AD 718609

28 August 1968

3480 Materiel Test Procedure 6-2-089
Electronic Proving Ground

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

FLASH UNIT, ELECTRONIC

1. OBJECTIVE

The objective of this materiel test procedure (MTP) is to present the subtests required to determine the technical performance, engineering adequacy, and safety characteristics of the test items as specified in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), or other development directives.

2. BACKGROUND

Electronic flash units provide and alternative or supplemental source of illumination to the purotechnic devices currently in use for night aerial photography with airborne photographic surveillance systems. A satisfactory electronic flash system will: (1) eliminate the danger inherent in the use of explosive cartridges; (2) provide greater uniformity of the illumination pattern; (3) ensure synchronization of the illimination source and the camera shutter; (4) permit the higher repetition rate of camera exposure required by higher airspeeds; and (5) increase the number of exposures possible per mission.

Although electronic flash units were used successfully during and after World War II, the excessive weight of the units has precluded their use with modern Army Reconnaissance Aircraft. Light weight construction techniques and solid state electronics have permitted development of electronic flasher systems capable of being used with current Army surveillance aircraft.

3. REQUIRED EQUIPMENT

a. Army Reconnaissance Aircraft equipped with a photograph surveillance system and modified as required for installation of electronic flasher unit
b. Camera and other selected components of the airborne
c. Pod alignment fixture
d. Photoelectric cells
e. Oscilloscope with camera
f. Time mark generator
g. Voltmeters
h. Ammeters
i. Frequency meters
j. Recording potentiometer, multichannel
k. Vacuum tube electrometer
l. Sensitometer
m. Densitometer
n. Microdensitometer
o. Spectrometer

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3.2 FACILITIES

a. Photographic laboratory
b. Meteorological support facility
c. Environmental test facility
d. Laboratory type power supply facility, including 115 volt/400 Hz and 28 volts dc source
e. Range areas of uniform terrain reflectance
f. Targets

4. REFERENCES

A. TM 11-401-1, Army Pictorial Techniques, Equipments, and Systems, Pictorial Fundamentals
B. TM 11-6760-212-35, Field and Depot Maintenance Manual, Photographic Surveillance System, Airborne KS-61A.
C. MIL-HDBK-25, Military Standardization Handbook, Glossary of Photographic Terms.
D. Report No. NADC AP-6117, Test and Evaluate XLS-3 Electronic Flash Unit, Bureau of Naval Weapons, 11 December 1961.
E. Night Photography With the Latest U. S. Electronic Flash Units, Royal Aircraft Establishment, Farnborough Hants (England), July 1966.
F. Report No. 65 AVG-3175, The Use of Illuminants in Night Photographic Reconnaissance, USAF Avionics Laboratory.
G. MIL-STD-461 (-), Electromagnetic Interference Characteristics, Requirements for Equipment.
H. MIL-STD-462 (-), Electromagnetic Interference Characteristics, Measurement of.
I. MIL-STD-463 (-), Definitions and Systems of Units, Electromagnetic Interference Technology.
J. Gronberg, F.T., et al., Xenon Flash as a Light Source for Night Aerial Photoreconnaissance, SPSE News, Volume 8, No. 6, Nov/Dec. 1965.

5. SCOPE

5.1 SUMMARY

The procedures contained in this MTP describe in general terms the engineering tests required to determine the technical characteristics, engineering adequacy, and safety characteristics of electronic flash units. The procedures particularly relate to flash units developed to provide illumination for night photography with airborne photographic surveillance systems. With appropriate instrumentation and photographic processing, the procedures may be used with flash units designed for energy output beyond the visible spectrum, as well as with units producing visible light. The tests will be made with reference to the technical requirements of QMR, SDR, or other applicable directives, and are to be applied on a selective basis as required by the particular test item.

When applicable, the procedures summarized below shall be followed to the extent required by test criteria for the specific test item. It should be understood that the test sequence will not necessarily be conducted in the order presented, and that some tests and steps will overlap or may be performed simultaneously.

a. Flash Duration and Flash Repetition Rate - The objectives of this subtest are to determine: (1) the time duration of the flash during the useful portion of the flash pulse; and (2) the flash repetition rate capability.

b. Synchronous Operation - The objective of this subtest is to determine the capability of the test item to operate in synchronization with the camera(s) of the photographic surveillance system at required speeds.

c. Illumination Intensity and Uniformity - The objectives of this subtest are to determine; (1) the intensity of the illumination provided by the test item; and (2) the distribution characteristics of the illumination.

d. Electrical Power Requirements - The objective of this subtest is to determine the operating characteristics and adequacy of the test item power supply.

e. Electromagnetic Interference Characteristics - The objectives of this subtest are to determine: (1) the adequacy of electromagnetic interference suppression techniques used in equipment design; and (2) the capability of the test item to perform satisfactorily in the presence of specified electromagnetic radiation.

5.2 LIMITATIONS

a. The aerodynamic characterisitcs of externally mounted flash units and the airworthiness of aircraft with the unit installed are not considered in this procedure.

b. This procedure does not include such aspects as Physical Characteristics (MTP 6-2-500), Human Factors (MTP 6-2-502), Reliability (MTP 6-2-503), Maintainability (MTP 6-2-504), or Environmental Chamber Tests (MTP 6-2-510).

c. This test procedure is limited to applications of the unit for vertical aerial night photography. Oblique applications are not considered.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Records

Prepare a log book for entry of each test item by nomenclature and serial number. Maintain a chronological record of: (1) daily and cumulative operating time for each flash unit, and (2) daily and cumulative number of times each flash module is triggered. For this purpose, operating time is defined as time during which power is applied to the test item so that the capacitor banks are charged.

6.1.2 Forms

Prepare detailed test data forms in advance of each test to permit timely and accurate recording of test results.

6.1.3 Initial Inspection

Prior to starting operational tests, perform any routine maintenance and adjustments required, and make tests to ensure that the equipment is in optimum operating condition.

6.1.4 Standard Equipment

For tests involving aerial photography, use standard types of film and processing procedures suitable for the camera system and specific application, in accordance with criteria of the particular equipment specification.

6.1.5 Safety

Evaluate the equipment for safety hazards in accordance with MTP 6-2-504, Safety.

6.2 TEST CONDUCT

6.2.1 Flash Duration and Flash Repetition Rate

a. Arrange the flash unit assembly and control system for bench test operation. Utilize a camera-equipped oscilloscope, a time mark generator, and a phototube for this test. Provide a power supply of nominal voltage and frequency. Install the phototube in front of the flash unit in a position which will permit light from all flash modules to strike it. Make the following interconnections as shown in block diagram, Figure 1:

1) Time mark generator to oscilloscope Z signal input
2) Flash trigger pulse circuit to: (1) flash unit, and (2) external sweep input of the oscilloscope. (Synchronize the trigger pulse with the flash unit and the oscilloscope).
3) Phototube output ot vertical signal input of the oscilloscope. (Provide battery and voltage divider as required for the phototube power supply).

b. Photograph the oscilloscope display while operating the flasher system through the range of design flash repetition rates. Perform two test runs as follows:

1) With the oscilloscope and time mark generator adjusted for best display to measure flash duration.
2) With the oscilloscope and time mark generator adjusted for best display to measure flash repetition rate.

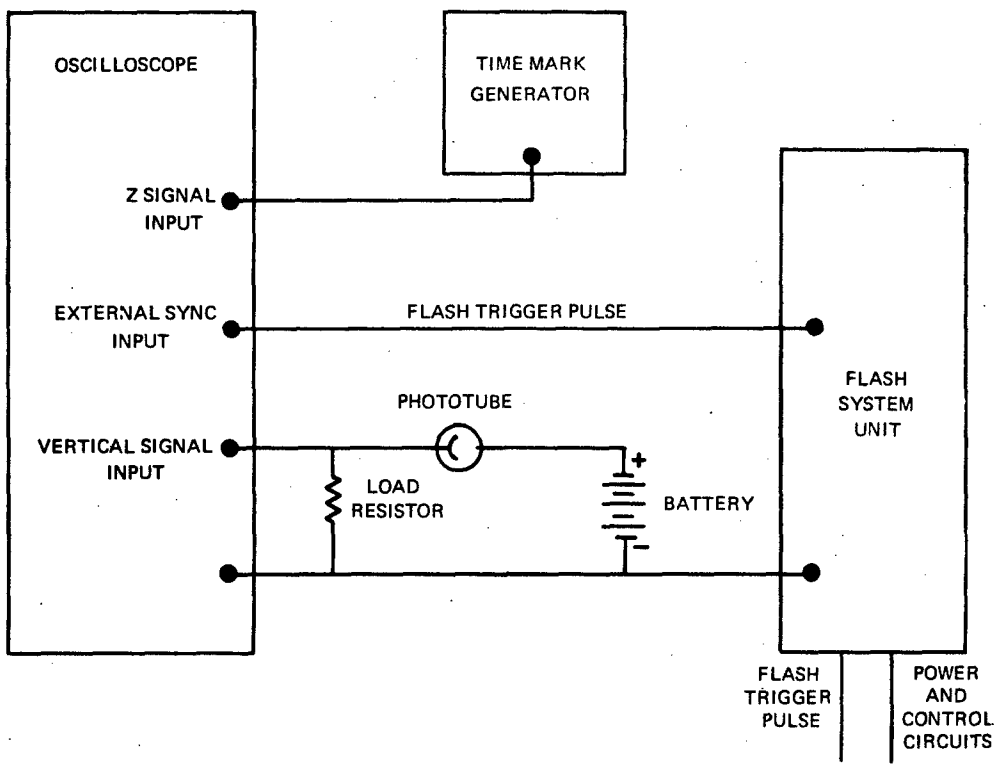

Figure 1. Type Equipment Arrangement for Test of Flash Duration and Flash Repetition Rate.

c. For units equipped with more than one flash module, perform the tests as follows: (1) with all modules operating; (2) with one module operating; and (3) with other design combinations of module operation.

6.2.2 Synchronous Operation

a. Arrange the test item, system operating unit, camera, camera lens cones, and control panel for bench testing. Utilize a camera-equipped oscilloscope, two phototubes of essentially identical optical/electrical characteristics, and a light source of sufficient intensity to produce a usable output from a phototube. Provide a stabilized power supply of nominal voltage and frequency. Assemble and interconnect the equipment in the following manner as shown in block diagram, Figure 2:

1) Place the light source in front of the center of the camera lens cone.
2) Place a phototube directly behind the center of the lens cone so light will strike the phototube when the camera shutter is open. Connect the output of the phototube to channel A of the oscilloscope.
3) Place the second phototube in front of the flasher unit so that it receives equal illumination from all operating flasher modules. Connect the output of this phototube to channel B of the oscilloscope.
4) Connect the output of the shutter actuate pulse circuit of the system operating unit to: (1) camera shutter, (2) flash trigger input of the test item, and (3) the sweep sync input of the oscilloscope.

b. Prepare the camera system for operation in the image motion compensation (IMC) mode. Apply a simulated V/H signal to the system operating unit to produce a shutter operating rate at the maximum design cycling rate of the test item.

c. Operate the system with triggering pulses of nominal voltage and time duration. Set the flash trigger delay time control at the position which most closely centers the flash pulse within the period in which the shutter is at its widest opening, as observed by comparison of tracings on the oscilloscope display.

d. Photograph the oscilloscope display during repeated synchronous operation tests. Take sufficient photographs to ensure a representative average.

e. Repeat the tests using various combinations of input trigger pulse voltages and pulse durations, in accordance with requirements of the individual equipment specification.

f. For flash units equipped with more than one flash module, perform the tests as follows: (1) with all modules operating; (2) with one module operating; and (3) with other design combinations of module operation.

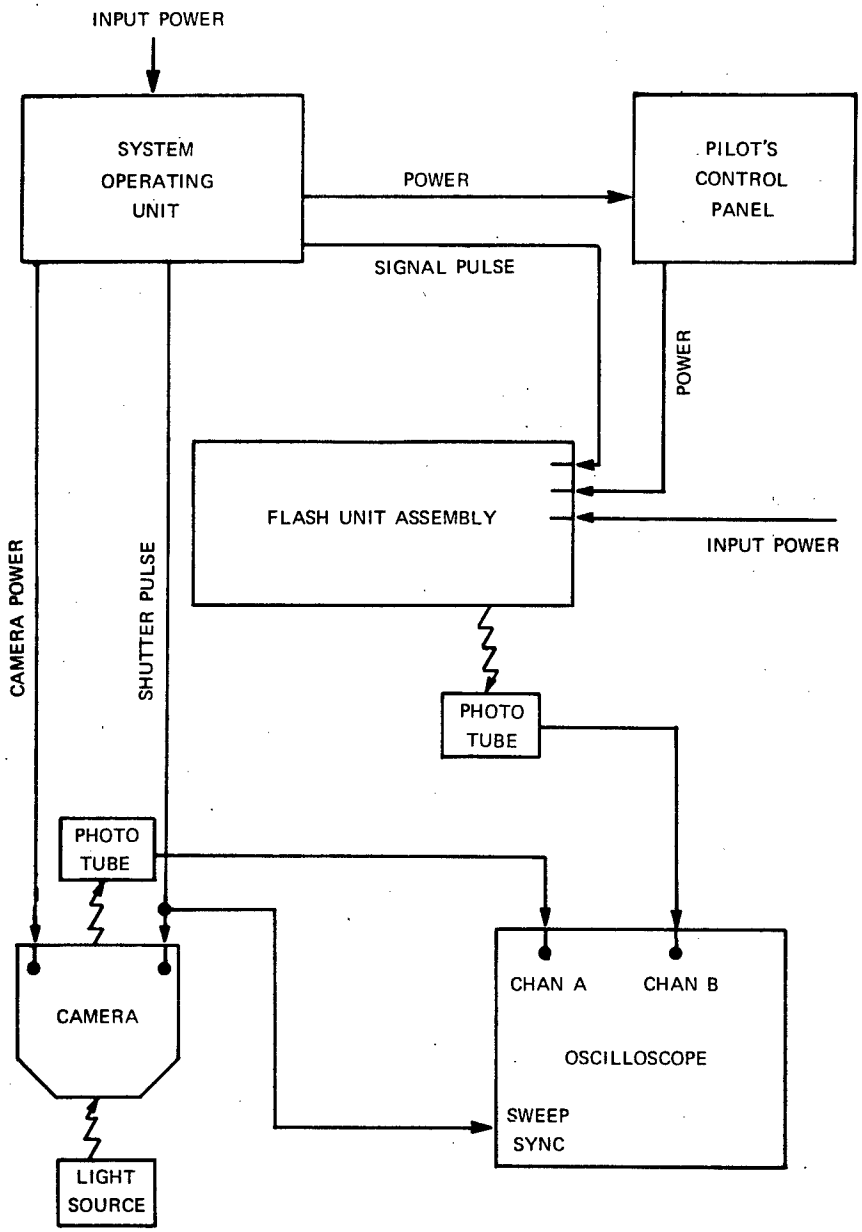

Figure 2. Type Equipment Arrangement for Synchronous Operation Test.

6.2.3 Illumination Intensity and Uniformity

6.2.3.1 Static Test

a. Install the test item (with necessary ancillary and test equipment for operation in a horizontal position) on an elevated platform with the optical axis of the light source facing the center of a large vertical plane. The dimensions of the vertical plane must be at least 75 by 75 feet and the plane must be at a distance of not less than 200 feet from the flash unit. Place calibrated phototubes, connected to recording potentiometers, at 7.5 degree intervals (with reference to the light source) along the diagonals of the test plane starting at the center point. Use additional phototubes, if necessary, to ensure coverage at the extreme corners of the test format area. See block diagram, Figure 3. The size of the instrumented area must be such that the sensors located at the extremes fall just within the limits of the illuminated area as computed by distance and beam angle of the light source. All distances and angles must be accurately measured to facilitate intensity measurements, including the relative intensities for pattern determination.

b. Operate the flash unit in a manually controlled mode, or at a relatively slow repetition rate (e.g., one flash or less every three seconds). Take sufficient flash intensity readings to ensure a representative average. Repeat the test at the various design flash repetition rates to determine if flash intensity is reduced at the higher rates.

c. If the flash unit is equipped with more than one flash module, perform the test with modules flashing simultaneously, and again for each module individually or in design combinations, with the other modules masked.

d. Repeat the test with the phototubes arranged in a vertical and horizontal (cross) pattern through the center of the test plane.

e. If the test item has an adjustable beam angle, repeat the above test for each beam angle as indicated by the individual equipment specification and test criteria.

f. If, during these procedures, the potentiometer readings indicate that areas of grossly deficient illumination exist, re-arrange the phototubes in patterns designed to define such areas, and continue testing.

6.2.3.2 Flight Test

a. Flights shall be made under essentially identical night-time conditions of natural lighting and visibility. Meteorological conditions shall be continuously monitored (paragraph 6.3.3.2 i).

b. Install the test item in a surveillance aircraft as the illuminant source for the photographic surveillance system.

c. Before loading the film in the camera, expose the leading end of the film to a 21-step gray scale, using a sensitometer. Upon completion of the test mission, expose the 21-step gray scale on the trailing end of the film before processing. Exercise special care during these procedures to avoid fogging the film.

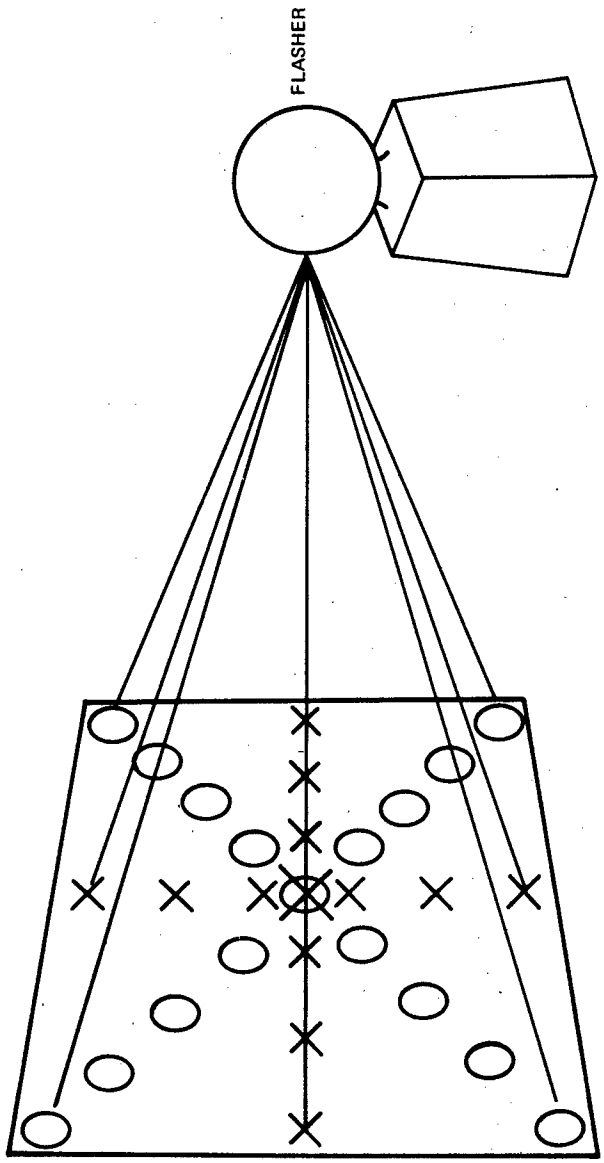

Figure 3. Type Equipment Arrangement for Test of Illumination Intensity and Uniformity.

d. Prior to and immediately following the actual mission flight, make several exposures over a spatial resolution target. The altitude above terrain for these exposures and the number of exposures required shall be determined by the individual equipment criteria and prevailing test conditions.

e. Make mission flights and multiple exposures over each of two or more areas of even terrain texture and reflectance. The exposures shall be made at various altitudes and in increments of altitude to be determined by individual equipment specifications and prevailing test conditions.

f. Upon completion of the mission, process the exposed film to a gamma of 1.0.

g. With a densitometer or microdensitometer, make density measurements of the 21 steps of the sensitometric strips exposed on the leading and trailing ends of the film.

h. Examine the developed film exposures and make density measurements as required for comparison with density measurements of the sensitometric strips and criteria of the individual equipment specification.

6.2.4 Electrical Power Requirements

a. This test shall be made under the procedures of the common engineering test, MTP 6-2-514, Electrical Power Requirements. However, when the primary power supply of the test item is a wind driven turbine-alternator, supplementary tests are required to determine the capability of the governor of the turbine-alternator to maintain voltages and frequencies within acceptable limits.

b. Flight tests shall be made at various airspeeds, to be determined by the characteristics and capabilities of the overall airborne photographic surveillance systems with which the test item is designed to be employed. For the flight tests, the power sink side of the plane of reference (paragraph 6.1.1, MTP 6-2-514) shall be instrumented to obtain voltage, current and frequency measurements. Readings shall be taken for each design flashing rate at each indicated air speed.

c. Operate the flasher system in the laboratory with voltage and frequency inputs obtained in the flight tests. With a camera-equipped oscilloscope, record the charging waveform and time interval required for capacitor bank voltage to reach the fully charged state.

d. The data obtained from these tests shall be applied as appropriate in the tests made under MTP 6-2-514.

e. The procedures of MTP 6-2-514 shall be modified as required for testing electrical power characteristics of circuitry for which the power is furnished by the aircraft electrical power system.

6.2.5 Electromagnetic Interference Characteristics

Perform tests to determine electromagnetic interference characteristics under criteria contained in MIL-STD-461, or as required by the individual equipment specification, using procedures prescribed in MIL-STD-462.

6.3 TEST DATA

6.3.1 Flash Duration and Flash Repetition Rate

The test data shall include the following:

a. Flash repetition rate in flashes per second
b. Number and identity of modules fired for each test run
c. Oscilloscope sweep control setting in μ sec./cm.
d. Time mark frequencies in pulses per μ sec.
e. Photographs of oscilloscope displays correlated with conditions of test
f. Supplementary notes

6.3.2 Synchronous Operation

The test data shall include the following:

a. Identification of photographic systems, including camera data
b. Cycling rate of photographic system in seconds per cycle
c. Trigger pulse voltage and pulse duration for each test run in mV.
d. Number and identity of modules fired for each test run
e. Sweep time scale factor of oscilloscope grid in μ sec/cm.
f. Photographs of oscilloscope displays correlated with conditions of test
g. Supplementary notes

6.3.3 Illumination Intensity and Uniformity

6.3.3.1 Static Tests

The test data shall include the following:

a. Sketch of test setup showing all critical dimensions
b. Photographs of test setup
c. Pattern and spacing of phototube layout
d. Flash repetition rate for each test run flashes/sec.
e. Beam angle of flash unit reflector in degrees
f. Number and identity of modules fired for each test run
g. Potentiometer recordings of phototube output correlated with conditions of test in mV.
h. Supplementary notes

6.3.3.2 Flight test

The test data shall include the following:

a. Identification of photographic system, including camera, film, and processing data

b. Calibrated values of 21-step wedge used in sensitometer in lumens
c. Standard sensitometric test chart data
d. Densitometer/microdensitometer readings in lumens
e. Test site and date and time of test
f. Completed flight log
g. Flight altitude profile in meters
h. Meteorological data to be taken at test sites at start of mission and every hour thereafter during each test:

1) Temperature and relative humidity in °F and percent
2) Atmospheric pressure in mm of Hg
3) Windspeed and direction in m./sec. and degrees
4) Cloud cover (percent)
5) Horizontal visibility (meters)
6) Sunset (time of day, GMT)
7) Moonrise (time of day, GMT)
8) Moonset (time of day, GMT)
9) Phase angle of the moon (degrees subtended)

6.3.4 Electrical Power Requirements

6.3.4.1 Flight Tests

The test data shall include the following:

a. Air speed of each test run (from flight log) in m./sec.
b. Flash repetition rate in flashes/sec.
c. Output voltage, current, and frequency of power supply in volts, amps, and Hz.

6.3.4.2 Laboratory Tests

The test data shall be photographs of oscilloscope displays correlated with conditions of test.

6.3.4.3 Common MTP Tests

Record data as indicated by MTP 6-2-514.

6.3.5 Electromagnetic Interference Characteristics

Record data as required by MIL-STD-461 and MIL-STD-462 and criteria of the individual equipment specification.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Flash Duration and Flash Repetition Rate

a. Measure and tabulate pulse duration for each set of conditions shown on the photographs made during the pulse duration test run, paragraph 6.2.1.b 1). Unless other wise stated in the individual equipment or photographic

system criteria, pulse duration is the time interval measured between the 50 percent amplitude points of the positive and negative slopes of the pulse.

b. Measure and tabulate pulse repetition rates for each set of conditions shown on the photographs made during the pulse repetition rate test run, paragraph 6.2.1.b(2.

6.4.2 Synchronous Operation

Present the data derived from analysis of the photographs in the form of graphs showing relative position (in time) of the flash and camera shutter opening for each test condition.

6.4.3 Illumination Intensity and Uniformity

6.4.3.1 Static Tests

Convert the potentiometer readings for each test run to units of incident illumination in footcandles (or other appropriate units of measurement). Enter the incident light strength readings (in positions representing respective sensor locations) on scale charts representing the format of the illuminated test area.

6.4.3.2 Flight Test

Present the test data in tabular, chart, and/or graphic form suitable for comparison and analysis.

6.4.4 Electrical Power Requirements

a. Reduce flight test data and related laboratory test data to tabular or chart form. Determine maximum flash repetition rate permitted with a given power supply voltage and frequency combination with the formula

$$R = \frac{1}{T}$$

Where: R = flash repetition rate in flash per second
T = time required for capacitor banks to reach the fully charged state (for a given voltage and frequency combination) in seconds

b. The rate, R, and the aircraft speed can be correlated by matching the voltage/frequency combination produced at a given airspeed to the voltage/frequency combination necessary to produce a flash repetition rate (R).

NOTE: The above computations will be necessary only if the time required to fully charge the capacitor banks at any airspeed is appreciably longer than the time required with a power supply of nominal voltage and frequency.

6.4.5 Electromagentic Interference Characteristics

Present the data in a format suitable for the applicable criteria and test methods of MIL-STD-461 and MIL-STD-462.

6.4.6 Summary

Compare all data collected in paragraph 6.3 with equipment specifications and requirements imposed by intended usage, and indicate conclusions as to the acceptability of the test item. If the equipment is found to be unacceptable, list reasons for its unacceptability along with remedial suggestions.