NATIONAL BUREAU OF STANDARDS REPORT

4669

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report For the Period January 1 to March 31, 1956

By
Photometry and Colorimetry Section
Optics and Metrology Division

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Radio Propagation Engineering. Frequency Utilization Research. Tropospheric Propagation Research.

Radio Standards. High Frequency Standards. Microwave Standards.

- Office of Basic Instrumentation
- Office of Weights and Measures

NATIONAL BUREAU OF STANDARDS REPORT

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Development, Testing, and Evaluation of Visual Landing Aids

Consolidated Progress Report
to the
Airborne Equipment Division
Bureau of Aeronautics
Department of the Navy

For the Period
January 1 to March 31, 1956

for
Bureau of Aeronautics Projects

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

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Development, Testing, and Evaluation of Visual Landing Aids

January 1 to March 31, 1956

I. REPORTS ISSUED

Report No.	Title
4533	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period October 1 to December 31, 1955.
4554	Computation of the Effective Intensity of Flashing Lights. C. A. Douglas
4558	Theory of the Transmissometer Photometric System. C. A. Douglas, A. N. Hill
21A-3/56	Operating Characteristics of Ballast Resistors of Reduced Size.
21P-1/56	Photometric Tests of Two Type 4545 PAR 56 Lamps and Three Special 250-Watt PAR 56 Lamps.
21P-3/56	Photometric Tests of Two 300-Watt, 25-Volt and Two 200-Watt, 6.6-Ampere PAR 56 Approach-Light Lamps.
21P-4/56	Photometric Test of Three 500-Watt, 20-Ampere and Three 300-Watt, 20-Ampere PAR 56 Approach-Light Lamps.

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.

Transmissometers. A second experimental phototube with an S-4 surface has been received and checked. This tube is more stable and has a lower dark current than the first tube of this

type. However, neither the sensitivity nor the dark current are as satisfactory as similar tubes with an S-1 surface. Neither surface has the desired spectral sensitivity. Efforts to obtain tubes with a photosensitive surface having the desired spectral sensitivity are continuing.

A report "Theory of the Transmissometer Photometric System," has been completed and released. This report presents an analysis of the theory of operation of the transmissometer photometric system, a discussion of the sources of error in the photometric system and methods of minimizing the errors, and an analysis of the effects of these errors upon the indicated visibility. (NBS Report No. 4558)

b. Airfield Lighting and Marking.

Approach-Light Lamps. Intensity distribution measurements and intensity-current/voltage measurements have been made of two 300-watt, 25-volt, and two 200-watt, 6.6-ampere, PAR 56 approach-light lamps manufactured by the Westinghouse Electric Corporation, and of three 500-watt, 20-ampere and three 300-watt, 20-ampere, PAR 56 approach-light lamps manufactured by the General Electric Company. The 500-watt lamp is intended for use in the high-intensity seadrome lighting at NAS, Norfolk. All of these lamps have beam patterns similar to those developed for the 350-watt and 399-watt approach-light lamps. The ratio of the intensities of the 500-watt and 300-watt, 20-ampere lamps is slightly greater than the ratio of their power consumption, presumably because the 500-watt lamps have a somewhat shorter life. The results have been reported in NBS Test Reports 21P-3/56 and 21P-4/56.

Constant-Current Regulator. A type C-1, 4-kilowatt, 6.6-ampere constant-current regulator was received from Navy stock and installed for use in tests of airfield lighting equipment. The regulator was found to be defective and has been sent to the manufacturer for repair.

Runway Distance Markers. The study of the intensity-current characteristics of PAR 38 lamps when operated from 30/45- and 200-watt, 6.6-ampere isolating transformers has been delayed because of the defective regulator.

c. Seadrome Lighting.

Improvement of Battery-Operated Seadrome Lights. Sample amperites of reduced size have been obtained from the manufacturer

and tested for use in these units. As shown in NBS Report 21A-3/56, these amperites were found to be satisfactory for this application. Small relays have been purchased and a new circuit model using the new amperites and small relays has been tested. These tests were satisfactory and a laboratory model has now been assembled which shows that the circuit using the small amperite and small relays can be placed within the space that is available in the container provided for the lamp circuit of the current model seadrome light. Two similar units constructed with better workmanship are now being built for a test afloat.

Development of High-Intensity Seadrome Light. The cable-fed seadrome light has been advanced by further analysis of possible lamps and filters. A more efficient combination of an H250-A5 mercury lamp and filter has been found which provides approximately four times as many lumens of green light per watt as is obtainable with an incandescent lamp and green filter.* However, when this combination was analyzed from the standpoint of luminance, it was found that it would be less efficient than the incandescent lamp and filter combination if the primary requirement is a light of maximum candlepower with an optical system of fixed size. An analysis has been started of the relative merits of reflectors, lenses, and combinations of lenses and reflectors for use in the cable-fed floating light.

Norfolk Installation. The tests of the 500-watt, 20-ampere, PAR 56 lamps described above indicate that this lamp will be a satisfactory threshold light.

d. Carrier Lighting.

A third set of controls for waveoff lights has been assembled.

A study was made of the feasibility of constructing in the National Bureau of Standards shops a mold for use in electroforming reflectors for the mirror landing aids system. While the mold can be constructed here, it appears that a shop such as that at the Gun Factory, which is equipped to handle work of this size, could do the work more efficiently.

e. Lighted Suit for Landing Signal Officer.

Details of the design of the LSO lighted suit equipment and of the schedule of work on the contract have been discussed with the contractor. A sample reel-fed wire for connecting the LSO

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*NBS Report 4449, Analysis of Mercury Lamps and Filter Combinations for Use as Aviation-Green Lights, prepared for the Department of the Air Force.

to the source of power has been received and examined. It has been concluded that such an alternative to the method of connection called for in the specification does not appear desirable.

f. General Laboratory and Consultive Services.

Technical advice and assistance have been given the Department of Justice in connection with the suit of the Welsbach Corporation claiming infringement by the Navy and Air Force of the Bartow patent for high-intensity runway lights.

The preproduction TSM-11 Cable Test-Detecting Set was returned to the laboratory for check after a year's use in the field. No significant changes were found in the Power Supply or Signal Generator units. An intermittently defective transistor was found in the Amplifier-Indicator and the gain at 300 cycles had increased significantly. The cause for this increase was not found.

Marking of Tall Towers. The procurement specifications and installation instructions for the identification lights and hazard beacons for marking tall towers, reported last quarter, have been incorporated in the report of the AGA Subcommittee to the Technical Division of the Air Coordinating Committee.

Effective Intensity of Flashing Lights. A report has been issued presenting a mathematical analysis of the effects on the effective intensity I_e, computed from the Blondel and Rey relation

$$I_e = \frac{\int_{t_1}^{t_2} I\,dt}{a + t_2 - t_1}$$

produced by changes in the limits of the integral. The maximum value of I_e is obtained when the times t_1 and t_2 are the times when the instantaneous intensity, I, is equal to I_e. Methods which facilitate the computation of I_e, the checking of conformance to effective intensity specifications, and the computation of the visual range of flashing lights, are given in the report. (NBS Report No. 4554)

Kinorama. Four demonstrations of the kinorama have been requested and these have been provided. Two of these were for personnel of the C.A.A., one for Mr. Jensen of the Air Transport Association, and one for Mr. Stevens, who was preparing an article for publication in the Readers Digest. Since Mr. Stevens will cover many other devices, it is not to be expected that much reference will be made in his article to the kinorama, but the Navy's sponsorship was pointed out to him so that proper credit could be given. The pilots and technical men all made favorable comments on the potential utility of the kinorama as a device for increasing the safety of landings under adverse weather conditions.

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. As reported last quarter, the stub approach-beacon installation at the end of runway 13 produced distortions in the localizer beam pattern. Therefore, a similar installation is now being installed on runway 31. Views of the trial installation on runway 13 are shown in figure 1. Figure 1a shows the localizer antenna shelter and behind it, on a pole, the approach beacon and the shield installed to reduce the distortion of the localizer beam pattern. Figure 1b is a view taken from the beacon showing the A-frame bracing the approach beacon, the catwalk to the beacon, and the rear of the antenna shelter. The guard rail on the catwalk had been removed because of its effect on the localizer beam. Figure 1c is a view of the shielded approach beacon and its supporting structure. A wood pole was used as the upper part of the structure instead of steel, to reduce the effects on the localizer beam. The beacon was mounted above the level of the bluff because it was felt that putting the beacon much below the level of the antenna shelter would create a hazardous condition.

Tests of the approach-beacon system, except for the testing of the stub system , have been carried as far as is practicable at the Field Laboratory. Installation of the following system of approach beacons at one or more Naval Air Station for tests of operational suitability is recommended. Beacons should be installed at distances of 1000 and 2000 feet from the threshold on the extended centerline of the runway. Each beacon should be constructed on a base of the type now used for airway and

airport beacons. The turntable should rotate at 12 rpm. Six type 300 PAR 56/SP lamps should be mounted on the beacon turntable. The peak of the beams of these lamps should be 5° above the horizon initially. Provision should be made so that the elevation can be adjusted from 3° to 8° above the horizon. Two intensity steps, 100% and 10%, should be provided. An intensity setting of 10% appears sufficiently low for use in good visibility at night; a third step, about 2%, might be desirable under some conditions of operation. The threshold-light system of the runway should be strengthened. Installation of at least five PAR 56 lamps with "approach-light" covers and green filters, in wings outboard of the runway lights is recommended. The spacing between these lights should be not more than eight feet. The beams of these lights should be elevated 5° and directed outward so the inner edge of the beam is nearly parallel to the runway centerline.

Airfield Lighting Maintenance Manual. The rework of the Step-by-Step Troubleshooting Procedure has been completed and the Procedure has been forwarded to Washington for editing and preparation for reproduction. A series of troubleshooting charts which outline the troubleshooting procedure in chart form have been completed also. Each of these charts covers a specific area of troubleshooting. The draft of the text accompanying these sections is nearly complete and the preparation of a section on General Troubleshooting is being prepared. It is planned to release these sections and obtain comments from the field before proceeding with the other sections of the Manual.

b. Electrical Engineering.

Survey Trip. In preparation for a contemplated survey of Naval and Marine Air Stations on the West Coast, the questionnaire used in the survey made in 1953 on the East Coast has been revised and expanded. The questionnaire will be used as a guide in interviewing maintenance personnel and in analyzing the data obtained.

Cable Fault Finding. The Handbook of Operations and Service Instructions for the TSM-11 Test Set (NAVAER 08-20-501) has been reviewed and several desirable modifications in the operation instructions have been noted.

c. Research on Visibility Measurements and Visibility.

Sky Brightness. Since the replacement of the gear reducers of the scan drives with heavier ones and the replacement of an apparently defective drive motor which was reversing spuriously, the horizon sky-brightness meters have operated satisfactorily. The self-balancing potentiometers intended to meter these units were received from the factory in a damaged condition. A Brown electronic recorder has, therefore, been overhauled and modified for use in recording sky brightness.

Slant Visibility Meter. The field and office installations of this instrument are shown in figure 2. The projector and detector are installed in the approach zone about 1000 feet from the threshold and 3000 feet from the recording equipment in the office. This slant visibility measuring system consists of a fixed-beam ceilometer projector and detector modified so that both rotate about colinear horizontal axes. The distance between units is 250 feet. The detector is directed so that it receives light from a section of the projector beam a known distance from the projector. Since the angular relationships are constant and since the distances from each unit to this section are constant, interpretation of the measurements is simplified. Calibration is accomplished by comparing the response of this instrument, when the beam of the scanning system is horizontal, with that of the transmissometer in the same area.

The 120-cycle signal from the detector is amplified by the recorder-amplifier, rectified, and fed into a 5-milliampere recorder. The gain of the amplifier is controlled by a selector switch so that an output suitable for the recorder is obtained. The drives of the field units and the recorder are coupled in the following manner. The chart drive of the recorder is coupled to a cam-operated switch which stops the chart after it has traveled a distance equivalent to 90° of scan. The drive restarts when the direction of scan of the field units is reversed. Thus, if the field units scan an angle of $90° + \Delta°$, the chart drive will stop on each scan and will lag the field units by $\Delta°$ on each scan but will never be in error by more than $\Delta°$. Without this synchronizing feature, the error would be $2n\Delta°$ where n is the number of scans since the drives were synchronized. The error, Δ, may be easily made small enough so that it is not important on a single scan, but would not be made small enough so that the cumulative error after a large number of scans is unimportant.

During this quarter the life of the projector lamps has been unduly short. Part of these failures were caused by sticking of the pressure regulator valve. Others appear to be due to defective lamps. Leakage of water during the heavy rains of January into the slip-ring assembly of the projector caused arcing across the bakelite base on which the rings were mounted and burned the insulation. A new base was fabricated and installed. It is planned to install a Teflon base here so that arcing will not cause failure of the insulation. In troubleshooting the instrument, two deficiencies in construction were noted. The interlock breaks only one side of the 230-volt power supply to the lamp transformer. Therefore, if there is a ground, either low or high resistance, near the center of the primary winding of the transformer, about 500 volts would be developed across the lamp socket with the interlock open. Also, the unguarded compressor fan is exposed when the door of the compressor compartment is opened. There is no interlock on this door to protect personnel. These deficiencies are also present in some fixed beam ceilometers. The deficiencies have been called to the attention of the manufacturer and the Weather Services.

100% Setting Calibrator. The range of adjustment of the 100% Setting Calibrator has been modified to adapt it to the projector lamps and calibrator phototubes now being used. Checks are being made of the permissible tolerances in the positioning of the photocell of the calibrator.

d. Personnel.

Mr. George Davis, Laboratory General Mechanic, has taken a position with a local store and is working for the Field Laboratory on a very limited WAE basis. This has left the Laboratory very much understaffed. It has, therefore, been necessary to do some recruiting for replacements locally. Two physics students from Humboldt State College have been hired as WAE employees and are working about half time. They will work full time during the summer months and are expected to continue at the Laboratory on a full-time basis after graduation.

a.

b.

c.

Figure 1. Approach Beacon Installation on Runway 13

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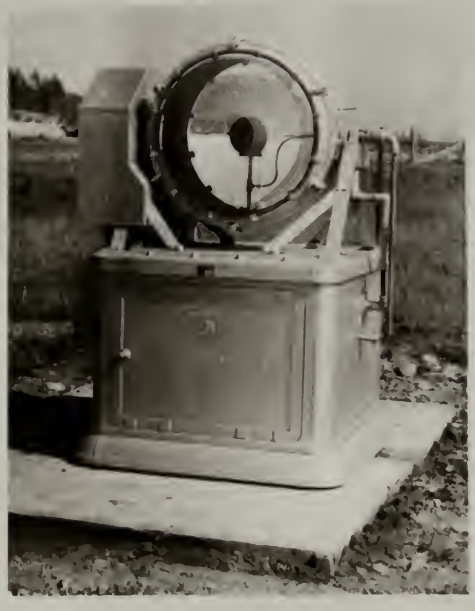
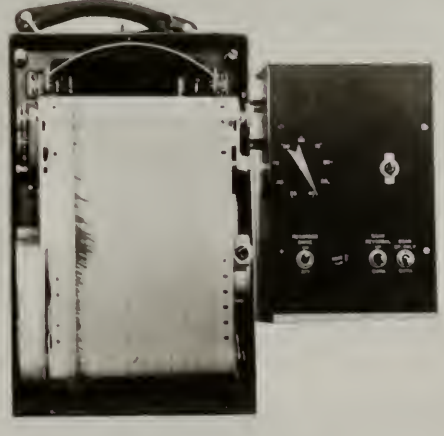


a. Projector

b. Detector

c. Recorder Amplifier



d. Recorder with self-synchronizing unit attached

Figure 2. Slant Visibility Meter

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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. 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 front 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. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.


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