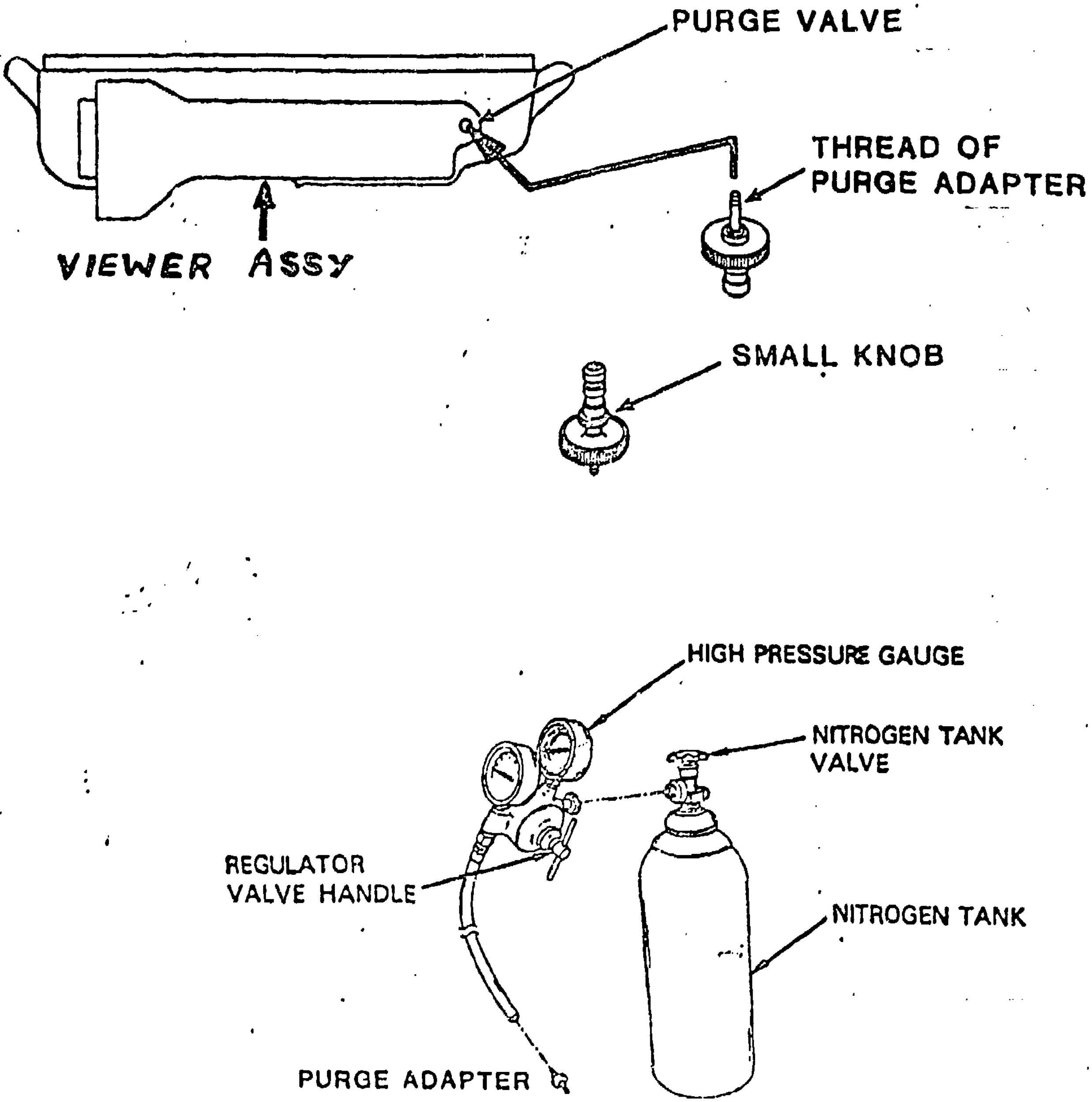

Figure 17. Setup to purge viewer assembly.