NATIONAL BUREAU OF STANDARDS REPORT

10 006

DEVELOPMENT, TESTING, AND EVALUATION OF VISUAL LANDING AIDS

Consolidated Progress Report

For the Period

October 1 to December 31, 1968

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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Analytical Chemistry—Polymers—Metallurgy — Inorganic Materials — Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides for the creation of appropriate opportunities for the use and application of technology within the Federal Government and within the civilian sector of American industry. The primary functions of the Institute may be broadly classified as programs relating to technological measurements and standards and techniques for the transfer of technology. The Institute consists of a Clearinghouse for Scientific and Technical Information,[3] a Center for Computer Sciences and Technology, and a group of technical divisions and offices organized by the following fields of technology:

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THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center for Radiation Research consists of the following divisions:

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

NBS PROJECT		NBS REPORT
2120411 2120414 2120641 2120653	February 28, 1969	10 006

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
October 1 to December 31, 1968

By
Photometry Section
Metrology Division
Institute for Basic Standards

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
October 1 to December 31, 1968

I. REPORTS ISSUED

Report No.	Title
9886	Circuit Description of a Prototype Cable Fault Locator.
9958	A Summary of Low Visibility Conditions at Arcata Airport.
9964	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the period July 1 to September 30, 1968.
212.11-45/67	Photometric Measurements of Eight 20A/PAR56Q/3 Clear-Cover Approach-and Runway-Light Lamps.
212.11-29/68	Photometric Tests of Two Deck Guide Lights manufactured by The L. C. Doane Company.
212.11-35/68	Static Load Test of a Flush Approach Light manufactured by Strong Electric Corporation.
212.11-37/68	Photometric Tests of Twelve Type Q6.6A/PAR56/3 Runway-and Approach-Light Lamps (Production Run).
212.11-37/68 Supplement.	Supplement. Life Tests of Twelve Type Q6.6A/PAR56/3 Runway-and Approach-Light Lamps (Production Run).
Memorandum Report	Gages for Type L-850 Light Base.
Memorandum Report	Intensity Distribution of a Flash Approach Light Manufactured by Strong Electric Corporation.
Letter Report	Intensity Distributions of a Type C-1 Runway Light.

II. VISIBILITY METERS AND THEIR APPLICATION

Field Testing of Fog Detectors and Visibility Meters.

Several types of fog detectors and visibility meters are being field tested at the Arcata Airport. The testing of these devices is continuing and much data during rain are being obtained. Work on the report and evaluation of the fog detectors is underway: this will be a composite report of all the fog detector devices. The draft of this report should be completed during the next quarter.

A detailed report of the performance of the instruments during this reporting period follows.

NBS Atmospheric Backscatter Meter (Shipboard Visibility Meter).

The NBS atmospheric backscatter meter has operated through most of this quarter, but some maintenance was required. The response of the thermostat in the electronics box deteriorated to the point where it no longer controlled the temperature within the designed range of 40 $\pm$ 3°C. The thermostat was replaced, but this type thermostat has such a wide temperature range that adjustment to the proper position is very difficult. A type of thermostat requiring less critical adjustment is needed. A commutating relay, K2200, and a photo-silicon-controlled rectifier, Q302, failed and had to be replaced.

Some resistors were also changed to new values to obtain more reliable operation of the relays. The outer surface of some of the carbon resistors in the lamp-photocell box appear to be deteriorating perhaps because of the ultraviolet radiation from the lamp. A shield to protect these components may be desirable. Except for the above mentioned malfunctions, this visibility meter has performed well. Occasionally the lamp fails to fire for undetermined reasons, but these misfires average only a few times per day. The response to decreased transmission in rain shows good sensitivity.

Videograph B Fog Detector.

The Videograph B fog detector continues to perform well. Moving the recorder from the field into the laboratory was attempted, but, because of the increase in noise and the possibility of induced voltages damaging components in the unit, the recorder was returned to the instrument shelter in the test area. A series of measurements to compare response against temperature was started to determine if the sensitivity may be affected by changes in temperature. Apparently, temperature variations have a minor effect on the sensitivity of the unit, and control of the

internal temperature of the unit may be needed. The Videograph B has a wide range of response to atmospheric transmission changes and shows good sensitivity in the most dense fogs which have occurred. There is a lack of sensitivity for conditions with visibility above five miles. Adjustments are available to increase sensitivity in these clearer conditions, but, with these adjustments, the fog detection ranges are inaccurate.

AGA Fog Detector.

The AGA fog detector has continued to function well. After 16 months of operation, this unit has required no maintenance except for one lamp replacement. There are no arrangements for continuously recording the response of this unit, but, by comparison with the transmissometer, the relay showing the presence of fog closes under approximately similar visibility conditions. Previously, the relay closed when transmittance over a 250-foot baseline went below 0.85. This has now been changed by adjustment of the instrument so that the relay will close at a transmittance of approximately 0.70, about one-half-mile visibility.

AGA Visibility Meter.

The AGA "tailored-beam" visibility meter has been returned to AGA. Much useful information was obtained with this equipment. The equipment originally performed well, but, after some minor malfunctions and repairs, the earlier performance was not attained. The reason was not determined. The equipment as tested did not have the desired sensitivity for very dense fogs, but minor changes in the design could improve sensitivity in this range. Further evaluation and report preparation will start during the next quarter.

Hoffman and Edison Fog Detectors.

There has been no further testing of either of these units since they were removed for malfunctions and the signal lines were used for other purposes. The sensitivity of response of these devices deteriorated rapidly after operating for one or two months. These units may be returned to operation at a later date for further testing when signal lines are available.

Effects of Height Above Ground on Transmission.

Measurements of transmittance at heights of 5, 10, and 15 feet above the ground have continued. The data are obtained from three

transmissometers mounted at these heights covering the same 250-foot baseline. The desired additional data of particular interest are information on the effect of rain on transmission as well as more information in fog. Evaluation of this data may be started by the end of the next quarter.

Fog Variability Studies.

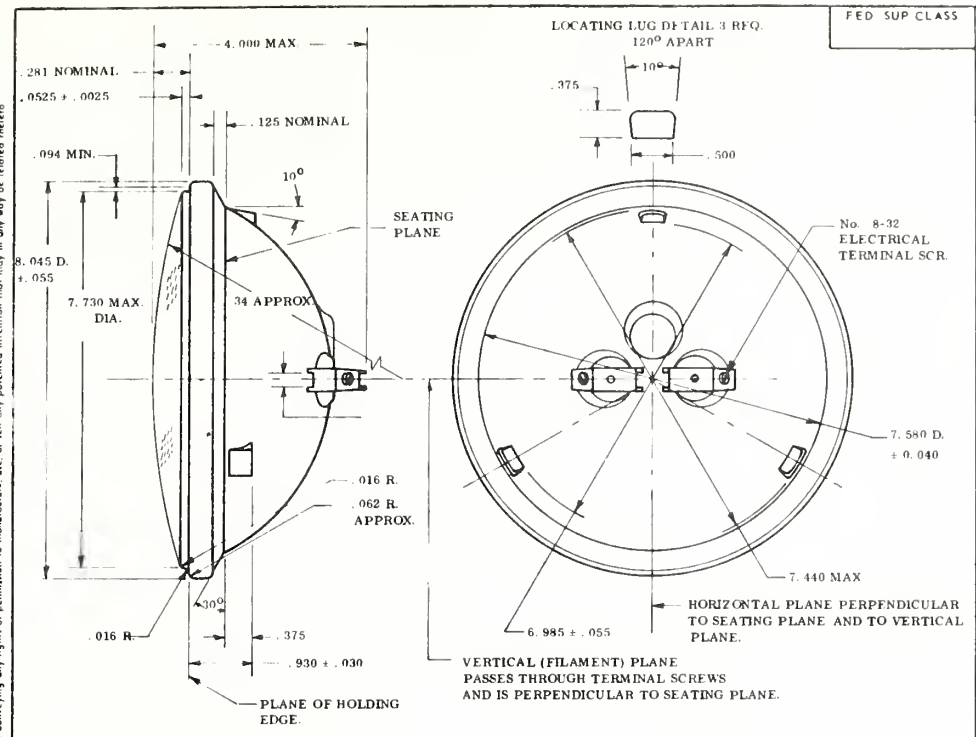
During this reporting period at the Arcata Airport, the elapsed time meters have recorded 219 hours of IFR conditions and 57 hours of runway lights operated at 100 percent intensity. These totals for the year of 1968 were 1920 and 260 hours, respectively. The report of the "Summary of Low Visibility Conditions at the Arcata Airport" has been issued. Further work on this task will be conducted at a reduced rate in order to concentrate efforts on airfield lighting tasks.

Transmissometers and Runway Visual Range Equipment.

A demonstration at the plant of the manufacturer of the new transmissometers and runway visual range (RVR) equipment being procured by FAA from Solid State Radiation Institute was attended. A conference with representatives from several government agencies was held in conjunction with the demonstration to determine the suitability of this equipment for providing RVR information to pilots in Category II and III conditions, and to standardize the equipment, installations, and use of information for these conditions. The RVR equipment being procured was considered suitable for providing the RVR information needed for Category II operations, but there was considerable doubt expressed by some of the attendees that information suitable for Category III operations could be obtained with this equipment.

MS Drawing for Transmissometer Lamp.

An MS drawing has been prepared for the transmissometer lamp to insure that the quality of this lamp is maintained and that the critical dimensions and the alinement of the beam with the lamp seating plane are controlled. See Figure 1.



DASH NO.	RATED VOLTS	INITIAL WATTS	FILAMENT TYPE	RATED LIFE HOURS	AVERAGE PEAK INTENSITY (MINIMUM) CANDELAS	BEAM APREAD AT 100,000 CANDELAS DEGREES		MAXIMUM DEVIATION OF BEAM AXIS FROM MECHANICAL AXIS	COVER
						HORIZONTAL	VERTICAL		
-1 (a)	6.0	120 ± 10	C-6 (b)	3,000	180,000	1.5 (d)	3 (d)	1.5°	Clear

(a) FILAMENT TO BE SHIELDED SO THAT NO DIRECT LIGHT FROM THE FILAMENT IS EMITTED FROM THE LAMP.
(b) AXIS OF THE FILAMENT TO DEVIATE FROM PARALLEL TO THE FILAMENT PLANE BY NOT MORE THAN 5°.
(c) WHEN LAMP IS MOUNTED WITH THE COVER GLASS INSERTED IN A 7.75 INCH DIAMETER HOLE IN A FLAT PLATE, THE DIRECTION OF THE PEAK OF THE BEAM SHALL BE WITHIN 1 1/2 DEGREES OF THE NORMAL TO THE PLATE.
(d) IN SERVICE THE LAMP WILL BE OPERATED WITH THE FILAMENT AXIS VERTICAL.

DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED. TOLERANCES: DECIMALS ±0.016, ANGLES ±1°.

EACH LAMP SHALL BE PERMANENTLY AND LEGIBLY MARKED WITH THE IDENTIFICATION NUMBER, MANUFACTURER'S TRADE MARK OR ABBREVIATION OF MANUFACTURER'S NAME, RATED VOLTS, AND WATTS.

REVISED

APPROVED

P.A. NAVY AS. Other Cust USAF	TITLE LAMP, INCANDESCENT, PAR-64 BULB, SCREW TERMINAL BASE, TRANSMISSOMETER	MILITARY STANDARD MS
PROCUREMENT SPECIFICATION MIL-L-6363	SUPERSEDES	SHEET OF

NOTICE — When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This standard has been approved by the Department of the Navy and is mandatory for use by that activity. All other military activities are required to employ this standard where suitable.

DD FORM 1 SEP 67 672-1 (Limited coordination)

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

Figure 1.

III. AIRFIELD LIGHTING AND MARKING

Beacon Manufactured by North American Aviation, Inc.

A beacon designed and built by North American Aviation for use in tests of obstruction lighting of tall TV towers was received from the National Aviation Facilities Experimental Center for intensity distribution checks. The unit contains six 500-watt, 20-ampere PAR-56 lamps arranged in a circle aimed upward and six similarly arranged pointing downward. A revolving mirror (with both surfaces reflecting) tilted 45° from its vertical axis generates a flashing beam with a 360° horizontal coverage and with a flash rate in any horizontal direction of twice the rate of rotation of the mirror. The 20-ampere lamps were operated at 18.6 amperes, as recommended by the manufacturer. Intensities measured at 20° horizontal intervals (the vertical angle of traverse was 6.0°) were as follows:

	Intensities (kilocandelas)	
Reference	Top 6 Lamps	Bottom 6 Lamps
0°	320	340
20°	290	350
40°	290	250
60°	270	310
80°	270	220
100°	280	290
120°	340	340
140°	340	260
"Average"	300	295

It was evident when looking into the beam that the mirror was not flat, and, as a consequence, all of the lamps were not making their proper contribution to the total beam intensity. Each of six lamps was burned in turn and the contribution of each was determined (not to 1% accuracy; hence, the total of more than 100%):

Lamp Number (arbitrary)	Percent Contribution
1	20
2	11
3	28
4	12
5	7
6	24
Total	102

It follows that, if each of the lamps were contributing to the extent of lamp number 3, the intensity of the unit would be increased about 70%.

The beam width (at points of 50% of peak intensity) in the vertical direction (one determination only) was about 9.5°.

A letter report will be issued.

In-Runway Visual Approach Slope Indicator (VASI).

Concern has been expressed regarding the use, by pilots of long-bodied aircraft, of the Visual Approach Indicator System (VASIS) when these aircraft are in the flare attitude. One suggested solution for this problem is the addition of a third set of bars to the VASIS, upwind of the present pair of bars, to define a second glide slope. However, since the addition of more bars to the present VASIS presents some problems, the installation of VASI-type lights in the runway might be advantageous in presenting the after-flare indication.

A configuration of on-hand components to simulate an in-runway VASI was assembled at the National Bureau of Standards and photometric measurements were made of the unit. The lamp was especially made for a short (28-inch) lamp-to-aperture distance. A vertical intensity distribution is shown in Figure 2. NBS Test Report 212.11-1/69 will be issued.

Flush Approach Light Manufactured by the Strong Electric Corporation.

A letter report was issued giving the results of photometric tests (made before the static load tests) of a flush approach light manufactured by the Strong Electric Corporation, Toledo, Ohio. The unit contained two 500-watt, single-ended experimental halogen-cycle lamps. A peak intensity of 19 kilocandelas was obtained. Beam widths (points of 50% of peak intensity) were 7.5° vertical and 28.5° horizontal (one determination of each).

Static load tests were made on the unit and reported in test report 212.11-35/68. Both lenses of the unit cracked during the test.

Flush Flasher Approach Light Manufactured by Amglo Corporation.

Photometric measurements were made of the smaller of two flush flasher approach lights manufactured by the Amglo Corporation, Chicago, model 3051. The energy supplied to the 3/4-inch diameter helical

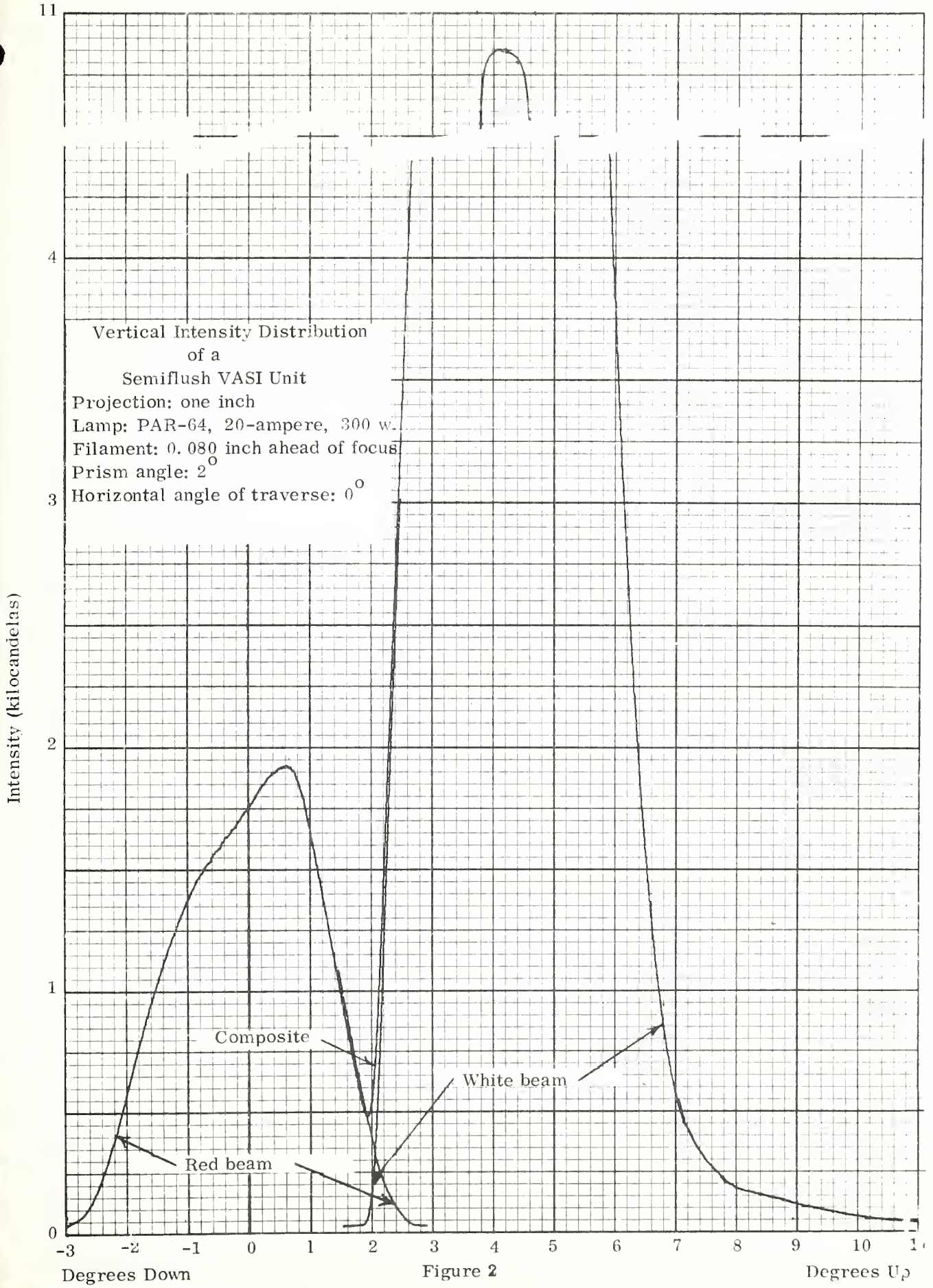

Vertical Intensity Distribution
of a
Semiflush VASI Unit
Projection: one inch
Lamp: PAR-64, 20-ampere, 300 w.
Filament: 0.080 inch ahead of focus
Prism angle: 2°
Horizontal angle of traverse: 0°
Intensity (kilocandelas)
11
4
3
2
1
0
Composite
White beam
Red beam
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
Degrees Down
Degrees Up

Figure 2

flashtube was 365 watt-seconds (nominal) per flash. The power supply was performing erratically, so the test was not conclusive. Since the power supply deteriorated further, it was not possible to test the larger unit, model 5858.

Figures 3 and 4 give a vertical and horizontal presentation of the intensity distributions in two planes. Figure 4 was made from data taken at 10° intervals and therefore does not show the irregularities of the continuously recorded trace of figure 3. A letter report will be issued.

Life Tests of Twelve Type Q6.6A/PAR56/3 Runway-and Approach-Light Lamps (Production Run).

Twelve Type Q6.6A/PAR56/3 runway-and approach-light lamps from a production run were life tested at rated current. Average life to burn-out or to the time when the voltage dropped to 95% of initial voltage of eleven lamps (one lamp burned out before the test was started) was 798 hours. Federal Specification WL-101 permits a 17% deviation from the stated life (1000 hours), or an average of not less than 830 hours to the sample tested. NBS Test Report 212.11-37/68 Supplement was issued.

Type C-1 Lights with Philips (Netherlands) Lamps.

A letter report was issued giving the photometric measurements of each of five lamps in a type C-1 runway edge light. Four lamps were made by Philips of the Netherlands and were operated at a current to make their luminous output 4800 lumens. The fifth lamp, manufactured by General Electric Company, was operated at 6.6 amperes, it having been previously determined that its lumen output was 4720 lumens. Peak intensities in one direction of the Philips lamps were 37, 32, 32 and 35 kilocandelas; for the GE lamp, 28 kilocandelas.

Field Tests of Cable-Fault Locator Developed by NBS.

The testing and evaluation of the Cable-Fault Locator (CFL) have continued, and a draft of the report was prepared. The CFL works well for tracing circuits and locating low-resistance-to-ground faults in cable buried directly in the ground. For many installations of cable in steel pipe, the cable could be traced and sometimes faults could be located, but for other circuits in steel pipe, the results were unsatisfactory. For open-circuit faults in direct-burial cable, the cable could be traced to within 50 feet or less of the fault and even up to the fault in some installations. Under conditions when useful results were obtained on the tests, the CFL performance was equal to or better than that of the AN/TSM-11 cable test-detecting set. Except near turns in

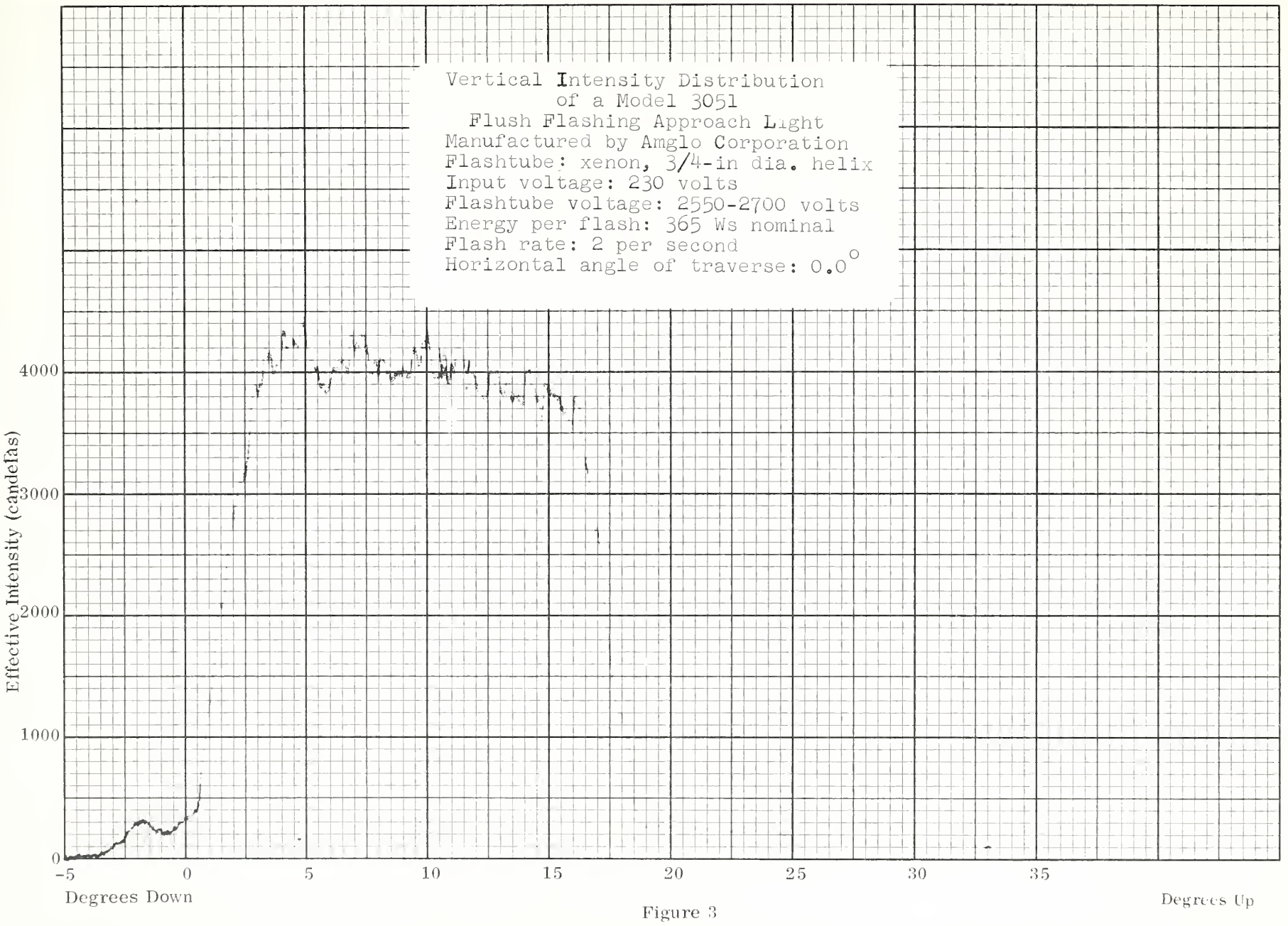

Vertical Intensity Distribution
of a Model 3051
Flush Flashing Approach Light
Manufactured by Amglo Corporation
Flashtube: xenon, 3/4-in dia. helix
Input voltage: 230 volts
Flashtube voltage: 2550-2700 volts
Energy per flash: 365 Ws nominal
Flash rate: 2 per second
Horizontal angle of traverse: 0.0°
Effective Intensity (candelas)
4000
3000
2000
1000
0
-5
0
5
10
15
20
25
30
35
Degrees Down
Degrees Up

Figure 3

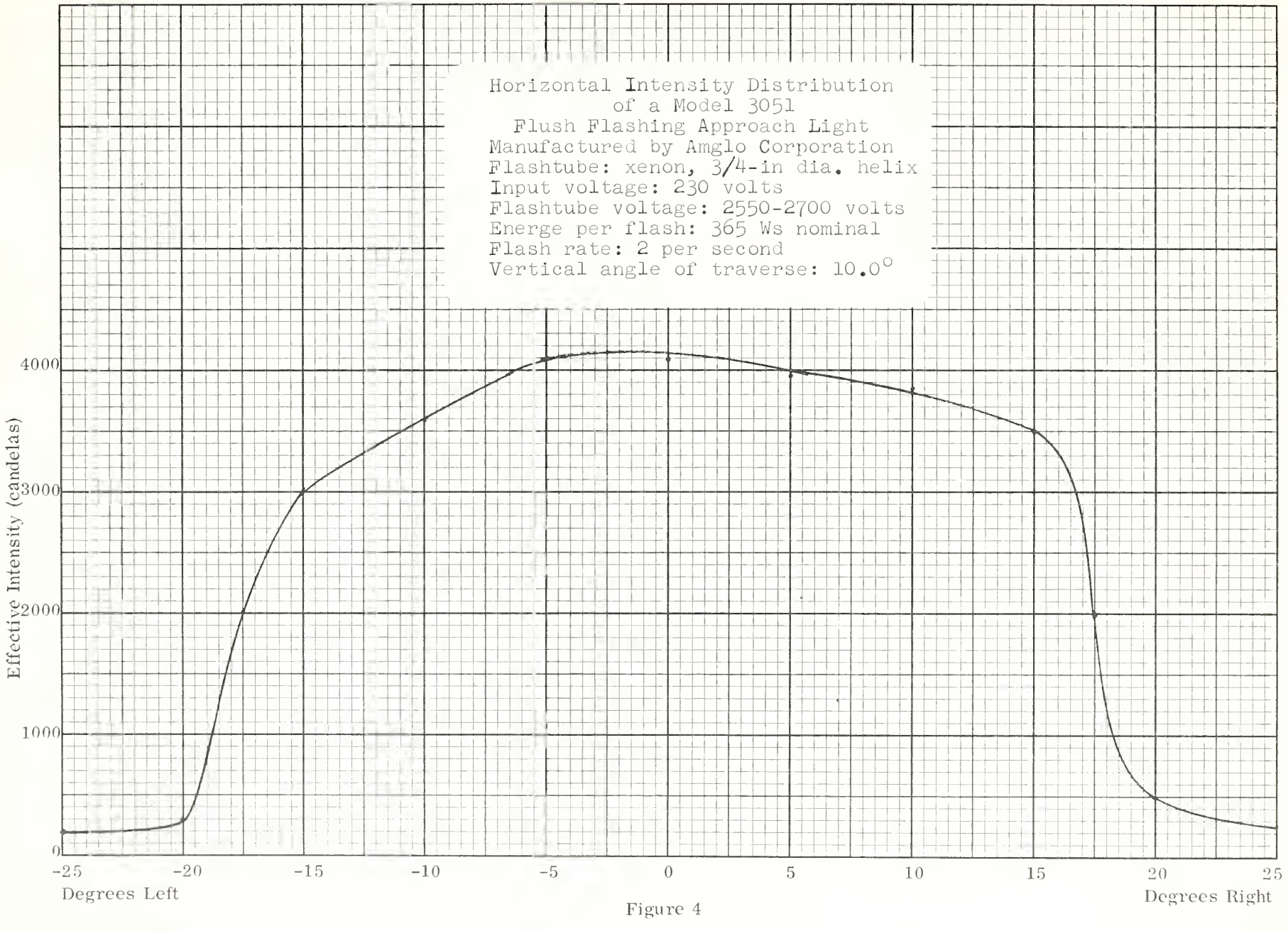

Horizontal Intensity Distribution
of a Model 3051
Flush Flashing Approach Light
Manufactured by Amglo Corporation
Flashtube: xenon, 3/4-in dia. helix
Input voltage: 230 volts
Flashtube voltage: 2550-2700 volts
Energe per flash: 365 Ws nominal
Flash rate: 2 per second
Vertical angle of traverse: 10.0°
Effective Intensity (candelas)
4000
3000
2000
1000
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
Degrees Left
Degrees Right

Figure 4

the cable, the depth of directly buried cable could usually be determined accurately with the CFL. The waveform of the output voltage from the signal generator, which is basically a squarewave, was badly distorted, depending on the circuit to which it was connected. The tendency towards distortion was increased with the higher test frequencies and the higher output voltage settings. The CFL is an improvement over the AN/TSM-11 in many respects, but these field tests have indicated areas where further improvements may be possible. A report on the CFL will be issued next quarter.

Airfield Lighting Maintenance Manual.

Following the review of Visual Landing Aids General Service Bulletin No. 27, Visual Landing Aids Design Standards--Landbased Installations, and several survey reports, reported last period, lists of types of lamps and transformers that are currently in use were prepared. The lamps were listed according to lamp types, fixture specifications, and light fixture or system. The transformers were listed according to application, fixture type, and electrical characteristics. These lists include information on types, specifications, standard drawing numbers, Federal Stock Numbers, fixture types, electrical ratings, and, when available, the superseded type, stock number, specification, and standard drawing number. The lists will be useful for preparing the Airfield Lighting Maintenance Manual.

Portable Inset-Light Photometer.

A portable wheel-mounted photometer has been completed except for the installation of the photometer measuring components. The construction of this photometer consists of a bottomless light-tight box (see Figure 5) that can be positioned over the light to be measured to make an in-place photometric check of touchdown zone and centerline lights. By using a folded light path, a measuring distance of approximately ten feet is used for the photometric test. This distance is considered minimum in order to obtain an accurate measure of the effects of dirt or moisture on the lens, which diffuse the light beam. A calibration check can be made of the photometer at any time by switching on a battery-powered reference light built into the unit. By visually observing the beam position on a translucent plastic window on the photometer, an indication can be seen of the vertical angular elevation of the beam. The photometric sensing unit will be mounted at the center of the plastic window, which will also be the center of the inset light beam if the vertical angle of the beam is correct.

This photometer has been designed as a feasibility model for making spot checks on the centerline inset lights selected at random.

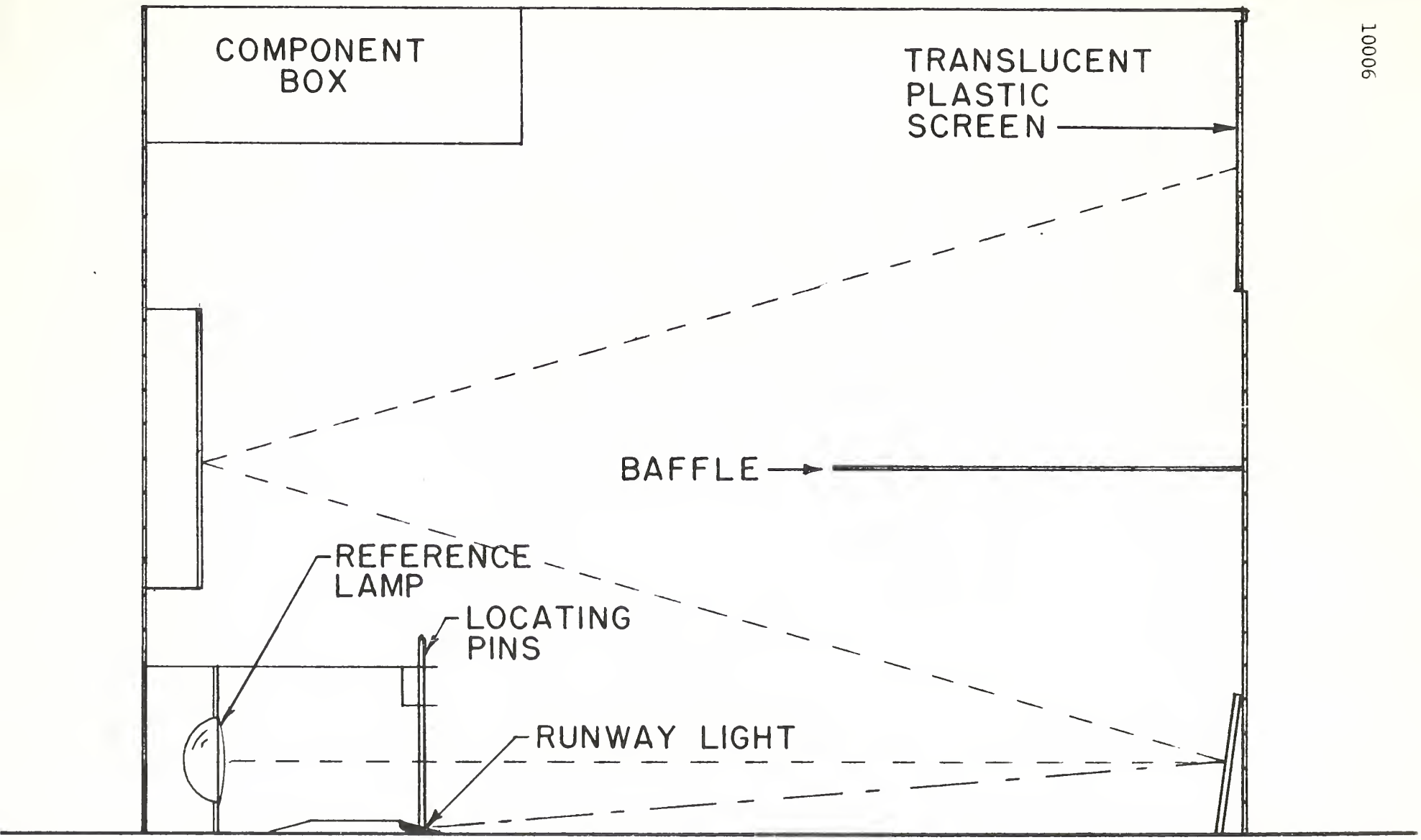

COMPONENT BOX
TRANSLUCENT PLASTIC SCREEN
BAFFLE
REFERENCE LAMP
LOCATING PINS
RUNWAY LIGHT

Figure 5.

IV. CARRIER LIGHTING AND MARKING

Light with Deep Elliptical Reflector for use as a Deck Floodlight.

Two interior-type fixtures with deep elliptical reflectors were received, one to accommodate a 500-watt T-24 lamp and the other a 750- or 1000-watt T-24 halogen-cycle lamp. Photometric measurements will be made of the units to determine the suitability of the elliptical-reflector-type unit for use as a glare-free deck floodlight.

V. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Draft Specifications.

Drafts of the following specifications and reports were reviewed and the comments were forwarded:

Specification MIL-R-6402B Regulator, Constant;

Current, Taxiway Lighting, Type M-2;

Required Operational Capability (ROC) for Runway Visual Range (RVR) Data to Support All-Weather Landing Systems;

Development of Transmissometer Calibration Techniques and Devices;

Transmissometer Calibration and Alignment; and

Flight Tests and Evaluation of Heliport Lighting for VRF.

Project Foggy Cloud.

The activities of Project Foggy Cloud at the Arcata Airport terminated November 15, 1968. This project was directed by the Earth and Planetary Division of the Naval Weapons Center, with its purpose to evaluate methods of modifying warm fog and stratus clouds. Some of the results near the end of the fog season appeared promising. A summary of this activity prepared by the project personnel is included with this report (see Appendix A). The NBS Visual Landing Aids Field Laboratory assistance on this project during this quarter consisted of a few observations and comments during tests, evaluating possibilities of fog or stratus during the month of November, and help in loading and preparing for departure. The present plans anticipate a return to Arcata next spring for more testing during the next fog season.

Bureau of Public Roads and Oregon State Highway Department.

John Hegmann, Bureau of Public Roads, and William Zirbes, Oregon State Highway Department, visited the VLA Field Laboratory at Arcata to discuss devices and means of detecting fog along highways. They are planning a test project for a section of Interstate 5 Highway in Oregon to compare instrument indications with observations by the Highway Patrol Officers in determining the presence of fog on the highway requiring reduced driving speeds. This project may extend over a period of three years. The problems of sampling errors, maintenance of and limitations of equipment were discussed. The transmissometers seemed the most suitable equipment presently available, but some of the fog detectors may prove suitable for this type use. They were considering an installation of one or more transmissometers using a 250-foot baseline for the initial installation.

APPENDIX A

FROM: PROJECT FOGGY CLOUD DATE: 11 November 1968

TO: NATIONAL BUREAU OF STANDARDS
POST OFFICE BOX 193
ARCATA, CALIFORNIA 95521

REF: 143/RSC:dp

SUBJECT: Summary of Project FOGGY CLOUD

1. Project Foggy Cloud was a field evaluation of methods of modifying warm fog and warm clouds. The project was planned and conducted by the Earth & Planetary Sciences Division of the Naval Weapons Center, in collaboration with the U. S. Army Atmospheric Sciences Laboratory, the U. S. Air Force Cambridge Research Laboratories and the U. S. Navy Weather Research Facility. On contract to NWC, personnel of Meteorological Operations, Incorporated, Hollister, California, participated directly in the project. Other agencies which contributed personnel, technical support or equipment to the project include the Tactical Air Command, Air Weather Service, U. S. Army Terrestrial Sciences Center and Cornell Aeronautical Laboratories.

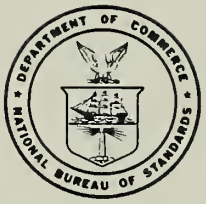
2. A total of 72 seeding tests and 41 supporting tests were run during the period 25 March to 10 November 1968. Twenty-five of these tests were conducted with pyrotechnic seeding agents, 30 with sprayed solution and 17 with dry powdered agents. Both ground based and airborne seeding techniques were evaluated for pyrotechnic and spray agents. During each test, the nature and extent of any cloud modification was measured and evaluated. Data gathered include standard weather observations; transmissivity; atmospheric soundings; aerial measurement of temperature dewpoint observations; and droplet-size data. Most of the data have been reduced to yield a time history of measurements and events before and after seeding. The most significant result of this project has been the discovery that a solution of 4 parts ammonium nitrate and 3 parts urea in 0.78 parts of water has extremely suitable properties for warm-fog modification. Although we have not yet developed a completely reliable technique to disperse warm fog, several airborne tests with this solution have yielded very encouraging results. It is reasonable to expect that future work will enable us to specify the unknown details necessary to engineer an operational fog-dispersal capability suitable for airport applications.

APPENDIX A (CONTINUED)

3. The project was based at the Arcata-Eureka Air Terminal because of its favorable weather regime, its special instrumentation and its history of use for projects of this kind. Testing was conducted principally at or over the airport or in suitable areas close to it. As has been the case in earlier projects, the cooperation by personnel of the National Bureau of Standards has once again been outstanding. We are indebted to Messrs. John Simeroth, James Davis and James Wilkerson for advice and assistance and completely voluntary collaboration in the many activities necessary to plan, conduct and evaluate the tests. These men provided background information and climatological data, pertinent test transmissivity data and other technical materials and references. They frequently observed our tests in person, providing us observations and helpful suggestions in locating tests and observational sites. They loaned us various equipment useful in accomplishing specific tasks. They relinquished use of our leased office spaces, without which we could not have operated. All of these activities were conducted in a spirit of friendly cooperation which is greatly appreciated.

4. Three reports on the project are planned on a priority time schedule. Information copies of these reports will be furnished to your office.

(Signed) Richard S. Clark
Richard S. Clark
Field Director


DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS