

NATIONAL BUREAU OF STANDARDS REPORT

8003

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period January 1 to March 31, 1963

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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Publications

The results of the Bureau's research are published either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and the Central Radio Propagation Laboratory Ionospheric Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 (\$1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 (\$1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (includes Titles of Papers Published in Outside Journals 1950 to 1959) (\$2.25); available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

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NBS REPORT

8003

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 25, D. C.

For the Period
January 1 to March 31, 1963

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director of the National Institute of
Standards and Technology (NIST)
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to additional evaluation
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of the Director, National
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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
January 1 to March 31, 1963

I. REPORTS ISSUED

<u>Report No.</u>	<u>Title</u>
7799	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period October 1 to December 31, 1962
21P-22/62	Photometric Measurements and Life Tests of Four PAR-64 Type Lamps for a Visual Approach Slope Indicator, Manufactured by Sylvania Electric Products Inc.
21P-41/62 Supp.	Luminous Output Measurements and Life Tests of Eight Developmental 120-Watt Lamps for Obstruction Lights, Submitted by General Electric Company
21P-42/62	Photometric Measurements and Life Tests of Four PAR-64 Type Lamps for a Visual Approach Slope Indicator, Manufactured by Westinghouse Electric Corporation
21P-45/62	Photometric Measurements and Life Tests of Four PAR-64 Type Lamps for a Visual Approach Slope Indicator, Manufactured by General Electric Company
21P-90/62	Photometric Tests of a Type OB22 Double Obstruction Light Using Four Different Types of Lamps
21P-91/62	Photometric Tests of Four Type 20A/PAR56/2 and Three Type 20A/PAR56 Approach-Light Lamps Manufactured by General Electric Company
Letter Report	6.6/6.6-Ampere, 300-Watt, Series Isolating Transformer Manufactured by Elastic Stop Nut Corporation of America

II. VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter. Work on the reduction and analysis of the data from the slant visibility meter has continued. The change in response of the slant visibility meter as a function of time, which is caused by change in atmospheric conditions, provides interesting information on how fogs perform. This information may be useful in evaluating the length of time for which a given scan will be reliable for use in estimating slant visibility. In order to make information available at an earlier date and to make more information available, the work on the slant visibility meter will be presented as a number of reports instead of a single complete report. An early report will describe the types and frequency of occurrence of restricted visibility weather conditions encountered at Arcata.

Except for occasional sudden changes in sensitivity of the receiver, the slant visibility meter continues to operate very satisfactorily. The changes in sensitivity seem to be correlated with the position of the phase shift adjustment. This will be investigated further.

Shipboard Visibility Meter. Spectral transmittance measurements have been made of the interference filters received last quarter. Two new photomultiplier tubes, one with a blue-sensitive surface and the other with a red-sensitive surface, have been ordered and received. These tubes will be tested in conjunction with the interference filters in an effort to improve the signal-to-noise ratio during daylight operation. An operational amplifier has been ordered and received. This amplifier will be used in a circuit designed to produce a logarithmic response, and will be used in a study of various methods of presentation of the output of the visibility meter.

Transmissometer.

Review of Transmissometer Manuals. The Technical Manuals for Transmissometer Sets AN/GMQ-10B and AN/GMQ-10C on "Operation and Service Instructions NAVWEPS 50-30GMQ10-2," "Overhaul Instructions NAVWEPS 50-30GMQ10-3," and "Illustrated Parts Breakdown NAVWEPS 50-30GMQ10-4" have been reviewed, and numerous corrections and suggestions for changes have been recommended.

Rerun of Transmissometer Manual. To meet the needs of the Weather Bureau, another rerun (400 copies) has been made of NBS Report 2588, Instruction Book for Transmissometer Set AN-GMQ-10.

100-Percent Setting Calibrator. A prototype 100 percent setting calibrator unit was loaned to the Air Force Cambridge Research Center for use in their program to procure calibrators.

Weather Bureau Transmissometer. The Weather Bureau transmissometer installation at Arcata has been designated as the official source of runway visibility data for low visibility conditions. Our instrument in the touchdown zone has been decommissioned. Transmission data for this area will be obtained from the Weather Bureau instrument.

Expanded-Scale Indicator. Work has continued on the draft of the report on the development of the expanded-scale indicator. Calculations for the graduation of a visibility-transmission converter for the expanded-scale indicator have been completed and checked. A preliminary model of the converter has been made and installed on the NBS (Washington) transmissometer.

Review of Proposals. At the request of the Weather Bureau, Instrument Division, reviews have been made of proposals submitted for the use of lasers, one in the measurement of "slant visibility" submitted by Aerometric Research Incorporated, and the other in long base-line transmissometers, submitted by Hoffman Electronics. The results of these reviews have been forwarded informally.

The Effects of Airfield Lighting on Horizon-Sky Brightnesses. The paper presented at the IES Aviation Committee meeting on this work has been reviewed and edited for use as an NBS formal report for this task.

III. AIRFIELD LIGHTING AND MARKING

Stub Approach Beacon System. Many comments have been received from airline and general aviation pilots in regard to the stub approach beacon installed on the approach to runway 13 at the Arcata Airport. This beacon is located approximately 400 feet downwind of the runway threshold, because of a 180-foot bluff just beyond this point, and was installed to evaluate the use of a stub approach beacon where terrain features make the installation of a standard approach beacon system impractical. The stub approach beacon was intended primarily to provide guidance in circling approach conditions. Most of the comments received have been favorable to the use of this beacon, especially for approaches with visibility of five miles or less. This beacon serves most usefully in marking the end of the runway and in providing guidance until the pilot is in the main beam of the runway lights. Some pilots feel that the beacon aids in keeping the aircraft lined up with the runway centerline on final approach and that the beacon is a valuable addition to the visual approach slope indicator (VASI). Earlier the stub beacon was criticized as lacking adequate

intensity, especially during daytime. Apparently the visual range and intensity of the beacon was being compared to that of the VASI. Recently there have been several comments stating that the nighttime intensity is too high during final approach and that the tower should be able to control this beacon. The control of the beacon at the tower was considered desirable at the time of the original installation, but there were no control circuits available, and the cost of installing the control cables for a temporary test installation was not considered justified.

The comments stating that the beacon intensity was too high were obtained when visibility was five miles or greater, and when the pilots had requested that the VASI be turned off. A shield for the approach side of the beacon is being considered to block out or to considerably reduce the intensity toward an aircraft on final and within two miles of the beacon. The shield would not interfere with the intensity for an aircraft off centerline, far out on final, or much below the glide path. This shield will probably be in the shape of an inverted triangle. If placed near the beacon, it would not have to be large in size. It is planned to put 500-watt, 20-ampere approach light lamps in this beacon to increase the visual range of the beacon.

One pilot reported that the approach beacon tends to cause vertigo both at night and in daytime. This report was made in regard to approaches made in good visibility conditions on straight-in approaches. No other pilot has made similar comments.

Apparently the breakage reported last period of the type 399PAR lamps from precipitation striking the hot lamps occurred only with lamps from one group. The present set of lamps has been operating for more than six weeks with no failures, and there have been many rains and squalls during that time.

Runway Identification Light. Two runway identification lights of the type specified in Specification MIL-L-21703(Aer) have been modified to provide synchronization of the rotation of the lamps in the two units. Synchronization is accomplished by the use of a synchronous timing motor whose output shaft rotates at approximately 38.7 r.p.m., which is slightly less than the speed of the slower of the two rotating light units. Separate rotating cams are attached to the output shaft of the timing motor drive and to each of the rotating lamp assemblies. Each cam actuates a microswitch twice during each revolution. If either of the rotating lamp assemblies were to rotate at the same rate as the output shaft of the timing motor drive, its cam and microswitch would remain in phase with the cam and microswitch on the timing drive. Since, however, the timing drive rotates at a

slightly slower rate than the rotating light, the operation of the pair of switches tends to remain slightly out of phase.

During the short interval of time that the switches are out of phase, a reverse voltage is applied to the motor which rotates the light, thus slowing it down until the microswitches are again in phase. Each of the rotating units, therefore, receives two synchronizing "pulses" per revolution. A reversing switch provides either "forward" or "counter-rotating" synchronization.

The two units will soon be installed on an outdoor range at the National Bureau of Standards for visual observations.

Visual Approach Slope Indicator.

PAR-64 VASI Lamps. NBS Test Reports 21P-22/62, 21P-42/62 and 21P-45/62 were issued giving the results of intensity and luminous output measurements and voltage maintenance as a function of burning time of twelve off-focus PAR-64 VASI lamps.

Taxiway Light Standard. The Proposed Guide to Taxiway Lighting and Marking prepared for the Taxiway Lighting Subcommittee of the IES Aviation Committee has been reviewed, and an outline prepared for the Navy Taxiway Lighting Standard has been drafted. The form of the Standard will be different from that of the Proposed Guide, but the information will be based upon that in the Guide.

Cable Test-Detecting Set TSM-11. The first draft of the report on the field tests of the cable test-detecting set TSM-11 was reviewed. Completion of the report is being delayed to permit further tests of the effectiveness, procedures, and limitations of the use of this equipment for locating multiple high-resistance grounds and open faults and for determining the depth the cable under test is buried. Work on these tests is awaiting an improvement in the weather so that the tests can be made on permanent circuits installed at the Arcata Airport. This report is expected to serve as a supplement to the Operations and Maintenance Handbook for the AN/TSM-11.

Airfield Lighting Cable Connectors Field Test. The investigation of the increased leakage current of one of the units under test is delayed because of the weather. Excavation to check the unit will be made as soon as the rainy season is over. The report will then be issued.

Effective Intensity of Flashing PAR399 Lamps. A study is being made of the effective intensity of flashing PAR399 lamps. The study will include the flashing of the clear lamps and lamps with red and green filters with applied voltage of 115, 80, 60, 44, 35, 27, and 21 volts at 60 cycles. Photographic transparencies have been made of the oscilloscope curves of relative intensity vs. time during the flashes with the various applied voltages and filters. A report will be issued upon the completion of the study which is now being made of these curves.

Intensity Maintenance of 500-Watt, PAR-56 Quartzline Lamps. Intensity distribution measurements have been made after every 100-hour burning period of 500-watt, PAR-56 Quartzline lamps. Both the prismatic and stippled-cover lamps have been burned for 500 hours. As previously reported, the quartz envelope in one of the stippled-cover lamps shattered after 200 hours of operation. This lamp burned out at 400.2 hours. The quartz envelope on another stippled-cover lamp was found shattered after 482 hours of burning. The peak intensity of this lamp after 500 hours of burning was about 25 percent of the initial peak intensity. A third lamp, showing evidence of shorted turns, had a peak intensity of about 75% of the initial peak intensity, and the fourth lamp, apparently intact, had a peak intensity of about 98% of the initial peak intensity.

Of the prismatic lamps, three are apparently still intact, and one shows evidence of shorted turns. The average peak intensity of the intact lamps was about 98% of the initial average peak intensity, and the peak intensity of the lamp with the apparently shorted turns was about 60% of the initial peak intensity.

Qualification Testing of 300-Watt PAR-56 Approach Light Lamps. Photometric tests of four type 20A/PAR56/2 and three type 20A/PAR56 approach light lamps were made. Minor deviations from the requirements of FAA Drawings C-5407-1 and C-5407-2 were found. The results were reported in NBS Test 21P-91/62. Life tests have been completed, and the results will be given shortly as a supplementary report.

Characteristics of 300-Watt Transformer. Measurements were made comparing the performance of a 6.6/6.6-ampere, 300-watt, series isolating transformer, manufactured by the Elastic Stop Nut Corporation of America, using 50- and 60-cycle inputs. Primary voltage, secondary voltage, and secondary current were measured at various primary currents. The results, which were reported in a letter report, show that there is no significant difference between the performance at 50 cycles and the performance at 60 cycles except for a very slight decrease in output current when the input current is 6.6 amperes.

Tests of 6000-Hour Obstruction Light Lamps. NBS Test Report 21P-41/62 Supplementary was issued giving the results of life tests of eight developmental 120-watt, 6000-hour, A-21 obstruction light lamps. The mean life of the eight lamps was 4461 hours; the mean lumen maintenance and efficacy maintenance (of the six lamps still burning at 70% of rated life) were 88% and 89%, respectively.

Double Obstruction Light, Type OB22. NBS Test Report 21P-90/62, entitled Photometric Tests of a Type OB22 Double Obstruction Light Using Four Different Types of Lamps was issued giving the results of photometric measurements which were made for the purpose of comparing the performance of four different types of lamps in a type OB22 obstruction light. The lamps used were of the following types:

- (A) 1020/66/A21
- (B) a developmental lamp, intended as a long-life replacement for the type 100A21P lamp
- (C) 100A21P
- (D) 100A21/TS

The vertical beam spread of the obstruction light lamped with lamp B, the developmental 120-watt, 6000-hour-life lamp, is less than the vertical beam spread when the other types of lamps are used. However, the beam pattern obtained with this lamp is considered preferable to the beam patterns obtained when the other two multiple lamps are used for the following reasons:

1. The peak intensity is substantially independent of azimuth
2. The average peak intensity is higher
3. The intensity in the range of elevations at which the lights are usually viewed from fixed-wing aircraft, -2.5° to 7.5° , is higher.

IV. SEADROME LIGHTING

FMF-6 Seadrome Light. A study is being made to determine the optimum design and voltage of a dry-battery pack for use in the redesign of the FMF-6, 6-watt, fluorescent seadrome light. The battery pack will power a transistorized inverter which will operate the 6-watt fluorescent lamp.

V. CARRIER LANDING AIDS

Off-Glide-Path Indicator. Further observations of the performance of a Fresnel Lens assembly to which an experimental High cell, a mock-up made by Control Instruments Division and incorporating a single xenon high-intensity source, had been added were made during daylight on one occasion from an observation station on the roof of an apartment house 1.3 miles from the lights. Intensity distribution measurements were also made of the unit on the outdoor range. The following tentative conclusions were drawn:

- a. The peak intensity of the xenon unit was higher than that of the tungsten unit previously observed; the vertical intensity curve of the xenon unit, however, (1) was more sharply peaked; (2) was much narrower at the 50% point; (3) matched the 2° spread of the tungsten at the 20% point; (4) but then spread to 4° just below the 5% point.
- b. Although the unit was not critically adjusted relative to the basic Fresnel assembly, a tendency of the light outside of the 2% area initially specified for the High-Low cells to interfere with the "meatball" was evident.

"Bindle Cards." Construction has been completed on components to be used with the "Bindle Card" system. This system is intended to give guidance to the helicopter pilot when he is making a cargo pick-up from shipboard. It consists of two rectangular shaped illuminated markers, the dimensions of the larger one being approximately one and one-half times those of the smaller one. These markers are placed aboard ship in such a way that when the helicopter pilot is in the correct position to make a pick-up, the larger rectangle, which is located farthest from him appears to be directly above the smaller rectangle, which is located approximately midway between him and the larger rectangle. When the two rectangular surfaces appear to the pilot to be the same size and the edges of the rectangles align with each other, the pilot will know he is in the correct position for a pick-up.

The units constructed at NBS were internally illuminated boxes using red lamps behind a translucent orange diffusing cover, thus providing conspicuous orange marks for daylight use and red-lighted marks at night. A variable autotransformer was shipped with each unit to provide intensity control at night.

VI. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Specifications, Drawings and Service Bulletins. The technical sections of the following specifications and service bulletins were reviewed, and the comments have been forwarded.

Draft	Portable Dual Control Switch Assembly
Draft	Flight Deck Guide Light
Bulletins 2, 3, and 4	NAEL-SE-432 Fresnel Lens Optical Landing System
Bulletin 6	NAEL-SE-432 Visual Landing Aids General Service
Bulletin	Visual Landing Aids Brightness
Bulletin	LPH Lighting
Federal and Military Specifications for Wire and Cable MS24526 (ASG)	Base Airport Marker Light

Demonstrator for 200-Watt Quartzline Lamp. A device was constructed to demonstrate the thermal shock resistance of quartzline lamps when the lamps are subjected to severe temperature changes. A 200-watt quartzline lamp was mounted in a cylindrical plastic housing in which the water level could be raised and lowered by means of a pump and timing motor located in the base, to cover and uncover the lamp. The lamp is under water for approximately 30 seconds of a two-minute cycle.

VII. MISCELLANEOUS

Visit to Fog Chamber. The fog chamber for testing airfield lighting at the University of California Illumination Laboratory was visited. This installation does provide a means of controlling the atmospheric conditions for performing tests, but the necessity for scaling down the distances and intensities, the increased problems in alinement and maintenance, the lack of control of the test vehicle as compared with an operational aircraft, and the effects of the boundary conditions will limit the validity of the results. Also in this type of laboratory condition as in field testing, the problem of acquiring vast quantities of data that are never adequately analyzed is difficult to overcome.

Pacific Airlines Fog Investigation. Mr. Donald Welch, pilot for Pacific Airlines, has consulted us in regard to availability of data on weather conditions at Arcata. He is interested in determining a means of more accurately forecasting the occurrence and duration of fog at Arcata. We were able to provide him with several leads that may be useful. We have had no report of his conclusions.

Standard Lamp Mechanism for Attic Range. The standard lamp and sector disk mounts on the photometric bar of the 100-meter attic range have been redesigned. A remotely operated linear drive mechanism moves both the standard lamp and sector disk in and out of the calibration position.

U. S. DEPARTMENT OF COMMERCE

Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS

A. V. Astin, *Director*



THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D. C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

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

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

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

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING LABORATORY

Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Troposphere and Space Telecommunications. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

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

RADIO STANDARDS LABORATORY

Radio Standards Physics. Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

Radio Standards Engineering. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

Joint Institute for Laboratory Astrophysics-NBS Group (Univ. of Colo.).

