December 1984 DCIEM No. 84-R-54

#45298

EYE MOVEMENTS OF SEA KING PILOTS DURING DESTROYER DECK LANDINGS AT NIGHT

A. Beach

Defence and Civil Institute of Environmental Medicine,
Box 2000, 1133 Sheppard Ave. W.,
Downsview, Ont. M3M 3B9
Canada

DEPARTMENT OF NATIONAL DEFENCE - CANADA

Table of Contents

ABSTRACT

The report documents the eye movement patterns of pilots landing Sea King helicopters on HMCS destroyers at night, when there was no visible natural horizon. The useage patterns of the currently fitted visual landing aids are discussed. Frame by frame analysis determined the percentage of time spent looking at, and the frequency and duration of use of, the various landing aids. The results are tabled and compared to the results obtained in daylight conditions. The study concludes that pilots alter their visual behaviour between daylight and night conditions in terms of the areas viewed, and the frequency and duration viewing those areas.

INTRODUCTION

In order to determine the effectiveness of the current visual landing aids fitted to Canadian Forces ships and to improve both the safety and efficiency of shipborne helicopter operations, DCIEM was tasked (1) to:

a) define the optimal information required to avoid disorientation during launch and recovery; and

b) define the functional form of a system capable of displaying the required information.

To address these concerns, DCIEM began an evaluation program to determine the utilization of the information currently presented to the Sea King pilots as they launch and recover aboard CF ships.

The DCIEM evaluation of pilot eye movements during daylight conditions when the pilots had a prominent natural horizon to aid their orientation has been reported previously (2). This report presents the evaluation of pilot eye movements during night conditions, when the pilots had no natural horizon and presumably relied more extensively on the visual aids mounted on the ship. This report has three objectives:

1. to document the eye movement patterns of pilots while landing and launching the Sea King at night from DDH class ships;

2. to document findings on the extent to which the present visual aids are used by pilots while landing and launching during night operations; and

3. to determine if differences in eye movement patterns exist between the day and night conditions.

METHODS

To fulfill the objectives of the study, both subjective and objective measures were used. The objective measures were the records of the pilots' eye movements as they flew the Destroyer Deck Landing sequence (DDL). A corneal reflection technique was used to measure eye movements. This method was one of the few available for recording eye movements in the dynamic maritime helicopter environment. The NAC eye mark recorder system (EMRS) was chosen because of its simple, reliable operation and its in-house availability.

Recording eye movements at night is more complex than in daylight. To facilitate successful night recordings the technique used in reference 2 had to be altered in two ways. First, the image obtained from the NAC system was passed through an image intensifier before it was recorded. This provided an image of sufficient brightness to be useful for analysis. The obtained field of view was restricted by approximately 20% when the image intensifier was used. However, it provided sufficient coverage to allow the eye movement to stay within the recorded frame and yielded satisfactory results.

Second, the image was recorded on VHS format video cassettes instead of the 16 mm film used during daylight conditions. The recorded video image had decreased acuity and grey-scale sensitivity when compared to the image recorded on 16 mm film. However, this reduction in quality was compensated for by the capability of the video to provide continual feedback of the quality of the recorded image. The complexities of the optics systems and the problems associated with scheduling the DDL sessions dictated that acceptable recordings be taken first time. The use of 16 mm film would not allow this due to the developing time required. Video, with its continual feedback capability, was necessary. The reduction in acuity of the recorded image with the video was more than offset by the benefits of immediate feedback of recording quality that the video allowed.

The study used three subjects for the objective eye movement recording sessions. All were fully qualified, active squadron pilots with Sea King experience ranging from 4 - 15 years.

The subjective data in the study were obtained by means of a questionnaire completed by 25 current Sea King pilots. The questionnaire addressed the following issues:

1. the difficulty of each phase of the landing sequence; and

2. the importance of each of the current visual landing aids.

Each pilot rated the difficulty of various aspects of the landing sequence on a five point scale. The pilots then rated how often they used each of several current visual landing aids on a five point scale. Appendix A contains a copy of the questionnaire. This subjective measure was included in the experimental protocol for two reasons:

1. to obtain a general impression of the effectiveness of the current visual aids from the pilots' viewpoint; and

2. to obtain a measure of how accurately pilots can report their eye movement activities during the landing sequence.

Table 1 shows the data on the experience of the pilots who completed the questionnaire. It indicates that a wide cross section of pilots was canvassed.

Table 1. Experience levels of the respondents.

Characteristic	Average	S.D.	Min	Max
Flying time (hrs)	2015	1244	600	4900
Sea King flying time (hrs)	1025	611	300	2800
DDL qualified time (years)	4	4.4	1	15
No. of DDLs flown - day	172	11	10	325
- night	86	67	2	255

DDL - Destroyer Deck Landing.

PROCEDURES

Objective Procedures

The success of the procedures used in reference 2 suggested that the recording of pilot eye movements at night could be completed safely. However, extra safety precautions had to be used to ensure the safety of the crew, and extra time and care was taken to ensure the quality of the recorded data. The procedures used during the night flights were similar to those used in the day. All recordings were made with the pilot sitting in the left hand seat. All pilots were continually monitored by the copilot, who was prepared to take control of the aircraft at any time. The only major difference was that at night, no approaches to the ship were recorded with the EMRS system. It was found in the daylight study (2) that approaches took an inordinate amount of time and added only marginally to the understanding of pilots' use of the landing aids. Therefore, in the night trials, the helicopter remained connected to the ship via the hauldown cable and all trials were flown with the pilot performing 'Yo-yos'. This decreased the time requirement of the trials substantially and yielded a more co-ordinated data collection.

All subjects were fitted with the EMRS on land before the recording session began, to ensure that the equipment was capable of capturing their viewing point. Experience with the system has demonstrated that the EMRS does not work with approximately 10% of the population, due to the unique morphology of each person's eye.

One complete cycle of the recording procedure consisted of the following events. With the helicopter secured to the deck via the Beartrap system, the pilot donned the EMRS and the system was calibrated. The pilot was instructed to take off and position the aircraft in the high hover position, 6 - 7 metres above the flight deck. He was instructed to hold this position for 30 seconds. The pilot then passed control of the aircraft to the copilot and rested until he felt prepared to continue with the trial. This 30 second recorded phase represented the high hover that the would occur in a launching sequence.

To begin the landing sequence, control of the aircraft was passed from the copilot back to the pilot, who maintained the high hover for 30 seconds. The pilot was then instructed to descend, at his discretion, to the low hover position, 1 - 1.5 metres above the flight deck. The low hover is used by the pilot and the Landing Signal Officer (LSO) to ensure the helicopter is properly aligned and ready to land. When established in the low hover, the pilot was again instructed to hold the hover for 30 seconds. At the end of this 30 seconds the pilot was instructed to land at his discretion. Once the aircraft was safely secured on the deck via the Beartrap, the calibration of the recording equipment was checked and corrected if necessary. This ended the recording sequence for the landing phase.

The 30 second holding period in the low hover position was used to ensure that sufficient eye movement data were collected, without being so long as to become tiresome for the pilot. Although this 30 second holding period is somewhat long compared to the normal 5 to 10 seconds, the pilots did not consider it to be abnormal.

Therefore, one complete cycle consisted of two high hovers (one in landing and one in launching) and one low hover, each 30 seconds in duration. Eye movement patterns were recorded for three complete cycles for each of the three pilots. All recordings were made with the hauldown cable attached to the aircraft and operating properly.

To allow familiarization with the system and procedures, one complete cycle was flown before any recordings were taken. This practice cycle gave the pilot some appreciation of how the EMRS would feel and react during the recording session. It also allowed the researchers the opportunity to determine whether the pilot understood the procedures he would be following. All recordings were made during night conditions with no visible natural horizon. Ship motion was between 5 - 15 degrees of roll and 1 - 2 degrees of pitch.

Subjective Procedures.

In January 1983, the questionnaire was administered to 25 pilots from the two Sea King squadrons from CFB Shearwater, HS423 and HS443. Due to the simplicity of the questionnaire, an experimenter was not present during its completion. The pilots were instructed to complete the questionnaires independently. No specific steps were taken to ensure that collaborative responses were not elicited.

ANALYSIS

Data Reduction

The eye movement data were reduced using a 20" video monitor, an HP 9845 desktop computer and an HP 9774 digitizer. The video monitor was placed directly in front of the researcher. A scale drawing of the hangar face and landing aids was placed on the digitizer. The data were reduced by advancing the recordings frame by frame and having the researcher determine the position of the pilot's viewpoint in relation to the hangar face. The researcher then translated this position onto the scale drawing and digitized the location. In this manner, the specific location of the pilot's viewpoint was determined and recorded. Examples of the basic output of the reduced data can be found in the following two figures. These outputs were useful in helping to formulate a general understanding of the pilot's visual behaviour.

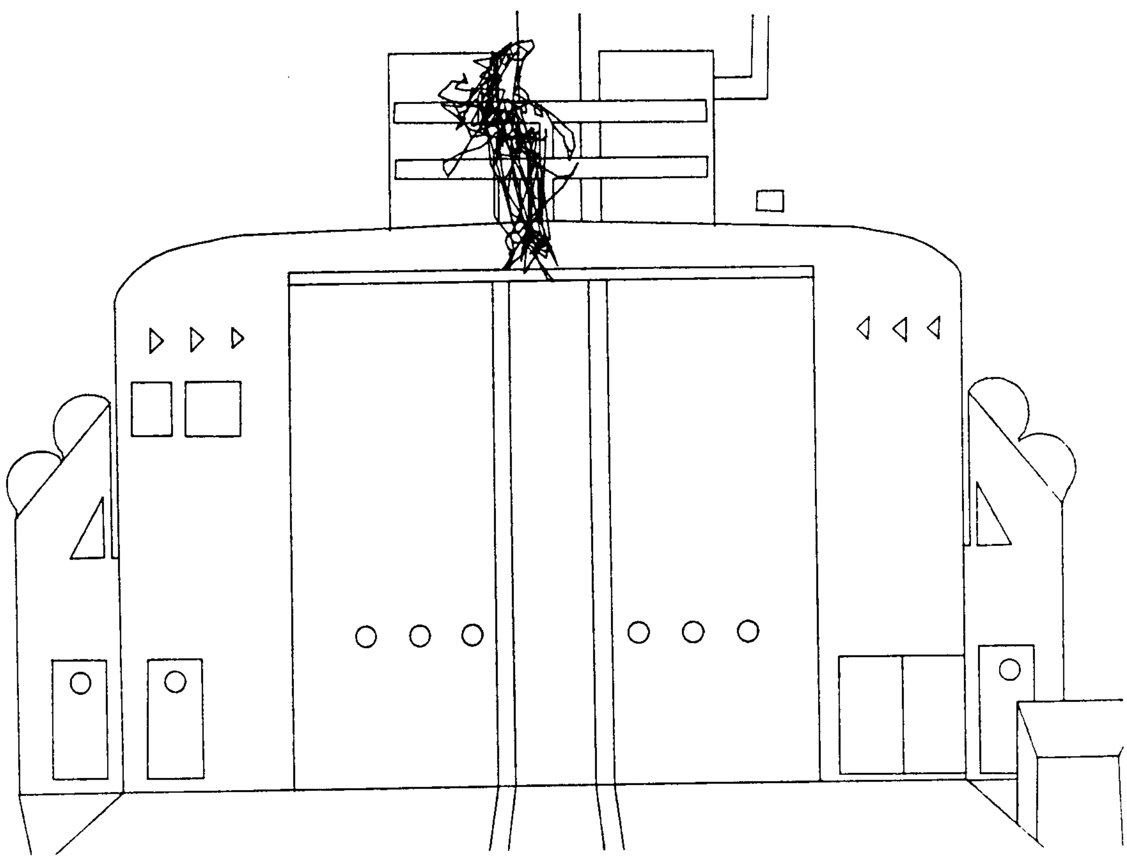

Figure 1. One pilot's eye movements for the high hover at night.

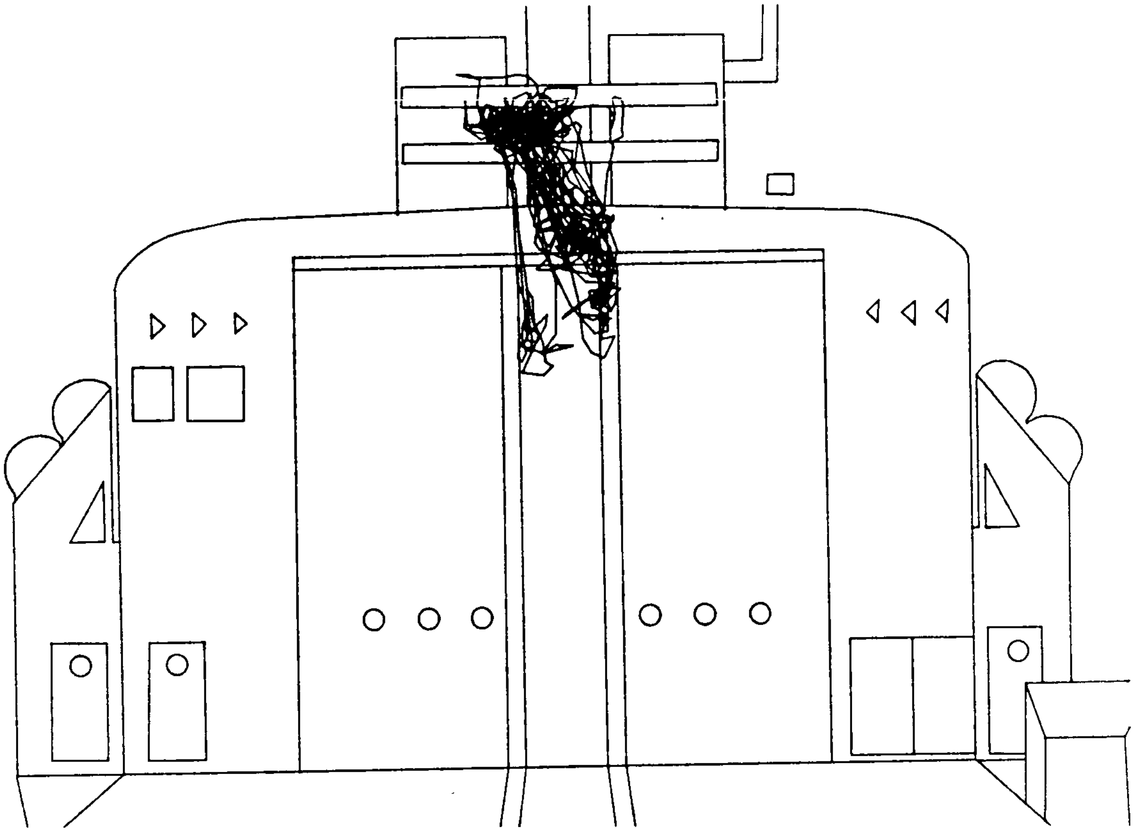

Figure 2. One pilot's eye movements for the low hover at night.

Data Analysis

A more detailed examination of the data was conducted using the following method. The visual field of the pilot was divided into 11 areas as shown in Figure 3. These 11 areas were determined by dividing the hangar face and visual aids into functional areas (i.e., horizon bars, vertical lines, etc). The boundary for each area was defined as the actual physical boundary of the visual aid plus 2 degrees of visual arc. This 2 degrees of visual arc was included in each area since the NAC mask has been reported by the manufacturer, and verified through calibration trials, to be accurate within 2 degrees. Preliminary trials had indicated that the pilots tended to look at specific features such as the horizon bars or vertical lines, rather than featureless areas such as the hangar face. Therefore, the 2 degree boundary was added around the features, rather than around the featureless areas. The visual areas used in the analysis are presented in Figure 3.

The methods of analysing eye movement data which had been developed for the daylight trials (2) were used to calculate the following:

1. number of glances into each area,
2. percent of time spent looking in each area,
3. average length of each glance,
4. probabilities of looking from one area to another.

A	ship's superstructure	G	lower hangar face
B	horizon bars	H	lower vertical lines
C	below horizon bars	I	between lower vertical lines
D	upper hangar face	J	portholes
E	upper vertical lines	K	houda and flight deck
F	between upper vertical lines		

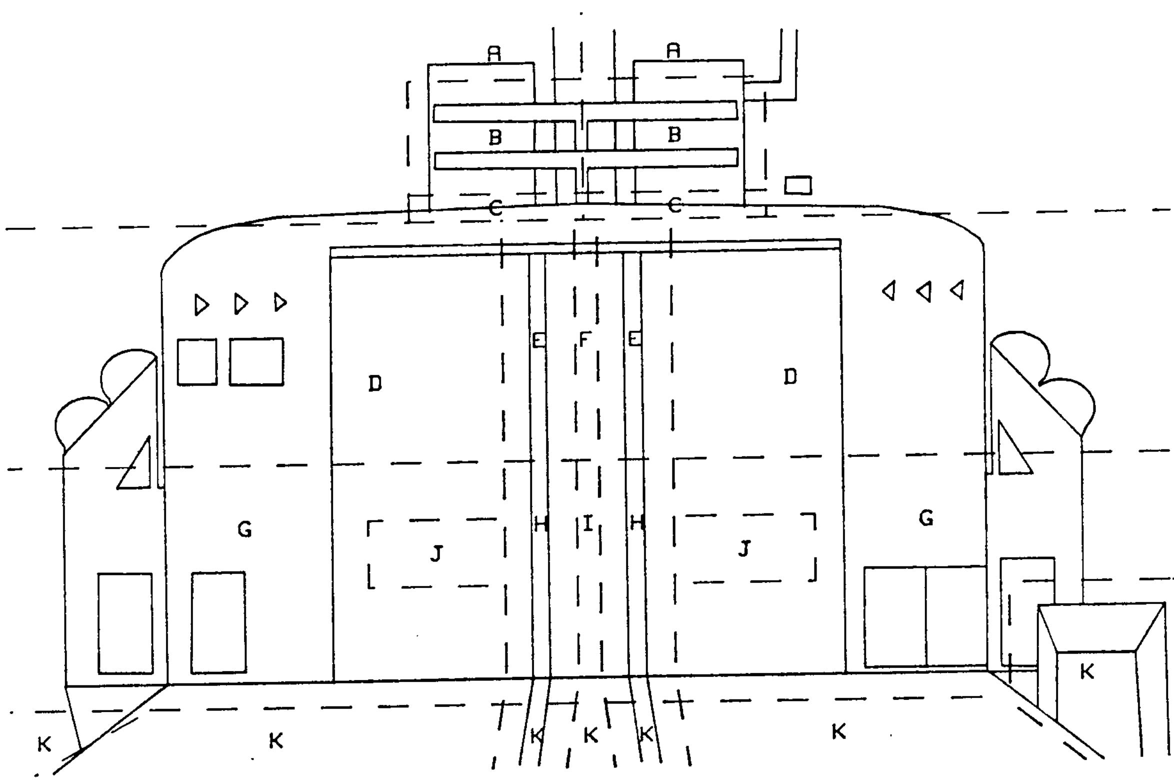

Figure 3. Areas of view used in the analysis

A test of the reliability of the analysis procedure was performed by having the researcher reduce the data for the same trial on three separate occasions using the reduction technique previously described. This reliability check indicated that the analysis procedure could identify reliably the most often used areas of view and the rank order of those areas, and could identify the percentage of time within those areas to within +/- 5%.

RESULTS

Objective Results

The study of pilots' eye movements in daylight (2), determined that there were no differences between the high hover when launching and the high hover when landing condition. Therefore, this study used the high hover when landing condition to be representative of any high hover and any reference to high hover refers to the landing condition.

The study of eye movements in daylight (2) revealed that there were no significant differences between pilots flying the same condition. Also, no significant differences were found between the repeat trials for the same subject. Because of these findings, interpilot differences and intertrial differences were not analysed in this report and were assumed to be insignificant. The small sample size of the night data precluded a statistical verification of these assumptions.

Figures 4 and 5 present the numerical summaries of the results averaged across all pilots in both flight conditions at night. Each figure represents the average values for all pilots taken during the 30 second recording periods. These figures reveal several findings and form the basis of all further discussion of the results. To aid in the presentation and discussion, individual segments of these figures will be identified and expanded upon in the following paragraphs.

Figure 4 shows that in the high hover, all pilot eye movements were to areas A, B, C, D and E. These areas were all above the horizontal midline of the hangar face. They correspond to approximate eye level in the high hover. The pilots rarely looked at areas F, G, H, I, J, or K, which were all below the midline of the hangar face and below the pilots' eye level.

Figure 5 shows that in the low hover, all pilot eye movements were to areas B, C, D, E, F. These areas were all above the horizontal midline of the hangar face and were above the pilots' eye level in the low hover. The pilots rarely looked below the midline of the hangar face in the low hover.

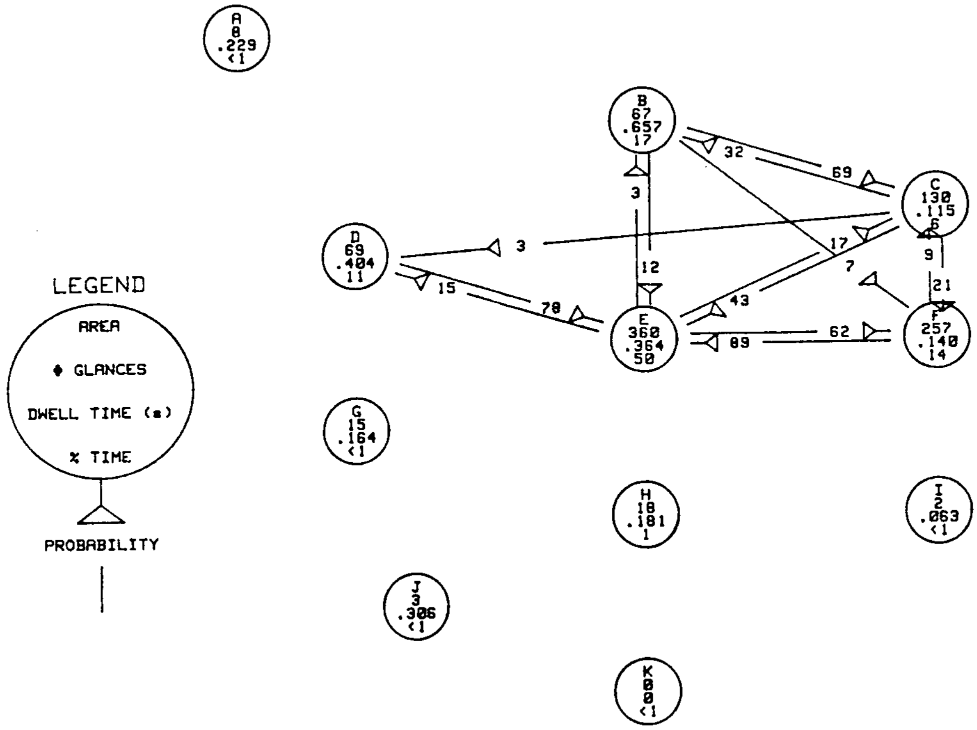

Figure 4. Summary of results for high hover at night.

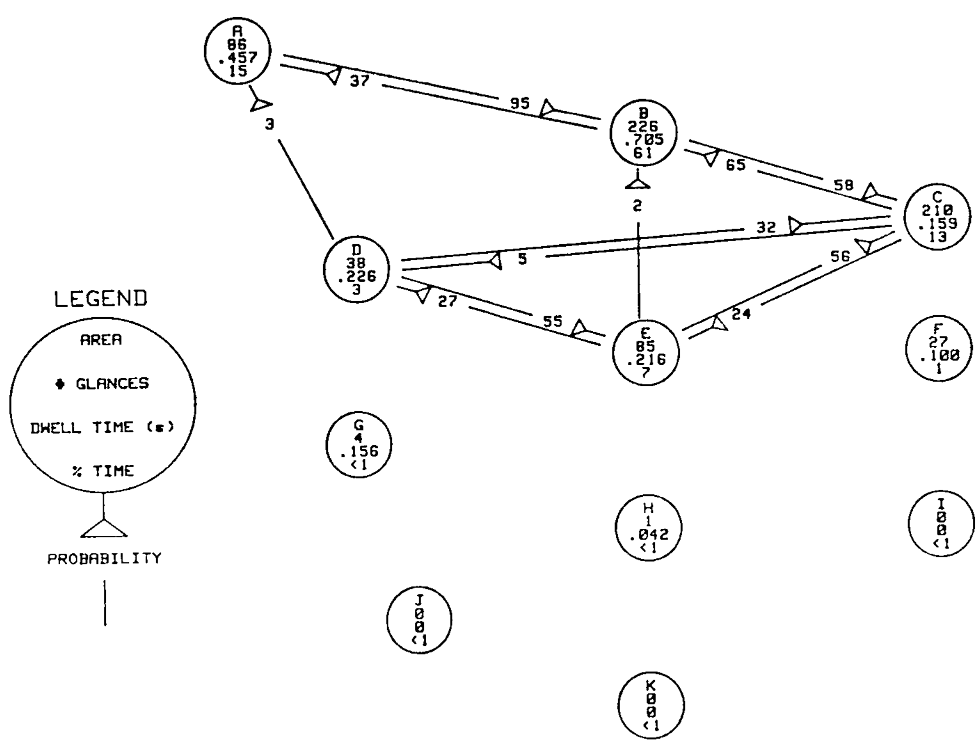

Figure 5. Summary of results for the low hover at night.

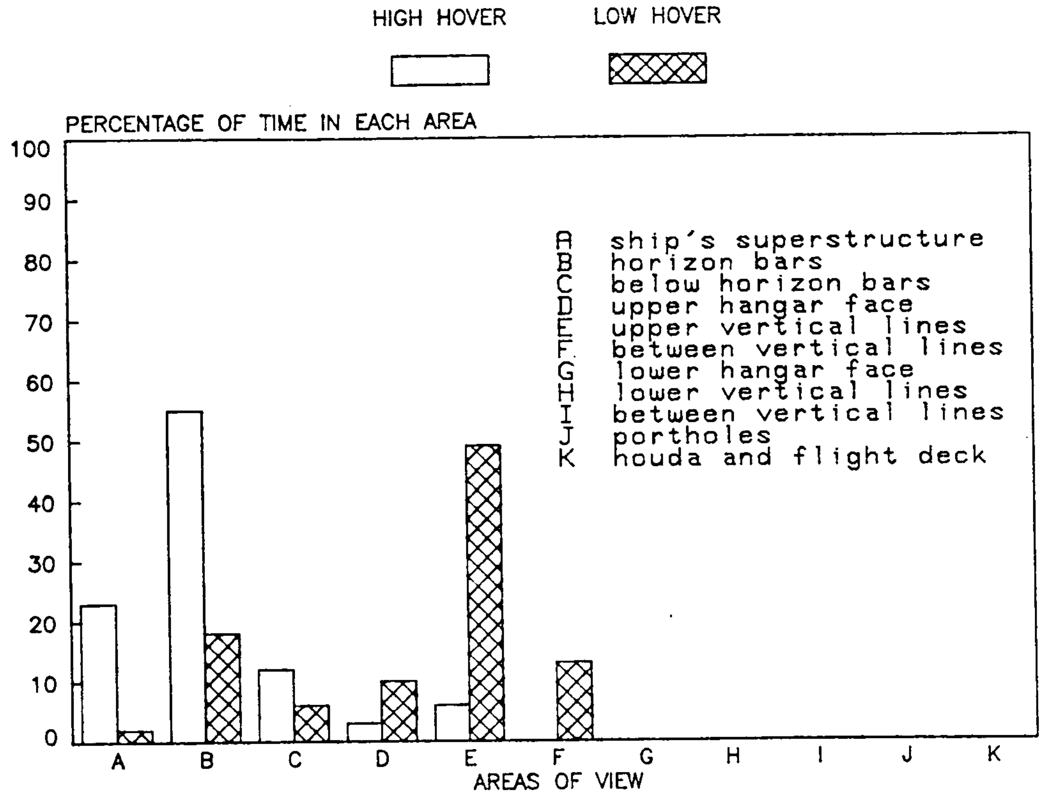

Figure 6. Intercondition differences at night.

Figure 6 presents the percentage of time the three pilots spent viewing each visual area in the high hover and low hover conditions averaged across all pilots and trials. The figure shows that the most often used visual aids in the high hover at night were the horizon bars and the superstructure of the ship located above the horizon bars. These two areas accounted for 78% of the total viewing time. In the low hover at night, the most often used visual aids were the horizon bars and the vertical lines on the upper hangar face. These areas accounted for 67% of the viewing time.

As shown in Figure 4, the visual aids with the longest dwell time in the high hover were the horizon bars and ship's superstructure. These areas, by virtue of their long dwell time and high frequency of use, can be considered the primary visual aids in the high hover. In summary, the visual patterns of pilots during high hover with no natural horizon can be characterized by concentration in two primary areas for relatively long periods of time with frequent glances of shorter duration to secondary visual aids.

The dwell analysis of the low hover indicates that the longest viewed visual aids were the vertical lines, the horizon bars and the hangar face. This, coupled with the high frequency of use indicates they were the primary visual landing aids. No other visual aids had sufficient dwell time and percentage useage to be considered secondary visual cues. Therefore, the visual activity of pilots in the low hover can be characterized by concentration on three primary areas, with very infrequent glances to other areas.

Subjective Results.

The subjective results of the questionnaire were used primarily to obtain current pilots' ratings of the difficulty in the DDL sequence, and how they think they use the current visual landing aids. Since the questionnaires were completed anonymously, it was not possible to match the three subjects' subjective responses with their objective eye movement recordings.

Table 2 presents the frequency distribution of results obtained from question 1. This question asked the pilots to rate their impressions of the difficulty of different aspects of the DDL sequence.

The table indicates that the pilots did not feel that any one aspect of the DDL is more than "difficult" during night conditions. The table indicates that pilots feel maintaining proper for/aft position is the more difficult task of the DDL, compared with acquiring the proper hover position, maintaining the proper lateral position or maintaining the proper altitude. In all conditions, initial acquisition of the proper hover position and maintaining the proper altitude over the flight deck were rated to be the least difficult tasks.

Table 3 contains the frequency distribution of results obtained from question 2, which asked the pilots to rate how often they used each of the various possible landing aids at night. The table indicates that the pilots felt the most used landing aids were the roll bars, the vertical lines on the hangar face, the hangar face itself and the trafficator lights. The table also indicates that the pilots feel the pitch bar is seldom used.

The subjective results of the night condition were, on average, one point higher than the corresponding day data. A Chi square analysis indicated that the difference between the day and night condition were statistically significant ($p < .05$). This indicates, as was expected, that pilots felt that the DDL sequence was more difficult at night.

Table 2. Frequency distribution of responses for question 1.

	no answer	1	2	3	4	5	mode	median
During approach to ship								
locating visually	1	2	13	5	4	0	2	2
acquiring glideslope	4	4	9	4	2	2	2	2
maintaining glideslope	4	4	10	3	3	1	2	2
determining distance	0	0	8	10	5	2	3	3
During hauldown cable hookup								
acquiring proper hover	0	12	9	4	0	0	1	2
maintaining altitude	0	12	10	2	1	0	1	2
maintaining for/aft	0	2	12	9	2	0	2	2
maintaining lateral	0	10	11	3	1	0	2	2
In high hover								
acquiring proper hover	0	12	10	3	0	0	1	2
maintaining altitude	0	14	8	3	0	0	1	1
maintaining for/aft	0	1	13	10	1	0	2	2
maintaining lateral	0	9	11	4	1	0	2	2
In low hover								
acquiring proper hover	0	7	11	6	1	0	2	2
maintaining altitude	0	8	11	5	1	0	2	2
maintaining for/aft	0	3	12	9	1	0	2	2
maintaining lateral	0	7	10	8	0	0	2	2
Launching								
acquiring high hover	0	15	9	1	0	0	1	1
transitioning from hover to forward flight	0	4	12	8	0	1	2	2
General								
matching ship's speed	0	9	9	7	0	0	2	2
acquiring horizon	1	2	9	10	3	0	3	3
anticipating motion	1	1	8	11	3	1	3	3
predicting lulls	1	2	9	11	1	1	3	3
adapting from cockpit to outside aids	0	4	9	8	3	1	2	2
adapting from aids to inside cockpit	0	4	10	8	2	1	2	2

1 not difficult
2 somewhat difficult
3 difficult
4 very difficult
5 extremely difficult

Table 3. Frequency distribution of responses for question 2.

	no answer	1	2	3	4	5	mode	median
roll bars	1	0	0	2	3	19	5	5
pitch bar	1	6	8	6	3	1	2	2
trafficators	1	1	0	3	6	14	5	5
dust pan lights	2	3	4	6	6	4	4	3
line up lines of deck	1	2	4	4	4	10	5	4
hangar face	1	2	0	1	4	16	5	5
hangar vertical lines	1	0	2	2	2	18	5	5
ship's funnels	1	11	7	3	3	0	2	3
ship's formast	1	13	9	1	1	0	2	2
houda	1	11	4	6	3	0	2	3
portholes	1	15	5	2	1	1	2	2

1 never
2 seldom
3 occasionally
4 often
5 very often

Day versus Night Comparison

Data collected in daylight conditions with a visible natural horizon (2) were compared to data collected in this study, at night with no visible natural horizon. A statistical analysis of the differences between the two sets of data was not possible due to the small and different sample sizes. As a result, only trends could be identified and these are reported here.

Figure 7 presents the high hover data and shows that two visual areas accounted for over 70% of the total viewing time. The horizon bars were the most used visual aid in both conditions. The second most often used aid in daylight was the vertical lines on the hangar face, whereas at night, the second most often used aid was the ship's superstructure. These findings indicate that the field of view of the pilots was located higher on the ship at night, when they do not have a natural horizon to assist them.

Figure 8 presents the same data for the low hover condition and indicates that the pilots' principal visual aid shifted from the lower vertical lines in daylight to the upper vertical lines at night. Also, at night the pilots looked at the horizon bars, whereas they never looked at them in daylight low hover conditions.

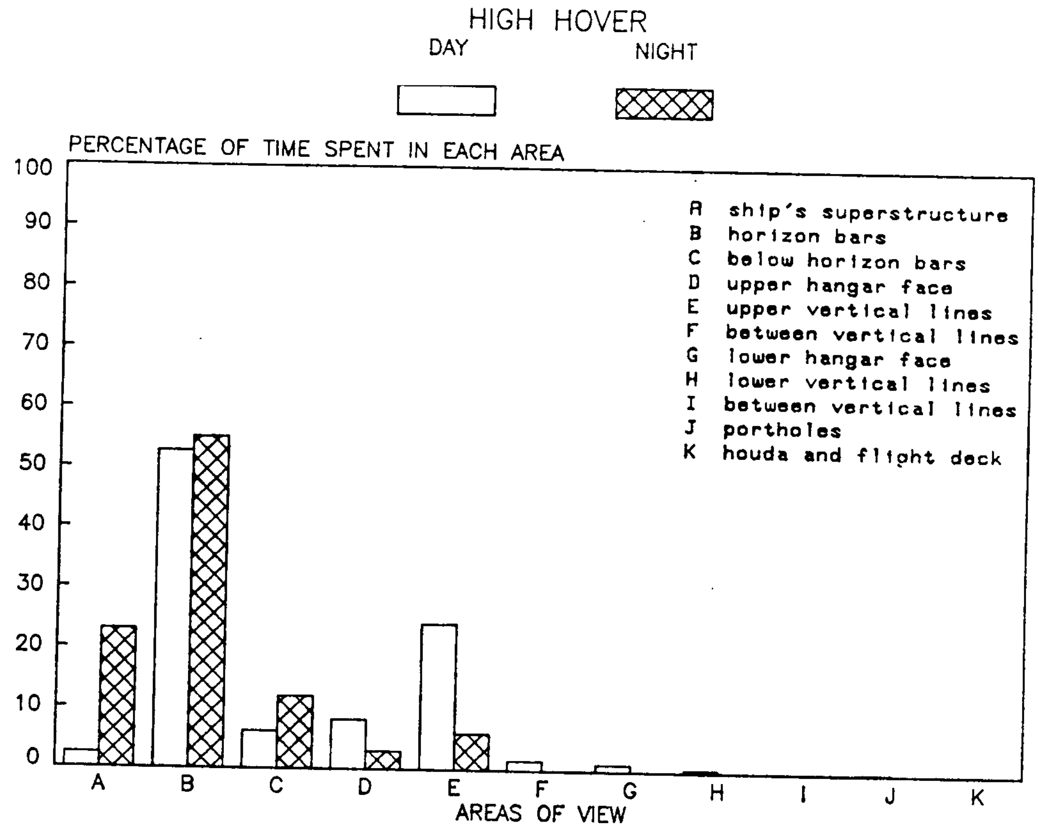

Figure 7. Day versus night comparison in the high hover.

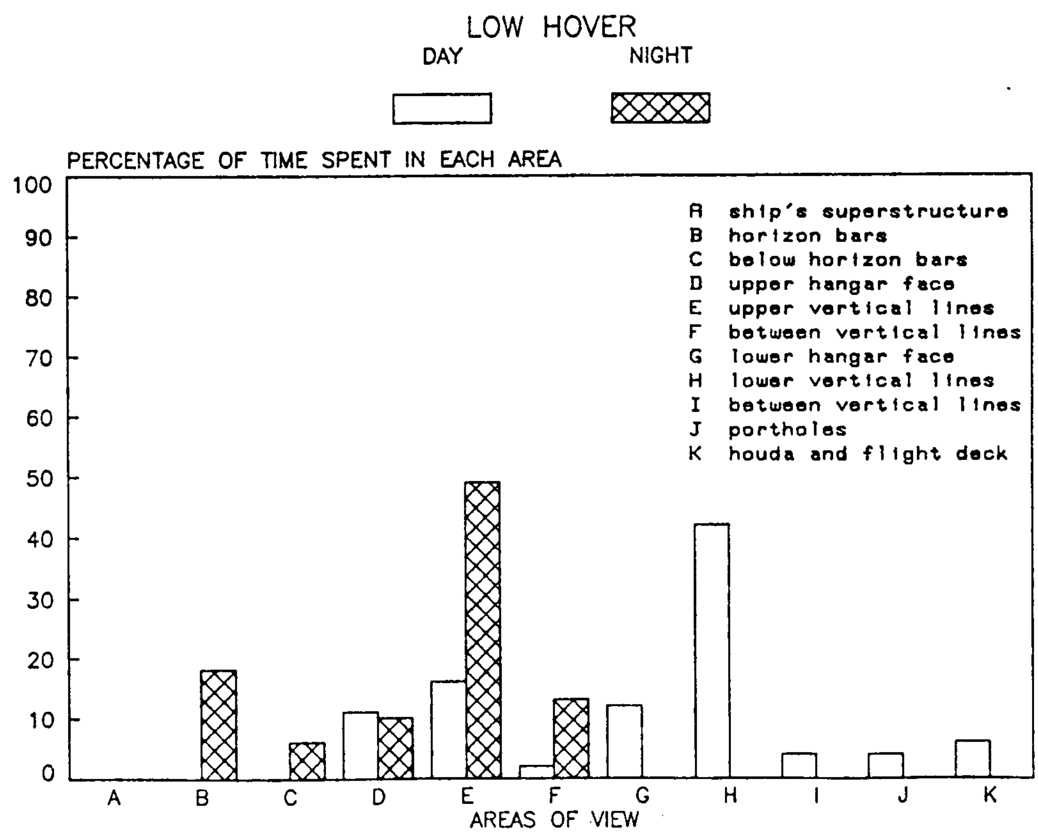

Figure 8. Day versus night comparison in the low hover.

DISCUSSION

The extent to which pilots alter their visual behaviour between night and day was characterized by three findings.

First, results from the daylight condition indicated that pilots restrict their eye movements to a 25 degree visual cone. The night data produced the same finding. However, the centre of this visual cone was higher on the ship's hangar at night than it was during the day. In daylight, for both the high and low hover, the pilots centred their field of view directly in front of the helicopter by looking at the visual aids that were located at eye level. However, at night, the pilots centred their vision on the horizon bars, often looking above and below them but never looking below the midline of the hangar face. Therefore, in the low hover at night, the pilots were looking at visual aids that were located well above eye level.

This may be due to the fact that at night, with no natural horizon, the pilot's need for a horizon reference was the predominant factor in determining his visual behaviour. In daylight, the natural horizon obtained by the pilot through peripheral vision may have provided him with sufficient orientation information to allow him to look away from the horizon bars. He did not have to make uncomfortable and vertigo causing head movements to obtain a horizon reference. However, at night, the pilot did not have the benefit of the natural horizon in his peripheral vision, and his need for a horizon reference forced him to look at the horizon bars. As a result, he maintained his field of view closer to the horizon bars and seldom moved his head to look away from them.

The fact that pilots concentrate on the area immediately in front of them, in both the high hover and low hover in daylight, argues for visual aids that are located at pilot eye height. The fact that pilots look up to the horizon bars while in the low hover at night, is not seen as a counter to that argument. Rather it is seen as an indication that the current horizon bars are not ideally located for use in the low hover. Ideally, all visual landing aids should be located at eye level directly in front of the pilot for daylight and night conditions in both the high and low hover.

Second, the dwell time analysis indicated that the average dwell time for the primary landing aids was shorter at night than in the day. This demonstrates that with no natural horizon, pilots increase their frequency of eye movements. An increase in eye movement is often used as indication of increased mental attention and workload (4). If this is true, the objective results of this study indicate that the DDL sequence is more demanding when their is no natural horizon, and places a higher workload on the pilot.

Third, the analysis indicated that pilots looked at fewer visual areas when there was no natural horizon available to them. At night, although all visual aids and details were visible, fewer visual aids were used. At night, a total of six visual areas were viewed, whereas all eleven visual areas were viewed in daylight conditions. This indicates that as the DDL sequence became more demanding, pilots restricted their eye movements to the visual aids that they found most useful and made fewer eye movements to areas that were not as useful.

It can also be possible that pilots try to maximize the available dwell time by restricting eye movements to fewer areas, thereby minimizing total movement time. However, the shorter dwell times at night appear to indicate that pilots do not use the extra time available to increase the dwell times. Instead, they use the extra time to view the specific areas more often.

The comparison of the subjective results obtained for the night and day conditions reveal two major findings. First, the pilots felt that all aspects of the DDL sequence were more difficult when there was no natural horizon. Anything that the pilots felt was not difficult during the day became somewhat difficult at night, and anything that was somewhat difficult during the day became difficult at night. This findings is consistent with the objective finding of this study which showed that the DDL sequence is more demanding when the pilots did not have a natural horizon and had to rely more heavily on the presented visual aids.

Second, the pilots felt that the same aspects of the DDL sequence were the most difficult during both day and night. They felt that maintaining proper for/aft position was the more difficult task compared with maintaining proper lateral position or altitude. This finding was due in part, to the lack of visual aids available to the pilot to indicate the proper for/aft position. The ship used in this study, and all HMC DDH class ships, have lateral line up lines painted on the deck to assist the pilot in maintaining proper for/aft position. However, these lines were located outside the pilot's useful field of view. To see them, the pilot would have to rotate his head and use his peripheral vision. This head movement was seldom made and as a result, the pilots relied almost exclusively on the audible commands from their copilot. The difficult in maintaining the proper for/aft position and the lack of direct visual assistance that the pilot had in maintaining this position argues for some for/aft position aids in any future work.

In summary, pilots had different visual behaviour at night than in daylight. Their need for a horizon reference forced them to look at the horizon bars and reduced their time spent viewing other visual aids when they did not have a natural horizon. The pilots looked at fewer visual aids and fixated on those aids for shorter periods of time at night. The pilots relied more extensively on the presented visual aids at night, when the DDL sequence became more difficult.

CONCLUSIONS

From the preceeding discussion and within the constraints of this study, the following conclusions can be made.

1. The primary visual landing aids used in the high hover when there was no natural horizon were the horizon bars and the ship's superstructure.

2. The primary visual landing aids used in the low hover when there was no natural horizon were the horizon bars and the vertical lines on the hangar face.

3. The pilot's eye movements differ between the natural horizon and no natural horizon condition in the areas viewed, their frequency and duration.

4. Pilot's require horizon information which can be obtained from the natural horizon or a horizon reference system.

5. Visual landing aids should be located at eye level directly in front of the pilot for both high hover and low hover conditions.

Acknowledgements

The authors wish to thank the Sea King pilots and aircrew of HS423 and HS443 squadrons of CFB Shearwater for their efforts throughout the difficult and time consuming recording sessions. In addition, the authors extend their appreciation to Helicopter Operational Test and Evaluation Flight (HOTEF) personnel, whose many talents and ideas aided this study immensely.

REFERENCES

1. DCIEM Task Description Sheet for 15D55, July, 1979.

2. Beach, A., M. Hill, S. Evans. Eye Movements of Sea King Pilots During Destroyer Deck Landings. DCIEM 84-R-31, Sept. 1984.

3. Hill, M., A. Beach. Development of an Operational In-Flight Eye Movement Recording System. Proceedings of the Human Factors Association of Canada Annual Meeting, 1982.

4. Asiala, C.F., S. Loy, R. Bull, J. Fitzgerald, Pilot Workload Assessment, AFARML-TR-80-109. Wright Patterson Air Force Base, 1980.

APPENDIX A

This appendix contains a sample copy of the questionnaire that was distributed to the pilots of HS423 and HS443 squadrons.

CONFIDENTIAL WHEN COMPLETED

DDL Evaluation Questionnaire

DCIEM is currently working on a project to examine the visual landing aids used by Sea King pilots during DDLs. An important part of the study involves gathering subjective evaluations from pilots concerning different aspects of the DDL and the effectiveness of the present visual landing aids. The questionnaires will be confidential when completed and are not being used to determine if you are following the training manual. Please feel free to comment on any aspect of the DDLs. Thank you for you time and effort.

What is your total flying time? _____ hrs
What is your total Sea King time ? _____ hrs
How long have you been DDL qualified? _____ years.
What is your total number of DDLs? _____ day
_____ night

Rate each aspect of the DDL cycle in terms of difficulty.

1 = not difficult
2 = somewhat difficult
3 = difficult
4 = very difficult
5 = extremely difficult

COMMENTS

During the approach phase to the ship

locating the ship visually ____

acquiring proper glideslope ____

maintaining proper glideslope ____

determining distance from ship ____

During hauldown cable hookup

acquiring proper hover position ____

maintaining altitude ____

maintaining for/aft position ____

maintaining lateral position ____

In the high hover position in preparation for landing

acquiring proper hover position ____

maintaining altitude ____

maintaining for/aft position ____

maintaining lateral position ____

During the low hover

acquiring proper hover position ____

maintaining altitude ____

maintaining for/aft position ____

maintaining lateral position ____

During take off

acquiring proper high hover ____

transitioning from hover to forward flight ____

In general, how difficult is each of the following?

matching ship's speed ____

acquiring horizon references ____

anticipating ship's motion ____

predicting lull periods ____

adapting from inside cockpit to outside aids ____

adapting from outside aids to inside cockpit ____

How often do you use the following visual aids during a DDL?

1 = never
2 = seldom
3 = occasionally
4 = often
5 = very often

		COMMENTS
roll bars	____	
pitch bar	____	
trafficators	____	
dust pan lights	____	
line up lines on deck	____	
hangar face	____	
line up lines on hangar	____	
ship's funnels	____	
ship's formast	____	
houda	____	
portholes	____	

Do you feel there are deficiencies in the present visual aids?

If so, please comment.

What solutions can you offer to improve those deficiencies?

Given no constraints, what would you consider to be the ideal visual aids system for use with CF ships?