

NATIONAL BUREAU OF STANDARDS REPORT

8612

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period July 1 to September 30, 1964

By
Photometry and Colorimetry Section
Metrology Division



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. Its responsibilities include development and maintenance of the national standards of measurement, and the provisions of means for making measurements consistent with those standards; determination of physical constants and properties of materials; development of methods for testing materials, mechanisms, and structures, and making such tests as may be necessary, particularly for government agencies; cooperation in the establishment of standard practices for incorporation in codes and specifications; advisory service to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; assistance to industry, business, and consumers in the development and acceptance of commercial standards and simplified trade practice recommendations; administration of programs in cooperation with United States business groups and standards organizations for the development of international standards of practice; and maintenance of a clearinghouse for the collection and dissemination of scientific, technical, and engineering information. The scope of the Bureau's activities is suggested in the following listing of its four Institutes and their organizational units.

Institute for Basic Standards. Electricity. Metrology. Heat. Radiation Physics. Mechanics. Applied Mathematics. Atomic Physics. Physical Chemistry. Laboratory Astrophysics.* Radio Standards Laboratory: Radio Standards Physics; Radio Standards Engineering.** Office of Standard Reference Data.

Institute for Materials Research. Analytical Chemistry. Polymers. Metallurgy. Inorganic Materials. Reactor Radiations. Cryogenics.** Office of Standard Reference Materials.

Central Radio Propagation Laboratory.** Ionosphere Research and Propagation. Troposphere and Space Telecommunications. Radio Systems. Upper Atmosphere and Space Physics.

Institute for Applied Technology. Textiles and Apparel Technology Center. Building Research. Industrial Equipment. Information Technology. Performance Test Development. Instrumentation. Transport Systems. Office of Technical Services. Office of Weights and Measures. Office of Engineering Standards. Office of Industrial Services.

* NBS Group, Joint Institute for Laboratory Astrophysics at the University of Colorado.

** Located at Boulder, Colorado.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

2120411
2120414
2120302

December 1964

NBS REPORT

8612

Development, Testing, and Evaluation of Visual Landing Aids

Consolidated Progress Report to

Ship Aeronautics Division
and
Meteorological Management Division
Bureau of Naval Weapons
Department of the Navy

and to
Federal Aviation Agency
Washington, D. C.

For the Period
July 1 to September 30, 1964

By
Photometry and Colorimetry Section
Metrology Division

IMPORTANT NOTICE

NATIONAL BUREAU OF STANDARDS
for use within the Government. Before
and review. For this reason, the report
whole or in part, is not authorized
Bureau of Standards, Washington, D. C.
the Report has been specifically prepared

Approved for public release by the
director of the National Institute of
Standards and Technology (NIST)
on October 9, 2015

Counting documents intended
used to additional evaluation
of this Report, either in
presence of the Director, National
Government agency for which
for its own use.



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS



Development, Testing, and Evaluation of Visual Landing Aids
July 1 to September 30, 1964

I. REPORTS ISSUED

<u>Report No.</u>	<u>Title</u>
8392	Approximations of the Effective Intensity of PAR-Type Lamps Mounted on a Rotating Turntable
8537	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period April 1 to June 30, 1964
8551	Bibliography of National Bureau of Standards Reports and Papers on Aviation Ground Lighting 1961 - 1964
21P-47/64	Photometric Measurements of Four Type PAR-64 Iodine-Cycle Lamps for a Visual Approach Slope Indicator
21P-48/64	Lumen Output and Intensity Distribution Measurements and Life Tests of Eight Developmental, 200-Watt, 6.6-Ampere, T-14 Runway Light Lamps
21P-49/64	Tests of Lamps for "Wheels-Up Warning" Systems
Letter Report	Measurements of the Operating Temperature at the End Seal of a 200-watt Iodine-Cycle Lamp Operated in a 200-watt Inset Light
Memorandum Report	Photometric Measurements of a Semiflush-Mount Prismatic-Type Airport Marker Light with a Prototype Beam Spreading Lens with Various Combinations of Components
Memorandum Report	Sylvania Flush-Frangible Flasher Modified to Operate PAR56 Flashtube Lamps

II. VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter Field Tests.

The slant visibility meter equipment is continuing to operate satisfactorily with only routine maintenance.

Study of Systematic Variations of Fog.

An additional transmissometer on a 500-foot baseline has been installed to overlap the baselines of two transmissometers which are located approximately end to end along a line. This transmissometer will aid in determining the size of the cells in variable fog and the direction of movement of the fog cells. A total of four transmissometers are now being used in sampling the test area. Comparison of the simultaneous measurements should be useful in obtaining a measure of the variability of fog density over a small area.

Earlier observations indicate that the visual range of targets in daylight in very dense fog at Arcata tends to be greater than the visual range obtained from the transmissometer indication. Additional observations were planned for this fog season to determine if this difference is consistent and, if so, the amount of this difference. The atmospheric conditions required for the observations are visual ranges of 1000 feet or less in daylight. Observations were obtained during only one fog period, but more suitable fog conditions are expected during the rest of the fog season. The number of observations was not sufficient to allow definite conclusions. The observations did agree with the results noted earlier, that is, the indicated visual range is considerably less than the observed range. Preliminary analysis has indicated some extremely low contrast thresholds which require further evaluation.

Shipboard Visibility Meter.

Tests of the instrumentation described in the Progress Report for the previous quarter (NBS Report 8537) continued and correlations of the readings of this instrument with transmissometer readings have been obtained. The results of this work indicate that a workable and useful system has been obtained.

A new type of flash lamp using a three-turn helix was installed, replacing the older type using a four-turn helix. The smaller coil in the new lamp will give a smaller, more intense beam. This should increase the signal pulse. A new timing switch using a snap action switch was installed, replacing the sliding contact type which was subject to frequent failures due to arcing.



Transmissometers.

High-pulse-rate receiver. A second transmissometer receiver and indicator have been installed on the NBS (Washington) range. The photopulse unit has been modified to produce a pulse rate of 20,000 pulses per minute in clear weather instead of the usual 4000 pulses per minute. The indicator is equipped with an automatic sensitivity control so that full scale pulse rates of 20,000, 4,000, and 800 pulses per minute will automatically be selected as the transmittance drops. The modified photopulse unit has operated satisfactorily throughout the quarter.

Receiver alignment difficulties. A visit was made with Weather Bureau personnel to Kansas City and St. Joseph, Missouri, to determine, if possible, the causes of the decreases in transmissometer readings which frequently occurred at a number of installations in the Kansas City area at sunrise on clear days. The cause of these decreases was traced to undersize field stops in the photopulse units, which reduced the tolerance to shifts in receiver alignment to virtually zero. Field stops 2.0 mm in diameter were used in the original transmissometer receivers but the receivers examined in the Kansas City area were equipped with field stops 1.5 mm in diameter. When these field stops were opened to 2.0 mm diameter, the receivers had an adequate alignment tolerance. Subsequent investigation of other receivers indicated that some photopulse units have been assembled with the field stop at a distance from the objective lens which is not equal to the distance the ground glass of the aligning tool is from the objective lens. Other photopulse units have been assembled with the secondary lens separated from the field stop. All photopulse units should be inspected and brought into conformity with the original design.

Runway Visual Range Thresholds.

The threshold illuminance values used in converting transmittance measurements to runway visual range are being reexamined by the Weather Bureau Research Station at NAFEC. To facilitate their work, Landing Aids Experiment Station transmissometer records and flight test reports have been collected and delivered to NAFEC.



III. AIRFIELD LIGHTING AND MARKING

Study of the Effective Intensity of PAR-Type Lamps Mounted in Rotating Beacons.

The results of this study are reported in NBS Report 8392, issued this quarter. Approximations of the effective intensity of several PAR-type lamps mounted on rotating turntables are given for turntable speeds of 1 to 200 rpm and for all angles of elevation. The data for each lamp type are given in a plot of effective intensity factor as a function of turntable speed, and a vertical intensity distribution. The method used in obtaining the effective intensity distributions is considered adequate for engineering design purposes where PAR-type lamps are to be used in revolving lights. Use of this method makes possible the easy and compact grouping of data for many lamp types and many turntable speeds for reference use.

Stub Approach Beacon.

No flight test data have been obtained during the quarter. The Federal Aviation Agency maintenance group has requested installation of new control cable to the instrument landing system localizer. If this cable is installed, control of the stub beacon from the tower can be arranged. Some of the pilots flying in to Arcata Airport have been checking to assure that this beacon will be available for use during the winter months.

Runway Identification Lights.

The two synchronized runway identification lights have been removed from the outdoor range at the National Bureau of Standards. The capacitor motors are being replaced by synchronous motors, which will allow simplification of the synchronizing circuits.

Beam Spreading Techniques for Semiflush Prismatic-Head Lights.

Photometric measurements were made of a feasibility model of a lens-type kit designed by Multi Electric Mfg. Inc. for use in type MC-2 lights to increase the vertical beam spread of these lights. (See NBS Reports 8169 and 8169 Supplementary.) Two 1/2-inch projection lights were tested when lamped with a 20A/PAR56Q/3 iodine-cycle lamp and when lamped with a 20A/PAR56/3 conventional lamp. Vertical beam spreads of more than twice those of the conventional MC-2 light were obtained. However, contrary to the data reported in NBS Report 8169, the peak intensity was reduced about 20%. The peak intensity with the iodine-cycle lamp was about 10% lower than the peak intensity with the conventional lamp. A memorandum report has been issued.

Q6.6PAR64/3 Iodine-Cycle Lamps for VASI Systems.

Photometric testing was completed on a group of Q6.6A/PAR64/3 iodine-cycle lamps for use in the VASI systems. The difference between the vertical intensity distributions of these lamps and those of conventional type lamps when they were measured through a simulated VASI (with the slot but without the bi-color spread lens) caused some concern, but did not seem to affect the output of the lamps when the red-white spread lens was used. With the slot and spread lens in the test system, the lamps compared favorably with previously tested conventional lamps. NBS Test Report 21P-47/64 was issued. The lamps are designed for a 2000-hour life and have been put on the life test racks. A supplementary report will be issued.

Developmental Lamps for Use in a Type C-1 (L-819) Runway-Edge Light.

NBS Report 21P-48/64 was issued giving the results of lumen output and intensity distribution measurements and life tests of eight developmental 200-watt, 6.6-ampere, T-14 runway light lamps. These lamps have a nominal rating of 200 watts, a rated lumen output of 4500 to 4600 lumens, and are designed for a 300-hour life. They are intended for use in the type C-1 (L-819) runway-edge light which is now being used with a 200-watt, 6.6-ampere (type 6.6A/T14P) lamp with an initial lumen output of 4800 lumens and a 75-hour life. The developmental lamps are a compromise between the type 6.6A/T14P lamp and the type 6.6A/T14/2P lamp specified in Specification MIL-L-5904C, which is a 204-watt, 6.6-ampere lamp having a rated life of 500 hours and an initial lumen output of 4200 lumens.

The lamps performed as designed except that their life was somewhat less than the intended 300 hours.

Intensity Maintenance of 500-Watt, PAR56 Quartzline Lamps.

The report on the results of the photometric measurements of these lamps has been completed.

Developmental 300-Watt, 20-Ampere, PAR56 Quartzline Approach and Runway Light Lamps.

The life tests of these lamps have been completed, and the report on the results of the tests is being prepared.



SATS Runway Centerline Lights.

The centerline lights used in the SATS landing mats are subject to damage from the shifting of the light fixtures and from tailhook impact. A study has been undertaken to develop an improved fixture, and a tentative design has been proposed using a lamp similar to the type 1968 lamp set in a long deep slot cut in a wide plate which will be flush with, and lock to, the adjacent sections of the matting.

Temperature Measurements of a 200-Watt Lamp in a Type L-843 Inset Light.

A letter report has been released giving the results of temperature measurements of the end seals of a 200-watt iodine-cycle lamp mounted in a type L-843 fixture. The equilibrium temperature of the end seals averaged 360°C. This temperature is slightly higher than the recommended maximum of 350°C. This deviation is not considered serious.

Lamps for "Wheels-Up Warning" Systems.

Tests have been made of the suitability of the new Q500PAR56/NSP (iodine-cycle) lamps for use as "wheels-up warning" lights. The lights are not as suitable as the 500-watt PAR64 lamps now being used as the maximum voltage that could be used for these lamps was 155 volts when the lamps were flashed at a rate of 90 flashes per minute with a 50% duty cycle. At 155 volts the operating life of the lamps was only 9 hours 30 minutes. The results of this test have been reported in a memorandum report. (NBS Test 21P-49/64.)

6000-Hour 700PS40 Lamps for the 300-mm Code, or Hazard, Beacon.

Measurements of luminous output were made of eight developmental 700-watt, 6000-hour lamps for the 300-mm code, or hazard, beacon. The lamps have C7A filaments and PS40 envelopes. The average initial output was 10,600 lumens. NBS Test Report 212.11P-34/65 will be issued after completion of the 6000-hour life test.

Flush-Frangible Light.

A flush-frangible light manufactured by Sylvania Electric Products, Inc. was delivered to NBS for circuit modifications. When General Electric PAR56 flashtubes were operated from this power supply, they would fire erratically if at all. To obtain satisfactory operation it was necessary to reverse the polarity of the triggering pulse and to increase its amplitude.



Navy Taxiway Lighting Standard.

The draft of the Navy Taxiway Lighting Standard has been reviewed and work on the diagrams illustrating light locations and spacings has been started. The figures and editing of this standard should be completed during the next quarter.

Field Tests of Cable Test-Detecting Set AN/TSM-11.

A report of tests of the AN/TSM-11 Cable Test - Detecting Set was drafted. This draft was then revised to serve as a guide for use of the set instead of being limited to a report of field tests of the equipment. This revision includes figures to show test connections and a diagram to illustrate the use of the set for determining the depth of a cable. The drafting of this guide has been completed and the report should be issued during the next quarter.

IV. SEADROME LIGHTING AND MARKING

No work was conducted in this field during the quarter.

V. CARRIER LANDING AIDS

Modified Source-Light Indicator Assembly of the Mark 6 Fresnel-Lens Optical Landing System.

Photometric measurements were made of a modified cell of a Source-Light Indicator Assembly of the Mark 6 Fresnel-Lens Optical Landing System. The modification consists of a two-piece machined metal "egg-crate" lens-restraining device. The matching faces of the two egg-crate pieces have a slight bow to match that of the Fresnel lens. When clamped between the two pieces, the lens is constrained to its original contour. The device reduces the peak intensity from 13.9 to 11.3 kilocandelas. Curves of relative brightness of the face of the cell as a function of distance from the center of the light of the unit with and without the constraining device were essentially the same. NBS Test Report 212.11P-27/65 will be issued.

Deck Guide Light.

Photometric tests of a bidirectional deck guide light manufactured by the L. C. Doane Company are in progress. The light was received from the Naval Air Engineering Laboratory where it had undergone hook impact tests. It is being tested with 45- and 100-watt iodine-cycle lamps.

Catapult Hook-Up Light.

Photometric tests were started of a light manufactured by the L. C. Doane Company for use in illuminating the underside of the aircraft when it is being attached to the catapult. However, the solder holding the prefocussing ring of the lamps failed repeatedly and tests were suspended. This lamp failure has been called to the attention of the manufacturer of the lamp as well as the manufacturer of the light.

LPH Angle-of-Approach Lights.

Specifications for an LPH angle-of-approach light were received from NAEL(SI) and are being reviewed.

VI. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Specifications.

Review of specifications and MS drawings and proposed revisions has continued.

Field Tests of Retroreflectors.

A range and installations for equipment have been prepared for testing the efficiency of retroreflectors as a function of the observer's distance from the reflector. The test range is along a taxiway and provides a continuous range of 6,000 feet. Present plans are to test various types of retroreflectors by maintaining a constant illuminance on the reflector and determining the intensity of the retroreflector by visual comparisons with a reference light which can be adjusted to the intensity of the retroreflector. Arrangements are included to make these comparison observations at different angles of incidence of the light illuminating the retroreflector and at different angles of divergence of the line of sight of the observer from the direction of illumination on the reflector. Preliminary observations indicate that the efficiency of some types of commercial retroreflectors continues to increase at ranges greater than 1000 feet. Since the test range and equipment are on or near operational surfaces of the Arcata Airport, the mounts for the retroreflectors, the comparison lights, and the light source are portable, or easily disassembled. A shelter was constructed to protect the instruments and controls and the recorder-controller from adverse weather conditions. Testing will begin next quarter.

Miscellaneous Consultive Services.

The Federal Aviation Agency maintenance group at Arcata reports a problem of stains on the red filters for the type MB-2 approach lights. These filters are used on the termination bars and wing bars and are mounted very near the ground. Some of the stained filters have been installed for approximately six years, but others for lesser time. These stains reduce the transmittance of the filters appreciably. The stains appear to be etched into the glass and could not be removed by solvents, cleansers, and cleaning abrasives. The green filters on the threshold lights do not seem to be affected by stains.

Technical assistance has been given to personnel of the Federal Aviation Agency in the review of proposals for the development of instrumentation to measure "slant visibility." FAA personnel were accompanied on a visit to Kennedy Airport to study the suitability of the narrow-gauge lighting at that airport for Categories II and III operation.



Lighting and Marking of TV Towers.

A three-day inspection trip was made with FAA personnel to locate a tall television tower to be used in tests of high-intensity obstruction beacons. In the course of this trip, several towers were observed in which only the structural members of the tower were painted with aviation surface orange and white. Conduits within the towers were not painted the color of the structural members at the same height. As a result, the effectiveness of the orange and white markings is reduced. Comparison of the test towers at Madison and Green Bay, Wisconsin, showed an advantage of the use of color segments longer than the forty feet now in use. No significant difference was observed between the black-and-white and the orange-and-white markings when all conditions of view encountered during these observations are considered.

VII. MISCELLANEOUS

Life Testing of Series Lamps.

The supplementary power source and control circuits described last quarter have been put into operation. This permits the life testing of our aviation series-service lamps at those times when the Life-Test generating facilities are operating at maximum capacity.

Theory of Photometry of Projection Apparatus.

The draft of the report "Review of the Elementary Theory of Projection Apparatus" has been completed and is being reviewed. The principles developed in this report are applicable to projectors producing beams which are not collimated and to beams which are not symmetrical. Very good agreement was found between the computed variation of illuminance with distance for a cell of the Fresnel-Lens Optical Landing System.

Photometry of Colored Light.

A study is being made of the magnitude of the errors introduced into the photometry of fittings emitting colored light when a photoelectric photometer is used and the photometer is calibrated with an incandescent source having a color temperature of about 2854°K. Vacuum phototubes having emissive surfaces which are red sensitive (S-1), are blue sensitive (S-4), or have approximately uniform spectral sensitivity (S-8) and barrier-layer cells, are being checked both with and without spectral-sensitivity-correcting filters.

Bibliography of NBS Reports and Papers on Aviation Ground Lighting.

NBS Report 8551 has been prepared and released to supplement NBS Report 7322. The present bibliography covers reports and papers issued during the period 1961 to 1964. Reports of tests of equipment and reports of transitory interest are not included.

Material for 4th Edition of IES Handbook.

Portions of the section of the IES Handbook covering aviation lighting have been drafted and forwarded to the Chairman of the Handbook subcommittee of the Aviation Lighting Committee.



Summary of Intensity Distributions of Aviation Ground Lights.

Intensity distributions typical of the types of aviation ground lights now in service are being collected into a report for ready reference as well as for use at the Third Meeting of the Visual Aids Panel. Intensity distribution data will be summarized in tabular form as well as by intensity distribution curves.

Position Material for Third Meeting of Visual Aids Panel.

The section of the U.S. Position for the Third meeting of the Visual Aids Panel relating to the intensity distributions of approach and runway lights has been drafted. Assistance has been given in the preparation of other sections of the Position.

NBS Report 8612
December 1964

US COMM NBS DC

