NATIONAL BUREAU OF STANDARDS REPORT

5305

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period January 1 to March 31, 1957

By
Photometry and Colorimetry Section
Optics and 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. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published 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 monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

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 ($0.75), available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Inquiries regarding the Bureau's reports should be addressed to the Office of Technical Information, National Bureau of Standards, 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 Installations Division
Bureau of Aeronautics
Department of the Navy
Washington 25, D. C.

For the Period
January 1 to March 31, 1957

For
Bureau of Aeronautics Projects

TED No. NBS-AE-10002
TED No. NBS-AE-10011

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids

January 1 to March 31, 1957

I. REPORTS ISSUED

Report No.	Title
5102	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period October 1 to December 31, 1956.
5138	Design of Cable-Fed Buoy Light.
5208	A Study of RM-42R Cells.
21N-1/57	Design Approval Tests of a Landing Signal Officer Lighted Suit Equipment.
21P-20/56	Intensity Distribution Measurements of a Condenser-Discharge Approach Light, Type CD-2.
21P-21/56	Intensity Distribution Measurements of an Experimental Condenser-Discharge Approach Light, Type CD-1.
21P-5/57	Report on the 45°, 0° Directional Reflectance and Chromaticity of Five Non-Skid Deck-Surfacing Materials.
21P-6/57	Intensity Distribution Measurements of a Condenser-Discharge Approach Light, Type CD-1.
Letter Report	Approach-Angle Light Assembly (March 26, 1957).

II. RESEARCH AND DEVELOPMENT, LABORATORY TESTING, AND CONSULTATION SERVICES IN CONNECTION WITH VISIBILITY, AIRFIELD LIGHTING, AND FOG MODIFICATION PROBLEMS (TED NBS-AE-10002).

a. Visibility Meters and Their Application.

Arrangements have been made for service testing of an experimental transmissometer calibrator by Mr. R. A. Halverson, Supervising

Electronics Technician, Weather Bureau 4th Region. This instrument is designed to permit accurate adjustment of the 100% setting of the transmissometer by direct measurements of the transmission. Since no estimate of the prevailing visibility is required, the calibrator can be used when the visibility is restricted and when no satisfactory visibility marks are available.

Mr. Halverson visited the Field Laboratory at Arcata where the principles of operation and calibration of the instrument were demonstrated. This instrument and the calibration procedure have been extensively field tested by the Field Laboratory and the modifications indicated by these tests have been made. Recent tests indicate that many photocells now being obtained are more linear than those which were considered in the design of the instrument. Therefore, the range of the linearity (calibration) adjustment of the instrument should either be increased or shifted to accommodate these cells. Reports describing the instrument and outlining the theory of its operation, giving the results of field tests and operating instructions, are being prepared.

Tests have been made of recent type WL-759 tubes. These tests indicate a substantial improvement over the tubes obtained one and two years ago. A group of Continental type CE-75 phototubes is being procured for service tests.

b. Airfield Lighting and Marking.

Photometry of Condenser-Discharge Lights. Measurements of the effective intensity distributions of a number of condenser-discharge lights have been completed and reported. NBS Test Reports 21P-20/56 and 21P-6/57 give the results of tests of lights now being installed in civil approach light systems. NBS Test Report 21P-21/56 gives the results of tests of a number of experimental lamp-reflector combinations for an approach light unit. The results of this test emphasize the difficulty of increasing the width of the main beam of a light by changes in the position of the lamp relative to the focus of the reflector or by small changes in the finish of the reflector. The peak effective intensities of all lights tested were in the 10,000- to 30,000-candle range.

The effective intensity distribution measurements were made automatically, using a photometric system developed for this purpose.

A description of the system is included in test reports 21P-20/56 and 21P-21/56. A formal report describing this system will be issued so that it can be used as a reference in specifications of test methods of flashing lights.

Materials for Marking Runways. An impact-adhesion test of runway marking materials has been decided upon, using a drop-hammer machine that will strike the surface of the test material at an angle of 45 degrees. Twenty-eight concrete blocks, 9" x 6" x 6", have been cast on which to mount specimens of Nefslabs and Crystalex specimens. The Crystalex specimens are being prepared by the Southern Crystalex Corporation; the Nefslabs specimens will be prepared in accord with the manufacturer's instructions.

Temperature cycling tests have been performed on three specimens of each of the five materials under test (Nefslabs, Crystalex, traffic paint, masonry paint, and heat-resistant paint. These tests are in accord with Federal Specification LP406b, Method 6011. At 80°C the Crystalex specimen softened and some flow-off occurred in vertically mounted specimens. The Crystalex specimens yellowed appreciably and the traffic paint specimens yellowed slightly; the others show no appreciable color change.

Visual Landing Aids Panel. The meetings of the ICAO Visual Landing Aids Panel, held in London from January 5 to 20, were attended. The data and papers made available as a result of these meetings have been reviewed. The results of the meetings may be summarized briefly, as follows: The emphasis was primarily on visual aids for use in good and in moderately restricted visibility. None of the findings or recommendations of the Panel are in conflict with those of NBS Report 4741. The U. S. Delegation was able to execute and defend the U. S. position in every respect.

Vision Committee Working Group. The Working Group of the Vision Committee appointed to act as advisor for the test program being conducted at Andrews Air Force Base met on February 15 and 16. Movies of flights in visibilities of about 1/4 mile were shown and flight demonstrations in clear weather were conducted. The appearance of the "minimum lighting system" developed at the London meeting was of particular interest. The 1000-foot wing bars and the T's formed by the threshold and runway lights gave fair elevation guidance and good ground plane definition from distances as great as three miles.

The red "pre-threshold" bar added to the definition of the threshold. Under the conditions of observation the red wing bars appeared to contribute very little to the system.

Heliport Lighting. An assembly of three approach-angle lights to be used for field tests was made and delivered to the Bureau of Aeronautics. One of these lights was modified to give an increased vertical angle for the green sector with a reduced vertical angle for the yellow sector, and one of the standard lights was directed slightly upward. A thermoflasher was included in the assembly and switches were so connected that it was possible to alternate either the two standard lights or one of the standard lights and the broad-angle light. It was also possible to operate either a standard light or the broad-angle light with a fixed characteristic. The assembly therefore made it possible to test several different signal arrangements, each of which should give the pilot more information than he can obtain from a single light. This assignment was closed with a letter report under date of March 26.

Life tests have been made with mercury primary cells at room temperature and at lower temperatures. These tests included three different discharge rates and indicated clearly that the mercury cells will not be satisfactory in any operation in which it is necessary that the battery itself be exposed for a considerable period to low temperatures. It was found that shelf life has relatively little effect on the voltage or ampere-hour capacity of these cells. Freezing temperatures, however, reduce the ampere hours obtainable from them to less than 3 percent of their capacity at room temperature. This assignment was closed with NBS Report 5208.

c. Seadrome Lighting.

Sea-Lane Marker Lights. An order has been placed with the A'G'A Division of Elastic Stop Nut Corporation of America for the 60 cable-fed buoy-mounted sea-lane marker lights being procured for service testing. It is our understanding that these lights will use the same metal parts as those used in the MB-1 over-run lights and will have a cylindrical fresnel lens. Quotations have been requested for the lamps for these lights but have not been obtained, as some details of the lamp design have not been determined.

A report on the work done on the design of a cable-fed seadrome light was prepared. Although a substantial effort was made to develop a better design for seadrome light buoys, the results were largely negative. It appears that some slight improvement may be possible through following one of several suggestions included in the report. NBS Report 5138 completed this assignment.

Approach Light Lamps. Quotations have been requested for the 500-watt, 20-ampere, PAR 56 approach light lamps, but have not been received. These lamps will be similar to those described in NBS Test Report 21P-4/56. The manufacturer states that bulb blackening will be rather rapid in these lamps because of their power consumption and that the intensity is expected to depreciate to 70% of initial intensity in less than the 100-hour rated life.

Corner Identification Lights. An improved method of operating the identification lights has been devised. The induction motor is replaced with a series motor. This motor is supplied through a small transformer connected in series with the lamps so that only a single isolating transformer is required. Although a series motor is not a constant speed motor, the changes in speed are small when the motor is operated in series with the lamps. This method eliminates the starting problems encountered when an induction motor was used. It also eliminates the need for using the two 200-watt isolating transformers which were required to operate the induction motor. Parts for converting the four identification lights to this method of drive have been ordered.

Seadrome lighting Circuits. The high-intensity seadrome lighting system drawings prepared by the Naval Air Engineering Facility (SI) have been reviewed by NBS personnel of the Field Laboratory and of the Washington Laboratory. Their comments and suggestions have been transmitted informally. The principal recommendation was a modification of the circuitry for dropping load when the system is switched over to a standby generator, so that the channel lights, etc., if at step 4 or 5, will not be turned out, but will be operated at a lower intensity setting.

d. Carrier Lighting and Marking.

Carrier Marking. Measurements have been made of the 45°, 0° directional reflectance of five non-skid deck surfacing materials. The results of these measurements are given in NBS Test Report 21P-5/57. These tests indicate that neither the yellow nor the red materials are as saturated as desired.

e. Lights for Carrier Deck Personnel.

The preproduction set of LSO lighted suit equipment has been tested and a report issued (NBS Test 21N-1/57). Changes in the design, based on the results of the test, have been made, and production is expected to get under way immediately. The initial production equipment will be sent to the National Bureau of Standards for confirming evaluation.

A model taxi-guidance light set has been designed and constructed, and appears satisfactory. Twelve sets will now be fabricated, based on the original design, and will be evaluated in fleet operations.

f. General Laboratory and Consultive Services.

Color Standards. A redraft of Part 1 of the U. S. Standard for Colors of Signal Lights has been completed but has not yet been circulated to the committee. A considerable start has been made on preparing a first draft of Part 2 of the Standard.

Cable Test - Detecting Set. The sensitivity of the amplifier-indicator of the preproduction set became so low that the Set was inoperative during use at the Field Laboratory. As with the other sets which have become inoperative, the fault was failure in the 20-mfd., 25-volt electrolytic capacitors in the indicator.

g. Personnel.

Mr. Edward G. Sharp, GS-3, Physical Science Aid (Physics), entered on duty March 18, 1957. The employment of Mr. Sharp will alleviate the shortage of personnel assigned to this project. However, the shortage is still critical.

III. VISIBILITY AND BRIGHTNESS TESTS, SURVEYS, EVALUATION AND ANALYSIS OF VISUAL LANDING AIDS, BASIC TESTS AND EQUIPMENT, AS A FIELD SERVICE AT ARCATA, CALIFORNIA (TED NBS-AE-10011).

a. Airport Lighting and Marking.

Approach Beacons. New turntables have been fabricated and installed on the approach beacons located 1500 and 2500 feet from the threshold. (An additional beacon is located 500 feet from the threshold for use in tests of a stub system.) The new units use a one-half inch steel plate for a turntable with six stock PAR 56 approach light assemblies (stock number R17MUEL-D476MU) to mount the lamps. Favorable comments from pilots using the beacons continue. Reports indicate that under clear bright daylight conditions the approach beacons provide useful information at distances beyond the outer marker. The ILS localizer at Arcata is now out of service, and the airlines are using the approach beacons on low intensity (without the approach lights) for nighttime approaches in conditions of good visibility and fair ceilings. Pilots of local industrial utility aircraft request that the beacons be turned on for final approach alignment in marginal VFR conditions. Commercial airline pilots also request the beacons under most marginal conditions. In addition, they use the approach beacons in conjunction with the approach light system for IFR approaches. It appears that little additional useful information will be gained by more tests of the beacons at Arcata. Therefore, installation for service tests at Navy and Marine Air Stations is recommended. A report summarizing the development and tests of the approach beacons is being prepared.

Runway Distance Markers. Comparison of the performance of a distance marker with the background finished with fluorescent orange paint with one finished with ordinary international orange indicates that the distance at which the numeral becomes legible on the sign finished with the fluorescent paint is appreciably less than that of the standard marker. The fluorescent orange marker is conspicuous at greater distances, but the higher brightness of the background reduces the legibility distance. A quite different principle of indicating the distance remaining is also being checked. This distance marker consists of a sign three feet high by six feet wide with an international orange background and six-inch circular dots arranged much in the manner as the dots

on dominoes. The sign has been constructed so that the arrangement can be easily changed to represent numbers from one to fourteen. At night, when suitable lamps are obtained, the marker will not be floodlighted but a small lamp will be installed at the position of every dot and connected to a selector switch so that any figure may be readily selected. During daylight the legibility distance of the dot arrangement is somewhat less than that of the digit on a standard sign. Night observations will be made as soon as the lamps are received.

b. Electrical Engineering.

Survey Trip. Comments recorded during conferences on the recent survey trip have been typed and transmitted informally to the Bureau of Aeronautics. A summary of the data from the questionnaire used during the trip is being compiled in preparation of the report of the Visual Landing Aids Field Survey. In reviewing these comments it was noted that at Miramar the electricians stated that the primary power (high voltage, and airfield lighting feeder cables) passed through manholes in the high-speed fueling area. These manholes were collecting aviation fuel. This is a particularly dangerous condition since this accumulation of aviation fuel in the manholes could cause an explosion if a cable fault occurred which produced an arc in one of these manholes. Corrective action should be taken to remedy this condition and all future electrical manhole installations should have their ducts sealed against fuel intrusion.

Maintenance Manual. A number of minor revisions have been made in the sections of the Maintenance Manual which cover the troubleshooting of series circuits. These sections have been completed and prepared for reproduction. They include a detailed step-by-step troubleshooting procedure, a brief step-by-step procedure, a set of troubleshooting charts, and a section covering troubleshooting by symptoms.

These procedures are being issued as a separate report so that they can be made available for use without waiting for the other sections to be completed and so that the reaction of those who will use the manual can be obtained before the other sections are put in final form. The other sections will be issued as separate reports as they are completed.

Cable Tracing. As reported in Section II, the indicator of the preproduction Cable Test - Detecting Set became so insensitive because of defective capacitors that the set was inoperative. The performance was so poor that a fault with a resistance of 10 ohms to ground could not be located. It now appears that the occasional poor performance observed during the last year was caused by intermittent failures of these capacitors, although laboratory tests had shown no significant change in sensitivity and frequency response.

c. Research on Visibility and Visibility Measurements.

Effective Intensity of Flashing Lights and Composite Light Sources. The draft and figures of the report of Effective Intensity of Composite Lights have been completed and are now being edited and prepared for reproduction. Computations for the effective intensity of the strobeacon and the approach beacon have been completed and the data are now ready for plotting and for use in drafting of the report. These reports will be completed during the next quarter.

Brightness Meters. The scan-drive mechanisms of the two horizon sky brightness meters are being reworked in the shop in Washington to correct the deficiencies which have been observed during operation at Arcata. In addition, heaters will be added to the receivers to reduce the possibility of condensation in the units.

Slant Visibility Meter. The high-voltage collector-ring assembly was completely rebuilt and new high-voltage wiring installed in the light source. After this was accomplished it appeared that lamp life has increased. The receiver scanning assembly and light source drive gear were removed and returned to Washington for rebuilding of the receiver and spring loading of the drive gears.

Transmissometers. Development and testing of a modified indicator bridge circuit has continued. Good results have been obtained with a bridge for a 5-ma indicator. This bridge uses two type 6J5 tubes operating into a common cathode resistor of 1000-2000 ohms as the lower arms of the bridge; a 50,000-ohm resistor in the upper arm of the bridge which is connected to the type 6J5 tube which is controlled by the signal from the type 2050 tube; and a 10,000-ohm resistor in the other upper arm. A linearity error of 1% of full scale has been obtained. This is somewhat higher than the linearity

error in the present circuit but is satisfactory. Another bridge designed for a 1-ma indicator is being tested.

d. Facilities.

During this period water and wind erosion of the bluff of the north end of the field made it necessary for the Department of Aviation to reroute some of the drainage ducts. It was necessary to disconnect the primary voltage feeder cables to the visibility test area while this work was being accomplished. At the close of this quarter this electrical power was restored and the light units at the visibility test area are available for testing if suitable weather conditions occur.

e. Personnel.

Mr. Earl F. Bienz, Laboratory Mechanic, GS-8, entered on duty January 2, 1957, transferring from the Engineer Development Board at Ft. Belvoir.

Mr. James E. Freiheit, Engineering Aid (General), GS-3, WAE, entered on duty January 25, 1957.

The Field Laboratory is now fully manned for the first time since the summer of 1954.

U. S. DEPARTMENT OF COMMERCE
Sinclair Weeks, *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 headquarters in Washington, D. C., and its major field laboratories in 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 reports and publications, appears on the inside front cover of this report.

WASHINGTON, D. C.

Electricity and Electronics. Resistance and Reactance. Electron Tubes. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat and Power. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology and Lubrication. Engine Fuels.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment. AEC Radiation Instruments.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Gas Chemistry. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

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

Metallurgy. Thermal Metallurgy Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Heating and Air Conditioning. Floor, Roof, and Wall Coverings. Codes and Specifications.

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

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analogue Systems. Application Engineering.

• Office of Basic Instrumentation

• Office of Weights and Measures

BOULDER, COLORADO

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

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering.

Radio Standards. Radio Frequencies. Microwave Frequencies. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Calibration Center. Microwave Physics Microwave Circuit Standards.