22 May 1969

Materiel Test Procedure 10-2-106
General Equipment Test Activity

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

BINOCULARS

1. OBJECTIVE

This document provides test methods and techniques necessary to determine the technical performance and safety characteristics of binoculars and their associated tools and equipment, as described in Qualitative Materiel Requirements (QMR's), Small Development Requirements (SDR's), Military and/or Technical Characteristics (MC's or TC's), and to determine the item's suitability for service tests.

2. BACKGROUND

Requirements exist for optical instruments which permit the user to view distant objects or events not otherwise discernbile and at the same time retain and enhance the natural stereoscopic vision effect provided by normal, unaided vision. These instruments, or binoculars, are required for use by Army personnel in the field for general observation and the approximation of small angles.

Conventional binoculars are required in two general types; hand-held and rigid-mount. Hand-held binoculars are usually limited to a magnification less than 10 power, while a magnification of 20 power is not uncommon for rigid-mount types.

Other requirements exist for helmet-mounted infrared binoculars to be used as an aid in the night operations of various vehicles and equipment in areas flooded with infrared light and for detection of infrared sources. Hand-held infrared binocular requirements also exist for providing visibility for night observation and under limited lighting conditions.

Conventional military binoculars responding to these requirements will be of the prism type, contain anti-reflection coated optical components, provide individual monocular focusing, and employ mechanical precision in the hinging of the binocular halves.

In addition to high performance optical systems, infrared binocular types will require for each binocular half a compact, built-in capability for converting emitted or reflected infrared radiation into visible rays and a portable self-contained power source for image conversion and infrared light generation.

All binocular types are required to demonstrate the capability to withstand prolonged and vigorous usage in the field under varied and often extreme environmental conditions.

3. REQUIRED EQUIPMENT

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a. Measuring Tape.
b. Ruler.
c. Caliper.
d. Scale for weighing.
e. Still Camera and Film.
f. Vibration Test Fixture with the following characteristics:

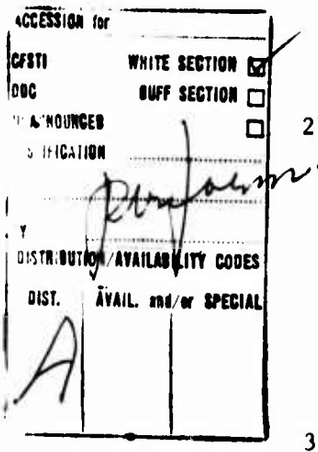
1) Physically suitable for mounting the test item in a normal operating position.
2) Capable of operating at a constant 30 cycle per second frequency with an amplitude of 1/16th inch.

g. Environmental Chambers:

1) Rain Test Chamber with the following characteristics:

a) Physically suitable for mounting the test item in a normal operating position.
b) Capable of producing simulated rainfall as follows:

(1) Rate: 4 inches per hour, +1, -0, inches per hour.
(2) Rainfall type: small droplets.
(3) Rainfall temperature: between 52 degrees F. and 68 degrees F.
(4) Rainfall dispersion: uniform over the test item.
(5) Rainfall direction: variable between the vertical to 45 degrees from the vertical in any direction.



2) Temperature Test Chamber with the following characteristics:

a) Physically suitable for mounting the test item in a normal operating position.
b) Containing a view port or window through which the binocular objective and eyepiece lenses may be clearly viewed during testing.
c) Capable of reaching and maintaining a temperature at least 10 degrees F. below the test item specified internal gas dew point temperature.

3) Cold Test Chamber capable of the following:

a) Physically suitable for containing the test item and performing adjustment operability tests (paragraph 6.2.1.j) on the test item with the temperature stabilized at the specified low temperature.
b) Capable of descending to a temperature of -80 degrees F.

4) Oven type test chamber capable of the following:

a) Physically suitable for containing the test item and performing adjustment operability tests (paragraph 6.2.1.j)

on the test item with the temperature stabilized at the specified high temperature.

b) Capable of being elevated to a temperature of +160 degrees F.

5) Pressure Test Chamber capable of the following:

a) Physically suitable for containing the test item, but not excessively larger than the test item.
b) Withstanding an internal pressure of 10 psig without detectable leakage for a minimum of 30 minutes.
c) Accepting, or having fittings which can be modified to accept, the available pressure test fixture (see item h below).

h. Pressure Test Fixture consisting of the following:

1) Source of compressed air.
2) Pressure regulator, on-off valve, and suitable hoses and fittings for connecting to the pressure test chamber (see item g.5 above).
3) Sensitive pressure gage calibrated from 0 psig to 10 psig in tenths of a pound (psig).

i. Collimating Test Fixture consisting of the following:

1) Two identical collimators or certified optical performance with built-in light sources and reticles.
2) An auxiliary telescope with cross hairs of certified optical performance mounted on the collimating fixture base by two parallel tracks which provide freedom of lateral movement.
3) An adjustable "Y" block-table suitable for accepting and rigidly mounting the test item.
4) Solid, level base.

j. Test Targets

1) Test target which is an enlarged facsimile of the test item reticle suitable for wall mounting.
2) National Bureau of Standards (NBS) resolution chart, part of NBS Circular 533, dated May 1953 (currently effective) or resolution chart specified by and included as part of MIL-O-13830A.
3) Test target consisting of a rectangular wood or metal strip similar to a yard or meter stick with a scale calibrated in convenient units.
4) Linear distortion test target consisting of three vertical, equally spaced lines. The equal-distant line will be centered on the target surface and the lines to the right and left are to be spaced to represent the angular displacement from optical center for which test item linear distortion is specified.

k. Auxiliary Telescopes, Collimating Telescopes, and Diffraction Slits:

1) Low power auxiliary telescope or collimator with cross hairs and an angular displacement scale.
2) Auxiliary telescope of 1 to 2 power with provisions for measuring angular displacement in the horizontal and vertical planes. Cross hairs are required.
3) Collimator with built-in diffusion screen and light source capable of operating at an approximate color temperature of 2500 degrees K with provision for monitoring the lamp operating voltage and current.
4) Auxiliary telescope or pick-up lens capable of focusing images onto the plane of the single slit specified by item h.5.
5) Single vertical slit suitable for projecting a diffracted image onto the plane of a photo multiplier or phototube cathode of the following approximate dimensions:

   a) 1.5 mm wide
   b) 5 mm high

6) Calibrated dioptometer with the following properties:

   a) Three power, minimum, with a focusing reticle
   b) Calibrated in 0.1 diopter
   c) Recently calibrated

7) Auxiliary telescope having a minimum of 3 power (3x) scaled in diopter.

l. Electronic Components

1) Photomultiplier or phototube with a Retma spectral response of S-3.
2) Photomultiplier signal amplifier or signal processor for connecting to the output of item l.1.
3) Output meter for photomultiplier or phototube signal amplifier calibrated in percent.

m. Running Torque Test Equipment

1) Inch-pound torque wrench capable of measuring running torque values specified for the test item.
2) Adapters suitable for connecting torque wrench to test item adjustment knobs.
3) Weight hanger and weights.

n. Special Test Equipment or Fixtures

1) United States Weather Bureau type rain gage.
2) Lens bench, suitable for mounting the test item, electronic equipment, collimator, pick-up lens system, and diffraction slit.
3) Foundation, suitable for mounting the test item and auxiliary

telescopes of item k.1 and k.2 above.

o. Theodolite-like Instrument for measuring angles
p. Thermocouple(s) capable of measuring from -80°F to +160°F

4. REFERENCES

A. USATECOM Regulation 385-6, Safety Release.
B. USATECOM Regulation 700-1, Value Engineering.
C. USATECOM Regulation 705-4, Equipment Performance Report.
D. MIL-F-13926A(MU), Fire Control Materiel: General Specification Governing the Manufacture and Inspection of.
E. MIL-O-13830A, Optical Components for Fire Control Instruments; General Specification Governing the Manufacture, Assembly, and Inspection of.
F. MIL-STD-1241A, Optical Terms and Definitions.
G. National Bureau of Standards Circular 533, Method for Determining Resolving Power of Photographic Lenses, 20 May 1953.
H. MIL-STD-150A, Photographic Lenses.
I. Kissam, Philip, Optical Tooling for Precise Manufacture and Alignment, McGraw-Hill Book Company, Inc., 1962.
J. MTP 10-2-107, Metascopes - Infrared, Image-Forming.
K. MTP 10-2-500, Physical Characteristics.
L. MTP 10-2-501, Operator Training and Familiarization.
M. MTP 10-2-503, Surface Transportability (General Supplies and Equipment).
N. MTP 10-2-505, Human Factors Evaluation.
O. MTP 10-2-507, Maintenance Evaluation.
P. MTP 10-2-508, Safety.

5. SCOPE

5.1 SUMMARY

This procedure describes methods of evaluating the technical characteristics of binoculars and their suitability for service testing. The required tests are summarized as follows:

a. Preparation for Test - A determination of the condition and physical characteristics of the test item upon arrival and the requirements for training and familiarization.

b. Mechanical Evaluation - A study, at ambient temperatures, to determine test item quality of construction, internal cleanliness, sealing integrity, internal dew-point temperature, and adjustment operability.

c. Eyepiece Focus - A determination of test item capability to deliver from each binocular half diverging rays within a specified diopter range.

d. Reticle Alignment - A study, at ambient temperatures, to determine test item reticle parallelism, scale calibration accuracy, and the degree of observed parallax.

e. Collimation - An evaluation to determine the degree to which the optical axes of the test item binocular-halves are parallel when positioned to

the maximum interpupillary settings.

f. Resolution - A determination of the capability of each test item binocular half to record fine detail in the object as limited by diffraction, optical system aberrations, and the precision employed in preparing and centering optical components.

g. Angular Magnification - A determination of the capability of each test item binocular half to produce on the retina images expanded by a specified number of diameters when the object is being viewed at a specified distance.

h. Linear Distortion - A determination of test item image deformation as caused by possible variations in the magnification of each binocular-half optical system.

i. Field of View - A determination of the maximum angle at which the test item will admit object field rays as limited by allowable image distortion.

j. Relative Light Efficiency - A determination of the relative loss of binocular-half image brightness resulting from objective lens light reflections and light losses within each optical path.

k. Extreme Temperature Effects - Determinations of test item adjustment operability while thermally stabilized at extreme temperatures and the capability of the test item to meet all specified performance criteria while thermally stabilized at standard ambient temperatures following exposure and thermal stabilization at extreme hot and cold temperatures.

l. Transportability - An evaluation to determine test item and specified shipping container capability to withstand shocks, extraneous forces, and impacts encountered during normal handling incident to shipment and while being transported.

m. Maintainability and Reliability Evaluation - That portion of the test which is concerned with the following: verification and appraisal of failures; determination and appraisal of maintenance characteristics and requirements; appraisal of design-for-maintainability appraisal of the maintenance test package; and, calculation of indicators which express the effects of the preceding aspects.

n. Safety - An evaluation to determine test item compliance with safety requirements and to confirm safety features of the test item.

o. Human Factors Evaluation - An evaluation to determine the degree to which test item physical design and revealed performance characteristics conform to recognized human factors engineering design criteria.

p. Value Analysis - An evaluation to determine any unnecessary, costly, or nice-to-have test item features which could be eliminated without reducing test item performance or safety.

5.2 LIMITATIONS

a. The engineering performance tests specified by this document are applicable to binoculars with the exception of the following infrared types:

1) Reticle Alignment Evaluations
2) Resolution Determination
3) Relative Light Efficiency Determination

b. Infrared binocular types should be subjected to the following

evaluations of MTP 10-2-107:

1) Image Forming Receiver Brightness Gain and Resolving Power Test.
2) Infrared Light Source Beam Characteristics and Light Source-Image Forming Receiver Alignment Test.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Initial Inspection

Upon receipt of the test item at the test site, perform the following:

a. Visually inspect test item packages and record the following:

1) Evidence of package deterioration or damage
2) Identification markings, including:

a) Name of contractor
b) Number and date of contract
c) Date of manufacture
d) Other markings pertaining to the test item

b. Photograph the test item(s) packages to identify received condition.
c. Weigh and measure the test item(s) packages and record the following:

1) Contents
2) Weight
3) Length, width, and height
4) Cubage

d. Unpack the test item and perform a visual inspection. Record the following when applicable;

NOTE: Defects uncovered during this inspection shall be classified in accordance with MIL-F-13926A(MU).

1) Evidence of defects in:

a) Manufacturing
b) Material
c) Workmanship

NOTE: The visual inspection shall include, but not be limited to, the following considerations:

a. Optical Glass, Physical Quality: Glass defects including cords, ream, bubbles, seeds, strain, laps, or folds in pressing should not be evident. Scratches present on optical surfaces should not exceed one quarter the diameter of the element containing a scratch, or as otherwise

specified. The permissible number of maximum size digs should not be more than one per each 20 mm of diameter of fraction thereof on any optical surface. In the absence of specific test item scratch and dig requirements, consult MIL-O-13830A, Table I. (This table is reproduced as part of this document as Appendix A).

b. Reticle Quality: Reticle markings should be inspected primarily for legibility, unless otherwise specified. Normally, defects in reticle numbers or letters will be acceptable provided each letter or figure is legible beyond doubt. All reticle lines should appear uniform in width and depth and intersections of lines should appear to be sharp.

c. Construction: Unless otherwise specified, the use of pads, shims, wedges, or openings under or around optical elements is not acceptable. All test item metal surfaces should be free from burrs and sharp edges. Material should be sound, of uniform quality and condition, and free of seams, cracks, and other defects which may adversely affect the strength, endurance, or wear resistance of the test item.

d. Workmanship: Workmanship should be of a quality consistent with the highest existing instrument production standards and practices.

2) Presence of markings, when applicable, including:

a) Identification, test item nomenclature, and serial number
b) Service instruction plates
c) Caution plates

6.1.2 Physical Characteristics

a. Determine the physical characteristics of the test item in accordance with the applicable procedures of MTP 10-2-500.

b. Weigh and measure the test item, as applicable, and record the following:

1) Weight, test item alone
2) Weight, test item, carrying case, neck strap, and lens caps
3) Diameter of each lens barrel
4) Overall length
5) Overall width, fully extended
6) Interpupillary distance, minimum
7) Interpupillary distance, maximum
8) Effective objective lens diameter
9) Effective eyepiece lens diameter
10) Reticle calibration
11) Rated angular magnification
12) Rated resolution
13) Rated field of view
14) Eyepiece focus range

15) Rated parallax
16) Filter(s) description and type
17) Neck strap, minimum length
18) Neck strap, fully extended length

6.1.3 Operator Training and Familiarization

Test personnel shall receive training and familiarization in accordance with applicable procedures of MTP 10-2-501 and the following:

a. Test Equipment: Ensure that each team member understands the requirement for each specified test equipment and test fixture. Orient the team jointly and by example illustrate methods of establishing a line of sight, leveling, and establishing planes parallel to other planes.

b. Terminology: Familiarize team members with trade terms and unique or state-of-the-art optical terminology not otherwise defined in the supplied instructional matter.

c. Hazards: Review all hazards and safety precautions associated with operating and maintaining the test team. Include the electrical shock hazards involved with infrared binocular image conversion. Caution all personnel regarding viewing the sun or other sources of intense visible light with any binocular or telescope.

6.2 TEST CONDUCT

NOTE: 1. All equipment failures shall be reported in accordance with USATECOM Regulation 705-4.
2. Throughout the engineering test procedures provided by this document, the binocular will be evaluated as two separate telescopes, except as otherwise specified by individual test procedures. Figure 1 below is provided to identify principal binocular parts and the terminology which is used in subsequent procedures for reference to those parts.

6.2.1 Mechanical Evaluation

6.2.1.1 Vibration

Determine the test item quality of construction and internal cleanliness by performing the following:

a. Rigidly mount the test item in a normal operating position on the vibration test fixture (see item f of paragraph 3).

b. Set the vibration test fixture operating controls to obtain a vibration frequency of 30 cycles per second and a vibration amplitude of 1/16th inch.

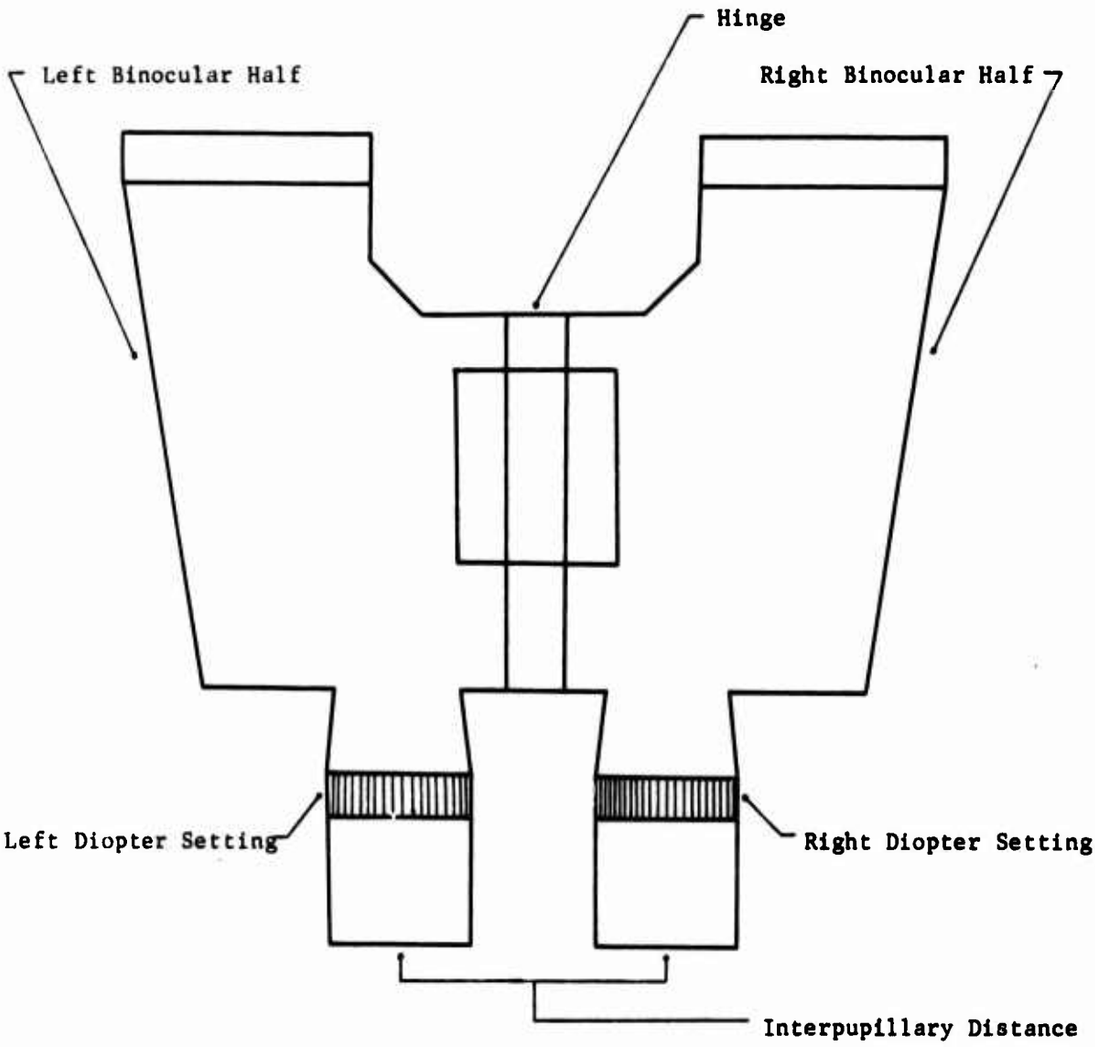


Figure 1 Binocular Principal Parts and Terminology

c. Activate the vibration test fixture and vibrate the test item for 5 minutes ± 15 seconds at the specified frequency and amplitude. Record the frequency and amplitude of vibration used.

d. Following the conduct of the vibration test, inspect the test item and record evidence of defects, including the following:

1) Loose or defective parts. (Identify defects by location using Figure 1).
2) Internal dirt or lint particles.

a) Number of particles grouped by dig size.
b) Location of particles in respect to optical axis of each binocular-half, as applicable.
c) Extent to which dirt or lint particles interferes with test item image quality or obscures reticle numbers/ figures.

3) Overall soundness of test item construction and degree of internal cleanliness.

6.2.1.2 Leakage

Determine test item capability of preventing the entrance of water or water vapor into either binocular-half by performing the following:

a. Set up the rain test chamber (see item g.1 of paragraph 3) to produce the following simulated rainfall:

1) Rate: 4 inches per hour, +1, -0, inches per hour.
2) Rainfall type: small droplets.
3) Rainfall temperature: between 52 degrees F. to 68 degrees F.
4) Rainfall dispersion: uniform over test item.
5) Rainfall direction: variable between the vertical to 45 degrees from the vertical in any direction.

b. Mount the test item in a normal operating position in the rain test chamber.

NOTE: The test should be conducted with the rain chamber temperature between 68 degrees F. and 86 degrees F.

c. Activate the rain test chamber and conduct the test for 2 hours, directing simulated rainfall on all test item surfaces which are normally subjected to rain.

d. Measure and record the following for each phase of the test (change in the direction of the rain):

1) Rainfall direction.
2) Test chamber temperature.
3) Length of time.
4) Rainfall type.
5) Rainfall diversion.
6) Rate of rain as measured by the U. S. Weather Bureau type rain gage.

e. At the completion of the 2 hour test period, remove the test item and conduct an inspection of the test item. Record evidence of the following:

NOTE: Identify defects or damage by location (Refer to Figure 1.)

1) Water penetration into either binocular-half
2) Internal damage to the test item
3) External damage to the test item

6.2.1.3 Internal Dew Point

Determine, where applicable, the dew point of the gas or gaseous mixture sealed within each test item binocular-half, by performing the following:

NOTE: When recording data, identify components as indicated in Figure 1.

a. Mount the test item within the temperature test chamber described in paragraph 3.g.2.

b. Set temperature controls to obtain a chamber temperature of approximately 15 degrees F. above test item specified internal gas dew point temperature.

c. As the internal test chamber temperature is descending to the value specified in step b and subsequent to test item temperature stability at that value, observe binocular lenses for visible evidence of condensation on external or internal lens surfaces.

NOTE: 1. Condensation visible on external lens surfaces indicates excessive water vapor within the test chamber and an improper atmosphere for conducting the test.
2. Condensation visible on internal lens surfaces indicates failure of the test item to meet the specified internal gas dew point requirement.

d. Reduce test chamber temperature by 5 degrees F. Allow time for test item temperature stability at the new value, and observe lens surfaces for visible evidence of condensation. The notes of step c shall apply. Record the temperature value and evidence of external or internal lens condensation.

e. Repeat step d with the test chamber temperature reduced to within 5 degrees of the specified internal gas dew point temperature value.

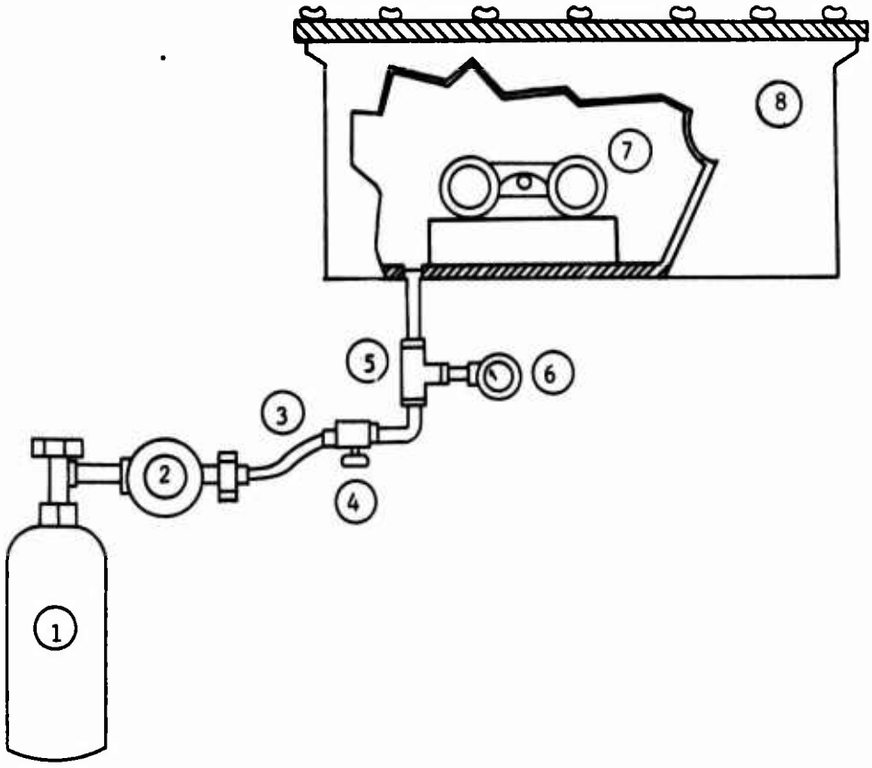
f. Reduce test chamber temperature in 1 degree F. increments until condensation on test item internal lens surfaces is observed or a temperature of approximately 7 degrees F. below the specified gas dew point is attained. Record the dew point temperature or the fact that the test item exceeded the dew point requirement by approximately 7 degrees F.

6.2.1.4 External Pressurization

Determine the capability of test item seals and construction to withstand external pressure, as specified in excess of ambient atmospheric pressure, for a given period of time by performing the following:

a. Assemble the pressure test chamber (see item g.5 of paragraph 3) and pressure test fixture (see item h of paragraph 3) as indicated in Figure 2.

b. Install the test item within the pressure chamber and seal the chamber so that it is airtight.



ITEM NO.	DESCRIPTION
1	SOURCE OF COMPRESSED AIR
2	PRESSURE REGULATOR
3	HOSE
4	ON/OFF VALVE
5	TEE CONNECTOR
6	SENSITIVE PRESSURE GAGE
7	TEST ITEM
8	PRESSURE CHAMBER

Figure 2 External Pressurization Test Set-Up

c. Charge the pressure chamber to 5 psig. When stabilized at the required pressure, cut off the charging source. Retain the specified pressure for 5 minutes ± 15 seconds. Record pressure in the pressure chamber at the completion of the test period. Record the actual pressurization period.

NOTE: Any drop in gage pressure will indicate test item leakage and will constitute evidence of unsatisfactory test item performance.

6.2.1.5 Adjustment Operability

Determine the forces required to operate test item adjustment knobs and center hinging mechanism at standard ambient temperatures by performing the following:

a. Prepare an inch-pound torque wrench with appropriate adapters to accommodate the following test item adjustment knobs, as applicable:

1) Right and left binocular-half diopter rings.
2) Any test item adjustment knob which requires rotation during the course of normal use.

b. Rigidly mount the test item in a normal operating position or as convenient for attaching the inch-pound torque wrench to the applicable test item adjustment knob.

c. Thermally stabilize the test item at an ambient temperature between 70 degrees F. and 80 degrees F. Record the stabilized temperature value.

NOTE: Thermal stabilization has been reached when the temperature of the largest internal centrally located test item mass does not vary more than 1 degree C. from the ambient temperature.

d. Attach the inch-pound torque wrench, with appropriate adapter, to each test item adjustment knob and perform the following:

1) Rotate the torque wrench/adapter/knob clockwise and while the knob is in motion, read the running torque required to rotate the knob.
2) Record the following:

a) Adjustment knob name
b) Binocular-half being tested, if applicable
c) Running torque value
d) Direction of travel

3) Repeat steps d.1 and d.2 with the torque wrench/adapter/knob rotated in a counterclockwise direction.

e. Disassemble the apparatus required to perform the running torque test.

f. Clamp one side of the binocular rigidly to a vertical fixture such that the binocular-half which is not clamped is approximately horizontal.

This initail set-up is performed with the binocular interpupillary adjustment extended to the maximum distance.

g. Attach the hanger of a standard measuring weight hanger firmly to the approximate point where the operator normally applies pressure to change the interpupillary distance.

h. Incrementally add weights to the weight hanger until a sufficient force is applied and the interpupillary distance is reduced to the minimum setting. Draw a diagram illustrating where the weight hanger was attached and record the weight, including the hanger weight, which was required to change the interpupillary setting.

i. With the binocular interpupillary distance set to minimum, re-clamp one side of the binocular to the vertical fixture and repeat the procedures of steps g and h to determine the force necessary to move the interpupillary setting to the minimum.

NOTE: The binocular is upside down for this procedure.

6.2.2 Eyepiece Focus

Determine the capability of the test item to deliver diverging image rays within a specified diopter range by performing the following:

NOTE: 1. The "diopter" is a measure of the power of a lens and is commonly used in measuring eyesight.
2. Military binoculars are commonly designed so that it is possible to independently move the eyepiece of each binocular-half a short distance along the optical path and thereby accommodate the eyes of persons possessing normal vision (0 diopter), farsighted vision (- diopter), and nearsighted vision (+ diopter). Typically, each binocular eyepiece is provided with a scale indicating the divergence in diopters so that an observer can quickly set the eyepieces to a close approximation of the proper focus for each eye.

a. Rigidly mount the test item and orient such that a dioptometer (see item k6 of paragraph 3) may be introduced into the line of sight of each binocular-half as required during subsequent procedures.

b. Sight through the dioptometer at a white background and adjust the eyepiece until the reticle is at a point of optimum definition and clarity.

c. Position the dioptometer behind the test item's left binocular-half eyepiece along the line of sight.

d. Set the test item's left binocular-half diopter adjustment to indicate zero.

e. Sighting through the dioptometer, adjust the dioptometer barrel (objective) to obtain best focus of the test item's left binocular-half reticle image or image of a convenient test target.

f. Observe the dioptometer barrel scale and index. Record the error in the test item's left binocular-half eyepiece diopter calibration.

g. Following an identical procedure, position the test item's left binocular-half eyepiece diopter adjustment to each scribed setting (+ diopter and - diopter) and establish best focus with the dioptometer barrel. Observe

the dioptometer scale and index and record, for each, the error, ability, or inability to obtain an actual diopter value.

h. Repeat steps c through g for the test item's right binocular-half.

6.2.3 Reticle Alignment

6.2.3.1 Reticle Scale Spacing and Parallax

Determine the amount of parallax in the reticle and the accuracy of the reticle scale by performing the following:

a. Prepare an enlarged facsimile of the test item reticle suitable for wall mounting. A high contrast target is preferred where the target lines and calibration marks are reproduced in black against a white background. In addition, reproduce calibration points on the test target representing the specified test item reticle accuracy and parallax tolerance limits.

NOTE: 1. Since military binoculars typically contain required reticles in only the left binocular-half, this evaluation does not pertain to the right binocular-half. Should this not be the case for the model under evaluation, alter subsequent procedures accordingly.
2. The dimensions of the test target will be scaled to suit individual reticle designs and the distance selected or specified for separating the test item from the target.
3. For test item reticles which are calibrated with conventional or standard scales intended for measuring small angles or linear displacements, existing collimator targets may prove suitable for this evaluation if accuracy permits comparisons within specified test item tolerances.

b. Mount the test target on a wall or other suitable vertical surface at the proper distance for test target scale dimensions.

c. Mount the test item on a tripod or other rigid foundation.

d. Adjust test item height and horizontal/vertical displacement to cause the left binocular-half line of sight to be perpendicular to the test target.

e. Adjust the left binocular-half diopter adjustment until the reticle is seen with optimum definition and clarity. Record whether or not the test target image is also at a point of optimum focus.

NOTE: Typically, the reticle is located at a fixed distance between the rear Porro prism and the field lens and, when properly aligned, gives the appearance of being as distant as the object being viewed. Since binocular design does not usually provide a means of adjusting the objective lens to reticle distance, it may not be possible to obtain optimum clarity of target image and reticle image focus simultaneously for an improperly aligned binocular. Under the foregoing stated condition, parallax will exist which cannot be corrected in the field by the binocular eyepiece diopter adjustment.

f. Test for parallax by moving the eye to the left and right (or up and down). If the reticle appears to move with respect to the object image, carefully refocus with the diopter eyepiece adjustment. Continue focusing back and forth until minimum parallax is observed.

g. Measure the parallax at optical center as observed when moving the eye left and right (and/or up and down). Record the distance at which parallax was measured and the observed parallax value following several observations.

NOTE: Personnel conducting these observations should possess normal visual acuity.

h. Precisely adjust the test item reticle boresight mark coincident with the appropriate test target reference point. Compare the reticle with the test target and record the cumulative scale error that exists at the reticle extremity opposite to the boresight reference point. Regardless of the cumulative scale error value, compare on a mark by mark basis and record the existence of any displaced scale marks and the resulting incorrect scale interval.

6.2.3.2 Reticle-Image Parallelism

Determine the degree of accuracy with which the test item vertical reticle line can be made parallel to the image of a vertical test target line which has been aligned to the vertical,by performing the following:

a. Utilize the test item enlarged reticle facsimile prepared for 6.2.3.1 as the evaluation test target.

b. Mount the test target at the distance specified in paragraph 6.2.3.1.b. Plumb the vertical line to local vertical within a tolerance of ± 5 minutes, or as otherwise specified.

c. Mount the test item horizontally on a foundation (see item n.3 of paragraph 3) capable of mounting a telescope behind the test item's left binocular half. (See NOTE 1 of paragraph 6.2.3.1.a).

d. Sighting through the left half of the test item, position one extremity of the test item's vertical reticle to the image of the test target vertical plumb line.

e. Mount the low power auxiliary telescope (see item h.1 of paragraph 3) along the line of sight behind the test item's left binocular-half eyepiece. Sighting through the auxiliary telescope, bring the auxiliary telescope vertical cross hair into coincidence with the test target vertical line image.

f. Sighting through the auxiliary telescope, observe the opposite test item vertical reticle extremity and the angular deviation of the reticle from the image of the test target vertical plumb line. Record the angular deviation.

6.2.4 Collimation

Determine the degree to which the optical axis of the test item binocular-halves are parallel when positioned to the maximum and minimum interpupillary settings, by performing the following:

a. Assemble the various components of the binocular collimation fixture (see item i of paragraph 3) as shown in Figure 3.

b. Separate the two collimators by exactly the difference between the test item objectives lenses when the binocular halves are spaced for maximum interpupillary distance.

c. With the auxiliary telescope along the optical axis of the left collimator, adjust the auxiliary telescope vertical cross hair to coincidence with a vertical plumb line.

NOTE: The test item is not installed at this time.

d. With the left collimator light source on, adjust the collimator reticle to coincidence with the auxiliary telescope cross hair.

e. Move the auxiliary telescope along the parallel track to the right collimator and repeat step d.

f. Return the auxiliary telescope to the left collimator position. Check collimator/auxiliary telescope reticle/cross hair coincidence. Recheck the right collimator; continue alignment until a satisfactory reference frame has been established.

g. Install the test item, with the interpupillary adjustment set to maximum, on the collimating "y" block such that the objectives lenses are parallel and match the position of the left and right collimators. Ensure that the test item is level with respect to the established reference frame. (See Figure 4).

h. With the auxiliary telescope behind the left binocular-half eyepiece, adjust the auxiliary telescope lateral position and height until the centers of the collimator and auxiliary telescope cross hairs are in coincidence and observe and record the following:

NOTE: This step will establish several reference values in addition to determining alignment of the left binocular-half's optical components with the mechanical frame of the test item:

1. Lateral scale reading of auxiliary telescope position
2. Image height reference value as indicated by the auxiliary telescope height adjustment index and scale.
3. Angular rotation of the image (image tilt) and direction of tilt as observed at the extremity of the vertical collimator reticle image.

i. Without changing any other adjustment, slide the auxiliary telescope on the track to behind the right binocular eyepiece and repeat step h.

j. Remove the test item from the collimating fixture. Set the interpulillary adjustment to minimum. Repeat steps b through 1.

6.2.5 Resolution

Determine the capability of each test item binocular-half to record fine detail in the object as limited by diffraction, optical system aberrations, and the precision employed in preparing and centering optical components, by performing the following:

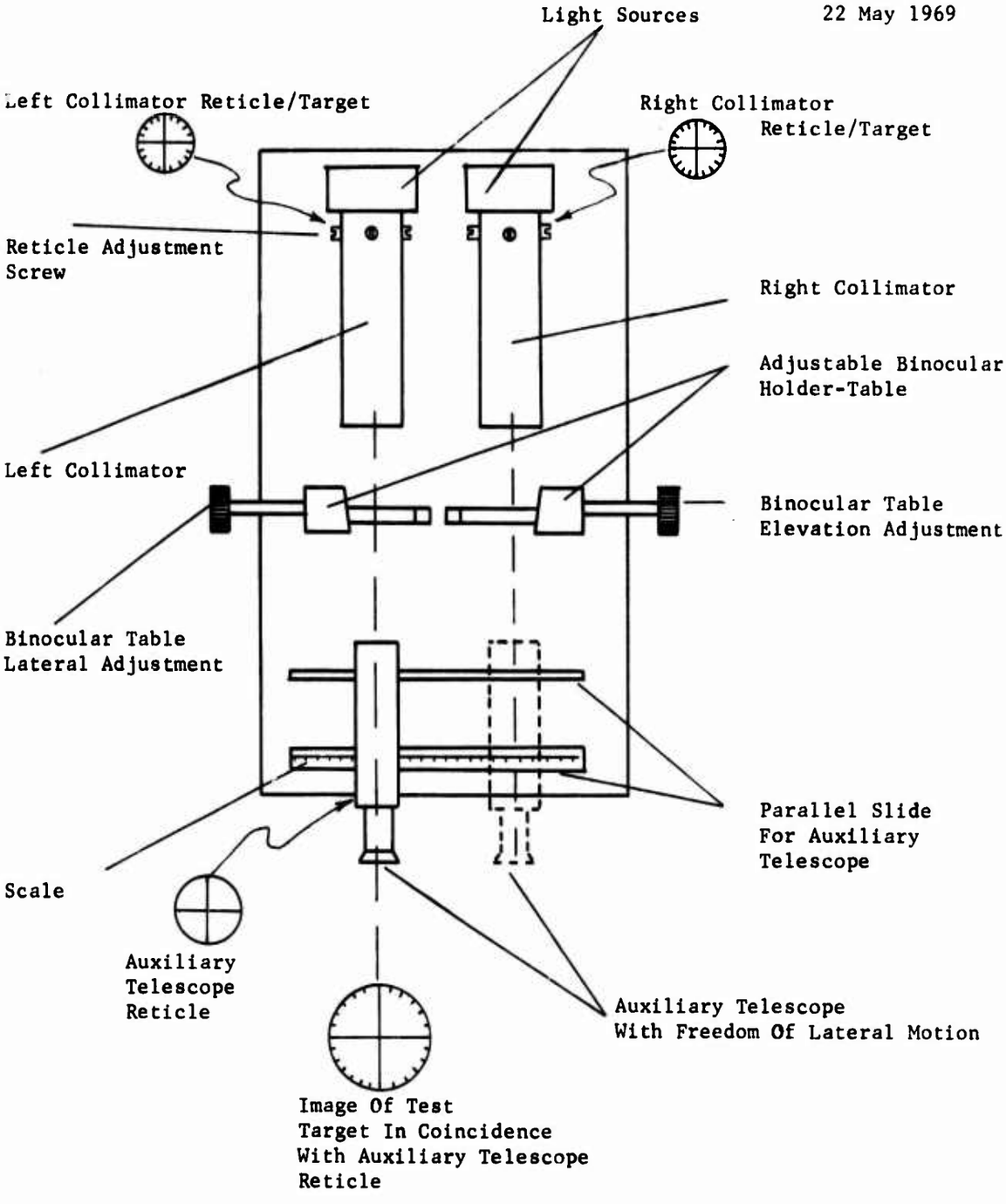


Figure 3 Typical Collimation Set-Up
Without Test-item

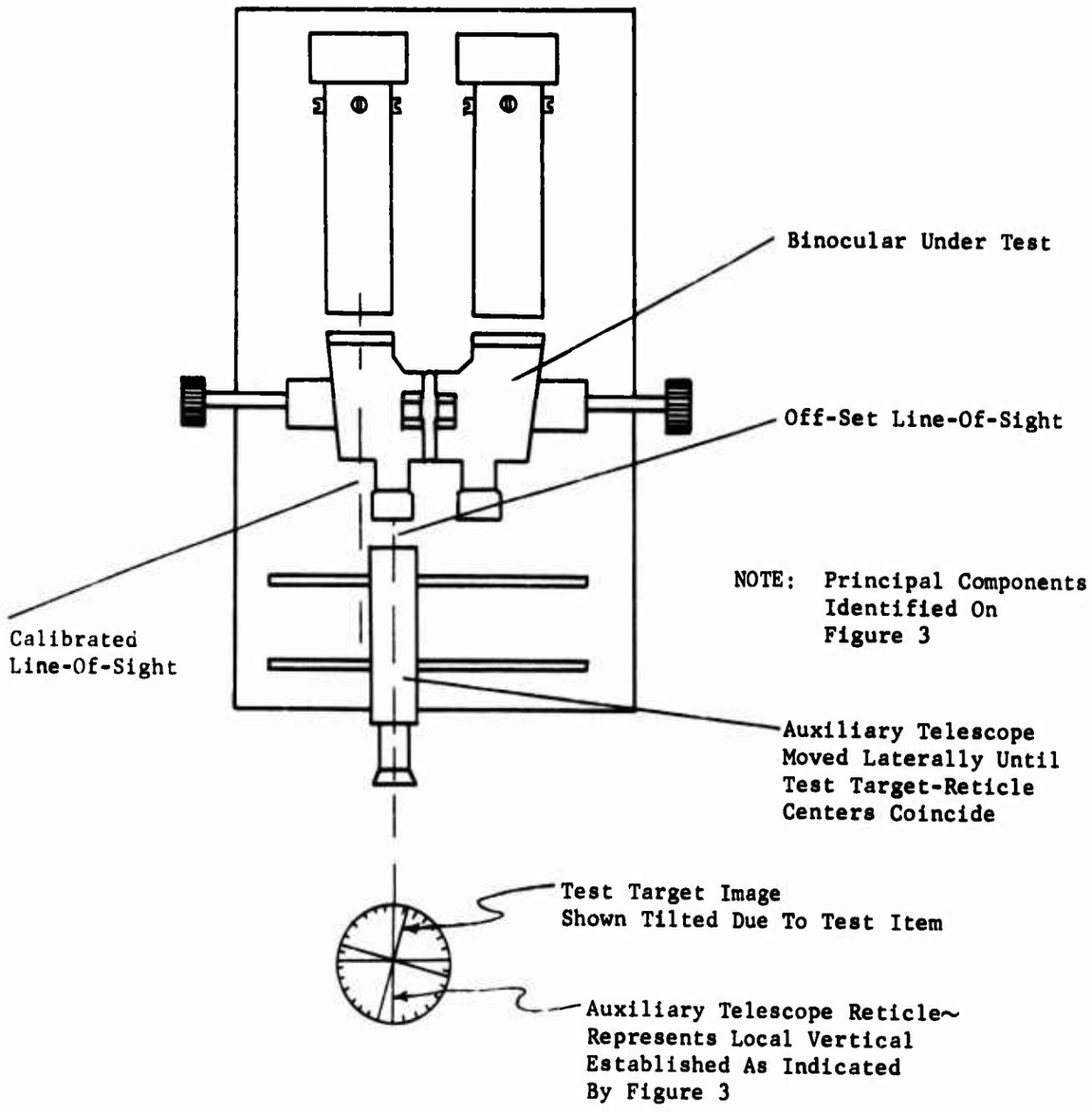


Figure 4 Typical Collimation Set-Up
with test item

NOTE: The limit of resolution is defined as the smallest angle separating two points for which the two points are still distinguished as separate points.

a. Ready the auxiliary telescope with 3-power (3X) scaled in diopter for use (see item k.7 of paragraph 3).

NOTE: The use of the auxiliary telescope in this evaluation is to ensure that the observer's eye is not the limiting factor in the determination of resolution.

b. Mount a copy of the high-contrast wall chart which is shown in the National Bureau of Standards (NBS) Circular No. 533, or a resolution chart specified for the test item, on a flat and otherwise suitable vertical surface. Record the type of resolution chart used.

NOTE: An alternate wall chart commonly employed for resolution testing is provided as part of MIL-O-13830A. Procedures and computation required for its use will be similar to those described herein.

c. Mount the test item oriented so that the auxiliary telescope may be conveniently introduced into the test item line of sight behind each eyepiece.

d. Determine the distance required between the test item objective lenses and the resolution chart as follows:

1) Using the specified test item resolution value in seconds of arc, select from Table 1 the identical value (seconds column) and the applicable resolution pattern number. If, for example, the test item resolution value was specified to be 6 seconds of arc, according to Table 1, the test chart could either be placed 35 or 50 feet from the test target. Where 35 feet is convenient, test pattern No. 80 is used for the test. Otherwise, test pattern No. 56 is satisfactory and will provide identical results.
2) For specified resolution values not directly found in Table 1, locate in the "seconds" column the approximate resolution value and select a pattern number. Using the specified resolution value and the line width corresponding to the selected pattern, compute the exact distance required between test item objective lenses and the chart, as follows:

a) $\text{ANGULAR SEPARATION IN SECONDS} = \text{ARC TAN X } \frac{\text{LINE WIDTH (mm)}}{\text{Tgt DISTANCE (mm)}}$

b) Solve for Tgt Distance and convert to feet or meters and record the value.

e. Position the test item so that the test item line of sight passes perpendicularly through the chart pattern numeral of the chart selected in step d and so that the test item-chart distance is equal to the distance selected.

Record the number of the chart pattern used and the test item chart pattern distance used.

f. Carefully focus the left binocular-half eyepiece to obtain optimum definition and clarity at center field.

g. Introduce the auxiliary telescope into the line of sight behind the test item left eyepiece. Focus the auxiliary telescope to obtain optimum definition and clarity at center field.

h. Observe the resolution chart through the auxiliary telescope and the test item and count the vertical lines near optical center. If the correct line count is obtained indicating that each line can be distinguished from the background, vertical resolution meets the specified requirement at center field. Record the results of vertical resolution observations at center field.

i. Observe the vertical resolution pattern toward the extremity of the lines. At the point where an accurate line count is not possible and the lines are impossible to discern individually, refocus the auxiliary telescope. If the line count can be correctly accomplished within a focus range of ± 1/8 diopter, or as otherwise specified, the vertical resolution toward the edge of field meets typical resolution requirements. Record the results of vertical resolution observations toward edge of field.

j. Repeat steps h and i using the horizontal lines on the resolution chart.

k. For test items equipped with objective lens filters, repeat steps h through j for each filter, installed as specified. Record the filter identification for each filter tested.

l. Repeat f through k for the right binocular-half.

6.2.6 Angular Magnification

Determine the capability of each binocular-half to produce on the retina an image expanded by a specified number of diameters when the object is being viewed at a specified distance by performing the following:

a. Attach two movable markers, which can be seen by the naked eye at the distance at which the target image in the test item will be sharp when the test item is focused to infinity, to the test target described in item j.3 of paragraph 3.

b. Mount the target along the vertical.

c. Rigidly mount the test item so that the test item line of sight is perpendicular to the target and at a distance from the target which will allow the test item to be focused to infinity, or at a distance specified for the test item magnification testing. Record the test item target distance.

d. Station a member of the test team at the target for the purpose of setting the movable markers when required by the test item observer.

e. Sight through the left binocular-half and choose a certain section of the target scale for reference. (For an example, a target scale calibrated in inches is used in Figure 5 where the 9 inch to 10 inch interval is selected for the reference). Record the binocular viewed scale calibration interval selected for reference.

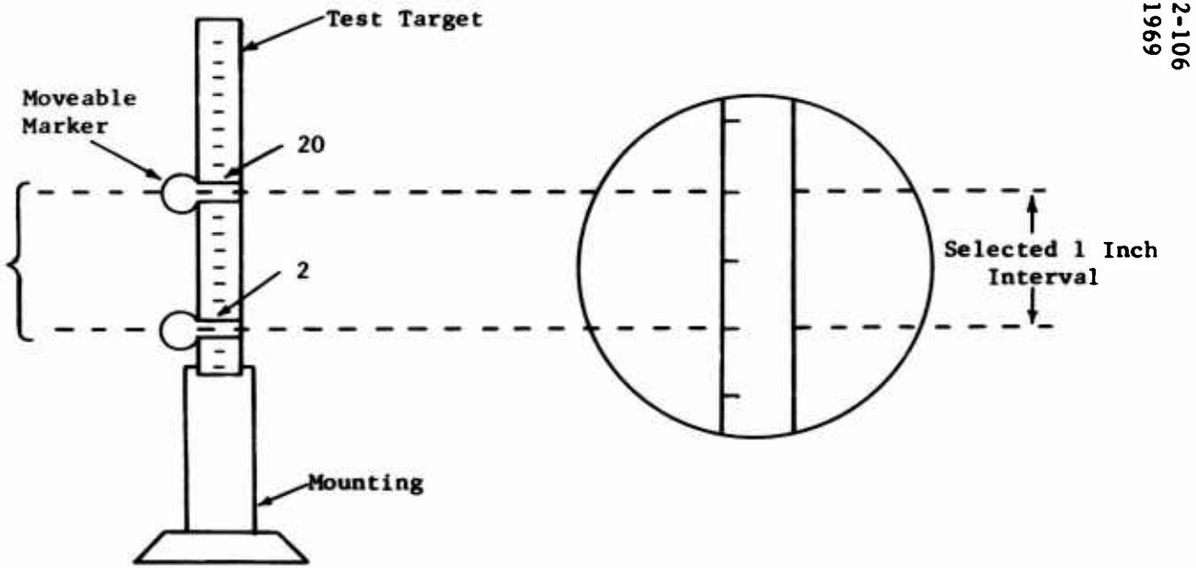
f. While sighting through the left binocular-half with one eye, as specified by step e, look directly at the target scale with the other eye. Signal the assisting team member to adjust the two movable markers on the

TABLE 1 ANGULAR SEPARATION OF LINES IN THE VARIOUS NATIONAL BUREAU OF STANDARDS (NBS) CIRCULAR NO. 533 RESOLUTION CHART PATTERNS AT DIFFERENT VIEWING DISTANCES

NBS PATTERN NUMBER	LINE WIDTH	ANGULAR SEPARATION FOR A TARGET DISTANCE OF:			
		25 ft	35 ft	50 ft	100 ft
	mm	SECONDS	SECONDS	SECONDS	SECONDS
80	0.31	8.5	6.0	4.2	2.1
56	.45	12.1	8.6	6.0	3.0
40	.62	16.9	12.1	8.5	4.2
28	.89	24.2	17.3	12.1	6.0
20	1.25	33.8	24.2	16.9	8.5
14	1.79	48.3	34.5	24.2	12.1
68	0.37	10.0	7.1	5.0	2.5
48	.52	14.1	10.1	7.0	3.5
34	.74	19.9	14.2	10.0	5.0
24	1.04	28.2	20.1	14.1	7.1
17	1.47	39.8	29.4	19.9	10.0
12	2.08	56.4	40.3	28.2	14.1

Moveable Markers Indicate An Interval Of 18 Units Equal To Test Item Selected Interval Of One Unit

Therefore, For This Illustration, Angular Magnification Is Equal To 18



Target As Viewed By The Unaided Left Eye

Target Scale As Viewed By The Right Eye Through The Test Item

Figure 5 Illustration Of Angular Magnification Determination Method

target scale as seen by the naked eye until they appear to be opposite the chosen marks as seen through the left binocular-half. (Continuing with the example of step e: If, the markers were separated by 18 inches and the reference interval was 1 inch, magnification is equal to 18 diameters.) Record the observed interval between the movable target scale markers.

g. Repeat steps e through f for the right binocular-half.

NOTE: Magnification will change when the eyepiece lens is moved in focusing. Therefore, binocular magnification is changed when focused on objects at different distances or when the eyepieces are adjusted for a different observer's eyesight.

6.2.7 Linear Distortion

Determine the degree of test item image deformation caused by variations in the magnification of each binocular-half optical system by performing the following:

a. Construct a linear distortion test target consisting of three vertical, equally spaced lines. The equal-distance line should be centered on the test target and the lines to the right and left should be spaced to represent the angular displacement from the optical axis for which the test item linear distortion requirement is specified and the distance at which the target is viewed.

NOTE: Although line height and width are not critical, these dimensions should be considered in respect to the distance at which the target is to be viewed.

b. Rigidly mount the test item on a foundation (see item m.3 of paragraph 3) which is suitable for mounting of auxiliary telescope behind each eyepiece, as required.

c. Mount the test target on a vertical surface.

d. Position the test item at the distance from the test target for which the target lines will represent the specified linear displacement and ensure that the test target is made perpendicular to the test item line of sight at the target center line. Record the distance between the test item and the target.

e. Adjust the left binocular-half to obtain a clear focus of the test target.

f. Mount the auxiliary telescope, described in item h.2 of paragraph 3, along the line of sight behind the left binocular-half eyepiece.

g. With the auxiliary telescope horizontal and vertical adjustments set to zero, observe the test target image and obtain a clear focus of the center line.

h. With the telescope, measure and record the angular height of the test target center line.

i. Rotate the telescope around the entrance pupil to the right test target line. Align the line to the telescope vertical cross hair and measure and record the angular height of the line.

j. Rotate the telescope around the entrance pupil to the left test

target line. Align the line to the telescope vertical cross hair and measure and record the angular height.

k. Remove the auxiliary telescope behind the right binocular-half eyepiece and repeat the procedures of steps f through j.

6.2.8 Field of View

Determine the maximum angle of view that can be seen at one time by an observer using the test item, by performing the following:

a. Prepare an instrument suitable for measuring angles similar in operation to a theodolite for use.

b. Mount the test item on a tripod and direct the line of sight toward a distant flat, vertical surface. Record the distance to the selected surface.

c. Station a member of the test team at the surface selected for observation.

d. Sighting through both test item eyepieces, signal the test team member to mark the extreme edges of the field as seen through the test item.

e. Replace the test item with the thedolite-like instrument and measure the true field of view. Record the value.

6.2.9 Relative Light Efficiency

Determine the relative loss of binocular-half image brightness resulting from objective lens light reflections and light losses within each test item optical path, by performing the following:

a. Assemble the following components, described in paragraph 3, as shown in Figure 6:

NOTE: Do not introduce the test item into the test set-up optical path at this time.

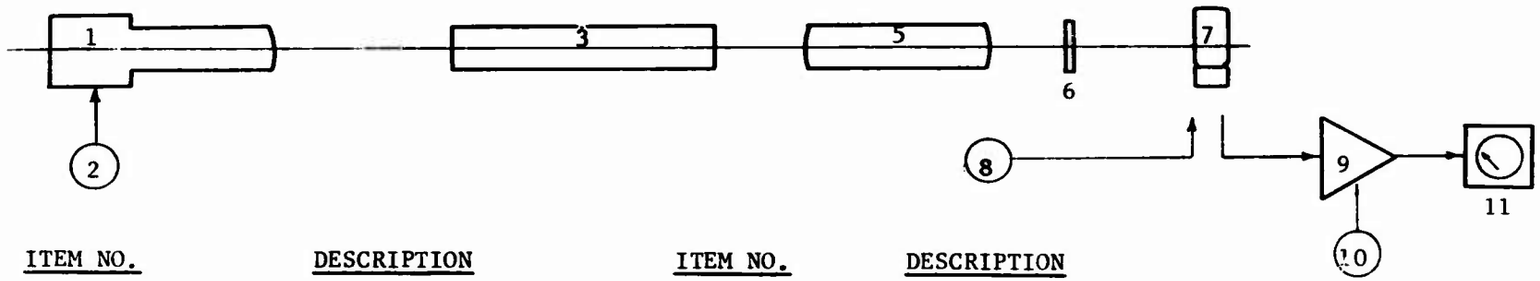
1) Collimator of item k.3
2) Pick-up lens system or auxiliary telescope of item h.4
3) Single vertical slit of item k.5
4) Photo multiplier or phototube of item 1.1

NOTE: The S-3 photo surface has a response closest to that of the human eye.

5) Amplifier or signal processor of item 1.2
6) Output meter of item 1.3
7) Lens type bench of item n.2

b. Apply power to the collimator light source. Adjust the focus of the collimator, auxiliary telescope, and slit to obtain a clear, well defined image on the surface of the photomultiplier cathode. Record the lamp operating voltage and amperage values.

c. Close off the light source from the photomultiplier cathode, and



ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
1	Collimator And Lamp	6	Single Vertical Slit
2	Lamp Power Source	7	Photomultiplier Tube - S-3 Response
3	Test Item	8	Photomultiplier Power Supply
4	Optical Axis	9	Amplifier
5	Auxiliary Telescope	10	Amplifier Power Supply
		11	Output Meter

Figure 6 Schematic Layout Of A Typical Relative Light Efficiency Test Set-Up

apply high voltage to the tube. Adjust the high voltage in relation to ambient temperature to attain the minimum operating dark current. The output meter should read zero percent. Record the photomultiplier high voltage and amperage values.

d. Admit light source rays onto the photomultiplier cathode and adjust the output to obtain a reading of 100%, following optimization of focus and other adjustments of test setup.

NOTE: 1. A change to any of the test apparatus adjustments following the establishment of the 100% point will void the evaluation.
2. During this evaluation, care should be exercised to prevent stray light from entering the test item, auxiliary telescope,slit, or photomultiplier cathode surface.

e. Introduce the left binocular-half into the optical path of the test apparatus. Focus the left binocular-half eyepiece to obtain a maximum output as observed on the amplifier output meter. Record the maximum value.

NOTE: Observe the restriction of NOTE 1 of step d.

f. Repeat step e for the right binocular-half .

6.2.10 Extreme Temperature Effects

Determine the effects of extreme temperatures on the performance of the test item by performing the following:

6.2.10.1 Low Temperature Tests

a. Prepare the cold test chamber of item g.3 of paragraph 3 for use.

b. Rigidly mount the test item in the cold chamber and attach a thermocouple to the largest internal centrally located test item mass.

c. Gradually reduce cold chamber temperature to -80 degrees F. and maintain this temperature until test item thermal equilibrium is attained.

NOTE: 1. Gradual temperature reduction is for protection of the test item and may vary as warranted within broad limits depending on how the particular binocular model under test is expected to be affected by thermal shock.
2. Thermal stabilization has been reached when the temperature of the largest internal centrally located test item mass does not vary more than 1 degree C. from the ambient temperature.

d. Raise the chamber temperature to -40 degrees F. or to the value specified for testing running torque. Maintain this temperature until test item thermal equilibrium is attained. Record the stabilized temperature value.

e. Measure and record the running torque data values for each adjustment knob as directed in paragraph 6.2.1.5.d.

f. Measure and record the force required to change the interpupillary distance as directed in paragraph 6.2.1.5 steps e through i.

g. Gradually increase cold chamber temperature to within the standard

ambient test region of 60 degrees F. to 90 degrees F.

h. Following attainment of test item thermal equilibrium, perform the following:

1) Inspect the test item for evidence of the following:

a) Lens cement separation
b) Glass breakage
c) Casting failure

2) Record a precise description of any defects found during this inspection and the stabilized temperature value.

i. Following the visual inspection of step h, perform the tests listed below in their entirety recording data as required by the individual test:

1) 6.2.1 Mechanical Evaluation
2) 6.2.2 Eyepiece Focus
3) 6.2.3 Reticle Alignment
4) 6.2.4 Collimation
5) 6.2.5 Resolution
6) 6.2.6 Angular Magnification
7) 6.2.7 Linear Distortion
8) 6.2.8 Field of View
9) 6.2.9 Relative Light Efficiency

6.2.10.2 High Temperature Tests

a. Prepare the oven type test chanber of item g.4 of paragraph 3 for use.

b. Rigidly mount the test item with thermocouple attached, in the test chamber.

c. Gradually raise the oven chamber temperature to +160 degrees F. and maintain this temperature until test item thermal equilibrium is attained.

d. Lower, gradually, the temperature to +150 degrees F. or to the temperature specified and maintain this temperature until thermal equilibrium is attained.

e. Perform the test procedures of steps e and f of paragraph 6.2.10.1.

f. Gradually decrease test chamber temperature to within the standard ambient test region of 60 degrees F. to 90 degrees F. Record the stabilized temperature.

g. Repeat the post temperature test procedures of steps h and i of paragraph 6.2.10.1.

6.2.11 Transportability

Subject the test item to applicable procedures of MTP 10-2-503 and the following:

a. Visually inspect the test item for defects prior to testing. Record the findings of this inspection.

b. Upon completion of the test, visually inspect the test item for damage and record evidence of damages observed.

c. Determine if the operation of the test item has been affected by subjecting the test item to the Mechanical Evaluation of paragraph 6.2.1.

6.2.12 Maintainability and Reliability Evaluation

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507 with emphasis on the following:

a. Organizational (O), Direct Support (F), and General Support (H) Maintenance Requirements.
b. Operator through General Support Maintenance Literature.
c. Repair parts.
d. Tools.
e. Test and handling equipment.
f. Calibration and maintenance facilities.
g. Personnel skill requirements.
h. Maintainability.
i. Reliability.
j. Availability.

6.2.13 Safety

Subject the test item to the applicable procedures of MTP 10-2-508 and observe and record the following throughout the test:

NOTE: Issue safety regulations in accordance with USATECOM Regulation 385-6 and observe all normal precautions governing the operation of the test item and test equipment.

a. Any dangerous or unsafe condition or any condition that might present a safety hazard including the cause of the hazard and the steps taken to alleviate any such hazard.
b. The safety features incorporated into test item design.
c. Adequacy of warning instructions and markings.
d. Suggestions to improve the existing safety precautions.

6.2.14 Human Factors Evaluation

a. Evaluate the test item to determine the degree to which the test item physical design and revealed performance characteristics conform to recognized human factors engineering design criteria by subjecting it to the applicable procedures of MTP 10-2-505.

b. In order to facilitate this evaluation prepare check lists of design criteria applicable to class IV A material as defined by HEDGE (Human Factors Evaluation Data for General Equipment) including the following:

1) General considerations to be included in checklists for all tests:

a) Title of test conducted
b) Adequacy of furnished instructions
c) Ease of performing tasks
d) Human factor design deficiency revealed by particular test
e) Time to perform test
f) Personnel required for task

2) Controls and indicators:

a) Location: How easy to operate and read
b) Markings: Clearly marked for function

3) Considerations to be included in checklist for the maintainability evaluation:

a) Ease of locating malfunction and determination of cause
b) Access to defective component
c) Ease of replacement and/or repair of malfunction

4) Performance characteristics which do not conform to recognized human factors design criteria, such as:

a) Poor collimation
b) A focus range not applicable to all possible Army personnel eyesight capabilities.
c) Poor color correction of lenses.
d) High light loses leading to dim images and eye strain
e) Too high magnification for hand-held applications
f) Excessive differences in binocular-half magnifications

5) Inadequacies of binocular design affecting ease of vision, user comfort, etc. if any.
6) Recommendations to improve man-item effectiveness, if any.

6.2.15 Value Analysis

Determine whether the test item has any nonfunctional, costly, or "nice-to-have" features as stated in USATECOM Regulation 700-1 by performing the following:

a. During operation of the test item, observe the test item for features which could be eliminated without compromising performance, reliability, durability, or safety.

b. Question test personnel regarding features of the test item which could be eliminated without decreasing the functional value of the test item or decrease man-item effectiveness.

c. Record the following:

1) Non-functional, costly, or"nice-to-have" features of the test item.
2) Test personnel comments and opinions regarding features to be eliminated.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Initial Inspection

Record the following:

a. Evidence of package deterioration or damage
b. Identification markings, including:

1) Name of contractor
2) Number and date of contract
3) Date of manufacture
4) Other markings pertaining to the test item

c. Package contents, by item
d. Package weight, in pounds
e. Package length, width, and height, in inches
f. Package volume, in cubic feet
g. For each test item component:

1) Evidence of defects in:

a) Manufacturing
b) Materiel
c) Workmanship

2) Presence of markings, including:

a) Identification, test item nomenclature, and serial number
b) Service instruction plates
c) Caution plates

6.3.1.2 Physical Characteristics

Record the data required by MTP 10-2-500 and the following:

a. Weight, test item alone, in ounces
b. Weight, test item, carrying case, neck strap, and lens caps, in ounces.
c. Lens barrel diameter, in mm.
d. Overall length, in mm.
e. Overall width, in mm.
f. Interpupillary distance, minimum, in mm.
g. Interpupillary distance, maximum, in mm.
h. Effective lens diameter, in mm.
i. Effective eyepiece diameter, in mm.
j. Reticle calibration.
k. Rated angular magnification, in diameters.
l. Rated resolution, in seconds of arc.

m. Rated field of view, in degrees.
n. Eyepiece focus range, in diopter.
o. Rated parallax, in mils.
p. Filter description and type.
q. Neck strap, minimum length, in inches.
r. Neck strap, maximum length, in inches.

6.3.1.3 Operator Training and Familiarization

Record the following:

a. Adequacy of training and familiarization program
b. Test director evaluation of test personnel as a team
c. Adequacy of supplied technical manuals for training purposes
d. Test personnel data as required by MTP 10-2-501.

6.3.2 Test Conduct

6.3.2.1 Mechanical Evaluation

6.3.2.1.1 Vibration -

Record the following:

a. Vibration frequency, in cycles per second.
b. Vibration amplitude, in inches.
c. Evidence of the following (identify test item parts by using the nomenclature of Figure 1):

1) Loose parts
2) Damaged components
3) Internal dirt or lint particles:

a) Number of particles grouped by dig size.
b) Location of particles in respect to optical axis of each binocular-half.
c) Extent to which dirt or lint particles interfere with test item image quality or obscures reticle numbers/ figures.

d. Overall soundness of test item construction and degree of internal cleanliness.

6.3.2.1.2 Leakage -

Record the following (identify test item parts using the nomenclature of Figure 1):

a. Length of time test item was subjected to rainfall in hours
b. For each phase of the rainfall exposure:

1) Rainfall direction, in degrees from the vertical
2) Test chamber temperature in degrees F.
3) Length of test, in minutes
4) Rainfall type, by drop description
5) Rainfall dispersion
6) Rate of rainfall in inches per hour

c. Evidence of water penetration into either binocular-half
d. Evidence of internal damage to the test item
e. Evidence of external damage to the test item

6.3.2.1.2 Internal Dew Point -

Record the temperature at which condensation appears on the internal lens surface of the test item of each binocular half.

6.3.2.1.4 External pressurization -

Record the following:

a. Test item initial external pressure, in psig
b. Test item external pressure following the timed period, in psig
c. Time of pressurization, in minutes and seconds

6.3.2.1.5 Adjustment Operability -

Record the following (identify test item components using the nomenclature of Figure 1):

a. Test area temperature, in degrees F.
b. For each adjustment knob tested:

1) Adjustment knob identification
2) Running torque value, in inch-pounds
3) Direction of travel, clockwise or counterclockwise, as applicable

c. Force required to change the interpupillary adjustment from:

1) Minimum to maximum
2) Maximum to minimum

6.3.2.2 Eyepiece Focus

Record the following for each binocular-half:

a. Binocular-half being tested (right or left)
b. Error in test item diopter calibration at zero diopter, in diopter
c. Error in each test item diopter calibration mark, in ± diopter
d. Inability to obtain an actual diopter value

6.3.2.3 Reticle Alignment

6.3.2.3.1 Reticle Scale Spacing and Parallax -

Record the following:

a. Capability of test item to be focused at optimum clarity for the object image and reticle simultaneously.
b. Parallax:

1) Distance test target was from test item when parallax was measured, in feet.
2) Measured parallax, in mils.

c. Reticle scale spacing:

1) Cumulative scale error, in reticle calibration units.
2) Identification of individual reticle calibration marks which are improperly etched.

6.3.2.3.2 Reticle-Image Parallelism

Record the value of angular deviation error in the alignment of the test item reticle to the image, in mils.

6.3.2.4 Collimation

Record the following:

a. Interpupillary distance (maximum, minimum)
b. Binocular-half being tested (right, left)
c. Telescope position when properly aligned:

1) Auxiliary telescope lateral position, in mm.
2) Auxiliary telescope height, in mm.
3) Angular rotation of collimator image with respect to the auxiliary telescope vertical cross hair, in mils/degrees.
4) Direction of rotation (clockwise, counterclockwise).

6.3.2.5 Resolution

Record the following for each binocular-half:

a. Binocular-half being tested (right, left).
b. Identification of resolution chart used.
c. Distance between the resolution chart and the test item, in feet.
d. Line count obtained at center field.
e. Line count obtained at vertical extremity of pattern lines.
f. Line count obtained at horizontal extremity of pattern lines.
g. Vertical and horizontal line count for each test item filter, if applicable.

6.3.2.6 Angular Magnification

Record the following:

a. Binocular-half being tested (right, left).
b. Distance between the test item and the target scale, in feet.
c. Scale interval selected for reference, in inches or cm.
d. Scale interval observed to be opposite reference interval, in inches or cm.

6.3.2.7 Linear Distortion

Record the following:

a. Binocular-half being tested (right, left)
b. Distance between test item and test target, in feet
c. Angular height of test target center line, in degrees
d. Angular height of test target right line, in degrees
e. Angular height of test target left line, in degrees

6.3.2.8 Field of View

Record the following:

a. Distance between the test item and the selected viewing surface
b. Field of view, in degrees

6.3.2.9 Relative Light Efficiency

Record the following:

a. Light source operating voltage, in volts
b. Light source operating amperage, in amperes
c. Photomultiplier high voltage, in kilo-volts
d. Photomultiplier amperage, in milliamperes
e. Left binocular-half image loss of brightness, in percent
f. Right binocular-half image loss of brightness, in percent

6.3.2.10 Extreme Temperature Effects

Record the following:

a. Temperature test reference (cold temperature, hot temperature).
b. For adjustment operability testing:

    1) Temperature of test item in °F.
    2) Running torque and interpupillary adjustment data as required in paragraph 6.2.1.5.

c. Damage to test item, including:

    1) Lens cement separation
    2) Glass breakage

3) Casting failure

d. Data as required by the following tests(at standard ambient temperatures).

1) 6.2.1 Mechanical Evaluation
2) 6.2.2 Eyepiece Focus
3) 6.2.3 Reticle Alignment
4) 6.2.4 Collimation
5) 6.2.5 Resolution
6) 6.2.6 Angular Magnification
7) 6.2.7 Linear Magnification
8) 6.2.8 Field of View
9) Relative Light Efficiency

6.3.2.11 Transportability

Record the following:

a. Data required by applicable procedures of MTP 10-2-503
b. Damage observed, if any
c. Mechanical Evaluation data as described in paragraph 6.2.1

6.3.2.12 Maintainability and Reliability Evaluation

Record data collected as described in the applicable sections of MTP 10-2-507.

6.3.2.13 Safety

Record the following:

a. Data collected as described by the applicable sections of MTP 10-2-508.
b. Dangerous or unsafe condition which presents or might present a safety hazard including the cause of the hazard and steps taken to alleviate any observed test item hazard.
c. Safety features incorporated into test item design.
d. Adequacy of warning instruction and markings.
e. Suggestions to improve existing test item safety precautions.

6.3.2.14 Human Factors

Record the following:

a. Data collected as described by applicable sections of MTP 10-2-505.
b. Inadequacies of binocular design affecting ease of vision, user comfort, etc., if any.
c. Recommendations to improve man-item effectiveness, if any.
d. Retain the checklists for the following general

1) General considerations
2) Controls and indicators
3) Maintenance Evaluation
4) Performance Evaluation

6.3.2.15 Value Analysis

Record the following:

a. Non-functional, costly, or "nice-to-have" test item features.
b. Test personnel comments and opinions regarding test item features which could be eliminated.

6.4 DATA REDUCTION AND PRESENTATION

Data shall be summarized to reveal significant discrepancies between the specified requirements and the observed performance of the test item and shall be presented in chart, tabular, or graphic form, as appropriate, or as described in the applicable sections of the referenced MTP's, and as follows:

6.4.1 Mechanical Evaluation

Data recorded during the conduct of the tests comprising this evaluation shall be displayed directly. The differences in test item performance at ambient temperature and during or following exposure to extreme hot and cold temperatures shall be clearly illustrated.

6.4.2 Eyepiece Focus

The performance of each binocular-half shall be displayed separately including the effects of exposure to extreme hot and cold temperatures. The differences in eyepiece focus between the binocular-halves shall be expressed in percent for each environmental condition.

6.4.3 Reticle Alignment

Data recorded during the conduct of the tests comprising this evaluation shall be displayed directly. The differences in test item performance at ambient temperature and following exposure to extreme hot and cold temperatures shall be clearly illustrated.

6.4.4 Collimation

Using the left binocular-half as the reference, display the differences of alignment existing between the left binocular-half and the right binocular-half. Express recorded differences in the measured units, and illustrate alignment criteria which is recognized as representing the thresholds of human eye strain. Display this data for tests conducted at ambient temperatures and following exposure to extreme hot and cold temperatures.

6.4.5 Resolution

The performance of each binocular-half shall be displayed separately including the effects of exposure to extreme hot and cold temperatures. The difference in resolution existing between the binocular-halves shall be expressed in percent for each environmental condition.

6.4.6 Angular Magnification

The performance of each binocular-half shall be displayed separately including the effects of exposure to extreme hot and cold temperatures. The difference in magnification existing between the binocular-halves shall be expressed in percent for each environmental condition.

6.4.7 Linear Distortion

The performance of each binocular-half shall be displayed separately including the effects of exposure to extreme hot and cold temperatures. The difference in distortion existing between the binocular-halves shall be expressed in percent for each environmental condition.

6.4.8 Field of View

Test item field of view performance revealed by this evaluation shall be displayed directly for each environmental condition.

6.4.9 Relative Light Efficiency

The performance of each binocular-half shall be displayed separately including the effects of exposure to extreme hot and cold temperatures. The difference of light transmission between the binocular-halves shall be expressed in percent for each environmental condition.

APPENDIX A

Table A-I Permissible Scratch and Dig Dimensions

Focal planes and near focal planes			Central zone ½ diameter of surface		Outer zone	
Beam diameter (mm)	Magnifying power	Focal length (mm)	Scratch	Dig	Scratch	Dig
Over 5			80	50	80	50
4-5			60	40	60	40
3.2-4			60	30	60	40
2.5-3.2			40	20	60	40
2.1-2.5			40	15	60	30
1.6-2.1			30	10	40	20
1.0-1.6			20	5	40	15
0.6-1.6			15	3	30	10
0.4-0.6			10	2	20	5
0.2-0.4			10	1	15	3
0.2	20-10	12.5-25	10	1	15	3
0.4	10-5	25-50	10	2	20	5
0.6	5-3.3	50-75	15	3	30	10
1.0	3.3-2	75-125	20	5	40	15
1.6	2-1	125-250	30	10	40	20