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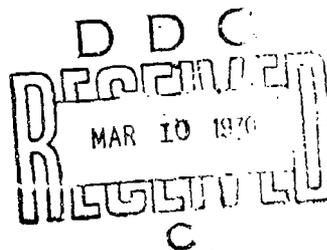
DEPARTMENT OF THE ARMY  
ARMY CONCEPT TEAM IN VIETNAM  
APO San Francisco 96384

2 FEB 1970

AVIB-AAD

SUBJECT: Final Letter Report - Night Flying Control System for UH-1

Commanding General  
USARV  
ATTN: AVHCG-DST  
APO 96375



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1. REFERENCES

- a. Message, 18671, JRATA, Headquarters, Military Assistance Command, Vietnam, 31 May 1966, subject: Request for Equipment.
- b. Message, J1641, ANCPM-IR-T, Headquarters, Army Materiel Command, 10 June 1966, subject: UH-1 Night Flying Control System.
- c. Message, 21221, JRATA, Headquarters, Military Assistance Command, Vietnam, 21 June 1966, subject: UH-1 Night Formation Flying System.
- d. Letter Report, STMBG-TD, US Army Aviation Test Board, 17 October 1966, subject: Product Improvement Test of Modified Tactical Formation Lights, RDT&E Project Number 4-3-0100-13, USATECOM.
- e. Disposition Form, AVHCC-DST, Headquarters, US Army, Vietnam, 29 March 1969, subject: Evaluation Tasking.

2. PURPOSE

To determine the operational suitability of the UH-1 Night Flying Control System (NFCS) for combat operations in the Republic of Vietnam (RVN).

3. OBJECTIVES

- a. Determine the suitability of the NFCS for UH-1 formation flights under varying conditions of visibility during combat operations.
- b. Determine the maintenance requirements of the NFCS.

4. BACKGROUND

The requirement for a better night flying control system came about as a result of increased night operations in RVN, including airmobile assault landings. The existing lights on the UH-1 helicopter do not provide pilots with adequate reference for visually determining relative

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positions (bearing, lateral and vertical distance, and rate of closure) of helicopters flying in formation at night. In June 1966, the Department of the Army approved an ENSURE for a night flying control system for the UH-1. An interim system, consisting only of fuselage lights, was evaluated by the 1st Aviation Brigade in 1967. This system had no advantages over the installed position lights. The 1st Aviation Brigade recommended that the system not be used under tactical conditions until a complete system (including rotor tip lights) was evaluated. Seven new systems (complete) were installed on UH-1D/H helicopters and shipped to RVN in August and September 1969. By 1 October six of the systems had arrived in country; the seventh system was not located. The evaluation began on 4 October 1969 using the six available aircraft.

## 5. SCOPE

The six systems were assigned to the 1st Aviation Brigade for a 30 day evaluation. These systems were distributed as follows: Three systems to the 117th Assault Helicopter Company (AHC) at Plantation (near Long Binh), and three systems to the 175th AHC in Vinh Long. In view of the short evaluation period, the light systems were operated during both day and night missions. The reason for this was to achieve maximum operating time on all systems during the evaluation period. Using the light continually provided the evaluators with a better opportunity to determine the maintenance and logistical requirements. Operational requirements of the evaluating units took precedence over data collection.

## 6. DESCRIPTION

a. The NFCS consists of four external electroluminescent panel-type lights and two incandescent main rotor blade tip lights positioned as follows:

- (1) One on top of the crew compartment directly to the rear of the UHF antenna to emit light upward and rearward.
- (2) Two on top of the cargo compartment on opposite sides of the transmission fairing to emit light upward.
- (3) One on the antitorque rotor pylon behind the FM radio antenna to emit light upward and slightly rearward.
- (4) One rotor blade tip light mounted on the outboard end of each main rotor blade to emit light upward and outward. (Figure 1)

b. This arrangement of lights is designed to provide pilots with a better means of estimating relative bearing, distance and rate of closure during night formation flight. When the aircraft is viewed from the rear, a line connecting the forward light and one of the side lights on the cargo compartment roof forms an angle of  $30^{\circ}$  relative to the longitudinal axis of the helicopter. The light on the tail pylon provides additional reference. The rotor-blade tip lights form an elliptical pattern when viewed from another helicopter in formation flight, providing a reference for determining lateral and longitudinal attitude of the preceding helicopter.

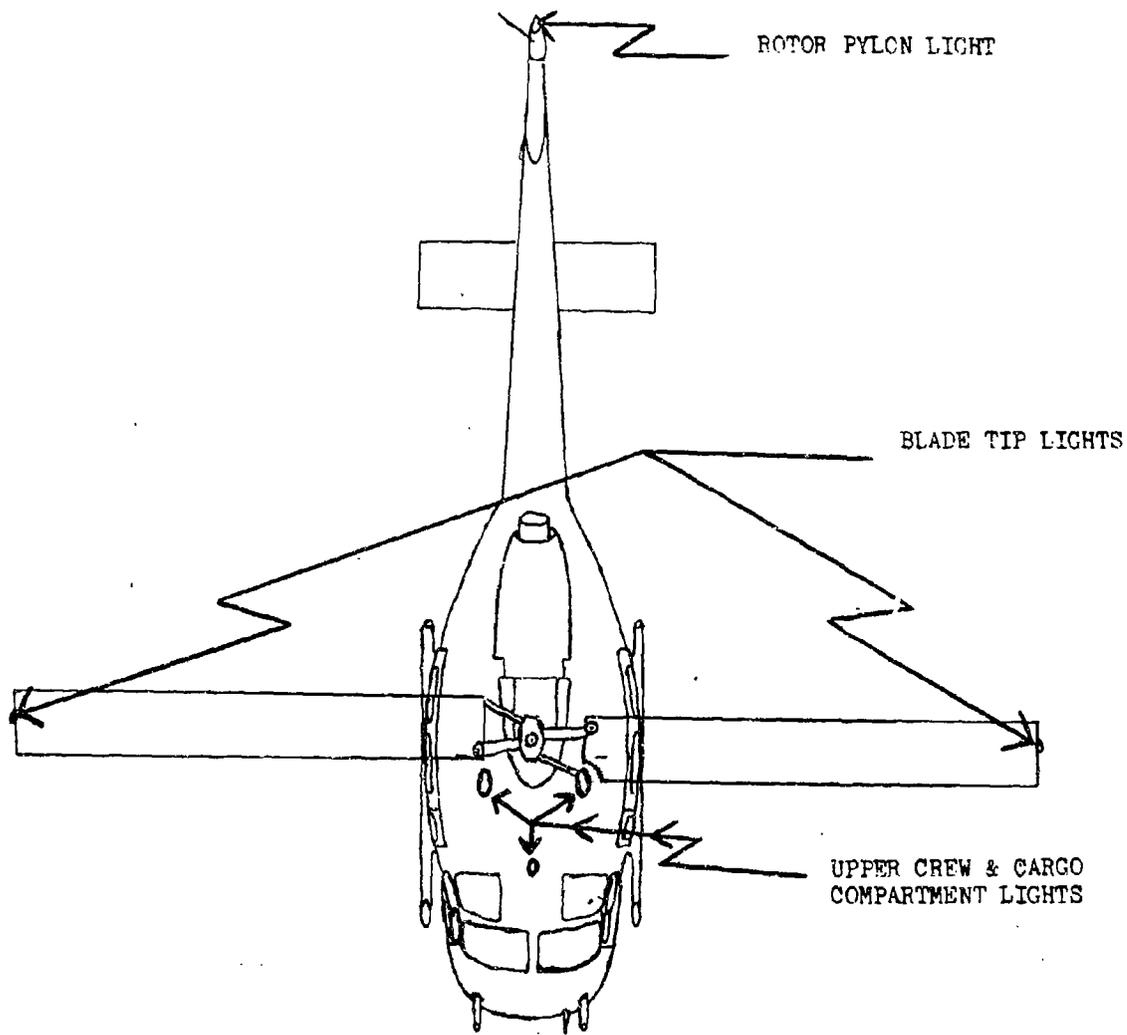


FIGURE 1.

Installation of Lights on Blades and Fuselage.

c. Intensity of the lights is controlled by varying the system voltage using two separate multiposition rotary switches located on the overhead control panel in the crew compartment. Each light circuit uses current from the 115-volt 400-cycle inverter. The panel-type lights operate on 24 to 115 volts AC, and the rotor blade tip lights on 2.7 to 7 volts AC.

## 7. APPROACH

a. Both evaluating units flew the maximum amount of time on the NFCS equipped helicopters consistent with tactical missions. Different flight formations were investigated while performing the following maneuvers:

- (1) Hover
- (2) Takeoff, climb and join-up
- (3) Level flight
- (4) Standard rate and half-standard rate turns
- (5) Formation break-up and rejoin
- (6) Descent and descending turns
- (7) Approach and landing

b. Formations consisting of from two to four aircraft were flown during the evaluation period. Helicopters were flown with separation distances that varied from a minimum of one rotor disc up to one mile.

## 8. ENVIRONMENT

a. Evaluating units were located in III and IV Corps Tactical Zones. Both units were assigned to combat aviation groups in general support of both US and Army of the Republic of Vietnam troops.

b. Night skies were clear with good visibility during most of the period. However, some visibility restrictions due to haze and intermittent rain showers were encountered.

c. Enemy activity was relatively slight throughout the evaluation.

## 9. SUMMARY OF RESULTS

### a. Usage

(1) Six NFCS-equipped helicopters were flown a total of 646 hours during the evaluation period. The NFCS lights were operated continually during day and night flights to determine maintenance requirements, and were evaluated at night during various formation flights of two to four helicopters. Missions flown were generally of two types.

(a) The 117th AHC performed nightly "Firefly" missions which consisted of one UH-1H equipped with the NFCS and two UH-1C escort aircraft. This unit evaluated the system by flying with the escort aircraft in close "V" formation enroute to and on return from the operational area. (Figure 2) While in operational area a loose trail formation with 500-1,000 meters separation was flown.

(b) The 175th AHC flew various patterns using from two to four UH-1Ds in close formation (2 to 5 rotor discs separation) while performing long range reconnaissance patrol insertions and extractions. As many as three aircraft having NFCS lights were flown in the same formation. A UH-1C helicopter gun team was normally employed to escort and cover these formations.

(2) A total of 55 hours was flown during the evaluation while performing the night missions described above.

#### b. Maneuvers

(1) For the purpose of identifying aircraft, the NFCS equipped helicopter is referred to as number 1 and other helicopters as number 2 or 3. The best position for the number 2 or 3 helicopter was determined to be at a 30° relative bearing to the number 1 helicopter and at a horizontal separation of two to five rotor discs and vertical separation of 5 to 15 feet. Vertical separation was higher than that normally flown during daylight formations in order to avoid obstruction of the side panel lights by the air-scoops on top of number 1 aircraft.

(2) When number 1 aircraft made a half standard rate turn away from number 2 at 80 knots airspeed, the pilot of number 2 viewed the rotor tip pattern as a straight line. At any greater degree of bank the light started to disappear. When number 1 aircraft increased its bank to a full standard rate turn, it was not possible for flight crews in number 2 aircraft to see any light from number 1. This did not pose a serious problem, however, because most formations turns at night were made at no greater than half the standard rate.

(3) Many pilots expressed the opinion that the presence of the rotor tip lights added significantly to safe operations at a hover, particularly in restricted areas such as landing zones and parking ramps.

(4) Figure 3 graphically illustrates pilots' opinions of the NFCS. During takeoff and climb the NFCS lights were difficult to see until the trailing aircraft were able to climb to a position level with or above number 1. Responses were particularly favorable during level flight. Pilots stated that the slightest control movement could be detected by observing the change in the rotor tip pattern.

#### c. Security

None of the NFCS equipped aircraft were fired upon during the evaluation. Ground observers reported that lights of the NFCS could not be seen as the aircraft flew overhead. It was noted, however, that the tail pylon panel light and the rotor tip lights could be seen at a distance

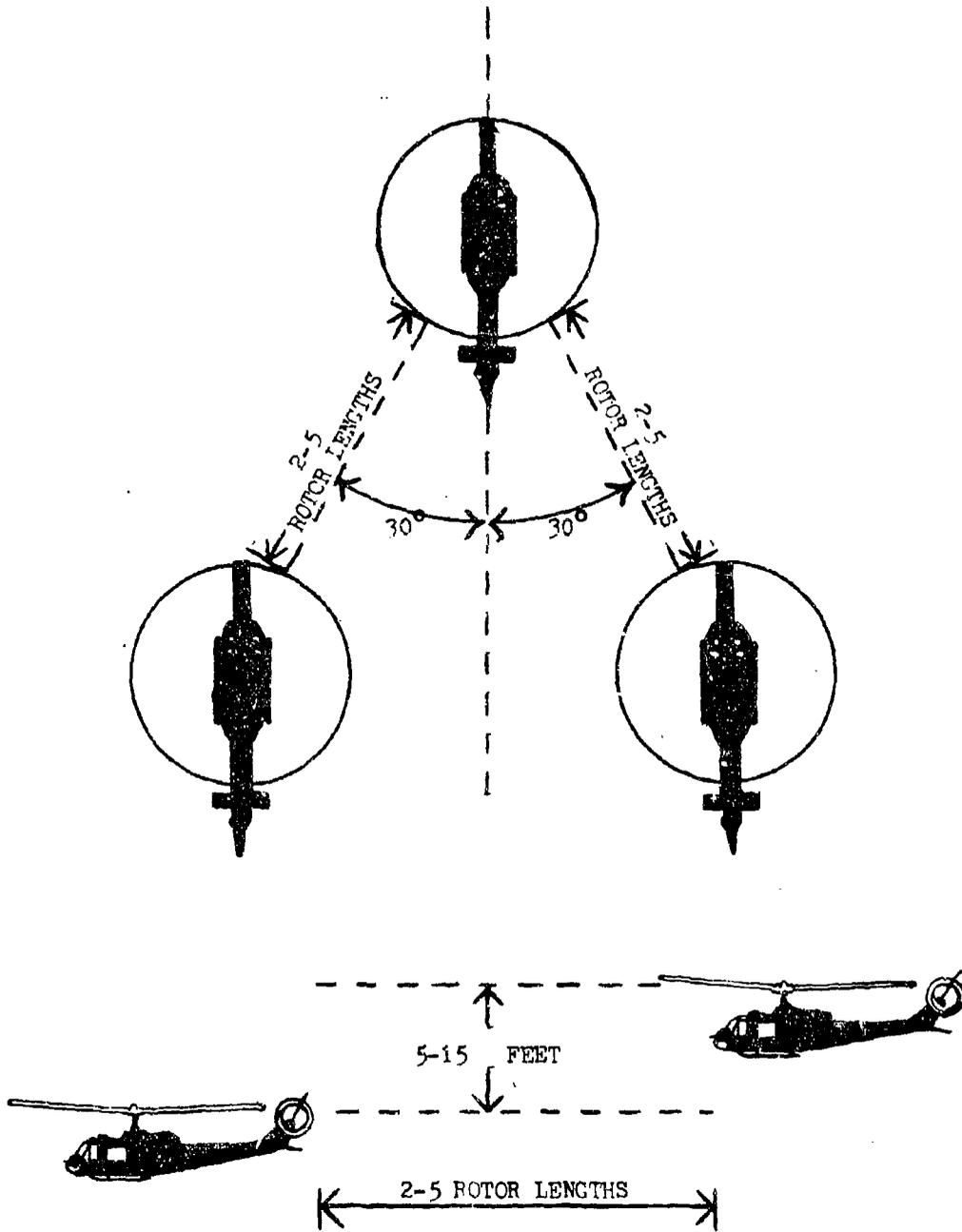


FIGURE 2.

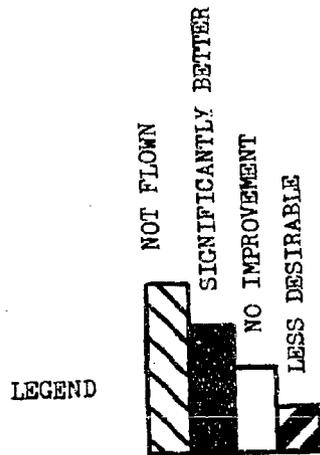
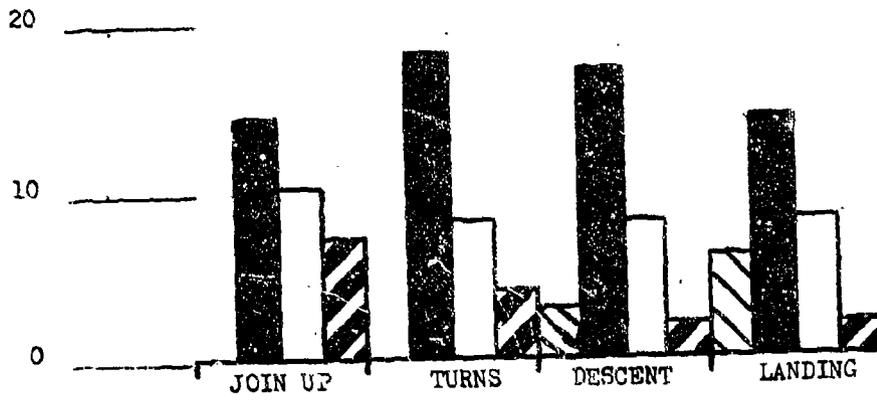
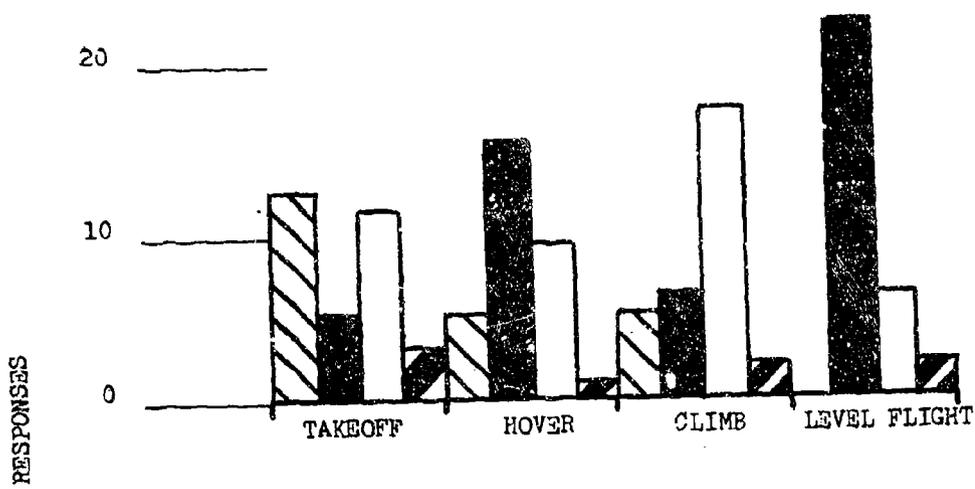


FIGURE 3. Summary of Pilot responses

up to 300 meters as the aircraft, flying away from an observer, banked to approximately 20°. Aircraft approaching to land could not be seen by an observer standing ahead of the landing aircraft; however, lights were visible after the aircraft passed overhead.

d. Light Intensity

(1) Figure 4 illustrates pilots' opinions of the intensity of the fuselage and rotor tip lights for all possible rheostat settings. Some were of the opinion that both systems could be brighter; however, most thought the lights were satisfactory at the maximum intensity setting.

(2) With lights turned up to maximum intensity, they could be seen at distances greater than a mile away. At any setting below number 3, all lights were extremely difficult to see, even when in close formation.

e. Orientation

Generally, pilots adjusted to flying with the NFCS very readily. However, as indicated in Figure 5, about 50 per cent of those responding became disoriented at some point in flight. Most disorientations were attributed to two causes. First, whenever number 1 aircraft turned away from number 2 and the number 2 pilot lost sight of all lights on number 1, he became disoriented and usually had to break out of formation and then rejoin. Second, many pilots became confused with the panel lights and had difficulty determining which two lights they should line up to maintain correct position. All panel lights were the same color and shape.

f. Reliability

(1) When the six aircraft were delivered to the evaluating units, only one NFCS was completely operational. The other five systems had defective rotor tip lights. One or both tip lights were inoperative. Unit electricians were able to repair three of the five systems. On one aircraft in the 117th AHC, both rotor tip lights were shorted out within the rotor blades and were unrepairable. One aircraft in the 175th AHC had one rotor tip light shorted within the blade that was not repairable; however, the other light continued to work. During a flight check at night it was discovered that one tip light was sufficient to form a closed rotor pattern and it could be used as effectively as two lights.

(2) All fuselage light systems worked with no failures. One panel light was cracked, presumably when someone stepped on it. Three out of six tail pylon panel light mounts cracked along the rear edge. A simple repair job using a strip of fiberglass to reinforce the weakened area corrected this problem. (See Figure 6)

(3) A total of 646 hours was flown on all six NFCS equipped aircraft without a failure. One aircraft was flown 155 hours.

(4) It was the opinion of unit maintenance personnel that a poor quality control at the installing maintenance facility and a lack of knowledge about the system in RVN maintenance units that assembled the

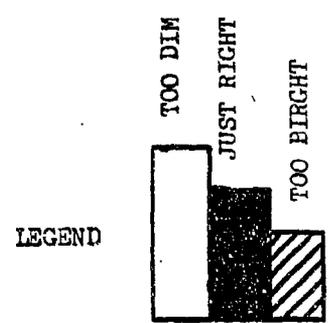
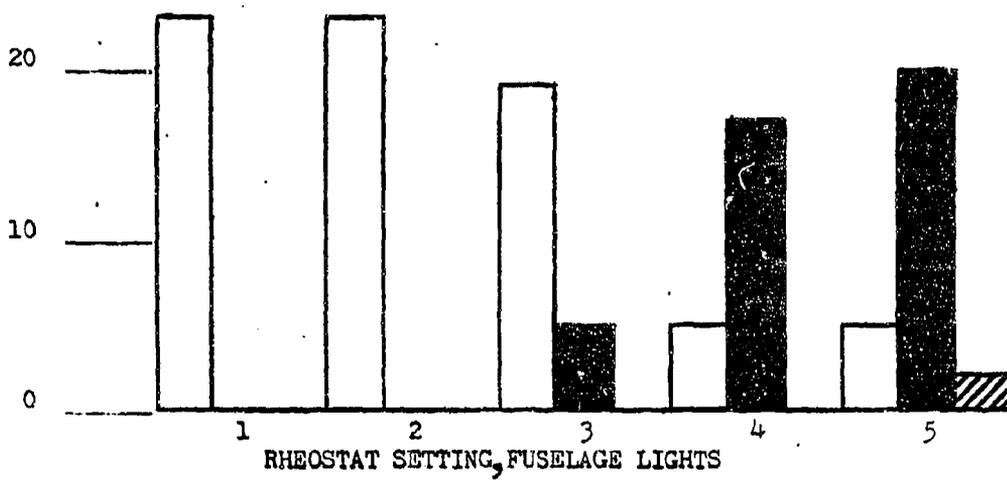
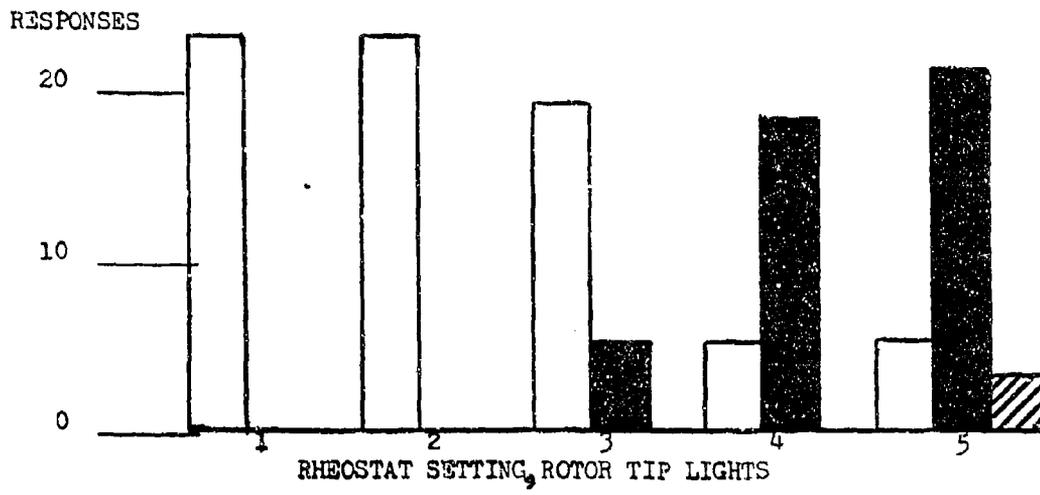


FIGURE 4. Light Intensity

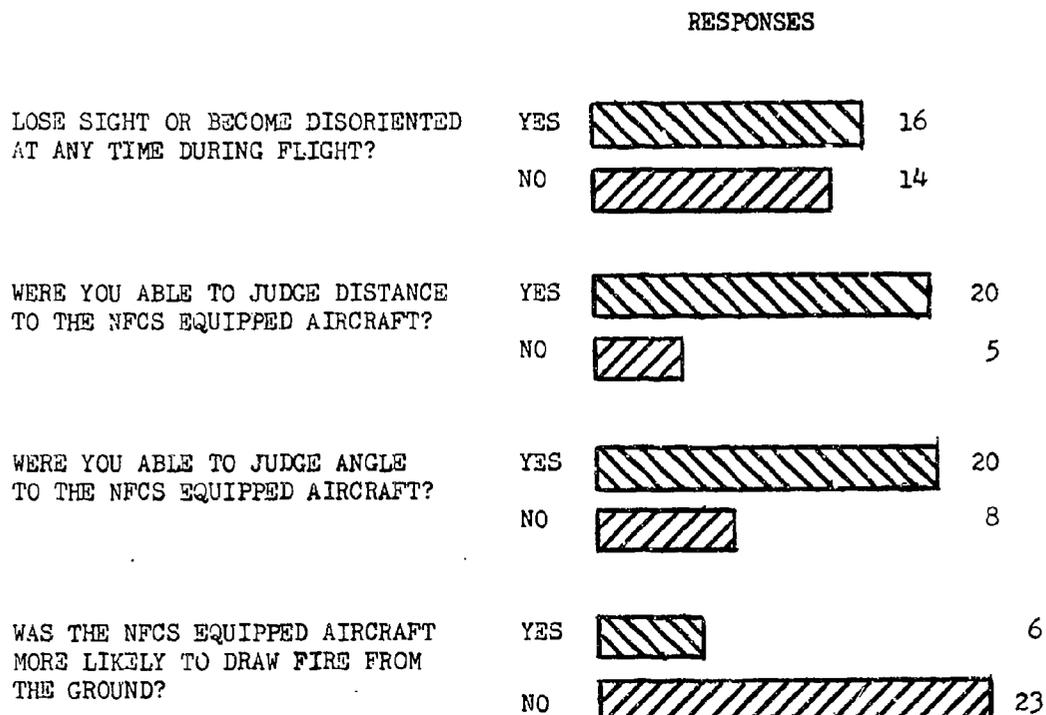


FIGURE 5. Pilot Responses to Specific Questions

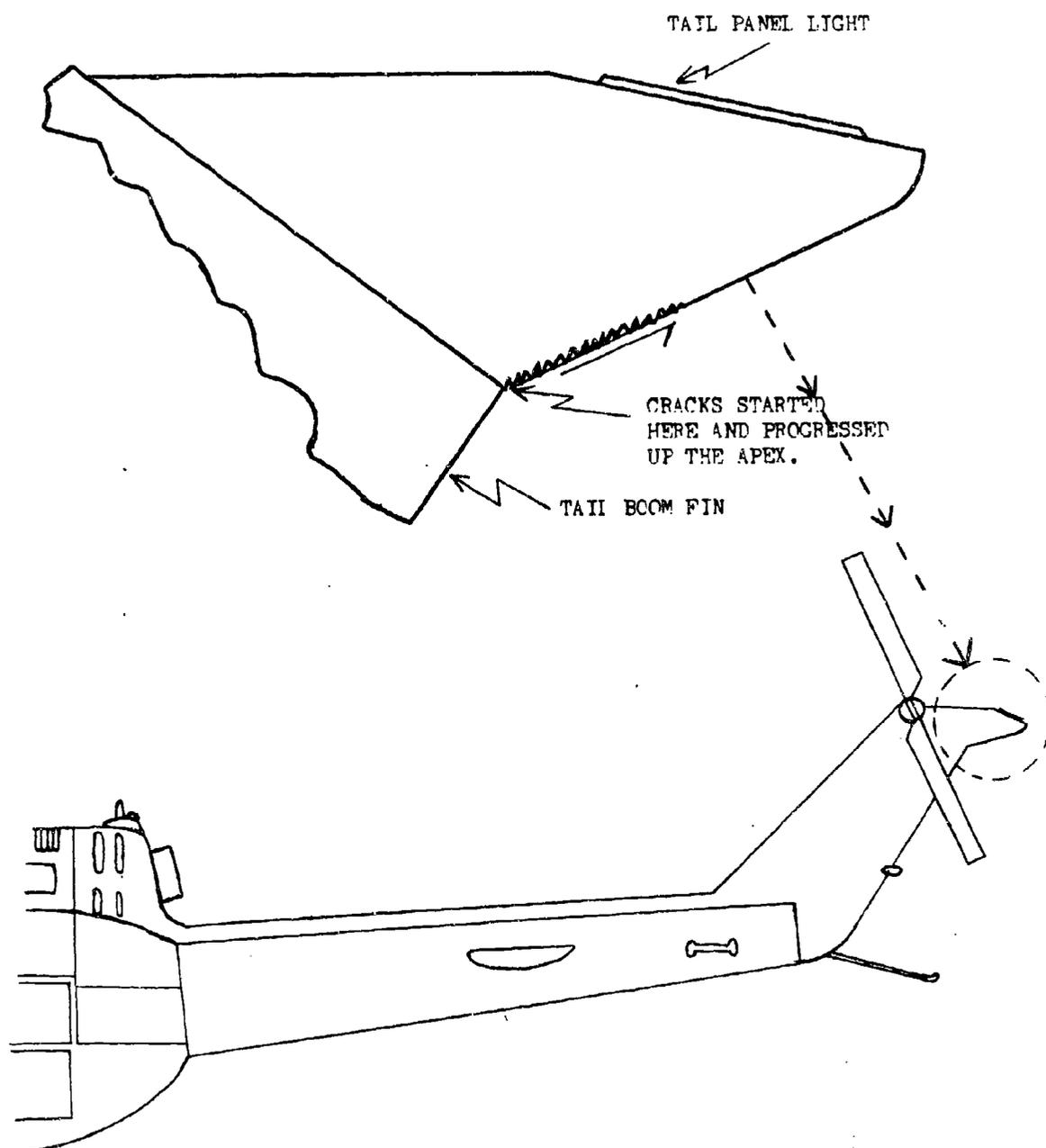


FIGURE 6. Diagram of Crack on Tail Boom Pylon.

aircraft upon arrival combined to cause the initial problems outlined in (1) above.

#### 10. FINDINGS

a. Average separation distance flown by number 2 aircraft was 10 feet vertical and 4 rotor discs horizontal.

b. The airscoops interfered with the view of the side panel lights causing pilots to stack up higher than customary.

c. NFCS lights enhanced performance of all maneuvers except takeoff and climb.

d. The rotor tip lights provided a significant improvement over existing navigation lights. In addition to providing a better reference for pilots during formation flying, the NFCS adds to overall safety during all types of night flying.

e. Although not absolutely secure from enemy observation, the NFCS is a definite improvement over the existing UH-1 lights.

f. When the rotor tip lights are turned to the brightest position, intensity is satisfactory under most conditions of close formation flight.

g. The intensity of the fuselage panel lights was satisfactory when operated at the brightest setting, but pilots sometimes became disoriented and confused as to which panel light they were observing.

h. Although several shortcomings existed when evaluating units received them, the NFCSs were practically maintenance free during the evaluation.

#### 11. CONCLUSIONS

a. The NFCS is a definite improvement over lights presently installed on the UH-1 with regard to formation flight, safety and security.

b. The NFCS is reliable and requires very little maintenance.

c. There are four shortcomings in the NFCS that, if corrected, would improve its overall value and make it suitable for all night flying requirements in RVN. These shortcomings are:

(1) The airscoops on top of the fuselage interfere with the view of the side panel lights. Panel lights should be repositioned slightly or elevated.

(2) When rheostat setting 1 or 2 on either circuit is used, lights are too dim. If technically feasible, these settings should be deleted and two higher intensity settings added. This would increase the maximum intensity by two increments.

(3) Panel lights on the fuselage were all the same size, shape, and color. This caused pilots some confusion in orientation. A distinctive color combination such as a red light on the left, a green light on the right, and blue lights at the front and rear positions would eliminate this problem.

(4) The FM antenna support mount on which the rear panel light is mounted developed cracks and should be made of stronger material.

12. RECOMMENDATION

It is recommended that the NFCS, incorporating the suggested improvements listed in paragraph 11, be adopted for use on UH-1 helicopters. The NFCS is not intended as a replacement for the existing standard navigational light system, but as an additional system for use in a combat environment.

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13. ABSTRACT Six Night Flying Control Systems (NFCS) for UH-1 helicopters were employed during night operations by the 117th and 175th Assault Helicopter Companies, 1st Aviation Brigade, during the period 4 October to 4 November 1969. The NFCS lights were used as the only reference lights for night formation flying for a total of 55 flight hours during which all normal maneuvers were performed with formation of two to four aircraft involved. Analysis of data collected reveals that the NFCS is a definite improvement over the present UH-1 light system. It was recommended that the NFCS be adopted for use on UH-1 helicopters.			

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