NATIONAL BUREAU OF STANDARDS REPORT

7384

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period April 1 to September 30, 1961

By
Photometry and Colorimetry Section
Metrology Division

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's research are published either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (Includes Titles of Papers Published in Outside Journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

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Development, Testing, and Evaluation of
Visual Landing Aids

Consolidated Progress Report
to
Ship Aeronautics Division
and
Meteorological Division
Bureau of Naval Weapons
Department of the Navy

and to
Federal Aviation Agency
Washington 25, D. C.

For the Period
April 1 to September 30, 1961

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
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I. REPORTS ISSUED

Report No.	Title
7040	Electrical Characteristics of Static Inverters for Battery-Operated Fluorescent Seadrome Lights
7147	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period January 1 to March 31, 1961
7182	Temperature Measurements of a 500-Watt, Flush Runway-Light Installation
7322	Bibliography of National Bureau of Standards Reports and Papers on Aviation Ground Lighting, 1945 - 1961
21P-16/60 Sup. #2 (Letter Report)	Physical and Electrical Tests of 20 Connectors for Airfield Lighting Cable, Submitted by Woodside Screw Machine Co. Inc.
21P-47/60 Sup.	Physical and Electrical Tests of Five Tee Receptacle Connectors for Airfield Lighting Cable, Manufactured by Clark Cable Corporation
21P-4/61	Photometric and Life Tests of Three Type 20A/PAR56 and Three Type 20A/PAR56/2 Approach-Light Lamps Manufactured by General Electric Company
21P-5/61	Photometric Tests of Four Prismatic-Type Semi-Flush Approach and Runway Lights Manufactured by Revere Electric Manufacturing Company
21P-6/61	Photometric Tests of a Duplex 24-Inch Drum-Type Rotating Beacons Manufactured by Westinghouse Electric Corp.
21P-8/61	Photometric Measurements of Three 200-Watt and Three 300-Watt PAR-Type Lamps Designed for Use in an RAE-Type Visual Glide Slope Indicator
21P-29/61	Intensity Distribution Measurements of a Condenser-Discharge Approach Light, Type CD-100, Manufactured by the General Electric Company
21P-31/61	Photometric Measurements of Eight PAR-Type Lamps Designed for Use in a Visual Glide Slope Indicator
21P-36/61	Photometric Measurements of Eight Type 6.6A/PAR64/3 Lamps Designed for Use in a Visual Glide Slope Indicator

Report No.	Title (cont.)
21P-43/61	Photometric Tests of a Semi-Flush Mount "Pancake" Light Manufactured by Newport Electronics, Inc.
Letter Report	Tests of 30/45-Watt Transformers
Purchase Description	Light Assembly, Goggle-Mounted
Memo Report	The Requirements of a Minimum Lighting System for Secondary Airports
Memo Report	"Scotchcast" Splices
Letter Report	Fading of Fluorescent Marker Paint
Memo Report	Transformer for "Wheels Warning" Lights, Manufactured by General Electric Company
Memo Report	Transformer for "Wheels Warning" Lights, Manufactured by Elastimold Divsion, Elastic Stop Nut Corp. of America
Memo Report	Effective Intensity of a Warning Light Manufactured by Federal Sign and Signal Corporation
Memo Report	Summary of Recommendations Resulting from Survey Trip To Lemoore Naval Air Station

II. VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter. A prefabricated shelter for use at the slant visibility meter site was erected for housing the recording and indicating equipment of the slant visibility meter, transmissometer, and brightness equipment. This shelter will be used for recording observations during tests.

All components of the slant visibility meter were carefully checked and the malfunctions corrected. The detector and recorder were calibrated for sensitivity. The major faults encountered were insufficient pressure from the air compressor, deterioration of the insulation on the high-voltage cable to the lamp, faulty mica capacitor in the detector amplifier, leakage of moisture around lens of detector, and defective tubes. The focus of the projector and the focus of the detector were readjusted. This equipment has been remarkably free of operational maintenance problems during the past seven years of operation. The air compressor has been temporarily replaced by another unit while awaiting parts for the original compressor. The calibration of the receiver after all maintenance was completed showed that sensitivity was as good as it had been in the past. The output of the amplifier was slightly improved over previous calibrations and the maximum output of the discriminator section was about normal (9.7 volts). The new type BH-6 lamps for the projector seem to vary only slightly in intensity and are providing good lamp life, but if they are turned off for any reason, they always crack.

In comparing the records of the slant visibility meter when the beam of the projector is horizontal with the transmission readings obtained from a 500-foot baseline transmissometer, the correlation was frequently found to be very poor, possibly because of nonuniformity of atmospheric conditions in a horizontal plane. To assist in evaluating results, a transmissometer with a 60-foot baseline was installed across the slant visibility projector beam in the vicinity of the place the detector views this beam. This transmissometer measures the transmission involved at the intersection of the lines of sight from the two units. This is an important factor in determining the scattering function. A 60-foot baseline was selected in order to keep the light source and receiver of the transmissometer out of the beam of the projector and out of the field of view of the detector of the slant visibility meter. This transmissometer has been operating very satisfactorily although in fog conditions there is often a great difference in equivalent transmission values from the two transmissometers. The lowest transmission value recorded by this transmissometer was 0.17, which corresponds to a 500-foot-base transmission of 4×10^{-7} and a nighttime visibility of approximately 290 feet.

After completion of the maintenance and calibration of the slant visibility meter, there was very little weather suitable for making comparative slant visibility observations to use in evaluating the information obtained from the installation. Approximately one hour is required to raise the tower and to prepare for observations. The tower cannot be left in the fully extended position because it is an obstruction to air traffic. The observations that have been obtained show that usually the light or target at 20 feet above the horizontal has a visual range of one hundred to several hundred feet greater than that for the light or target at 100 feet above the horizontal, although in some conditions the upper light or target may have the greater visual range. Observations were obtained for four different times of testing, but usually the fog periods have been of very short duration.

Transmissometer. See "Slant Visibility Meter" above for a description of the use of a 60-foot baseline transmissometer.

Transmissometer Manual. Transmissometer Manuals T.O. 31MI-2GMQ10-61 and T.O. 31MI-2GMQ10-63 were checked against NBS Report 2588 (Revised). Twenty-four paragraphs of this report could not be located in the new Manual. During the process of comparison, some incorrect statements were found.

Shipboard Visibility Meter. A dual-differential log-output electrometer has been purchased for study to determine its suitability as an output indicator for the shipboard visibility meter. The study made by the Naval Research Laboratory indicates that the logarithm of the visibility is proportional to the logarithm of the back-scattered flux. Since the back-scattered flux is in turn proportional to the output of the light source, the most desirable readout is the logarithm of the ratio of the back-scattered flux to the output of the light source. The electrometer, by indicating the difference between the logarithms of two inputs, gives the desired readout. Checks of the electrometer indicate that although it is not as stable as is desired, it is sufficiently stable for the purpose.

The Effect of High-Intensity Airfield Lighting on Background Luminance and Horizontal Illumination. A paper titled "Fog Brightnesses Produced by Runway and Approach Lights" was presented at the Spring Technical Conference of the Aviation Committee of the Illuminating Engineering Society by Mr. Simeroth. The background brightness and horizontal illumination values reported in this paper as being produced by the lighting systems are essentially those given in earlier Progress Reports. Data on the back-scatter of light from the runway lights and from the centerrow approach lights at rated intensity as measured from the threshold of runway 31 looking into the approach zone are as follows.

	Centerrow Approach Lights		Type M-2 Runway Lights	
Visibility Interval (miles)	Average Visibility (miles)	Background Luminance (ft-l.)	Average Visibility (miles)	Background Luminance (ft-l.)
Over 5	5.3	0.22	6.1	.0078
2 - 5	3.6	0.53	4.0	.015
1 - 2	1.5	0.56	-	-
1/2 - 1	-	-	0.85	.013
1/4 - 1/2	0.35	1.1	0.39	.025
3/16 - 1/4	0.22	1.1	0.21	.020
1/8 - 3/16	0.16	1.2	0.15	.015
Below 1/8	-	-	-	-

From the position of the measurements, the runway lights were behind the observer and the approach lights were in front of the observer. The measurements were corrected for the ambient brightnesses.

Analysis of the horizon luminance data shows how the increase in horizon luminance affects the change in effectiveness of illuminance from a single light source in a system as the intensity of the system is changed because of the change in the adaptation level of the observer. Assuming an average nighttime visibility of one-half mile, the horizon brightnesses produced and the relative effective

illuminance resulting are as follows.

Intensity Setting	Runway Lights		Slopeline Lights		Centerrow Lights	
	Brightness Produced (ft-l.)	Relative Effective Illuminance	Brightness Produced (ft-l.)	Relative Effective Illuminance	Brightness Produced (ft-l.)	Relative Effective Illuminance
Step 1	0.0006	1	0.006	1	0.08	1
Step 2	0.003	5	0.03	4	0.4	2
Step 3	0.015	20	0.15	8	2.	3
Step 4	0.08	60	0.8	15	10	4
Step 5	0.4	120	4	20	50	5

(Relative effective illuminance is $I_n/E_n \times E_1/I_1$ where I_n and E_n are the intensity and threshold illuminance applicable to brightness step "n" and E_1 and I_1 are the intensity and threshold illuminance applicable to brightness step "1".

The results indicate the limitations on the use of excessive intensities and beamspreads of lights for improving visual guidance at night.

III. DEVELOPMENT OF AIRFIELD LIGHTING AND MARKING COMPONENTS

Runway Turnoff Indicators. Some preliminary plans for test installations for lighting taxiway turnoffs have been prepared and the equipment required has been obtained. Several of the local pilots have been interviewed for suggestions on effective methods of lighting these turnoffs. The use of three runway lights along each edge of the taxiway has some merit, but does not provide adequate guidance until the aircraft is nearly aligned with the taxiway. The use of three closely spaced runway lights on each side of the taxiway, but in line with the edge of the runway, is of very little benefit. Present plans are to test the use of closely spaced type M-1 taxiway lights to determine the guidance they can provide. The installation will be made and the evaluation started early in the next period.

Taxiway Lighting and Marking. Further work on the proposed Miramar installation is awaiting instructions from the Navy Department. An informal meeting of the IES Taxiway Lighting Subcommittee was attended during the Spring Technical Conference on Aviation Lighting. The Subcommittee proposed that FAA should investigate the benefit of shielding taxiway lights, that FAA should review existing National Standards now and at least every three years hereafter. The Subcommittee will further investigate maintenance problems.

Tests of 24-Inch Beacon. A report has been issued giving the results of photometric tests of a 24-inch airport beacon. (NBS Test Report 21P-6/61) Results of this test were summarized in the previous progress report.

Lamps for Two-Color Visual Glide-Slope Indicators. Further study is being made of the effects of lamp characteristics upon the performance of a two-color visual glide-slope indicator. A total of 16 developmental 300-watt, 6.6-ampere, PAR-64 lamps were obtained from two manufacturers. A VGSI simulator was developed to overcome the lack of fine adjustment of the "breadboard" model previously used. The lamps were photometered in the simulator without the spread lens, with the spread lens but without a transition bar, and with the lens and transition bar.

Data taken with several of the lamps showed that the positioning device used to align the lamps with regard to the slot in the simulator was satisfactory in insuring maximum luminous flux through the slot of the simulator. The results were published in NBS Test Reports 21P-31/61 and 21P-36/61, covering the two groups of lamps. A rough draft was prepared of NBS Report 21P-37/61 covering alignment procedures and inspection criteria for lamps designed for the VGSI.

NBS Test Report 21P-8/61 was issued including data obtained from three 200-watt, 6.6-ampere, PAR-64 lamps and comparison was made with data previously published (NBS Test Report 21P-13/60) covering 300-watt, 20-ampere, PAR-64 lamps. The 300-watt lamps showed significantly greater peak intensities than the 200-watt lamps.

Flasher for Optical Landing System. A motor-driven flasher has been assembled to replace the present thermal flasher in the land-based, portable optical landing system. A 60 rpm motor was used, giving a flash rate of 60 flashes per minute with 50% on time, or, by changing to a double cam, a flash rate of 120 flashes per minute with 50% on time. The flasher was delivered to the Marine Corps Equipment Development Center, Quantico, Maryland, for use in their test program.

Transformers for "Wheels Warning" Lights. A test has been made of a prototype transformer manufactured by Elastimold Division of Elastic Stop Nut Corporation of America for "Wheels Warning" service. The transformer has a 2400-volt primary and a 180-volt secondary winding and is designed for the intermittent duty expected in service. The test consisted of a check, under simulated service conditions, of the flash characteristics of the lamp load to determine if the impedance of the transformer was sufficiently low to permit the required inrush current of the lamp.

Memo reports describing the results of tests of this transformer and the transformer produced by the General Electric Company (tested

last quarter) have been prepared and forwarded. The data contained in these reports should be useful in the preparation of a specification for transformers for "wheels warning" service. Although neither transformer produced intensities as high as those produced by the NBS "breadboard" arrangement, both transformers are considered satisfactory.

IV. DEVELOPMENT OF SEADROME LIGHTING COMPONENTS

Electrical Characteristics of Static Inverters for Battery-Operated Fluorescent Seadrome Lights. A report has been issued evaluating the use of a static inverter and 12-volt battery as the power pack for the type FMF-6B buoy-mounted 6-watt fluorescent channel marker light. The static inverter appears satisfactory for this use and would produce higher intensity, greater efficiency, longer battery life, and reduced cost than the present 90-volt power pack. A photoelectric switch could easily be employed in lights using these inverters since the battery voltage would be suitable.

It is also suggested that consideration be given to changing the specification for the FMF-6B light to substitute a power supply employing a 12-volt dry battery and a static inverter for the present 90-volt pack.

V. DEVELOPMENT OF CARRIER LIGHTING AIDS (TED RSSH-32001)

Helicopter Angle-of-Approach System for Carrier. Components for a three-color helicopter angle-of-approach system for carrier use were shipped to the Naval Air Material Center at Philadelphia. Material shipped included four carrier-aircraft approach lights equipped with redesigned filters and larger lamps. These lights consist of a 32-candlepower lamp mounted inside a metal housing with a plastic filter on one end. The filter is of three sections arranged vertically with red at the bottom, green in the center, and yellow at the top. Filters to provide widths of the green sectors of 3° and 6° were supplied.

The color visible to the pilot is determined by his position with respect to the glide slope, which changes the section of the filter through which the lamp filament is observed.

These three units are to be mounted on a stabilized revolving platform which will produce a flashing effect from the lights.

Off-Glide-Path Indicator. The two experimental Hi/Lo cells of an Off-Glide-Path Indicator designed and constructed by Burroughs Corporation have been received and were added to the indicator assembly of a Fresnel Lens Optical Landing System. The purpose of the work was to determine the feasibility of adding these cells to the indicator assembly and to provide an indicator which could be used in testing the effectiveness of the Off-Glide-Path Indicator.

These units are designed to give the pilot information above and below the region covered by the indicator of the system by projecting coded beams of white light above and below the beam of the indicator. The units were mounted above and below the cells of the indicator assembly on a framework clamped to the frame of the indicator assembly.

Lights for Carrier Deck Personnel. A purchase description, "Light Assembly, Goggle Mounted," prepared for use in the procurement of "eye-ball" lights, has been reproduced and a number of copies, sufficient for use in initial procurement, supplied to the Bureau of Naval Weapons. This document is based upon the lights designed at NBS and service tested on the USS Saratoga.

Intensity Distributions of a Flush Carrier-Deck Guide Light. Photometric tests were started on a flush carrier-deck light manufactured by the Oxford Corporation, Buffalo, New York. Preliminary analysis of the data indicated that the light did not meet the specification requirements, but that the prism might be adjusted to align the beam of the light so that the unit would meet the specifications.

Effective Intensity of a Warning Light. The effective intensity of a warning light manufactured by the Federal Sign and Signal Corporation was determined, to decide the suitability of this light for use as a homing light aboard aircraft carriers. The unit had an effective intensity of 5 kilocandles in the peak of the beam when producing 80 flashes per minute, and a beam spread of about 10 degrees to 50% of peak intensity.

VI. PHOTOMETRIC AND ELECTRICAL TESTS OF AIRFIELD AND SEADROME LIGHTING COMPONENTS.

Inspection Tests of Approach Light Lamps. NBS Test Report 21P-4/61 was issued describing photometric tests performed on three PAR-56 and three PAR-56/2 300-watt, 20-ampere approach light lamps, with a view to determining their compliance with FAA Drawings C-5407-1 and -2. The 16,000-isocandle curves of all PAR-56 lamps were slightly below specification requirements. The PAR-56/2 lamps met the specification requirements. All six lamps passed the life-test requirements of the specifications.

Intensity Distributions of a Semiflush-Mount Pancake Light. NBS Test Report 21P-43/61 was issued, giving the results of photometric tests made on a semiflush pancake light manufactured by Newport Electronics, Inc., Costa Mesa, California. The light was found to be deficient in intensity at the angles named in the specification, but the vertical intensity distributions indicated that the lamp was slightly

high in the light and that an adjustment of the lamp might bring the light into compliance with the requirements of the specification.

Intensity Distribution of Class B15 and Class B4 Semiflush Lights. NBS Test Report 21P-5/61 was issued covering the results of tests performed on two B4 and two B15 semiflush approach and runway lights manufactured by the Revere Electric Manufacturing Company, Chicago. None of the four units tested met the requirements of the specifications. The horizontal beam spreads at 7.5 kilocandles were low in 10 cases of the 16 measured. None of the units produced beams aligned within the ±1/2 degree tolerance of the positions specified.

Condenser-Discharge Approach Light. Intensity distributions were made of a type CD-1 condensor-discharge approach light manufactured by the General Electric Company, Hendersonville, North Carolina. The light met the requirements of Specification CAA-1106a. The results of the tests are reported in NBS Test Report 21P-29/61.

Temperature Rise of Semiflush Lights. Additional tests were made of the temperature rise of a 500-watt prismatic head light mounted on a base containing a 500-watt isolating transformer. The light was located in hot, dry soil. The United States Forest Service Office in Eureka, California, was requested to recommend a site in the Willow Creek area for making tests on these units. They suggested an open area near their new office north of Willow Creek where electricity, water, and police protection were available. This site was used.

The base was installed in a concrete slab similar to the one used at the Arcata Airport, with 6" encasement and a 30" x 30" top, 4" thick. The sun shone on the installation from about 9 a.m. to 5 p.m. daily. The free-air temperature ranged from 37°F to 95°F during the test. The soil was very dry. Aluminum foil was placed between the transformer and lamp and the transformer was laid on its side for the test.

The temperatures below the aluminum foil were slightly higher and the temperatures above the foil were considerably higher than those obtained in the tests made at the Arcata airport using aluminum foil in the same position.

Series-Isolating Transformers. A letter report giving the results of tests of 30/45-watt transformers has been released. Results of tests of these transformers are summarized in the Progress Report for January-March 1961.

Tests of Cable Connectors. Physical and electrical tests were performed on 20 connectors for airfield lighting cable manufactured by the Woodside Screw Machine Co., Inc. These connectors consisting of five samples of each of four types are the same types as those tested in NBS Tests 21P-16/60 and 21P-16/60 Supplementary. The present group of connectors was submitted for comparison tests in accordance with paragraph 4.3.2.3 of Specification MIL-C-7192B(Aer). These connectors were tested for conformance with the paragraphs of Specification MIL-C-7192B(Aer) and were found to fail to meet the specification requirements for Body and for Connecting and Disconnecting Forces. The results were given in a letter report.

Five tee receptacles for airfield lighting cable, manufactured by Clark Cable Corporation, were given physical and electrical tests in accordance with Specification MIL-C-7192B(Aer). These connectors are of the same type as those tested in NBS Test 21P-47/60, but have been redesigned to correct the deficiencies found in the previous test. The present connectors failed to meet several of the specification requirements. The results are reported in NBS Test 21P-47/60 Supplementary.

A memorandum report has been released reporting the results of insulation resistance and millivolt drop measurements of cable splices made with "Scotchcast" splicing kits. Four methods of cleaning the cable sheath were used. No failures in the bond between the cable sheath and the epoxy filler in any of the splices were observed during a nine-month period.

Splices in which the conductors were joined with "Stakon" connectors showed a lower millivolt drop than did those made with "Scotchlok" connectors. However, the voltage drops across the splices using "Scotchlok" connectors were lower than the maximum specified for cable connectors. No changes in the voltage drops across splices using either type connector were observed during a 12-month period.

Fading of Fluorescent Paints. Measurements were made of the fading of a panel submitted by Switzer Brothers Inc., coated with fluorescent "Fire Orange" enamel and a u.v. absorbing protective coat which had been exposed for 12 months in Florida. These measurements indicate a satisfactory service life in excess of a year. Additional panels are being obtained so that fading tests can be made on panels exposed in a variety of climates.

VII. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Specifications and Drawings. The technical sections of the following specifications and drawings were reviewed and the comments have been forwarded.

MIL-L-26202C, Light, Flush Approach, Runway, and Taxiway, General Requirements for

MIL-L-26311B and Amendment, Lighting System, Airport Approach, Condenser Discharge, Sequence Flashing, General Requirements For

MIL-L-8909, Light, Marker, Airport Approach, Centerline, High-Intensity, General Specifications for

MIL-L-19580A, Transformer, Brightness Control, Optical Landing System, 240V Primary, 7-1/2 KW, Type TO-1

MIL-C-22929, Cable, Electrical, Underwater, Seadrome Lighting

FAA BRD-L-3, Wire, Electrical, 600-Volt, Copper, Airport; Slot Installation

Drawings of Carrier Deck Markings

Survey Trip to Lemoore Naval Air Station. A trip was made to the 12th Naval District and to the new Lemoore Naval Air Station to make a survey of the airport lighting equipment installed there, to assist their Public Works and Operations personnel in procedures on maintaining and operating the visual landing aids, and to determine possible improvements to recommend for future installations. A detailed travel report of this survey was prepared because many of the features and discrepancies noted may be of general use in planning other future installations. Because of the length of this report, a special summary of the recommendations was also prepared.

Lamp-Out Monitor for VGSI. A study was made of the problems involved in the design of lamp-out monitors for Visual Glide Slope Indicator Systems. It was found that sensing the change in system current, either rms or average, or of the voltage across the regulator output terminals did not provide a suitable control but that the sensing of the change in the 3rd and higher harmonics of the current or voltage would provide a suitable signal for the monitor.

Minimum Lighting for Secondary Airports. At the request of the Human Factors Research Branch, Bureau of Research and Development, FAA, an analysis was made of the intensity distribution requirements of lights for small airports and a comparison was made of the merits of edge and centerline lights for these airports. The results of this analysis were reported in a memorandum report. The report recommended that the design of a lighting system for secondary airports

should be based on a study of the fundamental requirements for guidance that the system should provide, with consideration as to the characteristics of the aircraft using secondary airports and of the flight pattern of these aircraft during an approach and landing. Simple adaptation of the elements of the lighting system designed for major airports without due consideration to the fundamental requirements will result in a system unsatisfactory for the secondary airports.

Based on the analysis, the following priority for the installation of lighted visual landing aids at secondary airports was suggested as a general practice:

Priority I ..

Beacon
Circling Guidance and
Runway Edge Lights
Threshold Lights
Wind Indicator

Priority II

Taxiway Lights (if surfaced taxiways are provided)
Visual Glide Slope Indicator

Priority III

Approach Lights
Runway Centerline Lights

VIII. MISCELLANEOUS

Personnel. Jimmie C. Wilkerson entered on duty as an engineering aid on April 6 on a WAE basis. He was changed to full-time duty for the summer months and returned to a WAE status at the beginning of the Fall Semester.

Arcata Airport Installations. The Federal Aviation Agency has installed the strobe approach lights at the Arcata Airport. These lights are now in operation. Installation of the Visual Glide Slope Indicator is planned to start in October. Installation of the Runway Visual Range equipment is now scheduled for January 1962.

Operation "Pea Soup." The personnel from Aeronautical Icing Research Laboratory have returned to Arcata Airport for further test

work for the Air Force Cambridge Research Center during the coming fog season. They plan to continue the test work of last year. They will have special radar equipment for investigating atmospheric conditions, and will take atmospheric samples with rockets. They will be able to make available an instrument shelter for our use at the slant visibility meter test site. They will also have a Benson-Lehner Corporation Oscar Model E computer at Arcata for use in the reduction of data. This computer is equipped for automatic type-out and card punch. We can make use of this equipment if we desire.

Summary of NBS Reports on Visual Landing Aids. To make the results of NBS work in aviation ground lighting more readily available, a bibliography of the NBS reports written by the Aviation Ground Lighting group during the past fifteen years has been issued. A summary of each report is included in the bibliography. Test reports are not included.

Photometer Head. A photometer head consisting of a PJ-14B vacuum phototube in a light-tight box with a filter to provide a spectral response similar to the CIE standard observer luminosity function has been constructed and sent to FAA National Aviation Facilities Experimental Center at Atlantic City for use on the photometric range being constructed there. A detailed description of this unit and its application is given in NBS Report 5294.

U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics. Electrolysis and Metal Deposition.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Crystal Growth. Physical Properties. Constitution and Microstructure.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Solid State Physics. Electron Physics. Atomic Physics.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Molecular Kinetics. Mass Spectrometry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Interval Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

Radio Systems. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.


NBS