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NIGHT VISION BINOCULARS

Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland

30 June 1972

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13. ABSTRACT Describes a method for evaluation of night vision goggles operational and functional performance characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for preoperational inspection, physical characteristics, safety, durability, reliability, electronic and light interference, patrollings, driving, close-in tasks, static observation, human factors, troop acceptability, and value engineering.			

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U. S. ARMY TEST AND EVALUATION COMMAND
EXPANDED SERVICE TEST - SYSTEM TEST OPERATIONS PROCEDURES

AMSTE-RP-702-102

Test Operations Procedure 6-3-083

30 June 1972

NIGHT VISION BINOCULARS

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SECTION I
GENERAL

1. Purpose and Scope. a. The test procedures discussed herein apply to the expanded service testing of night vision goggles, a lightweight, head-mounted, binocular, image-intensifier viewing system which permits the wearer to perform tasks which require both hands to be free. The goggles are designed to improve vision at short ranges to the extent that security from detection is maintained yet daytime efficiency is approached. The goggles may be worn with or without the standard helmet, and provide a capability for night viewing regardless of the level of ambient light

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b. The use of these procedures will provide both objective and subjective analyses to determine whether the test item satisfies the criteria stated in appropriate requirements documents and its suitability for U. S. Army use. Specific subtests will depend on the characteristics of the test item, the type of troops available for testing, and the stated requirements of the materiel need document. Current standard night vision goggles should be used for comparison and control purposes.

c. The environmental criteria for conducting the expanded service test using these procedures are applicable to all climatic categories. As used herein, the night environment is defined as: full moon, 1×10^{-2} to 4×10^{-2} foot candles; half-moon, 1×10^{-3} to 4×10^{-3} foot candles; starlight, 1×10^{-4} to 4×10^{-4} foot candles; overcast, 1×10^{-5} to 4×10^{-5} foot candles; dawn and dusk, 1 to 10 foot candles; and twilight, 1×10^{-1} to 10 foot candles.

2. Background. a. Since almost the beginning of recorded history, man has recognized the need to improve an army's ability to conduct night operations. Any improvement in that ability will enable an army's units not only to exploit more fully the advantages of the night environment, but also to surpass the counter an enemy's night-operating capability. If the ability of the individual U. S. soldier to operate at night can be increased, if he can be aided in short-range surveillance, in driving, in patrolling, and in work requiring close-in vision, then the overall ability of the U. S. Army to operate at night will also be enhanced.

b. Several requirements for night vision binoculars to improve the individual soldier's capabilities in the above mentioned areas have been established. It can be expected that more such requirements will be forthcoming in the future.

3. Equipment and Facilities.

- a. Test item and accessories.
- b. Control items and accessories.
- c. Maintenance test package.
- d. Safety release.
- e. Appropriate equipment publications.
- f. Test unit, with TOE weapons and equipment, to include protective masks.
- g. Vehicles, wheeled and tracked.

- h. Photographic equipment (still and motion pictures should be used when appropriate to supplement data obtained during testing).
- i. Night driving test areas.
- j. Adequate night field exercise areas
- k. Stopwatches.
- l. Meteorological equipment.
- m. Photometer.
- n. Communication equipment.
- o. Safety and first aid equipment.
- p. Light sources, visible and invisible.
- q. Data reduction and processing equipment.

SECTION II TEST PROCEDURES

4. Supporting Tests. a. Published MTP/TOP's and the subtests listed below -- further defined in Section III where necessary -- should be considered in formulating and developing an expanded service test plan. Additional reference material is listed in appendix A.
- b. In his preparations, the test officer should follow the general guidance laid down in MTP 6-3-501, Pretest Inspection for Service Test. The test officer should also conduct the necessary administrative, personnel, and supply preliminaries outlined in the appropriate test officer guides and manuals, or in unit or organizational standing operating procedures. Keeping in mind the fact that sufficient pretest training must be accomplished to ensure that the test soldiers are equally familiar with the test item and the control item. It is extremely important that the performance of the test item not be degraded because of its newness, or because the test troops are unfamiliar with the item.
- c. During each supporting test, sufficient data to arrive at valid conclusions should be collected. To determine the best way to collect sufficient data, the test officer should realize his statistical objectives may be constrained by limited numbers of test items, limited time, limited manpower, and a limited amount of support and control

equipment. The test officer will find it advantageous to consult with a statistical analyst to develop an experimental design prior to preparing his test plan, since a proper experimental design will aid in the control of bias and in the measurement of precision. Additional statistical guidance can be found in TOP 3-1-002, Confidence Intervals and Sample Size, and in National Bureau of Standards Handbook 91, Experimental Statistics.

d. The test officer should also consult with human factors personnel for assistance in the preparation of pertinent portions of his test plan and test reports, and for the development of interview and questionnaire items.

<u>TEST TITLE</u>	<u>PUBLICATION NO.</u>
a. Preoperational Inspection and Physical Characteristics (refer to para 5)	
b. Safety	
c. Durability and Reliability	
d. Security from Detection	1-3-515
e. Electronic and Light Interference	
f. Patrolling	
g. Driving	
h. Close-In Tasks	
i. Static Observation	
j. Transportability/Portability	10-3-506 and 7-3-511
k. Adverse Conditions	3-3-524
l. Compatibility	6-3-512
m. Maintenance Evaluation	6-3-524 and TECR 750-15
n. Human Factors and Troop Acceptability	
o. Value Engineering	

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Preoperational Inspection and Physical Characteristics.

a. Objectives.

(1) To determine whether the test items and control binoculars are in proper condition for testing.

(2) To determine the physical characteristics of the test items.

b. Method.

(1) All test items and control binoculars will be inspected for completeness, serviceability, and any evidence of damage.

(2) One of each type test and control item will be individually photographed.

(3) The test items and control binoculars will be weighed and measured.

(4) The test items and control binoculars will be evaluated against the appropriate operator's instructions, field manuals, or other related material to determine suitability for testing.

(5) Test soldiers will attempt to position and use the test goggles while wearing the steel helmet, while wearing the protective mask, while wearing the steel helmet and protective maske, and, for the drivers of armored personnel carriers, while wearing the CVC helmet.

c. Data Required.

(1) A record of any defects or discrepancies that may affect the operation of the test items and control binoculars.

(2) Photographs of the test and control items.

(3) A record of the weights and measurements of the test and control items.

(4) A record of any difficulties encountered when the test soldiers attempt to use the test goggles while wearing the steel helmet, the protective mask, or the CVC helmet. A photographic record should be made when feasible.

d. Analytical Plan. In all cases, a subjective evaluation will be made to determine whether the equipment is in proper condition for testing, and to determine whether the required physical characteristics have been met.

6. Safety.

a. Objective. To determine whether the test items are safe for personnel use and to verify the adequacy of the safety statement and/or safety release.

b. Method.

(1) Safety will be evaluated to determine whether there are any unduly restrictive features and whether the safety statement and/or safety release covers the necessary safety requirements for the operation of the test items.

(2) This subtest is conducted concurrently with all other subtests, and in compliance with the safety statement and/or safety release.

(3) During all testing, observations will be made to determine whether any unsafe conditions or safety hazards exist.

c. Data Required.

(1) A record of the occurrences of any unsafe conditions.

(2) A record of any restrictions imposed on the effective use of the test items because of safety considerations.

d. Analytical Plan. Data will be subjectively evaluated to determine if the criteria stated in the requirements documents have been met.

7. Durability and Reliability.

a. Objective. To determine the reliability and durability of the test item under tactical conditions.

b. Method.

(1) Conduct this subtest concurrently with all other subtests.

(2) Inspect the test item at the beginning and end of each test phase.

(3) Use the applicable portions of MTP 6-3-506, Durability, and read MTP 6-2-503, Reliability, for background information.

c. Data Required. Record of all test item failures, malfunctions, breakage, or other equipment failures throughout the conduct of the test program.

d. Analytical Plan. Durability is the ability of the test goggles to perform satisfactorily for a specified duration under specified operating conditions. Reliability is defined as the probability that the test goggles will perform their intended function for a specified interval under stated conditions. The durability and reliability characteristics of the test goggles should be determined during the course of the test program by conducting accelerated life testing and transport for sufficient time to develop a test item history of deterioration, degradation, and maintenance. This history, together with observations of test goggle performance recorded by test supervisory personnel, should then be analyzed to determine the test item's durability and reliability. The data obtained should be compared with the durability and reliability characteristics requirements specified in the appropriate requirements documents or other approved criteria.

8. Electronic and Light Interference.

a. Objective.

(1) To determine whether there are any mutual interference effects when the test goggles and other electronic pieces of equipment are operated in close proximity one to the other.

(2) To evaluate the resistance of the test item to countermeasure effects of visible and invisible radiation.

b. Method.

(1) Operate the test goggles close to representative types of electronic and communication equipment normally found in the organizations which will employ the goggles.

(2) Operate the test goggles, view directly various visible light sources -- flashlights, vehicle headlights, vehicle taillights, illumination flares -- to determine what effects, if any, visible light countermeasure activities have on the test item.

(3) Operate the test item, view directly various infrared light sources, to include flashlights and vehicle lights with infrared filters, to determine what effects, if any, invisible light countermeasure activities have on the test goggles.

c. Required Data.

(1) Results of employment of the test goggles in close proximity with electronic communication, to include nomenclature of radios, radar sets, and other equipment used, and the methods employed.

(2) Ease of countermeasuring the test item by visible and invisible light means.

d. Analytical Plan.

(1) The analysis of qualitative and quantitative data will be recorded separately. The data should be presented in narrative form supplemented, as required, by tables, charts, graphs, photographs, and motion pictures.

(2) With either qualitative or quantitative results, the final evaluation as to whether or not the criteria are met should be subjective.

9. Patrolling.

a. Objective. To determine to what extent the test goggles assist the soldier during night patrolling operations.

b. Method.

(1) A reconnaissance patrol consisting of three reconnaissance teams will conduct a night reconnaissance of two areas. Each test soldier will be equipped with an appropriate patrolling load. One team will be issued test goggles; one will use the control binoculars; and the third team will have no night vision equipment.

(2) After crossing a line of departure, the patrol leader will conduct a route reconnaissance to a bridge site. Enroute to the bridge site, the various test goggles and control binoculars will be used to check map coordinates, identify obstacles, and conduct general surveillance. After reaching the bridge site, each of the three teams will individually examine the bridge and make a sketch of the structure.

(3) After completing the bridge reconnaissance, the patrol will receive and be required to decode a message which gives it an additional mission: to search an area in which the bodies of several enemy soldiers have been reported, to treat several wounded enemy soldiers and search them for any item of intelligence value, and to search the surrounding area.

(4) While moving back to the friendly lines, the patrol will encounter and be required to avoid an enemy observation post.

(5) During the patrol, test soldiers will be required to use the various test and control items and compare their performance to that of the unaided eye. Test soldiers will be required to read maps, decode messages, operate equipment, measure structures, draw pictures, search areas, search personnel, and treat wounds.

(6) Test and control items will be rotated among the teams after completion of the reconnaissance and after treatment and search of the wounded men.

(7) The patrol will be conducted under the various conditions of the night environment as spelled out in paragraph 1, above.

c. Data Required.

(1) A record of any difficulties encountered while using the test goggles.

(2) A record of the range at which the enemy observation post was detected.

(3) A record sketch of the bridge structure.

(4) A record of the treatment of the wounded men.

(5) A record of any items found on the wounded men.

(6) The comments of test soldiers and observations of test supervisory personnel.

(7) A record of light and weather conditions.

d. Analytical Plan. A subjective analysis will be conducted by test personnel to determine whether the test goggles demonstrate a capability significantly better than that afforded by the unaided eye.

10. Driving.

a. Objective. To determine whether the test goggles provide a better night driving capability than the control binoculars, and the extent to which they aid the individual soldier in performing driving tasks at night.

b. Method.

(1) Utility trucks, cargo trucks, and armored personnel carriers will be used during this support test. The vehicles will be operated both in convoy and in moves by individual vehicles.

Driving exercises using the test and control items will be conducted with and without infrared headlights under conditions of moonlight, starlight, and overcast night skies.

(2) Driving exercises will include driving on primary roads, or unimproved roads, and cross-country. Each driving exercise will require the operators to stop and start, to negotiate turns, and to avoid obstacles. Each exercise will be timed from start to finish.

(3) For the first test run drivers will be instructed to negotiate the courses no faster than 10 miles an hour and to stop immediately if they see any obstruction across their path. If the course is negotiated safely during the first run the vehicle speed will be increased on subsequent runs in 5 mph increments until the vehicle commander determines that the maximum safe operating speed has been reached.

(4) The primary road exercise will be used for convoy driving involving all vehicles except the armored personnel carriers. The unimproved roads and cross-country tracks will be used for exercising individual drivers.

(5) During convoy operations, the time intervals between vehicles will be determined and recorded as the vehicle pass predetermined points.

(6) Cardboard obstacles will be used during the individual test runs, thereby requiring drivers to stop. The distances from the obstacles to the stopped vehicles will be recorded.

(7) During the vehicles operation, drivers will be periodically required to check the level of the transmission fluid and oil in the utility and cargo trucks, and the level of the transmission fluid and road wheel oil in the armored personnel carriers.

(8) Driving of the armored personnel carriers will be limited to unimproved roads and the cross-country course. The drivers of the APCs should be required to operate with both open hatches and closed hatches to evaluate the interface between the goggles and the drivers periscopes.

(9) During at least one of the night driving exercises, drivers will be required to wear the test and control items for a minimum period of 4 hours, with only normal rest periods permitted.

c. Data Required.

(1) A record of light and weather conditions.

(2) A record of stopping distances, measured from the front bumper of the vehicle to the obstacle, by light condition, by test and control item, and with and without an infrared light source.

(3) A record of vehicle interval measured in time by light condition, by test and control item, and with and without an infrared light source.

(4) A record of observations from test supervisory personnel and comments by test soldiers.

(5) A record of any difficulties encountered by the test soldiers in performing the vehicle checks.

(6) A record of the time it takes each driver to negotiate each driving exercise.

d. Analytical Plan. Comments of test soldiers, observations of test supervisory personnel, average stopping distances, and average vehicle time intervals for the test and control items will be evaluated subjectively to determine whether the test goggles meet the criteria established in the requirements documents. Measurements of distance and interval will be subjected to an analysis of variance at an appropriate confidence limit to determine if a significant difference exists between the test and control goggles. The latter measures will also serve as a point of comparative evaluation of test soldier comments.

11. Close-In Tasks.

a. Objective. To determine the extent to which the test goggles assist the soldier in performing close-in tasks at night.

b. Method.

(1) During all phases of testing, observations will be made concerning the use of the test goggles in performing close-in tasks. These observations will include but will not be limited to:

- (a) Reading of maps and sign posts.
- (b) Coding and decoding of messages.
- (c) Searching of personnel.
- (d) Treatment of wounds.
- (e) Reaction to mischange incidents (changing of tires, winching out vehicles).

(f) Checking oil levels.

(2) A fire direction center consisting of at least three test soldiers will conduct an exercise simulating the execution of a number of mortar fire missions. The test soldiers will be required to set up a plotting board, plot the range and deflection for a target, and then make corrections for range and deflection. This exercise will be repeated until each test soldier has plotted a specified number of targets and made a correction for each one while using the test goggles with an infrared light source. The exercise will be repeated using the test goggles in the passive mode under full-moon, half-moon, starlight, and overcast night conditions.

c. Data Required.

(1) A record of the observations of test supervisory personnel and the comments and performance of the test soldiers.

(2) A record of any difficulties encountered by the test soldiers while performing the tasks specified above.

(3) A record of the success or failure of the fire mission conducted using the plotting board.

(4) A record of the light and weather conditions.

d. Analytical Plan. The results of the plotting board exercise will be considered to be binomially distributed and an appropriate limit of reliability established at a designated confidence level. In all cases, a subjective evaluation will be made to determine if the criteria stated in the requirements documents have been met.

12. Static Observation.

a. Objective. To determine if the test goggles provide an increased night observation capability for a static defense position.

b. Method.

(1) Test soldiers equipped with the test goggles will observe differing arrays of targets and personnel. Each target array will consist of from one to five observation targets at varying ranges and will be presented to each test soldier a specified number of times. Arrays will remain exposed to a test soldier's view for a predetermined period of time. Each time an array is shown, the test soldier will be required to determine the number of type of targets presented.

(2) After the test soldiers have observed all target arrays while using the test goggles, the entire exercise will be repeated, using the unaided eye in one sequence and the control items in another.

(3) All test exercises will be conducted under conditions of full-moon, half-moon, starlight, and overcast night conditions.

c. Data Required.

(1) A record of weather and light conditions.

(2) Total targets presented, by range, for observation by each test and control item, and by the unaided eye.

(3) Total targets observed, by range, by test and control item, and by the unaided eye.

(4) Recorded times for detection and recognition of targets in all modes.

d. Analytical Plan. A analysis of variance will be used to compare observation ratios to determine if there is a significant difference between test and control items and the unaided eye at the ranges tested. The analysis will be performed at an appropriate level of significance utilizing a binomial distribution.

13. Human Factors Engineering and Troop Acceptability.

a. Objectives.

(1) To determine the suitability of the test items with respect to the requirements and limitations of the human operator.

(2) To determine the compatibility of the test items with the helmet, gas mask, and equipment the wearer must use, e.g., driver's periscope, CVC helmet intercom.

b. Method.

(1) During all testing, observations will be made to determine features of the test items which are not compatible with the skills, limitations, and requirements of the human operators. These observations will include, but will not be limited to, the following:

(a) Adequacy of the field of view, to include peripheral vision.

(b) Adequacy of Range.

- (c) Physical discomfort resulting from use of the test item.
- (d) Eye strain or fatigue after prolonged use.
- (e) Difficulties in adjustment, to include fit and focus.
- (f) User preference for one test item over another.
- (g) Compatibility with Laser Safety Goggles.

(2) Prior to and upon completion of each night's driving exercises, a depth perception test will be administered to each driver at the test site by test supervisory personnel. The test will be administered to the test soldiers while they are not wearing the test goggles.

(3) The recorded test observations will be supported and expanded by the administration of a final questionnaire prior to the release of the test soldiers.

(4) The subjective data collected from both questionnaire categories will be quantified and then correlated with the objective data collected from the static test elements.

c. Data Required.

(1) A record of all observations by test supervisory personnel and comments of test soldiers concerning the test goggles and the specific items of observations mentioned in subparagraph b, above.

(2) The completed questionnaires.

d. Analytical Plan. In all cases, observations and comments concerning the design of the test items with respect to human capabilities, limitations, and requirements will be subjectively evaluated. Means of pre- and post-driving depth perception tests will be calculated and confidence intervals for means will be established. Data will be tested for normality and subjected to an appropriate transformation to determine if there is a significant difference between the measures.

14. Value Engineering.

a. Objective. To determine whether there are any unnecessary or costly features which could be eliminated without sacrificing the essential quality of the test item.

b. Method. Throughout testing, special attention will be given to the identification of nonessential or nice-to-have features.

c. Data Required. A record of any nonessential or costly features of the test items.

d. Analytical Plan. In all cases, a subjective analysis will be made to determine whether the test goggles contain nonessential or costly features.

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**APPENDIX
REFERENCES**

1. AR 70-10, Test and Evaluation During Development and Acquisition of Materiel.
2. AR 70-38, Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
3. TECOM Reg 750-15, Maintenance Portion of the Service Test.
4. TECOM Reg 385-6, Verification of Safety of Materiel During Testing.
5. Applicable Technical Manuals for Test and Control Items.