

NATIONAL BUREAU OF STANDARDS REPORT

7757

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period July 1 to September 30, 1962

By
Photometry and Colorimetry Section
Metrology Division



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

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 itself 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 Basic Radio Propagation Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of non-periodical 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 PROJECT

0201-20-02411
0201-20-02414
0201-30-02303

November 1962

NBS REPORT

7757

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
July 1 to September 30, 1962

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
July 1 to September 30, 1962

I. REPORTS ISSUED

<u>Report No.</u>	<u>Title</u>
6190 Supp.	Current-Intensity, Voltage-Intensity, and Current-Voltage Characteristics of Airfield Lighting Lamps
7519	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period October 1 to December 31, 1961.
7522	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period January 1 to March 31, 1962
7536	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period April 1 to June 30, 1962
7591	The Transition Zone of the Visual Approach Slope Indicator As a Function of Beam Chromaticities
7702	Output Maintenance of Sealed-Reflector Approach and Runway Lights
7712	Overcurrent Protector for Monocyclic-Square Type Series-Circuit Regulators
21P-12/62	Chromaticity and Photometric Tests of Filters for Visual Approach Slope Indicator Equipment
21P-25/62 Supp.	Supplemental Tests of a Type AL-1 Flush Approach Light Unit Manufactured by Crouse-Hinds Company
21P-41/62	Luminous Output and Intensity Distribution Measurements of Eight Developmental 120-Watt Lamps for Obstruction Lights
21P-57/62	Qualification and Photometric Tests of a Preproduction Model of a Circling Guidance Light Manufactured by Multi Electric Manufacturing, Inc.
21P-59/62	Intensity Distribution Measurements of Six Developmental 600-Hour Lamps for Use in a 300-mm Code, or Hazard, Beacon

II. VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter. Visual observations of slant visibility to elevations of 20, 60, and 100 feet above the ground level have been obtained whenever possible when atmospheric conditions reduce visibility to within the limits of the 3700-foot range. These observations will be compared with the measured horizontal transmission, the slant visibility meter reading, and theoretically computed values. Not enough observations have been analyzed to determine the correlation with the other data. Data from the slant visibility meter records for 1958, 1961, and 1962 are being tabulated for study of the frequency of occurrence of restrictive atmospheric conditions and analyzed for comparison to assumed theoretical layered conditions. A tower used to carry the visibility targets and threshold lamps for these tests was damaged when it was blown down by high winds. The tower has been repaired.

Shipboard Visibility Meter. Modification of the gating circuit designed to reduce the integral of the a-c noise produced by the background was completed. However, before tests of the performance of the system could be made, the capacitor in the power supply of the flash-tube failed. A new capacitor has been ordered but has not been received.

Transmissometer.

100 Percent Setting Calibrator. The report of the development, theory of operation, and service testing of a 100 percent setting calibrator for the transmissometer has been drafted. The report includes appendixes covering instructions for making the field installation for using the calibrator, instructions for checking the linearity and adjusting the sensitivity of the calibrator, and a discussion of other possible methods of determining the transmissometer setting. The calibrator, when correctly adjusted for sensitivity and linearity and used carefully, can be used to determine the transmission reading with an error of less than 1.5% when transmission is uniform and 0.90 or better. Nonuniformity of atmospheric conditions is the most serious limitation on using the calibrator to determine the setting for the transmissometer.

Because of the general interest in a calibrator, a conference was arranged with personnel of the several weather services. Problems in the use of a calibrator were reviewed and NBS experience in this field was reported.

Expanded Scale Indicator. A report of the development of the expanded scale transmissometer indicator is being completed.

A converter relating meter deflection to visibility and intended for use on the recorder of expanded scale indicators is being designed.

Brightness Measuring Equipment. A transmissometer, a fixed direction brightness receiver, a power supply, a three-range indicator, and a three-range automatic sensitivity control were loaned to the University of California Illumination Laboratory for the Federal Aviation Agency fog chamber project. This equipment will supplement the transmissometer which was loaned earlier.

The Effect of High-Intensity Airport Lighting on Background Luminance and Horizontal Illumination. The paper entitled "Horizon-Sky Brightnesses Produced by Airfield Lighting" has been issued as part of the Collected Papers of the Washington Conference, May 4 and 5, 1961, of the Aviation Committee of the Illuminating Engineering Society. This work will also be issued as an NBS report.

Nomographs for the Computation of Visual Range. The Allard's Law relation, $E = I I^D / D^2$, can not be solved directly for D and can not be solved for I or D with an ordinary desk calculator unless logarithms are used. For these reasons, nomographs are generally used in visual range computations. These nomographs have been prepared in many different forms. However, they are, in general, based upon particular thresholds and units of measurement and hence lack flexibility. The set of nomographs used at the National Bureau of Standards for many years, based on a design developed by M. K. Laufer, provide the required flexibility. These nomographs are now being prepared in a form suitable for release as an NBS report.

III. AIRFIELD LIGHTING AND MARKING

Visual Approach Slope Indicators.

Effect of Color Filter on Location of Transition Zone in a Visual Approach Slope Indicator. A group of eight observers was used as an evaluating team to determine the effects of changes in the chromaticities of the VASI beams resulting from the use of "highway-red" and "color-correcting white" (4000°K) filters on the location of the transition zone. A statistical analysis of the data accumulated indicated a large (but normally distributed) variation in the responses of the observers. The study showed specifically that changes in both the color temperature of the lamps and of the filters affected the elevation angle of the pink zone systematically and the width of the pink zone randomly. All of the changes, however, were small. NBS Report 7591 giving the results of the study was issued.

PAR-64 VASI Lamps. Additional photometric measurements were made of the twelve off-focus PAR-64 VASI lamps at the end of 250, 500 and 750 hours of burning time. In view of the variability of the lamps from the (three) different manufacturers, a second group of lamps similar to the first was put on life test in order that the voltage drop across each lamp could be observed during the first 500 hours of burning. NBS Test Reports 21P-22/62, -42/62 and -45/62 will be issued on the completion of the life test of the second group of lamps.

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Chromaticity and Photometric Tests of VASI Filters. NBS Test Report 21P-12/62 was issued giving the results of chromaticity and photometric tests made on several samples of VASI filters received from Kopp Glass, Inc. The tests indicated a transmission ratio above 0.20 for the aviation-red glass, above 0.15 for the highway-crossing-red glass, and a horizontal beam spread of 18° (at 50% of peak intensity) when the filters were used with 300-watt, 6.6-ampere, PAR-64 VASI lamps.

Overcurrent Protector for Series-Circuit Regulators. A report on the development and service testing of an overcurrent protector for series-circuit regulators has been completed. This protector can automatically reduce the brightness setting of the series-circuit regulator from step B5 to step B4 when the output current reaches a predetermined value (6.7 amperes rms). The protector will operate whether the increase in current is produced by opened secondaries of isolating transformers in the circuit or from an increase in input voltage. Also the protector can indicate that a reduction in brightness step from increased output current has occurred although the regulator has been deenergized.

Stub Approach Beacon System. No progress was made because of lack of winds favorable to approaches on this runway. Favorable winds are expected during the next quarter and additional comments on the performance of the stub approach beacon are expected then. The coverage by the stub beacon installation has been increased on the downwind leg on the approach by shortening the shield behind the beacon. This did not seriously affect the signal of the Instrument Landing System (ILS) localizer.

Photometric and Efficiency Tests of a Transformer-Type Pancake Light. Photometric tests and current-voltage measurements have been made of a semiflush mount pancake light manufactured by Strong Electric Company, Toledo, Ohio. The unit has an integral isolating transformer with a 20-ampere primary. The secondary supplies a 6.6-ampere, 200-watt quartzline lamp. The transformer provides 6.4 amperes in the secondary circuit. A preliminary examination of the data indicated a peak intensity of slightly more than 9.5 kilocandles. The efficiency of the transformer was 83%.

Circling Guidance Light. NBS Report 21P-57/62 was issued. This report gives the results of qualification tests and photometric measurements of a preproduction model of a circling guidance light manufactured by Multi Electric Manufacturing, Inc., Chicago, Illinois. The tests were made to determine the conformance of the light to the requirements of Specification MIL-L-22252(Aer). These units, as similar units tested previously, failed to meet all beam spread requirements of the specification, but the deficiencies in the intensity between specified angles were not significant. It was recommended that the units be accepted after correction of eight minor deficiencies.

Lamp Characteristics. NBS Report 6190 Supplementary was issued. This report is a supplement to NBS Report 6190 which contains a compilation of measurements of the intensity-current-voltage characteristics of lamps of the types generally used in approach, runway, and taxiway light systems. This supplement reports the characteristics of those lamps which have been developed since Report 6190 was issued in October 1958.

Output Maintenance of Sealed Reflector Approach and Runway Light Lamps. NBS Report 7702 was issued presenting an analysis of the periodic measurements of the relative output of 6.6-ampere and 20-ampere approach light lamps. Curves were presented showing the decrease in output with burning time for the complete lamps and for selected zones of the lamps for both vertical and horizontal positions of the seating planes. Except for the 6.6-ampere lamps with stippled covers, all of the lamp types showed better maintenance of both peak intensity and lumen output when they were burned in their design position. In general, the relative lumen output of the lamps decreased more slowly than the relative peak intensity. Therefore, maintenance of total lumen output is not a good measure of the performance of the lamps.

500-Watt, PAR-56 "Quartzline" Approach and Runway Light Lamps. A study was made of two types of 500-watt, 20-ampere, PAR-56 "quartzline" lamps for the purpose of comparing the photometric characteristics of these PAR-56 "quartzline" lamps with the photometric characteristics of the PAR-56 lamps of the same rated wattage in present use, whose requirements are specified in Military Standard Drawings MS 24348(ASG) and MS 24488(USAF). The results are reported in NBS Test Report 21P-44/62. All of the eight lamps met the requirements of the applicable drawing. The initial peak intensity of these lamps is somewhat lower than that of the 500-watt, PAR-56 lamps in use at present. Tests are now being made on their intensity maintenance as a function of burning time. A supplementary report will be issued at the completion of these tests.

Photometric and Life Tests of 6000-Hour Obstruction Light Lamps. NBS Test Report 21P-41/62 was issued giving the results of the initial photometric tests made on eight developmental 6000-hour, A-21 obstruction light lamps designed for 120-volt operation at 120 watts. The lamps were still on life test at the close of the quarter and the results of that test will be reported in a supplemental report.

Intensity distribution measurements were made using these lamps in a type AN-L-10 clear globe. The peak intensity was approximately 450 candles and the vertical beam spread at 50% of peak intensity was approximately 10 degrees.

Photometric and Life Tests of 6000-Hour, 300-mm Code, or Hazard, Beacon Lamps. Initial photometric tests were made on six developmental 6000-hour lamps for use in a 300-mm code, or hazard, beacon. This type lamp has a PS-40 bulb, a C-7A filament and a mogul prefocus base. Intensity distribution measurements were made using these lamps in the lower section of a code beacon. The peak intensity and the vertical beam spread were both about 20% higher with the new lamps than they were with the 500-watt, 1000-hour-life lamps. NBS Test Report 21P-59/62 was issued giving the results of these tests. The lamps were put on life test and the results will be reported in a supplemental report.

Supplemental Tests of Gasket Material and Cable Assemblies. The results of the tests at the National Bureau of Standards of a type AL-1 flush approach light showed some deficiencies in the gaskets supplied with the unit. The FAA had previously found the cable assemblies submitted with the units to be unacceptable. Gasket material, sheath material and finished cable assemblies were submitted a second time for test. The retesting indicated the gasket material was not the same as that used in the original gaskets. The gasket material resubmitted for test was deficient in that part of the test having to do with ultimate elongation after oil immersion. The cable-assembly rubber was found deficient on two counts, original tensile strength and tensile strength after subjection to an oxygen atmosphere for 96 hours at 70°C. The cable assemblies were tested for hardness of the sheath. They were acceptable on this test. Test Report 21P-25/62 Supplementary was issued.

Frangible Couplings. A report, "Tests of Removing Stubs of Tube Base Adapters" has been drafted. Tube base adapters were modified by forming slots in the section of the adapter below the "break-off" groove. Slots were formed on the outside of some adapters and on the inside of others. After the adapter had been broken off, tests were made to determine the difficulty in removing the stub from a flange by breaking out sections with a hammer and drift pin. The stubs with the slots on the inside were much easier to remove. A modification of the tube base adapters is recommended to make it easier to remove these stubs which may become so corroded that the stub cannot be unscrewed. This modification consists of forming rectangular-shaped slots along the inside wall from the top of the inside hexagonal section to the bottom of the adapter. These slots should be a minimum of one-eighth-inch wide and should be deep enough to be within one-sixteenth inch of the bottom of the threads on the outside of the adapter. The slots should be located at the corners of the inside hexagonal section. Only one slot was used in the tests but slots at adjacent corners of the hexagonal section may be desirable.

Airfield Lighting Connectors Field Tests. The leakage current of the connectors being tested was measured again. Most of the connectors had a small increase in leakage current but none of the connectors indicated a trend toward failure. These connectors have been buried approximately three feet deep for 36 to 42 months. The connector with the greatest

leakage had a leakage current of 28 microamperes at 15,000 volts with no appreciable change for the past two years. This included the leakage across the taped end of the cable. The leakage current of some of the connectors was less than 0.1 microampere. The ground resistance in the vicinity of this test site was measured twice and found to be between 270 to 300 ohms to the driven ground rod. A draft of a report on these tests for the sections up to the results has been prepared.

IV. SEADROME LIGHTING

Cold-Cathode, Transistorized, FMF-6 Light. Photometric tests have been made of a cold-cathode, transistorized, FMF-6 Seadrome Light manufactured by Nelson Lights Company, South Pasadena, California, for the purpose of comparing the characteristics of this light with those of the lights in present use, whose requirements are specified in Specification MIL-L-7835(Aer). A comparison is also made with a transistorized-inverter type unit whose characteristics are given in NBS Report 7040. The test unit, with a maximum intensity of about 1.26 candles, has the lowest efficacy of the four units compared. One reason for this is that, other things being equal, low wattage, cold-cathode lamps inherently have a lower efficacy than hot-cathode lamps, primarily because the power loss at the electrodes is much greater in the cold-cathode lamps, especially for low values of lamp current.

The performance of the cold-cathode light described above, the presently used 6-watt FMF-6 light operated by a 90-volt dry battery, a 6-watt FMF-6 light using a transistorized inverter and a 12-volt dry battery (see NBS Report 7040) and the relative merits of a photoelectrically operated switch (see NBS Report 6225) and the "wand-operated" switch (see NBS Report 5781) were discussed at a conference with representatives of several organizations of the Bureau of Naval Weapons which was held to formulate the future program for battery-operated buoy-mounted lights.

V. CARRIER LIGHTING AIDS (TED NBS RSSH-32001)

Lights for Carrier-Deck Personnel. A qualitative evaluation has been made of the goggle-mounted lights submitted as preproduction samples by Englehardt Industries and the results were reported informally. Because of a combination of several factors, the intensity of these lights was considerably lower than that of the NBS-constructed samples. As required by the specification, lamps of a type having a longer life and lower output were used in the new design. No reflectors were used behind the lamps. The transmittance of the red filters was approximately 0.10 instead of 0.20. Any one of these three changes would be permissible, but with the combination of all three, the output of the lights appears marginal.

Stabilization of Optical Landing System. Technical advice and assistance has been given on problems related to the stabilization of the OLS.

Off-Glide-Path Indicator. Installation of the Fresnel Lens Assembly with attached experimental Hi-Lo cells on an outdoor range has been completed. Arrangements are being made for the installation of a telephone at an observation station on an apartment-house roof about 1.3 miles to the north of the lens assembly.

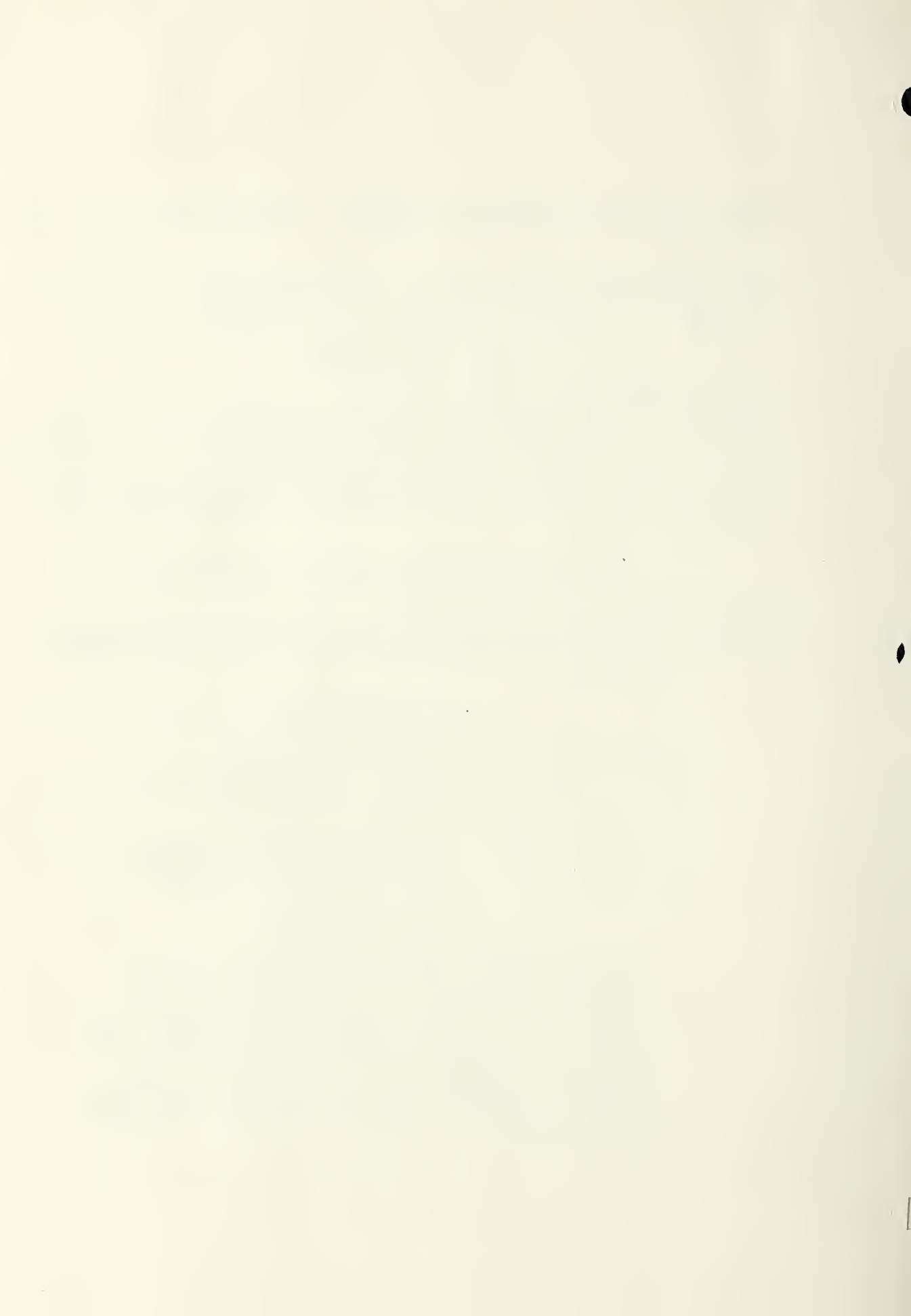
Sequence-Flashing Light Controller System. To aid in the development of the design requirements for a sequence-flashing light controller for carrier centerline guide lights, a switching device has been constructed. This device will apply an additional short duration pulse voltage to a light in a simulated centerline system. The optimum voltage of the pulse and duration for the applied voltage will be determined from visual observations.

VI. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Specifications and Drawings. The technical sections of the following specifications and drawings were reviewed and the comments have been forwarded.

MIL-L-6363C	General Requirements for Aviation Service Incandescent Lamps
MIL-L-22252A	Runway Circling Marker Light
MIL-T- (Draft)	Isolating Transformer for Wheels Warning Light
Y & D Drawing No. 894982	Definitive Drawing, Runway Distance Marker, Plan and Installation Details
W-L-101f	Lamp, Incandescent (Electric, Large, Tungsten-Filament)

A study was made comparing the Federal purchases in 1961 of the lamps listed in table IV as aviation lamps with the sales of other aviation lamps. Of the fifteen lamps with the highest dollar volume of purchases in 1961, only three are presently listed in W-L-101 and purchases of ten of the fourteen lamps listed were less than \$5000. An effort is being made to have the listing of aviation lamps in the specification revised.

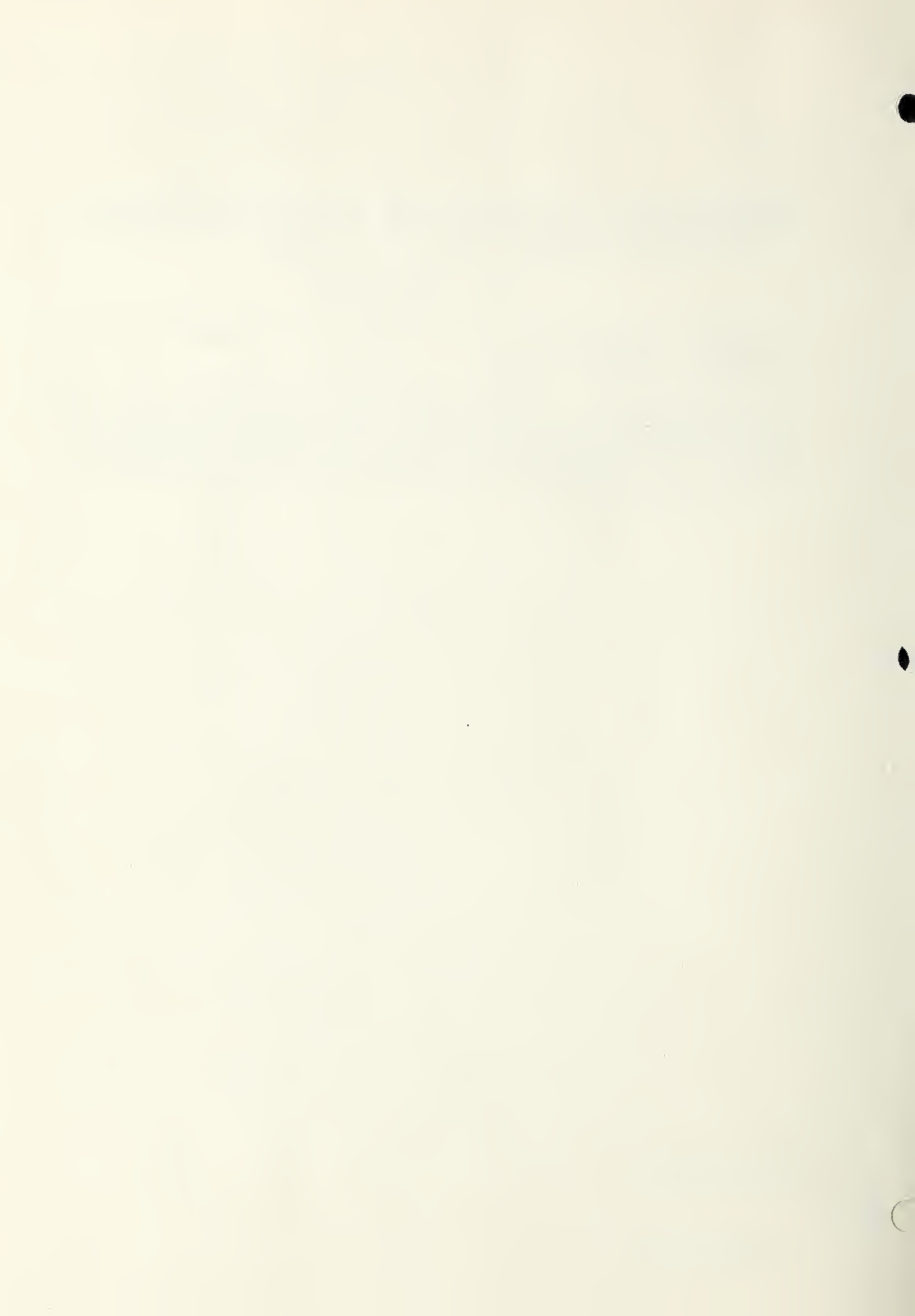


ICAO Activities. Mr. Douglas attended a three-week meeting of the Visual Aids Panel as representative of the International Commission on Illumination and served as Chairman of the Panel.

VII. MISCELLANEOUS

Personnel. Weston W. Williams, a mathematician employed for summer work at Arcata, resigned July 16.

Operation Pea Soup. Operation Pea Soup and the Aeronautical Icing Research Laboratory at the Arcata Airport were closed on September 30. Two 92-foot telescoping antenna towers and a portable instrument shelter were transferred to the National Bureau of Standards for use at the Field Laboratory.



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.

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

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. Microscopy and Diffraction. 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 Equipment. Cryogenic Processes. Properties of Materials. Cryogenic Technical Services.

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.

Radio Propagation Engineering. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. 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 Physics. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Millimeter-Wave Research.

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

