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FINAL REPORT

Project No. 430-206-01X

FLIGHT TEST AND EVALUATION OF HELIPORT LIGHTING FOR VFR

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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
National Aviation Facilities Experimental Center
Atlantic City, New Jersey 08405

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FINAL REPORT

FLIGHT TEST AND EVALUATION OF HELIPORT LIGHTING FOR VFR

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for

SYSTEMS RESEARCH AND DEVELOPMENT SERVICE

March 1969

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ABSTRACT

The guidance value of heliport lighting system components was tested under VFR conditions in a joint FAA/U.S. Army effort. The overall system included lighting to identify and locate the heliport and support the approach and landing of helicopters.

Forty-six civil and military pilots flew on 11 nights at Tipton Army Airfield, Fort Meade, Maryland, producing the following conclusions: The heliport beacon, flashing green-yellow-white, had adequate range and distinctiveness but could be improved by a change in flash rate; the yellow pad perimeter lighting met all requirements; the white approach direction and yellow landing direction lighting components were satisfactory; both pad surface floodlighting and pad inset lights were used satisfactorily, and all pilots who were shown the painted maltese cross marking rated it as an aid at night; the lighted wind sock provided adequate wind direction information if overflown first, but neither the lighted wind sock nor the lighted wind tee tested were adequate to provide this information to a pilot on the approach path at one-half mile from the pad.

A minimum VFR heliport lighting system is recommended to include the beacon for location information, the perimeter lights and painted marking for pad identification, and the lighted wind sock to provide wind information. Other components are recommended for installation when required by special conditions.

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INTRODUCTION

Purpose

The purpose of this project was to evaluate the effectiveness of a number of lighting systems developed to provide landing guidance for military and civil rotorcraft operating in VFR conditions at night.* Specific systems were designed to identify the heliport and individual helipads, to provide wind direction information, and to provide guidance during the approach and landing phase. The ultimate objective of this effort is to evolve a standard VFR heliport lighting system.

Background

Aerodrome Manual, Part 10, published by the International Civil Aviation Organization (ICAO), in 1957, stated general requirements for the marking of helicopter landing area boundaries and obstructions. In 1959 the FAA published a Heliport Design Guide with recommendations for heliport lighting. Yellow perimeter lights 25 feet apart, floodlighting of the landing area, and an identification beacon were suggested. In 1961 the FAA initiated research with a review of visual guidance systems in use at heliports. Laboratory studies and field tests were conducted to indicate the guidance values of several simple lighting patterns for heliports (see Reference 1).

In a 1964 FAA report (see Reference 2), based on flight tests at Fort Belvoir, Virginia, the following lighting elements were evaluated as suitable for heliports: (1) yellow perimeter lights not over 40 feet apart; (2) floodlighting of the touchdown zone; and (3) a bull's-eye pattern rather than the common triangle and H. Another edition of the Heliport Design Guide was also published in 1964, essentially restating the lighting recommendations in the original 1959 edition.

The November 13, 1964, minutes of the ICAO Visual Aids Panel stated that the pad perimeter lights should be yellow. Ten to fifty-foot spacing and a minimum of five lights per side were also recommended. Requirements for floodlighting of the pad were considered subject to debate, while some form of flush lighting fixtures was thought to be of possible value. The need for approach lighting in VFR conditions and the possible utility of aiming point and visual approach slope indicator

*For civil helicopters there is no minimum visibility for VFR. The U. S. Army bars VFR with less than one-half mile and 300 feet, and generally the military services do not fly VFR in weather providing less than 1-mile visibility.

systems were topics of debate. "The Panel agreed that although it was unable to propose specifications on helicopter lighting or marking... that further study of the subject would be worthwhile and fruitful."

FAA and Corps of Engineers personnel met on March 2, 1965, to coordinate FAA and U. S. Army programs for developing, testing, and evaluating heliport lighting systems. The Corps of Engineers personnel stated that they had received urgent requests to expedite heliport lighting and wished to proceed with development of lighting to meet U. S. Army requirements. It was agreed that the urgent military requirements would be set down in writing and a plan for joint effort in the development of standards and equipment would be forthcoming.

As a preliminary effort, a series of lighting tests was conducted at Cincinnati's Lunken Airport. Various configurations were photographed to depict different pad sizes, light spacing, and pattern geometries from several approach angles. Spacing approach light bars 25 feet apart along the approach path was judged to be better than the alternatives tested, 50 and 75 feet, because the longer spacings were confused with street lights. During this period, additional studies were conducted by the FAA and Corps of Engineers at Fort Rucker, Alabama, and Fort Wolters, Texas, to select a daytime heliport marking pattern (see Reference 3).

With the Lunken Airport test results in hand, a preliminary series of field lighting tests was conducted at Fort Meade (Tipton Army Airfield), Maryland, late in 1966. A heliport identification beacon was installed, and temporary lighting fixtures were spiked into the grass off the end of the fixed-wing runway to provide a simulated helipad with a yellow-lighted perimeter, either 50 or 150 feet square, and to provide triple-light bars of lead-in lights for approach guidance. For 2 weeks, flights into the grass helipad were made by pilots, most of whom were veterans of Viet Nam and accustomed to flying with a minimum of lights as guidance aids. From the 1966 tests it was concluded that five lights per side were sufficient to define the helipad perimeter. The lead-in lights, of a color different from that of the perimeter lights, appeared to be of some value although the 100-watt lamps used were found to be too bright on even the minimum of three standard brightness steps. Additional guidance aids were called for by the pilots to assist in depth perception and to give indication of the horizontal plane in the final touchdown maneuver.

A questionnaire was prepared to obtain pilot opinion on the utility of the experimental Fort Meade heliport beacon. Voluntary responses were, however, insufficient to support any conclusions. Therefore, it was decided to question the pilots in later flight tests on both the beacon and other elements.

In preparation for the final test series, discussions of the operational requirements for helipad VFR lighting were held. Six requirements were identified: (1) beacon guidance to the heliport and guidance in the form of perimeter lights to enable the pilot to find the landing pad; (2) approach direction guidance to be provided by some form of rows of lights outside the pad perimeter where omnidirectional approach is barred; (3) landing direction guidance where straight-in approach landing transition is not feasible because of cross wind conditions; (4) actual wind direction information; (5) a civil-only requirement for approach slope information where obstruction clearance or noise abatement problems dictate; and (6) flare and touchdown guidance for rapid operations.

With a view toward the military requirement to bring a large number of aircraft into a heliport with a premium on time, the U.S. Army project personnel stated the purpose of further testing as "development of the optimum standard lighting. . . ." Review of present civil heliport lighting at typical installations around the U. S., on the other hand, indicated that perimeter lighting supplemented by aircraft landing lights was proving sufficient to support night VFR operations. Lead-in or approach lighting seemed, generally, to be unnecessary for VFR. Hence, there appears to be a difference in the operational requirements for military and civil lighting systems. Standardization is highly desirable in the area of visual guidance, but special needs at particular locations have always been recognized. Hence, the implication should not be taken that the present tests define a system which must include in all applications all six guidance elements mentioned above. Rather the goal has been to determine what are the minimum lights to accomplish each requirement, recognizing that only a few heliports have all of the requirements.

Table I summarizes the ranges at which the various visual guidance information elements are thought to be required. As is usually the case, most tests have had to be conducted in clear weather not really representative of the lower ranges of VFR conditions. Since no effective low visibility simulation device is available, there is a problem in determining with certainty the success or failure of the particular lights installed at Tipton Army Airfield to attain the stated required visual ranges in reduced visibility. In particular, intensities provided in the system are unlikely to be adequate by day. The daytime requirements are not expected to be met by lighting, with the exception of heliport location given by the beacon, and standard marking would be expected to provide the listed daylight ranges for helipad position and flare and touchdown guidance.

TABLE I

VFR RANGE AT WHICH HELIPORT LIGHTS SHOULD PROVIDE GUIDANCE

	Day	Night
*Heliport location (Beacon) (Not more than 1/4 mile from pad)	1 mile in 1-mile met. vis.** (300'-3000' alt.)***	3 miles in 3-mile met. vis.
Helipad position (Perimeter)	No day lighting requirement (Marking)	1 mile in 1-mile met. vis. (300'-1500' alt.)***
Approach direction (External double row of lights)	No day requirement for lighting (Marking)	(Tentative Army requirement) 1 mile in 1-mile met. vis. (300'-1500' alt.)
Landing (wind) direction (External single row of lights)	No day requirement for lighting (Marking)	1/2 mile - Military 1/4 mile - Civil in 1-mile met. vis.
Flare and touchdown (Floodlights, inset lights)	No day requirement for lighting (Marking)	From 50' height to touchdown
Approach glide path (VASI)	1 mile in 1-mile met. vis. (Civil only)	1 mile in 1-mile met. vis. (Civil only)

* A heliport may contain one or more helipads.
** Meteorological visibility.
*** Altitudes listed are height over the ground.

Description of System

The test helipad at Tipton Army Airfield, Fort Meade, Maryland, consisted of a hard-surfaced landing area in the form of a square with 80-foot sides. This was surrounded by 20-foot shoulders on each of the four sides. Illumination of the helipad and identification of the landing area were provided by floodlighting from eight floodlight units located on the shoulders to the north and south, and by individual yellow perimeter lights located around the entire edge of the pad. Inset lights were provided within the surface of the landing pad itself to assist the helicopter pilot during the final phases of the landing. Additional lighting to provide landing direction and take-off guidance was located outside of the perimeter of the pad. The wind tee and wind sock were also illuminated to allow use during hours of darkness. Details of the individual lighting systems tested are given in the following paragraphs (see Figure 1).

Perimeter Lighting: Sixteen omnidirectional medium-intensity yellow light units were located at equal distances around the entire perimeter of the hard-surfaced helipad. Circuits were arranged so that three, five, or seven lights per edge could be displayed for evaluation. However, preliminary testing proved the adequacy of the five light per edge configuration, and this was the pattern used throughout the formal evaluation effort. The light units were standard L-810 obstruction light fixtures, using a 1020 lumen 6.6A lamp, with yellow filter globes replacing the usual red globes to provide distinctive coloration (Figure 2).

Pad Floodlighting: Eight floodlight units, each containing two 250-watt directional floodlights, were located to the north and south of the helipad, with four units on each side. These lights were shielded so that a cutoff of light 4 feet above the pad surface was provided to prevent blinding the approaching helicopter pilot (Figure 3).

Inset Lighting: Five 45-watt "pancake" type lighting fixtures were installed in the pad itself, flush with the surface, to provide final approach guidance. Four of these units were fitted with blue color filters to reduce intensity to below the glare point and to provide distinctive coloration. One of the units, located in the exact center of the helipad, was white and was intended to provide an aiming point for final touchdown. Late installation of this center "aiming point" light unit necessitated use of a fixture physically different but photometrically similar to the four initially installed (Figures 4 and 5).

Approach Direction Lighting: Thirty-four medium-intensity omnidirectional white lights were arranged in two rows of 17 lights each extending a distance of 400 feet from the eastern edge of the helipad shoulder. The interval between each pair of lights was 25 feet.

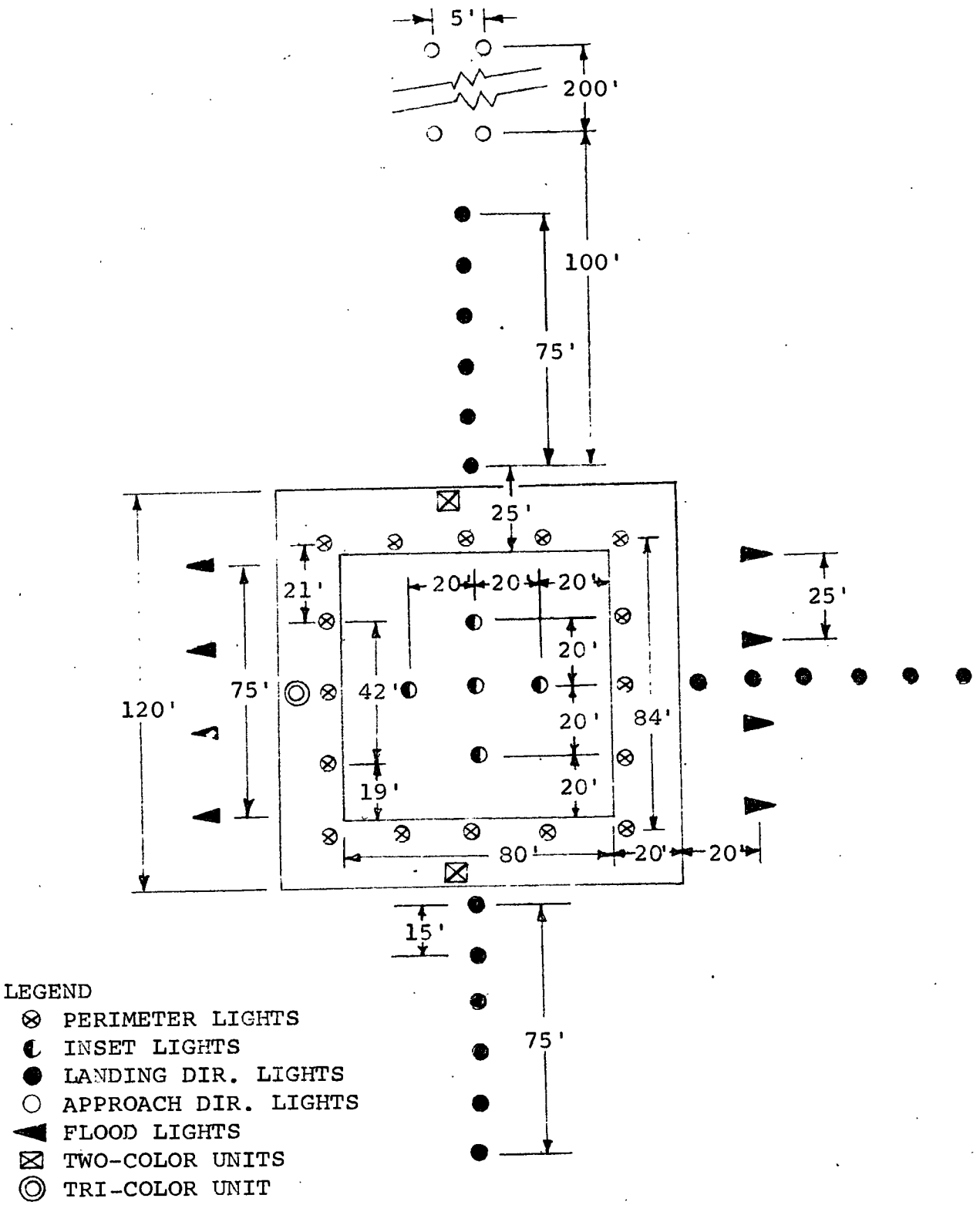

FIG. 1 HELIPAD LIGHTING LAYOUT
TIPTON ARMY AIRFIELD
FORT G. G. MEADE, MARYLAND

FIG. 2 PERIMETER LIGHTING UNIT

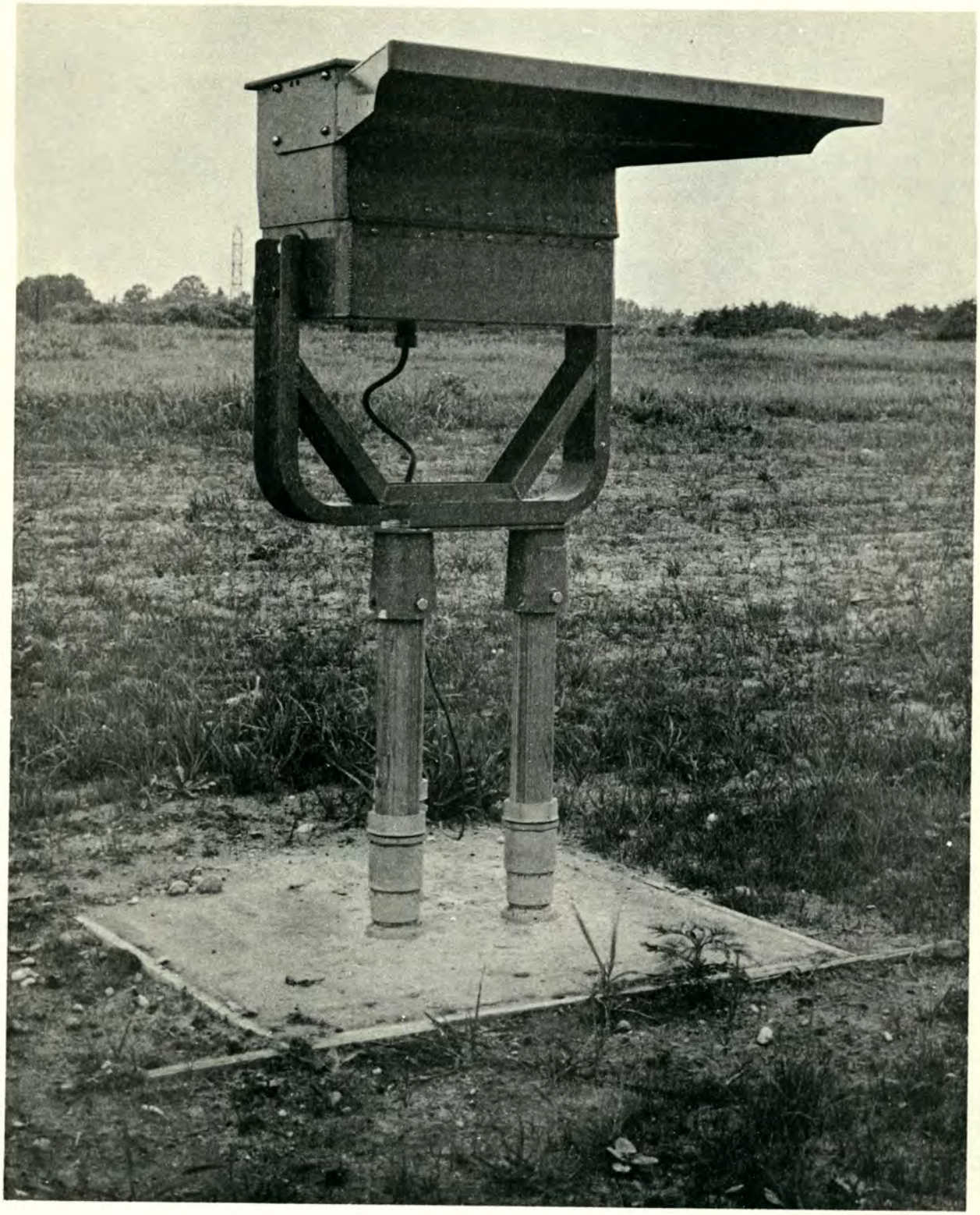

FIG. 3 PAD FLOODLIGHTING UNIT

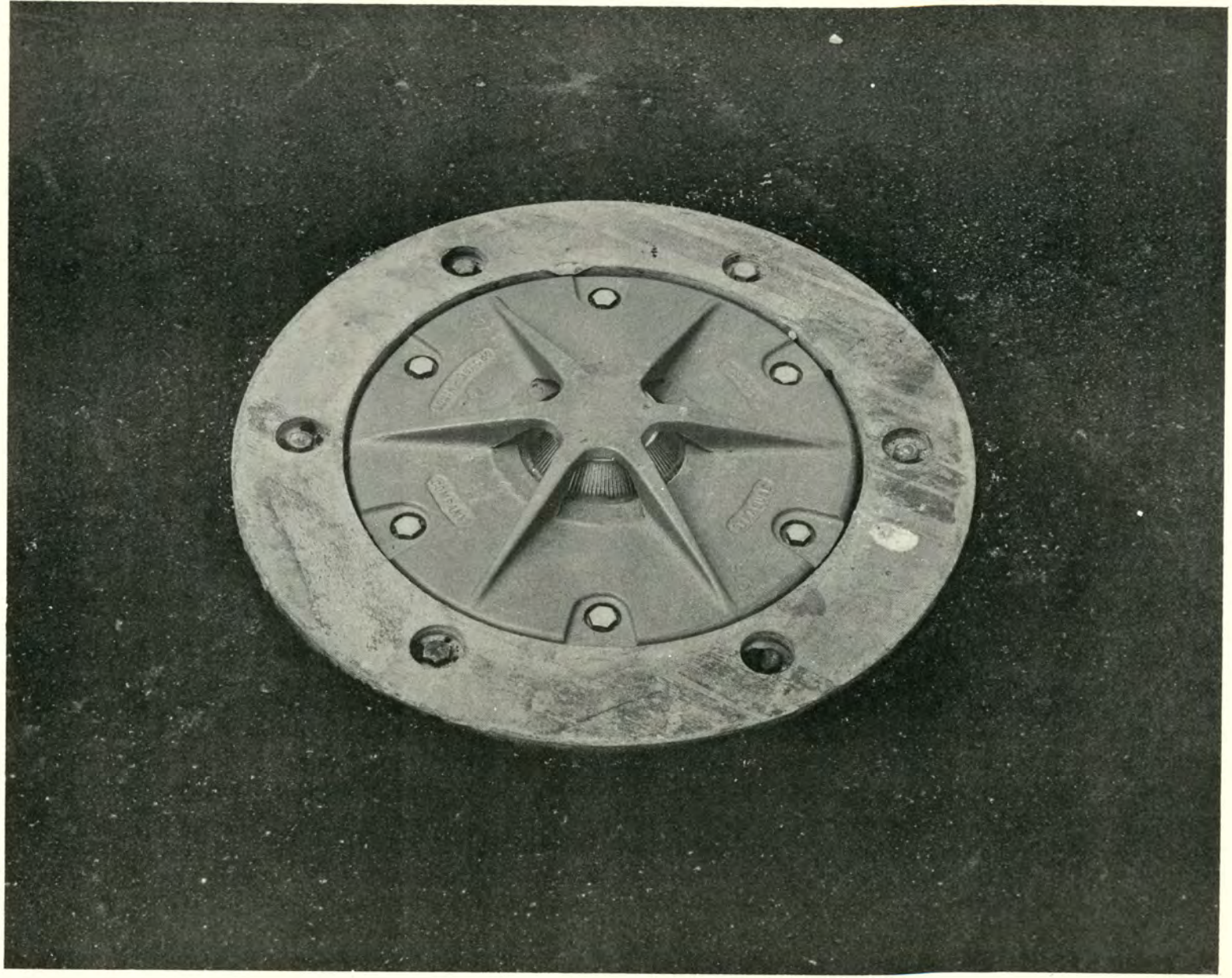

FIG. 4 OMNIDIRECTIONAL INSET LIGHT UNIT

FIG. 5 "AIMING POINT" INSET LIGHT UNIT

Circuiting was such that any or all of the four 100-foot segments of the lead-in lighting system could be displayed at any one time. During the formal test period the middle 200 feet were used. Thus, the approach direction corridor began 100 feet from the pad perimeter and extended to a distance 300 feet from the pad. The light units were standard L-810 obstruction light fixtures, using a 1020 lumen 6.6A lamp, with clear globes to provide distinctive coloration (Figure 6).

Landing Direction Lighting: Six 45-watt medium-intensity omni-directional lighting units were located in lines with 15-foot intervals between units to the east, west, and south of the helipad shoulders. These lights were used to indicate desired landing or take-off direction and were circuited so that any desired line could be displayed. The light units were standard L-810 obstruction light fixtures using a 1020 lumen 6.6A lamp, with yellow filter globes to provide distinctive coloration (Figure 7).

Wind Tee and Wind Sock Illumination: Floodlighting above the wind sock and multiple lamps on the wind tee made both visible at night (Figures 8 and 9).

Visual Approach Slope Lighting: Both two-color and tri-color indicators were installed for evaluation during the latter part of the testing. The two units of the two-color indicator were centered on the east and west shoulders of the pad to provide an 8° approach slope to the east. Figure 10 shows one unit of the two-color indicator, manufactured by General Electric Company. The single unit tri-color indicator was mounted on the north shoulder so as to provide an 8° approach slope to the west. Figure 11 shows the tri-color indicator, manufactured by Lockheed Industrial Products.

Heliport Identification Beacon: Six PAR-56 lampholders were mounted on the periphery of a round steel plate facing outward. The plate was rotated at a speed of 12 r/min by a standard DCB-36 airport beacon-drive motor. Filters were installed over the 250-watt lamps to provide a green-yellow-white flash sequence having double flashes of each color in succession. Overall flash rate was 72 flashes per minute (Figure 12). This particular beacon was not a prototype of a final model but rather was a feasibility model.

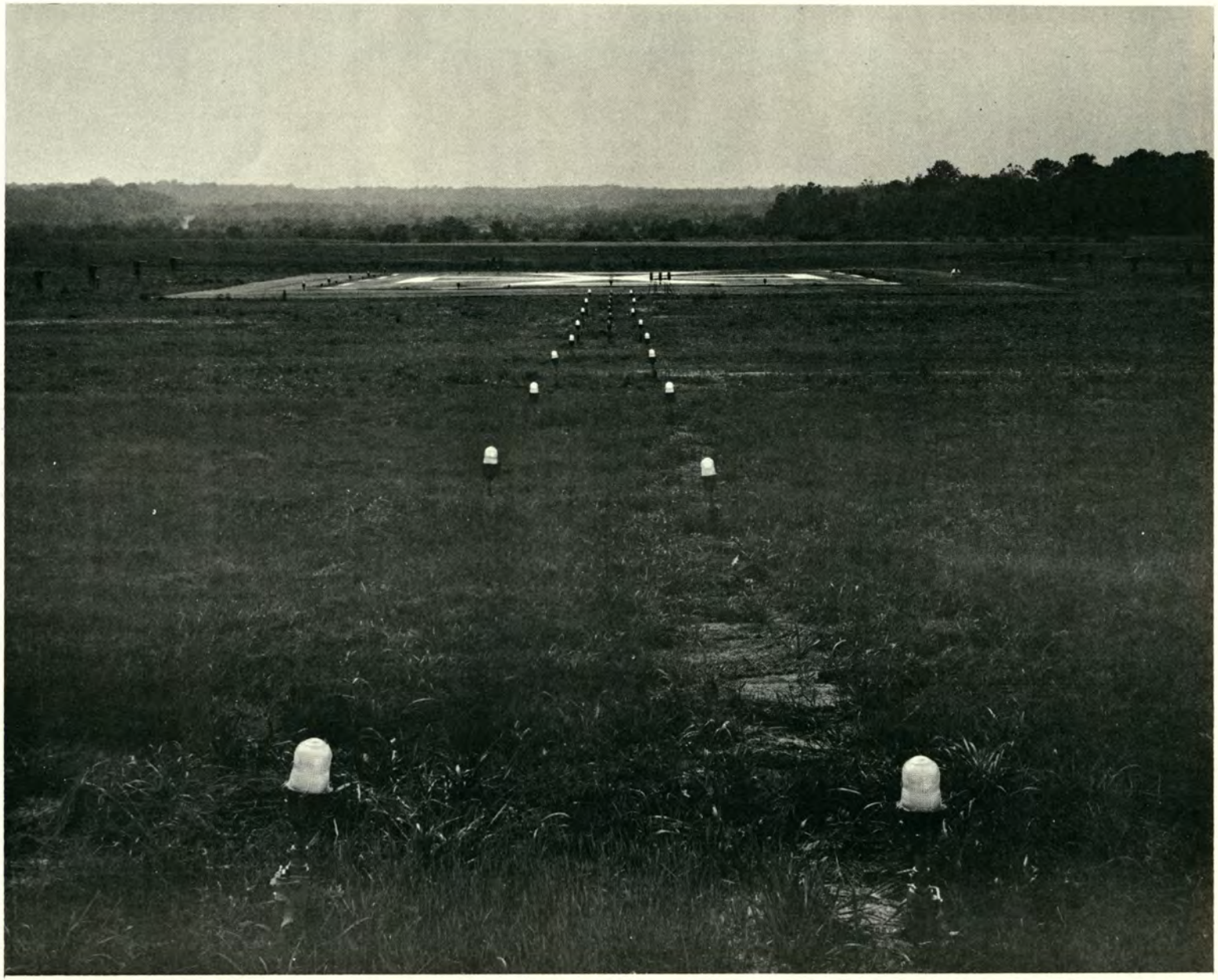

FIG. 6 APPROACH DIRECTION LIGHTING UNITS

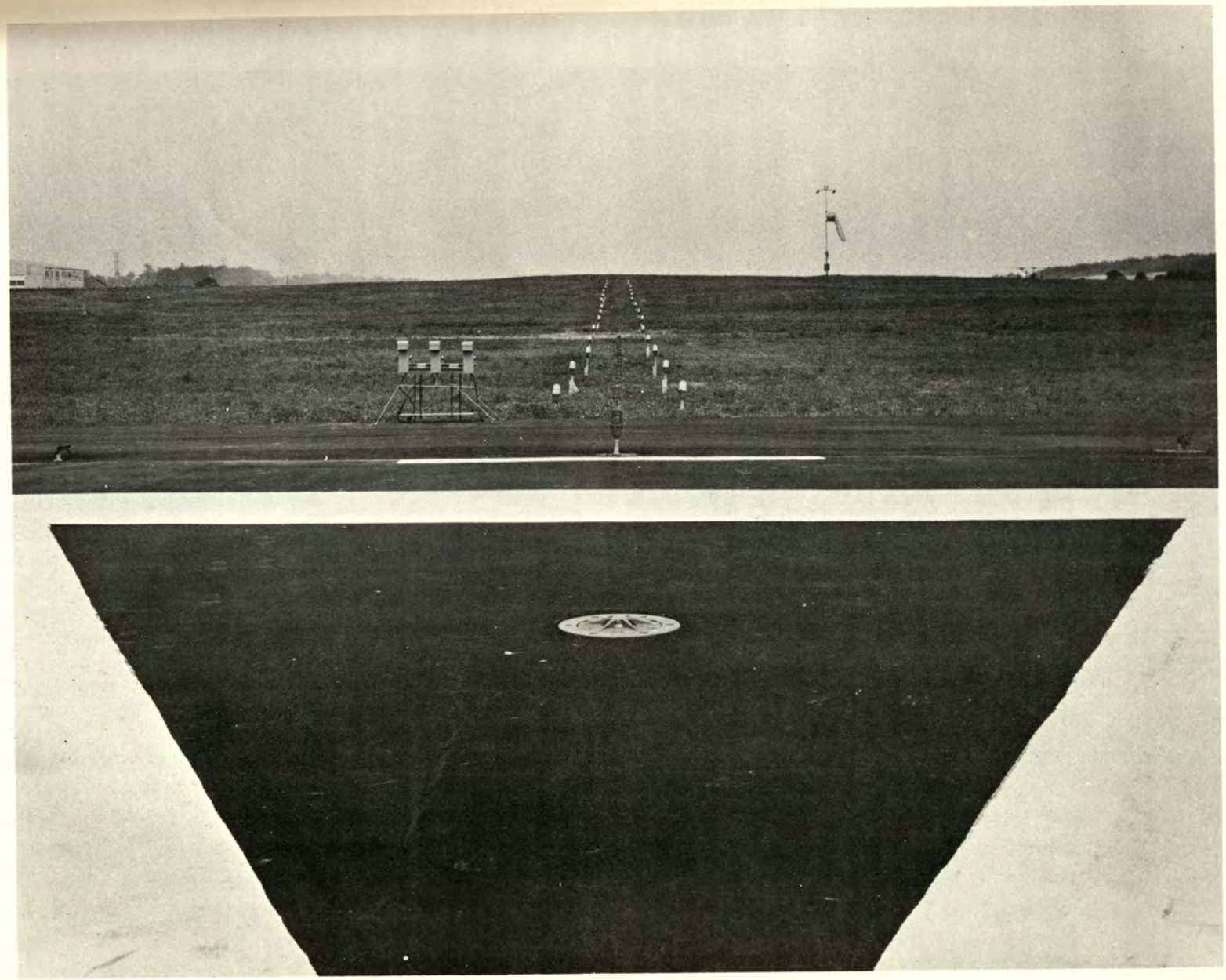

FIG. 7 LANDING DIRECTION LIGHTING UNITS

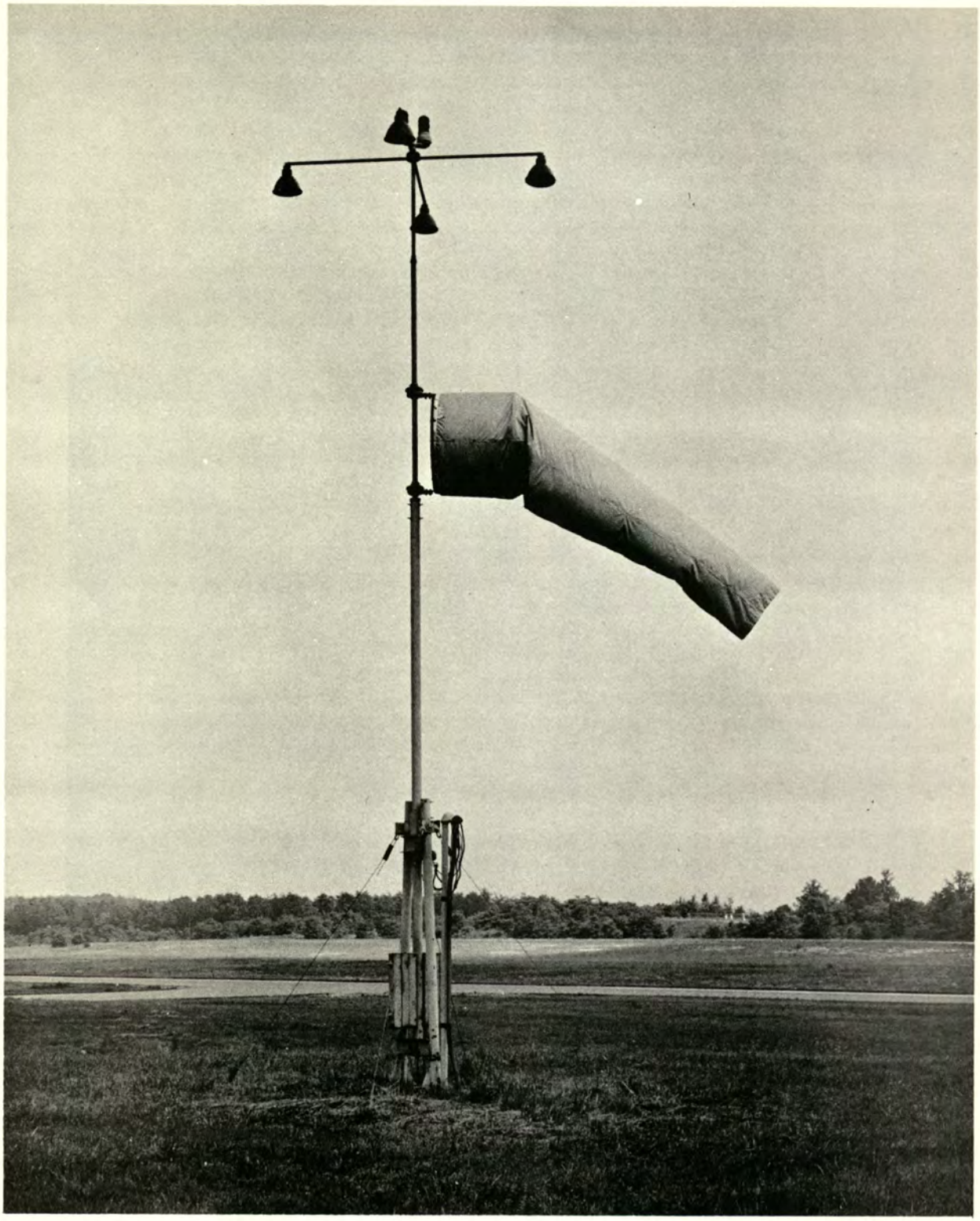

FIG. 8 ILLUMINATED WIND SOCK

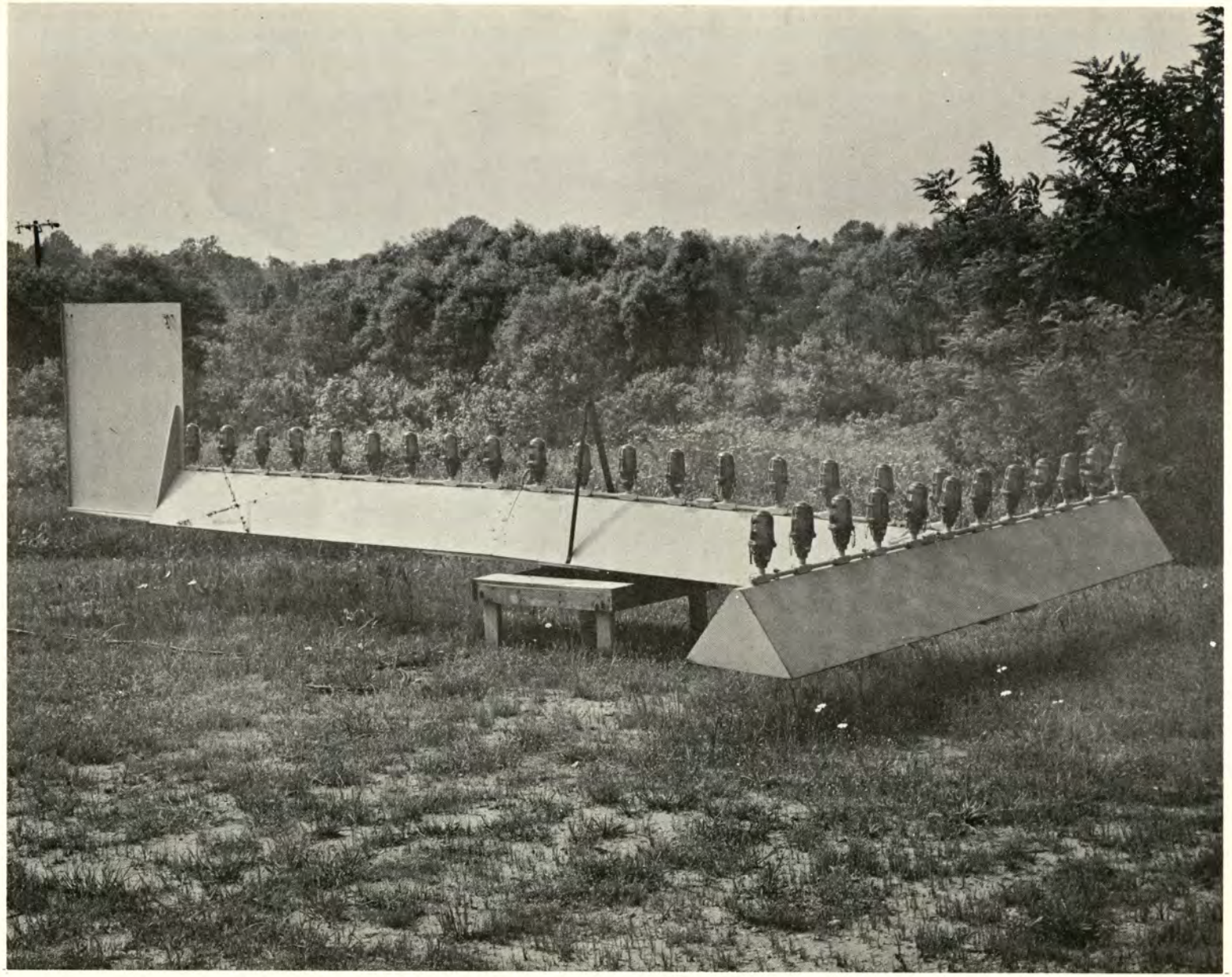

FIG. 9 ILLUMINATED WIND TEE

FIG. 10 GENERAL ELECTRIC COMPANY VISUAL APPROACH SLOPE UNIT

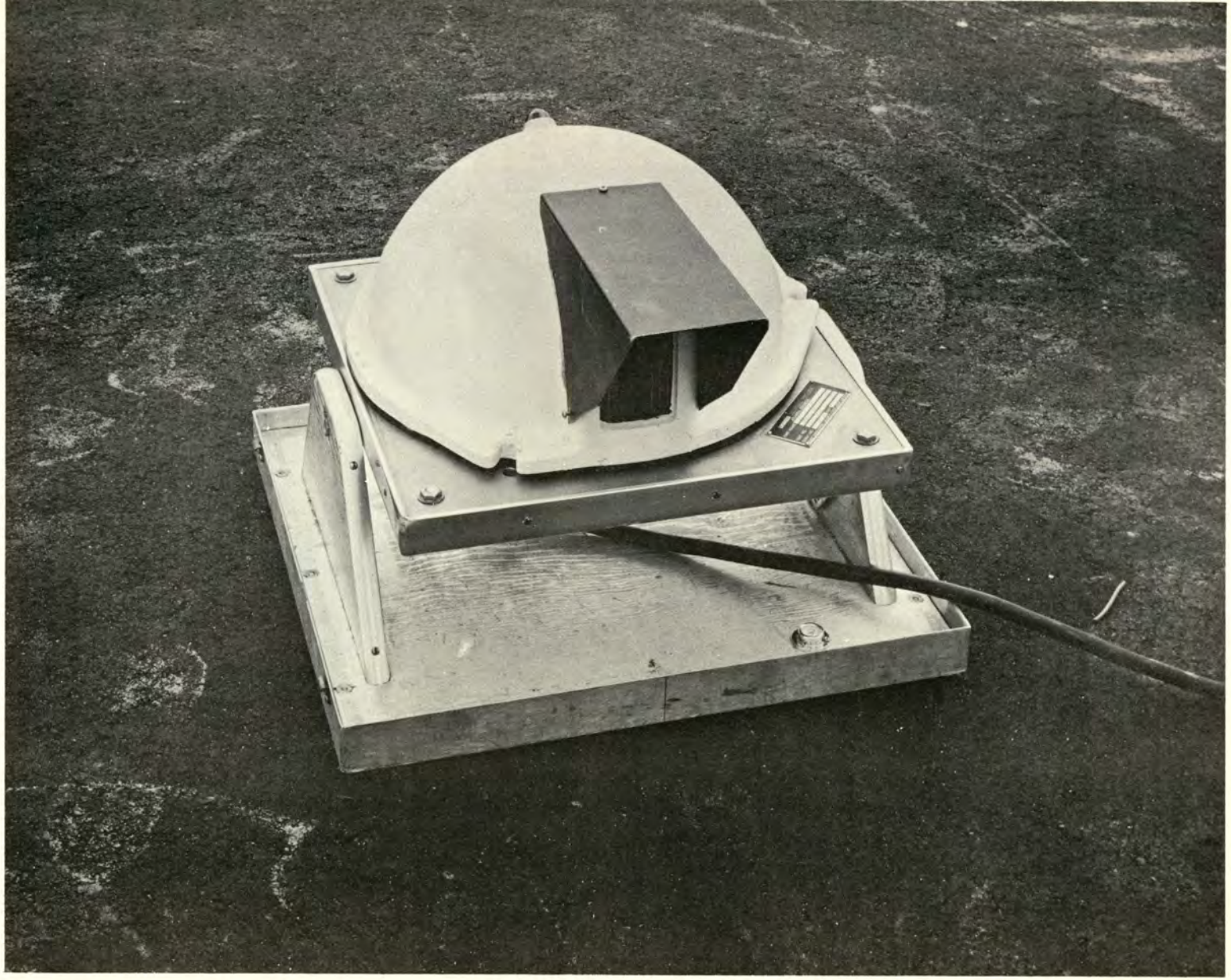

FIG. 11 LOCKHEED INDUSTRIAL PRODUCTS VISUAL APPROACH SLOPE UNIT

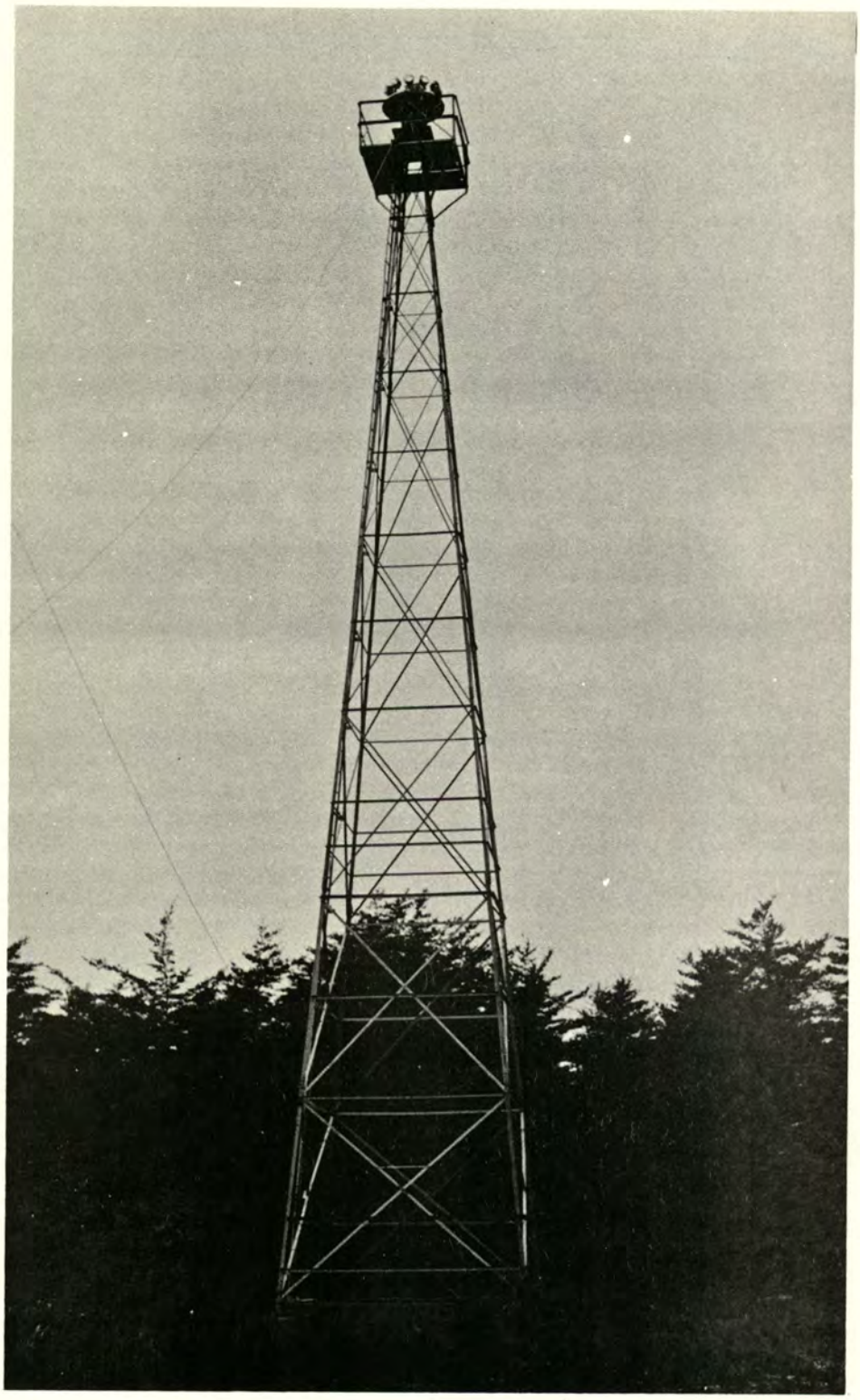

FIG. 12 HELIPORT IDENTIFICATION BEACON

DISCUSSION

Test Design

The measurements usually employed in studies of airport visual guidance systems are of two broad types: performance measures and pilot opinion. Typical of system performance measurement is the aircraft position information, for example, localizer and glide slope deviation, obtained from a tracking range. Other often used performance measures include rate of descent at touchdown and longitudinal and lateral positioning at touchdown. Pilot opinion usually is tabulated following systematic exposure to the various lighting alternatives with the subjects asked which provided adequate or superior guidance under specified conditions.

It was determined that helicopter track information measured in X, Y, and Z coordinates could not be obtained from ground equipment or cameras in the Tipton Field tests. The aircraft was positioned for each run, however, by reference to prearranged landmarks seen from the air. Lack of an instrument range accounts for the absence of physical measurement of most aspects of system performance and necessitated placing chief reliance on measures of pilot preference and opinion. As substitutes for the usually desired physical measurement, however, it was decided to employ ratings made by a data-recording "observer-pilot" occupying a rear seat of each helicopter during flights. Serving as a member of the project team, and making his tabulations during all flights, these observers provided data on the adequacy of location and direction guidance perceived by the subject-pilot as well as data on the actual approach and landing that is somewhat analogous to the data that might have been obtained by inspecting tracking range plots. The lights were switched to an array determined by a set schedule, and the observer-pilot had in his hands a diagram of the path that should be followed by the pilot if he received the intended guidance. If the pilot did not receive the guidance and turned in the wrong direction or followed the wrong track for part of his approach, the observer-pilot was prepared to note this. While less precise than the numbers obtainable by physical tracking, it was hoped that these data would prove useful beyond the questionnaire and debriefing data.

Derived from observer-pilot tabulations, the following criteria or guidance standards were selected to be employed in deciding whether a particular requirement had been met.

Detection of Heliport Location and Identification of Helipad Location: From the air, the subject-pilot reported that he saw the

heliport beacon and stated the direction from the helicopter using clock code; similarly, the subject-pilot reported verbally that he saw the yellow perimeter defining the pad and stated its relative position.

Recognition of Approach Information: After the subject saw the heliport area, and while at the required distance from the pad, he did or did not respond by stating the appropriate approach direction.

Wind Information: The pilot identified wind information correctly or incorrectly prior to making the landing and used the wind guidance correctly.

Approach Slope: Since in some civil applications either obstruction clearance or noise abatement problems may necessitate that relatively shallow approach angles be avoided, adherence to a visually projected "on path" beam was recorded. Two types of approach slope indicators were tested, the General Electric Company two-unit two-color indicator and the Lockheed VAPI (Mark III with 35-watt projection lamp), a tri-color device.

Pilot acceptance is, of course, essential. Hence, the subject-pilots were asked to fill out post-test questionnaires in which they made judgments of the adequacy of the guidance provided by each element and additional judgments of the need or importance of each element. The observer-pilot debriefed all subjects who had flown with him and recorded their general reactions and additional remarks, evaluations, and suggestions for improvements or further tests.

Test Procedures and Conditions

The testing consisted of two phases. Phase I pertained to location of the heliport through observation of the beacon and perimeter lights, and to identification of the helipad by perimeter lighting. Phase II included testing of lighting configurations that provided approach and landing direction information and guidance during the flare and touchdown or final stage of landing. Phases I and II were conducted over a 2-month period with night flights devoted to heliport identification, helipad identification, and actual approaches and landings to test the approach direction, landing direction, and flare and touchdown guidance elements. Location of the heliport test site at Fort Meade, Maryland, permitted evaluation of the visual aids under varying background conditions, i. e., against the high brightness and light density of the Fort Meade main post complex to the north of Tipton Army Airfield and against the relative darkness of the uninhabited areas to the south (Figure 13).

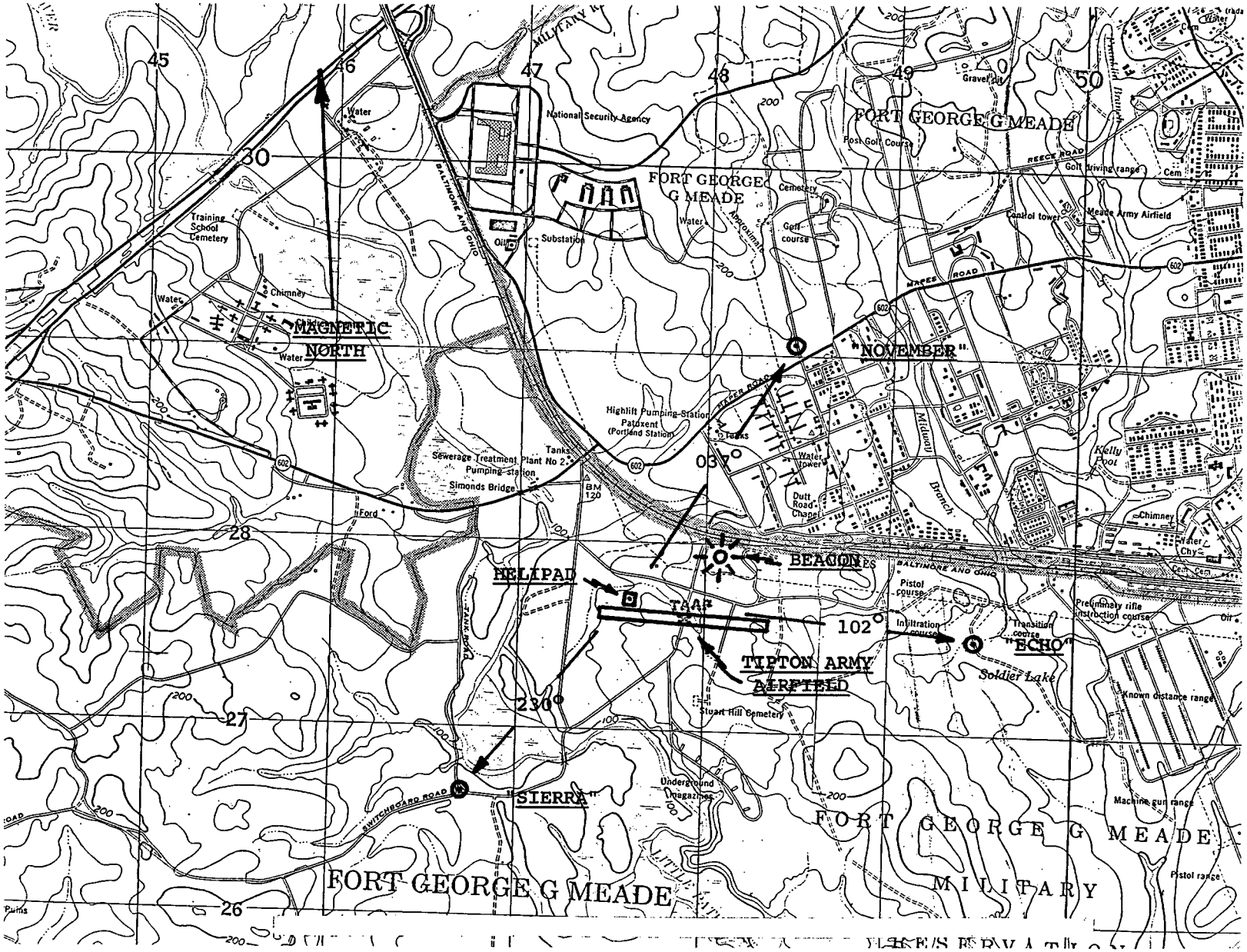

FIG. 13 MAP OF TEST SITE - FORT GEORGE G. MEADE, MARYLAND

Phase I: The first operational requirement is that the heliport be located visually from a distance of 3 miles at night in 3-mile meteorological visibility. The beacon was located 1,250 feet from the center of the pad, conforming to the general rule that the heliport location beacon must be within one-quarter mile of the landing pad. Test Phase I covered this operational requirement and was conducted as follows: Two helicopters flew simultaneously at similar altitudes, representing a low angle of approach and about 300 feet above the terrain. These two helicopters were positioned over landmarks shown on the area map, providing slant distance from the helicopter to the pad of approximately the 1 to 1 ratio required of guidance and visibility, as closely as the current weather permitted, up to a maximum position of 3 miles. Landmarks were provided 1 mile from the pad center, 2 miles from the beacon, and 3 miles from the beacon (Figure 14).

A given Phase I run began with the helicopter positioned over a landmark representing the distance to the pad equal to the meteorological visibility, up to 3 miles. The beacon, perimeter, and full system of helipad lights were operating. The subject-pilot was asked to locate the heliport visually by scanning for the beacon and/or perimeter. Upon seeing the heliport lights, he reported their direction to the observer-pilot who recorded the response. If the heliport direction was not seen, the helicopter was flown toward the beacon until the beacon and/or perimeter lights were seen and an estimate of the detection range could be recorded. To the extent practicable, additional pilot subjects occupied rear seats in the helicopter and supplemented the perceptual judgments of the front-seat subject-pilot with their own.

After the beacon had been surely and correctly identified by the subject, the perimeter lights became the item of interest. Occasionally, the yellow perimeter was seen before the beacon or at the same time. When this occurred, it was recorded by the observer-pilot along with an estimate of range of detection of the perimeter. When the beacon was detected first, the subject-pilot was asked specifically whether or not he could also see the perimeter. If not, the helicopter proceeded toward the beacon, not the pad itself, unless the two lay along the same track line. During this run toward the beacon, the subject-pilot continued to search for the perimeter, knowing that it was somewhere within one-quarter mile of the beacon. When detection of the perimeter occurred, the observer-pilot received the report and recorded it with a distance-to-the-pad estimate. Rear-seat pilots, if any, added their observations under the instruction to search independently and avoid influencing the subject-pilot.

During the Phase I flights, one subject-pilot flew the helicopter with a safety-pilot sitting in the other front seat. As noted above, the

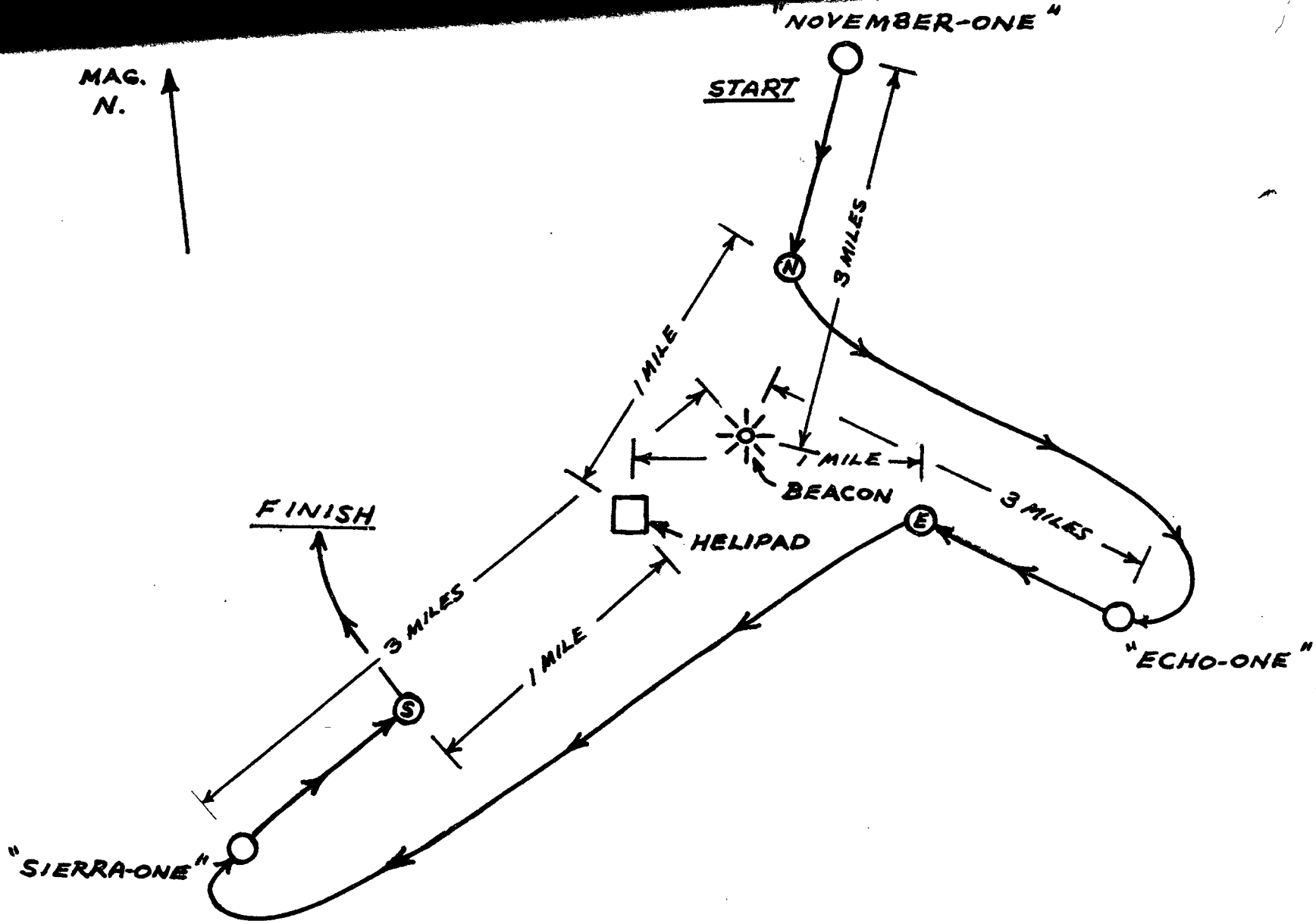

FIG. 14 PHASE I RUN PATTERN

observer-pilot, who was not always qualified in the particular aircraft, although he was always a rated pilot, plus any additional subject-pilots, were seated in the rear. For test control, the safety-pilot and observer-pilot were plugged-in to both intercom and a UHF channel common to the tower and to the light control operator.

Upon completion of one series of observations in a Phase I run, the safety-pilot directed the subject-pilot to fly out from the pad area to a second starting landmark. Again, beacon detection was attempted, followed by flight toward the beacon until perimeter location was detected, followed by an outbound flight to a third starting landmark. The third run toward the pad completed the work of the front seat subject-pilot, and he either exited the helicopter following a landing back at the usual apron adjoining Base Operations, or, switched seats with a rear seat pilot. If no additional subjects were carried in the rear, a new subject got on board at Base Operations, and the three-run sequence was repeated. A three-run sequence was completed in about 15 minutes.

Pretests served to permit selection of highly visible landmarks, rehearsal of data collection techniques, and certain added purposes. Appropriate brightness settings for various visibility conditions were determined with the goal of providing the required distance of detection while avoiding blinding the pilot close-in or in the process of landing or taking off. In addition, a decision on the length of approach lights to be employed in the main test series was made in pretests. Various segments of the 400 feet of approach lighting were turned on to select the length of lights that attained the operational requirement for recognition of approach direction from specified distances and avoided objections of "black-hole" effects.

Phase II: The second operational requirement is that the lighting system insures that the pilot receives approach direction information, landing direction information, and guidance to support actual flare and touchdown. Phase II tests sometimes were conducted on the next night following the completion of Phase I, and in other instances as an immediate follow-on to Phase I flights.

The subject-pilot flew to a hover or stationary orbit over a predetermined landmark 1 to 2 miles from the pad center. Again, two helicopters operated simultaneously at 300 feet altitude (Figure 15).

The subject-pilot attempted to locate the helipad by its perimeter and extra-perimeter lights, and as in Phase I, he flew toward the helipad (if disoriented using a vector provided by the safety-pilot) until he saw the helipad lighting system. This detection range was estimated and recorded by the observer-pilot, and the subject-pilot then attempted

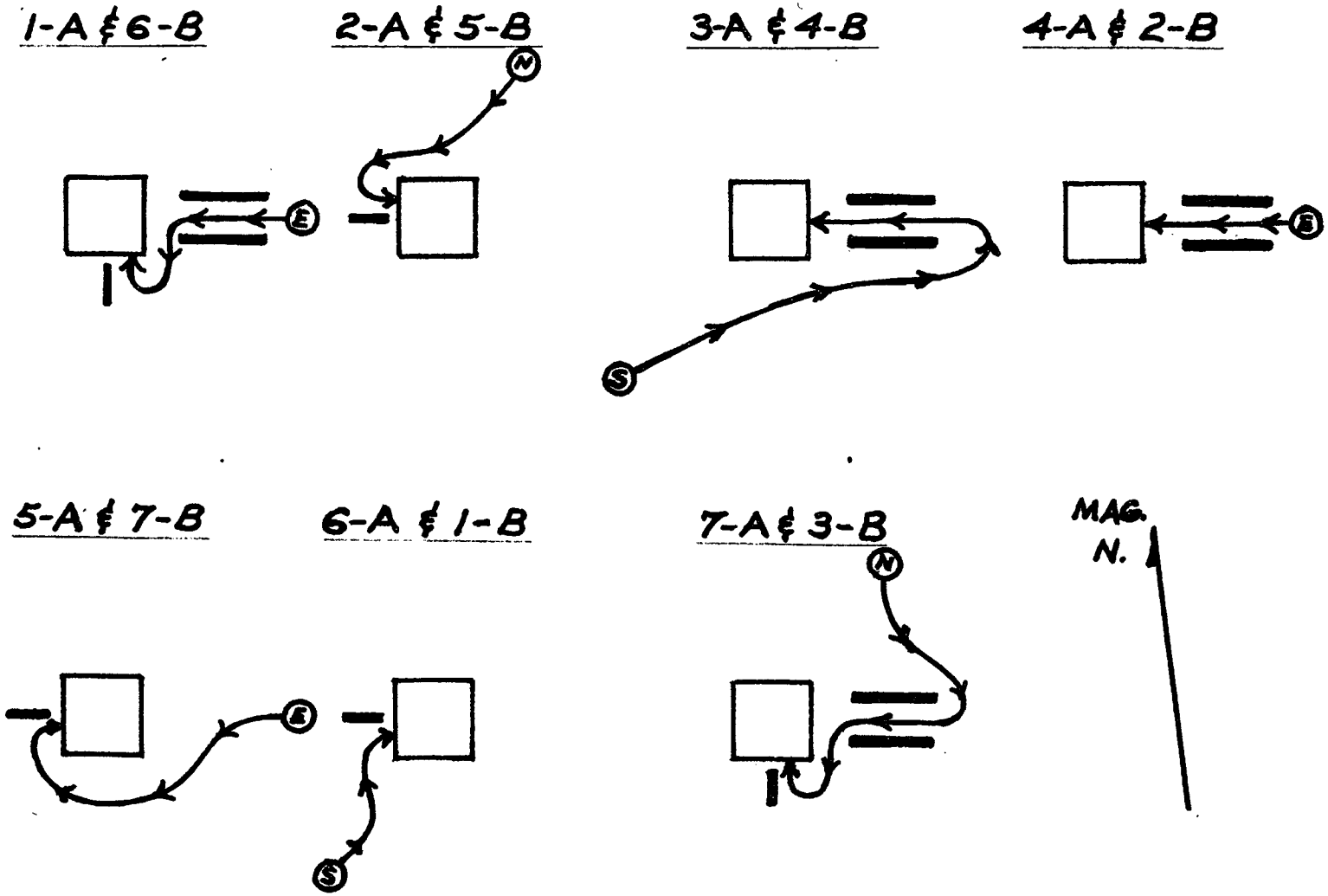

FIG. 15 PHASE II RUN PATTERNS

to state the approach direction indicated by the lights in use, flying closer to the pad if necessary to raise the guidance information to useful levels. The estimated range at which the subject-pilot reported correctly the indicated approach direction was recorded, and the subject-pilot proceeded to fly to the pad following the commanded approach direction.

The subject-pilot reported when he first received landing direction information from the lighting system, and an estimate of this detection range was recorded by the observer-pilot. Using all the guidance provided by the full system in use, the subject-pilot flew to the pad, particularly adhering to the on-path signal of the approach slope indicator (if any were in use) during the flight from 300 feet altitude to about 100 feet altitude. If there were a difference in the lighted approach direction and landing direction, the subject-pilot went off the approach slope path as necessary in the vicinity of 100 to 50 feet altitude. The subject-pilot continued the approach, came to a hover at about 3 feet over the pad surface, and then landed. The observer-pilot recorded data on rate of correction, and anything unusual in the completion of the approach and landing.

For determination of whether wind direction had been seen correctly, an analogous procedure was followed. The observer-pilot asked the front subject-pilot to report what wind direction he saw displayed in lights when he first saw it clearly.

Following the landing, the subject-pilot took off and flew the helicopter to another indicated landmark. He held there until the signal to begin the next run was given by the tower. The second helicopter was making his approach and landing during the first helicopter's outbound run and held at the scheduled landmark. When number two completed his landing, the control tower ordered the lights switched to the setup scheduled for the next run, and the first helicopter began again while the second was outbound.

Unlike Phase I, available rear seats generally were not used to carry other pilots since the same basic patterns were shown to each in turn. The basic data collected consisted of the reports and approach and landing performance ratings obtained with the subject actually flying, and the goal was to cycle a sample of 40 subject-pilots through the full set of basic approach direction/landing direction arrays. These constituted seven runs per pilot, requiring about 40 minutes, and allowing up to five pilots per helicopter per night.

In this plan of seven landings per pilot, it was not possible to show each subject all possible combinations of pad floodlights, inset lights, and approach slope systems. Two landings were made with both

floodlights and inset lights, two were made with floodlights alone, two with inset lights alone, and one was made with neither and the pilot allowed to use his landing lights and clues available from surface marking and glow of other lights, particularly the perimeter, or sources such as the moon.

Subjects and Aircraft

Pilot subjects numbered 46 in all. This included 39 in the uniformed services (30 U. S. Army, 8 U. S. Air Force, and 1 U. S. Coast Guard) and 7 civilians. Army pilots flew the CH-21, ranged in rank from Chief Warrant Officer-2 to Lieutenant Colonel, and varied in flight experience from lows of 800 hours in helicopters and 10 hours in the CH-21 to highs of 4,400 hours in helicopters and 2,500 hours in CH-21's. Air Force pilots flew the UH-1, a more modern and maneuverable craft, held the rank of Captain and Major, and varied in hours experience from 2,000 hours in helicopters and 12 hours in the UH-1 to highs of 5,300 hours in helicopters and 450 hours in UH-1's. Two Army pilots flew as observers only in Phase I and did not actually land on the experimental helipad.

Of the civilian pilots, four were FAA employees and helicopter rated, ranging in experience from 9,500 hours overall and 3,300 hours in Bell 47G-type to 400 hours overall and only 30 hours in Bell helicopters. Fixed wing pilots who rode as observers only accounted for two additional civilians, while the last civilian was privately employed and had 3,500 hours in helicopters, 1,500 of them in the Bell.

Results

The function of this heliport lighting system is to provide guidance to pilots enabling them to locate the heliport, identify the landing pad, and conduct approach and landing operations under VFR conditions. Each element in the total system was designed with a particular guidance requirement in view; hence, the test results will be reported on each element-requirement in turn.

Beacon: Heliport location should be given by the distinctive appearance of the green-yellow-white flashes. A total of 42 pilots flying helicopters and 4 pilots riding rear seats as observers were directed to locations approximately 3 miles from the experimental beacon. While out at these locations all the pilots were asked to look for the beacon and to report its location. Following the flights, the pilots filled out printed questionnaires that included four items on the beacon. The results were consistent in showing that the beacon performed its task. Of the respondents, 42 out of 45 reported that they got the direction to the heliport from the beacon at the maximum distance tested, usually 3 miles. Similarly, 42 of 45 said the beacon was distinctive enough for ready identification, 40 of 45 said the signal was bold enough, and the preponderance of the specific comments offered in response to a final open end question was in the form of suggestions for further improvement of a reasonably satisfactory guidance element. Only two comments were strongly negative. Questions and responses on the beacon are summarized in Appendix 1, Table 1-I.

Since the uniformed and civil pilots and observers showed no striking differences in response, the numbers electing each alternative may be pooled, yielding the following totals. For questions 1 and 2, 42 out of 45 endorsed the beacon as providing clear identification information from the maximum distance tested and providing the information in sufficiently distinctive form. On question 3, 40 out of 45 stated that the beacon was bold enough for identification at the required range.

All of these results may be tested for statistical significance by application of the sign test (see Reference 4). The outcome of this check is that all three proportions found on the beacon questions are significant beyond the .01 level. The statistical inference may be stated as follows: The deviations from half "yes" and half "no" are so large as to practically eliminate the possibility that they occurred through chance. It is concluded, then, that the pilots gave overwhelming support to the idea that the beacon is powerful and distinctive enough to perform its basic job—identification of the heliport at 3 miles or more. Observer-pilot records fully supported this conclusion.

Members of the test team discussed the performance of the experimental heliport beacon with the subject pilots and among themselves. The consensus of opinion emerging from the comments offered by pilots and the test team observations over a period of use of 4 weeks includes two major points. First, the range of detection of the beacon is very great, one crew reporting initial sighting immediately after leaving Washington, D. C., some 12 miles away, but the multiple flash code for specific field identification is considerably less than optimum. A plain, three-flash sequence of green-yellow-white was preferred to multiple flash codes within color bands. Second, the rotation speed might be increased. If this were done at the same time that the multiple flashes within a color were eliminated, each cycle would consist of an onset of green, a dark interval, an onset of yellow, a dark interval, and an onset of white, followed by a dark interval. In the judgment of most parties to the discussions, this "three-bang" beacon would be more distinctive than the 10-lamp, "mini-flash" beacon rotating slower.

Perimeter: Edge lights define the useable surface and identify for the pilot the actual pad location, as contrasted to general heliport location (given by the beacon). Upon initiation of the present test series, of all the elements, a perimeter light system was closest to a design specification. Yellow lights, about five per side, have become conventional. From the earlier Tipton tests it was concluded that pilots preferred to have few perimeter lights, even when the pad was large and the spacing much greater than that obtaining with the smallest number of lights provided on a small pad. Five has been the number chosen because it is enough to allow for some lamp outage; it is an odd number so that each side has a lighted mid-point for aiming, and it seems applicable to pads in the popular size ranges of 50 to 150 feet on a side.

All that remained in the way of required results on pad perimeter lighting was a brightness statement--settings that provide the required range without excessive glare in final landing maneuvers—and a determination of lamp types, elevations, and lenses that meet the night operational requirements. There was reason to doubt that either the experimental perimeter or any other feasible set of perimeter lights could provide sufficient candlepower to obtain the range obtainable by daylight from helipad marking.

During the 11 nights of flying in the Phase II series, the perimeter brightness was varied according to the current weather and the suggestions of the pilots flying to the pad. At no time was there any question of the capacity of the lamps and filters to provide sufficient night brightness; at all times selected levels were in the range of 10 to 20 percent of maximum intensity. Responses to specific questions on the yellow perimeter are summarized in Appendix 1, Table 1-II.

As in the case of the beacon results, the data from military and civil pilots show parallel trends and may be pooled. This gives 28 to 18 saying the yellow perimeter appeared to define a four-sided area at a 3-mile range. That proportion fails of statistical significance, even at the .05 level, and leads to the conclusion that the perimeter is not fully effective at the maximum range at which it can be detected. Subjective observations indicated that at 3 miles and a low elevation such as 300 feet absolute altitude, the perimeter often appears as a smudge or at best a line of yellow. Observer-pilots specifically asked each pilot to state when the perimeter became adequate in defining a four-sided landing pad, and these data were extremely consistent in selecting 1 mile as the positive answer.

Question 2 produced the same result as 1, 28 to 18, an unconvincing vote for the effectiveness of the perimeter lights at 3 miles. The final three specific questions, in contrast, produced divisions of 44 to 2, 44 to 2, and 43 to 3, all significant far beyond the .01 level. These results indicate that the perimeter was highly effective when seen from 1 mile or less.

An overwhelming majority said the perimeter was distinctive enough in form and color. Similarly, the pilots reported the perimeter bold enough. Finally, they endorsed the choice of five lights to a side. Review of the comments indicates here again a general satisfaction with the yellow perimeter.

Approach Direction: Heliports in use today for civil operations do not have approach lights, and the operators of civil helicopters in several metropolitan areas surveyed by R. F. Gates in 1967 reported that they did not recognize a requirement for approach lights to support VFR operations.* The usual reasoning seems to be that civil helicopter operators tend to know in advance the obstructions or special noise abatement areas that may require approaching a heliport from one particular direction, or, alternatively, they use radio to contact a controller for special approach instructions. For these reasons, the present test of approach direction lights was aimed at determining whether or not a particular pattern of particular fixtures, developed after pretesting at Cincinnati and Tipton Field, was capable of conveying approach direction information, if such were required. In no sense was

*Personal communication, R. F. Gates, NA-523, National Aviation Facilities Experimental Center, Atlantic City, New Jersey 08405

the aim to determine the civil need for visual approach direction. It may be that military heliports more frequently require visual approach direction information.

The questions asked and the numbers of responses obtained are shown in Appendix 1, Table 1-III. Since pilots occasionally added comments not specifically called for in the printed questionnaire, these have been inserted next to the questions referred to.

The pooled total of 42 yes to 2 no (two Army subjects did not complete the Phase II runs and did not fill out the questionnaire portions covering approach direction, landing direction, and pad surface lighting, hence the Phase II N = 44) indicates that the approach lights served to give the commanded direction at the starting distance, 1 mile or more. Similarly, the second and third questions received 41 to 2 and 41 to 1 votes in favor of the effectiveness of the pattern. Question 4 provided 36 yes answers to whether or not the approach direction lights should have clear lenses versus 6 who asked for yellow. Intensity was reported as satisfactory by 38, while 4 said too bright, and 2 said too dim. Length and spacing were satisfactory to 34 versus 10 who found fault, suggesting for the most part, wider spacing. Finally, 26 said nothing was objectionable about the approach direction lights while 17 recommended changes, a number of them having to do with matters not reflecting directly on the adequacy of the lights.

With the exception of the last question, calling for recommended changes, all the questions produced statistically significant proportions of response favoring the adequacy of the approach direction lights.

Some of the subject pilots expressed dissatisfaction with the concept of a landing direction different from the approach direction. Preflight briefings attempted to explain the purpose of the runs with this difference. The subjects were told that omnidirectional approach might be barred because of obstacles, noise abatement rules, or in some military instances, security factors. Approach direction lights, then, would provide guidance as to the direction in which the helipad should be approached. This direction might, however, not be suitable for a straight in flight to hover and touchdown because of a possible conflict with actual wind direction. Hence, landing direction lights might be added to provide guidance, to the nearest 45°, as to the final direction that should be followed, subsequent to approach, and during the actual landing.

The subject pilots were particularly cautioned that the approach direction did not have to be followed all the way in to the pad, but rather was intended to guide the approach from 1 mile to, perhaps, 1/4 mile.

Having reached the near vicinity of the pad, the pilot was to consider the approach completed and swing around to make good the indicated landing direction during the final descent. Pilots were specifically instructed to terminate the approach direction track early enough to swing around and pick up the landing direction in a safe and comfortable manner. Apparently, some of the subjects rejected this briefing and felt that the approach direction lights, extending from 300 feet to 100 feet from the pad, commanded them to fly along that line all the way down over the lights. This would leave the pilot with little room to hook around and pick up a final landing direction 90° opposed to the approach. Since this misunderstanding of the ground rules recurred with several pilots, it must be assumed that the briefing asked comprehension of a difficult point: Fly in the direction laid out by the approach direction lights but not necessarily over the approach direction lights themselves. Perhaps approach direction lights placed this close in to the helipad must be expected to define not merely a direction but an actual path for any but the most carefully trained pilot. This expectation, if sound, would tend to argue against using the present configuration.

Landing Direction: The landing direction lights are short (75-foot) single rows of yellow lights similar to the units making up the perimeter. When a particular row is turned on it provides information to the pilot that he should come in over the pad from that side to make his landing, usually because of the prevailing wind. It is possible to imagine a helipad with approach direction restrictions but without the space available for installation of an approach direction light system. Hence, there may be additional uses, such as substitute approach direction indicators, for the short row of landing direction lights.

Landing direction information is required from one-half mile (military) and one-fourth mile (civil) in low VFR weather. The results in Appendix 1, Table 1-IV, indicate that the lights have the required range, 40 to 4 reporting that when seen without approach direction lights, the landing direction lights were distinctive and prominent enough, and a similar 40 to 4 reporting the adequacy of guidance with the longer, white system turned on.

Possible confusions among the systems were reported by 12 pilots. Examination of the specific comments reveals, however, that many of the possible confusions noted would not affect adversely the safety or efficiency of the landing. For example, missing the landing direction lights when they were tacked on at the end of the approach direction system would not matter. A straight-in would be commanded whether or not the landing direction lights were seen separately.

Intensity of the lights was satisfactory to 38 versus 5 reporting glare and 1 reporting insufficient intensity. Similarly, the pattern was

approved by 37 versus 7, 4 voting for a longer row and 1 for fewer lights. Nothing was objectionable to 33 while 11 recommended changes ranging from changed color, to less lights, to greater spacing.

As noted in the discussion of approach direction lights, a number of pilots voiced some objection to the so-called dog-leg approach and landing. The last item under landing direction lights aimed at this specific condition and found 40 pilots saying the light information was clear and adequate, with different approach and landing commands, while 4 said the guidance was not adequate.

With a sample of 44 total, only 32 votes are needed to reach the .01 level of significance. Hence, all the results approving the landing direction lights may be viewed as real.

Surface Lighting and Marking: Questions asked on helipad surface lights are reported in Table 1-V in Appendix 1. The pilots had flown approaches and come to hover over the helipad with five inset lights on, with the floodlight units on, and with both or neither of these systems lighted. The perimeter lighting was always turned on, and those lights extended a general illumination over the helipad somewhat similar to that spread by the floods, although less uniform.

When offered a choice of one system on versus both inset lights and floodlights, the majority voted for both, 36 to 6 and 34 to 8, both statistically significant proportions ($p = <.01$). Forced to choose one or the other alone, 17 chose inset lights while 26 selected floodlights, a difference that fails to reach significance at the .05 level. It should be noted that pilots were not informed as to which lights were on in any particular run. Since the perimeter lights and general ambient lighting illuminated the pad, it is likely that the addition of floodlights was not a marked change. Hence, some pilots may not have been impressed with the value of floodlights. If tested on an otherwise unlighted pad, the floods might have been viewed as more necessary.

When asked whether or not surface lights were necessary, 26 pilots said no, while 18 said yes. Those who had said yes to this question were fairly evenly divided in preferences for inset or floodlights. Taking this result in combination with the various comments, one may conclude that some light on the helipad is desired. It makes the painted marking visible and aids in depth perception in landing. How this light is provided seems not to be crucial to many pilots. If they know where the pad is located they may be able to get by with the aircraft landing light. Somewhat better would be a pad illuminated by floodlights or glow from the perimeter. Since virtually every comment

on the perimeter accepts the perimeter as essential, a real requirement as opposed to nice-to-have, additional pad surface lights may be seen as supplements allowing more even illumination in to the center of the pad, increasing the light level so that small details of the surface may be seen, and generally easing the perceptual task. A few comments were specific in approving the center inset light as an aiming point, but the majority (24 to 19) said they did not land with special attention to it. This, a senior pilot stated, was because it is unsafe to concentrate on the spot directly under the helicopter when in the final descent. Visual attention is better directed to the sides with concentration on aircraft attitude.

The particular pad fixtures and their intensity, location, and pattern were approved by the pilots, 38 to 6 for the insets and 37 to 7 for the floodlights.

A group of general and miscellaneous questions was appended to the questionnaire administered after the Phase II approaches and landings. These questions and response frequencies are summarized in Table 1-VI in Appendix 1.

On test method, the pilots in the military sample said that there were sufficient runs, 35 to 1, and the single dissenter wanted fewer flights. Hence, it may be assumed that sufficient exposure to the alternate lights was given. The civil pilots were divided 4 to 4 on this question, apparently because the visual glide slope indicator comparison was added and unfavorable weather conditions were encountered.

Questioned as to possible aid from a painted marking pattern at night, overall 33 to 11 said yes, a proportion significant beyond the .01 level. This overall may be broken down into pilots who flew the first week when there was no painted marking, 7 yes and 11 no, and the later weeks, with marking, 26 yes and zero no. This split makes it clear that the marking was seen as an aid. Since the painted maltese cross was new, the Tipton Field application being the first instance of use of the pattern chosen in earlier joint FAA/U.S. Army tests, a specific question was put to the pilots who flew after the first week. The pilots were asked to comment on the particular marking. The result was a strong endorsement of the pattern. Pilots said that it was distinctive. By this they meant that it identified the pad, a large maltese cross never otherwise being seen from the air. Also, the comments stressed the usefulness of the particular pattern in that it extended well out to the sides of the pad and provided heavy parallel lines off to the sides of the helicopter. A single coat of white runway paint had been applied to the black asphaltic concrete pad surface. This did not give a high gloss finish to the marking, as might have resulted from repeated coats of the white paint. This effect was approved by the pilots, as well, with several noting the

relative absence of glare. In incidental flying past Fort Meade a few observations have been accumulated to the effect that the maltese cross is a very satisfactory helipad surface marking.

Suggestions for cockpit fog simulation were sought from the pilots. The various responses are to be considered for the forthcoming IFR test series.

Wind Direction: Wind direction information was displayed by two means--elevated floodlights pointed down on the conventional wind sock and lamps installed directly on the wind tee. With a few exceptions these wind lights were shown to the pilots during their approaches. The observer-pilot specifically pointed them out if they were not spotted quickly, and the subject-pilot was asked what the wind indication was. After the flight experience three questions were asked, and the responses are summarized in Table 1-VI in Appendix 1.

It is evident from the responses of the subject-pilots that neither the lighted wind sock nor the lighted wind tee was judged to be satisfactory by more than a small majority, the wind sock failing of endorsement by a 25 to 19 majority of no votes, and the wind tee receiving 26 yes against 17 no. The wind sock was limp during some of the flights. Its location as an elevated structure along the approach path caused some dissatisfaction as well. The wind tee was judged hard to read. At the suggestion of several pilots the green lamps along the top of the T shape were replaced with yellow lamps. This color combination then failed to receive approval by the next group of pilots who said again that it was hard to see the indicated direction. When pressed to choose between a wind sock and a wind tee a majority of 28 to 13, barely significant at the .05 level, elected the wind tee apparently on the basis that if approached from such a direction that it could be read, it would be visible at greater range.

These results indicate that the present wind indicator devices are not fully satisfactory in providing wind direction information to a pilot while on final approach at 1/2-mile range. If, however, the pilot overflies the indicators prior to making his approach so as to view the indicators at short range from overhead, either the wind tee or wind sock will provide adequate wind information. This procedure is normal practice in fixed wing operations, and would be equally applicable for rotary wing operations.

Visual Approach Slope: The two visual approach slope indicators were tested with the final eight pilots, all civil in classification, during the last week of the Tipton Field series.

To accomplish the comparison of the two indicators, the pilot flew toward the pad from a position 1 mile to the east. He departed the pad to a position 1 mile to the west, reversed direction, flew back to the pad, and then continued on to the initial east position. Three circuits were completed in this manner so that the pilot had accomplished three approaches on each of the two units.

After completing the six approaches, the subject-pilot was asked four questions. The data are fragmentary due to the use of only eight subjects and the inability of two of these to fly the helicopter from the pilot's seat. One thing is evident, however, and this is that the night range of both systems is adequate to support approaches from a distance of 1 mile. The majority of subjects saw and identified the signals at ranges greater than 1 mile. There was a wide divergence of opinion on the altitude at which the different indicators ceased to be of aid during the approach; there is, however, no marked difference between the two indicators in the effective altitudes reported. Because of the brevity of the approach slope indicator phase of these tests, a conclusion cannot be drawn.

SUMMARY OF RESULTS

1. Subject-pilots reported that the heliport beacon provided a bold, distinctive identification of the heliport, but that single flashes of each of the three colors would be more effective than the double flashes used.

2. The helipad perimeter lighting color, intensity and configuration were rated highly satisfactory by the majority of the subject-pilots.

3. The subjects felt that the approach direction lighting provided useful approach guidance, but that the spacing between the two longitudinal rows of lights should be increased for better recognition quality.

4. The landing direction lighting color, intensity, and configuration were judged satisfactory by a majority of the subject-pilots.

5. Pilot opinion indicated that the helipad surface lighting should not be considered essential to successful completion of the landing maneuver. The subjects did not express a clear preference for either the floodlight or inset light type of surface lighting.

6. Neither the lighted wind sock nor the lighted wind tee was judged satisfactory in providing wind information during approach at a range of one-half mile.

7. Subject-pilots indicated that they received useful approach slope information from both types of approach slope indicator at ranges of slightly over 1 mile.

8. The painted helipad marking was judged to be a valuable supplemental flare and touchdown aid by a majority of the pilots for whom it was displayed.

CONCLUSIONS

Based on the results of this evaluation, it is concluded that:

1. The heliport identification beacon is adequate with regard to boldness and intensity. Single flashes of each of the three colors appear preferable to multiple flashes.

2. The helipad perimeter lighting is adequate for providing ready identification of the helipad at distances of 1 mile or less.

3. The approach direction lighting provides adequate approach guidance information at ranges of 1 mile or less, except that spacing between longitudinal rows of lights is not sufficient.

4. The landing direction lighting provides adequate landing direction guidance at ranges of one-half mile or less.

5. Helipad surface lighting (both floodlight and inset light types) provides supplemental guidance during the flare and landing operation, but is not essential to successful completion of the landing maneuver when a helipad perimeter lighting system is provided.

6. Neither the lighted wind sock nor the lighted wind tee provides adequate wind direction information under the test conditions. However, either system would be adequate if the pilot flies over the heliport to view the indicator at short range prior to landing. For providing wind direction information prior to take off, the lighted wind sock would be superior to the lighted wind tee.

RECOMMENDATIONS

Based on the results of this evaluation, it is recommended that:

1. The Basic Heliport VFR Lighting System consist of the following components as a minimum requirement:

   a. heliport identification beacon

   b. helipad perimeter lighting

   c. lighted wind sock

2. The following components be adopted as optional additions to the Basic Heliport VFR Lighting System for use when justified by special terrain and operational limitations:

   a. approach direction lighting

   b. landing direction lighting

   c. pad surface lighting

3. The following action be taken:

   a. Develop an improved heliport identification beacon displaying single short duration flashes of each of the three colors at a rate of 36 flashes per minute (12 green-yellow-white flash sequences per minute).

   b. Increase the spacing between longitudinal rows of lights in the approach direction lighting to 10 feet.

   c. Develop an improved lighted wind direction indicator if a requirement exists to provide this information at a 1/2-mile range during approaches.

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APPENDIX 1

TABULAR SUMMARIES OF RESULTS

TABLE 1-I

HELIPORT LOCATION LIGHTING

Question	Number of Pilots Responding	
	Military	Civil
1. When did you first clearly identify the general direction to the heliport by locating the rotating green-yellow-white beacon?		
a. At the maximum distance tested	37	5
b. After flying in toward the heliport	1	2
2. Was the rotating green-yellow-white beacon distinctive enough compared to other beacons and airport lights for ready identification?		
a. Yes	35	7
b. No	3	0
3. Was the signal from the rotating green-yellow-white beacon bold enough for identification at the range you needed it?		
a. Yes	33	7
b. No	5	0

4. General comments on the beacon or suggestions concerning its usefulness.

A-1*- Very good
A-2 - The beacon was easily distinctive. The colors stood out boldly.
A-3 - A little faster rotation and more of a flashing type light to get your attention for first sighting.
A-4 - The beacon seemed to be more of a continuous light than the standard beacon.
A-6 - Outstanding.
A-7 - Very effective. Landing lights not needed on approach.

*"A" identifies military subjects in the "Alpha" helicopter, "B" in the "Bravo" helicopter, and "C" identifies civil pilots flying in the Bell.

TABLE 1-I (Continued)

Question	Number of Pilots Responding: Military	Number of Pilots Responding: Civil
4. General comments on the beacon or suggestions concerning its usefulness (continued)		

A-8 - Suggest using higher intensity lights on beacon. Reason: When beacon was backgrounded by other lights it became difficult to recognize.

A-9 - Yellow portion stands out quite clearly and makes the beacon quite distinctive.

A-10 - It seemed that the flashes might have been spaced closer for quicker identification. At lower altitudes, the white merged with background lights. The yellow was distinctive at all distances and elevations.

A-12 - The beacon was easily identifiable at all distances tested - easily discernible from all other lights.

A-13 - From an aviator's standpoint it is confusing since green and white or amber and white combinations have specific meanings when used for beacon lights at airports.

A-14 - Excellent signal.

A-15 - Should rotate faster to help distinguish from background lights of city, camp, etc.

A-16 - Rotation speed of beacon could be increased thereby interfering less with the horizon scan of the pilot.

A-17 - Beacon should rotate at a higher speed.

A-18 - 3 split lights are good but beacon should rotate faster due to the time involved in identifying.

A-19 - Blended in with background from Sierra.

B-3 - The beacon was identified at 3-mile range. However, at any greater range I believe the colors would be less distinguishable. I would like to try a two-color beacon like white and yellow of greater intensity. Intensity is important because helicopter flying is done in poor visibility and it is in poor visibility that you need the beacon. On a clear night I don't need a beacon to find a heliport.

TABLE 1-I (Continued)

Question	Number of Pilots Responding: Military	Civil
4. General comments on the beacon or suggestions concerning its usefulness (continued)		

B-4 - Beacon should be brighter.
B-7 - Excellent selection of color and dual flash of each color. Clearly recognizable as heliport lights and positively not confused with airport lights.
B-10 - On all maximum distance check points I could see the yellow heliport lights; however, it was a little hard to tell it was a heliport.
B-12 - Tri-color is excellent idea.
B-13 - Not sure how it would show with other lights in background.
B-14 - Very good. Very easy to distinguish. Believe it is an outstanding aid in finding the heliport.
B-15 - Beacon very distinctive and excellent idea.
B-16 - Should be set away from any other blinking lights.
B-17 - Was not distinctive enough.
B-19 - Beacon did not have enough intensity to make it distinguishable from a distance equal to that of a standard airport beacon.

C-2 - With the beacon in its present location it was easy to find and identify - background lighting presented no problem. Further testing in high density background lighting might be advisable.
C-3 - Beacon not evaluated on this, the second series.
C-4 - Rotation is slow, white light shows too long and beacon is lost when background has many such bright lights. This was particularly noticeable when going to Echo.
C-5 - The red/white/amber coding is distinct once the beacon site is identified. I would expect a transient pilot to have problems in seeing the

TABLE 1-I (Continued)

Question	Number of Pilots Responding	
	Military	Civil
4. General comments on the beacon or suggestions concerning its usefulness (continued)		
beacon if it were located in the midst of other environmental lights. (Same problem with any airport beacon. The rotating light is of questionable value as an "attention getter.")		
C-7 - I noticed the beacon during our first run. I didn't look for it during the other runs and it apparently didn't catch my eye because I don't remember seeing it except on the first run.		
C-8 - Saw beacon at maximum range of 1 mile. Did not fly out further than 1 mile.		

TABLE 1-II

HELIPAD LOCATION AND DEFINITION LIGHTING

Question	Number of Pilots Responding	
	Military	Civil
1. At your altitude and distance of first clear detection, did you see the yellow perimeter as defining a four-sided area?		
a. Yes	22	6
b. No	16	2
2. When did you first clearly locate the landing pad by seeing the yellow perimeter?		
a. At the maximum distance tested	21	7
b. After flying in toward the heliport	17	1
3. Was the yellow perimeter distinctive enough in form and color to enable you to pick out the helipad as different from other lighted areas nearby?		
a. Yes	36	8
b. No	2	0
4. Was the yellow perimeter signal bold enough to support ready helipad identification?		
a. Yes	36	8
b. No	2	0
5. Do you consider the number of lights in the yellow perimeter sufficient to define the helipad?		
a. Yes	35	8
b. No	3	0

TABLE 1-II (Continued)

Question	Number of Pilots Responding: Military	Civil
6. General comments on the yellow perimeter or suggestions on its usefulness.		

A-1 - Very good; is bold enough for ready identification.
A-2 - The yellow perimeter light stood out quite boldly and was easily detected.
A-3 - Good. Possibly different color lights at the corners.
A-5 - The yellow perimeter lights and white approach blended when located in close proximity.
A-7 - Very effective. Landing lights not needed on approach.
A-10 - The color was great, but the grouping of lights was difficult to identify as a heliport. Felt that fewer lights and less intensity would have helped.
A-12 - Good identification - it could not be confused with any other area in the vicinity of the test facility.
A-14 - Excellent.
A-17 - Too many yellow lights on perimeter.
A-18 - Too many lights.

B-2 - At 600 feet helipad looked one-sided (clustered) until approximately 1 mile out.
B-3 - The lights were intense enough to spot readily but because of this intensity the glare became uncomfortable as we got in close. I'll reserve decision until I shoot some approaches but as of now they are too glaring.
B-7 - Suggest only perimeter lights without flood or central lights.
B-11 - Number of lights was sufficient but added lights may be more distinctive (a solid sided rectangle) in an area with more lights.
B-12 - Yellow lights observed in conjunction with maltese cross easily and distinctly define the helipad as a helipad.

TABLE 1-II (Continued)

Question	Number of Pilots Responding	
	Military	Civil
6. General comments on the yellow perimeter or suggestions on its usefulness (continued)		
B-13 - No real problem even with the aircraft landing light and center lights (blue and white pancake).		
B-14 - Most useful.		
B-16 - Pad must be larger so as not to be hidden behind console and cockpit structure.		
B-17 - Yellow lights were very distinctive.		
B-18 - Lights too bright in relation to taxiway and runway lights. Caused cockpit glare.		
C-2 - Excellent.		
C-4 - Amber color appears distinctive when compared to many red and white commercial lights.		
C-5 - Excellent definition. The lights were clear at 3 miles and the rectangular area clearly recognizable at sufficient distance (approximately one-half mile) for approach and landing.		
C-6 - Might be a problem to differentiate yellow perimeter helipad lights in a highly lighted community or industrial area. Very definitive in area evaluated as a helipad area.		
C-7 - Looks good.		
C-8 - Considered lights distinctive enough to spot pad without trouble. Intensity very good. Color good. Even under heavy rain conditions, identification was not at all difficult.		

TABLE 1-III

APPROACH DIRECTION LIGHTING

Question	Number of Pilots Responding: Military	Number of Pilots Responding: Civil
1. Did the double row of white approach lights give you a satisfactory indication of the commanded approach direction from the starting location of your runs?		
a. Yes	35	7
b. No	1	1
Comments C-2 (Yes) - From Echo, approach lights looked short due to distance and low angle.		
2. Were the approach direction lights prominent and distinct enough so that, when they were on, it was evident that a single approach direction was commanded?		
a. Yes	33	8
b. No	2	0
Comments B-9 (Yes) - Except for approach to east when coming in from east.		
3. If you answered Yes to No. 2, was the particular direction well defined by the pattern of the lights?		
a. Yes	33	8
b. No	1	0
Comments B-5 (Yes) - From point Echo with landing direction lights to the east, direction could not be determined until approximately one-half mile from pad. B-8 (Yes) - But could have been spread farther apart.		

TABLE 1-III (Continued)

Question	Number of Pilots Responding: Military	Civil
4. Do you feel that the approach direction lights should have clear lenses, as in this test, or should they be yellow, similar to the landing direction and perimeter lights?		
a. Approach direction lights should be clear	29	7
b. Approach direction lights should be yellow	5	1
Comments		
B-8 - I would rather see them a different color, such as red.		
5. Was the intensity of the double row of approach direction lights satisfactory, too bright, or too dim?		
a. Intensity was satisfactory	30	8
b. Intensity was too bright	4	0
c. Intensity was too dim	2	0
No comments		
6. Was the pattern of approach direction lights satisfactory in length and spacing to provide adequate guidance?		
a. Pattern was satisfactory	28	6
b. Pattern was not satisfactory	8	2
Comments		
A-1 (Yes) - Approach lights could be located closer to pad if pad is located at airfield to insure that they are part of the system.		
A-3 (No) - Spacing too close on the lights.		
A-5 (No) - A wider lane would be more satisfactory.		
A-6 (No) - Suggest approach lights be spaced wider apart.		
A-8 (No) - Needs slightly wider separation between rows; 1- to 2-feet more.		
A-16 (Yes) - Due to airfield gradient the lights failed to give a definitive direction when approached from the east to land to the east.		
A-17 (No) - Spacing—too many lights—too close.		

TABLE 1-III (Continued)

Question	Number of Pilots Responding: Military	Civil
6. Was the pattern of approach direction lights satisfactory in length and spacing to provide adequate guidance (comments continued)		

B-5 (No) - Lights should be spaced farther apart, alternating or a different color.
B-6 (Yes) - Would like to see flashing lights to indicate same.
B-7 (No) - Should be spaced a little farther apart and a little farther (25 feet) away from the heliport lights.
B-8 (Yes) - Could have been farther apart.
B-14 (No) - Approach lights should be spaced just a little wider apart. I believe this would enable the pilot to distinguish the landing direction lights from the approach lights when they are in the same direction.

C-2 (No) - At a distance and at a low angle, the lights appeared to be spaced too close together (from Echo).
C-5 (No) - If spacing between present lights were increased, would improve guidance instead of the solid parallel light bars being presented in current configuration. A definitive longitudinal spacing, not necessarily longer, but removal of alternate lights would possibly improve pattern.

7. Was there anything objectionable about the approach direction lights? Please explain.		
a. Nothing was objectionable	20	6
b. I recommend the following change(s)	15	2

Comments

A-4 (Recommend changes) - I feel that a cargo helicopter loaded would have a difficult problem trying to land in another direction than he approached.
A-5 (Recommend changes) - They blended in with yellow lights; therefore, recommend more contrast in color.

TABLE 1-III (Continued)

Question	Number of Pilots Responding	
	Military	Civil
7. Was there anything objectionable about the approach direction lights? Please explain. (comments continued)		

A-16 (Recommend changes) - A slingshot arrangement be used open on one end to clearly define the approach direction.
A-17 (Recommend changes) - Less lights and lower intensity.

B-2 (Recommend changes) - Approach direction and landing direction can't be changed on final.
B-8 (Recommend changes) - Could have a lower intensity.
B-14 (Recommend changes) - If the approach direction lights are on a different heading than the landing direction lights, the approach direction lights should be located farther out from the pad to allow the pilot to better maneuver his aircraft for the landing.
B-15 (Recommend changes) - With floodlights and approach direction the lighting was too bright.
B-17 (Recommend changes) - Should be a larger pattern.
B-18 (Recommend changes) - Too bright.

C-2 (Recommend changes) - Wider spacing - longitudinal.
C-5 (Recommend changes) - More spacing between lights - possibly alternating white and yellow might help.

TABLE 1-IV

LANDING DIRECTION LIGHTING

Question	Number of Pilots Responding: Military	Civil
1. With the approach direction lights turned off, were the landing direction lights distinctive and prominent enough to give you the landing direction when you required it?		
a. Yes, I saw the landing direction in plenty of time.	33	7
b. No, landing direction lights lacked enough range.	3	1
Comments B-7 (Yes) - Even more prominent. C-5 (Yes) - Both. Saw landing direction in plenty of time in prevailing conditions. Under more reduced visibility, might be more distinctive (brighter).		
2. With the approach direction lights also on, were the landing direction lights sufficient to give the guidance that you required?		
a. Yes, I was sure of landing direction in plenty of time.	34	6
b. No, landing direction guidance was unsatisfactory.	2	2
No comments		
3. Did the landing direction lights stand out from the approach lights, when both were on, and/or from the perimeter lights, or were there possible confusion(s)?		
a. Yes, landing direction lights were distinct.	26	6
b. No, landing direction lights could be confused	10	2
If you answered b, please comment or suggest a remedy to avoid possible confusion.		
Comments A-5 (Could be confused) - Both sets of lights blended together when approximately 1 1/2 miles out. No problem within one-quarter mile.		

TABLE 1-IV (Continued)

Question	Number of Pilots Responding: Military	Number of Pilots Responding: Civil
3. Did the landing direction lights stand out from the approach lights, when both were on, and/or from the perimeter lights, or were there possible confusion(s) (comments continued)		

A-8 (Could be confused) - When landing and lined up the landing direction lights look like one of the perimeter lights (as one light). It was not apparent that there were a string of lights until on short final.
A-13 (Could be confused) - They blend with the perimeter lights from a distance. Suggest another color.
A-14 (Could be confused) - When landing direction was 180° to approach direction, landing lights blended with perimeter lights.
A-17 (Could be confused) - When landing direction lights were same direction as approach lights.
A-18 (Could be confused) - When approach lights and direction lights were the same direction.

B-7 (Could be confused) - Not really confused but would like to see a different color or darker amber color.

C-1 (Could be confused) - Spread approach lights apart or make landing direction lights longer.
C-3 (Could be confused) - Spread approach direction lights and stretch landing direction lights.
C-5 (Yes) - Yes from approximately 1/2 to 3/4 mile only.

	Military	Civil
4. Did you experience excessive glare from the landing direction lights? Was the intensity satisfactory, or should it be increased?		
a. Glare was a problem; reduce the intensity	5	0
b. Intensity was satisfactory	30	8
c. Intensity should be increased	1	0

Comments
A-8 (Intensity should be increased) - To more than perimeter lights.

TABLE 1-IV (Continued)

Question	Number of Pilots Responding: Military	Civil
5. Was the pattern of landing direction lights satisfactory in length and spacing to provide adequate guidance?		
a. Pattern was satisfactory	32	5
b. Pattern was not satisfactory	4	3
If you answered b, please comment.		

Comments

A-8 (Pattern not satisfactory) - Should be longer.

A-16 (Pattern not satisfactory) - Due to field gradient the lights observed from the east for an approach to the east were not clearly definable.

A-17 (Pattern not satisfactory) - Too many.

A-19 (Pattern not satisfactory) - Landing light row should be longer. Hard to distinguish when landing direction was opposite approach direction.

C-1 (Pattern not satisfactory) - Could be longer.

C-3 (Pattern not satisfactory) - Unable to determine landing direction when observing the landing direction lights in line with them when at a distance of approximately 1 mile.

C-5 (Pattern not satisfactory) - Could be one or two more lights longer under present spacing criteria.

6. Was there anything objectionable about the landing direction lights? If so, please explain.		
a. Nothing was objectionable	27	6
b. I recommend the following change(s)	9	2

Comments

A-4 (Recommend changes) - Reduce the intensity.

A-9 (Recommend changes) - I believe that the landing direction lights can be eliminated and the approach lights can be utilized as both.

A-14 (Recommend changes) - A color contrasting to perimeter lights.

A-16 (Recommend changes) - Greater spacing of landing direction lights or increased intensity with increased spacing.

TABLE I-IV (Continued)

Question	Number of Pilots Responding: Military	Civil

6. Was there anything objectionable about the landing direction lights? If so, please explain. (comments continued)

A-17 (Recommend changes) - Less lights.

B-17 (Recommend changes) - When landing direction lights are on same side as you are positioned, it is a little difficult to distinguish until you get a little closer to the airfield.
B-17 (Recommend changes) - Did not like to dog-leg the approach.

C-1 (Nothing was objectionable) - Could be longer.
C-8 (Recommend changes) - When the landing direction lights were in the approach path direction, it seemed possible to lose or fail to notice them in the perimeter lights.

7. When both approach direction and landing direction lights were on, but landing direction was different from approach direction, was the guidance satisfactory?

	Military	Civil
a. Yes, light information was clear and adequate	32	8
b. No, the guidance was not adequate	4	0

If you answered b, please specify the inadequacy.

Comments
A-3 (No) - With the test run area only 1 mile from the heliport, I thought there was not enough time to use the approach lights and then set up for the landing direction lights.
A-12 (Yes) - Pattern direction would be helpful although I suppose not essential.

B-2 (No) - Can't change direction on final.
B-5 (Yes) - I feel that approaching the pad from one direction and landing in another could create problems for a loaded aircraft.
B-12 (Yes) - Guidance satisfactory only if pilot fully understands what is expected of him with a situation of "differential" pattern.

TABLE 1-IV (Continued)

Question	Number of Pilots Responding	
	Military	Civil
7. When both approach direction and landing direction lights were on, but landing direction was different from approach direction, was the guidance satisfactory (comments continued)		
B-17 (Yes) - But again change in final at low air speed and low altitude was bad.		
B-19 (Yes) - When landing direction lights are in a different direction than approach lights, the turn to final can get pretty tight.		
C-4 (Yes) - If you understood the system.		

TABLE 1-V

HELIPAD SURFACE LIGHTING

Question	Number of Pilots Responding: Military	Civil
1. As aids to flare and touchdown, please compare the following two light conditions: inset lights alone versus inset lights with floodlights.		
a. Inset lights alone are superior	4	2
b. Inset lights plus floodlights are superior	31	5
Comments		
A-8 - Never saw floodlights used on any of my approaches.		
C-1 - No insets needed except one middle white.		
2. As aids to flare and touchdown, please compare the following two light conditions: inset lights with floodlights versus floodlights alone.		
a. Inset lights plus floodlights are superior	28	6
b. Floodlights alone are superior	6	2
Comments		
B-3 - No difference.		
C-5 - Floodlights not needed.		
3. As aids to flare and touchdown, please compare the following two light conditions: inset lights alone versus floodlights alone.		
a. Inset lights alone are superior	13	4
b. Floodlights alone are superior	22	4
Comments		
A-18 (Floodlights alone are superior) - When painted cross is on pad.		

TABLE 1-V (Continued)

Question	Number of Pilots Responding: Military	Civil
4. Based on the run(s) that you made without either inset lights or floodlights turned on, do you think that any kind of lighting of the pad surface needs to be added to the perimeter lights?		
a. Yes, some kind of pad surface lights are needed	13	5
b. No, the aircraft's landing lights and pad perimeter lights are enough	23	3

Comments

A-6 (No) - Pad surface lights are nice to have items but not completely necessary.

5. If you answered Yes to the previous question, please mark one or more kinds of pad surface lights that you feel are satisfactory.		
a. Inset lights will supply the guidance	6	4
b. Floodlights will meet the need	6	2
c. Other	4	2

If you answered c, please specify

Comments

A-5 (Other) - A red set of lights across the surface gives impression of red carpet and aids in depth perception.

A-12 (Other) - Both inset and floodlights in combination were the best observed.

B-4 (Other) - Floodlights and inset lights.

B-12 (Other) - Center inset only. Wasted expense for additional lights (inset).

C-1 (Other) - Floodlights plus one middle light.

C-3 (Other) - Center white light is desirable if no landing light installed on helicopter.

TABLE 1-V (Continued)

Question	Number of Pilots Responding: Military	Civil
6. To the degree that inset lights as a class are satisfactory and necessary, were the five particular lights used in this test adequate in intensity, location, and pattern?		
a. Yes, inset lights were adequate	33	5
b. No, inset lights were not adequate	3	3
If you answered b, please comment.		

Comments

A-8 (No) - Not sufficient.

B-1 (Yes) - Center white inset should be dimmed down.
B-5 (No) - I feel that the white light distracts more than aids the final approach.
B-15 (Yes) - Blue lights very hard to detect until pad is reached.
B-17 (Yes) - Not necessary.

C-1 (No) - Need just one middle.
C-3 (No) - Rotate blue lights 45° so that they are still visible in event overrun center.
C-4 (No) - They are drowned out by perimeter lighting.

7. To the degree that floodlights are satisfactory and required, were the eight particular floodlights used in this test adequate in intensity, location, and pattern?		
a. Yes, the floodlights were adequate	30	7
b. No, the floodlights were not adequate	6	1
If you answered b, please comment.		

Comments

A-2 (No) - Could not readily notice except prior to landing.
A-3 (No) - The other lights flooded out the floodlights.
A-8 (No) - Lights not observed.
A-17 (No) - Higher intensity and possibly add some more.

B-2 (No) - Increase intensity.

TABLE 1-V (Continued)

Question	Number of Pilots Responding: Military	Civil
7. To the degree that floodlights are satisfactory and required, were the eight particular floodlights used in this test adequate in intensity, location, and pattern (comments continued)		
B-12 (No) - Were not bright enough (if "Necessary").		
B-16 (Yes) - I don't feel floodlights are necessary because pad is adequately lit by perimeter lights and white paint.		
C-8 (No) - As the test was conducted in heavy rain, the pad reflected the floodlights considerably and had a tendency to suggest reflection blinding if the conditions were right.		
8. To the extent that there was any difference, did you find it easier feeling for the ground when you hovered over the center inset light or when you landed without attending to the center light?		
a. Yes, center inset light aiming was helpful	15	4
b. I prefer landing without special attention to the inset light	21	3
Comments		
A-19 (Prefer landing without special attention to inset light) - Good flight technique requires peripheral vision for landing from hover. This precludes use of center inset.		
9. Was there any tendency to overshoot the pad when you came in without one or another particular lighting element?		
a. Yes, tended to overshoot when no pad surface lights were turned on	3	0
b. Yes, tended to overshoot when the landing direction lights were off leaving a gap after the approach lights	0	0
c. No, did not tend to overshoot	33	6
Comments		
A-19 (No) - Overshooting caused by downwind landing conditions.		

TABLE 1-VI

GENERAL COMPARISONS, MARKING AND PROCEDURES

Question	Number of Pilots Responding	
	Military	Civil
1. Under which of the following conditions was it easier to fly directly to your intended point of hover?		
a. With no lights between the approach direction lights and the pad perimeter	6	0
b. With landing direction lights turned on between the approach direction lights and the pad perimeter	21	6
c. With approach direction lights on and a different set of landing direction lights on	8	2
Comments		
B-3 (No choice) - No difference.		
B-13 (c.) - Got confused on last run. Approach lights were on with direction lights in center.		
2. Did you have enough runs in this experiment to compare the different lights?		
a. Yes, runs were sufficient	35	4
b. No, more runs were needed	1	4
If you answered b, how many would you suggest?		
Comments		
A-7 (No) - Three		
3. Does a painted marking pattern on the pad aid under night conditions?		
a. Yes, marking is helpful at night	25	8
b. No, only lights are useful	11	0
Comments		
A-5 (Yes) - White line or white X.		
A-8 (Yes) - Using iridescent paint.		
A-12 (Yes) - The maltese cross gave position relative to pad regardless of your location on the pad.		

TABLE 1-VI (Continued)

Question	Number of Pilots Responding	
	Military	Civil

3. Does a painted marking pattern on the pad aid under night conditions (comments continued)

A-13 (Yes) - Very easy to see in all light conditions.
A-15 (Yes) - Marking is helpful in landing. It gave texture. Also it was distinctive for identification.
A-16 (Yes) - Maltese cross was a distinctive pattern and easily discernible. Flat paint used was relatively glare proof.
A-17 (Yes) - Landing cross was satisfactory. However, I feel that it should be the standard marking used in the Army and should be another color. I received a glare from the cross and I felt that I was hovering much lower than I actually was.
A-18 (Yes) - Liked the type cross.
A-19 (Yes) - Any marking for contrast with black background.

B-4 (Yes) - Painted centerline.
B-11 (Yes) - Helps depth perception.
B-12 (Yes) - Used in conjunction with center inset.
B-13 (Yes) - Outstanding.
B-15 (Yes) - Very good and helpful marking. Paint had limited glare.
B-16 (Yes) - Maltese marking and paint choice very satisfactory. Marking very distinct and unusual. Paint type very satisfactory because of mini reflection when landing light is used and yet very distinct from altitude.
B-17 (Yes) - Liked maltese cross very much.
B-18 (Yes) - If small aircraft. Large aircraft would always be well forward.
B-19 (Yes) - The cross is an excellent aid.

C-1 (Yes) - Need simpler pattern +.
C-3 (Yes) - Others may also.
C-5 (Yes) - Maltese cross very good. Do not need landing lights.

TABLE 1-VI (Continued)

Question	Number of Pilots Responding: Military	Civil

4. Do you have any suggestion as to how we can simulate poor visibility such as haze or fog for future heliport guidance tests?

Comments

A-1 - Have pad painted white, then reflection of landing light on the bubble will interfere with vision.
A-2 - Dust.
A-6 - You might consider different color face shields, i.e., red or smoked clear, etc.
A-8 - Use some sort of spray on aircraft's windshields.
A-14 - Vary intensity of lighting.
A-15 - Landing light on helicopter maladjusted.
A-16 - Obscure of helicopter with window spray on one side only.
A-19 - Glazed acetate in cockpit.

B-1 - Hover in the area.
B-7 - Visor lenses of certain colors have a vision restricting capacity.
B-8 - A clear sunvisor which has some type of coating or frosting on it.
B-11 - Wait for a calm day and use a smoke generator.
B-14 - Shoot the approach in dusty condition.
B-18 - Smoke generators.

C-1 - Wait for actual low visibility conditions.
C-2 - Fog generating device of some kind.
C-5 - Using frosted retractable glass hood.
C-6 - Spray on water base whitewash to partially restrict forward visibility.
C-7 - Small smoke signals used in life rafts could possibly be used for short periods of time to simulate fog.
C-8 - Maybe frosted glass paint on half the bubble and a safety pilot on the other side.

TABLE 1-VI (Continued)

Question	Number of Pilots Responding: Military	Civil
5. Wind sock satisfactory at one-half mile?		
a. Yes	15	4
b. No	21	4

Comments

B-2 (No) - Wind sock tends to clutter the approach. Not useable at one-half mile.

B-18 (No) - Limp sock gives no information.

C-5 (No) - If sock hangs straight down, cannot detect that it is a wind sock.

C-6 (-) - Location was distinct. With the wind calm, lack of sock movement was noticeable. If the wind were stronger, I would have had more confidence in the wind information.

C-7 (No) - Wind was calm.

6. Wind tee satisfactory at one-half mile?		
a. Yes	25	1
b. No	10	7

Comments

A-7 (No) - Never saw it.

A-13 (No) - T tends to appear as straight line from distance.

A-19 (No) - Hard to distinguish wind direction at distance due to insufficient contrast of two colors.

B-9 (-) - Not observed.

B-19 (Yes) - All green wind tee is better than yellow and green.

C-1 (Yes) - With higher angle of approach.

C-2 (No) - Did not see wind tee.

C-5 (No) - Never lit up - not seen.

C-6 (No) - I couldn't see it, perhaps because I was aware of wind direction anyhow, and was concentrating on the other lights.

C-7 (No) - Didn't see the T.

C-8 (No) - Was not on. If it was, couldn't see it.

TABLE 1-VI (Continued)

Question	Number of Pilots Responding: Military	Civil
7. Preference:		
Wind sock	11	2
Wind tee	23	5

Comments

A-4 (wind sock) - Prefer wind sock, since it gives you wind speed as well as direction. Also, the wind tee is sometimes tied down.

B-7 (wind sock) - Gives direction and velocity.

B-12 (wind sock) - The lights of the wind tee are far more noticeable at a distance than the wind sock, but information could be extracted sooner from the wind sock when closer in.

B-16 (wind tee) - Wind tee information can be seen farther away than sock.

C-2 (both) - Light winds might move a wind sock but not wind tee.

C-5 (-) - Only saw wind sock. Under normal conditions would prefer a lighted wind tee.

C-6 (wind tee) - I'd like another look.

C-8 (wind tee) - Couldn't be any worse than sock.

APPENDIX 2

SAMPLE FORMS AND QUESTIONNAIRES

PILOT BRIEFING

Background

Aerospace Industries Association's 1967 report lists 1179 heliports in operation in the United States. The FAA lists 452 of these heliports in its 1967 airport survey. If heliports operated guidance lights in the same ratio as fixed wing airports do, using the lower figure above, there would be upwards of 150 lighted heliports in the United States. This is enough installations to warrant specification of a standard system of lights and marks to assist the pilot to locate and use the heliport.

Three chief groups have worked toward development of VFR heliport lighting standards. Requirements appear in ICAO's Aerodrome Manual, the FAA Heliport Design Guide, and in Defense Department publications. Presently, these requirements have been summarized as follows: (a) in VFR conditions, heliport lights should provide guidance for heliport location from 1 mile in 1-mile day meteorological visibility, and from 3 miles in 3-mile night meteorological visibility; (b) similarly, actual helipad position should be visible by night at 1-mile range in equal visibility; (c) when omnidirectional approach is barred by obstructions or special conditions such as noise criteria, commanded approach direction should be visible from 1 mile in 1-mile conditions, all of the above conditions being met from altitudes down to 300 feet over the terrain; (d) wind direction should be visible up to one-half mile from the pad at night in 1-mile visibility; (e) pad surface lights should aid control in the final phase of landing from 50 feet height down to touchdown; and (f) where required by special conditions, approach glide path should be seen from 1 mile in equal meteorological visibility.

Purpose

Previous tests of parts of a system intended to meet the VFR heliport guidance requirements have been held at Tipton Army Airfield, Fort Meade, and at other installations. Now, our purpose is to test and evaluate the guidance lights that have evolved from this prior experience. The full system includes these elements:

1. Perimeter Lighting: Sixteen 45-watt omnidirectional yellow lights are located at equal spacings around the perimeter of the paved helipad.

2. Pad Floodlights: Eight floodlight units, each containing two 250-watt lamps, are located on the north-south sides of the pad.

3. Inset Lights: Five 45-watt "pancake" fixtures are set into the pad itself, including one for aiming in the center.

4. Approach Direction: Thirty-four 45-watt omni-directional white lights are arranged in two rows extending out to the east from the helipad shoulder.

5. Landing (wind) Direction: Six 45-watt omni-directional lights are lined up on the east, west, and south, leading up to the helipad shoulders.

6. Wind Tee and Wind Sock: Floodlights illuminate the actual wind indicators.

7. Rotating Beacon: A green-yellow-white flash sequence is emitted by a beacon 1250 feet from the helipad.

Phases of Test

The lighting system evaluation will have three phases. First, the beacon and pad perimeter lights will be tested to determine how well they aid pilots to locate the heliport and the specific landing pad.

Second, the approach direction, landing direction, wind indicator, and pad surface lights will be used in actual approaches and landings.

Finally, the system selected after the preceding two series will be tested in regular use here at Tipton Army Airfield.

Criteria

To determine the guidance value of the lights, you will be asked to fly to specified locations, illustrated on the attached maps, and do two things. In Phase I you will be asked to indicate the direction to the heliport and the location of the pad in clock-code from your helicopter. In Phase II, pilots will be asked to fly to and land on the pad—following the approach direction given by the lights and using the landing direction

and wind lighting--with various combinations of flood and inset lights and with no pad surface lighting, but the helicopters landing lights turned on.

Before each flight you will be given specific instructions. During the flight you will be asked to report what you see from the lights. After the flight you will be asked to fill out a questionnaire stating your preferences and estimating the guidance values of various lights.

INSTRUCTIONS FOR PHASE I

You _____ will fly helicopter _____.
name code

You _____ will fly helicopter _____.
name code

Here are your safety-pilots _____ in _____,
name code

and _____ in _____.
name code

Your observer-pilots are _____ in _____,
name code

and _____ in _____.
name code

The safety-pilot in the right seat is in command of the aircraft at all times. He and the observer-pilot are plugged-in to UHF to the test control in the tower and light control on the field. You will be on intercom with the safety-pilot and observer-pilot only. As you progress from one run to another, your safety-pilot will direct you to the starting locations.

The observer-pilot will write down your judgments of heliport direction and pad location. He will ask you when you see the beacon and when you see the yellow perimeter lights. In responding, you will give him the clock-code direction over the intercom.

Please respond also by saying what you see of the heliport lighting system and the general airfield lights, and comment on the visibility conditions and any other factors that you consider significant. If you see any ambiguous light signal, if the required guidance is lost at any time when you are headed toward the helipad, or if any other light or event interferes with your certain identification and location information, please tell the observer-pilot so that he may make a note.

After you land you will be asked to give general comments and evaluations, and for other suggestions that you may have. Any questions?

(Trio each of subject-pilot, safety-pilot, and observer-pilot now split off and go over current weather, special instructions on altitude, use of landing lights, length of the run series, etc., as required.)

INSTRUCTIONS FOR PHASE II

You _____ will fly helicopter _____.
name code

You _____ will fly helicopter _____.
name code

Here are your safety-pilots _____ in _____.
name code

and _____ in _____.
name code

Your observer-pilots are _____ in _____.
name code

and _____ in _____.
name code

The safety-pilot in the right seat is in command of the aircraft at all times. He and the observer-pilot are plugged-in to UHF to the test control in the tower and light control on the field. You will be on intercom with the safety-pilot and observer-pilot only. As you progress from one run to another, your safety-pilot will direct you to the starting locations.

The observer-pilot will write down a rough chart of the track your helicopter follows in approach and landing. He will record the range at which you report the commanded approach direction and the commanded landing direction. He will record what you give him as actual wind information from the wind sock or wind tee if one is lighted, and he will record your comments during the run. The observer-pilot will estimate how well you follow the guidance given by the light system including the approach slope. He will record positioning at hover, with your target being to come to hover three feet above the center of the pad.

You are encouraged to comment on the guidance value of the lights or to explain any unusual feature of the run or any unusual maneuver if you think the observer-pilot is not fully aware of what you are doing and why.

After you land you will be asked to give general comments and evaluations, and for other suggestions that you may have. Any questions?

(Trio each of subject-pilot, safety-pilot, and observer-pilot now split off and go over current weather, special instructions on altitude, use of landing lights, length of the run series, etc., as required.)

HELIPORT LIGHTING QUESTIONNAIRE

PHASE I

HELIPORT LOCATION AND HELIPAD DIRECTION USING BEACON AND YELLOW PERIMETER LIGHTS

INSTRUCTIONS

The questions in Phase I pertain to: (a) Your experience in locating the heliport by sighting the green-yellow-white rotating beacon and/or the yellow helipad perimeter lights; and (b) your experience in clearly identifying the landing place by the yellow perimeter and obtaining guidance from the lights as to the direction in which to fly to reach the helipad.

Name_____ Date_____

PHASE I

Beacon	Mark Appropriate Answer
1. When did you first clearly identify the general direction to the heliport by locating the rotating green-yellow-white beacon?	
a. At the maximum distance tested	( )
b. After flying in toward the heliport	( )
2. Was the rotating green-yellow-white beacon distinctive enough compared to other beacons and airport lights for ready identification?	
a. Yes	( )
b. No	( )
3. Was the signal from the rotating green-yellow-white beacon bold enough for identification at the range you needed it?	
a. Yes	( )
b. No	( )

4. General comments on the beacon or suggestions concerning its usefulness.

_____

_____

_____

_____

_____

_____

_____

_____

Yellow Perimeter

Mark Appropriate Answer

5. At your altitude and distance of first clear detection, did you see the yellow perimeter as defining a four-sided area?

   a. Yes . . . . . ( )
   b. No . . . . . ( )

6. When did you first clearly locate the landing pad by seeing the yellow perimeter?

   a. At the maximum distance tested . . . . . ( )
   b. After flying in toward the heliport . . . . . ( )

7. Was the yellow perimeter distinctive enough in form and color to enable you to pick out the helipad as different from other lighted areas nearby?

   a. Yes . . . . . ( )
   b. No . . . . . ( )

8. Was the yellow perimeter signal bold enough to support ready helipad identification?

   a. Yes . . . . . ( )
   b. No . . . . . ( )

9. Do you consider the number of lights in the yellow perimeter sufficient to define the helipad?

   a. Yes . . . . . ( )
   b. No . . . . . ( )

10. General comments on the yellow perimeter or suggestions on its usefulness.

_____

_____

_____

_____

HELIPORT LIGHTING QUESTIONNAIRE

PHASE II

APPROACH DIRECTION, LANDING DIRECTION,
FLARE AND TOUCHDOWN GUIDANCE

INSTRUCTIONS

The questions in Phase II pertain to: (a) Your experience in obtaining guidance from the lights that give approach direction, when one particular approach direction is commanded; (b) the adequacy of landing direction information provided by shorter strings of yellow lights leading to the pad; and (c) your experience in using the helipad lights to complete actual flare and touchdown.

To insure that all questions mean the same thing to everyone, it is requested that you look at the helipad lighting layout shown on the next page and use the names given thereon for the different light elements.

Name _____ Date _____

Approach Direction Lights	Mark Appropriate Answer
1. Did the double row of white approach lights give you a satisfactory indication of the commanded approach direction from the starting location of your runs?	
a. Yes	( )
b. No	( )
2. Were the approach direction lights prominent and distinct enough so that, when they were on, it was evident that a single approach direction was commanded?	
a. Yes	( )
b. No	( )
3. If you answered yes to #2, was the particular direction well defined by the pattern of the lights?	
a. Yes	( )
b. No	( )
4. Do you feel that the approach direction lights should have clear lenses, as in this test, or should they be yellow, similar to the landing direction and perimeter lights?	
a. Approach Direction Lights should be clear	( )
b. Approach Direction Lights should be yellow	( )
5. Was the intensity of the double row of approach direction lights satisfactory, too bright, or too dim?	
a. Intensity was satisfactory	( )
b. Intensity was too bright	( )
c. Intensity was too dim	( )
6. Was the pattern of approach direction lights satisfactory in length and spacing to provide adequate guidance?	
a. Pattern was satisfactory	( )
b. Pattern was not satisfactory	( )
Comment: _____	

Mark Appropriate Answer

Approach Direction Lights

7. Was there anything objectionable about the approach direction lights? Please explain.

   a. Nothing was objectionable . . . . . ( )
   b. I recommend the following change(s) _____

   _____

   _____

Landing Direction Lights

8. With the approach direction lights turned off, were the landing direction lights distinctive and prominent enough to give you the landing direction when you required it?

   a. Yes, I saw the landing direction in plenty of time. ( )
   b. No, landing direction lights lacked enough range. ( )

9. With the approach direction lights also on, were the landing direction lights sufficient to give the guidance that you required?

   a. Yes, I was sure of landing direction in plenty of time. . . . . ( )
   b. No, landing direction guidance was unsatisfactory. ( )

10. Did the landing direction lights stand out from the approach lights, when both were on, and/or from the perimeter lights, or were there possible confusion(s)?

    a. Yes, landing direction lights were distinct . . . ( )
    b. No, landing direction lights could be confused . ( )
    If you answered b, please comment or suggest a remedy to avoid possible confusion: _____

    _____

    _____

11. Did you experience excessive glare from the landing direction lights? Was the intensity satisfactory, or should it be increased?
    a. Glare was a problem; reduce the intensity . . . ( )
    b. Intensity was satisfactory . . . . . ( )
    c. Intensity should be increased . . . . . ( )

Mark Appropriate Answer

Landing Direction Lights

12. Was the pattern of landing direction lights satisfactory in length and spacing to provide adequate guidance?

a. Pattern was satisfactory . . . . . ( )
b. Pattern was not satisfactory . . . . . ( )
If you answered b, please comment: _____

_____

_____

13. Was there anything objectionable about the landing direction lights? If so, please explain.

a. Nothing was objectionable . . . . . ( )
b. I recommend the following change(s) ( )

_____

_____

_____

14. When both approach direction and landing direction lights were on, but landing direction was different from approach direction, was the guidance satisfactory?

a. Yes, light information was clear and adequate. ( )
b. No, the guidance was not adequate . . . . . ( )
If you answered b, please specify the inadequacy:

_____

_____

_____

Mark Appropriate Answer

Inset and Floodlights

15. As aids to flare and touchdown, please compare the following two light conditions: inset lights alone versus inset lights with floodlights.

    a. Inset lights alone are superior . . . . . ( )
    b. Inset lights plus floodlights are superior . . . ( )

16. As aids to flare and touchdown, please compare the following two light conditions: inset lights with floodlights versus floodlights alone.

    a. Inset lights plus floodlights are superior . . . ( )
    b. Floodlights alone are superior . . . . . ( )

17. As aids to flare and touchdown, please compare the following two light conditions: inset lights alone versus floodlights alone.

    a. Inset lights alone are superior . . . . . ( )
    b. Floodlights alone are superior . . . . . ( )

18. Based on the run(s) that you made without either inset lights or floodlights turned on, do you think that any kind of lighting of the pad surface needs to be added to the perimeter lights?

    a. Yes, some kind of pad surface lights are needed . . . . . ( )
    b. No, the aircraft's landing lights and pad perimeter lights are enough . . . . . ( )

19. If you answered yes to #17, please mark one or more kinds of pad surface lights that you feel are satisfactory.

    a. Inset lights will supply the guidance . . . . . ( )
    b. Floodlights will meet the need . . . . . ( )
    c. Other . . . . . ( )

    If you answered c, please specify: _____

Mark Appropriate Answer

Inset and Floodlights

20. To the degree that inset lights as a class are satisfactory and necessary, were the five particular lights used in this test adequate in intensity, location, and pattern?

a. Yes, inset lights were adequate . . . . . ( )
b. No, inset lights were not adequate . . . . . ( )
If you answered b, please comment _____

_____

_____

21. To the degree that floodlights are satisfactory and required, were the eight particular floodlights used in this test adequate in intensity, location, and pattern?

a. Yes, the floodlights were adequate . . . . . ( )
b. No, the floodlights were not adequate . . . . . ( )
If you answered b, please comment _____

_____

_____

22. To the extent that there was any difference, did you find it easier feeling for the ground when you hovered over the center inset light or when you landed without attending to the center light?

a. Yes, center inset light aiming was helpful . . ( )
b. I prefer landing without special attention to the inset light . . . . . ( )

23. Was there any tendency to overshoot the pad when you came in without one or another particular lighting element?

a. Yes, tended to overshoot when no pad surface lights were turned on . . . . . ( )
b. Yes, tended to overshoot when the landing direction lights were off leaving a gap after the approach lights . . . . . ( )
c. No, did not tend to overshoot . . . . . ( )

Mark Appropriate Answer

Inset and Floodlights

24. Under which of the following conditions was it easier to fly directly to your intended point of hover?

    a. With no lights between the approach direction lights and the pad perimeter . . . . . ( )
    b. With landing direction lights turned on between the approach direction lights and the pad perimeter . . . . . ( )
    c. With approach direction lights on and a different set of landing direction lights on . . . . . ( )

General

25. Did you have enough runs in this experiment to compare the different lights?

    a. Yes, runs were sufficient . . . . . ( )
    b. No, more runs were needed . . . . . ( )
    If you answered b, how many would you suggest ___

26. Does a painted marking pattern on the pad aid under night conditions?

    a. Yes, marking is helpful at night . . . . . ( )
    Comment _____
    b. No, only lights are useful . . . . . ( )

27. Do you have any suggestion as to how we can simulate poor visibility such as haze or fog for future heliport guidance tests? _____

    _____

    _____

    _____

28. Wind sock satisfactory at one-half mile?

    a. Yes ( )
    b. No ( )

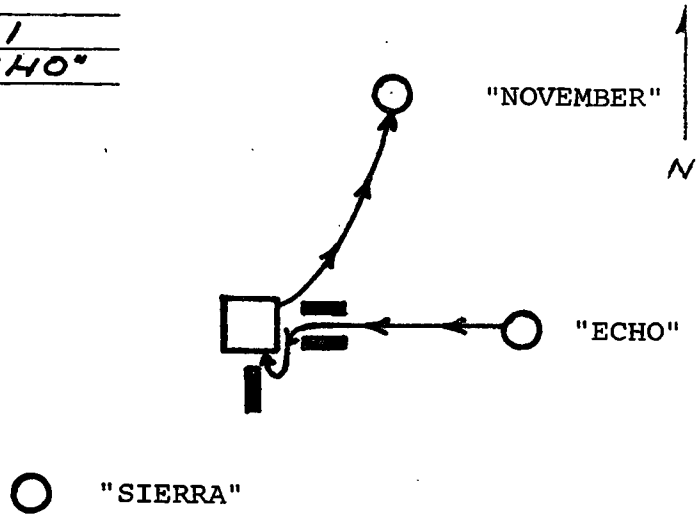
29. Wind tee satisfactory at one-half mile?

    a. Yes ( )
    b. No ( )

PHASE II

General	Mark Appropriate Answer
30. Do you have a preference between the lighted wind sock and wind tee?	
a. Prefer wind sock	( )
b. Prefer wind tee	( )
31. At what distance from the helipad did you see the units?	
a. Two-color: _____	
b. Tri-color: _____	
32. At what altitude did the units cease to be of aid?	
a. Two-color: _____	
b. Tri-color: _____	
33. Which system did you prefer?	
a. Two-color	( )
b. Tri-color	( )
c. Why?	

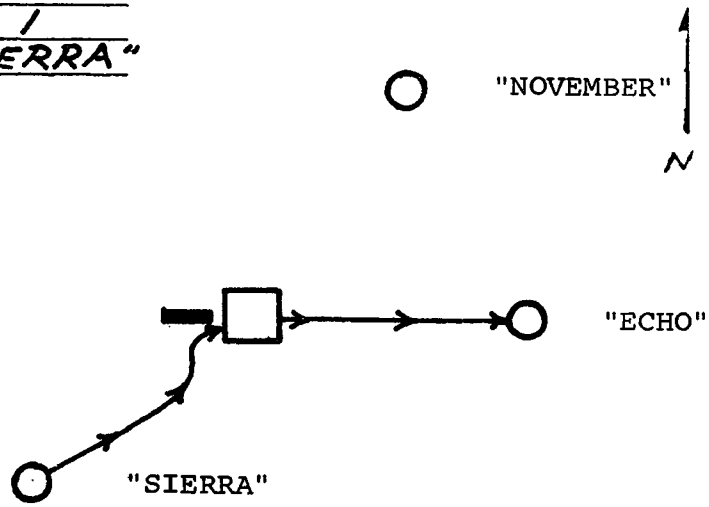
SERIES: _____
RUN No: 1
START: "ECHO"



INSET LIGHTS

OBSERVER'S NOTES:

SERIES: _____
RUN No: 1
START: "SIERRA"



INSET LIGHTS

OBSERVER'S NOTES:

SAMPLE OBSERVER PILOT CHECKSHEET

00346575

69 00589