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Materiel Test Procedure 6-2-183
Electronic Proving Ground

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

METEOROLOGICAL EQUIPMENT, CLOUD HEIGHT SET - (BEAM TYPE)

3819

1. OBJECTIVE

The objective of this materiel test procedure (MTP) is to determine the technical performance under controlled conditions of cloud height measurement systems employing illumination techniques.

2. BACKGROUND

Cloud height measurement has been accomplished by various methods in the past. Some of these methods have included use of balloon flights, reports of aircraft pilots, and measurement equipment designed for the purpose. In 1945, an equipment designated Ceiling Light AN/TMQ-2 was available from signal supply sources. Current meteorological equipment requirements of the Army were outlined in a paper dated June 1959 and subsequent studies titled "Meteorological Data Requirements for the Field Army 1965 - 1970" as shown in documents USAEPG SIG 970-28 and 970-39, 1961. A U. S. Army Electronic Proving Ground (USAEPG) report dated March 1962 indicates the military equipment and commercial items designated for interim use. A tactical cloud height set of commercial origin was procured for evaluation and tested late in 1962. Subsequent to that test, an equipment using a laser light source has been tested.

Since cloud height can be of great importance to military pilots, a continuing need exists for developing and testing cloud height measurement equipment to ensure that it is reliable and suitable for use at tactical airfields.

3. REQUIRED EQUIPMENT

a. Theodolite
b. Standard calibrated ceilometer
c. Light intensity meter
d. Clinometer
e. Power source
f. Voltmeter
g. Ammeter
h. Wattmeter
i. Oscilloscope
j. Aircraft for support with special equipment
k. Portable tower (100 feet or more)
l. Smoke generating equipment

4. REFERENCES

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I. TM 11-2416, Ceiling Light Set, 1945.
J. TM 11-2419, Ceilometer, AN/GMQ-2, 1951.
K. TM 11-6660-208, Projector, ML121, 1960.
L. MTP 6-2-514, Electrical Power Requirements.
M. MTP 6-2-210, Power Supplies, Electrical
N. MTP 6-2-222, Radar, Target and Ranging.
O. MTP 6-2-223, Radar, Weather.
P. MTP 6-2-508, Electromagnetic Vulnerability.
Q. MTP 6-2-509, Electromagnetic Compatibility
R. MTP 6-2-015, Amplifiers, General.
S. MTP 6-2-165, Lasers.

5. SCOPE

5.1 SUMMARY

This MTP describes the basic engineer ng tests for cloud height measuring systems. Its objective is to provide subtests to determine the technical characteristics of the test items. The following subtests and their objectives are provided:

a. Electrical Power Requirements - The objective of this subtest is to determine power requirements of the test item components and of the system as an operating entity.

b. Power Supply, Electrical - The objective of this subtest is to determine the technical characteristics of the test item power supply, to include batteries.

c. Illuminator Technical Characteristics - The objective of this subtest is to determine light beam intensity, accuracy of focus, and beamwidth of the test item.

d. Detector Sensor Technical Characteristics - The objective of this subtest is to determine threshold response and directivity of response of the test item.

e. Scanner Movement Technical Characteristics - The objective of this subtest is to determine the practical limits and usability of the angular height scanner system.

f. Lamp Cooling System - The objective of this subtest is to determine the operating temperatures under cooling, and effectiveness of thermostatic controls.

g. Angular Height Component Technical Characteristics - The objective of this subtest is to determine by analysis and comparison, the accuracy and limiting values of the computer component.

h. Display Components Technical Characteristics - The objective of this subtest is to determine the response, accuracy, and reliability of the read-out component.

i. Amplifier Technical Characteristics - The objective of this subtest is to determine the adequacy, accuracy, and linearity of the amplifier component.

j. Integrated System Technical Characteristics - The objective of this subtest is to determine the efficiency, accuracy, and the degree of design compliance of the complete system.

k. Laser System - The objective of this subtest is to determine the performance characteristics of a cloud height set utilizing laser components.

l. Radar System - The objective of this subtest is to determine the performance characteristics of a cloud height set utilizing Radar components.

m. Radio Frequency Compatibility - The objective of this subtest is to determine electromagnetic interference effects.

5.2 LIMITATIONS

This MTP is restricted to test items which employ illumination techniques for measurement of cloud base height. Illumination techniques are defined to include the conventional high intensity light beam, the radar beam, or the laser beam.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Criteria applicable to the test item shall be ascertained and incorporated in the test plan.

b. Support requirements shall be tabulated.

c. Assignment and allotment of time shall be requested or authorized.

d. Obtain the safety statement and ascertain the appropriate action to be taken on any recommendations therein.

e. A schedule of personnel required and their degree of training shall be provided.

f. Provision shall be made for minimum essential training of personnel. They shall be instructed in test objectives and in safety requirements.

g. A time schedule for performance and completion of testing shall be prepared. Concurrent tests shall be identified.

h. The test item shall be inspected for damage, completeness, and operability. All deficiencies shall be corrected.

i. Forms for recording of data shall be prepared as required.

j. Test instruments and standards of comparison shall be adjusted and aligned and the calibration certificate verified.

k. Subtests, as appropriate to the type of test items, shall be selected from the tests presented in paragraph 6.2.

6.2 TEST CONDUCT

6.2.1 Electrical Power Requirements

This test shall be performed as indicated in applicable portions of MTP 6-2-514.

6.2.2 Power Supply, Electrical

This test shall be performed as indicated in applicable portions of MTP 6-2-210. Battery power shall be tested as in the following paragraph.

6.2.2.1 Battery

Determine the suitability of the battery for the particular test application.

6.2.2.2 Stabilizer

The voltage stabilizer shall be tested to determine its effectiveness. This test shall be conducted as directed in MTP 6-2-210. However, stabilizers for battery power shall be tested as follows:

a. Connect the voltage stabilizer unit in circuit with the normal (or simulated) load as it would be connected in use.
b. Supply power from variable, controlled laboratory source.
c. Place a calibrated voltmeter across the load terminals.
d. Vary the impressed voltage between 90 percent and 120 percent of designated operating value and insure proper equipment operation.

6.2.2.3 Generator

a. The generator power source may be a portable hand-crank type, an engine driven machine, or commercial power.
b. The generator, when a component of the test item, shall be tested to determine adequacy of voltage and current capacity by use of voltmeter, ammeter, and laboratory load bank for 15 minutes minimum.

6.2.3 Illuminator Technical Characteristics

High intensity illuminator systems are of three types or variations thereof. This paragraph does not cover radar or laser equipment. The following subtests consider each type separately.

6.2.3.1 Lightweight Portable Illuminator

This is best described as dependent upon an incandescent lamp and battery power. It is designed for ease of transport, and adequate illumination for cloud heights to approximately 3,000 feet.

a. Connect the light source in its holder to an adjustable voltage source of suitable value.
b. Connect a calibrated voltmeter and ammeter as shown in Figure 1.

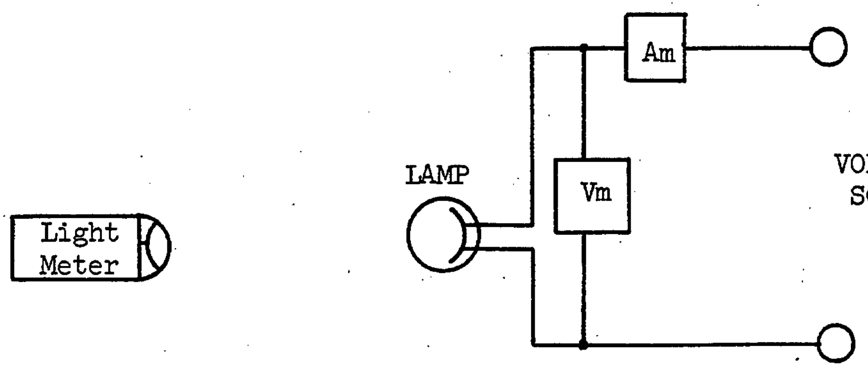

Figure 1. Connection of Calibrated Voltmeter and Ammeter.

c. Adjust the voltage to lamp operating value (rated voltage) and turn on power.

d. With the light meter, measure light intensity in lumens on the centerline of the beam at 100, 500, and 1,000 meters. Horizontally at each distance, locate the two points with 50 percent of centerline intensity. Observe two additional points midway between centerline and the 50 percent points.

e. Adjust voltage until light intensity on the beam centerline is one-half that observed in subparagraph d above.

f. Repeat observations at the distances and points indicated in subparagraph d above.

g. Adjust the lamphouse and reflector to the indicated vertical. Check perpendicularity of the beam from two directions 90 degrees apart, at a distance of 1,000 feet (using theodolite, transit, or plumb line).

6.2.3.2 Fixed Beam Illuminator

In a fixed or heavy transportable set, the illuminator may be a high intensity light source set rigidly in a mount which can be accurately locked in a perpindicular position (on a line joining the earth's center and the zenith). If the mount and light can be placed on its side, the beam intensity may be measured as in paragraph 6.2.3.1. If such manipulation is not practicable, the illuminator shall be tested with the beam in its perpendicular, operational configuration.

a. Erect an antenna tower such as AB-585G (or taller beside the illuminator base.

b. Provide a boom for support of the light-intensity meter and capable of use at any platform level of the tower.

c. Establish horizontal (and vertical) position of the illuminator holder or mounts and verify with a spirit level. This position shall be attainable by use of integral adjustment devices.

d. Establish a perpendicular line on the side of the erected tower. A series of points can be located by use of a spirit level mounted at right angles to the vertical. Measure the exact distance from the illuminator source to the perpendicular already located. At the top of the tower, measure the distance between perpendicular and the point of maximum light intensity. The procedure in paragraph 6.2.3.1.g may be used.

e. By use of plumb line, locate the light meter in the perpendicular (centerline) above the light source in its vertical beam position. Use the platform nearest 25 feet above light source. If the light has been found to be out of collimation in performing the procedure in subparagraph d above, make the required adjustment to place the beam exactly vertical. This determination and adjustment shall be comparable to that indicated in paragraph 6.2.3.1.g.

f. Place the light meter at the point where the intensity is 50 percent of the centerline value. Repeat at 180 degrees (diametrically opposite). Use same height as in subparagraph c above.

g. Place the light meter at the two points midway between the centerline and the points found in subparagraph f above.

h. Repeat the procedures in subparagraphs e, f, and g at elevations of one-half, three-fourths, and maximum tower height. Use the platform level nearest the indicated elevation in each case.

6.2.3.3 Revolving Beam Illuminator

This type of light source may be acceptable to test in the horizontal plane. The procedure in paragraph 6.2.3.1 is applicable. Should mechanical reasons necessitate testing above the horizontal, make use of the method outlined in paragraph 6.2.3.2. For test of collimation, refer to 6.2.3.1.g. or 6.2.3.2.d.

6.2.3.4 Pre-focused Light Sources

Light sources supplied for mounting that require no lamp adjustment are considered pre-focused but shall be tested by laboratory methods for sharpness of focus and parallelism of the beam.

a. A target of sufficient size to include the cross-sectional beam area between the 50 percent values found in paragraph 6.2.3.1.d and surfaced with brilliant white, matte surface paint shall be prepared.

b. When the focus of lens and/or reflector system is variable, the illuminator system shall be focused in prescribed manner. When not variable, the test shall be performed without modification of the test item.

c. With the light source in operation, the target shall be moved slowly away from it until a focus is indicated, or substantial uniformity (parallelism) of the beam is demonstrated.

6.2.4 <u>Detector Sensor Technical Characteristics</u>

The sensor may be fixed in a vertical line of sight or it may be mounted to scan in a vertical plane from the horizontal (0 degrees) to the zenith (90 degrees). (The sensor element may be tested in the laboratory).

a. Mount the sensor in its operating mount, connected to a calibrated millivoltmeter, on an optical bench.

b. Mount a calibrated standard light source at a convenient distance, axial with the sensor. The standard shall produce light of frequency appropriate to the test item. This light source shall be variable in intensity to a brightness of 20 lamberts. (The lambert is the unit of brightness equal to 0.318 candle per square centimeter).

NOTE: Detection selection characteristics may be for light of specific or limited frequency (wavelength). The standard light source used is determined by the item under test.

c. Increase the brightness from 0 to a value sufficient to produce a meter reading.

d. Increase the brightness in regular steps to the maximum of 20 lamberts.

e. Hold the light source at a constant value that shows three-quarter scale on the meter. Turn the sensor horizontally, in 1-degree steps, to left and right of the axial line, until the reading drops to a minimum. Repeat in the vertical plane.

f. Expose the sensor in its mount, with sunshade, to the open sky between 10 a.m. and 2 p.m. Do not point at the sun.

g. Transit the sensor from horizon to the zenith and around the horizon 360 degrees.

6.2.5 Scanner Movement Characteristics

The scan mechanism (sensor or light projector) oscillates up and down in the vertical plane containing the stationary component. When the sensor line and light beam intersect at the cloud base, the sensor produces a signal which is recorded or observed and converted to cloud height.

6.2.5.1 Moving Sensor (Scanner)

This arrangement accurately trains the sensor on the vertical light beam and oscillates between the horizontal and the zenith.

a. Establish a vertical line on the tower, if used, or use the vertical edge of a tall building. Place a light source with the characteristics of the test item's light source at the top of that vertical and move it downward in 10-foot increments.

b. Place the sensor, in its operating mount, at the end of a baseline equal to that specified for the system. Orient to point at the vertical path in which the light source is moved.

c. Connect sensor to a millivoltmeter and at each light position, operate the sensor mount through one oscillation.

d. Connect a calibrated height indicator component and repeat step c if necessary to show alignment. Place a calibrated clinometer on the scanner at each position.

6.2.5.2 Moving Light Source (Scanner)

This arrangement trains the vertically rotating light beam on a vertical line above a fixed sensor from the end of a specified baseline. After collimation of the lamp and mount (ref. paragraph 6.2.3.1.g), replace the light source described in paragraph 6.2.5.1.a. with a standard sensor and test with a light source scanner as indicated in that paragraph. (The sensor must face the light source).

6.2.5.3 Vertical Movement Accuracy

The rotating beam mechanism and the oscillating sensor mechanism alternatively can be checked for play and mechanical tolerance within the device as follows:

a. Level the mount as exactly as the spirit level can indicate, with the moving element at an angle of 45 degrees.

b. Suspend a plumb bob over the exact center of the device, in the plane containing the plumb line, the 45 degree line of direction, and the light (sensor) center.

c. Rotate the device to the vertical.

6.2.6 Lamp Cooling System

Projection lamps may be cooled by normal air circulation (convection), by the use of fans, or by air jets using compressed air. This subtest provides a procedure for examining the temperature range within the lamphouse.

a. Place thermocouples which have been connected to an appropriate strip-chart recorder, within the lamphouse as follows:

1) At the base of the lamp envelope.
2) At the top but not touching the lamp envelope.
3) On the inside surface of the lamphouse near its center.
4) In the air inlet.
5) In the air exhaust.

b. When lamp and cooling devices are used, turn them on and operate them for the normal duty cycle, or for a period not to exceed one hour, whichever is less.

c. Observe time duration of forced air movement through the housing.

d. When only radiating fins are used for lamp cooling, contact thermocouples shall be applied as in subparagraphs a 1), 2), 3) and to the outermost fin edge.

e. A standard mercury thermometer shall be suitably located to indicate ambient temperature of the test area.

f. If thermostats are used to control air flow or lamp operation, observe the operation of the thermostats during the temperature change test. In addition, check the thermostats in the electrical laboratory for range of operation. A temperature controlled current of air shall be passed over the thermostat with calibrated thermometer attached. The air temperature shall be slowly increased until the thermostat is activated. The air temperature shall then be slowly reduced until the thermostat returns to its initial condition.

6.2.7 Angular Height Component

a. In those test items that use conventional light sources and sensors, the angle of elevation is the variable factor by which the varying cloud height is determined.

b. In portable systems, the angle measuring device is a clinometer. This device shall be tested by placing it in a rigid support at various angles as indicated by its index. A protractor accurate to one degree of arc shall be used to measure the setting.

c. In systems using rotating or oscillating beam (sensors), the angle of elevation shall be measured by protractor each 10 degrees from 30 to 60 degrees, and each 5 degrees from 60 to 90 degrees. Agreement of values with the display shall be verified. (See paragraph 6.2.4)

6.2.8 Display Components

a. Test recording and instantaneous display elements of the test item for accuracy and agreement with transmitted data, measured or calculated independently. Such display elements normally consist of some form of strip-chart recorder, cathode-ray tube (oscilloscope), or moving pointer system.

b. Rotate the scanner upward in 5-degree steps to 60 degrees. Continue the rotation in 1-degree steps to 90 degrees (vertical). Repeat this series 5 times.

c. Determine each step position with a calibrated clinometer or protractor.

d. Observe the indicated positions (height) on the test item scale.

6.2.9 Amplifier Test

a. Sensor output can be passed through an amplifier to increase the signal to a level adequate to operate the display or recorder.

b. Test the amplifier component as directed in MTP 6-2-015.

6.2.10 System Test

6.2.10.1 Preparation for Test

The desirable medium for system test is actual cloud cover at varying heights to the maximum expected to be measured, with comparison to a standard ceilometer. However, the true "center of reflection" lies above the cloud base by amounts which vary with atmospheric conditions.

Greatest accuracy of system response can be achieved by use of known targets at measured distances. This is the preferred method and shall be used for all systems capable of operation in the horizontal plane. When mechanical consideration preclude such measurement in the horizontal plane, an attempt shall be made to secure adequate tests and with real clouds.

When horizontal testing is impracticable and atmospheric clouds are not present in adequate amount or at desired altitudes, some artificial reflector must be devised. One such reflector can be an airborne platform, such as a rotary wing aircraft flown at specified altitudes vertically above the test item. The greater the altitude the greater is the difficulty of placing the target above the test item synchronously with the scan time. This solution is considered usable only at low altitudes (below 2,000 feet). An artificial cloud can be provided by an aircraft equipped with smoke generating equipment. These artificial cloud targets are discussed in Appendix A.

6.2.10.2 Horizontal Measured-Distance Test

Test items which can be directed in the horizontal plane shall be tested for accuracy in the horizontal.

a. Mount the sensor or light projector (fixed element) with its axis horizontally directed over a measured range.

b. Mount the movable (oscillatory) element at normal distance and turned to oscillate in the horizontal plane containing the component placed in subparagraph a above.

c. Prepare a plane target 15 by 30 feet with white matte surface, suitable for movement to any desired range from the test item and perpendicular to its axis of direction.

d. Put the test item in operation, with the target at a range equal to the greatest cloud base height expected (criteria). This distance may approach 30,000 feet.

e. Move the target toward the test item in 1,000 foot steps and operate as before.

f. At 5,000 feet, begin 500 foot steps.

6.2.10.3 Vertical Measured-Distance Test

a. Test items which must be tested in a vertical position shall be tested against available natural cloud formations when possible. Alternatively, substitute cloud targets may be prescribed as outlined in Appendix A.

b. When tests can be conducted against natural cloud formations, aircraft shall be employed to fly at the base of the cloud and report altimeter readings (cloud height). These altitudes shall be accepted as the measured vertical distance for comparison with readings of the cloud height set.

c. A standard ceilometer, if available, shall take cloud height concurrently with readings of the test item.

NOTE: Reflected light comes from many of the cloud particles, to some depth into the cloud dependent upon the cloud density. The net effect is measurement to a "center of reflection" somewhat greater than the height of the cloud base as reported by the aircraft from the altimeter. This difference, although recognized, will not change the comparative relationship for purposes of the test.

d. Concurrent observations shall be made with the test item and with the standard.

6.2.11 <u>Radar Systems</u>

a. Use of radar for measurement of cloud height employs the radar principle of measurement of the travel time of the radar signal to the reflecting area of the cloud and return of the reflected wave.

b. The radar equipment shall be tested as indicated in applicable portions of MTP 6-2-222.

c. Test of the system shall be accomplished by comparison as directed in paragraph 6.2.10.3.

6.2.12 <u>Laser Systems</u>

a. Use of the laser principle is similar to that of the radar and measures height in terms of time for the light flash to reach the cloud and return to the detector.

b. The laser component of the test item shall be tested as indicated in applicable portions of MTP 6-2-165.

c. Test of system performance shall be accomplished as indicated in paragraph 6.2.10.3 above.

6.2.13 Radio-frequency Compatibility

a. All system types shall be tested for electromagnetic interference in accordance with applicable sections of MIL-STD-461 and 462.

b. Systems employing a radar subsystem shall be tested for electromagnetic compatibility and vulnerability in accordance with applicable portions of MTP 6-2-509 and MTP 6-2-508.

6.3 TEST DATA

6.3.1 Electrical Power Requirements Data

a. Record nameplate data and handbook data to show the following for each component:

1) Voltage
2) Current
3) Power.

b. Record measurements of voltage, current, and power.

c. Record current drain from battery (when supplied) and variations of voltage.

d. Record data as indicated in applicable portions of MTP 6-2-514.

6.3.2 Power Supply Data

6.3.2.1 Battery Data

a. Record battery current variation under projector load (simulated) and variation of the current as the battery is discharged.

b. Record changes in voltage as the battery discharges.

c. Record voltage at projector terminals concurrently.

d. Record values for the above against time from turn-on to the point of inadequate power.

e. Repeat five cycles of steps a, b, and c.

f. Power supplies, electronic, shall be tested as directed in MTP 6-2-210.

6.3.2.2 Stabilizer Data

Record output voltage from the stabilizer as the input voltage is varied. Continue this operation for 15 minutes. Observe variation in output.

6.3.2.3 Generator Data

Data from this test when conducted, shall be recorded as indicated in applicable portions of MTP 9-2-095. Adequacy of available power is the objective. Output voltage shall be recorded continuously and variations noted.

6.3.3 Illuminator Technical Data

6.3.3.1 Portable Type Equipment Data

a. Record light intensity at prescribed distance and crossbeam positions as shown in Table I.

Table I. Light Intensity Measurements

Distance (in meters)	Center-line	Left side 50% point	Left mid-point	Right side 50% point	Right mid-point
100					
500					
1000					

Distribution of Light Intensity

b. Record the same data at reduced intensity (paragraph 6.2.3.1.f)
c. Record adjustment required to bring the beam to the exact perpendicular.

6.3.3.2 Fixed Beam Illuminator Data

a. Record adjustments required to make the beam vertical.
b. Record measurements of the following:

1) Center of light beam to tower vertical (bottom).
2) Maximum beam intensity to tower vertical (top).

c. Record data in a table similar to that indicated in paragraph 6.3.3.1 above.

6.3.3.3 Revolving Beam Data

Record data as in paragraph 6.3.3.1 above.

6.3.3.4 Prefocused Lamp Data

a. Record amount of final system adjustment made.
b. Record distance to target at sharpest focus (virtual image).
c. Record the "depth of focus" and beam divergence at 1,000 meters.

6.3.3.5 All Types

a. Record threshold brightness (lamberts) giving a readable value on sensor indicator.
b. Record brightness (lamberts) producing full scale (or maximum) meter deflection.
c. Record sensor output at each point when moved from axis to left and right.
d. Record sensor output from clear sky.
e. Record variations of response each 10 degrees, both horizontal and vertical.

6.3.4 Detector Sensor Data

a. Record the light frequency used.
b. Record the distance from test item to light source.
c. Record the brightness (lamberts) to produce a meter reading.
d. Record the series of increasing brightness versus resultant meter reading of sensor output.
e. At three-quarters scale on the meter, record the changing values as the sensor is turned horizontally from the direct centerline. The "minimum" may be zero but need not be, due to extraneous light.
f. Record the same data in the vertical plane.
g. Record the effect of "open sky" light on the sensor as shown on the meter.
h. Record variations of background effect as the sensor is pointed to all directions.

6.3.5 Scanner Movement Data

6.3.5.1. Moving Sensor Scanner

a. Record frequency characteristics of the light source and of the sensor.
b. Record baseline length and maximum height of the vertical established.
c. Record angular height at each light position.
d. Record response of sensor at each light position.
e. Record height reading at each light position.

6.3.5.2. Moving Light Source Scanner

a. Record characteristics of light and scanner as before.
b. Record baseline and vertical line lengths.
c. Record responses as in c, d, and e above.

6.3.5.3 Vertical Movement Accuracy

Record coincidence or deviation of the centerline of beam or sensor from vertical.

6.3.6 Lamp Cooling System Data

a. Record ambient temperature continuously throughout the test.
b. Record type of cooling or method of air circulation in the lamphouse.
c. Record thermocouple readings at 15-second intervals.
d. Record periods of air movement through the lamphouse.
e. Record all thermocouples temperatures of the lamphousefin assembly when convection cooled.
f. Record variation limits of temperature used and the temperatures at which the thermostats actuate the power circuits.

6.3.7 Angular Height Component

a. Record elevation angles of rotating mount in comparison with protractor values.

b. Record elevation angles of rotating mount in comparison with protractor values as shown in Table II.

Table II. Elevation Angle Measurement

	30°	40°	50°	60°	65°	70°	75°	80°	85°	90°
Mount Reading										
Protractor Reading										

6.3.8 Display Component Data

a. Record each series of scanner positions.
b. Record cloud heights indicated by test item.

6.3.9 Amplifier Test Data

a. Data shall be taken as indicated in applicable portions of MTP 6-2-015.
b. Record sensor output.
c. Record indicator input as required.

6.3.10 System Test

6.3.10.1 Preparatory Data

a. Record size of cloud and estimated density (scattered, thin, medium, heavy).

b. Record calibration of standard ceilometer versus altimeter.

6.3.10.2 Horizontal Measured-distance Data

a. Record measured distance to target at each step.
b. Record test item measurement.

6.3.10.3 Vertical Measured-distance Data

a. Record altitude of the aircraft as reported from its on-board altimeter.

b. Record test item height reading.
c. Record the same data at each altitude flown.
d. Record readings of standard ceilometer concurrently for each reading of the test item.

6.3.10.4 Incandescent and High Intensity Data

Preceding sections of this paragraph apply equally to these test items.

a. Record measurement values from the test item.
b. Record measurement values from the standard.
c. Record altitudes from radar altimeter when aircraft are used.

6.3.11 Radar System Data

Record data pertaining to the radar components as indicated in applicable portions of MTP 6-2-222.

6.3.12 Laser System Data

Record data pertaining to the laser component as indicated in applicable portions of MTP 6-2-165.

6.3.13 Radio-frequency Compatibility Data

Record data as indicated in applicable portions of MTP 6-2-508 and MTP 6-2-509.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Electrical Power Requirements

Reduce and present data as indicated in MTP 6-2-514.

6.4.2 Power Supply

6.4.2.1 Battery Data

a. Tabulate values recorded.
b. Compute averages for presentation.

6.4.2.2 Stabilizer Data

a. Tabulate input voltages
b. Tabulate output voltages
c. Plot the above values versus time at 15-second intervals.
d. Present the accumulated data as a curve plotted on rectangular axes.

6.4.2.3 Generator Data

a. Present data as indicated in MTP 6-2-210.
b. Present performance of the manually powered generator.
c. Indicate whether performance was adequate or inadequate.

6.4.3 Illuminator Data

6.4.3.1. Portable Type

a. Plot tabular data to present a graphical distribution of light intensity.

b. Plot the data as in step a for reduced intensity.

c. Compare step a plot with step b plot to present the ability of the source to function at low power levels.

d. Present degree of maladjustment overcome to secure vertical positioning.

6.4.3.2 Fixed Beam Type

a. Plot light density as in paragraph 6.4.3.1.

b. Plot variation of light beam axis from the vertical.

6.4.3.3 Revolving Beam Type

Plot and present data as in paragraph 6.4.3.1

6.4.3.4. Prefocused Lamp

a. State adjustment required, not provided for by the pre-set mount.

b. Diagram to scale the distance from light to virtual image (sharpest definition)

c. On the diagram, indicate the distance over which the image is distinct. This indicates the degree of parallelism of the beam.

6.4.3.5 All Types

Tabulate values in lamberts for:

a. Threshold illumination.

b. Full-scale illumination.

c. Tabulate sensor outputs versus light source and location.

d. Average all repetitions and use this average for presentation.

6.4.4 <u>Detector Sensor Data</u>

a. Plot on rectangular axes brightness versus sensor output (meter reading).

b. Plot on rectangular axes changes in sensor output versus horizontal deviation from the axial line.

c. Repeat in the vertical plane.

d. Record sensor output from "open sky".

e. On polar coordinates plot the sensor response vertically (0 degrees to 90 degrees) and horizontally (0 degrees to 360 degrees).

6.4.5 <u>Scanner Movement Data</u>

6.4.5.1 Moving Sensor Scanner

a. Tabulate and correlate readings. Comparison shall demonstrate degree of accuracy.

b. Where indicator readings are in height, computation from the angle and baseline factors shall be made.

6.4.5.2 Moving Light Source

a. Tabulate sensor output versus light position.
b. Tabulate sensor angle versus clinometer angle.
c. Compute true height.
d. Tabulate true height versus readings of standard indicator.

6.4.5.3 Vertical Movement

Reduce and display vertical movement data as a first order of differences to give a measure of failure to remain vertical throughout the arc from 0 to 90 degrees.

6.4.6 Lamp Cooling System

a. Tabulate the data as taken.
b. Average repeated test values.
c. Plot differences between intake and exhaust. These represent the gradient.
d. Display ambient temperatures readings.
e. Display volume of cooling air per minute.

6.4.7 Angular Height Component Data

a. Plot multiple series of readings on rectangular coordinates when variations are observed from series to series.
b. Determine averages and plot average graph.
c. Determine the mean of deviations in each series and plot separately.
d. Use the graphical relationships and shown to form the basis of evaluation.

6.4.8 Display Component

a. Compute mathematical value of cloud height corresponding to the baseline used at each angular setting. ($H = B \tan \theta$)

Height equals Base times tangent of the angle

b. Tabulate as follows for each series:

Table III

Reading No.	Angle Set	Height Indicated	Height Computed

6.4.9 Amplifier Test Data

Reduce and present these data as indicated in applicable portions of MTP 6-2-015.

6.4.10 System Test

6.4.10.1 Preparatory Data

Report a narrative description of cloud target and plot standard ceilometer heights versus altimeter.

6.4.10.2 Horizontal Measured-distance Data

Tabulate measured distance versus test item measurement. Show first order differences.

6.4.10.3 Vertical Measured-distance Data

a. The same presentation shall be made for any target selected.
b. Tabulate the readings taken from test item, standard ceilometer, and altimeter.
c. Display first order differences between the two ceilometers.
d. Make separate tabulations for each height of cloud base utilized.

6.4.11 Radar System Data

Reduce and present data pertaining to the radar component as indicated in MTP 6-2-222.

6.4.12 Laser System Data

Present data pertaining to the laser component as indicated in applicable portions of MTP 6-2-165.

6.4.13 Radio-frequency Compatibility Data

Reduce and present these data as indicated in applicable portions of MTP 6-2-509.

NOTE: All data collected in accordance with paragraph 6.3 shall be compared to equipment specifications and requirements imposed by intended usage and a conclusion shall be drawn as to the acceptability of the equipment tested for the intended usage. If the equipment is found to be unacceptable, reasons for its unacceptability shall be listed along with remedial suggestions.

APPENDIX A

ARTIFICIAL CLOUD SUBSTITUTES

FOR

TESTING CLOUD HEIGHT SETS

GENERAL

In the absence of cloud formations, an aircraft with smoke generating equipment shall be flown above the test site to provide an artificial cloud of substantial size. Several crossings, under radio control, shall be made to center the "cloud" over the test item. A theodolite for tracking and correction of headings shall be employed. Compensation for windage shall be made by flying successive short legs parallel to the preceding ones. Such a pattern operates to deliver a large, rectangular area. Complete coordination between aircraft and direction station shall be arranged and rehearsed prior to the scheduled test. The standard ceilometer shall be tested for accuracy by comparison with readings of a radar altimeter flown at the cloud layer base being measured by the ceilometer. Smoke thins rapidly in even moderate wind. This may be overcome by repeated passes through the preceding smoke at the same altitude.

VERTICAL DISTANCE TEST

Test items which cannot be operated in other than normal (vertical) position require provision of cloud cover (natural or artificial) or a suitable airborne target.

a. Using the largest rotary wing aircraft available, paint the underside of all surfaces including rotor(s) a matte white with water soluble pigment (for easy removal).

NOTE: Target areas of such aircraft as seen from directly below are shown in Table AI.

Table AI. Target Areas of Various Army Aircraft

				Side of Equivalent Square
CH-47A (Chinook)	oval	98'x59'	5034 sq ft	70'
CH-21C (Shawnee)	oval	86'x44'	2600 sq ft	51'
CH-37B (Mojave)	circle	72' dia	4072 sq ft	64'
CH-34C (Choctaw)	circle	56' dia	2423 sq ft	49'
UH-19D (Chickasaw)	circle	53' dia	2206 sq ft	47'
UH-1B (Iroquois)	circle	44' dia	1420 sq ft	38'
OH-23D (Raven)	circle	35' dia	956 sq ft	31'

b. Fly the target at altitudes 100 yards apart to 500 yards (5 observations); 200 yards apart to 1,500 yards (5 observations); and 250 yards apart to 2,000 yards (2 observations). Observe the adequacy of reflection at each point. Difficulty experienced in keeping the target in the beam at a given altitude will result in dome departure from exact altitudes. If greater heights must be measured, the directed criteria of the military requirements shall be followed.

c. Install and operate a standard ceilometer immediately adjacent to the test item.

ARTIFICIAL CLOUDS

a. Reflecting areas, simulating clouds, may be produced by an airborne smoke generator or other device for dispersing a light-reflecting medium at desired altitudes.

b. This cloud shall be prepared as indicated in Section I.

c. Simultaneous measurements shall be taken by the test item and by the standard ceilometer.

NOTE: When water-soluble type, easily removable surfacing cannot be used to maximize reflectivity of the aircraft, an alternate solution may be devised by preparation of a plane surface target to be attached to or suspended below the air vehicle.

This target shall be as light in weight as possible, constructed with a rigid frame, diagonally braced and covered with chickenwire mesh, supporting a thin white cloth as the reflecting medium. Its size shall be determined by and adapted to the lift aircraft. If rigidly attached, the size must be such that it does not materially affect the aerodynamic maneuverability of the lift aircraft. It should not exceed the width of landing gear (or skids) in greatest dimension as shown in Table AII.

Table AII. Aircraft Landing Gear Width

OH-23A	7'9"	CH-21C	14'0"
UH-1B	8'4"	CH-37B	20'0"
UH-19D	11" 0"	CH-47A	11'11"
CH-34C	12'0"		

If suspended by sling below the lift aircraft the construction shall be rugged enough to support a reasonable amount of ballast (sand bags) to ensure full extension of sling. This target shall be flown at the altitudes listed above.