Branch Office

NATIONAL BUREAU OF STANDARDS REPORT

9903

DEVELOPMENT, TESTING, AND EVALUATION OF VISUAL LANDING AIDS

Consolidated Progress Report

For the Period

January 1 to March 31, 1968

By
Photometry Section
Optics Metrology Branch
Metrology Division
Institute for Basic Standards

NBS

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards[1] was established by an act of Congress March 3, 1901. Today, in addition to serving as the Nation's central measurement laboratory, the Bureau is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To this end the Bureau conducts research and provides central national services in three broad program areas and provides central national services in a fourth. These are: (1) basic measurements and standards, (2) materials measurements and standards, (3) technological measurements and standards, and (4) transfer of technology.

The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, and the Center for Radiation Research.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement, coordinates that system with the measurement systems of other nations, and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of an Office of Standard Reference Data and a group of divisions organized by the following areas of science and engineering:

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Reactor Radiation—Linac Radiation—Applied Radiation—Nuclear Radiation.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D. C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

NATIONAL BUREAU OF STANDARDS REPORT

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9903

DEVELOPMENT, TESTING, AND EVALUATION OF VISUAL LANDING AIDS

Consolidated Progress Report to
Ship Installations Division
and
Meteorological Division
Naval Air Systems Command
Department of the Navy
and to
Federal Aviation Administration

For the Period
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Development, Testing, and Evaluation of Visual Landing Aids

January 1 to March 31, 1968

I. REPORTS ISSUED

Report No.	Title
9694	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for Period October 1 to December 31, 1967.
212.11-1/68	Photometric Tests of a Neon Obstruction Light Manufactured by Nelson Lights.
212.11-2/68	Photometric Tests of a Neon Obstruction Light.
Memorandum Report	Transmissometer Indicator Zero Shifts.
Memorandum Report	"Scattered-Light" Errors in Transmissometer Measurements.

II. VISIBILITY METERS AND THEIR APPLICATION

Shipboard Visibility Meter.

The instrument was operated on the roof of the Administration Building at NBS for all but the last week and a half of this period. Satisfactory operation continued with a few failures. The flash lamp arc did not extinguish when the instrument was turned on with outdoor temperatures of about 20°F or less. The lamp always operated properly at higher temperatures. No satisfactory explanation of this phenomenon has been found. The lamp manufacturer suggests increasing the charging resistor to 1.5Ω or higher. This will be done when the instrument is removed from the roof.

The contacts of the thermostat in the electronics box failed, apparently due to the high inrush current of the heater lamp. The thermostat was replaced and a resistor installed to reduce the maximum surge current. The contact resistance of the signal peak-detector dump relay became excessive, causing the output record to appear noisy. The relay was replaced.

The instrument was removed from the roof March 20. The lamp-photocell box is being disassembled so drawings can be made of the mechanical parts. As soon as this is completed, the operation of the instrument will be checked and prepared for shipment to Arcata.

During this period all circuit drawings were completed and a preliminary instruction manual was prepared. Work is now in progress on the final instruction manual to be in the form of an NBS report.

Fog Detector Field Tests.

Low visibility conditions suitable for evaluating the performance of these devices was limited during this period, but there were enough conditions to check performance on several occasions. This period has been useful for evaluating long term stability and operating performance. Details are covered in the individual reports given below.

The Edison Fog Detector.

Operation of the Edison forward-scatter fog detector was continued. The external baffle of the light source was changed to eliminate the diffraction of the light from water droplets accumulating on the baffle. The new baffle was made from aluminum sheeting, with the same diameter as the red plastic, except that, at the bottom edge, a long point was formed to put any droplets which accumulate so far away that refracted light from the source cannot reach the detector. The sensitivity

of this unit has continued to decrease until it is only about one-fifth of that when the new detecting element was installed. Some of the decreased sensitivity may be from loss in lamp output. The lamp is flickering from failure to fire regularly. This lamp will be replaced when a new lamp is obtained. The signal still varies with changes in transmittance although the sensitivity is greatly reduced.

The Hoffman VMS-508A Fog Detectors.

Both of the Hoffman backscatter fog detectors were returned from the manufacturer after repair. The malfunctions were reported to be a faulty emitting gallium-arsenide diode in one unit and improper optical alinement in the other. Both units were calibrated at Arcata and installed in the field for testing. For three weeks both units were operated with the output signal recorded for comparison with the transmittance records. In good visibility one unit, S/N007, had a normal minimum reading of 0.18 milliampere with the signal varying constantly over 0.02 ma., and for similar conditions the unit, S/N005, read approximately 0.22 ma. with the signal varying by 0.04 ma. Initially the output of both units was approximately 1 ma. for transmittances of 0.1 over a 250-foot baseline--visibility 300 feet (day) or 800 feet (night). After three weeks unit 005 was changed to operate as a fog detector, which should operate a relay to energize an alarm system when the visibility decreases to the selected level. In the beginning 005 appeared to operate the relay as expected, but after a few weeks the relay was energized in daytime in very good visibility, although a visibility of three miles or less should have been required. Within another week the relay was energized continuously both day and night even though the visibility was very good and the controls were set to require visibility of one mile or less. Unit 007 showed very little sensitivity to changes in transmittance. At this point the units were changed to record the output of 005 and to operate 007 as a fog detector. The 005 unit did not indicate any response to changes in transmittance but 007 did energize the relay when transmittance indicated about the three-mile visibility which was selected. After another two weeks 007 kept the alarm relay energized for all conditions unless the one mile or less visibility range was selected and it was nighttime. At this time neither of the units could be calibrated. The cover glass on the transmitter of unit 007 broke again within one week after being reinstalled in the field. Testing of these units has been discontinued.

The AGA Fog Detector.

The AGA backscatter fog detector has operated throughout this period without requiring specific maintenance. It has no facilities for continuously recording the output signal, but a relay for the alarm device is energized when the backscattered light balances the pilot signal, which is adjusted by the grey-scale setting. Only two grey-scale settings have been used during this period. At first the grey-scale

was set to 1. 0, which balanced when transmittance over a 250-foot baseline was approximately 0. 9, and later the grey-scale was set to 1. 5, which balanced at approximately 0. 85 transmittance. Over a period of months there has been no noticeable change in the value of transmittance required to obtain a balance. These tests will continue.

Videograph Fog Detector.

The Videograph fog detector is a visibility meter which operates on the principle of atmospheric backscatter. The basic unit is manufactured in West Germany by F. Frungel Impulsphysics Corporation. The unit under test is a Videograph B with internal interrogator, which was procured as one of a group from Automatic Power, Inc., through U. S. Coast Guard. The transmitted light is produced by a xenon flash-lamp, which creates a high-intensity flash of very short duration, with 1. 2 to 1. 5 flashes per second. The scattered light is detected by a vacuum phototube; the sampled volume is from 15 to 100 feet in front of the instrument. The receiver is designed to accept only the light from the pulses of the flash-lamp, to prevent being affected by daylight. The output of the receiver is indicated by a meter calibrated for visibility in nautical miles and kilometers. An alarm relay is provided which can be slected to close when visibility lowers to 4, 3, 2, or 1 nautical mile. The Videograph B is energized by a nominal 12 volts direct current supply. It is equipped with an automatic internal interrogator to monitor the performance and insure that the transmitter and receiver are functioning. The performance is checked by opening a shutter to admit a sample of light from the flash-lamp to the phototube via a light guide. When operating satisfactorily this light should produce an indication of 0. 8 kilometer visibility.

This unit was operated in the laboratory to determine its performance characteristics before it was installed in the field. A recording milliammeter was connected in series with the visibility indicator meter. The unit did not have arrangements for installing a recorder, but a visibility meter setting potentiometer provided adjustment to compensate for the resistance of the recorder. A sensitivity potentiometer is used to adjust the B+ voltage across the phototube; for this unit a setting of 4. 44 was specified as the correct setting. The USCG stated that this unit had been checked and that this setting gave a correct reading of 0. 8 kilometer on the performance check. When the checks were performed at Arcata the sensitivity setting had to be reduced to 1. 75 to achieve the correct reading. The unit operated satisfactorily on a 12-volt battery, but using a limited-current battery charger on the battery caused erratic performance. A power supply with a well-filtered output gave satisfactory operation. The operation in the laboratory showed response to atmospheric changes. The unit will be installed in the field for regular performance operation early next quarter.

AGA Visibility Meter.

A visibility meter developed by AGA Aktiebolog was obtained on a 6-month loan for feasibility evaluation. This equipment is a prototype unit which had been tested in Sweden; it operates on the basic principles of the AGA fog detector. In the AGA visibility meter the axes of the projector beam and the receiver field of view are one meter apart. Since the projector and receiver are housed in separate units, the comparison beam from the projector is directed to the receiver by a fiber-optics light guide. The grey-scale of the instrument is rotated by a servo motor to obtain a balance. A potentiometer is mounted on the shaft of the grey-scale to furnish a signal voltage for the recorder, corresponding to the balance of the grey-scale. This visibility meter measures the backscatter from the region 20 to 700 feet in front of the unit. This equipment can be operated at any inclination from the horizontal to 60 degrees. The emitter is designed to refract suitable amounts of light towards the axis of the receiver optics--sometimes referred to as a tailored beam--to obtain a response which is relatively uniform for each section of the sampled volume.

The equipment was installed in an instrument shelter at the Arcata Airport near the transmissometer T-L2, from which the transmittances for evaluating the response of the fog detectors is obtained. The equipment was put into operation and the calibration of the performance checked by representatives of AGA. The records show great sensitivity to changes in atmospheric conditions down to visibilities of one-half mile. The output is slightly affected by daylight conditions. After a few weeks operation the output showed an instability, which was caused by roughness or poor contact of the potentiometer from which the output signal is obtained. Shortly after this potentiometer was replaced the performance deteriorated because the lamp had dropped out of the base and was hanging by the filament leads, but was still operating. After replacing the lamp the performance did not return to normal. At the end of the quarter further repair work was awaiting instructions from AGA.

Slant Visibility Meter.

The slant visibility meter was reactivated to obtain data for evaluating the response of the AGA visibility meter when the latter is operated at the higher inclination angles.

Fog Variability Studies.

The draft of the "Summary of Low Visibility Conditions at the Arcata Airport" was completed and forwarded for review. The report includes a 10-year summary of hours with transmittance below 0. 5 over a 500-foot baseline, a two-year tabulation of runway visual ranges (RVR) below 1000 feet and below 800 feet, and a five-year

summary of FAA observations of low-ceiling and low-visibility conditions. The report should be issued soon.

The instrument flight rule (IFR) conditions and the amount of time the runway lights were operated at 100 percent (Step 5) intensity are recorded by elapsed time meters. The hours of each for January, February, and March and for the entire 1967 year are as follows:

	Quarter	1967
Instrument flight rules (IFR)	367 hours	2110 hours
Runway lights at step 5 intensity	30 hours	231 hours

A check of the records for T-D transmissometer showed the following hours of low visibility conditions for the year 1967:

Transmittance below 0.5	--daytime	150 hours
Transmittance below 0.5	--nighttime	458 hours
RVR below 1000 feet	--daytime	29 hours
RVR below 1000 feet	--nighttime	17 hours
RVR below 800 feet	--daytime	6 hours
RVR below 800 feet	--nighttime	0 hours

Transmissometer Scattered-Light Error.

The measurements to determine the amount of light from the transmissometer projector that is seen by the receiver after scattering are summarized in a Memorandum Report, "Scattered-Light Errors in Transmissometer Measurements." The error for several values of transmittance are given for receiver field of view--half-cone angle--of 9.2, 12, 18, 25, 31, and 62 milliradians. Also a table showing the error in indicated visibility in daytime resulting from this scattered light error is given.

Transmissometers.

The Memorandum Report of Transmissometer Indicator Zero Shifts has been issued. Information on the gradual down-scale of the ZERO reading of some transmissometer indicators during conditions with low transmittances are discussed. To reduce these zero shifts a replacement of a bathtub type capacitor with a type having low charge retention and a slight modification of the RC smoothing circuit of the indicator voltmeter section are recommended.

III. AIRFIELD LIGHTING AND MARKING

Field Tests of Type L-842 Inset Runway Lights with Forced Drainage Modification.

The five type L-842 inset runway lights, which are on continuing field tests at Arcata, were opened for inspection after eight months of operation. This was during the rainy season. Water was poured over the lights while they were energized and also shortly after turnoff on the day of the inspection to simulate rain continuing through a period of operation. After cooling to the natural temperature the lights were opened and examined. Both the unmodified units and one of the units modified for forced drainage were dry and showed no evidence of corrosion or moisture. One of the modified units had a few drops of water in it and marks showing that on occasions it had contained greater quantities of water. The other modified unit had water covering the lamp and showed considerable corrosion. All units were reinstalled without removing the water. Next day, after operating for a three hour period and cooling off, the lights were again examined and all units were without water and the cavities were nearly dry. Apparently the forced drainage modification will remove the water that may accumulate if the light is operated continuously for three hours, but the light may tend to suck in water during the cooling period.

Airfield Lighting Connector Field Tests.

Leakage current measurements were made on the 13 airfield lighting cable connectors buried at the Arcata Airport for continuing tests. These connectors have been buried for more than eight years. These leakage current measurements were made near the end of the rainy season. Eight of the connectors showed a slight increase in leakage. Leakage of three connectors had increased by a factor of two. Two of the connectors had no appreciable change.

Field Tests of Cable-Fault Locator Developed by NBS.

The cable-fault locator developed by NBS has been tested on many circuits at the Arcata Airport by locating faults and tracing circuits. This equipment performs better than the AN/TSM-11 cable test-detecting set. Tracing series circuit cables with the new NBS cable-fault locator is easy and accurate. Direct-burial cable is easy to trace. Cables in metallic-duct or with an armor sheath can be followed, but greater care is required. In locating ground faults the NBS unit can locate shorts to ground within a few inches. Fairly high resistances to ground can be located also, but the limit on high resistance faults has not been determined. In circuits with

multiple high-resistance faults usually several faults could be located, but those which were located would have to be repaired before other faults on the circuit could be located. A primary advantage of the NBS fault locator over the AN/TSM-11 in locating ground faults was the availability of another test frequency for use when interference was a problem. The NBS fault locator can be used to follow the circuit to within 100 feet or less of an ungrounded open fault. By tracing an open circuit from both ends the approximate location of the ungrounded open fault could be determined. The NBS cable-fault locator can be used to determine the depth of direct burial cable very accurately by measuring the distance the detecting element must be raised above the ground to decrease the reading to one-half value. A progress report is being prepared on testing this cable-fault locator and should be issued soon. Testing of this equipment will be continued.

Type L-852 Wide-Angle Airport Taxiway Light.

One type L-852 bidirectional wide-angle airport taxiway light was received for test on February 6, 1968. The lamp used is a 65-watt Q65T2-1/2/1CL halogen-cycle lamp in a prefocused mount. The light met the isocandela requirements of the specification (L-852) in both directions. The light has provision for inserting two colored glass filters, but none was used for the test. NBS Test Report 212.11-3/68 will be issued.

Lights for Marking Transmission Lines and Their Supporting Structures.

A neon catenary light and a pair of condenser-discharge obstruction lights (a "master" unit with a timing circuit and a "slave" unit) were received from the Bonneville Power Administration, Portland, Oregon, for test.

Before the catenary light was tested it was found that a similar unit had been tested in 1955. That unit had an intensity of 70 candelas in a particular direction with a primary magnetomotive force of 1000 ampere-turns, and 35 candelas with 500 ampere-turns. The present unit, with one measurement in the same direction, had an intensity of 32.5 candelas with 500 ampere-turns.

Only the master c-d obstruction light was tested. With 118 volts applied the effective intensity (in the horizontal direction of the handle on the unit) was above 1160 candelas between 5° and 10° vertical and increased from 130 candelas to 1180 candelas from 0° to 5° vertical. The flashtube power was 12.5 watt-seconds per flash (at 42 fpm) for each flashtube.

Neon Obstruction Lights.

A neon obstruction light manufactured by Nelson Lights, Los Angeles, was tested (1) with the red lens (an AN 2541-12 globe) which came with the light, (2) with a clear lens (an AN 2541-11 globe) and (3) with no lens. At 120 volts input, between 2.5° and 12.5° vertical in one vertical distribution, intensity fell below the 32.5 candelas requirement of FAA Specification L-810: the minimum intensity, with the red lens was 16.0 candelas, with the clear lens, 21.5 candelas and with no lens, 23.5 candelas. NBS Test Report 212.11-1/68 was issued.

A second neon obstruction light (from an unknown manufacturer) was supplied by the FAA for test. The neon tube is a five-turn spiral 4-inches in diameter and 9-inches in height. At 120 volts input the intensity in the region between 2.5° and 12.5° vertical at some angles of azimuth fell to 26 candelas, below the 32.5 candela requirement of FAA Specification L-810. NBS Test Report 212.11-2/68 was issued.

Centerline Lighting for SATS.

Photometric measurements were made on two of the four SATS centerline lights described in NBS Report 9694. One of the lights measured contains 75 type 715 lamps encased in three clear tygon tubes. The other three lights contain 39 type 715 lamps encased in three translucent polyethylene tubes. Intensity comparison of the two types of units is shown in Figure 1.

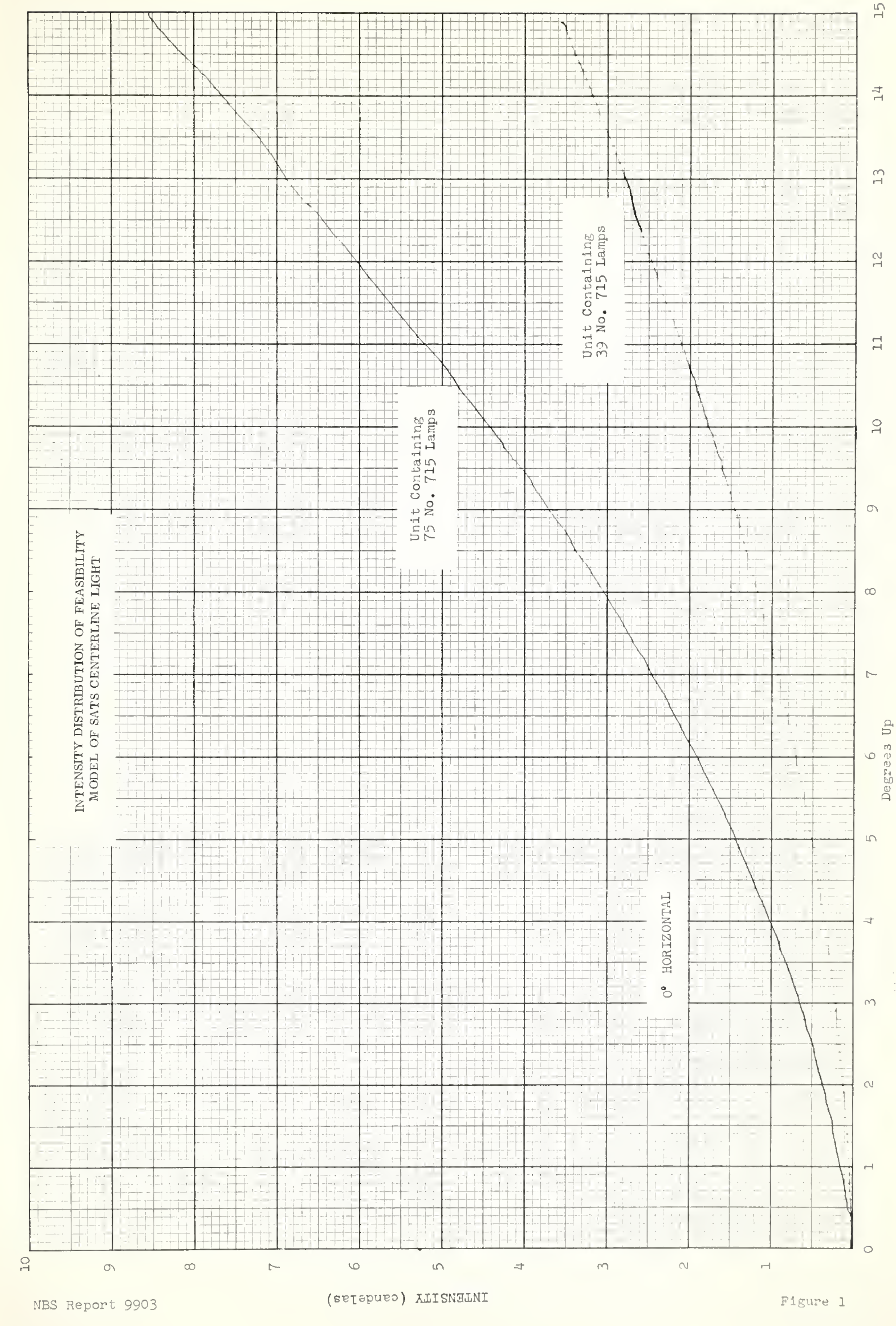
INTENSITY DISTRIBUTION OF FEASIBILITY
MODEL OF SATS CENTERLINE LIGHT
Unit Containing
75 No. 715 Lamps
Unit Containing
39 No. 715 Lamps
0° HORIZONTAL
Degrees Up
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
INTENSITY (candelas)
1 2 3 4 5 6 7 8 9 10

Figure 1

IV. CARRIER LIGHTING AIDS

Criteria for the Inspection of Fresnel Lenses.

A task was established for determining criteria for the inspection of Fresnel lenses. Several lenses were received from the Naval Air Engineering Center, Philadelphia. The lenses had all been rejected as unfit for service by that organization but there was no evidence that the lenses were operationally unfit for service or even if some of the criteria used for rejecting the lenses would prove critical in an operational situation.

Some work was done with the lenses to determine if a measure of the stray light, say at 1° off the peak of the beam, could be used as a criterion. Since there was no lens available which had been judged operationally good, the results of the tests were inconclusive. There were differences in the amount of stray light of the lenses tested but these differences were largely not apparent when the lenticular lens was installed on the cell, as this lens adds a substantial amount of stray light in the direction of measurement.

V. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

The following proposals, draft reports and specifications have been reviewed. Comments have been forwarded by letter, marked copy of the document, and/or conferences with cognizant DOD and FAA personnel.

Heliport Lighting Test Program

FAA Specification 1100 "Photometric Procedures for Condenser-Discharge Lamps"

Interim Report "Transmissometer Calibration Techniques and Devices"

Purchase description for DF OLS. NAEC-MISC-08637. ID No. 80020.

VI. MISCELLANEOUS

Project Foggy Cloud.

A group from China Lake Naval Weapons Center has set up Project Foggy Cloud at the Arcata Airport. The purpose of Project Foggy Cloud is modification of fog and low stratus by seeding. The seeding is planned to be accomplished by airborne pyrotechnics, ground burns, and air drops of liquids and powders. A wide variety of chemical compositions is to be tested. The evaluation of effectiveness is to be determined from airborne meteorological measurements, photography, and visual observations. Originally the plans were to operate for only four or five weeks during the spring and perhaps return for more work during the fog season, but this was changed to a continuing operation through the fog season.

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