NATIONAL BUREAU OF STANDARDS REPORT

6941

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period April 1 to June 30, 1960

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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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 June 30, 1960

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
6846	Proposed Design of a Taxiway Guidance System for Miramar Naval Air Station (1)
21P-8/60	Intensity Distribution Measurements of a 300-mm Code or Obstruction Marker Beacon Using Five Types of Lamps (1)
21P-9/60	Photometric and Life Tests of Six Type 20A/PAR56/3 Flush Approach/Runway-Light Lamps (1)
21P/14A/60	Photometric Measurements of a 200-Watt, 20-Ampere, PAR-64 Lamp Designed for Use in an RAE-Type Angle-of-Approach Indicator (2)
21P-14B/60	Photometric Measurements of a 200-Watt, 16.6-Ampere, PAR-64 Mazda 23 G.A. Indicator Lamp Supplied for Use in an RAE-Type Angle-of-Approach Indicator (2)
21P-15/60	Photometric Tests of Two Type 6.6A/PAR56/3 Airport Lamps After Service in Type MC-2 Lights (2)
21P-16/60	Physical and Electrical Tests of Connectors for Airfield Lighting Cable (1)
21P-17/60	Photometric Tests of Four PAR-64 Lamps in a Breadboard Model of an RAE-Type Angle-of-Approach Indicator (2)
21P-24/60	Photometric Tests of a Semi-Flush Mount "Pancake" Light (2)
21P-27/60	Qualification Tests of a Runway Identification Light (1)
21P-28/60	Flush/Frangible Flasher Type CD-100F (2)
21P-29/60	Intensity Distribution Measurements of a Flush/Frangible Flasher Type CD-100F (2)
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21P-29/60	Intensity Distribution Measurements of a Flush/Frangible Flasher Type CD-100F (2)
Lab. No. 6.4/295-6	Static Load Tests of a Dobson Corporation Landing Light (1)

Report No.	Title (Cont)
Memo Report	Yards and Docks Drawings for Airfield Runway and Taxiway Lighting (1)
Letter Reports (2)	Tests of 30/45-Watt transformers from Brown Field (1)

(1) For Bureau of Naval Weapons

(2) For Federal Aviation Agency

II. VISIBILITY METERS AND THEIR APPLICATION

Shipboard Visibility Meter. Construction has been started of a feasibility model shipboard visibility meter based on the design shown in NBS Report 6410.

Slant Visibility Meter. Plans are being made to move the slant visibility meter to a site east of runway 31 at Arcata. This move is required in order to be able to install a tower to carry targets for slant visibility observations. A 100-foot tower, which can be raised and lowered, can be made available for our use. This tower is the property of the Air Force. It was brought to the airport for use in Operation Pea Soup but will not be used for this purpose during the coming fog season. Since control and signal cables will not be available from this site to the laboratory, present plans are to place the slant visibility meter recorder-amplifier and the transmissometer indicator and recorder in an instrument shelter near the field site. Along with the visual observations by our observers, we hope to be able to obtain observations from aircraft for correlating and evaluating the instrument data.

Transmissometer.

Expanded Scale Indicator. Development of the expanded scale indicator has been completed and a report is being drafted. The relation between transmission and output meter or recorder reading is given in Table I. Arrangements have been made to have one of the indicators in use by the Aviation Weather Research Project, Atlantic City, converted to an expanded scale unit.

TABLE I

Transmission	Output Meter Reading (Fraction of Full Scale Reading)
1.00	1.000
.95	.981
.90	.962
.85	.941
.80	.919
.75	.896
.70	.872
.65	.847
.60	.821
.55	.793
.50	.763
.45	.730
.40	.694
.35	.654
.30	.611
.25	.563
.20	.507
.18	.482
.15	.438
.10	.353
.08	.312
.06	.263
.04	.206
.02	.124
.01	.069
.005	.037

Review of AWRP Report. At their request a review was made of the draft of a Report prepared by the Aviation Weather Research Project giving the results of their studies at Newark in the determination of visibility conditions at airports.

Errors in Transmissometer Measurements Resulting from Scattered Light. Some additional work on the analysis of the data of the scattered light measurements using a transmissometer was completed. Several figures were redrawn and two new figures were prepared. This completes the work on the field tests for this task. Some theoretical analysis and historical information will be added before this report is issued.

Measurements of Natural Sky Brightness and Illumination. Considerable time was spent on calibration of the brightness measuring equipment. The illuminometers have remained stable. The brightness meters have been somewhat unstable as shown by the calibrations in the laboratory. Much of this instability is caused by changes in the dark current and leakage current of the photopulse unit. The error in the calibration from dark current or leakage current has been determined by two independent methods with satisfactory correlation. Another calibration error which has been more difficult to determine is the lack of consistent correlation of the results from calibrations in the laboratory with results obtained in the field. After considerable investigation, including the interchange of units, it appears that one of the units changes sensitivity by about 20 percent when moved from the field to the laboratory even though the same power supply is used for calibration that is used in the field. By using a third unit, it has been possible to determine which unit has this instability. By determining a new calibration taking into account this shift, the earlier records which have been obtained should be usable.

Much of the earlier data which has been compiled was corrected for calibration errors. Collection of records and data has been discontinued because of shortage of personnel. Analysis of data will be continued when additional help is available or upon completion of higher priority tasks.

III. DEVELOPMENT OF AIRFIELD LIGHTING AND MARKING COMPONENTS

Visual Glide Path Indicators. Intensity distribution measurements have been made of a Sylvania 200-watt, 20-ampere and a 200-watt, 16.6-ampere Mazda 23 G. A. Indicator Lamp. These lamps, which were submitted by NAFEC, are PAR-64 lamps designed for use in RAE-type Visual Glide Path Indicators. They have C-6 filaments located somewhat ahead of the focus of the parabolic reflection of the lamps to produce a converging beam on the slit of the light. The results are reported in NBS Test Reports 21P-14A/60 and 21P-14B/60.

Photometric tests were made of a "bread board" model of an RAE type Visual Glide Path Indicator using the two lamps described above and two similar 300-watt, 20-ampere lamps manufactured by the General Electric Company (described in NBS Test Report 21P-13/60). The results of this study are reported in NBS Test Report 21P-17/60.

300-mm Code or Obstruction Beacon. A study was made of the performance of the "Hazard" beacon using five types of lamps. The five types of lamps used in the 300-mm code beacon were: a 500-watt, 120 volt, code beacon lamp having a PS-40 bulb, a C-9 filament and a mogul prefocus base; a 500-watt, 120-volt lamp having

a CC-8 filament 4.0 cm in length, and a mogul prefocus base; a 1200-watt, 115-volt, airway beacon lamp having a T-20 bulb, a CC-8 filament 5.9 cm in length, and a medium bipost base; and two 200-watt, 6.6-ampere "quartzline" lamps having T-4 quartz bulbs, CC-8 filaments 1.0 cm in length, and recessed single-contact bases used in combination with two "dummy lamps." Each of the five types of lamps in turn was operated in the code beacon in order to compare performance in this light.

The intensity distributions obtained with the "quartzline" lamps were very satisfactory. In addition, if lamps of this type are used, it is possible to provide spare lamps in the light. The results of this study are reported in NBS Test Report 21P-8/60.

Runway Distance Markers. The testing of the Cecil Field runway distance markers has been completed and a draft of the report prepared. This report will be issued early next quarter. The performance at nighttime of the Cecil Field markers is much better than the externally illuminated standard runway distance markers and the performance in daylight is almost as good as that of the standard markers. Six 75-watt, 120-volt lamps energized from the runway lighting circuit by a 200-watt, 6.6-ampere series transformer are recommended for use in illuminating the Cecil Field markers although with this arrangement the marker is not as bright as desirable for conditions when visibility is less than one-fourth mile. These markers require very little maintenance. No special shielding of lights is required.

Taxiway Lighting and Marking. The report of the proposed design of taxiway lighting, guidance signs, and markings for Miramar Naval Air Station (NBS Report No. 6846) has been issued. As proposed, the installation will require approximately 694 elevated and 328 flush lights for edge marker lights, 168 pancake or flush lights for centerline lights, and 73 taxiway guidance signs. New runway turnoff and taxiway intersection markings and taxiway edge markings are proposed.

A group of figures and slides have been prepared to illustrate the principles used in the design of the Miramar system. They will be useful in presentations of the plans for the system and in the preparation of a general taxiway lighting and marking standard.

Intensity Distribution Study of Class B and Class BB Semi-Flush Lights. Photometric tests were begun on three flush mount approach lights; a 1/2" high unidirectional; a 1/2" high bidirectional; and a 1" high unidirectional light. The lights are manufactured by Multi-Electric Manufacturing, Inc. Each light is being tested with a 200-watt, a 300-watt, and a 500-watt PAR 56 lamp.

Final Report on Air Force Project. A report "Development of Landing Aids for Jet Aircraft" was drafted. This is the Final Report for the work which was conducted at the National Bureau of Standards for the Air Force during the period 1954 through 1959.

IV. DEVELOPMENT OF SEADROME LIGHTING COMPONENTS

Sealane (Runway) Identification Light. The motor-drive circuit of the preproduction sample runway identification light submitted by Mink-Dayton, Inc. has been modified to obtain stable operation. Tests of the light have been completed and reported in NBS Test Report 21P-27/60. Some modification of the motor drive and additional moisture proofing is required before the light will be suitable for service use.

Photoelectric Switch for Seadrome Lights. The possibility of using silicon sun cells in the photoelectric switch has been further investigated. If silicon "sun cells" are to be used in the control (described in the Progress Report for the quarter July to September 1958, NBS Report 6225), the following filters are suitable: Corning Type 1-69 infrared absorbing visible transmitting glass for the "On" circuit and Corning Type 7-57 infrared transmitting, visible absorbing glass for the "Off" circuit. However, the use of this system is not recommended even though the sensitivity is significantly greater than the sensitivity of the system using selenium cells with red and green glasses. The circuit as shown in figures 2 and 3 of NBS Report 6225 will not function satisfactorily during daylight when the sun is obscured. The cause of the difficulty is the low proportion of infrared in the radiation from the sky. Thus if the OFF and ON cells are balanced satisfactorily for the incandescent activating light and for sunlight, the response of the OFF cells will be much too low when they are irradiated by skylight only.

If silicon cells are used it appears that the difficulties can be overcome by the addition of a third set of cells which would be used without a filter. About ten cells connected in series would be required. These cells would be connected directly to a sensitive relay. This relay would open the circuit between the battery and the photoelectric control unit. These cells would be mounted on the surface of a vertical cylinder above the regular OFF cells. Since all of these cells could not be illuminated simultaneously by the control light, the series of cells would not respond to this light. Hence the ON circuit could function as designed. However, skylight would illuminate all cells and cause them to actuate the OFF relay.

V. DEVELOPMENT OF CARRIER LIGHTING AIDS

Feasibility Tests of Proposed Carrier Lighting Systems.

General Electric Runway Floodlight. Work has continued on measuring intensity distributions and evaluating a General Electric floodlight employing a 200-watt "quartzline" lamp. The intensity distributions will be used in a determination of the net illuminance distribution produced by a configuration of these floodlights. Floodlights of this type have been proposed for use in illuminating carrier decks.

A trip by Mr. Freund was made aboard the USS Saratoga for the purpose of visual observations and photometric intensity measurements of the experimental deck lighting. However, weather conditions did not permit the photometric measurements on this trip.

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

Tests of Airfield Lighting Connectors.

Qualification Tests. Tests of the preproduction samples of airfield lighting connectors submitted by Woodside Screw Machine Co., Inc have been completed and reported. Although the connectors met all dimensional requirements and the materials of which the connectors were made met the physical requirements, the forces required to join or separate the connectors were far above specification limits. (NBS Test 21P-16/60)

Connector Kits. Nine Joy Cable Connector Kits were tested at Arcata during this period. Six connectors were completely assembled for insulation resistance measurements and an additional three connectors were checked for voltage drop and mechanical dimensions. The nine assemblies were checked for separation forces. A preliminary draft of the report of these tests was sent to Washington for review.

Epoxy Splice Kits. A study has been made of the voltage drop across Scotchcast splices, and of the change in voltage drop with time using both Scotchlok and Stakon connectors. A further examination was conducted after field reports of electrical failure at the splices. A memo report containing the results of this study has been prepared. The release of these data awaits the receipt of the results of field tests being conducted at the Arcata, California, Field Laboratory on splices of this type.

Quartz Lamps. Production samples of 6.6-ampere 200-watt and 6.6-ampere 45-watt quartzline lamps (6.6A/T4Q/CL and 6.6A/T2-1/2Q/CL respectively) manufactured by the General Electric Company have been obtained for test. Measurements of the relative intensity-current characteristics, relative intensity-voltage characteristics, and of the horizontal intensity are planned for the next quarter. An investigation of the output deterioration when the lamp is operated at a bulb temperature below the critical temperature or the operation of the iodine cycle and at a bulb temperature above the critical temperature is planned.

Flush Approach/Runway Lights. Six type 20A/PAR56/3 flush approach/runway-light lamps were given photometric and life tests. The lamps were manufactured by the General Electric Company and are 499-watt, 20-ampere lamps with CC-6 filaments and have covers which are stippled on the inside. These lamps have a peak intensity of approximately 400,000 candles, a horizontal beam spread of 15 degrees, a vertical beam spread of 10 degrees at 10% of peak intensity, and a life of about 75 hours to 70% of initial intensity. (NBS Test 21P-9/60.)

Intensity distribution measurements were made of two type 6.6A/PAR-56/3 lamps which were removed from narrow-gage lights installed in type MC-2 lights at the National Aviation Facilities Experimental Center. The lamp covers had become covered with rust deposited by condensation dripping from the head of the lights onto the lamps. The rust was removed and the lamps were then tested again. It was found that the effect of the dirt was to make one lamp 39% its normal intensity and the other 47% its normal intensity. (NBS Test 21P-15/60.)

"Pancake Light". Intensity distribution measurements were made of a "pancake light" (which projects 7/16 inch) manufactured by Structural Concrete Products Corp. and lamped with a 6.6 ampere, 45 watt "quartzline" lamp. The intensity of the beam of this light was approximately 75 candles. The low angle cut-off is below 0° elevation. (NBS Test 21P-24/60.)

Open Grid Light. Photometric tests have been made of a Dobson open grid type light using two 6.6A/PAR56/3 lamps to determine compliance with the intensity distribution requirements of specification MIL-26202A for class C3 lights. There were no significant deviations from the specification requirements. (NBS Test 21P-38/60.) Static load tests of the cover plate of this light were made by the Engineering Mechanics Section and reported by letter.

Type CD-100F Flush/Frangible Condenser Discharge Light. Intensity distribution measurements, to determine compliance with specification FAA-1250, were made on one type CD-100F Flush/Frangible Flasher manufactured by Hershey Manufacturing Company and of a CD-100F Flush/Frangible Flasher head without a power supply manufactured by Kemlite Laboratories Inc. The lights were tested both as "flush" and as "frangible" lights. Both lights met the intensity requirements for the "frangible" light and neither completely met the intensity requirements for the "flush" light. The results of these tests are reported in NBS reports 21P-28/60 and 21P-29/60.

Series Isolating Transformers. Several 30/45 watt series isolating transformers which had failed in service at Brown Field or at Cecil Field were examined. All transformers had either broken down from the primary to ground or had a low primary to ground resistance. New transformers were obtained from the depot at Mechanicsburg and tested. One of these transformers failed during an accelerated high temperature cycling test. Sample transformers have been delivered to the manufacturer for examination. The results of these tests were reported in detail in letters of April 14 and June 2.

VII. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Specifications and Drawings.

The technical sections of the following specifications and drawings have been reviewed. Comments have been forwarded by letter or informally.

Draft Specification, Light, Beacon, Approach, Airport.

Draft Specification, General Requirements for Flush Approach Lights (MIL-L-26202B.) (Review of this specification is not complete.)

Yards and Docks Airfield Lighting Drawings and the Modifications suggested by NAEF(SI).

Heliport Lighting Drawings.

Draft Specification, Equipment, Lighted Suit, Landing Signal Officers.

Draft Specification, Light Channel Marker, Water Aerdrome, Buoy Mounted, Fluorescent (MIL-L-7835A) and related drawings.

Draft Specification, Light Marker, Portable, Emergency, Battery Operated.

Demonstration Model of Lighting Systems. A control mechanism to operate the 8 different lighting systems in an automatic cycle was designed and constructed at NBS for the scale model runway of the airfield at NAS Lemore, California, which was constructed by NAEF (SI) for use in visual demonstrations of the lighting systems.

Lamp Tabulation. A tabulation is being made of the lamps used in Navy airfield lighting, their characteristics, the type of service, and the type of lights in which the lamps are used.

VIII. MISCELLANEOUS

Personnel. Mr. James E. Freiheit has left the Arcata Field Laboratory to enter Navy Officers' Candidate School. This leaves the group shorthanded for the coming fog season until a replacement qualified for the work can be found.

"Operation Pea Soup". Assistance has been given the Aeronautical Icing Group, the Air Force contractor for Operation Pea Soup, in the coordinating of location of equipment and the obtaining of power at their sites with the NBS test installations.

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *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 Measuments. Dielectrics.

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

Heat. Temperature Physics. Heat Measurement. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research. Equation of State. Statistical Physics. Molecular Spectrocopy.

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

Chemistry. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. 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. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer. Concreting Materials.

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

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

Atomic Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. 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. Ionosphere Research. Regular Prediction Services. Sun-Earth Relationships. VHF Research. Radio Warning Services. Airglow and Aurora. Radio Astronomy and Arctic Propagation.

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

Radio Standards. High-Frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Electronic Calibration Center. Microwave Circuit Standards.

Radio Communication and Systems. Low Frequency and Very Low Frequency Research. High Frequency and Very High Frequency Research. Modulation Systems. Antenna Research. Navigation Systems. Systems Analysis. Field Operations.


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