NATIONAL BUREAU OF STANDARDS REPORT

7147

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period January 1 to March 31, 1961

By
Photometry and Colorimetry Section
Metrology Division

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

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 work take the form of either actual equipment and devices or published papers. These papers appear 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.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($1.50), available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

NATIONAL BUREAU OF STANDARDS REPORT

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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
January 1 to March 31, 1961

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
January 1 to March 31, 1961

I. REPORTS ISSUED

Report No.	Title
7104	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period October 1 to December 31, 1960
Letter Report	Static Load Tests of "Pancake" Type Runway-Taxiway Light, January 23, 1961
Letter Report	Test of Fittings for Conformance to FAA Drawing No. C-5456, March 10, 1961
Letter Report	Intensity Distribution Measurements of a Flush/Frangible Flasher, February 27, 1961

II. VISIBILITY METERS AND THEIR APPLICATION

Shipboard Visibility Meter. The mechanical construction of the breadboard model of the shipboard visibility meter has been completed and the unit has been adjusted in the laboratory using an oscilloscope to read the output signal. When the preliminary laboratory tests are completed, an electronic recording circuit will be constructed and calibrated so that visibility readings can be read directly.

Slant Visibility Meter. No weather suitable for tests occurred during the quarter. The instrument is in standby status at its new location. (See Progress Report for the previous quarter.)

Transmissometer.

Expanded Scale Indicator. Rechecks of the calibration of two modified indicators have been completed. A report describing the modification and giving the results of calibration checks has been started.

Transmissometer Technical Order. A review is being made of the recently issued Technical Order. A number of statements have been found which should be corrected or changed either by amendment or in the next issue.

The Effect of High-Intensity Airfield Lighting on Background Luminance and Horizontal Illumination. Additional data on the effect of runway edge lights and centerrow approach lights on horizon brightness were obtained from positions near the runway threshold. These data are to be used as a measure of the amount of back scatter light from each system. The data reported earlier were primarily from forward scatter light. The amount of back-scatter light increases as visibility decreases down to about two miles visibility, remains fairly constant for visibilities between one-fourth and two miles, and decreases again as visibility drops below one-fourth mile. The back scatter of light from the center-row approach lights in a direction approximately two degrees above the horizon directly over the lights gives a maximum background brightness of one footlambert or more. The back scatter of light from the runway lights when measured in the same direction as for the approach lights gives a maximum value of over 0.02 footlambert. Since the brightness varies appreciably with the direction of view from a given position, the effect of this increase in background brightness on the ability of pilots to see and use the lights can not be determined without further investigation. A report giving the results of the measurements to date should be issued during the next quarter. A paper is being prepared reporting the results of these measurements and analyzing the effects of this increase in background brightness on the performance of airfield lighting sys-tems. The paper is to be presented at the next meeting of the Aviation Committee of the Illuminating Engineering Society.

III. DEVELOPMENT OF AIRFIELD LIGHTING AND MARKING COMPONENTS

Airfield Lighting Maintenance Manual. Most of the preliminary draft of Section II, Preventive Maintenance and Repair, has been completed. Considerable revision and reduction in size are needed. Much of the data for Section I, Theory and Description of Airfield Lighting Systems and Equipment, has been accumulated. Besides the information needed for the Manual, a considerable amount of addition-al information has been gathered and will be tabulated and issued for the benefit of other interested groups.

Runway Turnoff Indicator. - Several favorable comments have been received at Arcata from local pilots on the installation of several closely spaced runway lights on each side of the turnoff onto the taxiway. One turnoff has three runway lights on each side of the taxiway in line with the row of runway lights and spaced at 10-foot intervals. Another turnoff was marked by using three runway lights along the edge of the taxiway spaced at 10-foot intervals with beams of these lights alined along the runway and these lights are energized from the runway light circuit. The higher intensity

and close spacing seem to be of appreciable benefit in marking the turnoffs, but which arrangement is more suitable is still in doubt. Further tests are planned for the next quarter.

Tests of 24-Inch Beacon. Photometric tests have been completed on a 24-inch airport beacon manufactured by Westinghouse Electric Corporation. The beacon was tested with both 1000-watt C-13 and 1200-watt CC-8 lamps with T-20 bulbs. The effects of removing the auxiliary reflector of the unit to make room for a 1200-watt lamp with a T-24 bulb were also studied. An attempt was also made to raise the beam by lowering the lamp table of the lamp changer of the beacon. (This beacon has a swivel type lamp changer; the procedure outlined in Technical Memorandum No. WCLE-TM-57-12 can not be used to adjust the beam elevation.) When used with the 1200-watt lamp and the auxiliary reflector, the unit would have a peak effective intensity of 100 kilocandles when the spread lens was used and about 270 kilocandles when no cover glass was used. The vertical beam spread with the 1200-watt lamp was, of course, much greater than with the 1000-watt lamp. The beam elevation was at 10° vertical. Removing the auxiliary reflector reduced the with-lens value about 15% and the without-lens value about 5%. Lowering the lamp table of the lamp changer in order to raise the beam was considered unsatisfactory in the field because it would then be necessary to refocus the unit in the field. The report should be issued shortly.

Transformers for "Wheels Warning" Lights. A test has been made of a prototype transformer manufactured by the General Electric Company 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. The transformer appears to be satisfactory.

Lamps for Two-Color Visual Glide-Slope Indicators. A study is being made of the effects of lamp characteristics upon the performance of a two-color visual glide slope indicator. Intensity distribution data for three 200-watt, 6.6-ampere, PAR-64 lamps were obtained. The lamps are experimental models designed for use in the indicator. Data were obtained for the bare lamps and for the lamps in conjunction with a "breadboard" model of the indicator. A prototype model of a device was made for positioning the lamps in the indicators to obtain maximum light output. Additional data were taken with three 300-watt, 20-ampere, PAR-64 lamps (previously reported in NBS Test 21P-13/60) for comparison with the data taken using the 200-watt lamps.

Taxiway Lighting and Marking. The IES Taxiway Lighting Subcommittee met at the National Bureau of Standards on February 17, 1961. Mr. Wall substituted for Mr. Simeroth and acted as secretary for the session. The members of the committee agreed that its first task was to organize the work of previous taxiway committee and other groups with a view to determining which problem areas are still extant. Many of the problems involved in the operation of large airports were reviewed. Each member was assigned one or more reports to be summarized and presented at the next committee meeting. As the NBS part of this task, the "Dunlap and Associates report on Taxiway Lighting, Routing and Destination Marking System for Airfields", and the material on taxiway lighting in the Landing Aid Experiment Station's "1949 Final Report" have been reviewed and detailed summaries prepared.

Further work on the proposed Miramar installation is awaiting instructions from the Navy Department.

A report on the legibility range of the taxiway guidance sign which has been under test is planned for the next quarter. The maximum range in VFR conditions day or night is approximately 700 feet and is about 400 feet in one-eighth mile visibility at night.

Output Maintenance of Sealed-Reflector Approach- and Runway-Light Lamps. Analysis of the periodic measurements of relative output of 20-ampere approach-light lamps is nearly complete. Curves have been drawn showing the decrease in output with burning time both for the complete lamps and for selected zones of the lamps for both vertical and horizontal positions of the seating plane. Similar measurements of 6.6-ampere approach-light lamps have been started.

Minimum Lighting for Secondary Airports. At the request of the FAA Bureau of Research and Development, an analysis is being made of the intensity distribution requirements of lights for small airports.

Intensity Control for Shore-Based Mirror Landing Systems. Consideration has been given to the problem of balancing the intensity of the "meat-ball" and the datum lights of the shore-based mirror landing system. A single intensity control is used to vary the voltage applied to both the source lights for the "meat-ball" and the datum lights. If the intensities are balanced when the system is at full intensity, the intensity of the "meat-ball" will be about twice the intensity of the datum lights when the lights are operated at the lowest intensity setting primarily because the transmittance of the green filters decreases and the transmittance of the yellow filters increases as the temperature of the lamp filaments is decreased. A simple method of counteracting this effect and balancing the intensities of the "meat-ball" and the datum lights at pilot request is to change the number of source lights which are burned. With suitable

circuitry it is possible to select four different numbers of source-light lamps to be lighted by means of two additional control wires and one double- and one single-pole relay. The procedure outlined above will be satisfactory only if, when the system is operated at full intensity, the intensity of the "meat-ball" when all source light lamps are lighted is more than the intensity of the datum lights.

IV. DEVELOPMENT OF SEADROME LIGHTING COMPONENTS

Static Inverters for Battery Operated Seadrome Lights. Life tests of a 12-volt dry cell power pack used with 2 static inverters to operate a 6-watt fluorescent lamp have been completed. These results will be issued as part of a general report on static inverters. The tests show that use of the static inverters with 12-volt batteries instead of the present 90-volt dry cell pack would result in increased battery life, light output, and efficiency, and would permit the incorporation of a photoelectric switch in the seadrome light which would not be possible with the 90-volt pack.

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

Lights for Carrier Deck Personnel. A purchase description, "Light Assembly, Goggle Mounted" has been prepared for use in the procurement of "eye-ball" lights. This document is based upon the lights designed at NBS and service tested on the USS Saratoga.

VI. PHOTOMETRIC AND ELECTRICAL TESTS OF AIRFIELD AND SEADROME LIGHTING COMPONENTS (TED-SI-5003)

Inspection Tests of Approach-Light Lamps. Intensity distribution data were obtained for three PAR-56 and three PAR-56/2 300-watt, 20-ampere approach-light lamps to determine their conformance to the specifications of 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 Distribution of Class B-15 and Class B-4 Semiflush Lights. Photometric tests were started on two Class B-15 and two Class B-4 1-inch projection semiflush runway lights manufactured by the Revere Electric Mfg. Co. Intensity distributions were made of each unit when it was lamped with a 200-watt lamp to determine conformance to the photometric requirements of MIL-L-26202B. A preliminary analysis of the data indicates that the units do not comply with either the beam elevation requirements of the specifications or the intensity requirements.

Series-Isolating Transformer. Twelve 30/45 watt, 6.6-ampere series isolating transformers of the type which had given trouble at Brown Field and Cecil Field were received from NSD Clearfield and tested. All twelve met the requirements of Specificiation MIL-T-7641 as regards primary-to-ground insulation resistance (1000 megohms). Of the first group (6), one transformer failed with 10,000 volts applied after an accelerated high temperature cycling test. The second group (6) was baked for five days and given a weekend soak. All then showed more than 1000 megohm primary-to-ground when a voltage of 10,000 volts was applied. One broke down just above 10,000 volts and another at 11,000. The insulation resistances after breakdown were in the range 100 to 600 megohms.

Test of Cable Connectors. Measurements made on the buried connectors after the winter rains show that there has been no appreciable change in the leakage current of these connectors. The leakage current increased somewhat for nine of the connectors and there was a decrease in leakage current for the other six connectors.

Four of the test connectors have 2400V a.c. applied continuously to them. This is accomplished by using a 100va, 2400/120-volt switchboard transformer. A 100-watt lamp is connected between the power source and the 120-volt primary of the transformer as a current-limiting device should there be a failure in one of the connectors.

Temperature Rise of Prismatic Head Lights. To date four tests have been made of the temperature rise of a 500-watt prismatic head light mounted on a base containing a 500-watt isolating-transformer. The data from test four has not been fully checked. From the preliminary check all tests show similar trends of temperature rise. Tests 2 and 3 were made while the soil was wet and ambient temperatures at night were near and below freezing. Test 1 was made while the soil was dry and ambient temperatures were in the 40° to 50° F range at night. Test 4 was made when no precipitation occurred and when the ambient temperature at night was in the upper 30°F's. Tests 1, 2, and 4 were made with the transformer in the upright position. In test 2, two thicknesses of aluminum foil were placed between the lamp and transformer, and test 3 was made with the transformer placed on its side.

Further tests are planned in an area where the ambient temperature is much higher than in the current tests. The results of the present tests will be reported in the near future, while the results of planned tests will be reported upon their completion.

It appears from the tests to date that placing the transformer on its side and keeping all transformer leads below the lamp level prevents charring of the leads, and that the insulation of the secondary lead to the lamp should be made of material to withstand high (500°F) temperature and should be covered with fiber glass. The transformer used in the first test was the only one that opened at the seams, and one of the three transformers has been used for tests 3 and 4. The use of aluminum foil between the lamp assembly and transformer helps retain the heat in the upper portion of the base assembly, thereby affording some additional protection to the transformer.

Qualification Test of Fittings. Several sealing bushing fittings manufactured by the Spring City Electrical Manufacturing Company were tested for conformance to FAA Drawing No. C-5456.

Static Load Test of "Pancake" Light. A pancake light manufactured by Sylvania Electric Products, Inc. was subjected to a static load test by slowly applying a load of 20,000 pounds through a rubber block without failure.

Photometry of Flush/Frangible Approach Lights. At the request of the Visual Aids Section, FAA, check intensity distribution measurements were made of a flush/frangible condenser-discharge approach light manufactured by the General Electric Company and of a similar light manufactured by Sylvania Electric Products, Inc. The purpose of these measurements was to assist the manufacturers in checking their photometric procedures.

VII. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

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

MIL-L-26202C(ASG). Light, Flush Approach, Runway, and Taxiway, General Requirements for

MS 27033(ASG). Light, Marker, Airport Runways - Flush

The following specifications have been reviewed and comments will either be forwarded later or given informally.

Draft Specification. Light, Flood, Night Vision (Land Based Installations Only)

MIL-L-22277(Wep) (Amendment 3). Landing System, Optical, Portable

MIL-L-22232A(Wep). Sealane Marker Light, Cable Connected, Buoy Mounted

MIL-W-22654(Wep). Wand, Taxi Guidance

MIL-L-19661A(ASG). Light, Marker, Portable, Emergency, Airfield, Battery Operated

Lamp Tabulation. The tabulation of lamps used in Navy airfield lighting service has been reviewed and a number of changes reflecting current usage have been recommended.

VIII. MISCELLANEOUS

Arcata Airport Installations. The Federal Aviation Agency is preparing to add condenser discharge lights to the center row approach-light system. This work is scheduled for completion early this summer. Assistance was given to F.A.A. regional personnel in the location and routing of underground ducts and cables on the field to be used in conjunction with the installation of this system. The F.A.A. has been attempting to correct errors in the glidepath signal of the instrument landing system. The temporary installation in the approach zone of two sets of baffles made from chicken wire appears to have eliminated much of the difficulty. A permanent installation will be made soon. Previous work in correcting the glide path errors by the Landing Aid Experiment Station and the C.A.A. by means of an artificial ground plane installation were described to F.A.A. Regional Electronics personnel.

Operation "Pea Soup." The group from Aeronautical Icing Research plans to return to Arcata Airport in June for further test work for the Air Force Cambridge Research Center.

Personnel. The Entrance on Duty forms for Mr. Jimmie C. Wilkerson, engineering aid, have been received. He will report for duty soon on a "while actually employed" basis and this will help to alleviate our shortage of personnel.

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 ten years is being prepared. A summary of

each report is included in the bibliography. Test reports are not being included.

Check of Spectral Response of Vacuum-Phototube Photometers. A recheck has been made of the accuracy of the spectral correction of the photometers used in the photometry of flashing and of low intensity lights and in measurement of sky brightness. The results were very satisfactory, indicating that no significant errors result from the effects of differences in the color temperature of the sources photometered.

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. Analytical Chemistry. Inorganic Chemistry.

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.

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.

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

Atomic Physics. Spectroscopy. Radiometry. 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. Molecular Structure and Radiation Chemistry.

• Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

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. Space Telecommunications.

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


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