NATIONAL BUREAU OF STANDARDS REPORT

8920

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period January 1 to March 31, 1965

By
Photometry and Colorimetry Section
Metrology Division
Institute for Basic Standards

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
2120411 2120414 2120302	June 1965	8920

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

For the Period
January 1 to March 31, 1965

By
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Development, Testing, and Evaluation of Visual Landing Aids
January 1 to March 31, 1965

I. REPORTS ISSUED

Report No.	Title
8653	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period October 1 to December 31, 1964
21P-47/64 Supp.	Life Tests and Lumen Maintenance of Thirteen Q6.6/PAR64/3 Lamps for a Visual Approach Slope Indicator
212.11P-27/65	Photometric Tests of a Lens Cell of the Fresnel-Lens Optical Landing System with an "Egg Crate" Lens-Restraining Device
212.11P-69/65	Photometric Tests of a Metal Blinder for a PAR-56 Condenser-Discharge Approach Light
212.11P-77/65	Electrical and Photometric Tests of a PAR-56 Type Condenser-Discharge Approach-Light Lamp
212.11P-79/65	Photometric Tests of a Lens Cell of the Fresnel-Lens Optical Landing System with an Overlay Mask with a 0.06-Inch-High Source Slot
Memorandum Report	Flood Emergency Activities of the National Bureau of Standards Visual Landing Aids Field Laboratory, Arcata, California, December 21, 1964 to January 16, 1965.
213.04/313-2	Hardness Measurements of Six Inset Runway Lights

II. VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter.

The data and results obtained from the slant visibility meter were reviewed. No additional data are now being accumulated from this equipment as sufficient information is available for preparing a report. Work on assimilating this data into report form will begin soon.

Shipboard Visibility Meter.

Data are being collected in a variety of weather conditions relating the measurements of the feasibility model of the shipboard visibility meter to measurements of transmittance made with a 750-foot baseline transmissometer. These measurements indicate that, as would be expected, even minor random variations in atmospheric transmittance which occur in only small volumes have a greater effect on the backscatter measurements than they do on direct measurements of transmittance. See figure 1.

The problem of designing and constructing a field test model of the instrument has been undertaken by the Measurement Engineering Division. Preliminary design studies are now being made.

Transmissometers.

High Pulse Rate Receiver. Tests of a method of increasing the pulse rate of transmissometer photopulse units by modifying the circuit by the addition of R102A and C102A as indicated in figure 2 have been completed.

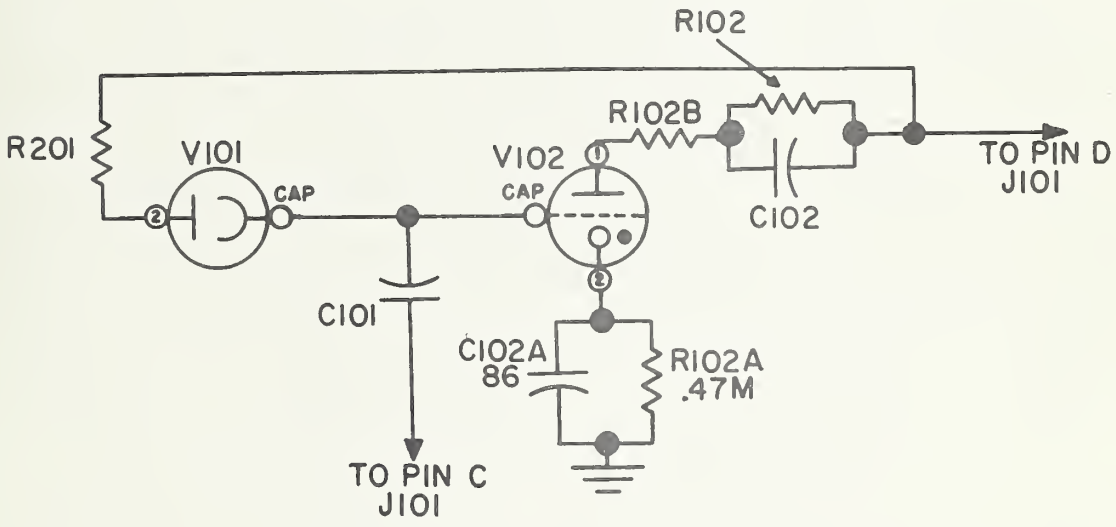

Figure 2. Modified Transmissometer Photopulse Unit

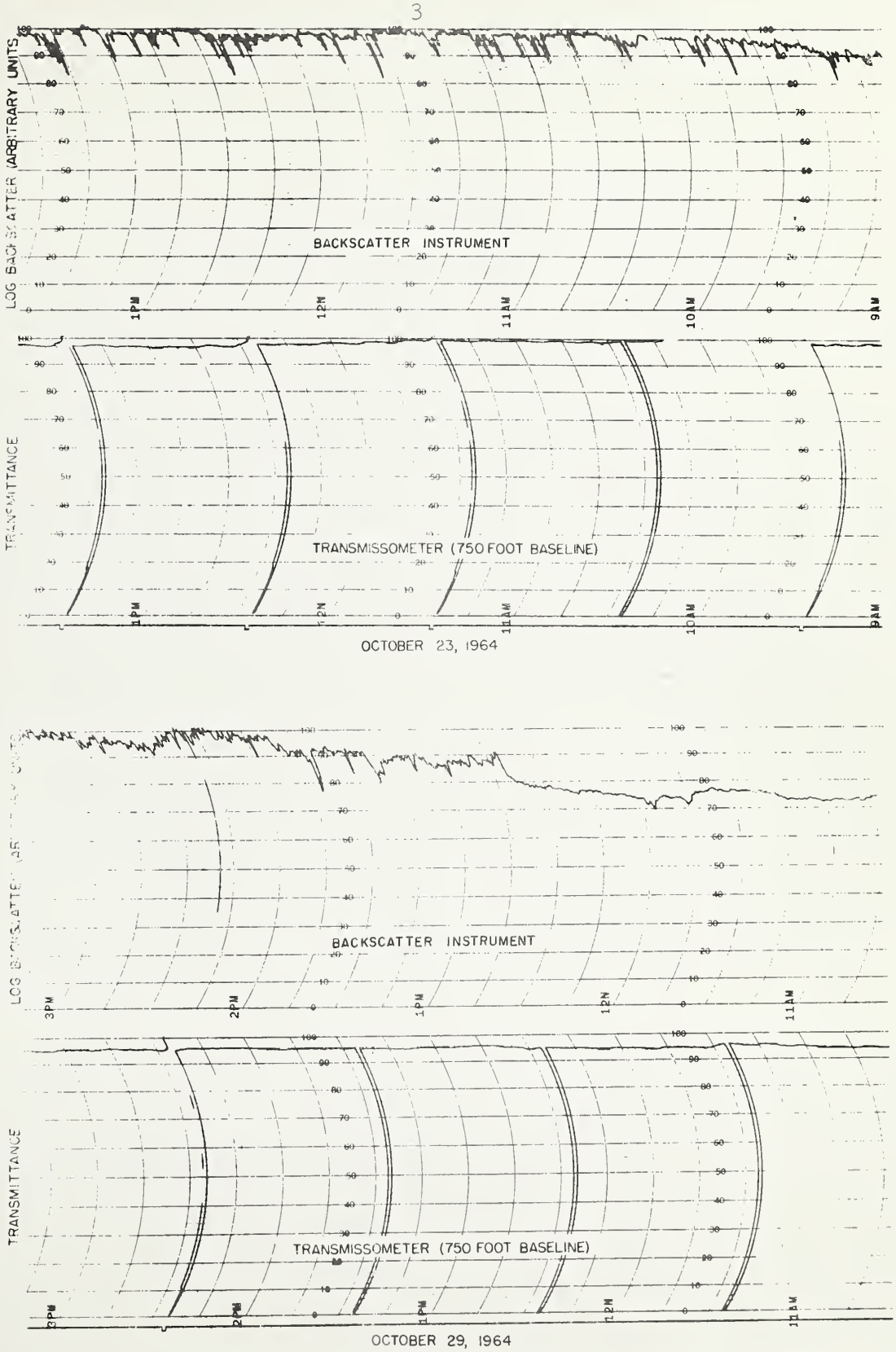

Figure 1. Simultaneous records of the backscatter visibility meter and the transmissometer at NBS Washington. The sharp dips in the backscatter meter readings are caused by local smoke and blowing leaves.
NBS Report 8920.

With the modified photopulse unit it was possible to obtain a pulse rate, in clear air, greater than 20,000 pulses per minute, at least 5 times the pulse rate of the conventional photopulse unit.

The sensitivity of the unit was satisfactorily stable. However, when the tube initially used for V102 was replaced with other type WL-759 tubes, wide variations in clear weather pulse rate, from 2 to 20 times the pulse rate of the unmodified unit, were observed. Some of the trigger tubes were unstable when operated in the modified unit. In addition, most of the trigger tubes showed wide deviations from linearity. Hence there appears to be no object in continuing further work on this circuit. Tests of the feasibility of using a photomultiplier in place of the phototube have been started.

Air Force 100 Percent Setting Calibrator. Installations for testing the Air Force 100 percent setting calibrator were prepared for the runway 31 touchdown transmissometer and for one of the transmissometers, T-M, in the fog variation study test area. Tests with this calibrator, with one exception, have indicated agreement within ±3 percent of the observed and past record indications of the correct 100 percent setting. On one occasion the calibrator indicated a setting value of 102 percent when the correct setting should have been 97 or 98. The most serious problem in using this calibrator is the time required in obtaining the reading at the FAR position after the reading at the NEAR position is obtained. When towers are involved and the calibration is being made by one man, this time may be 10 to 20 minutes and any changes in transmittance during this period will seriously affect the results.

250-Foot-Baseline Transmissometers. In preparation for tests comparing the transmittances recorded by transmissometers with 500-foot baselines with those recorded by transmissometers with 250-foot baselines, the concrete bases for the two 250-foot baseline transmissometers were poured. The 250-foot-baseline transmissometers will be alongside and 10 feet from the Weather Bureau transmissometer near the touchdown zone of runway 31 at Arcata. The receivers, projectors, indicators, power supplies, and towers for two transmissometers are being loaned by the Weather Bureau.

Meter Failures. An analysis was made of a report of excessive failure of meters in the Amplifier-Power Supply and Projector Power Supply units. The failures are believed to be caused by circuit failures in the signal lines or by lightning and not by starting transients. A circuit modification was suggested to disconnect both sides of the meters from the lines when the meters were not in use.

Signal and Power Lines. At Arcata the Federal Aviation Agency has replaced the signal and power cables for the ILS between the tower and the glide-slope and localizer buildings. The old cables are being made available for our use. These and some other abandoned cables running from the tower into the area near the glide-slope building will be used to bring the signals from the transmissometers and other test units into the laboratory. Some work has been done on salvaging these cables. Additional work will await completion of installation of the new equipment.

Weather Bureau Transmissometer Signal. The Federal Aviation Agency has reported interference on the ILS monitor signal lines from the Weather Bureau transmissometer signal. Before the new cable was installed, the transmissometer signal lines were in the same cable as the ILS signal lines, and coupling between lines was suspected to be responsible for the interference. However, interference was still present when the ILS signals were put into the new cable, and the transmissometer signal was kept in the old cable. Both cables come into the glide-slope building. The interference was eliminated by putting the transmissometer signal into a cable which does not enter the glide-slope building and which follows a different route to the tower building than that of the ILS cable.

Backscatter Meter.

The four backscatter meters which are being constructed by Hoffman Electronics under an Air Force - Coast Guard contract are expected to be delivered to Arcata for initial testing early in the next period. Field installations for these units will not be prepared until the equipment is received. Plans for testing this equipment are discussed in the Progress Report for October to December 1964.

Variation-of-Fog Studies.

During this quarter there were no observations or periods of fog selected for analysis because of lack of suitable atmospheric conditions and because the stands and equipment were being reworked to improve operating performance. The temporary stands used for mounting the field units were subject to alinement shifts which had some effect on the indicated transmittance. To improve the stability of the units, concrete footings for the receiver stands were prepared, the tops of the stands were guyed to anchor rods with turnbuckles, the focus of each receiver was checked and adjusted, and the diameter of each field stop was increased from 1.5 millimeters to 2.1 millimeters. Other maintenance was continued on the equipment and a check procedure was established to eliminate possible sources of error in readings.

Analysis of the data obtained during last fog season has continued. Ratios of indicated transmittances from the different units during selected periods of fog were determined from selected sample records of fog.

Visibility Thresholds.

The analysis of the data comparing visual observations of a 4-foot by 4-foot black target in dense daytime fog with the transmissometer indications has continued in an effort to explain the apparent discrepancies reported in the last Progress Report. A new 4-foot by 4-foot target and three 1-foot by 1-foot targets have been installed at each end of the 1000-foot visual observation range. The small targets are located adjacent to the large target with a small target at the same elevation as the bottom, center, and top of the large target. This arrangement is intended to determine if the visual range is affected appreciably by small changes in height above ground when the target is six to ten feet above the ground. Telephotometer measurements of the brightness of the targets and background will also be made during the next fog season to determine by direct measurement the observer's contrast threshold in dense daytime fogs, if equipment can be made available.

III. AIRFIELD LIGHTING AND MARKING

Navy Taxiway Lighting Standard.

The draft of the Navy Taxiway Lighting Standard was revised. The figures were revised and prepared for reproduction. This Standard will be issued during the next quarter.

Stub Approach Beacon.

The stub approach beacon to runway 13 at Arcata has been transferred to the Humboldt County Department of Aviation. This beacon has not been operating, but operation is expected to be resumed when control cables to the tower are made available. These controls will be in the cable abandoned by the Federal Aviation Agency.

Runway Identification Light.

The revision of the synchronizing circuits has been completed. Under this revision, when the two units, each driven by synchronous motors, are out of phase, the current to the "slave" motor is interrupted during a portion of each cycle, while the "master" motor continues to run without interruption at synchronous speed. The angular error is gradually reduced by a small amount once during each cycle until the phase of the slave matches that of the master, and each unit then runs at synchronous speed of 30 rpm, 60 flashes per minute. A reversing switch, located in the slave unit, controls the direction of rotation of that unit so that the pair may be rotated in the same angular direction, or may be counter-rotated to provide directional guidance. The units will be mounted on the NBS outdoor range for observations.

Runway Centerline Lights for SATS Mat.

A proposed design for a centerline light fixture has been made. Since the completion of the design, the following additional requirements for the fixture were obtained from NAEL(SI):

1. The fixture must not project above the surface of the mat.
2. There must be no drain holes in the fixture.
3. The lamp enclosure must be watertight.
4. The unit must be capable of being operated by two flashlight batteries (D-cells) in the event of an emergency.
5. The top surface of the fixture must not exceed 2 3/4 inches in width.

If these requirements are valid, the following design is proposed for consideration. Basically, the unit should be an aluminum slab, the thickness of the mat, 24 inches long and 2-3/4 inches wide on the top surface, with interlocking profiles on all four sides. The slab should contain an open 1-1/2-inch-wide flat-bottom slot centered on the axis of the 24-inch dimension and tapering from the top surface on each end to 1/4 inch from the bottom surface at a point approximately 1 inch from each side of the center, providing a flat surface on the bottom of the slot approximately 2 inches long and 1-1/2 inches wide for mounting the lamp housing.

A low-wattage lamp in a sealed, watertight, bidirectional, plug-in enclosure should be mounted on the bottom of the 2-inch by 1-1/2-inch surface. The enclosure may contain a pair of lenses to control the vertical intensity distribution of the light. The lamp should be mounted as high as possible within the enclosure, which would mean a minimum of protection overhead. A narrow, horizontal slot should be milled through one of the sloping faces of the 1-1/2-inch wide slot to accommodate an armored cable that would lead from the lamp enclosure through the narrow slot, around a milled radius, into the edge raceway of the mat, and terminate in a watertight battery container holding the D-cells. Provision should be made for plugging an external low-voltage source into the battery container for use under normal conditions.

Drainage of Inset Lights.

A study has been undertaken to determine the feasibility of the forced draining of inset lights. One type of light, containing a 45-watt quartz-iodine lamp, was selected on the basis of immediate availability, although the principles involved would apply to any type of inset light. Two units of the selected type were modified by machining a sump in the bottom of the inside of the light chamber. A copper tube was inserted into the sump through a hole drilled through the wall of the chamber from the top surface at a point outside of the gasket that seals the removable cover plate to the lamp chamber. In one unit the tube extended up through the cover plate and was flush with the top surface of the plate. In the second unit the tube extended up to, and was flush with, the top surface of the sidewall of the light chamber, so that the cover plate provided some degree of protection for the top end of the tube. In laboratory tests, various amounts of water were put into the light chamber. In one test the chamber was filled with water. The unit was then assembled and operated at rated current. In each case the expansion and "breathing action" in the chamber forced, for all practical purposes, all of the water from the light chamber. It is proposed to put these two units in the field for testing their performance under service conditions.

A preliminary test was made to investigate the feasibility of filling the light chamber with a type of silicone fluid, thus eliminating the presence of air in the sealed enclosure. This first test indicated that the coefficient of thermal expansion of the fluid probably was too high for successful operation of the present unit. A modification of the unit is under consideration to further investigate the feasibility of a silicone-fluid-filled unit.

Distance-To-Go Lights.

A total of six different configurations of symbols and digits representing distance-to-go marking has been constructed. Preliminary observations indicate that the system consisting of Arabic digits seems to have little merit. There appears to be some merit in a system in which the digit "5" is represented by a transverse bar of lights, the numeral "10" by 2 transverse bars, and the digits 1, 2, 3, and 4 by the corresponding number of longitudinal bars of lights. Any numeral up to 14 could then be represented by a combination of, at most, 2 transverse bars and 4 longitudinal bars, numeral 15 being represented by 3 transverse bars. These preliminary observations, however, have not indicated a significant superiority of any one particular system of configurations.

Modified Cell of the Source-Light Indicator Assembly of the Mark 6 (Shipboard) Fresnel-Lens Optical Landing System for Use as a Heliport Landing Aid.

Photometric measurements were begun on a cell modified, for use in a helicopter landing aid, in such a manner as to provide a virtual image distance of 28 feet, and, consequently, an augmented field angle.

Hardness of Inset Lights.

Hardness measurements have been made on six inset runway lights. The results are given in table 1.

Table 1. Hardness of Inset Lights

Sample Identification	Test piece	Rockwell hardness Avg	Rockwell hardness Range	Brinell hardness, 3000 kg load
Westinghouse (12 in. dia)	(a)	B81	B71-B88	200
Westinghouse (8 in. dia)	(a)	B81	B71-B92	185
Multi 1130	(a)	B88	B82-B91	164
Structural Electric	Casting	(b)	(b)	122
	Center plate	C37	C37-C38	-
Sylvania R.I.L.E.	Center ring	B86	B76-B98	180
	Outer ring	B96	B93-B98	-
Magdisc	(a)	B92	B88-B94	-

(a) One piece top

(b) Results ranged from B10 to B75. Rockwell B scale does not seem satisfactory for this material.

Metal Blinder for a PAR-56 Condenser-Discharge Approach Light.

Photometric measurements were made of a PAR-56 Condenser-Discharge Approach Light, type FT 34HP, with a metal blinder, a device 11-1/2" long, 10-1/2" wide, and 4" high at the end which is fastened to the lampholder, tapering to a height of 3/4" at the cutoff end. The cutoff angle is 2.40° below horizontal when the lamp seating plane is vertical. Relative intensities in the vertical plane through the axis of the unit with and without the blinder are as follows:

Elevation (degrees)	Relative Intensity	Elevation (degrees)	Relative Intensity
+15	100%	-5	40%
+10	90%	-10	21%
+ 5	73%	-15	4%
0*	55%	-18	0

* 0° vertical contains the axis of the light.

Results are reported in detail in NBS Test Report 212.11P-69/65.

PAR-56-Type Condenser Discharge Approach-Light Lamp.

Electrical and photometric tests were made of one FT34HP, a four-turn helical flashtube mounted in a PAR-56 envelope. NBS Test Report 212.11P-77/65 was issued, from which the following table is taken:

Table 2. Comparison of Present Unit with Previously Tested Condenser-Discharge Approach Lights.

a. Measured Values

From NBS Test Number	Peak Intensity (kilocandelas)	Beam Spread in Degrees at 5 kilocandelas		at 10 kilocandelas		Intensity at 25° Beam Spread	
		Vertical	Horizontal	Vertical	Horizontal	Vertical (kilocandelas)	Horizontal (kilocandelas)
212.11P-77/65[1]	21.4	38.3	37.6	28.9	29.8	12.4	13.7
21P-44/61[2]	19.8	38.4	38.8	29.7	29.8	12.3	13.0
21P-20/56[3]	18.1	33.1	32.2	24.9	23.9	9.8	9.0
b. Values Adjusted to 60-watt Seconds Per Flash							
212.11P-77/65	18.3	36.8	36.1	26.3	27.5	10.6	11.7
21P-44/61	15.4	36.3	35.5	24.0	25.4	9.6	10.1
21P-20/56	16.8	32.4	31.1	23.9	23.0	9.1	8.4

[1] Flashtube operated at 70 watt-seconds per flash.

[2] Developmental 3-turn helix in PAR-56 bulb; flashtube operated at 77 watt-seconds per flash.

[3] Conventional type CD-2 unit utilizing a flashtube and 13-inch-diameter reflector; no cover glass; operated at 64.5 watt-seconds per flash.

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

Measurements of luminous output were made of the remaining seven of eight developmental 700-watt, 6000-hour lamps for the 300-mm code, or hazard, beacon after approximately 4200 hours of burning time, 70% of design life. The average luminous output was 6800 lumens, which is 64% of the average initial output. Lamp #2 burned out at 2606 hours. The life test will continue.

Q6.6PAR64/3 Iodine-Cycle Lamps.

NBS Test Report 21P-47/64 Supplementary was issued, giving a mean lumen maintenance of four developmental iodine-cycle lamps for VASI systems of 98% after 1000 hours, and, for one lamp, a lumen maintenance of 91% after 1400 hours of burning.

IV. SEADROME LIGHTING AND MARKING

No work was conducted in this field during the quarter.

V. CARRIER LANDING AIDS

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

NBS Test Report 212.11P-79/65 was issued giving the results of photometric measurements of a cell with a 0.06-inch-high source slot.

NBS Test Report 212.11P-27/65 was issued giving the results of photometric measurements of a cell with an "egg crate" lens restraining device.

Photometric testing was begun on a lens cell in which the plastic Fresnel lens was replaced by a multiple-element glass lens, housed in a "black box" 10" x 14" x 8", to reduce the "glare" or stray light emitted by the unit.

VI. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Review of Specifications.

Review of specifications or drawings for proposed revisions has continued.

VII. MISCELLANEOUS

Activities During the Flood Emergency.

For the month of January much of the activity of the Visual Landing Aids Laboratory at Arcata, California, was directed toward assistance in the flood emergency and airlift into the area which was isolated by the floods in Northern California during the latter part of December. See the Progress Report for the previous quarter.

Photometry of Colored Light.

Additional measurements were made for inclusion in the forthcoming paper on the photometry of colored light. The 929 phototube - Wratten filter combinations showed less spread than was expected. Therefore, a new group of phototubes was tested. These exhibited similar uniformity.

Paper on Atmospheric Transmissivity.

A paper "Some Problems in the Determination of Atmospheric Transmissivity" was presented at the Conference on Atmospheric Limitations to Optical Propagation held at Boulder, Colorado on March 18 and 19.

Definitions.

A draft of definitions of terms applicable to retroreflectors was prepared for use by the IES Testing Procedures Committee.

Definitions of aviation lighting terms were drafted for inclusion in the ASA definitions.

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