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1997 Canadian Forces Air Operations Vision Survey

Section I
Operational Visual Requirements

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EXECUTIVE SUMMARY

Visual standards for pilot selection and retention have been in place since World War I, but such standards are often empirically derived because of a paucity of data relating standards to actual operational visual requirements. Visual demands and requirements in military operational flying are changing with evolving technologies e.g laser guidance systems, HUD, NVGs, FLIR.

In 1997, DCIEM was tasked by Air Command to review and propose amendments to Canadian Forces aircrew visual standards. As the first step in this process, the DCIEM Central Medical Board (CMB) designed an in-depth questionnaire – the CF Air Operation Pilot Vision Survey (AOPVS) – to acquire information from current CF aircrew on a variety of visual parameters. The AOPVS was divided into three main sections including 1- Operational Visual Requirements, 2 - Visual Aids and 3 – Clinical and Administrative Support.

The AOPVS was sent to 1551 pilots, with a 60% return from the 1331 who actually received the questionnaire. This Report presents the results of Section 1 – Operational Visual Requirements. The purpose of this section was to acquire information regarding the perceived level of difficulty associated with flying tasks in 9 operational roles. Information regarding the importance of contrast sensitivity and problems with glare was also acquired.

The greatest number of tasks rated as "difficult" or "very difficult" were encountered in rotary wing operations, including tactical helicopter, search and rescue, and maritime patrol. In fixed wing aircraft, maritime patrol pilots identified the largest number of "difficult" or "very difficult" tasks. Somewhat surprisingly, fighter operations were not generally rated as visually demanding. Difficult visual tasks in all environments were generally related to specific military operations such as NVGs, target and smoke detection rather than general flying tasks.

Contrast sensitivity was identified as being important especially in conditions of low visual contrast such as flying over snow or water. Glare is a continuing problem in CF flying operations, with reflected glare being a particular problem interfering with CRT visualization in the Griffon and Aurora.

With this information provided by current CF pilots, which identifies and ranks the most difficult visual tasks in nine operational flying environments, the aim is to generate new assessment methods and visual standards based on the visual challenges faced by today's pilots.

ABSTRACT

Introduction: DCIEM conducted an operational vision survey of current Canadian Forces pilots. The overall survey was designed to acquire information on operational vision requirements, visual aids, and clinical and administrative support. In Section I, Operational Visual Requirements, pilots in 9 different operational flying roles were asked to rank order from 11 to 65 different flying tasks for which they had operational experience. Information was also acquired about the importance of contrast sensitivity and the problems of glare in operational flying. **Results**: 1551 questionnaires were sent out. 813 questionnaires were completed and 200 returned "undelivered" for a response rate of 61% from those actually received. The average age was 37 years, range 24-54. The greatest number of tasks rated as "difficult" (D) or "very difficult" (VD) were in rotary wing flying. Tac Hel (TH) so identified 12 tasks in 6 of 10 groups. SAR RW had 12 tasks in 7 of 10 groups. Maritime patrol RW had 14 D or VD tasks in 8 task groups. In fixed wing operations, maritime patrol rated as the most challenging with 11 tasks in three groups rated as D or VD. Fighter operations were not generally rated as visually demanding with only 2 tasks in 11 task groups rated as D or VD. Tasks rated as D or VD were almost all related to operational flying such as NVGs, target or smoke detection, and not to general flying requirements. Contrast Sensitivity was identified by the pilot population as being important in all military flying operations, particularly in conditions of low visual contrast such as flying over snow or water, or at dawn or dusk. Glare is a continuing problem in CF flying operations. In particular, reflected glare was identified as a problem interfering with CRT visualization in the Griffon and Aurora.

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INTRODUCTION

Vision has been recognized as a critical function since the very beginnings of military aviation. Standards were set for visual requirements for pilot training even before World War I (the US War Department required normal vision without glasses, and normal colour vision in standards first published in 1912). Then, as now, vision was one of the most common causes for rejection of candidates for pilot selection, and disqualification of trained pilots. Vision issues were and remain controversial; the basis for vision standards seems more often empirical than scientific; high contrast visual acuity as measured by standard eye tests is but one of many visual functions, yet forms the basis for most vision standards. Although visual functions such as visual acuity, vergence, night vision and grating contrast have shown ambiguous results when correlated with simulated tasks such as target detection and landings (Buzzelli et al 1989; Kruk et al 1981; Kruk and Regan 1983; Morris and Temme 1989), other functions such as contrast sensitivity and small letter contrast sensitivity have shown promising results (Ginsburg and Evans, 1982; Rabin 1995). With the introduction of new visual aids, vision enhancers (Night Vision Goggles [NVG]) and information display technology (Cathode Ray Tube [CRTs] instruments), sharp distance vision is no longer the sole important visual function , contrast perception and colour vision are gaining in importance.

Previous studies have examined visual tasks specific to the rotary wing environment and the difficulty of carrying out night operations (Giu 1969; Hammer 1987) but no studies have attempted to rank in terms of visual difficulty or characterize in terms of visual function those military flying tasks perceived as most visually demanding by pilots.

In August 1995, the Command Surgeon of Air Command tasked DCIEM to review and propose amendments, if required, to the current CF aircrew visual standards. As the first step in this visual standard validation process the DCIEM Central Medical Board (CMB) designed an in-depth questionnaire - the "1997 CF Air Operation Pilot Vision Survey" (1997 CFAOPVS) to access the operators' point of view on a variety of visual parameters. The primary goal of this survey was to identify those flying tasks considered by current pilots as the most visually difficult in each CF operational role. The second goal was to gather information regarding the performance of specific visual aids, visual protectors and vision enhancers, as well as feedback concerning administrative and clinical support for vision-related issues.

It is anticipated that the results of this study will be used in the design of specific visual tests capable of assessing visual function under simulated conditions representative of the military flying environment. The results of these tests will then be correlated with that of current visual testing to validate or amend the current standards. This operationally oriented process should result in operationally relevant visual standards.

The survey was divided into three main sections: 1. Operational Visual Requirements, 2. Visual Aids, and 3. Administrative and Clinical Support . The survey also included a section to gather demographic data from the population answering the survey. The results derived from the analysis of the first section titled "Operational Visual Requirements" are reported here.

Topics covered by this section were:

- the perceived level of visual difficulty associated with specific flying tasks in 9 operational roles.;
- the perceived importance/unimportance of contrast sensitivity in the conduct of general visual tasks in these operational flying roles ;
- the perceived acceptability/unacceptability of glare on general visual tasks, CRTs instruments and HUD reading;

METHODS

The 1997 CFAOPVS was reviewed by the Commander of Air Command and the Director of Flight Safety and received full approval and support. The survey was then sent out to all Canadian Forces pilots. In May 1997 1551 questionnaires were sent to all regular and reserve CF pilots listed within NDHQ as of April 1997. Accompanying the survey were letters from the Commander of Air Command and the Director of Flight Safety recognizing the importance of this exercise and encouraging pilots to provide personal input and experience. Four months were allocated to complete and return the survey to DCIEM. Pilots were asked to provide input only for those questions for which they had operational knowledge (experience).

Questions were of three types: yes/no answers, a choice of answers with the possibility of a written comment, and rated answers. For all questions requiring a rating, an example of the scale to use was presented above the question or at the beginning of a sequence of questions using the same scale. Rating was achieved through one of the 3 different 5-point scales:

Scale	Rating value				
	1	2	3	4	5
Acceptability	wholly unacceptable	unacceptable	borderline	acceptable	wholly acceptable
Importance	very unimportant	unimportant	borderline	important	very important
Difficulty level	very difficult	difficult	borderline	easy	very easy

STATISTICAL ANALYSIS

Statistical analysis was designed to answer the following questions:

- Which visual tasks are considered most visually demanding in each of 9 specific operational roles?
- What is the importance of contrast sensitivity in specific visual tasks?
- What is the perceived level of acceptability/unacceptability of the effect of glare on general visual tasks and instrument reading including the CF-188 HUD?
- Is the rating or the choice of answer(s) influenced by the operational role, position, experience level, correction required, use of spectacles, use of contact lenses, airframe, operational role or age group?

To answer each of these questions, non-parametric tests were used:

- One sample sign test (OSST) (equivalent to a parametric one sample t-test) testing whether the values are centered around a specific value. This test was used to assess whether the rating of a specific group was centered around a specific value such as "2" (unacceptable/unimportant/hard) or "4" (acceptable/important/easy).

- Mann-Witney U (MWU) (equivalent of a parametric t-test) testing the hypothesis that the distribution underlying two groups is the same. The MW was used to assess the effect of two-level demographic variables such as position, experience level, correction, spectacles and contact lenses.

- Kruskal-Wallis (KW), equivalent to a one-way ANOVA, testing the hypothesis that the distribution underlying three or more groups is the same. The KW was used to evaluate the effect of multi-level demographics variables such as airframe, operational role or age group.

- Friedman Ranking (FR), equivalent to a 2-way ANOVA, testing the hypothesis that the response to a condition is the same against the hypothesis that at least one condition produces a different outcome. The FR was used to rank the effect of different conditions amongst themselves such a series of tasks or a series of viewing conditions.

RESULTS

A. DEMOGRAPHICS

1. General

By October 1997, 813 questionnaires were completed and returned to DCIEM from the initial 1551 sent out. Sixty-four (64) questionnaires were returned stating "released from the CF" and 136 with stated "posted ", "unknown", or "no return address". The final return rate for this voluntary CF survey, was 56%. However, if we account strictly for those who did, in fact, receive the survey the return rate was 60%. Table 1 presents the percentage of participation of each rank, including regular and reserve personnel, based on the April 97 NDHQ Pilot 32A personnel list.

The distribution between regular and reserve forces was 92% and 8% respectively, which compares favorably to 88% regular, 12% reserve calculated from the NDHQ April 97 list. Pilots were distributed throughout 10 operational roles at the time the survey was filled out; Tactical Helicopter (TH), Search & Rescue Rotary Wing (S&RRW), Search & Rescue Fixed Wing (S&RFW), Maritime Patrol Rotary Wing (MPRW), Maritime Patrol Fixed Wing (MPFW), Transport (TSPT), Fighter (FGT), Jet Trainer (JTRG), Primary Trainer Fixed Wing (PTFW) and Primary Trainer Rotary Wing (PTRW).

Of the 813 pilots who answered the survey, 725 provided their current operational role. Table 2 presents the operational role distribution between regular and reserve forces. The distribution between staff officer and operational pilot was respectively 25% and 75%. When considering the six main military operations (TH, S&RRW, MPRW, MPFW, TSPT and FGT) the highest percentage of staff officer, 32%, was encountered in the FGT group while the lowest, 18%, was encountered in the MPFW/RW groups.

The average age of those who answered the survey was 37 years old (± 8 years) and 45% were between 30-39 years old. The youngest and oldest pilots were respectively 24 and 54 years old. Table 3 provides a frequency distribution for the various age groups by rank.

A total of 357 pilots provided their military rotary wing (MRW) flying time and 671 pilots their military fixed wing (MFW) flying time. Average experience level intervals for these two groups were respectively 1000-2500 hours and 2500-5000 hours. Sixty-six pilots (8%) had over 1000 hours flying experience in each environment. Table 4 presents the frequency distribution of experience level by rank in both rotary (a) and fixed (b) wing environments.

B. Ranking the visual difficulty of CF operational flying tasks: what the pilots said.

a. Results

Although CF pilots are involved in 10 operational roles, this survey deals primarily with 9 of them. S&R FW was omitted as the number of pilots currently occupying this position was too low for statistical analysis. In fact, only 5 Twin Otter pilots who are employed in S&R and TSPT duties answered the survey.

Of the 813 pilots who answered the survey, 779 provided input as to their operational knowledge of one or more CF air operations; 513 (63%) provided input for one operational role, 200 (25%) for two; 53 (7%) for three, and 8 (<1%) for four or more roles. Thirty-four (4%) did not provide any information. The frequency distribution of the nine operational role responses is presented at Table 5.

The total number of tasks to be rated varied in each operational role from 65 to 11 as shown in Table 6. As pilots were asked to provide input only for those tasks in which they had operational knowledge, the number of respondents varied for each task. Complete descriptive statistics for each visual task of the nine operational roles, including mean rating, standard deviation, count, minimum and maximum rating, are presented at Appendixes 1 Tables a-i. Appendix 2 Tables a-h presents the overall Friedman Ranking for the most common visual tasks in all nine operational roles.

As a first analysis, tasks were regrouped under a series of 4 to 11 headings. Table 7 provides an overview of the ratio of task(s) rated as "very difficult" or "difficult" to the total number of tasks in each of these groups for every operational role.

The greatest number of tasks rated as "very difficult" or "difficult" was encountered in the Rotary Wing operational flying environment. TH identified 12 individual tasks in 6 of 10 task groups as "difficult or very difficult". S&RRW had the same number in 7 of 10 groups. MPRW had 14 "difficult" or "very difficult" tasks interspersed in 8 task groups. RW visually demanding tasks are mainly encountered in VFR flying, approaches, hover, target and smoke detection.

In fixed wing flying, Maritime Patrol (MPFW) rated as the most challenging operational role visually. Eleven tasks distributed between three groups were rated as "difficult" or "very difficult". These groups of tasks included VFR flying, target detection and smoke detection.

Somewhat surprisingly, fighter operations were not generally rated as visually demanding. In fact, only 2 tasks, encountered in 2 of 11 task groups, VFR flying and air-to-ground target detection were rated as "difficult" or "very difficult".

There was no common group of tasks for which all FW operational roles rated task(s) as visually demanding.

Tables 8 a-h present the mean rating and the Friedman Ranking (FR) of the first to 50th percentile of the most commonly performed visual tasks in the nine CF operational roles. All tasks rated as "difficult" or "very difficult" have been reported on this table even if they were not included in the FR analysis. NVG tasks in general, could not be included in the FR as the number of individuals with NVG experience was too low; the only exception was that of TH. For RW operational roles, tasks ranked first by the FR analysis were very role specific: hover, target/smoke detection, and approaches at night unaided and under NVG for TH; smoke/target detection, hover and approaches at night and above water for S&R RW, target identification, ship/lights identification at night unaided for MPRW and approaches for PTRW. Visually demanding tasks for MFW were unaided smoke/target identification at sea at night for MPFW, formation and air refueling at night unaided for TSPT; air/ground target detection for FGT; formation for JTRG. PTFW did not report any visually demanding tasks.

The effect of demographic variables such as overall military flying experience and use of corrective lenses (spectacles or contact lenses) on the selection of visually demanding tasks and on the FR of the most common visual tasks was not significant.

b. Discussion.

(1) Rotary wing environment

There are some specific characteristics describing the operational environment of the visual tasks rated as "difficult" by the TH and S&R pilots. First, they are performed under low levels of illumination (mainly night unaided) which decreases contrast , alters depth perception and can cause visual illusions. Second, they are performed under restricted field of view (NVG flying, slinging, hovering), which impairs assessment of relative position of objects in a three dimensional space. Third, they are characterized by low contrast (night unaided, NVG, target and smoke detection in forested area). The assessed difficulty of MPRW tasks is increased by sea operations which are characterized by lack of contrast, depth perception difficulties, field of view limitations, and ship motion detection.

(2) Fixed Wing Environment

Fixed wing visually difficult tasks are characterized by lack of contrast (low level flying above water), lack of depth perception (formation flight night unaided) and depth/parallax perception (low-level parachute extraction).

(3) Fighter

The low number of tasks assessed as visually demanding (only two of a possible 37) is somewhat puzzling, given the extreme importance placed on vision in the past in fighter operations. One possible explanation is that the visual demands in fighter operations have changed with the current generation of fighter aircraft, with most information now being available from on-board acquisition and HUD systems, with much less reliance on the naked eye than was the case in the past. This is not the case in other operational roles such as TH, S&RRW or MPRW where acquisition, recognition and identification are frequently done by the naked eye.

The fact that the FGT have not rated more than one visual task as "difficult" should not be interpreted as "there are no difficult visual tasks in the FGT environment". Rather these results should alert us to the fact that fighter pilots may have a tendency to rely increasingly on their onboard acquisition computers to perform tasks that were once performed by the naked eye. Although there are great advantages to such technology, computers cannot replace the naked eye for tasks such as visual target identification, which remains a critical element of fighter ops (the recent Gulf War and Iraq episodes of destruction by friendly fire highlight the critical importance of direct visual identification).

(4) General comments

The tasks identified as visually demanding are mainly restricted to military operations rather than standard flying visual tasks - with the exception perhaps of RW landing tasks which are also performed by other RW groups (Coast Guard, RCMP helicopter, etc). Regardless of the operational role, tasks rated as visually difficult are characterized by reduced contrast (NVG flying, unaided at night, over forested areas and rough water), lack of defined texture (water, flat terrain), illumination side effects such as shadow formation (NVG, rough terrain), and restricted field of view (NVG flying).

The level of difficulty associated with a visual task seems to be independent of experience level. This suggests that the perceived level of difficulty of a given visual task lies within the task itself and/or the environmental conditions under which they are performed rather than with experience level. This does not mean that a visual task might seem or even become easier to perform as experience level increases. What it shows is that the perceived level of visual difficulty is a function of visual parameters rather than experience level. This hypothesis would also explain why tasks considered as visually demanding in each operational role are tasks for which this role has an increased level of flying experience (e.g. NVG for TH, landing on a ship at night for MPRW, low level flying above a rough sea for MPFW).

Tasks considered visually difficult were the same whether or not corrective lenses were worn. The explanation may lie in the fact that the difficulty of visual tasks reflects a range of visual functions including contrast sensitivity, night vision, and motion detection which are not measured by the normal Snellen visual acuity charts which form the basis for current CF visual standards. Since the tasks identified as visually demanding cannot be characterized by visual acuity levels alone, one can hypothesize that the selection of a task as difficult goes beyond visual acuity function to include other visual functions such as contrast, motion and depth perception effects.

The visual characteristics of visually difficult tasks – low illumination level, illumination side-effects, contrast level, restricted field of view, depth perception and motion detection provide guidelines for the design of operationally relevant visual testing methods. They indicate which visual parameters are to be varied in order to assess visual function under representative military operational conditions. Not all of these characteristics can be used to assess the visual capability of a pilot. Field of view (FOV), or the effect of the illumination cannot be correlated to a precise visual function. Laboratory research can provide guidelines as to the level of FOV restriction that can be imposed without affecting one's performance. Research has demonstrated that restricting one's FOV up to 70° has significant effects on tracking performance of low frequency, large amplitude moving target (Sandor and Leger, 1991). Further, the large head movements required to follow such targets are detrimental to performance (Gretsky and Leech, 1977). Adverse illumination effects, such as shadowing causing visual illusions, can be minimized through training, and knowledge about the flying operations which predispose to such phenomena.

Those visual functions that can be objectively assessed with currently available technology to derive visual standards for the visually demanding military flying tasks would be: (1) night vision (Levy and Glovinsky, 1997), (2) contrast sensitivity with and without glare (Rabin, 1995), (3) parallax or motion threshold (Kruk et al, 1981) and (4) depth tracking perception (Kruk and Regan 1983).

C. CONTRAST SENSITIVITY

a. Results

Table 14 presents the overall mean rating and the FR results of contrast sensitivity importance in a total of 16 general visual tasks. For each task, and independently of the operational role, contrast sensitivity was rated as either "important" or "very important" with the exception of "formation flying" by FGT pilots who rated it as "borderline".

The ranking order of the importance of contrast sensitivity for each task was role specific. For the various operational roles, tasks ranked the highest were: NOE NVG, low level over snow, NVG, low level over water and flying toward the sun by TH; over snow, low level over water, in mountains and at dawn/dusk by S&RRW; low level over water, dawn/dusk and landing in minimum meteorological conditions by MPRW; over snow, landing in minimum meteorological conditions, flying towards the sun, and dawn/dusk by TSPT; low level over snow, water, fields in mountains and at dawn/dusk by FGT and dawn/dusk and landing in minimum meteorological conditions by JTRG.

There were no noticeable differences in the ranking order of the importance of contrast sensitivity as a function of the wearing of corrective lenses (spectacle or contact lenses), age group or experience level.

b. Discussion

In recent years, the importance of contrast sensitivity has been increasingly investigated in air operations (Rabin, 1995, Ginsburg and Evans, 1982). In the design of this survey this consideration was addressed despite the concern raised, that aircrew might not understand the concept of "contrast sensitivity". The results of this survey have shown that pilots are aware of and concerned about contrast sensitivity.

The results also show that the ranking order of visual tasks influenced by contrast sensitivity was role specific. This is an interesting phenomenon, as one would generally believe that the perceived requirement for a visual function such as visual acuity or contrast sensitivity would be compensated for by one's experience level. One hypothesis would be that the perceived importance of contrast sensitivity in a given task is dependent on the conditions under which the task is performed rather than how easily it can be performed. This follows the trend in identification of visually demanding tasks.

It is worth mentioning that unlike visual acuity for which standards are set, contrast sensitiviy is not a visual function currently assessed in CF aircrew. However, investigations have shown the importance of contrast sensitivity in air operations (Rabin , Ginsburg and Evans, 1981, Ginsburg, 1981), especially in the military environment as this visual function seems to be linked to performance of time restricted visual tasks (Rabin, 1995).

D. GLARE

a. Results

(1) Effect of glare on general visual tasks

The rating of the effect of glare on the performance of general visual tasks was "borderline", the distribution of the rating was significantly different between seven of the 10 CF operational roles (KW p-value 0.0052). Table 9a presents the rating frequency distribution and the mean ranking average in seven of these operational roles. S&R FW (5 individuals), PTRW (12 individuals) and PTFW (1 individual) were omitted due to their relative low numbers. The effect of glare was judged mostly "unacceptable" in MPFW, MPRW and S&R RW operations. Although to a lesser degree, glare was also a concern in TH operations. Transport and JTRG did not seem, as a group, to consider glare as adversely affecting their general visual tasks.

Significant differences in the rating of glare are identified by the analysis as a function of airframes (KW p-value 0.0029). Table 9b presents the rating frequency distribution and the mean ranking averages in 14 different airframes. The Sea King, the Aurora, and the Labrador are the airframes mostly affected by glare followed by the Griffon, the Hercules and the Silver Star. Of interest, although the transport group rated the effect of glare as generally "borderline", the Hercules and the Dash-8 pilots had a tendency to rate its effect slightly more "unacceptable" than did the Challenger pilots. The difference between these three airframes was significant (KW p-value 0.03). As for the rating provided by the Airbus, the Boeing 707, the Buffalo and the Twin Otter, their low numbers (respectively 3, 6, 5, 5) do not allow an accurate rating of the perception of the glare problem.

Demographic factors such as wearing of spectacles or contact lenses or the age groups did not influence the rating of the acceptability/unacceptability of glare in the performance of general visual tasks as shown at Table 10. However, it is worth mentioning that in the case of the variable "age group" there appears to be a trend toward unacceptability with an increase in age (KW p-value 0.06).

(2) Effect of glare on Cathode Ray Tube (CRT) Instruments reading

For the purpose of this report, the airframes considered to be equipped with CRT technology were: CC-137 Airbus, CP-140 Aurora, CC-144A/B Challenger, CC/CT-142 Dash-8, CH-146 Griffon and CF-188 Hornet. The effect of glare on the reading of the CRTs was generally rated "borderline". The Aurora pilots rated glare on average as "unacceptable" while Challenger and the Airbus pilots rated it as "acceptable". The frequency distribution of ratings and KW mean rank values for each airframe are presented at Table 11. Analysis have shown a significant difference between airframes (KW $p > 0.0001$). The Aurora and the Griffon are most sensitive to this problem. The Aurora and the Griffon accounted respectively for 47% and 37% of all "wholly unacceptable" and 27% and 47% of all "unacceptable".

Demographic factors such as the wearing of spectacles or contact lenses or age groups did not influence the rating of the acceptability/unacceptability of glare in the reading of CRTs as shown at Table 12.

(3) **Rate the effect of glare on the Head Up Display (HUD) (CF-188 only)**

This question was limited to the CF-188 pilots. As a group the effect of glare on the reading of the HUD was judged "borderline". Although not significant, the KW analysis by age group showed a tendency toward unacceptability with increasing age. Table 13 presents the frequency distribution of the rating by age group along with the KW mean rank and the OSST p-values.

The rating of the acceptability/unacceptability of glare in the reading of the HUD remained unchanged by the addition of demographic variables such as glasses or contact lenses.

a. Discussion

Glare in aviation is generally of two types - solar and veiling. Solar glare is encountered when flying toward the sun or above water. Veiling glare is present when light is scattered or reflected onto the visual scene by scratched visors, sunglasses, windshields and even by the reflection of lights in the aircraft transparencies at night (Brennan, 1989). There was no distinctions made between these types of glare in the questionnaire. However, from the FR analysis by operational roles and subsequently by airframes, conclusions are drawn regarding the type of glare encountered:

(1) **Solar glare** caused by the reflection of sun light on water or snow is inherent to specific air operations such as MP and S&RRW. This particular problem cannot be alleviated. Palliative measures such as sun visors with higher optical density are currently being investigated but they are limited by the optimization of reducing glare while preserving visual acuity and contrast sensitivity (Brennan, 1989).

(2) **Veiling glare** caused by the reflection or scattering of sun light on instrument panels, occurs on specific aircraft CRTs. Based on the results of this survey, this problem continues to be critical for Aurora and Griffon pilots. In the Aurora, shields have been installed around CRTs to decrease the side effect of glare but this does not seem to have sufficiently alleviated the problem. Griffon pilots do not have the same set-up and their responses indicate that unless missions occur under covered sky or at night, veiling glare on the CRT is a major problem. Glare on instruments is ergonomic by nature and can be minimized, if not totally alleviated, by proper positioning the CRTs inside the cockpit. An assessment of the impact of a direct light source on the reading of horizontal CRTs should have demonstrated this potential problem. This problem is not encountered in aircraft such as the Airbus or the Challenger which have all their CRT instruments located on the front instrument panels.

(3) **Increased sensitivity to glare with age**. Generally speaking there seems to be a tendency toward unacceptability of glare, regardless of its type, for general visual tasks and instrument reading whether CRTs or HUD, as age progress. This tendency follows clinical and laboratory results (Owsley et al, 1983) and can be describe as a natural aging phenomena. Wolbbarsht and Landers (1985) suggested that it might be advisable to consider testing older aircrew for sensitivity to glare. Level of glare sensitivity can be easily determined during routine eye examination. Normative data can be acquired over a few years and limiting glare sensitivity values derived by simulating visual tasks in specific operational conditions in the laboratory. Standards may later be determined to assess a limit beyond which glare sensitivity could be detrimental to safe air operations.

CONCLUSIONS

This section of the Air Operations Pilot Vision Survey provides relevant information on:

- Visual tasks rated as the most visually demanding in each of nine different operational roles;
- Visual tasks most sensitive to contrast perception; and,
- On the airframes most prone to the adverse effects of glare and on the potential increased sensitivity to glare with age.

Visual Task Level of Difficulty

The survey reveals that the majority of operational flying roles perceived as most difficult from a visual perspective are encountered in the rotary wing environment TH, S&R RW and MPRW. In the fixed wing environment, the largest number of difficult visual tasks were reported in the MPFW environment. Somewhat surprisingly, very few tasks were rated as visually difficult in FGT operations, possibly because of the significant increase in information available from on-board data acquisition systems.

The survey reveals that flying tasks perceived as visually demanding are not influenced by one's overall flying experience or the wearing of corrective lenses but rather are specific to the environmental conditions under which they are performed. The most difficult visual tasks are encountered under conditions of unaided night vision, low contrast and texture, restricted field of vision, and are influenced by depth and motion perception.

Overall, the survey has demonstrated that difficult visual tasks were related to specific military operations rather than general flying and were not influenced by the wearing of corrective lenses. This finding is perhaps the most important as it provides an operational basis to argue why visual military standards for air operations are and should remain more stringent than civilian ones and should include other visual function analysis than high contrast visual acuity.

Contrast Sensivity

This visual function was identified as being important in all military operational flying operations, particularly in conditions of low visual contrast such as flying over snow or water, at dawn or dust, or in minimum meteorological conditions. This data highlights the importance of further research and standardization in this area.

Glare

Glare is a continuing operational problem in CF flying operations. Direct, solar glare is an unavoidable problem which requires ongoing research and development of optimal visual filters and protection by visors and sunglasses. Reflected or veiling glare is a particular problem, interfering with CRT visualization in the Griffon and Aurora.

RECOMMENDATIONS

(1) CF visual standards should be validated against visual tests simulating those tasks deemed as most visually demanding by the CF pilots. These tests are characterized by low contrast, low illumination, high noise and small depth/motion detection threshold. Operational conditions most representative of these tasks would be:

- contrast level representative of NVG viewing under low illumination (quarter moon or less);
- contrast level and visual noise associated with the detection of target and smoke in forested area and rough sea during day, night unaided and NVG viewing conditions;
- illumination and contrast level detection representative of landing under minimum meteorological conditions; and,
- illumination, contrast and motion threshold detection for shipboard landing under rough and calm sea during day and night time.

(2) Glare sensitivity should be included in the visual testing of all aircrew candidates and for those pilots of 40 years or over.

(3) Further research should be directed to contrast sensitivity as an important visual parameter. Contrast sensitivity should be included in aircrew vision screening, and standards developed based on objective testing.

(4) Consideration should be given to relocating the Griffon Flight Data CRT on the front instrument panel.

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Table 1 RETURN RATE (PERCENTAGE) BY RANK

Rank	Survey count (Oct 1997)	NDHQ count (April 1997)	Percentage
Captain	520	927	54
Major	196	348	56
Lieutenant Colonel	72	115	63
Colonel	15	36	41
General	4	4	100

Table 2 FREQUENCY DISTRIBUTION NAD PERCENTAGE OF CURRENT REGUALAR AND RESERVE FORCE PILOTS IN 10 OPERATIONAL ROLES

Operational role	Regular Op	Regular Staff	Reserve Op	Reserve Staff	Total	Percentage
Tactical Helicopter	111	34	26	3	176	21.6%
Search & Rescue RW	24	8	0	0	32	3.9%
Search & Rescue FW*	4	0	1	0	5	0.6%
Maritime Patrol RW	59	13	2	0	77	9.5%
Maritime Patrol FW	60	12	0	1	76	9.4%
Transport	101	29	11	2	143	17.6%
Fighter	96	43	3	2	149	18.3%
Jet Trainer	50	3	0	0	53	6.5%
Primary Trainer FW	0	0	0	1	1	0.1%
Primary Trainer RW	12	1	0	0	13	1.6%
Unknown	38	38	1	7	88	10.8%

*Twin Otter pilots only

As some pilots might may have neglected to provide either their force or their position the total might not reflect the sum of the counts for each operational role

Table 3 FREQUENCY DISTRIBUTION OF AGE GROUPS BY RANK

	Number of respondents by age group			
Rank	20-29	30-39	40-49	50-55
Captain	156	288	64	10
Major	•	67	103	26
Lieutenant Colonel	•	6	42	24
Colonel	•	•	11	3
General Officers	•	•	2	2

Table 4 FREQUENCY DISTRIBUTION OF EXPERIENCE LEVEL IN (a) Military Rotary Wing (MRW) AND (b) Military Fixed Wing (MFW)

4a. **MRW**

Experience Level (hrs)	Rank				
	Captain	Major	Lieutenant Colonel	Colonel	General Officer
200-1000	57	5	1	•	•
1000-2500	118	30	2	•	1
2500-5000	48	52	22	3	•
> 5000	6	9	1	1	1
Total	229	96	26	4	2
Average (hrs)	1000-2500	2500-5000	2500-5000	2500-5000	2500-5000
Average Overall (hrs)			1000-2500 hrs		

4b. **MFW**

Experience Level (hrs)	Rank				
	Captain	Major	Lieutenant Colonel	Colonel	General Officer
200-1000	128	39	14	4	1
1000-2500	144	25	8	•	•
2500-5000	119	60	28	5	3
> 5000	29	43	15	5	•
Total	420	167	65	14	4
Average (hrs)	1000-2500	2500-5000	2500-5000	2500-5000	2500-5000
Average Overall (hrs)			2500-5000		

Table 5 FREQUENCY DISTRIBUTION OF OPERATIONAL KNOWLEDGE IN 9 OPERATIONAL ROLES

Operational role	Count
Tactical Helicopter	195
Search & Rescue RW	62
Maritime Patrol RW	104
Maritime Patrol FW	104
Transport	194
Fighter	99
Jet Trainer	50
Primary Trainer FW	91
Primary Trainer RW	46

Table 6

TOTAL NUMBER OF VISUAL TASKS TO BE RATED IN 9 OPERATIONAL ROLES

Operational role	**# of tasks to rate**
Tactical Helicopter	61
Search & Rescue RW	65
Maritime Patrol RW	55
Maritime Patrol FW	28
Transport	26
Fighter	38
Jet Trainer	13
Primary Trainer FW	11
Primary Trainer RW	17

Table 7 RATIO OF TASKS RATED AS "DIFFICULT" OR "VERY DIFFICULT" BY GROUP OF TASKS FOR EACH OPERATIONAL ROLE

Operational Role	Groups of tasks									
	VFR Flying	Formation	Approaches	Landing	Hover	Hoist/Sling	Target Detection	Smoke Detection	Traffic Ident	Runway lights Ident
Tactical Helicopter	3/10	2/3	2/9	0/7	1/8	0/5	2/6	2/6	0/3	0/4
Search & Rescue RW	1/6	1/3	2/9	0/7	1/8	1/5	4/10	2/10	0/3	0/4
	VFR Flying	Formation	Approaches	Landing	Hover	Hoist/Sling	Target Detection	Smoke Detection	Ship Ident	Ship lights Ident
Maritime Patrol RW	2/12	0/3	3/10	1/6	1/6	1/7	2/6	1/6	0/2	3/4

	VFR Flying	Approaches	Landing	Target Detection	Smoke Detection	Traffic Ident	Runway lights Ident
Maritime Patrol FW	4/8	0/2	0/3	3/6	4/6	0/3	0/4

	Formation	Air Refuelling	Approaches	Landing	Low Level Dropping	Low AltPara Extraction	Traffic Ident	Runway lights Ident
Transport	1/3	1/2	0/2	0/3	0/6	1/2	0/3	0/4

	VFR Flying	Formation	Air Refuelling	Approaches	Landing	Target Detec Air/Ground	Target Detection Air/Air	Bombing	Intercept	Traffic Ident	Runway lights Ident
Fighter	1/4	0/3	0/3	0/2	0/6	1/3	0/3	0/3	0/3	0/3	0/4

	VFR Flying	Formation	Approaches	Landing	Traffic Ident	Runway lights Ident
Jet Trainer	0/4	1/2	0/2	0/2	0/3	0/4

	Approaches	Landing	Hovering	Traffic Ident	Runway lights Ident
Primary Trainer RW	1/8	0/3	0/2	0/3	0/3

	Approaches	Landing	Traffic Ident	Runway lights Ident
Primary Trainer FW	0/3	0/3	0/3	0/3

Table 8a-h MEAN RATING OF THE TASKS CONSIDERED AS THE MOST DIFFICULT (shadowed in gray) AND FRIEDMAN RANKING (FR) VALUE FORTHE FIRST 50TH PERCENTILE OF THE HARDEST MOST COMMON TASKS

(N) is the number of individual who provided input (G) is the number of tasks most commonly performed

8a TACTICAL HELICOPTER

#	Tasks	Mean rating	Std Dev	Count	FR N=55 G=53	p-value >0.001
9	NOE NVG flat terrain	2	1	108	•	
10	NOE NVG rough terrain	2	1	107	•	
12	Formation night unaided	2	1	93	•	
13	Formation NVG	2	1	83	•	
37	Hover NVG water	2	1	129	12	
52	Smoke detection night unaided forested area	2	1	140	13	
44	Target detection day forested area	2	1	163	15	
46	Target detection night unaided forested area	2	1	151	15	
4	VFR night unaided rough terrain	2	1	195	16	
51	Smoke detection night unaided open field	2	1	140	16	
17	Tactical approach NVG	2	1	125	18	
33	Hover night unaided flat terrain	3	1	173	18	
20	Glide path approach night unaided single light	2	1	193	20	
35	Hover NVG flat terrain	3	1	130	20	
45	Target detection night unaided open field	2	1	151	21	
6	NVG rough terrain	3	1	138	21	
32	Hover water day	3	1	172	21	
54	Smoke detection NVG forested area	3	1	125	21	
5	NVG flat terrain	3	1	139	23	
25	Landing NVG	3	1	137	23	
29	Confined area NVG	3	1	149	23	
50	Smoke detection day forested area	3	1	165	23	
3	VFR night unaided flat terrain	3	1	193	24	
15	Approach VFR min meteo night unaided (1000', 3 miles)	3	1	193	25	
39	Hoist NVG	3	1	101	25	
43	Target detection day open field	3	1	164	25	
47	Target detection NVG open field	3	1	134	26	
48	Target detection NVG forested area	3	1	133	26	
53	Smoke detection NVG open field	3	1	125	26	

8b SEARCH & RESCUE ROTARY WING

33	Hover NVG water	1	1	19	•
8	Formation night unaided	2	1	10	•
16	Glide path approach night unaided single light	2	1	55	•
38	Sling NVG	2	1	5	•
48	Target detection NVG rough water	2	1	22	•
56	Smoke detection NVG forested area	2	1	20	•
58	Smoke detection NVG rough water	2	1	18	•
44	Target detection night unaided forested area	2	1	56	7
53	Smoke detection night unaided open field	2	1	57	9
4	VFR night unaided rough terrain	2	1	62	10
42	Target detection day rough water	2	1	56	10
15	Glide path approach night unaided T-Y lights	3	1	44	10
43	Target detection night unaided open field	2	1	56	11
28	Hover day water	3	1	62	14
40	Target detection day forested area	3	1	58	14
3	VFR night unaided flat terrain	3	1	61	15
11	Approach VFR min meteo night unaided (1000', 3 miles)	3	1	62	15
30	Hover night unaided rough terrain	3	1	60	15
20	Landing night unaided	3	1	62	17
29	Hover night unaided flat terrain	3	1	61	17
59	Traffic pattern identification day position light	3	1	61	17
41	Target detection day calm water	3	1	56	18
65	Runway lights identification night unaided bad weather	3	1	62	18
52	Smoke detection day rough water	3	1	56	19
63	Runway lights identification day bad weather	3	1	62	19
10	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	62	20
62	Runway lights identification day good weather	3	1	61	20
60	Traffic pattern identification night unaided position light	4	1	61	22
24	Confined area day	4	1	60	23
50	Smoke detection day forested area	4	1	60	23

8c MARITIME PATROL ROTARY WING

#	Tasks	Mean rating	Std Dev	Count	FR N=79 G=36	p-value >0.001
18	Approach NVG ship rough sea	2	1	4	•	
37	Sling NVG	2	1	4	•	
22	Landing night unaided ship rough sea	2	1	102	9	
41	Target detection night unaided rough sea	2	1	99	9	
53	Ship identification night by light bad weather	2	1	102	9	
8	VFR night unaided low level rough sea	2	1	97	11	
16	Approach night unaided ship rough sea	2	1	102	11	
28	Hover night unaided rough sea	2	1	102	11	
7	VFR night unaided low level calm sea	2	1	97	12	
27	Hover night unaided calm sea	2	1	102	12	
47	Smoke detection night unaided rough sea	2	1	100	12	
40	Target detection night unaided calm sea	2	1	100	13	
15	Approach night unaided ship calm sea	2	1	104	14	
51	Ship identification day by light bad weather	2	1	100	15	
52	Ship identification night by light good weather	2	1	102	15	
55	Ship identification shape day bad weather	3	1	103	15	
5	VFR night unaided calm sea	3	1	102	16	
6	VFR night unaided rough sea	3	1	103	16	
39	Target detection day rough sea	3	1	100	17	
21	Landing night unaided ship calm sea	3	1	102	18	
45	Smoke detection day rough sea	3	1	101	18	
46	Smoke detection night unaided calm sea	3	1	100	18	
20	Landing day ship rough sea	3	1	103	19	

(N) is the number of individual who provided input

(G) is the number of tasks most commonly performed

8d TRANSPORT

#	Tasks	Mean rating	Std Dev	Count	FR N=47 G=15	p-value >0.001
2	Air refueling night unaided	2	1	25	•	
13	Low altitude parachute extraction NVG	2	2	7	•	
7	Formation night unaided	2	1	73	2	
15	Low level dropping cargo night unaided	3	1	85	5	
23	Runway lights identification night unaided good weather	4	1	189	5	
18	Low level dropping paratroopers night unaided	3	1	87	6	
21	Runway lights identification day good weather	4	1	187	6	
10	Landing night unaided	4	1	187	8	
24	Traffic pattern identification by shape day	4	1	187	8	
26	Traffic pattern identification by lights night unaided	4	1	181	8	

8e MARITIME PATROL FIXED WING

#	Tasks	Mean rating	Std Dev	Count	FR N=75 G=21	p-value >0.001
6	NVG rough sea	1	1	4	•	
5	NVG calm sea	2	2	4	•	
14	Target detection NVG calm sea	2	1	21	•	
15	Target detection NVG rough sea	2	1	21	•	
20	Smoke detection NVG calm sea	2	1	8	•	
21	Smoke detection NVG rough sea	2	1	8	•	
19	Smoke detection night unaided rough sea	2	1	99	4	
13	Target detection night unaided rough sea	2	1	101	5	
17	Smoke detection day rough sea	2	1	101	6	
3	VFR night unaided low level calm sea	2	1	102	7	
4	VFR night unaided low level rough sea	2	1	102	7	
11	Target detection day rough sea	3	1	91	8	
18	Smoke detection night unaided calm sea	3	1	101	8	
12	Target detection night unaided calm sea	3	1	100	9	
27	Runway lights identification night unaided bad weather	3	1	101	11	

8f FIGHTER

#	Tasks	Mean rating	Std Dev	Count	FR N=41 G=29	p-value >0.001
4	NVG low level rough terrain	2	2	5	•	
18	Cable landing NVG	3	2	4	•	
23	Target detection air/ground through HUD night unaided	2	1	67	6	
6	Formation night unaided	3	1	88	10	
9	Air refueling night unaided	3	1	67	10	
19	Target detection air/air through HUD day	3	1	79	10	
26	Bombing air/air through HUD night unaided	3	1	54	11	
12	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	105	12	
11	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	107	13	
17	Cable landing night unaided	3	1	71	13	
22	Target detection air/ground through HUD day	3	1	83	13	
29	Air intercept air/air through HUD night unaided	3	1	85	13	
2	VFR day low level rough terrain	3	1	107	14	
31	ACM flat light	3	1	83	14	
36	Runway lights identification day good weather	3	1	106	14	
32	Traffic pattern identification by shape day	4	1	101	14	
38	Runway lights identification night unaided good weather	4	1	106	14	
18	Cable landing NVG	3	2	4	15	
33	Traffic pattern identification position light day	3	1	106	15	
35	Runway lights identification day bad weather	3	1	106	15	

8g JET TRAINER

#	Tasks	Mean rating	Std Dev	Count	FR N=96 G=11	p-value >0.001
2	Formation night unaided	2	1	121	•	
4	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	121	4	
11	Runway lights identification day bad weather	3	1	116	4	
3	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	118	5	
13	Runway lights identification night unaided bad weather	3	1	117	5	
6	Landing night unaided	4	1	115	6	
7	Traffic pattern identification position light day	4	1	105	6	
8	Traffic pattern identification position light night unaided	4	1	106	6	
10	Runway lights identification day good weather	4	1	113	6	

8h PRIMARY TRAINER ROTARY WING

#	Tasks	Mean rating	Std dev	Count	FR N=27 G=17	p-value >0.001
6	Glide path approach night unaided single light	2	1	42	3	
2	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	45	5	
11	Traffic pattern identification position light day	3	1	44	6	
15	Runway lights identification day bad weather	3	1	43	6	
5	Glide path approach night unaided T-Y lights	3	1	42	7	
17	Runway lights identification night unaided bad weather	3	1	44	8	
1	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	4	1	46	9	
8	Landing night unaided	4	1	45	9	
13	Traffic pattern identification by shape day	4	1	41	9	

Table 9 a-b RATING OF THE ACCEPTABILITY OF THE EFFECTS OF GLARE ON THE PERFORMANCE OF GENERAL VISUAL TASKS AND KRUSKAL-WALLIS MEAN RANK (a) In 7 main operational groups (b) by airframes

9.a By operational groups

Operational role	Wholly unacceptable	Unacceptable	Borderline	Acceptable	Wholly acceptable	Total count	KW Mean Rank	Mean Rating
Maritime Patrol FW	3	16	31	22	0	73	306	Borderline
Maritime Patrol RW	6	16	27	28	0	77	309	Borderline
Search & Rescue RW	0	5	18	8	4	31	311	Borderline
Tactical Helicopter	11	35	46	65	24	161	330	Borderline
Transport	7	34	34	64	1	147	352	Borderline
Fighter	6	22	45	65	8	147	373	Borderline
Jet trainer	0	6	14	30	9	52	417	Borderline

Kruskal Wallis (KW) p- value 0.0054

9.b By airframes

Airframe	Wholly unacceptable	Unacceptable	Borderline	Acceptable	Wholly acceptable	Total count	KW Mean Rank	Mean Rating
CH-124 Sea King	5	13	21	24	0	63	233	Borderline
CP-140 Aurora	2	13	27	20	1	63	234	Borderline
CH-113 Labrador	0	4	11	7	0	22	239	Borderline
CH-146 Griffon	8	22	34	47	3	114	250	Borderline
CC-130 Hercules	4	11	17	20	4	56	253	Borderline
CT-133 Silver Star	0	7	12	11	2	32	258	Borderline
CC/CT-142 Dash 8	1	6	4	10	1	22	259	Borderline
CF-188 Hornet	4	9	25	36	4	78	281	Borderline
CT-114 Tutor	0	6	14	30	2	52	309	Acceptable
CC-144 A/B Challenger	0	2	1	16	1	20	358	Acceptable

Kruskal Wallis (KW) p- value 0.0028

Table 10 MANN-WITNEY* AND KRUSKAL-WALLIS† MEAN RANK OF THE ACCEPTABILITY/UNACCEPTABILITY OF THE EFFECTS OF GLARE ON THE PERFORMANCE OF GENERAL VISUAL TASKS FOR DEMOGRAPHIC VARIABLES SUCH AS SPECTACLES, CONTACT LENSES AND AGE GROUP

Variables	Status	Count	Mean Rank	p-value
*Spectacles	Wear	218	335	0.48
	Don't wear	465	345	
*Contact lenses	Wear	43	336	0.55
	Don't wear	596	319	
†Age group	20-29	156	409	0.06
	30-39	339	398	
	40-49	212	360	
	50-55	64	355	

Table 11 RATING OF THE ACCEPTABILITY OF THE EFFECTS OF GLARE ON THE READING OF CRTS

Airframe	Wholly unacceptable	Unacceptable	Borderline	Acceptable	Wholly acceptable	Total count	KW Mean Rank	Mean Rating
CP-140 Aurora	9	17	6	6	1	39	77	Unacceptable
CH-146 Griffon	7	29	26	18	1	81	101	Borderline
CC/CT-142 Dash 8	0	5	5	10	1	21	140	Borderline
CF-188 Hornet	3	8	23	34	9	77	151	Borderline
CC-144 A/B Challenger	0	0	6	10	3	19	173	Acceptable
CC-137 Airbus	0	0	0	2	1	3	205	Acceptable
Total	19	62	66	82	16	245		

Kruskal Wallis (KW) p- value <0.0001

Table 12

MANN-WITNEY* AND KRUSKAL-WALLIS[†] MEAN RANK OF THE ACCEPTABILITY/UNACCEPTABILITY OF THE EFFECTS OF GLARE ON THE READING OF CRT FOR DEMOGRAPHIC VARIABLES SUCH AS SPECTACLES, CONTACT LENSES AND AGE GROUP

Variables	Status	Count	Mean Rank	p-value
*Spectacles	Wear	69	116	0.20
	Don't wear	146	104	
*Contact lenses	Wear	20	102	0.79
	Don't wear	176	98	
†Age group	20-29	52	138	0.18
	30-39	118	114	
	40-49	65	124	
	50-55	9	133	

Table 13

FREQUENCY DISTRIBUTION KW MEAN RATING AND OSST P-VALUES FOR THE RATING OF GLARE ON HUD READING BY AGE GROUP

Age Group	Wholly unacceptable	Unacceptable	Borderline	Acceptable	Wholly acceptable	Total count	Mean Rating	KW Mean Rank	OSST p-value for test value unacceptable
20-29	2	2	3	9	2	18	Borderline	44	0.0042
30-39	6	8	12	9	4	39	Borderline	36	0.0009
40-49	4	3	4	4	2	17	Borderline	34	0.18
Total	12	13	19	23	8	75		p-value (0.18)	

Table 14 OVERALL MEAN RATING OF THE IMPORTANCE OF CONTRAST SENSITIVITY IN 16 VISUAL TASKS AND FRIEDMAN RANKING RESULTS FOR THE MOST COMMON TASKS IN 7 OPERATIONAL ROLES

		All opeational role confounded					FR by Current Operational role (p-value <0.0001)						
#	Tasks	Mean rating	Std Dev	Min	Max	Count	Tac Hel N=102 G=13	S&RRW N=22 G=9	MPRW N=69 G=6	MPFW N=60 G=6	TSPT N=88 G=6	FGT N=84 G=11	JTRG N=42 G=6
7	Low level flying over snow	5	1	1	5	612	9	6	•	•	5	8	•
11	NOE NVG	5	1	1	5	150	9	•	•	•	•	•	•
3	Flying toward the sun	4	1	1	5	748	8	5	3	4	4	7	4
5	NVG flying	4	1	1	5	223	8	•	•	•	•	•	•
9	Low level flying over water	4	1	1	5	669	8	6	4	4	•	8	4
12	Landing in minimum meteo conditions	4	1	2	5	736	8	6	4	4	5	7	3
2	Dawn/dusk	4	1	2	5	750	7	5	4	3	4	7	4
6	Low level flying over fields	4	1	1	5	598	7	4	•	•	•	7	•
10	NOE flying	4	1	1	5	265	7	•	•	•	•	•	•
8	Low level flying in mountains	4	1	1	5	590	6	5	•	•	•	7	•
1	Broad day light	4	1	1	5	746	5	4	2	3	3	6	3
4	Night flying unaided	4	1	1	5	733	5	4	3	3	3	6	3
13	Formation flying	4	1	1	5	546	4	•	•	•	•	4	•
14	HUD flying day	4	1	1	5	134	•	•	•	•	•	6	•
15	HUD flying night unaided	4	1	1	5	132	•	•	•	•	•	6	•
16	HUD flying night NVG	4	1	1	5	29	•	•	•	•	•	•	•

(N) is the number of individual who provided input

(G) is the number of tasks operationally relevant

APPENDIX 1 VISUAL TASKS MEAN RATING IN 9 OPERATIONAL ROLES

1a. Tactical Helicopter

#	Tasks	Mean rating	Std Dev	Count	Min	Max
9	NOE NVG flat terrain	2	1	108	1	4
4	VFR night unaided rough terrain	2	1	195	1	5
10	NOE NVG rough terrain	2	1	107	1	5
12	Formation night unaided	2	1	93	1	5
13	Formation NVG	2	1	83	1	5
17	Tactical approach NVG	2	1	125	1	5
20	Glide path approach night unaided single light	2	1	193	1	5
37	Hover NVG water	2	1	129	1	5
44	Target detection day forested area	2	1	163	1	5
45	Target detection night unaided open field	2	1	151	1	5
46	Target detection night unaided forested area	2	1	151	1	5
51	Smoke detection night unaided open field	2	1	140	1	5
52	Smoke detection night unaided forested area	2	1	140	1	5
3	VFR night unaided flat terrain	3	1	193	1	5
5	NVG flat terrain	3	1	139	1	5
6	NVG rough terrain	3	1	138	1	5
7	NOE day flat terrain	3	1	174	1	5
8	NOE day rough terrain	3	1	173	1	5
14	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	195	1	5
15	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	193	1	5
19	Glide path approach night unaided T-Y lights	3	1	194	1	5
21	Glide path NVG T-Y lights	3	1	133	1	5
22	Glide path NVG single light	3	1	147	1	5
24	Landing night unaided	3	1	193	1	5
25	Landing NVG	3	1	137	1	5
27	Slope landing NVG	3	1	151	1	5
28	Confined area day	3	1	193	1	5
29	Confined area NVG	3	1	149	1	5
32	Hover water day	3	1	172	1	5
33	Hover night unaided flat terrain	3	1	173	1	5
34	Hover night unaided rough terrain	3	1	185	1	5
35	Hover NVG flat terrain	3	1	130	1	5
36	Hover NVG rough terrain	3	1	147	1	5
38	Hoist day	3	1	142	1	5
39	Hoist NVG	3	1	101	1	5
40	Sling day	3	1	172	1	5
41	Sling night unaided	3	1	170	1	5
42	Sling NVG	3	1	121	1	5
43	Target detection day open field	3	1	164	1	5
47	Target detection NVG open field	3	1	134	1	5
48	Target detection NVG forested area	3	1	133	1	5
50	Smoke detection day forested area	3	1	165	1	5
53	Smoke detection NVG open field	3	1	125	1	5
54	Smoke detection NVG forested area	3	1	125	1	5
55	Traffic pattern identification day position light	3	1	185	1	5
59	Runway lights identification day bad weather	3	1	132	1	5
61	Runway lights identification night unaided bad weather	3	1	132	1	5
16	Tactical approach day	4	1	190	1	5
18	Glide path approach day	4	1	170	1	5
23	Landing day	4	1	179	1	5
26	Slope landing day	4	1	192	1	5
30	Hover day flat terrain	4	1	194	1	5
31	Hover day rough terrain	4	1	179	1	5
49	Smoke detection day open field	4	2	165	1	5
56	Traffic pattern identification night unaided position light	4	1	186	1	5
57	Traffic pattern identification day shape	4	1	185	1	5
58	Runway lights identification day good weather	4	1	130	1	5
60	Runway lights identification night unaided good weather	4	1	132	1	5
1	VFR day flat terrain	4	1	193	2	5
2	VFR day rough terrain	4	1	194	2	5
11	Formation day	4	1	192	2	5

1b. Search & Rescue

#	Tasks	Mean rating	Std Dev	Count	Min	Max
33	Hover NVG water	1	1	19	1	3
38	Sling NVG	2	1	5	1	3
48	Target detection NVG rough water	2	1	22	1	4
56	Smoke detection NVG forested area	2	1	20	1	4
58	Smoke detection NVG rough water	2	1	18	1	4
4	VFR night unaided rough terrain	2	1	62	1	5
8	Formation night unaided	2	1	10	1	5
16	Glide path approach night unaided single light	2	1	55	1	5
42	Target detection day rough water	2	1	56	1	5
43	Target detection night unaided open field	2	1	56	1	5
44	Target detection night unaided forested area	2	1	56	1	5
6	NVG rough terrain	3	1	25	1	4
17	Glide path NVG T-Y lights	3	1	14	1	4
21	Landing NVG	3	1	25	1	4
23	Slope landing NVG	3	1	21	1	4
46	Target detection NVG forested area	3	1	23	1	4
47	Target detection NVG calm water	3	1	22	1	4
3	VFR night unaided flat terrain	3	1	61	1	5
5	NVG flat terrain	3	1	25	1	5
10	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	62	1	5
15	Glide path approach night unaided T-Y lights	3	1	44	1	5
18	Glide path NVG single light	3	1	21	1	5
20	Landing night unaided	3	1	62	1	5
25	Confined area NVG	3	1	23	1	5
28	Hover day water	3	1	62	1	5
29	Hover night unaided flat terrain	3	1	61	1	5
30	Hover night unaided rough terrain	3	1	60	1	5
37	Sling night unaided	3	1	37	1	5
40	Target detection day forested area	3	1	58	1	5
41	Target detection day calm water	3	1	56	1	5
52	Smoke detection day rough water	3	1	56	1	5
54	Smoke detection night unaided forested area	3	1	57	1	5
59	Traffic pattern identification day position light	3	1	61	1	5
62	Runway lights identification day good weather	3	1	61	1	5
35	Hoist NVG	3	1	11	2	4
11	Approach VFR min meteo night unaided (1000', 3 miles)	3	1	62	2	5
13	Tactical approach NVG	3	1	8	2	5
31	Hover NVG flat terrain	3	1	22	2	5
32	Hover NVG rough terrain	3	1	22	2	5
55	Smoke detection NVG open field	3	1	20	2	5
57	Smoke detection NVG calm water	3	1	18	2	5
63	Runway lights identification day bad weather	3	1	62	2	5
65	Runway lights identification night unaided bad weather	3	1	62	2	5
9	Formation NVG	3	0	1	3	3
19	Landing day	4	1	62	1	5
26	Hover day flat terrain	4	1	61	1	5
27	Hover day rough terrain	4	1	61	1	5
34	Hoist day	4	1	62	1	5
49	Smoke detection day open field	4	1	60	1	5
50	Smoke detection day forested area	4	1	60	1	5
51	Smoke detection day calm water	4	1	57	1	5
53	Smoke detection night unaided open field	4	1	57	1	5
64	Runway lights identification night unaided good weather	4	1	62	1	5
1	VFR day flat terrain	4	1	62	2	5
2	VFR day rough terrain	4	1	62	2	5
7	Formation day	4	1	30	2	5
14	Glide path approach day	4	1	61	2	5
22	Slope landing day	4	1	62	2	5
24	Confined area day	4	1	60	2	5
36	Sling day	4	1	62	2	5
39	Target detection day open field	4	1	58	2	5
45	Target detection NVG open field	4	1	23	2	5
60	Traffic pattern identification night unaided position light	4	1	61	2	5
61	Traffic pattern identification day shape	4	1	62	2	5
12	Tactical approach day	4	0.5	21	3	4

1c. **Maritime Patrol Rotary Wing**

#	Tasks	Mean rating	Std Dev	Count	Min	Max
8	VFR night unaided low level rough sea	2	1	8	1	4
16	Approach night unaided ship rough sea	2	1	5	1	4
22	Landing night unaided ship rough sea	2	1	102	1	4
7	VFR night unaided low level calm sea	2	1	97	1	5
15	Approach night unaided ship calm sea	2	1	102	1	5
18	Approach NVG ship rough sea	2	1	102	1	5
27	Hover night unaided calm sea	2	1	102	1	5
28	Hover night unaided rough sea	2	1	102	1	5
40	Target detection night unaided calm sea	2	1	100	1	5
41	Target detection night unaided rough sea	2	1	99	1	5
47	Smoke detection night unaided rough sea	2	1	100	1	5
51	Ship identification day by light bad weather	2	1	100	1	5
52	Ship identification night by light good weather	2	1	102	1	5
53	Ship identification night by light bad weather	2	1	102	1	5
37	Sling NVG	2	1	4	2	4
9	NVG calm sea	3	1	7	1	4
17	Approach NVG ship calm sea	3	1	4	1	4
29	Hover NVG calm sea	3	1	4	1	4
3	VFR day low level calm sea	3	1	104	1	5
5	VFR night unaided calm sea	3	1	103	1	5
6	VFR night unaided rough sea	3	1	97	1	5
10	NVG rough sea	3	1	8	1	5
11	NVG low level calm sea	3	1	7	1	5
12	NVG low level rough sea	3	1	104	1	5
20	Landing day ship rough sea	3	1	103	1	5
21	Landing night unaided ship calm sea	3	1	102	1	5
24	Landing NVG ship rough sea	3	2	2	1	5
31	Hoist day calm sea	3	1	102	1	5
36	Sling night unaided	3	1	69	1	5
39	Target detection day rough sea	3	1	100	1	5
45	Smoke detection day rough sea	3	1	101	1	5
46	Smoke detection night unaided calm sea	3	1	100	1	5
50	Ship identification day by light good weather	3	1	100	1	5
55	Ship identification shape day bad weather	3	1	103	1	5
23	Landing NVG ship calm sea	3	1	3	2	4
30	Hover NVG rough sea	3	1	5	2	4
33	Hoist NVG calm sea	3	2	2	2	5
43	Target detection NVG rough sea	3	1	8	2	5
49	Smoke detection NVG rough sea	3	1	4	2	5
1	VFR day calm sea	4	1	104	1	5
2	VFR day rough sea	4	1	104	1	5
4	VFR day low level rough sea	4	1	102	1	5
13	Approach day ship calm sea	4	1	103	1	5
14	Approach day ship rough sea	4	1	104	1	5
19	Landing day ship calm sea	4	1	103	1	5
25	Hover day calm sea	4	1	103	1	5
26	Hover day rough sea	4	1	103	1	5
32	Hoist day rough sea	4	1	101	1	5
35	Sling day	4	1	96	1	5
38	Target detection day calm sea	4	1	102	1	5
44	Smoke detection day calm sea	4	1	100	1	5
48	Smoke detection NVG calm sea	4	1	4	2	5
54	Ship identification shape day good weather	4	1	103	2	5
42	Target detection NVG calm sea	4	1	8	3	5
34	Hoist NVG rough sea	4	1	1	4	4

1d. Transport

#	Tasks	Mean rating	Std Dev	Count	Min	Max
2	Air refueling night unaided	2	1	25	1	5
7	Formation night unaided	2	1	73	1	4
13	Low altitude parachute extraction NVG	2	2	7	1	5
12	Low altitude parachute extraction day	3	1	17	1	5
15	Low level dropping cargo night unaided	3	1	85	1	5
18	Low level dropping paratroopers night unaided	3	1	87	1	5
20	Runway lights identification day bad weather	3	1	190	1	5
22	Runway lights identification night unaided bad weather	3	1	189	1	5
8	Formation NVG	3	1	3	2	3
19	Low level dropping paratroopers NVG	3	1	5	2	3
9	Landing day	4	1	192	1	5
10	Landing night unaided	4	1	187	1	5
14	Low level dropping cargo day	4	1	94	1	5
21	Runway lights identification day good weather	4	1	187	1	5
23	Runway lights identification night unaided good weather	4	1	189	1	5
24	Traffic pattern identification by shape day	4	1	187	1	5
25	Traffic pattern identification position light day	4	1	181	1	5
1	Air refueling day	4	1	25	2	5
6	Formation day	4	1	112	2	5
11	Landing NVG	4	1	4	2	4
17	Low level dropping paratroopers day	4	1	93	2	5
26	Traffic pattern identification position light night unaided	4	1	181	2	5
16	Low level dropping cargo NVG	4	1	4	3	4

1e. Maritime Patrol Fixed Wing

#	Tasks	Mean rating	Std Dev	Count	Min	Max
6	NVG rough sea	1	1	4	1	2
21	Smoke detection NVG rough sea	2	1	8	1	3
5	NVG calm sea	2	2	4	1	4
19	Smoke detection night unaided rough sea	2	1	99	1	4
20	Smoke detection NVG calm sea	2	1	8	1	4
3	VFR night unaided low level calm sea	2	1	102	1	5
4	VFR night unaided low level rough sea	2	1	102	1	5
13	Target detection night unaided rough sea	2	1	101	1	5
14	Target detection NVG calm sea	2	1	21	1	5
15	Target detection NVG rough sea	2	1	21	1	5
17	Smoke detection day rough sea	2	1	101	1	5
18	Smoke detection night unaided calm sea	3	1	101	1	4
8	Landing night unaided	3	1	98	1	5
11	Target detection day rough sea	3	1	91	1	5
12	Target detection night unaided calm sea	3	1	100	1	5
25	Runway lights identification day bad weather	3	1	101	1	5
27	Runway lights identification night unaided bad weather	3	1	101	1	5
1	VFR day low level calm sea	4	1	103	1	5
7	Landing day	4	1	101	1	5
9	Landing NVG	4	1	15	1	5
10	Target detection day calm sea	4	1	102	1	5
16	Smoke detection day calm sea	4	1	100	1	5
22	Traffic pattern identification by lights day	4	1	90	1	5
23	Traffic pattern identification by lights night unaided	4	1	90	1	5
24	Traffic pattern identification by shape day	4	1	103	1	5
26	Runway lights identification day good weather	4	1	100	1	5
28	Runway lights identification night unaided good weather	4	1	101	1	5
2	VFR day low level rough sea	4	1	102	2	5

1f. **Fighter**

#	Tasks	Mean rating	Std Dev	Count	Min	Max
4	NVG low level rough terrain	2	2	5	1	5
23	Target detection air/ground through HUD night unaided	2	1	67	1	5
2	VFR day low level rough terrain	3	1	107	1	5
3	NVG low level flat terrain	3	2	5	1	5
6	Formation night unaided	3	1	88	1	5
7	Formation NVG	3	2	5	1	5
9	Air refueling night unaided	3	1	67	1	5
11	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	107	1	5
12	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	105	1	5
14	Landing night unaided	3	1	106	1	5
15	Landing NVG	3	1	6	1	5
17	Cable landing night unaided	3	1	71	1	5
18	Cable landing NVG	3	2	4	1	4
19	Target detection air/air through HUD day	3	1	79	1	5
20	Target detection air/air through HUD night unaided	3	1	76	1	5
22	Target detection air/ground through HUD day	3	1	83	1	5
26	Bombing air/air through HUD night unaided	3	1	54	1	5
29	Air intercept air/air through HUD night unaided	3	1	85	1	5
31	ACM flat light	3	1	83	1	5
33	Traffic pattern identification position light day	3	1	106	1	5
34	Traffic pattern identification position light night unaided	3	1	104	1	5
35	Runway lights identification day bad weather	3	1	106	1	5
36	Runway lights identification day good weather	3	1	106	1	5
37	Runway lights identification night unaided bad weather	3	1	106	1	5
21	Target detection air/air through HUD NVG	3	1	4	2	5
24	Target detection air/ground through HUD NVG	3	1	4	2	4
30	Air intercept air/air through HUD NVG	3	1	8	2	5
1	VFR day low level flat terrain	4	1	107	1	5
8	Air refueling day	4	1	80	1	5
10	Air refueling NVG	4	1	6	1	5
25	Bombing air/air through HUD day	4	1	79	1	5
28	Air intercept air/air through HUD day	4	1	99	1	5
38	Runway lights identification night unaided good weather	4	1	106	1	5
5	Formation day	4	1	107	2	5
13	Landing day	4	1	107	2	5
16	Cable landing day	4	1	80	2	5
32	Traffic pattern identification by shape day	4	1	101	2	5
27	Bombing air/air through HUD NVG	4	1	3	3	5

1g. **Jet Trainer**

#	Tasks	Mean rating	Std Dev	Count	Min	Max
2	Formation night unaided	2	1	139	1	5
3	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	118	1	5
4	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	121	1	5
11	Runway lights identification day bad weather	3	1	116	1	5
13	Runway lights identification night unaided bad weather	3	1	117	1	5
6	Landing night unaided	4	1	115	1	5
7	Traffic pattern identification position light day	4	1	105	1	5
10	Runway lights identification day good weather	4	1	113	1	5
12	Runway lights identification night unaided good weather	4	1	117	1	5
1	Formation day	4	1	121	2	5
5	Landing day	4	1	121	2	5
8	Traffic pattern identification position light night unaided	4	1	106	2	5
9	Traffic pattern identification by shape day	4	1	110	2	5

1h. **Primary Trainer Fixed Wing**

#	Tasks	Mean rating	Std Dev	Count	Min	Max
5	Traffic pattern identification position light day	3	1	87	1	5
9	Runway lights identification day bad weather	3	1	89	1	5
11	Runway lights identification night unaided bad weather	3	1	89	1	5
1	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	4	1	91	1	5
2	Approach VFR min meteo night unaided (1000' , 3 miles)	4	1	88	1	5
4	Landing night unaided	4	1	90	1	5
6	Traffic pattern identification position light night unaided	4	1	87	1	5
10	Runway lights identification night unaided good weather	4	1	90	1	5
3	Landing day	4	1	91	2	5
7	Traffic pattern identification by shape day	4	1	89	2	5
8	Runway lights identification day good weather	4	1	88	2	5

1i. **Primary Trainer Rotary Wing**

#	Tasks	Mean rating	Std Dev	Count	Min	Max
6	Glide path approach night unaided single light	2	1	42	1	5
2	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	45	1	4
5	Glide path approach night unaided T-Y lights	3	1	42	1	5
15	Runway lights identification day bad weather	3	1	43	1	5
11	Traffic pattern identification position light day	3	1	44	2	5
17	Runway lights identification night unaided bad weather	3	1	44	2	5
12	Traffic pattern identification position light night unaided	4	1	40	1	5
14	Runway lights identification day good weather	4	1	42	1	5
1	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	4	1	46	2	5
4	Glide path approach day	4	1	44	2	4
8	Landing night unaided	4	1	45	2	5
9	Hover day	4	1	44	2	5
10	Hover night unaided	4	1	44	2	5
13	Traffic pattern identification by shape day	4	1	41	2	5
3	Tactical approach (day)	4	1	37	3	5
16	Runway lights identification night unaided good weather	4	1	45	3	5
7	Landing day	5	1	46	2	5

APPENDIX 2

FRIEDMAN RANKING OF THE MOST COMMON VISUAL TASKS IN NINE (9) OPERATIONAL ROLES

(N) is the number of individual who provided input and (G) is the number of tasks most commonly performed

2a. Tactical Helicopter

#	Tasks	Mean rating	Std Dev	Count	FR N=55 G=53	p-value >0.001
9	NOE NVG flat terrain	2	1	108	•	
10	NOE NVG rough terrain	2	1	107	•	
12	Formation night unaided	2	1	93	•	
13	Formation NVG	2	1	83	•	
59	Runway lights identification day bad weather	3	1	132	•	
61	Runway lights identification night unaided bad weather	3	1	132	•	
57	Traffic pattern identification day shape	4	1	185	•	
58	Runway lights identification day good weather	4	1	130	•	
60	Runway lights identification night unaided good weather	4	1	132	•	
37	Hover NVG water	2	1	129	12	
52	Smoke detection night unaided forested area	2	1	140	13	
44	Target detection day forested area	2	1	163	15	
46	Target detection night unaided forested area	2	1	151	15	
4	VFR night unaided rough terrain	2	1	195	16	
51	Smoke detection night unaided open field	2	1	140	16	
17	Tactical approach NVG	2	1	125	18	
33	Hover night unaided flat terrain	3	1	173	18	
20	Glide path approach night unaided single light	2	1	193	20	
35	Hover NVG flat terrain	3	1	130	20	
45	Target detection night unaided open field	2	1	151	21	
6	NVG rough terrain	3	1	138	21	
32	Hover water day	3	1	172	21	
54	Smoke detection NVG forested area	3	1	125	21	
5	NVG flat terrain	3	1	139	23	
25	Landing NVG	3	1	137	23	
29	Confined area NVG	3	1	149	23	
50	Smoke detection day forested area	3	1	165	23	
3	VFR night unaided flat terrain	3	1	193	24	
15	Approach VFR min meteo night unaided (1000', 3 miles)	3	1	193	25	
39	Hoist NVG	3	1	101	25	
43	Target detection day open field	3	1	164	25	
47	Target detection NVG open field	3	1	134	26	
48	Target detection NVG forested area	3	1	133	26	
53	Smoke detection NVG open field	3	1	125	26	
22	Glide path NVG single light	3	1	147	27	
49	Smoke detection day open field	4	2	165	27	
21	Glide path NVG T-Y lights	3	1	133	28	
42	Sling NVG	3	1	121	28	
36	Hover NVG rough terrain	3	1	147	29	
41	Sling night unaided	3	1	170	29	
7	NOE day flat terrain	3	1	174	30	
8	NOE day rough terrain	3	1	173	30	
14	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	195	30	
24	Landing night unaided	3	1	193	30	
28	Confined area day	3	1	193	30	
38	Hoist day	3	1	142	30	
27	Slope landing NVG	3	1	151	31	
34	Hover night unaided rough terrain	3	1	185	31	
40	Sling day	3	1	172	32	
18	Glide path approach day	4	1	170	32	
19	Glide path approach night unaided T-Y lights	3	1	194	33	
23	Landing day	4	1	179	33	
30	Hover day flat terrain	4	1	194	34	
11	Formation day	4	1	192	36	
31	Hover day rough terrain	4	1	179	36	
16	Tactical approach day	4	1	190	37	
56	Traffic pattern identification night unaided position light	4	1	186	37	
55	Traffic pattern identification day position light	3	1	185	38	
2	VFR day rough terrain	4	1	194	40	
1	VFR day flat terrain	4	1	193	42	
26	Slope landing day	4	1	192	42	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

2b. Search & Rescue Helicopter

#	Tasks	Mean rating	Std Dev	Count	FR N=45 G=39	p-value >0.001
33	Hover NVG water	1	1	19	•	
8	Formation night unaided	2	1	10	•	
16	Glide path approach night unaided single light	2	1	55	•	
38	Sling NVG	2	1	5	•	
48	Target detection NVG rough water	2	1	22	•	
56	Smoke detection NVG forested area	2	1	20	•	
58	Smoke detection NVG rough water	2	1	18	•	
5	NVG flat terrain	3	1	25	•	
6	NVG rough terrain	3	1	25	•	
9	Formation NVG	3	1	1	•	
13	Tactical approach NVG	3	1	8	•	
17	Glide path NVG T-Y lights	3	1	14	•	
18	Glide path NVG single light	3	1	21	•	
21	Landing NVG	3	1	25	•	
23	Slope landing NVG	3	1	21	•	
25	Confined area NVG	3	1	23	•	
31	Hover NVG flat terrain	3	1	22	•	
32	Hover NVG rough terrain	3	1	22	•	
35	Hoist NVG	3	1	11	•	
37	Sling night unaided	3	1	37	•	
46	Target detection NVG forested area	3	1	23	•	
47	Target detection NVG calm water	3	1	22	•	
55	Smoke detection NVG open field	3	1	20	•	
57	Smoke detection NVG calm water	3	1	18	•	
7	Formation day	4	1	30	•	
12	Tactical approach day	4	0.5	21	•	
45	Target detection NVG open field	4	1	23	•	
54	Smoke detection night unaided forested area	3	1	57	6	
44	Target detection night unaided forested area	2	1	56	7	
53	Smoke detection night unaided open field	2	1	57	9	
4	VFR night unaided rough terrain	2	1	62	10	
42	Target detection day rough water	2	1	56	10	
15	Glide path approach night unaided T-Y lights	3	1	44	10	
43	Target detection night unaided open field	2	1	56	11	
28	Hover day water	3	1	62	14	
40	Target detection day forested area	3	1	58	14	
3	VFR night unaided flat terrain	3	1	61	15	
11	Approach VFR min meteo night unaided (1000', 3 miles)	3	1	62	15	
30	Hover night unaided rough terrain	3	1	60	15	
20	Landing night unaided	3	1	62	17	
29	Hover night unaided flat terrain	3	1	61	17	
59	Traffic pattern identification day position light	3	1	61	17	
41	Target detection day calm water	3	1	56	18	
65	Runway lights identification night unaided bad weather	3	1	62	18	
52	Smoke detection day rough water	3	1	56	19	
63	Runway lights identification day bad weather	3	1	62	19	
10	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	62	20	
62	Runway lights identification day good weather	3	1	61	20	
60	Traffic pattern identification night unaided position light	4	1	61	22	
24	Confined area day	4	1	60	23	
50	Smoke detection day forested area	4	1	60	23	
22	Slope landing day	4	1	62	24	
61	Traffic pattern identification day shape	4	1	62	24	
36	Sling day	4	1	62	25	
14	Glide path approach day	4	1	61	26	
34	Hoist day	4	1	62	26	
39	Target detection day open field	4	1	58	26	
51	Smoke detection day calm water	4	1	57	26	
2	VFR day rough terrain	4	1	62	27	
49	Smoke detection day open field	4	1	60	27	
1	VFR day flat terrain	4	1	62	28	
26	Hover day flat terrain	4	1	61	28	
27	Hover day rough terrain	4	1	61	28	
19	Landing day	4	1	62	29	
64	Runway lights identification night unaided good weather	4	1	62	29	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

2c. Maritime Patrol Rotary Wing

#	Tasks	Mean rating	Std Dev	Count	FR N=79 G=36	p-value >0.001
18	Approach NVG ship rough sea	2	1	4	•	
37	Sling NVG	2	1	4	•	
9	NVG calm sea	3	1	8	•	
10	NVG rough sea	3	1	7	•	
11	NVG low level calm sea	3	1	8	•	
12	NVG low level rough sea	3	1	7	•	
17	Approach NVG ship calm sea	3	1	5	•	
23	Landing NVG ship calm sea	3	1	3	•	
24	Landing NVG ship rough sea	3	2	2	•	
29	Hover NVG calm sea	3	1	4	•	
30	Hover NVG rough sea	3	1	5	•	
33	Hoist NVG calm sea	3	2	2	•	
36	Sling night unaided	3	1	69	•	
43	Target detection NVG rough sea	3	1	8	•	
49	Smoke detection NVG rough sea	3	1	4	•	
34	Hoist NVG rough sea	4	1	1	•	
42	Target detection NVG calm sea	4	1	8	•	
48	Smoke detection NVG calm sea	4	1	4	•	
22	Landing night unaided ship rough sea	2	1	102	9	
41	Target detection night unaided rough sea	2	1	99	9	
53	Ship identification night by light bad weather	2	1	102	9	
8	VFR night unaided low level rough sea	2	1	97	11	
16	Approach night unaided ship rough sea	2	1	102	11	
28	Hover night unaided rough sea	2	1	102	11	
7	VFR night unaided low level calm sea	2	1	97	12	
27	Hover night unaided calm sea	2	1	102	12	
47	Smoke detection night unaided rough sea	2	1	100	12	
40	Target detection night unaided calm sea	2	1	100	13	
15	Approach night unaided ship calm sea	2	1	104	14	
51	Ship identification day by light bad weather	2	1	100	15	
52	Ship identification night by light good weather	2	1	102	15	
55	Ship identification shape day bad weather	3	1	103	15	
5	VFR night unaided calm sea	3	1	102	16	
6	VFR night unaided rough sea	3	1	103	16	
39	Target detection day rough sea	3	1	100	17	
21	Landing night unaided ship calm sea	3	1	102	18	
45	Smoke detection day rough sea	3	1	101	18	
46	Smoke detection night unaided calm sea	3	1	100	18	
20	Landing day ship rough sea	3	1	103	19	
3	VFR day low level calm sea	3	1	104	20	
50	Ship identification day by light good weather	3	1	100	21	
32	Hoist day rough sea	4	1	101	23	
4	VFR day low level rough sea	4	1	104	25	
31	Hoist day calm sea	4	1	102	25	
1	VFR day calm sea	4	1	104	26	
25	Hover day calm sea	4	1	103	26	
26	Hover day rough sea	4	1	103	26	
38	Target detection day calm sea	4	1	102	26	
14	Approach day ship rough sea	4	1	103	27	
35	Sling day	4	1	96	27	
54	Ship identification shape day good weather	4	1	103	27	
13	Approach day ship calm sea	4	1	104	28	
19	Landing day ship calm sea	4	1	103	28	
44	Smoke detection day calm sea	4	1	100	28	
2	VFR day rough sea	4	1	104	29	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

2d. Transport

#	Tasks	Mean rating	Std Dev	Count	FR N=47 G=15	p-value >0.001
2	Air refueling night unaided	2	1	25	•	
13	Low altitude parachute extraction NVG	2	2	7	•	
8	Formation NVG	3	1	3	•	
12	Low altitude parachute extraction day	3	1	17	•	
19	Low level dropping paratroopers NVG	3	1	5	•	
1	Air refueling day	4	1	25	•	
11	Landing NVG	4	1	4	•	
16	Low level dropping cargo NVG	4	1	4	•	
7	Formation night unaided	2	1	73	2	
15	Low level dropping cargo night unaided	3	1	85	5	
23	Runway lights identification night unaided good weather	4	1	189	5	
18	Low level dropping paratroopers night unaided	3	1	87	6	
21	Runway lights identification day good weather	4	1	187	6	
10	Landing night unaided	4	1	187	8	
24	Traffic pattern identification by shape day	4	1	187	8	
26	Traffic pattern identification position light night unaided	4	1	181	8	
20	Runway lights identification day bad weather	3	1	190	9	
6	Formation day	4	1	112	10	
14	Low level dropping cargo day	4	1	94	10	
17	Low level dropping paratroopers day	4	1	93	10	
25	Traffic pattern identification position light day	4	1	181	10	
22	Runway lights identification night unaided bad weather	3	1	189	11	
9	Landing day	4	1	192	12	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

2e. Maritime Patrol Fixed Wing

#	Tasks	Mean rating	Std Dev	Count	FR N=75 G=21	p-value >0.001
6	NVG rough sea	1	1	4	•	
5	NVG calm sea	2	2	4	•	
14	Target detection NVG calm sea	2	1	21	•	
15	Target detection NVG rough sea	2	1	21	•	
20	Smoke detection NVG calm sea	2	1	8	•	
21	Smoke detection NVG rough sea	2	1	8	•	
9	Landing NVG	4	1	15	•	
19	Smoke detection night unaided rough sea	2	1	99	4	
13	Target detection night unaided rough sea	2	1	101	5	
17	Smoke detection day rough sea	2	1	101	6	
3	VFR night unaided low level calm sea	2	1	102	7	
4	VFR night unaided low level rough sea	2	1	102	7	
11	Target detection day rough sea	3	1	91	8	
18	Smoke detection night unaided calm sea	3	1	101	8	
12	Target detection night unaided calm sea	3	1	100	9	
27	Runway lights identification night unaided bad weather	3	1	101	11	
8	Landing night unaided	3	1	98	12	
2	VFR day low level rough sea	4	1	102	12	
26	Runway lights identification day good weather	4	1	100	12	
1	VFR day low level calm sea	4	1	103	13	
22	Traffic pattern identification by lights day	4	1	90	13	
23	Traffic pattern identification by lights night unaided	4	1	90	13	
25	Runway lights identification day bad weather	3	1	101	14	
10	Target detection day calm sea	4	1	102	14	
24	Traffic pattern identification by shape day	4	1	103	14	
16	Smoke detection day calm sea	4	1	100	15	
7	Landing day	4	1	101	16	
28	Runway lights identification night unaided good weather	4	1	101	16	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

2f. Fighter

#	Tasks	Mean rating	Std Dev	Count	FR N=41 G=29	p-value >0.001
4	NVG low level rough terrain	2	2	5	•	
3	NVG low level flat terrain	3	2	5	•	
7	Formation NVG	3	2	5	•	
18	Cable landing NVG	3	2	4	•	
15	Landing NVG	3	1	6	•	
20	Target detection air/air through HUD night unaided	3	1	76	•	
21	Target detection air/air through HUD NVG	3	1	4	•	
24	Target detection air/ground through HUD NVG	3	1	4	•	
30	Air intercept air/air through HUD NVG	3	1	8	•	
10	Air refueling NVG	4	1	6	•	
27	Bombing air/air through HUD NVG	4	1	3	•	
23	Target detection air/ground through HUD night unaided	2	1	67	6	
6	Formation night unaided	3	1	88	10	
9	Air refueling night unaided	3	1	67	10	
19	Target detection air/air through HUD day	3	1	79	10	
26	Bombing air/air through HUD night unaided	3	1	54	11	
12	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	105	12	
11	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	107	13	
17	Cable landing night unaided	3	1	71	13	
22	Target detection air/ground through HUD day	3	1	83	13	
29	Air intercept air/air through HUD night unaided	3	1	85	13	
2	VFR day low level rough terrain	3	1	107	14	
31	ACM flat light	3	1	83	14	
36	Runway lights identification day good weather	3	1	106	14	
32	Traffic pattern identification by shape day	4	1	101	14	
38	Runway lights identification night unaided good weather	4	1	106	14	
33	Traffic pattern identification position light day	3	1	106	15	
35	Runway lights identification day bad weather	3	1	106	15	
14	Landing night unaided	3	1	106	16	
34	Traffic pattern identification position light night unaided	3	1	104	17	
1	VFR day low level flat terrain	4	1	107	17	
25	Bombing air/air through HUD day	4	1	79	17	
5	Formation day	4	1	107	18	
8	Air refueling day	4	1	80	18	
28	Air intercept air/air through HUD day	4	1	99	18	
16	Cable landing day	4	1	80	19	
13	Landing day	4	1	107	20	
37	Runway lights identification night unaided bad weather	3	1	106	21	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

2g. Jet Trainer

#	Tasks	Mean rating	Std Dev	Count	FR N=96 G=11	p-value >0.001
2	Formation night unaided	2	1	121	•	
1	Formation day	4	1	139	•	
4	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	121	4	
11	Runway lights identification day bad weather	3	1	116	4	
3	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	3	1	118	5	
13	Runway lights identification night unaided bad weather	3	1	117	5	
6	Landing night unaided	4	1	115	6	
7	Traffic pattern identification position light day	4	1	105	6	
8	Traffic pattern identification position light night unaided	4	1	106	6	
10	Runway lights identification day good weather	4	1	113	6	
9	Traffic pattern identification by shape day	4	1	110	7	
12	Runway lights identification night unaided good weather	4	1	117	8	
5	Landing day	4	1	121	9	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

2h. Primary Trainer Fixed Wing

#	Tasks	Mean rating	Std dev	Count	FR N=83 G=11	p-value >0.001
5	Traffic pattern identification position light day	3	1	87	5	
9	Runway lights identification day bad weather	3	1	89	5	
11	Runway lights identification night unaided bad weather	3	1	89	5	
1	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	4	1	91	5	
2	Approach VFR min meteo night unaided (1000' , 3 miles)	4	1	88	5	
4	Landing night unaided	4	1	90	6	
6	Traffic pattern identification position light night unaided	4	1	87	6	
8	Runway lights identification day good weather	4	1	88	6	
7	Traffic pattern identification by shape day	4	1	89	7	
3	Landing day	4	1	91	8	
10	Runway lights identification night unaided good weather	4	1	90	8	

2i. Primary Trainer Rotary Wing

#	Tasks	Mean rating	Std dev	Count	FR N=27 G=17	p-value >0.001
6	Glide path approach night unaided single light	2	1	42	3	
2	Approach VFR min meteo night unaided (1000' , 3 miles)	3	1	45	5	
11	Traffic pattern identification position light day	3	1	44	6	
15	Runway lights identification day bad weather	3	1	43	6	
5	Glide path approach night unaided T-Y lights	3	1	42	7	
17	Runway lights identification night unaided bad weather	3	1	44	8	
1	Approach VFR min meteo day (clear of clouds, 1 mile, uncontrolled airspace)	4	1	46	9	
8	Landing night unaided	4	1	45	9	
13	Traffic pattern identification by shape day	4	1	41	9	
9	Hover day	4	1	44	10	
12	Traffic pattern identification position light night unaided	4	1	40	10	
3	Tactical approach (day)	4	1	37	11	
4	Glide path approach day	4	1	44	11	
14	Runway lights identification day good weather	4	1	42	11	
10	Hover night unaided	4	1	44	13	
16	Runway lights identification night unaided good weather	4	1	45	13	
7	Landing day	5	1	46	13	

(•) could not be included in the ranking as the number of individual with experience in these tasks was insufficient

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ABSTRACT

Introduction: DCIEM conducted an operational vision survey of current Canadian Forces pilots. The overall survey was designed to acquire information on operational vision requirements, visual aids, and clinical and administrative support. In Section I, Operational Visual Requirements, pilots in 9 different operational flying roles were asked to rank order from 11 to 65 different flying tasks for which they had operational experience. Information was also acquired about the importance of contrast sensitivity and the problems of glare in operational flying. **Results**: 1551 questionnaires were sent out. 813 questionnaires were completed and 200 returned "undelivered" for a response rate of 61% from those actually received. The average age was 37 years, range 24-54. The greatest number of tasks rated as "difficult" (D) or "very difficult" (VD) were in rotary wing flying. Tac Hel (TH) so identified 12 tasks in 6 of 10 groups. SAR RW had 12 tasks in 7 of 10 groups. Maritime patrol RW had 14 D or VD tasks in 8 task groups. In fixed wing operations, maritime patrol rated as the most challenging with 11 tasks in three groups rated as D or VD. Fighter operations were not generally rated as visually demanding with only 2 tasks in 11 task groups rated as D or VD. Tasks rated as D or VD were almost all related to operational flying such as NVGs, target or smoke detection, and not to general flying requirements. Contrast Sensitivity was identified by the pilot population as being important in all military flying operations, particularly in conditions of low visual contrast such as flying over snow or water, or at dawn or dusk. Glare is a continuing problem in CF flying operations. In particular, reflected glare was identified as a problem interfering with CRT visualization in the Griffon and Aurora.

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