NATIONAL BUREAU OF STANDARDS REPORT

9964

DEVELOPMENT, TESTING, AND EVALUATION OF VISUAL LANDING AIDS

Consolidated Progress Report

For the Period

July 1 to September 30, 1968

By
Photometry Section
Metrology Division
Institute for Basic Standards

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D. C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
2120411 2120414 2120641 2120653	December 31, 1968	9964

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 Administration

For the Period
July 1 to September 30, 1968

By
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NBS

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NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
July 1 to September 30, 1968

I. REPORTS ISSUED

Report No.	Title
9903	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the period January 1 to March 31, 1968.
9904	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the period April 1 to June 30, 1968.
9350 Supplementary	Photometric Characteristics of U. S. Carrier Deck Lights

II. VISIBILITY METERS AND THEIR APPLICATION

NBS Atmospheric Backscatter Meter (Shipboard Visibility Meter).

The atmospheric backscatter meter designed by NBS was installed just before the start of this period and has operated throughout the quarter. The lamp-photocell unit is shown as installed at the left in figure 1. In testing for an intermittant operation in the log-ratio board, the troubles suddenly disappeared and have not reoccurred, but the cause was not located. New connectors were installed on the lamp-voltage cable, which were intended to reduce the likelihood of breakage. The equipment operated through the quarter without serious malfunction. The thermostat which controls the temperature in the electronics box became erratic and would close the heater circuit at any temperature between $38^{o}C$ to $42^{o}C$. The temperature ranged from 38^{o} to $45^{o}C$, which is well beyond the design range of 39^{o} to 42^{o}. This thermostat will be replaced. Near the end of the quarter there were occasional failures to trigger the light source even when operating in the DAY mode. Later this trouble was determined to be caused by the deterioration of the silicon-controlled rectifier (SCR) photodiode.

The response of the instrument to visibility conditions correlates very well with atmospheric changes. The sensitivity to change in clearer visibilities is much greater than that of the transmissometer and the sensitivity is still adequate for visibilities down to a few hundred feet. The sensitivity to changes in conditions for visibilities below 800 feet at night and 400 feet in daytime may be less than desired. On one occasion in very dense fog the OUTPUT reading became slightly negative. Backscatter meter readings have been compared with transmissometer readings only for intermittent instances. A detailed analysis will be needed to determine stability and effects of rain, different types of fogs, etc.

Construction was started on spare plug-in boards for the field unit now under test at Arcata. One of each different circuit board has been completed and tested. These are now available should any problems occur.

During the testing of the replacement log-ratio circuit board, an intermittent fault existed similar to the problem encountered with the unit at Arcata. The trouble was found to be a bad solder joint at one of the pins used to hold components on the board. This suggests the cause of the problem at Arcata. The decision has been made to make printed circuit boards for Model II, which will not only eliminate the component holding pins, but will reduce the total number of solder joints.

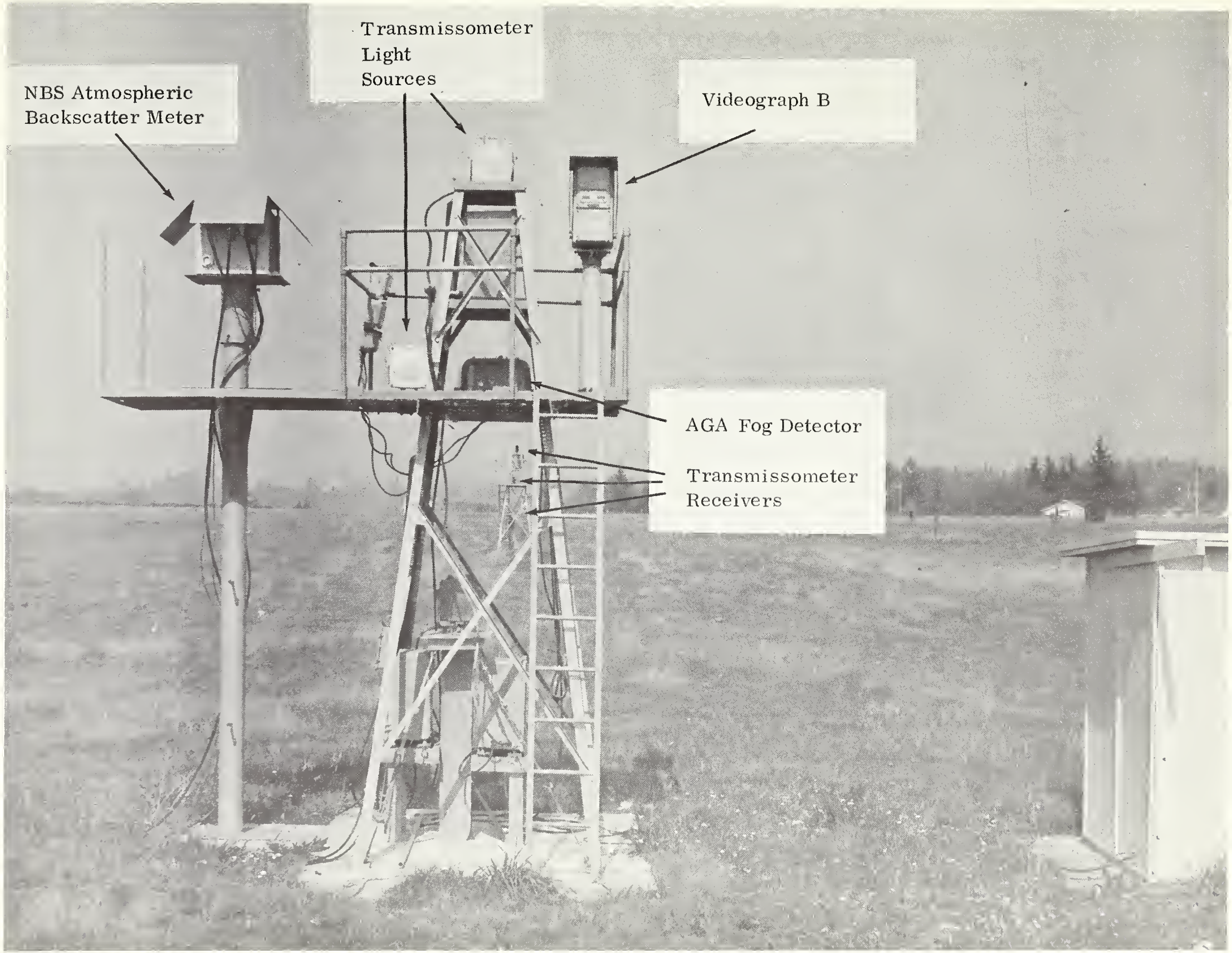

Figure 1. Fog detectors and visibility meters installation and test range.

The present circuit design seems to be satisfactory, making design of printed boards a relatively simple procedure. The lay-out has been completed for all the boards, and boards have been made for the averaging, peak-detector, and log-ratio circuits. The log-ratio circuit was designed to incorporate the temperature-controlled transistor pair of the Fairchild integrated circuit μA726C. This circuit has been completed and tested. A 10°C increase in ambient temperature from room temperature caused about a 0.3% of full scale change in the output for all ratios over the full 1000 to 1 range. Without the temperature controlled integrated circuit at least a 3% change would occur. If the equipment is located in an environment tolerable by the operators (50 to 100°F), temperature control of the electronics box will not be required.

All major components for Model II have been ordered except for cabinets or housings. These should be ordered during October to ensure delivery by the end of the year. The 4-inch diameter, 1-meter focal length lens must be ordered from the optical shop. The remaining circuit boards should be completed and tested this month.

Field Tests of Several Fog Detectors and Visibility Meters.

Operation of several types of fog detectors and visibility meters has continued. Several of these installations are shown in figures 1 to 5. There were many periods of fog of various densities suitable for evaluating the response of these instruments. The field testing will continue into the next quarter. Discussion of the performance of these instruments follows.

Videograph Fog Detector.

The Videograph B fog detector has continued to operate satisfactorily during this quarter. This unit as installed is shown in the foreground of figure 3. The output reading is being recorded continuously and can be used as a visibility meter indicator as well as a fog detector. These records shown good response to changes in atmospheric conditions over the ranges of visibility which have occurred. The response is very sensitive to changes in clearer conditions and the unit does not completely saturate in very dense fog. Variations in ambient temperature seem to have some effect on the sensitivity of this instrument. The performance appears very favorable, and a more complete analysis of the data for correlation with atmospheric parameters will be made.

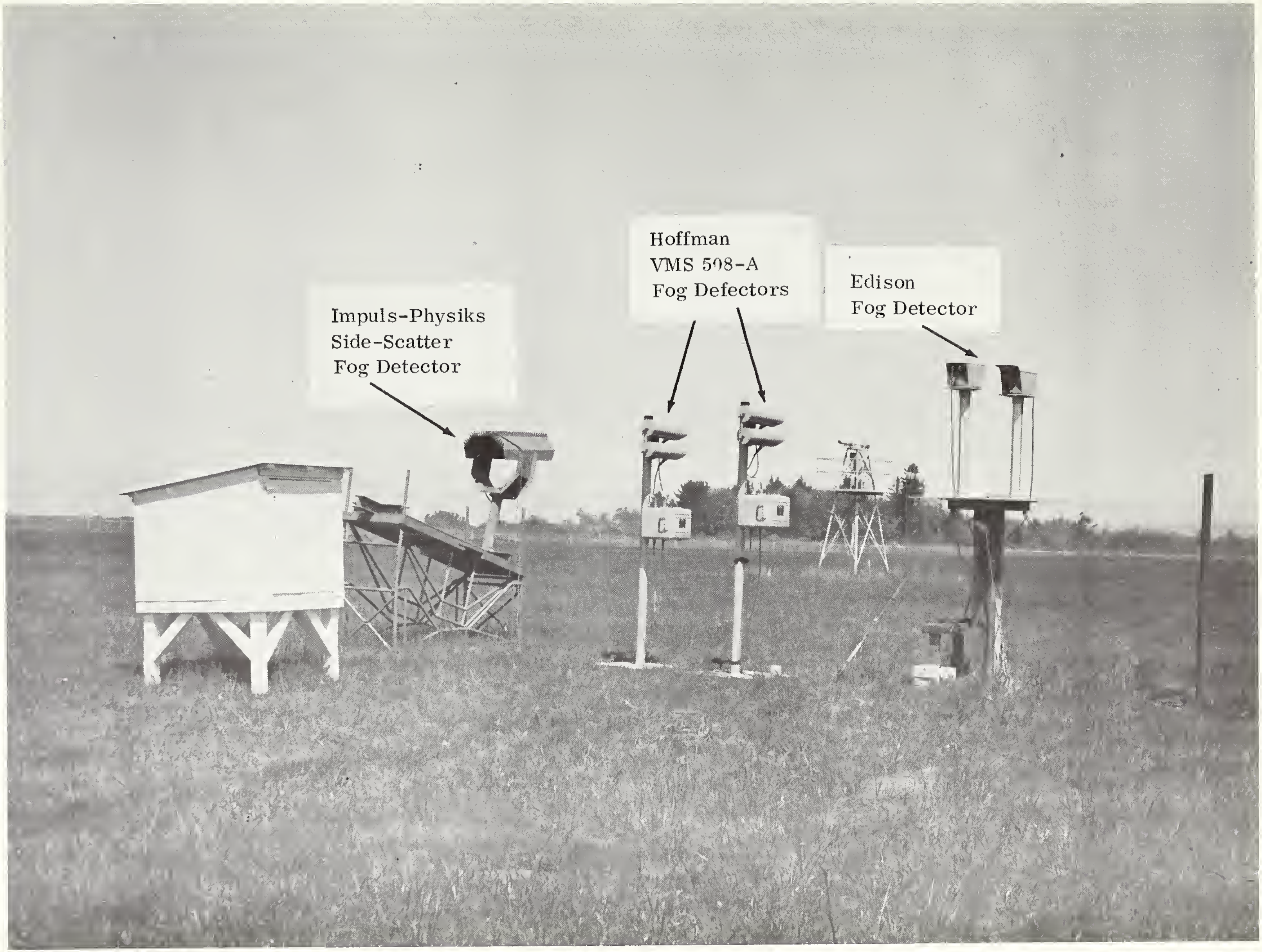

Figure 2. Early fog detector installations.

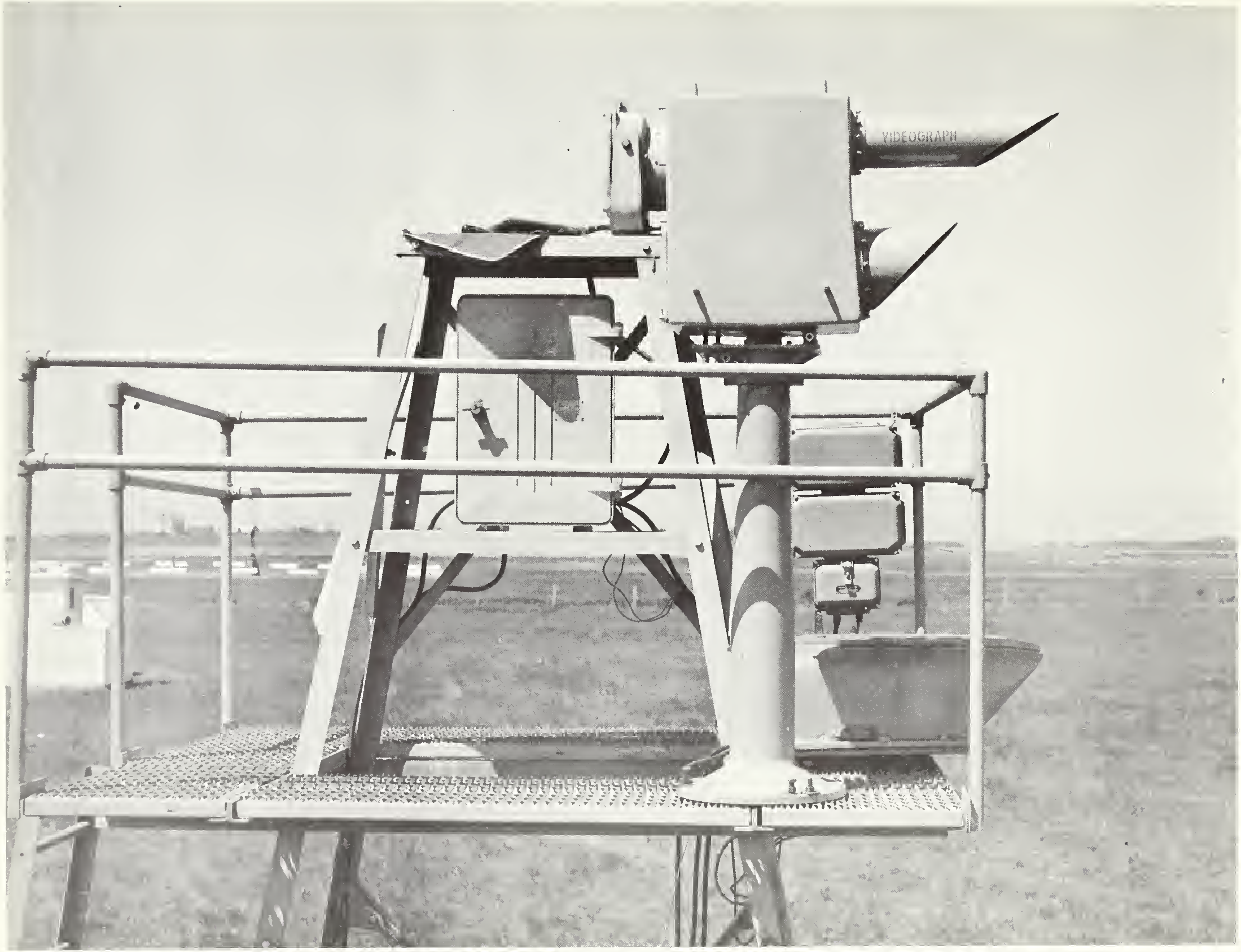

Figure 3. The Videograph B fog detector with sunshade removed.

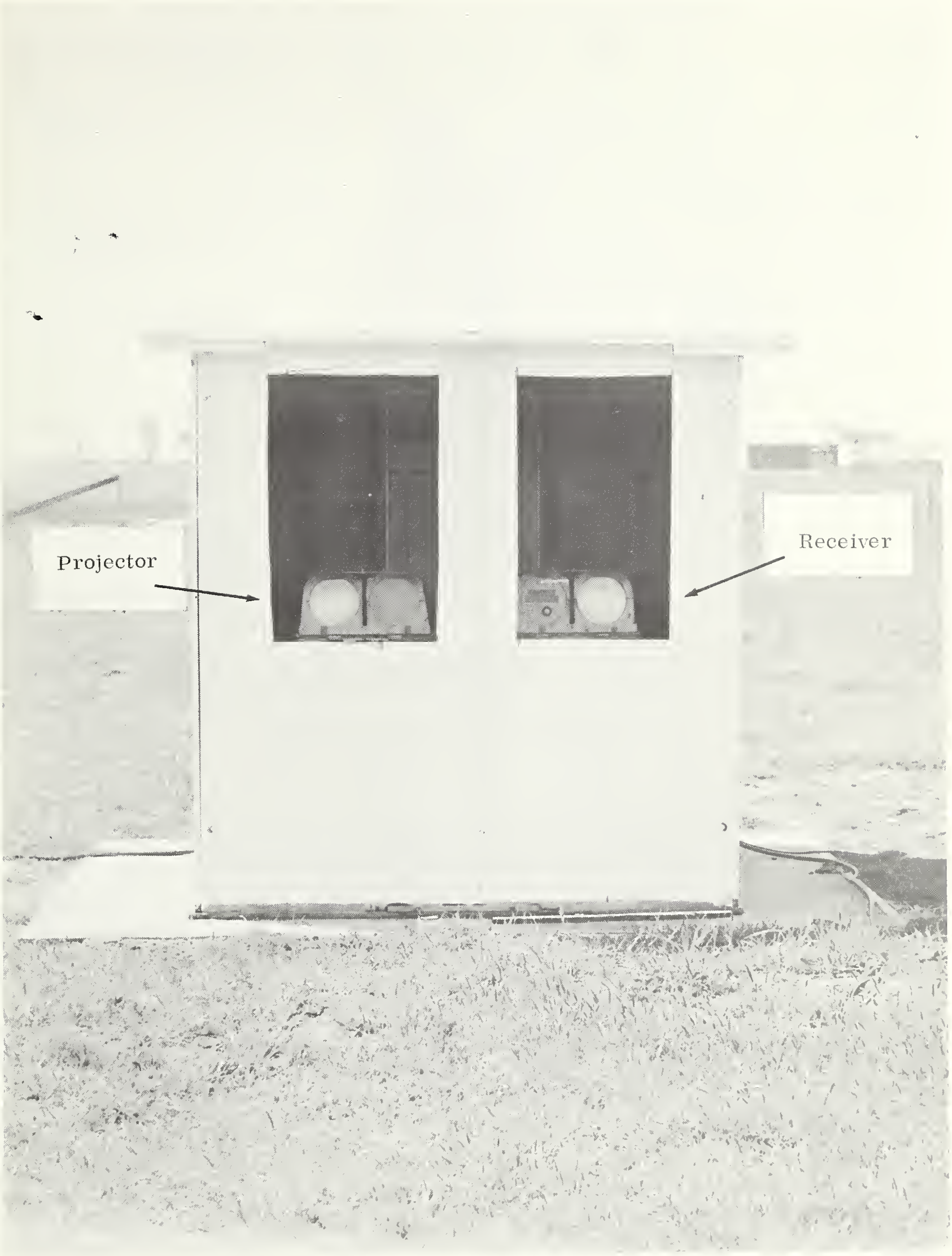

Figure 4. AGA Visibility meter installation.

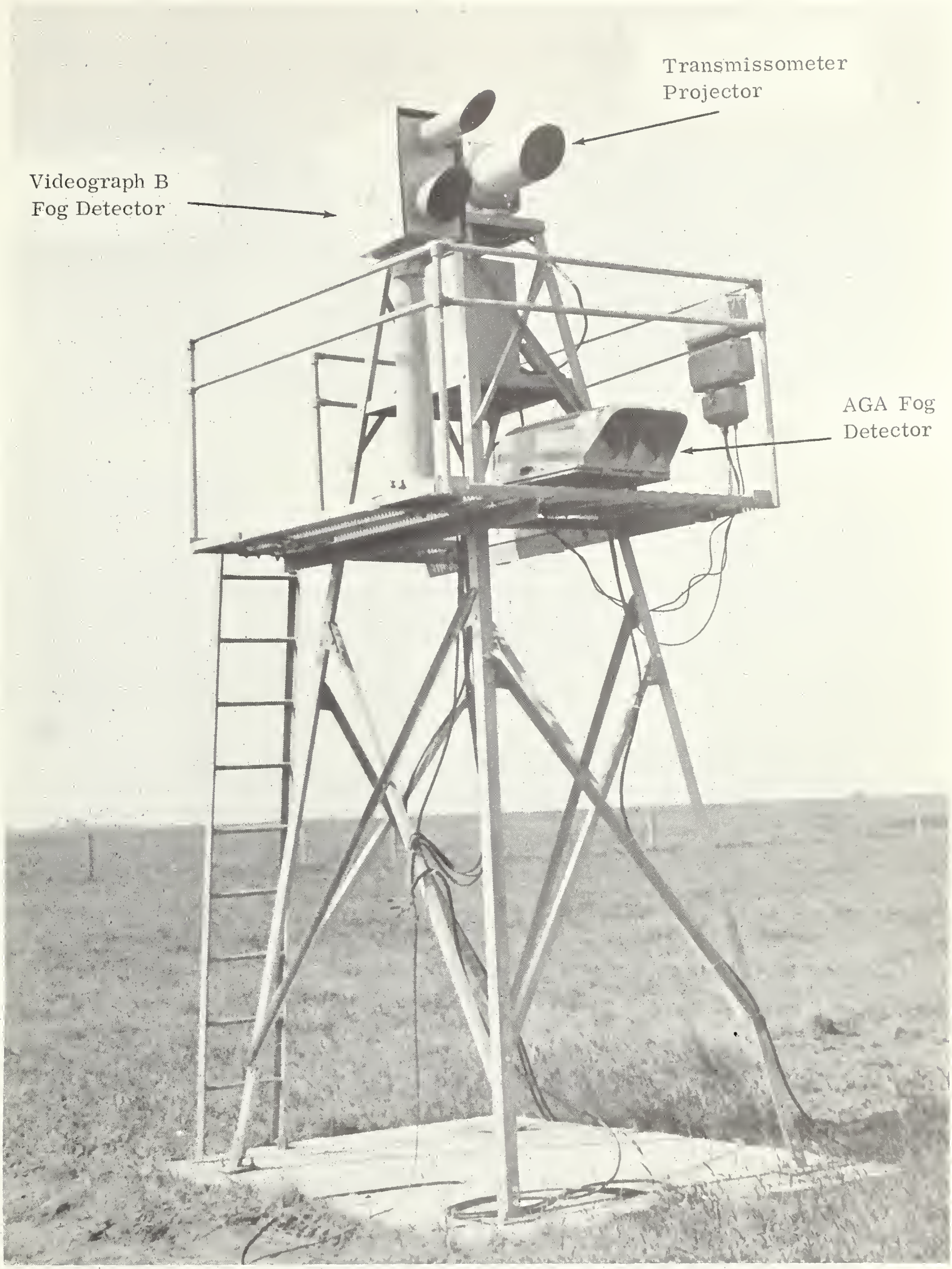

Figure 5. Fog detector installation.

AGA Visibility Meter.

The AGA visibility meter was kept in operation throughout this period. This unit as installed inside the instrument shelter is shown in figure 4. The loan of the equipment was extended but the equipment will be returned early next quarter. After repairs to the lamp, the performance was much improved, but the instrument never recovered the original sensitivity. The response was affected by daylight, but the amount of change has not been determined. The sensitivity to change in conditions is very great for clearer conditions, but the unit appears to saturate for visibilities much below one mile. A more complete analysis of the response will be required to determine the usefulness of this equipment.

AGA Fog Detector.

The AGA fog detector has continued to operate well. This unit as installed on the transmissometer stand is shown in figure 5. On a maintenance check, the separation of the lamp from the base was noted and the lamp was replaced. There was no appreciable change in the transmission value at which the alarm circuit would close either before or after the lamp replacement.

Hoffman VMS-508A Fog Detectors.

Because of the shortage of signal lines from the field test site to the laboratory, the Hoffman VMS-508A fog detectors have not been put back into operation. With the removal of some of the other fog detector installations, these two units will be reinstalled for further operation.

Edison Fog Detector.

The sensitivity of the Edison fog detector had deteriorated until useful data was not being obtained. After replacement of the lamp, the response was improved, but the sensitivity did not fully return to that obtained earlier. The installation was dismantled so that the signal lines and stand could be used for other installations. Further tests of this unit are planned when a new detecting element is obtained.

Effect of Height Above Ground on Transmission.

The installation for preliminary investigation of the effect of height on atmospheric transmission was completed at the beginning of this quarter. Three transmissometers using the same 250-foot baseline are installed with one at 5 feet, one at 10 feet, and one at 15 feet above the ground. These units are

located at the site previously designated as T. L2 transmissometer. The installations of the projectors and receivers are shown in figures 1 and 6. The indicators and recorders are located in the Field Laboratory. In advection fogs, usually the top transmissometer indicates the lowest transmittance. In radiation or ground fog, which is less common at Arcata, the bottom transmissometer usually indicates the lowest transmittance. The center transmissometer seems to agree more nearly with the top unit than with the bottom unit. This may indicate that the ground effect on fog density is most noticeable in the first five feet, but extends above 15 feet. Frequently the fog density changes rapidly, and the normal recorder chart drive speed of 3 inches per hour is too slow to adequately correlate the three records with the time variations. On several occasions the chart drive speed was changed to 12 inches per hour, which permits the variations with time to be followed satisfactorily. These transmissometers operating as the test installation will be continued.

Transmissometers.

A memorandum on the operational life and malfunctions of the "phototubes" and "triggertubes" used in the photopulse unit of the transmissometers was prepared to furnish the FAA with technical information on the reliability of these components. Both tubes have very long operational life when tubes which are unsatisfactory at the initial installation are eliminated. The malfunctions in these components are rarely catastrophic failures requiring immediate replacement, but usually are very gradual decreases in sensitivity, or instabilities of only a few percent.

A problem with crosstalk from the NBS transmissometers affecting the indication of the FAA runway visual range (RVR) equipment was encountered. This trouble occurred when the output signals of the transmissometer indicators were fed into a tape recorder. Apparently there was some leakage of this signal onto the signal lines to the RVR computer, although the fault or leakage path was never identified. The RVR computer seemed to be most sensitive to this crosstalk during the background check. The RVR computer at Arcata is connected directly to the transmissometer input signal line, where the pulses have an amplitude of only 16 to 20 volts, and the leakage-signal pulses may have been on this order of amplitude. If the input signal for the RVR computer were taken from the output of the transmissometer indicator, the input could be biased to eliminate leakage from other transmissometer signals and noise from other sources.

Fog Variability Studies.

The report of the "Summary of Low Visibility Conditions at the Arcata Airport" has been revised to include the occurrences of runway visual range (RVR)

Figure 6. Transmissometer receiver installation to determine effect of height on transmission tests.

below 600 feet and the minimum RVR for each of these occurrences. Data for low RVR in 1967 has been added. Also the low visibility and ceiling observations for 1967 as reported by Federal Aviation Administration (FAA)-Flight Service Station (FSS) have been added.

During this quarter, the elapsed time meters have recorded 861 hours of instrument flight rules (IFR) conditions and 116 hours of operating runway lights at 100 percent intensity. The metering of the time when transmittance over a 500-foot baseline is below 0. 5 has been discontinued.

III. AIRFIELD LIGHTING AND MARKING

Flush Approach Light Manufactured by Strong Electric Corporation.

A prototype flush approach light manufactured by the Strong Electric Corporation, Toledo, Ohio, was submitted for static load tests and for before-and-after photometric tests. The unit was lamped with two experimental 20-ampere, 500-watt, single-ended halogen-cycle lamps. For the load tests strain gages were affixed to the under side of the light head before the load was applied. The load was applied in 10, 000 pound increments. At 40, 000 pounds cracking noises were heard but, because of the cushioning material placed between the light and the testing machine to distribute the load, it was not possible to determine the source of the noises. Testing was stopped at 80, 000 pounds, and the load was removed. Some permanent deformation was recorded. Both exit windows were found to be broken after the test. The light was given a photometric test before the load test but not afterwards. The results appear in NBS Test Report 212. 11-35/68.

Flush Flasher Manufactured by the Amglo Corporation.

A prototype flush flasher approach light has been received from the National Aviation Facilities Experimental Center, Atlantic City, New Jersey, for photometric tests. The unit is lamped with a linear Xenon flashtube delivering 450 watt-seconds per flash at half-second intervals. The unit is the smaller of two made under an FAA development contract.

Type C-1 Lights with a Philips (Netherlands) Lamp.

Two type C-1 edge lights, and four lamps manufactured by N. V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands, were received for photometric tests. Three of the lamps were broken on arrival. Tests will be made (after the receipt of replacement lamps) to obtain a light intensity comparison between the same fixture with the Philips and with U. S. -made lamps.

Centerline Lighting for SATS.

The four prototype centerline lights, described in NBS Progress Report 9694, were delivered to NATC at Lakehurst, New Jersey in July. These lights are to be installed in a SATS system at Lakehurst for a service evaluation.

Q6. 6A/PAR56/3 Lamps with Clear Covers.

NBS Test Report 212. 11-37/68 gives the results of photometric tests made of twelve Q6. 6A/PAR56/3 runway-and approach-light lamps taken from a factory-production run. The formerly-used light-stippled cover has been replaced by a clear cover for this type lamp.

It is suggested in the report that MS24488(USAF) be modified as follows: Minimum beam dimensions through the optical axis: 80, 000 candelas, change from 6^{o}H x 5^{o}V to 5^{o}H x 4^{o}V. 20, 000 candelas, change from 10^{o}H x 8^{o}V to 11^{o}H x 7^{o}V. Minimum peak intensity, change from 150, 000 to 170, 000. Cover glass, change from "stippled" to "clear". Rated average laboratory life (hours) (burned base down), change from 300 to 1000.

The 3040K average color temperature indicates a 1000-hour lamp. The lamps were put on life test and a supplementary report will be issued.

Photometric Tests of 500-Watt, 20-Ampere PAR-56 Halogen Cycle Approach- and Runway-Light Lamps with Clear Covers.

NBS Test Report 212. 11-45/67 contains the results of photometric measurements made during this period of a group of eight clear cover lamps. The test was made to determine if a lamp with a clear cover is a satisfactory replacement for the presently-used type Q20A/PAR56/3 halogen-cycle approach- and runway-light lamp.

Portable Inset-Light Photometer.

A conference was held with FAA personnel to discuss the feasibility of constructing a photometer to make periodic checks on the intensity of the runway inset lights. It was decided that NBS will construct a wheel-mounted manually pushed photometer which will be of a relatively simple and inexpensive design and intended only for making spot checks on the system. A more complex and expensive design will be necessary if each light is to be checked, as the time required to check each individual light would be prohibitive using a hand-pushed device.

Gages for Checking Type L-850 Light Bases for Conformance to Specification.

The two gages ("go" and "not-go") for checking type L-850 light bases for dimensional conformance to specification were not acceptable as regards the spacing

of the bolt-hole positions. The holes were rebored on a precision indexing head.

Field Tests of Cable-Fault Locator Developed by NBS.

Additional tests with the cable-fault locator were made during the dry season when ground resistance was higher than normal. Many of these tests were made in areas where other cables and pipes were located. Often faults were not located or the wrong conductor would be followed. Some laboratory investigation of the signal and response of the receiver were made. The waveform of the output signal from the generator is affected by the load of the circuit and by the inductance of the circuit, particularly from the isolating transformers. Some additional tests are needed to clarify performance in certain cases. These tests and a revision of the test report should be completed next quarter.

Field Tests of Type L-842 Inset Runway Lights with Forced Drainage Modification.

These lights continue to be operated three hours daily. The forced drainage modification appears to be of little value, because the effectiveness in removing water from the unit depends on the lights being energized for a considerable time after precipitation has ceased. Except to replace lamps as they fail, no further work on this task is contemplated.

Obstruction Lights for Transmission Line Towers.

At the request of the FAA a scale model of a five hundred foot transmission line tower has been assembled. It will be used in a determination of the optimum flash rate, flash sequence and physical location of the lights on the tower. This system has been observed by officials from the FAA and a final observation will be made in the near future. The proposed system tentative to a final observation will be using three clear lights located in approximately the center of the tower at five hundred, three hundred and twenty-five and one hundred and fifty-foot levels. The flash sequence will be the center light first, top light second and the bottom light third, with a flash rate of sixty flashes per minute. The time interval between the second and third flash will be approximately three or four times the time interval between the first and second flash.

IV. CARRIER LIGHTING AND MARKING

Measurement of Flight Deck Illumination and Luminance.

Instruments were received for the task of measuring flight deck illumination and luminance on several aircraft carriers. The photometer will be calibrated and an exploratory series of measurements will then be made, probably at NATC, Patuxent River, Maryland.

Deck Guide Lights.

Two deck guide lights manufactured by the L. C. Doane Company, Essex, Connecticut, were received for test. Both units are lamped with 6. 6-ampere, 200-watt, single-ended (prefocused) halogen-cycle lamps. One light is intended for carrier deck centerline use while the other is for edge or athwart deck use. Photometric measurements were made of both units and the results appear in NBS Test Report 212. 11-29/68.

Catupult Bridle Inspection Light.

A hand held spotlight with a low intensity narrow beam has been constructed and delivered to NATC at Lakehurst, New Jersey. This light is equipped with a series of baffles intended to restrict the beam angle to prevent any direct light from being seen by the pilot. This unit was left at Lakehurst for evaluation to determine the requirements in future units as to the beam angle and intensity.

Weight Display Unit.

The weight display unit described in NBS Progress Report 9694 was delivered to NATC at Lakehurst, New Jersey in July.

Summary of Photometric Tests of U. S. Carrier Deck Lights.

NBS Report 9350 Supplementary was issued giving the photometric characteristics of U. S. carrier deck lights. The report includes a table of selected characteristics, fifteen intensity distribution curves and six photographs or drawings of the lights included in the report.

Criteria for the Inspection of Fresnel Lenses.

Work on this task was postponed pending the arrival of a second cell from the Naval Air Engineering Center (SI), Philadelphia.

V. MISCELLANEOUS TECHNICAL AND CONSULTATIVE SERVICES

Review of Specifications and Publications.

A service bulletin, a technical manual, and several survey reports of Naval Airfield lighting installations and equipment and visual landing aids (VLA) were reviewed. Comments were forwarded for consideration on revisions and further work. The publications reviewed were as follows:

1. Visual Landing Aids General Service Bulletin No. 27.

2. Technical Manual NAVAIR 51-50AAA-2 Visual Landing Aids Design Standards--Landbased Installations.

3. NAEC-ENG-7474-1 OLS Whitehouse Visual Landing Aids Configuration.

4. NAEC-ENG-7474-2 NAS Lemoore Visual Landing Aids Configuration.

5. NAEC-ENG-7474-3 NAS Cecil Field Visual Landing Aids Configuration.

6. NAEC-ENG-7474-4 NAS Jacksonville Visual Landing Aids Configuration.

Frequently these publications do not specify the current lamps and transformers and the Survey reports indicate that out-dated equipment is being used. To assist in both maintenance and design, lists of lamps and transformers are being prepared. These lists will include type number, specification, standard drawing number, electrical ratings, Federal stock number, fixture types and specifications, and, when available, the superseded type, stock number, specification, and standard drawing number. These lists will be completed next quarter.

Other documents reviewed were:

Ringo - An Alignment System for Helicopters.
Draft - Report: - Evaluation of Several Multi-transmissometer Systems.
FAA Draft Specification: - Centerline Retroreflective Marker.
FAA Draft Specification: - Power and Control Assembly for Two-Box VASI.

VI. MISCELLANEOUS

Operation Foggy Cloud.

Project Foggy Cloud is a field evaluation of methods of modifying warm fog and stratus clouds, which has been operating at the Arcata Airport since March. This project is planned and directed by the Earth and Planetary Division of the Naval Weapons Center in collaboration with several other government agencies. This operation will continue to the end of the fog season. The NBS Field Laboratory was authorized to cooperate with this project when assistance was necessary. The NBS efforts on this project up to the end of this period are summarized as follows:

A. Project location planning.

1. Provided data and information on fog and low stratus conditions at Arcata Airport.

2. Provided information on space and facilities available at Airport.

3. Reviewed airport operation policies and past test operations.

4. Discussed available instrumentation and services.

B. Establishment of project operations.

1. Assisted in arranging for office space, storage facilities, aircraft servicing and loading areas, and testing sites.

2. Helped plan sites and, in some cases, assisted with installation of rawin and radar equipment, instrumentation vans, visual observation ranges, ground seeding sites, instrument locations, and patterns for aerial seeding and airborne instrument flights.

3. Aided in unloading equipment and supplies, advised on local sources or contacts for services and supplies, operated forklifts and special equipment of NBS and Humboldt County when required.

4. Provided signal and recorders (temporarily) from two transmissometers.

5. Participated in early briefings of operating plans to insure safety, to avoid conflicts with other agencies, and to correlate observations and measurements to evaluate results.

C. Early Test Operations.

1. Provided escort vehicles (until suitable vehicles and communications were obtained) for necessary operations on or near runways and taxiways.

2. Provided radio communications to FAA for coordinating tests with air traffic and to relay information between test pilots and ground test personnel.

3. Assisted in igniting and burning pyrotechnics, "salty dogs," and "salty frogs."

4. At times made and reported visual observations of conditions and results, transported others to areas on or near taxiways and runways for observations and measurements.

D. Continued operations.

1. Coordinated safety operations for ground seeding tests (most of this was on our own time outside of working hours).

2. Provided transmissometer signals and special transmission data as requested.

3. Reported incidental observations which appeared pertinent to tests.

4. Moved helium tanks with forklift as required to replenish supply for rawin.

5. Permitted limited use of shop equipment, tools, meters and components and parts.

6. Provided electrical power to some of the instrument sites.

7. Arranged for special facilities at times.

8. Provided consultation on meteorological information, prospects for fog (short and long range), miscellaneous information.

9. Briefed special visitors on conditions and operations at Arcata.

A brief summary of the Foggy Cloud operation through this season as prepared by their personnel will be included in the next Progress Report.

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