NATIONAL BUREAU OF STANDARDS REPORT

9443

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period April 1 to June 30, 1966

By
Photometry and Colorimetry Section
Metrology Division
Institute for Basic Standards

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NBS PROJECT October 1966 **NBS REPORT**

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Development, Testing and Evaluation of Visual Landing Aids

Consolidated Progress Report to

Ship Installations Division
and
Meteorological Division
Naval Air Systems Command
Department of the Navy

and to

Federal Aviation Agency

For the Period
April 1 to June 30, 1966

By
Photometry and Colorimetry Section
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Development, Testing, and Evaluation of Visual Landing Aids
April 1 to June 30, 1966

I. REPORTS ISSUED

Report No.	Title
9385	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period January 1 to March 31, 1966.
21P-51/66	Photometric and Thermal Shock Tests of Inset Light Filters and Lenses.
Memorandum Report	Peak-to-Peak Voltages of 200-Watt 6.6-Ampere Isolation Transformers.
Paper	"Can Infrared Improve Visibility Through Fog?" Illuminating Engineering, 61 243 (1966).

II VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter.

The first draft of the slant visibility meter report has been revised and forwarded for comment. The revisions did not change the conclusions reported in the previous period. Appreciable further revisions are anticipated before the report is completed.

The air compressor has been repaired and the system is again in operating condition. After repairing the compressor, no difficulties were encountered in returning the slant visibility meter back to operation. If the proposed laser project is tested at Arcata, the results from the slant visibility meter may be useful in evaluating the results from the laser.

Transmissometers.

High Pulse Rate Receiver. Tests of the high pulse rate receiver have been completed. A summary report will be prepared. As a consequence of the move of the National Bureau of Standards facilities to Gaithersburg, the transmissometers operating at Washington have been decommissioned.

Shipboard Visibility Meter.

The design of the peak detector circuit has been completed and two units have been constructed. They have been tested with the signal from the programmable slope pulse generator. The results follow:

Input pulse 1 to 99% risetime $\cong$ 40 μs

	Input Pulse Peak Amplitude (V)	Detector Output (V)	Error (mV)	Error (%)
	10.076	10.033	43	.4
	3.193	3.172	21	.7
Signal	1.007	1.005	2	.2
Channel	0.324	0.322	2	.6
Detector	0.106	0.105	1	1.
	0.0372	0.0371	.1	.3
	0.0170	0.0168	.2	1.2
	0.0104	0.0104	----	--
	9.969	9.943	26	.3
	3.168	3.152	16	.5
Reference	0.992	0.992	--	--
Channel	0.3170	0.3168	.2	.1
Detector	0.1033	0.1018	1.5	1.5
	0.0362	0.0375	1.3	3.5
	0.0170	0.0175	.5	3
	0.0094	0.0103	..9	10

The reference channel detector does not perform as well as the signal channel detector at low signal levels but this detector will always operate on signals with peak amplitudes near 10 V.

The two peak detectors and the log-ratio circuit have been constructed on plug-in cards which slide into a rack-mounted cage. This will allow individual blocks in the system to be changed without major packaging modifications. Oscilloscope photographs showing the input to the detector and the output of the detector, taken with a dual trace chopper oscilloscope are shown in figure 1. Pictures A and B show the operation with 10 V and 100 mV peak pulses with about the same risetime as the full power light pulse. Pictures C and D are the results with faster risetime pulses to determine if the detectors will work if the light is reduced by using a small energy storage capacitor which results in a faster risetime pulse. In picture C, the pulse is exceeding the slewing rate of the detector. This indicates that the reduced light pulse will have to be stretched by placing an inductor in series with the flash lamp to slow the risetime.

An operational amplifier connected as a current-to-voltage amplifier has been assembled to immediately follow the photomultiplier tube. This amplifier will feed the signal through a cable to the location of the remaining electronics. The electronics of the system including the preamplifier, peak detectors, log-ratio circuit and a single long-time-constant averaging circuit have been tested using the pulse generator signal. A coaxial attenuator is switched in and out of the input line to the preamplifier to simulate the reference and signal pulses from the photomultiplier. The complete circuit has been tested with different amplitude reference pulses. For values between 5 V_p and 10 V_p the output is linear within 0.3 dB for signals -20 dB and -40 dB with respect to the reference. The third decade is off by between 0.6 dB and 2 dB depending on the reference amplitude. It appears that for the best results in very clear weather (smallest signals) the reference amplitude should be set 9 V_p and 10 V_p. A meter to monitor the reference peak amplitude will be provided. In a later model of the system an automatic control system to set this level could be incorporated.

The electronics will next be adapted to the previously constructed flash lamp and photomultiplier assembly to allow testing of the entire system before construction is begun on a new lamp-photocell assembly.

<u>Fog Variability Studies.</u>

The fog variability data from the 1965 fog season were carefully reviewed for possible sources of error. Corrections for all errors detected did not change the mean results appreciably. The summary of these results was included in the report for the previous period. These data indicate that in dense fog a given location may consistently have higher transmittance than another nearby location during one fog season and average lower transmittance during another season.

Fog Detectors for Coast Guard.

The U. S. Coast Guard arranged a project for further evaluation of several types of fog detectors. An instrument shelter for housing buoy-type battery racks was constructed and the stands for mounting the fog detectors were installed. A trailer house furnished by the Coast Guard for housing the recording equipment and for working space was positioned. The required cables for power and signal lines, including the transmissometer signal, were installed. The Coast Guard personnel installed the units and operated them for the initial calibration check at Arcata.

Four types of fog detectors were installed: a backscatter fog detector type HS-508 manufactured by Hoffman Electronic Corporation; a Videograph A fog detector manufactured by Impuls Physik G.m.b.H.; a fog detector manufactured by Walter Kidde and Company; and a fog detector manufactured by Thomas A. Edison Instrument Division Laboratory. The Kidde instrument did not operate satisfactorily and was returned to Baltimore. The other three instruments were operated for several days and calibrated to indicate a fog condition when the visibility decreased to approximately five miles. Because of instability of atmospheric conditions during 5-mile visibility conditions and because of the relatively long time constants designed into the circuits, a precise adjustment was difficult. The three units had adequate sensitivity to detect a 5-mile visibility condition. After the units had been calibrated, they were moved from Arcata to the San Francisco Bay area for comparison with the manual control of fog warning devices. It is planned to return the instruments to Arcata for continuous operation during the regular fog season.

The continued interest in the backscatter type instruments for fog detection and measuring transmittance indicates that our experience in 1965 with the Hoffman type backscatter fog detectors may be of value to others. Therefore, a report will be prepared. This report will be concerned primarily with installation and maintenance but some evaluation of performance will be included. It should be completed during the next quarter.

Sperry Rand Laser Visibility Meter.

A project for Sperry Rand Research Center to test a laser visibility meter at Arcata for the Federal Aviation Agency has been proposed. If this project is authorized, the NBS Field Laboratory will provide facilities and arrange for obtaining the correlating data. This laser is a pulsed-ruby laser which will have the beam aimed horizontally. The backscattered return signal will be observed to determine transmittance and variations in transmittance. The correlating data will be obtained from three 250-foot baseline transmissometers to be installed along the direction of the beam in the first 3000 feet of the path of the laser beam.

Three sites for location of the laser on the Arcata Airport have been considered. The most practical and the most convenient location appears to be for the laser to be located near the ILS glidepath building with the beam aimed across the fog variability studies test area. This site will also be convenient for comparing laser data with slant visibility meter data. The work during this period has been limited to site studies, estimation of costs for installations, and planning for the possible installation.

III. AIRFIELD LIGHTING AND MARKING

Airfield Lighting Maintenance Manual.

The draft of Part II, the Maintenance Section, of the manual on "Maintenance of Airfield Lighting Systems" was reviewed, and a new draft based on this review is to be prepared.

Improved Cable-Fault Locating Set.

Work during the past quarter consisted of building a prototype model of the Receiving Unit and improving the circuit design of the Signal Generator which is still in the breadboard stage. The prototype Receiving Unit worked well, but a comparison of this receiver with the old commercial receiving unit suggested that improvements were still desirable. In particular, the new receiver was more easily overloaded by strong interfering signals and had much more audible noise in the audio output signal. The input amplifier of the receiver was consequently modified and is now at least as resistant to overload as the commercial receiver. The audible noise in the output of the new receiver does not appear to degrade the effectiveness of the receiver because the desired signal is easily distinguished from the background noise. However, an attempt will be made to reduce the noise.

Construction of a prototype model of the Signal Generator has not begun yet because of difficulty in obtaining parts. If the suppliers can deliver on schedule, construction can begin in September 1966.

The project is expected to be completed in its entirety before the end of 1966.

Heliport Beacon.

A full scale test bed has been constructed to permit field testing of the system of coding heliport beacons described in the Progress Report for the previous quarter (NBS Report 9385). This unit is not intended as a heliport beacon, but merely as a framework for testing the coding. The unit was designed, and construction was completed during this quarter.

The base, an airway beacon base, rotates a 4-foot diameter turntable at 12 r.p.m. Ten PAR-56 lamps, with filters (where needed), are mounted in MB-1 (PAR-56) approach-light lampholders at 36° intervals at the periphery of the table. Provision is made for operating the unit with either of 2 types of lamps: type 250PAR rated at 12.5 volts with a 35°H. and 7°V. beam spread (to 10% of maximum intensity) and type 399PAR rated at 115 volts with a 50°H. and 20°V. spread. By turning these lamps 90° in the lampholder, the beam spreads become 35°V., 7°H. for the type 250PAR lamp which gives a short flash, and 50°V., 20°H. for the type 399PAR lamp which gives a long flash. The sequence of colored flashes, as the table rotates, is as follows: (blank), white, green, green, white; this is followed by any desired combination of a maximum of 4 yellow flashes, and then a (blank) to complete the cycle of ten intervals.

The unit is being held at NBS awaiting instructions for installation for a field evaluation.

Inset Light Lenses.

NBS Report 21P-51/66 was issued giving the results of photometric measurements and thermal shock tests of a group of colored lenses and filters to determine their suitability for use in 45-watt inset lights.

There appears to be no advantage in using colored lenses in lieu of clear lenses with colored filters.

BB-3 and B-3 Omnidirectional, Semiflush Lights.

A type BB-3 omnidirectional, semiflush light was purchased from Multi Electric Mfg. Inc., Chicago, Illinois. Photometric tests will be made of this unit and a type B-3 unit now on hand at the National Bureau of Standards.

PAR-64 Iodine-Cycle VASI Lamps with Filaments Precisely Positioned at the Factory.

Eight developmental type Q6.6A/PAR-64/3 lamps were received from General Electric Company, Cleveland, Ohio, and photometric tests were begun. The quartz-iodine tubes had been positioned in the PAR type reflectors by a newly developed technique intended to ensure correct placement of the filament with respect to the focus of the reflector of the lamp. The test was designed to determine the adequacy of the filament placement of this group of lamps and of the placement technique. A preliminary analysis of the data indicates that all of the lamps tested would perform adequately in a VASI unit. Two of the lamps had beams whose peaks deviated nearly 1° from the horizontal plane (the seating plane of the lamps are vertical) when first tested; this deviation did not degrade the intensity seriously as determined by testing the lamps in a VASI simulator by projecting the beam through the slot of the simulator.

Type L-850 Semiflush Prismatic Light.

One type L-850 semiflush prismatic light was received from Structural Electric Company, Windsor Locke, Connecticut, for a photometric study to determine compliance to FAA Specification L-850.

Taxiway Guidance Sign.

A type TGS taxiway guidance sign has been prepared for use in visual observations to determine the legibility range of signs of this type in dense fog and in good visibility, both by day and by night. These tests should be completed during the next period.

IV. CARRIER LIGHTING AND MARKING

Modulated Tri-Color Glide Slope Indicator.

The modulated tri-color glide slope indicator has been delivered to NATC, Patuxent River for flight test.

V. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Numerous technical inter-agency conferences relating to problems of visual range and airfield lighting have been attended. Several draft reports, specifications, and proposals have been reviewed technically.

VI. MISCELLANEOUS

RVR at Arcata.

The Weather Bureau has installed the runway visual range (RVR) equipment at the Arcata Airport. This installation has not been officially commissioned at the end of this period.

Survey for Microvision Test Site.

Mr. Paul A. Noxon of the Bendix Corporation visited Arcata and consulted the NBS personnel in regard to conditions of interest in testing the "Microvision" landing instrument system here. He considered this location very favorable for testing the system except for the limited occurrence of radiation type fog. There had been no agreement to authorize this project at any site at the time of his visit.

Visibility in Fog.

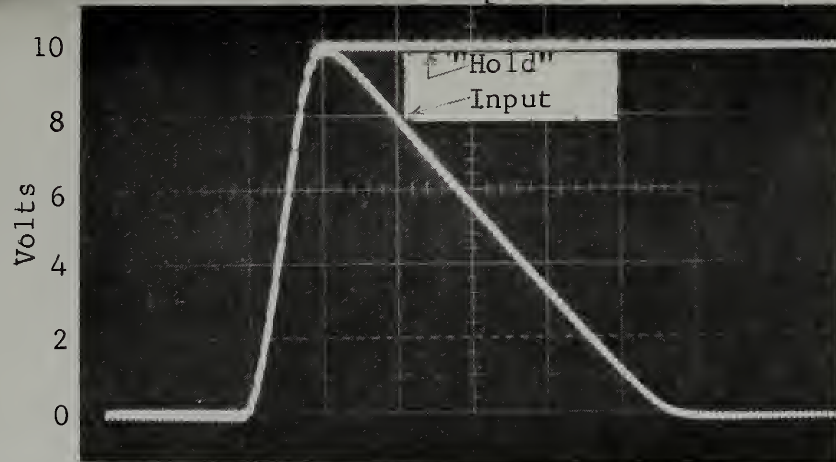
The paper "Can Infrared Improve Visibility Through Fog?" (by A. Ashley of Airborne Instruments Laboratory and C. A. Douglas) was published in the April 1966 (Vol. 61 page 243) issue of Illuminating Engineering as a Transaction of the IES.

A paper, "Photometric Considerations of PAR-56 Lamps" by Andrew C. Wall was presented at the Aviation Committee Meeting (IES) at Syracuse, New York, on 24 June, 1966.

Move to Gaithersburg Facility

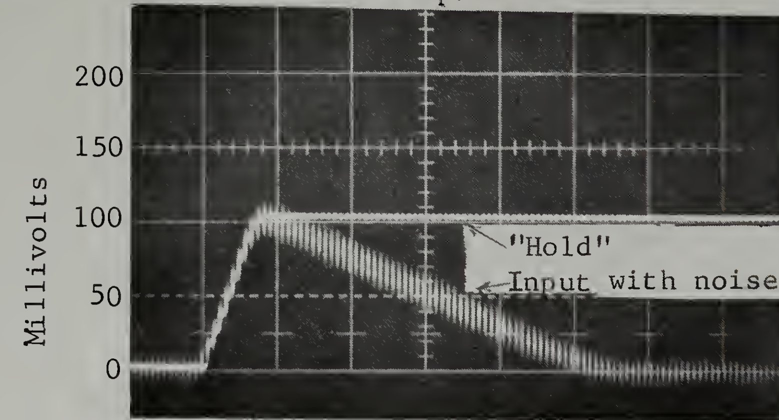
A substantial part of the period has been spent in preparing the facilities at the Gaithersburg Laboratories following the move from Washington late last quarter. These facilities include a 300-foot indoor Photometric range, a 1200-foot outdoor range, a lamp and lighting-system test room containing a constant-voltage regulator, a constant-current regulator, and a simulated airfield lighting system, in addition to general purpose laboratories.

Signal Channel
Input pulse:- $10V_p$, ~50μs to peak



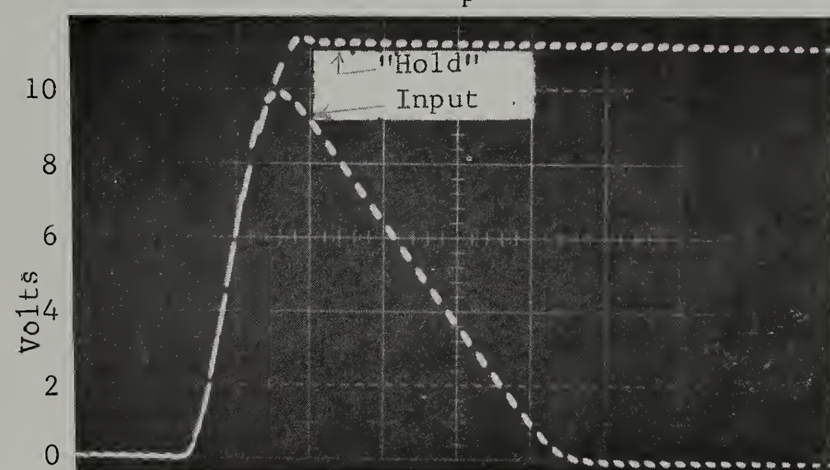
50μs/large division
A

Signal Channel
Input pulse:- $0.1V_p$, ~5μs to peak



50μs/large division
B

Reference Channel
Input pulse:- $10V_p$, ~24μs to peak

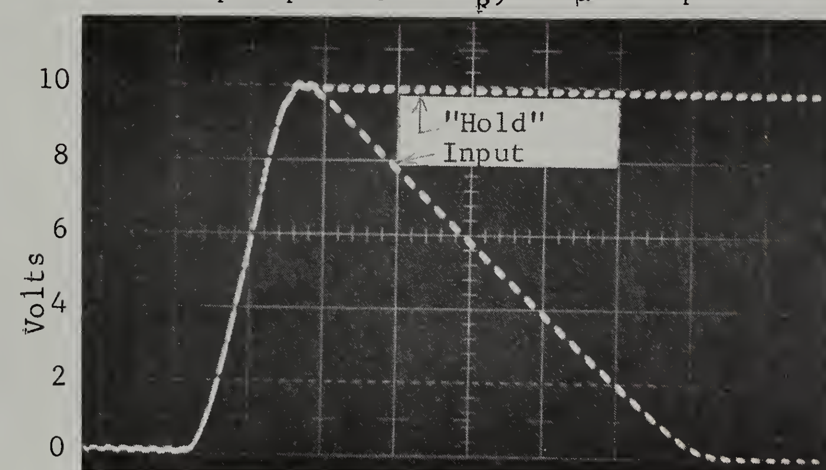


20μs/large division

Note: Input pulse slewing rate exceeds capabilies of detector circuit.

C

Signal Channel
Input pulse:- $10V_p$, ~30μs to peak



20μs/large division
D

Input and Output ("Hold") Waveforms of Peak Detector and Hold Circuit.

Figure 1

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