Rhodes & Associates Inc.
HUMAN FACTORS CONSULTANTS

177 Jenny Wrenway, Toronto, Ont. M2H 2Z3
Phone: 416-494-2816 Fax: 416-494-0303
Email: wayne-rhodes@rogers.com

TP 13875E

Assessment of Aircraft Maintenance Engineers (AMEs) Hours of Work: Phase 1

Prepared for Transportation Development Centre

Transport Canada

by

Rhodes & Associates Inc.

October 2001

TP 13875E

Assessment of Aircraft Maintenance Engineers (AMEs) Hours of Work

by

Wayne Rhodes

Rhodes & Associates Inc.

October 2001

This report reflects the views of the author and not necessarily those of the Transportation Development Centre.

Un sommaire français se trouve avant la table des matières.

Transport Canada | Transports Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No. TP 13875E	2. Project No. 9995	3. Recipient's Catalogue No.
4. Title and Subtitle Assessment of Aircraft Maintenance Engineers (AMEs) Hours of Work: Phase 1		5. Publication Date January 2002
		6. Performing Organization Document No.
7. Author(s) Wayne Rhodes		8. Transport Canada File No. ZCD2450-B-333
9. Performing Organization Name and Address Rhodes & Associates Inc. 177 Jenny Wrenway Toronto, ON M2H 2Z3		10. PWGSC File No. MTB-0-01647
		11. PWGSC or Transport Canada Contract No. T8200-0-0536/001/MTB
12. Sponsoring Agency Name and Address Transportation Development Centre (TDC) 800 René Lévesque Blvd. West Suite 600 Montreal, Quebec H3B 1X9		13. Type of Publication and Period Covered Final
		14. Project Officer H. Posluns

15. Supplementary Notes (Funding programs, titles of related publications, etc.)

16. Abstract

This survey investigates several characteristics of the hours that aircraft maintenance engineers (AMEs) work, as well as AME fatigue and the strategies used to obtain sleep and maintain performance. Questionnaires were sent to 5000 AMEs throughout Canada, and 1209 were returned, completed. Twelve AMEs from various types of operations were interviewed to augment the data from the questionnaires. The main findings include:

- AMEs are working, on average, over 50 hours per week, when overtime is included;
- Many are extending 12-hour shifts, or working additional 12-hour shifts on days off; others are working 5 or more days of 10-hour shifts in a row;
- Many are working for long periods with very few days off for recovery;
- Some are working long shifts, back-to-back, with under 8 hours between for rest;
- A significant number of AMEs are working during days off, either doing overtime for a single employer, or doing additional shifts for another employer;
- Between 8 and 10 percent of AMEs in the major airlines, air taxi and rotary (helicopter) operations are working their longest reported shifts (a mean of 21 to 25 hours) more than 4 times per month;
- Fifty percent of the AMEs reported that overtime worked during the night shift had a strong negative effect on their work performance (another 30 percent reported a weak negative effect); and
- Planned naps are common in field operations, while opportunistic naps are often taken in hangar-based facilities.

17. Key Words Aircraft maintenance engineers, fatigue, fatigue countermeasures	18. Distribution Statement Limited number of copies available from the Transportation Development Centre

19. Security Classification (of this publication) Unclassified	20. Security Classification (of this page) Unclassified	21. Declassification (date) —	22. No. of Pages xxiv, 56, apps	23. Price Shipping/ Handling

CDT/TDC 79-005
Rev. 96

Canada

Transports Canada | Transport Canada

FORMULE DE DONNÉES POUR PUBLICATION

1. N° de la publication de Transports Canada TP 13875E	2. N° de l'étude 9995	3. N° de catalogue du destinataire
4. Titre et sous-titre Assessment of Aircraft Maintenance Engineers (AMEs) Hours of Work: Phase 1		5. Date de la publication Janvier 2002 6. N° de document de l'organisme exécutant
7. Auteur(s) Wayne Rhodes		8. N° de dossier - Transports Canada ZCD2450-B-333
9. Nom et adresse de l'organisme exécutant Rhodes & Associates Inc. 177 Jenny Wrenway Toronto, ON M2H 2Z3		10. N° de dossier - TPSGC MTB-0-01647 11. N° de contrat - TPSGC ou Transports Canada T8200-0-0536/001/MTB
12. Nom et adresse de l'organisme parrain Centre de développement des transports (CDT) 800, boul. René-Lévesque Ouest Bureau 600 Montréal (Québec) H3B 1X9		13. Genre de publication et période visée Final 14. Agent de projet H. Posluns

15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.)

16. Résumé

Cette étude porte sur les heures de travail des techniciens d'entretien d'aéronefs (TEA), sur la fatigue des TEA et sur les stratégies qu'ils utilisent pour dormir suffisamment afin de ne pas compromettre leur rendement. Des questionnaires ont été envoyés à 5 000 TEA partout au Canada. De ce nombre, 1 209 ont été retournés remplis. Pour compléter les données recueillies par les questionnaires, les chercheurs ont réalisé des entrevues avec douze TEA travaillant dans divers types d'exploitation. Voici un aperçu des résultats de l'enquête :

- en moyenne, les TEA travaillent plus de 50 heures par semaine, heures supplémentaires comprises;
- beaucoup font des heures supplémentaires en plus de leur quart de 12 heures, ou effectuent des quarts de 12 heures supplémentaires pendant leurs jours de congé; d'autres font des quarts de 10 heures pendant cinq jours consécutifs ou plus;
- beaucoup travaillent pendant de longs cycles et ont très peu de jours de congé pour récupérer;
- certains effectuent de longs quarts de travail, séparés par à peine 8 heures de repos;
- un grand nombre de TEA travaillent pendant leurs jours de congé, soit qu'ils fassent des heures supplémentaires pour leur employeur habituel, soit qu'ils effectuent des quarts supplémentaires pour un autre employeur;
- de 8 à 10 p. cent des TEA à l'emploi de grandes compagnies aériennes, d'exploitants de taxis aériens et d'exploitants d'hélicoptères effectuent leur plus longue période ininterrompue de travail (de 21 à 25 heures en moyenne) plus de quatre fois par mois;
- 50 p. cent des TEA ont déclaré que les heures supplémentaires ajoutées à un quart de nuit nuisent grandement à leur rendement au travail (un autre 30 p. cent a fait état d'un léger effet négatif);
- les siestes planifiées sont pratique courante lors des opérations menées sur le terrain; lorsque le travail est exécuté dans le hangar, les TEA s'accordent souvent des pauses pour dormir.

17. Mots clés Techniciens d'entretien d'aéronefs, fatigue, contre-mesures à la fatigue		18. Diffusion Le Centre de développement des transports dispose d'un nombre limité d'exemplaires.		
19. Classification de sécurité (de cette publication) Non classifiée	20. Classification de sécurité (de cette page) Non classifiée	21. Déclassification (date) —	22. Nombre de pages xxiv, 56, ann.	23. Prix Port et manutention

Acknowledgements

The author would like to thank the following people for their valuable insight and assistance:

- Jean Watson at the Office of Aviation Medicine at the U.S. Federal Aviation Administration;
- The Canadian Federation of Aircraft Maintenance Engineer Associations; and
- Air Transport Association of Canada.

The author also extends his gratitude to the aircraft maintenance engineers who gave their time and wisdom and who, through interviews, questionnaires and written narratives, provided the valuable information necessary to make this study possible.

The author thanks Jim McMenemey at Transport Canada's Safety Branch for his insights on application within the aviation safety environment.

Finally, the author is grateful to Jacqueline Booth-Bourdeau, senior technical program manager of the Aviation Maintenance Branch of Transport Canada, for her clarity of purpose and excellent guidance throughout the project.

Wayne Rhodes

President, Rhodes & Associates Inc.

October 15, 2001

Executive Summary

Background

Over the past decade several fatigue studies focusing on aviation have been conducted. These include a series of NASA studies on commercial pilots (Gander et al., 1998a and 1998b), as well as research on air traffic controllers (Rhodes et al., 1994 and 1996; Luna et al., 1997) and aviation maintenance technicians (Sian & Watson, 1999; Johnson et al., 2001). This research was initiated as a result of the recognition that many accidents attributed to human error were caused by fatigue-related performance deficits. The National Transportation Safety Board, the Canadian Aviation Safety Board (now the aviation division of the Transportation Safety Board of Canada), the U.S. Federal Aviation Authority (FAA) and the U.K. Civil Aviation Authority (CAA) have acknowledged that fatigue in aviation is a serious and pervasive problem, and must be better understood. These organizations have frequently recommended research on fatigue in aviation. The FAA in particular has undertaken several research efforts examining fatigue and its effects on aviation maintenance technicians (Watson, 1999).

In 1996 the Safety of Air Taxi Operations (SATOPS) task force recommended that Transport Canada "*...initiate a Canadian Aviation Regulation Advisory Council (CARAC) review to determine if AME duty times should be regulated, and if so, determine appropriate limitations*". This study was commissioned as a direct result of the SATOPs task force and represents the initial step in addressing the issue of fatigue in the aircraft maintenance environment.

The approach taken borrows from some of the FAA's work, but is tailored for the work environment of Canadian aircraft maintenance engineers (AMEs). The study focuses on the extent of hours of work, the impact of these hours on potential and reported levels of fatigue, and the amount of sleep obtained by AMEs. The study was conducted using a questionnaire and interviews.

Methodology

Transport Canada mailed the questionnaire, along with an envelope addressed to the contractor's business address, to 5000 AMEs. This approach ensured the complete confidentiality of the AMEs' information, a necessary component to guarantee reliable, valid data. Questionnaires were completed and returned by 1209 AMEs, and 12 AMEs were interviewed. The information on the questionnaires was entered into an Excel data file, and the analysis was performed using the Number Crunchers Statistical (NCSS) 2001 statistical package. The analysis was limited to basic descriptive and comparative statistical treatments.

Results

The main findings of the research are as follows:

- AMEs are working, on average, over 50 hours per week, when overtime is included;
- Many are extending 12-hour shifts, or working additional 12-hour shifts on days off; others are working 5 or more days in a row of 10-hour shifts;
- Many are working for long periods with very few days off for recovery;
- Some are working long shifts, back-to-back, with under 8 hours between for rest;
- A significant number of AMEs are working during days off, either doing overtime for a single employer, or doing additional shifts for another employer;
- AMEs working for rotary (helicopter) and air taxi services are working the highest number of hours;
- Airline and rotary AMEs work the most overtime;
- The highest levels of fatigue are reported by AMEs working for airlines, probably because of the high percentage of night work and long shifts;
- AMEs working shifts reported the highest levels of fatigue;
- The most continuous hours of work are reported by AMEs working for rotary operations;
- AMEs working on demand work more hours than those working shifts or standard days;
- Salaried AMEs work more hours than those paid by the hour;
- The longest shifts were reported by AMEs at rotary and charter operations;
- Between 8 and 10 percent of AMEs in the major airlines, air taxi and rotary operations are working their longest reported shifts (a mean of 21 to 25 hours) more than 4 times per month;
- Fifty percent of the AMEs reported that overtime worked during the night shift had a strong negative effect on their work performance (another 30 percent reported a weak negative effect);
- Between 25 and 38 percent (the highest percentages for all facilities) of the AMEs at the airlines (major, regional and charter) reported that they had nodded off at the wheel;
- Between 9 and 12 percent of AMEs at the major and regional airlines reported that they had actually fallen asleep at the wheel;
- Planned napping as a strategy to maintain alertness is common in rotary field operations, and almost non-existent in most other operations;
- Unplanned naps are often taken at major airlines and general aviation facilities;

- Most AMEs reported that they are obtaining 8 hours of sleep on days off, 7 hours of sleep prior to day and evening shifts, and 6 hours prior to night shifts; and
- The majority of AMEs modify their sleep patterns on their days off following night shifts.

Conclusions

The results of the questionnaire and interview analysis show that AMEs are generally working more than the standard 40-hour week. Most are working, on average, 48 hours per week, and often work demands push this as high as 70 hours during peak times, for operations such as rotary, stand alone and taxi services. AMEs at rotary operations worked the longest hours over all, an average of 141 hours for each 14-day period. This translates into over 70 hours per week. A substantial number of those were beyond this amount and some even reported working almost every day of the year.

Most of the AMEs reported that they obtained adequate sleep (ranging from 6 to 8 hours) on workdays. Sleep prior to a night shift was less than obtained at night, and was probably barely enough. AMEs in rotary operations were sometimes able to get some sleep when they had finished cleaning and repairing equipment at the base, doing their paperwork and attending to other chores. This sleep wasn't always restful, and sometimes would be obtained in a noisy camp. Sleep at night, after getting the aircraft ready to fly in the morning, would be short since the aircraft had to be ready to fly at daybreak. Since many rotary operations are flying north of 60, the amount of daylight during the peak season, summer, would be considerable. Many AMEs work 10 to 12 hour shifts that rotate such that one cycle is a string of nights or days, and the next one is the opposite (days or nights). These AMEs then have the same number of days off between each cycle for rest. This may be 4 days on, 4 days off, 5 days on, 5 days off, or 7 days on, 7 days off, for example. This kind of work structure includes several nights in a row and can lead to a building sleep debt if sleep during the day is inadequate. Interview data showed that AMEs who could obtain close to the "natural" amount of sleep they need to function well managed better than those who could not get enough day-time sleep.

Generally, AMEs reported that work performance is degraded on extended shifts and nights. Over 30 percent indicated that their performance was seriously affected when having to work overtime, particularly on night shifts. This is a common response from personnel working shifts and irregular hours. It is clear, also, that long shifts combined with many consecutive nights affect AME performance, e.g., those doing shift-based or on-demand work face the highest incidence of falling asleep or nodding off while driving.

Napping is allowed by rotary operations, where more opportunities for naps occur, and the long workdays, with much of the work occurring at night, can lead to fatigue and poor performance. The AMEs in rotary operations have found that getting sleep when possible is critical for maintaining performance during their irregular work hours. Many AMEs in operations where napping is not allowed report that, in fact, they do nap. This indicates that AMEs in such operations generally sustain a certain level of sleep deprivation. It is likely that several factors are involved, including overtime levels, early morning starts, many nights worked in a row, and work hours outside their main job. For AMEs, caffeine is the strategy of choice for coping with fatigue. Exercise, napping and diet are the second, third and fourth most commonly used countermeasures.

The majority of AMEs working shifts and on-demand hours modify their sleep on days off and maintain different sleep patterns from those followed on work days. Only those working a standard day shift do not modify their sleep on days off. That means that most of those working nights go back to sleeping at night when they have days off. This precludes any beneficial shift in circadian rhythm, resulting in a certain amount of circadian disrhythmia. Those AMEs interviewed acknowledged that if they slept too long during the day immediately following their last midnight shift, they were unable to sleep that night, and were somewhat “out of sorts” for the first two days of their days off. However, if they slept for only a couple of hours on the first day off and got a good sleep that night, the slight feelings of disorientation were effectively reduced.

During extended shifts or shifts in poor weather, cold or heat, the majority of AMEs reported that they were very fatigued by the end of a shift. About 10 percent of the AMEs indicated that they found it hard to stay awake after an extended night shift. This is in sharp contrast to the ratings AMEs gave for standard shifts, where the majority of AMEs were mostly alert or wide awake. Most AMEs also reported that they are tired at the end of midnight shifts, while another 20 percent reported that they are very tired at the end of their night shift.

Future Options

The following options are suggested to help alleviate the fatigue issues indicated by the results of the survey.

- Assessment of AME tasks that are susceptible to fatigue in all types of work environments;
- Development of fatigue management program (FMP) guidelines for AMEs, tailored for the different types of operations; and
- A trial of the FMP guidelines, using the evaluative component to ascertain its effectiveness.

Each of the FMP guidelines should consist of the following components:

- FMP planning guidelines;
- Educational components for *AMEs*, *Supervisors and Managers*, and *Trainer*s;
- Guidelines for schedule development;
- Evaluation component (pre-post questionnaires, interviews, measurement of relevant statistics); and
- Duty-time requirements

References

Gander, P., Graeber, C., Connell, L., Gregory, K., Miller, D., & Rosekind, M. (1998a) Flight crew fatigue I: objectives and methods. *Aviat. Space and Environ. Med.*, 69 (9) – Section 2: B1-7.

Gander, P., Rosekind, M., & Gregory, K. (1998b) Flight crew fatigue VI: a synthesis. *Aviat. Space and Environ. Med.*, 69 (9) – Section 2: B49-60.

Johnson, W., Mason, F., Hall, S., & Watson, J. (2001) *Evaluation of aviation maintenance working environments, fatigue, and human performance*. FAA Report. Federal Aviation Administration.

Luna T., French J., & Mitcha J. (1997) A study of USAF air traffic controller shiftwork: sleep, fatigue, activity, and mood analyses. *Aviat. Space and Environ. Med.,* 68(1):18-23.

Rhodes, W., Heslegrave, R., Ujimoto, K.V., Hahn, K., Zanon, S., Marino, A., Côté, K., Szlapetis, I., & Pearl, S. (1996) *Impact of Shiftwork on Air Traffic Controllers, Phase II: Analysis of Shift Schedule Effects on Sleep, Performance, Physiology and Social Activities*. TP 12816E Transportation Development Centre Report.

Rhodes, W., Szlapetis, I., Hahn, K., Heslegrave, R., & Ujimoto, K.V. (1994) *Impact of Shiftwork on Air Traffic Controllers, Phase I: Determining Appropriate Research Tools and Issues*. TP 12257E Transportation Development Centre Report.

Sian, B. & Watson, J. (1999) Chapter 11: Study of fatigue factors affecting human performance in aviation maintenance. In *FAA Research 1989-2001/Human Factors in Aviation Maintenance and Inspection/FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase Reports (1991-1999)*. Federal Aviation Administration.

Watson, J. (1999) Introduction. In *FAA Research 1989-2001/Human Factors in Aviation Maintenance and Inspection/FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase Reports (1991-1999)*. Federal Aviation Administration.

Sommaire

Contexte

Au cours de la dernière décennie, plusieurs études sur la fatigue dans le monde de l'aviation ont été réalisées. Mentionnons une série d'études menées par la NASA sur les pilotes professionnels (Gander et coll., 1998a et 1998b), de même que des recherches sur les contrôleurs de la circulation aérienne (Rhodes et coll., 1994 et 1996; Luna et coll., 1997) et sur les techniciens d'entretien d'aéronefs (Sian & Watson, 1999; Johnson et coll., 2001). La présente étude a été lancée après qu'il eut été constaté que nombre des accidents imputés à une erreur humaine sont causés par une baisse de rendement attribuable à la fatigue. Le National Transportation Safety Board des États-Unis, le Bureau canadien de la sécurité aérienne (devenu la division de l'aviation du Bureau de la sécurité des transports du Canada), la Federal Aviation Authority (FAA) des États-Unis et la Civil Aviation Authority (CAA) du Royaume-Uni reconnaissent la gravité et l'omniprésence du problème de la fatigue en aviation, et l'importance de mieux le cerner. Ils ont d'ailleurs souvent été à l'origine de recherches dans ce secteur. La FAA, notamment, a effectué plusieurs études sur la fatigue et ses effets sur les techniciens d'entretien d'aéronefs (Watson, 1999).

En 1996, le Groupe de travail chargé de l'examen de la sécurité de l'exploitation d'un taxi aérien (SATOPS) faisait la recommandation suivante : «*Transports Canada devrait demander au Conseil consultatif sur la réglementation aérienne canadienne (CCRAC) d'entreprendre un examen visant à déterminer s'il faut réglementer les heures de service des TEA, et si tel est le cas, de déterminer les limites appropriées*». La présente étude est le résultat direct des travaux du groupe SATOP et constitue une première étape dans l'étude de la question de la fatigue dans le secteur de l'entretien des aéronefs.

La démarche empruntée, bien qu'elle s'inspire des travaux de la FAA, a été spécialement adaptée à l'environnement de travail des techniciens d'entretien d'aéronefs canadiens. L'étude porte sur la durée des périodes de travail, l'effet de cette durée sur le degré de fatigue potentiel et le degré de fatigue déclaré, et sur la quantité de sommeil prise par les TEA. Des questionnaires et des entrevues ont servi à recueillir l'information.

Méthodologie

Transports Canada s'est chargé de poster le questionnaire à 5 000 TEA. Celui-ci était accompagné d'une enveloppe réponse portant l'adresse du contractant. Cette démarche garantissait l'entière confidentialité des renseignements fournis par les TEA, un ingrédient essentiel à des données fiables et valides. Les questionnaires ont été remplis et retournés par 1 209 TEA et 12 TEA ont été rencontrés en entrevue. Les renseignements figurant sur les questionnaires ont été entrés dans un fichier de données Excel et l'analyse a été exécutée à l'aide du programme statistique NCSS (Number Cruncher Statistical Software) 2001. L'analyse s'est limitée à des traitements descriptifs et comparatifs de base.

Résultats

Voici les principaux résultats qui sont ressortis de l'enquête :

- en moyenne, les TEA travaillent plus de 50 heures par semaine, heures supplémentaires comprises;
- beaucoup prolongent leur quart au-delà de 12 heures, ou font des quarts de 12 heures supplémentaires pendant leurs jours de congé; d'autres font cinq jours consécutifs ou plus de quarts de 10 heures;
- beaucoup travaillent pendant de longs cycles et ont très peu de jours de congé pour récupérer;
- certains effectuent de longs quarts de travail, séparés par à peine 8 heures de repos;
- un grand nombre de TEA travaillent pendant leurs jours de congé, soit qu'ils fassent des heures supplémentaires pour leur employeur habituel, soit qu'ils effectuent des quarts de travail supplémentaires pour un autre employeur;
- les TEA à l'emploi des exploitants d'hélicoptères et de taxis aériens sont ceux qui font les plus longues heures;
- les TEA à l'emploi des compagnies aériennes et des exploitants d'hélicoptères sont ceux qui font le plus d'heures supplémentaires;
- les TEA au service des compagnies aériennes déclarent les degrés de fatigue les plus élevés, probablement en raison du fort pourcentage de travail de nuit et des longs quarts de travail qui caractérisent ce secteur;
- les TEA qui travaillent par quarts déclarent les degrés de fatigue les plus élevés;
- les TEA au service d'exploitants d'hélicoptères déclarent les plus longues heures de travail ininterrompu;
- les TEA qui travaillent «à la demande» effectuent davantage d'heures que ceux qui travaillent par quarts ou selon un horaire de jour ordinaire;
- les TEA salariés travaillent davantage d'heures que ceux qui sont payés à l'heure;
- les quarts les plus longs sont déclarés par les TEA à l'emploi des exploitants d'hélicoptères et des compagnies de vols nolisés;
- de 8 à 10 p. cent des TEA à l'emploi des grandes lignes aériennes, des compagnies de taxi aérien et des exploitants d'hélicoptères effectuent leur plus longue période de travail (de 21 à 25 heures en moyenne) plus de quatre fois par mois;
- 50 p. cent des TEA ont déclaré que les heures supplémentaires ajoutées à un quart de nuit nuisent grandement à leur rendement au travail (un autre 30 p. cent a fait état d'un léger effet négatif);

- c'est chez les compagnies aériennes (tous types confondus : grandes compagnies, transporteurs régionaux et exploitants de vols nolisés) que les plus forts pourcentages (25 à 38 p. cent) de TEA ont déclaré avoir «cogné des clous» au volant;
- de 9 à 12 p. cent des TEA des grandes compagnies aériennes et des transporteurs régionaux ont déclaré qu'ils étaient déjà tombés endormis au volant de leur véhicule;
- les siestes planifiées sont une stratégie courante de maintien de la vigilance lors des opérations d'entretien d'hélicoptères sur le terrain; elles sont toutefois quasi inexistantes dans la plupart des autres types d'activités;
- les TEA à l'emploi des grandes compagnies aériennes et des compagnies d'aviation générale prennent souvent des siestes non planifiées;
- la plupart des TEA ont déclaré prendre 8 heures de sommeil pendant leurs jours de congé, 7 heures avant les quarts de jour et de soir, et 6 heures avant les quarts de nuit;
- la majorité des TEA modifient leurs habitudes de sommeil pendant les jours de congé qui suivent les quarts de nuit.

Conclusions

L'analyse des données recueillies grâce au questionnaire et aux entrevues a révélé que les TEA travaillent généralement plus que la semaine normale de 40 heures. Ils travaillent en moyenne 48 heures par semaine, quand l'ampleur de la tâche, en période de pointe, n'allonge pas leur semaine de travail jusqu'à 70 heures, dans le cas des TEA à l'emploi d'exploitants d'hélicoptères ou de taxis aériens, ou des TEA autonomes. Dans l'ensemble, ce sont les TEA au service d'exploitants d'hélicoptères qui travaillent les plus longues heures, soit une moyenne de 141 heures par période de 14 jours. Cela veut dire plus de 70 heures par semaine. Un nombre important de TEA travaillent encore plus d'heures et certains ont déclaré travailler presque tous les jours de l'année.

La plupart des TEA ont déclaré dormir suffisamment (de 6 à 8 heures) pendant leur cycle de travail. Ils dorment moins, et probablement pas assez, avant d'entreprendre un quart de nuit, en tout cas moins que s'ils avaient la nuit pour dormir. Les TEA qui travaillent à l'entretien d'hélicoptères ont parfois la chance de dormir un peu, après avoir fini de nettoyer et de réparer les appareils, et s'être acquittés d'autres tâches, comme remplir les registres et autres formulaires. Mais ce sommeil n'est pas toujours réparateur, surtout lorsqu'il doit être pris dans un baraquement bruyant. Et lorsqu'ils peuvent dormir la nuit, une fois l'aéronef prêt à voler le lendemain matin, ils ne leur reste pas beaucoup de temps de sommeil jusqu'au décollage de l'aéronef, à l'aube. Comme beaucoup de missions d'hélicoptères ont lieu au nord du 60^{e} parallèle, les jours sont très longs en saison de pointe, l'été. Ainsi, de nombreux TEA effectuent des quarts de10 à 12 heures agencés de façon telle qu'ils travaillent de nuit ou de jour pendant tout un cycle, et l'inverse pendant le cycle suivant. Entre deux cycles, ils ont un nombre de jours de repos équivalant au nombre de jours travaillés : 4 jours de travail, 4 jours de congé, 5 jours de travail, 5 jours de congé, ou 7 jours de travail, 7 jours de congé, par exemple. Ce type d'horaire comprend plusieurs nuits de travail de suite et risque d'engendrer un déficit de sommeil chez les TEA qui ne parviennent pas à dormir suffisamment le jour. Les données recueillies en entrevue ont révélé que les TEA qui parvenaient à obtenir la quantité de sommeil dont ils ont «naturellement» besoin pour bien fonctionner s'en sortaient mieux que ceux qui ne réussissaient pas à dormir suffisamment pendant le jour.

Règle générale, les TEA ont signalé une baisse de leur rendement au travail lors de quarts de travail prolongés et de quarts de nuit. Plus de 30 p. cent ont même révélé que leur rendement était fortement perturbé lorsqu'ils devaient faire des heures supplémentaires, surtout immédiatement après un quart de nuit. Cette réponse est courante de la part des personnes qui travaillent par quarts et selon des horaires irréguliers. De plus, il n'y a pas de doute que de longs quarts de travail, répétés plusieurs nuits de suite, altèrent le rendement des TEA. Ainsi, ce sont ceux qui travaillent par quarts ou à la demande à qui il arrive le plus souvent de s'endormir ou de cogner des clous au volant.

Les TEA qui travaillent à l'entretien d'hélicoptères ont relativement plus d'occasions de prendre des siestes, occasions qu'ils ont tout avantage à saisir, puisque leurs périodes de travail sont longues et qu'ils travaillent la plupart du temps la nuit, conditions susceptibles d'engendrer fatigue et baisse de rendement. Ces TEA ont eux-mêmes constaté qu'il est très important de dormir lorsqu'on le peut, afin d'effectuer un bon travail, malgré des horaires de travail irréguliers. Beaucoup de TEA dont les employeurs interdisent les siestes déclarent qu'ils prennent quand même des pauses pour dormir. Il faut comprendre que les TEA à l'emploi d'exploitants d'hélicoptères se trouvent généralement obligés de composer avec un manque de sommeil. Plusieurs facteurs sont probablement en cause, dont les heures supplémentaires, le fait de commencer à travailler tôt le matin, les nombreuses nuits de travail consécutives, et le travail effectué en marge de l'emploi principal. Pour les TEA, la caféine est une stratégie de choix pour lutter contre la fatigue. L'exercice, les siestes et le régime alimentaire viennent respectivement au deuxième, troisième et quatrième rang des contre-mesures les plus courantes à la fatigue.

La majorité des TEA qui travaillent par quarts et «à la demande» ont des habitudes de sommeil différentes selon qu'ils travaillent ou qu'ils sont en congé. Seuls ceux qui travaillent de jour gardent les mêmes habitudes de sommeil, qu'ils travaillent ou pas. Ainsi, la plupart des travailleurs de nuit recommencent à dormir la nuit lorsqu'ils sont en congé. Ils empêchent de la sorte leur rythme circadien de s'adapter à l'horaire de nuit, et se trouvent ainsi à le contrarier, jusqu'à un certain point. Les TEA rencontrés en entrevue ont admis que s'ils dormaient trop longtemps pendant la journée suivant immédiatement leur dernier quart de nuit, ils étaient incapables de dormir la nuit suivante et se trouvaient en quelque sorte «mal en train» pendant leurs deux premiers jours de congé. Mais s'ils dormaient seulement quelques heures pendant leur premier jour de congé pour pouvoir bien dormir la nuit suivante, ils se sentaient mieux par la suite.

La plupart des TEA ont déclaré être très fatigués à la fin d'un quart de travail prolongé ou d'un quart effectué dans des conditions météorologiques difficiles, ou dans une chaleur ou un froid intense. Environ 10 p. cent ont indiqué qu'ils trouvaient difficile de rester réveillés après un quart de nuit prolongé. Cela contraste vivement avec les réponses données au sujet des quarts de jour ordinaires, pendant lesquels la plupart des TEA se sentaient vigilants ou bien réveillés. La plupart des TEA ont également souligné qu'ils sont fatigués, et 20 p. cent, qu'ils sont très fatigués, après un quart de nuit.

Axes d'intervention future

Il est recommandé de prendre les mesures ci-après afin d'atténuer le problème de la fatigue chez les TEA.

- Évaluer les tâches des TEA susceptibles d'engendrer de la fatigue dans tous les types d'environnements de travail.
- Mettre au point un programme de gestion de la fatigue (PGF) à l'intention des TEA, adapté aux différents environnements de travail.
- Mettre à l'essai le PGF en utilisant le module évaluation pour en évaluer l'efficacité.

Chaque PGF devrait comporter les éléments suivants :

- lignes directrices pour la planification du PGF;
- volet éducatif destiné aux *TEA*, *surveillants et gestionnaires,* et aux *formateurs*;
- lignes directrices pour la confection des horaires;
- module évaluation (questionnaires avant-après, entrevues, collecte des données statistiques pertinentes);
- exigences concernant les heures de service.

Références

Gander, P., Graeber, C., Connell, L., Gregory, K., Miller, D., & Rosekind, M. (1998a) Flight crew fatigue I: objectives and methods. *Aviat. Space and Environ. Med.*, 69 (9) – Section 2: B1-7.

Gander, P., Rosekind, M., & Gregory, K. (1998b) Flight crew fatigue VI: a synthesis. *Aviat. Space and Environ. Med.*, 69 (9) – Section 2: B49-60.

Johnson, W., Mason, F., Hall, S., & Watson, J. (2001) *Evaluation of aviation maintenance working environments, fatigue, and human performance*. FAA Report. Federal Aviation Administration.

Luna T, French J, Mitcha J. (1997) A study of USAF air traffic controller shiftwork: sleep, fatigue, activity, and mood analyses. *Aviat. Space and Environ. Med.* 68(1):18-23.

Rhodes, W., Heslegrave, R., Ujimoto, K.V., Hahn, K., Zanon, S., Marino, A., Côté, K., Szlapetis, I., Pearl, S. (1996) *Impact of Shiftwork on Air Traffic Controllers, Phase II: Analysis of Shift Schedule Effects on Sleep, Performance, Physiology and Social Activities*. TP 12816E Transportation Development Centre Report.

Rhodes, W., Szlapetis, I., Hahn, K., Heslegrave, R., Ujimoto, K.V. (1994) *Impact of Shiftwork on Air Traffic Controllers, Phase I: Determining Appropriate Research Tools and Issues*. TP 12257E Transportation Development Centre Report.

Sian, B. & Watson, J. (1999) Chapter 11: Study of fatigue factors affecting human performance in aviation maintenance. In *FAA Research 1989-2001/Human Factors in Aviation Maintenance and Inspection/FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase Reports (1991-1999)*. Federal Aviation Administration.

Watson, J. (1999) Introduction. In *FAA Research 1989-2001/Human Factors in Aviation Maintenance and Inspection/FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase Reports (1991-1999)*. Federal Aviation Administration.

Contents

List of Figures

List of Tables

1. Introduction

The impact of fatigue on psychomotor (e.g. reaction time) and cognitive (e.g. decision-making, memory, perception) performance has been thoroughly documented in the aviation industry (Foushee et al., 1986; Gander et al., 1998a; Heslegrave and Rhodes, 1997; Rosekind et al., 1996; Rhodes et al., 1996; Tepas, 1982). Shift structures, job environment, and personal factors, have been identified as the major causes of fatigue (Folkard, 1996). The amount of rest (sleep in particular) between shifts and the time of day in which the shift occurs have been shown to influence the amount of sleep debt (accumulation of lost sleep). The greater the sleep debt, the greater the level of fatigue. The greater the level of fatigue, the greater the decrement in job performance. There is mounting evidence that after people have been awake for 23 hours, their performance is degraded in the same way that the legal limit of alcohol will affect our ability to think and function (Dawson & Reid, 1997; Lamond & Dawson, 1999). Add another few hours of working without sleep, and personnel are performing as if they had quite a few alcoholic drinks. Even after 12 hours of sustained work our decision-making abilities degrade significantly (Lamond & Dawson, 1999). Clearly, the responsibility of all personnel who have a significant impact on aviation safety is to ensure that they arrive at work fit for duty – i.e. awake, alert and able. Therefore, they must get their required sleep by doing all they can to protect their sleep times and keep themselves fit. Similarly, it behooves all agencies and companies in the aviation industry to provide work schedules, training and resources (money, facilities and equipment) to ensure that personnel can achieve their goals.

The significance of these responsibilities is further strengthened by the fact that human error in aviation is a major contributor to the cause of aviation disasters (87% attributed to some form of human error, 13% attributed to design flaws – Nagel, 1988). However, if the design errors are considered to be the failings of the designers (humans), the proportion approaches 100%. Therefore, for all intents and purposes, all aviation accidents are caused by some form of human error. Some very small proportion (probably less than 2%) may actually have been caused by impossible weather conditions or some completely unforeseen failure of materials. Even debris left on the tarmac (the possible cause of the Concorde disaster) by a previous flight may point to a need for better procedures or better visibility of the runways, or a combination of these. All human endeavors are affected, negatively, by fatigue. Hence, it is likely a wise decision to try to reduce fatigue where possible, as a means of improving system safety.

Of the human errors that contribute to air accidents, 12% are attributed to maintenance and inspection deficiencies (Nagel, 1988). This number may actually be higher since some of the other categories may have occurred as a result of a maintenance error; for example, a maintenance deficiency may have led to the circumstances that ultimately led to the conditions that occurred when, for example, an improper crew response occurred.

The types of errors that may be sensitive to fatigue effects include:

- Missed details during inspection tasks such as those in quality assurance activities;
- Improper resetting and calibrating of equipment;

- Missed steps during an assembly task;
- Incomplete tightening of fasteners during assembly;
- Reduced ability to finely adjust equipment;
- Difficulties remembering details about equipment specifications;
- Omission of potentially important information during the hand-over of the repair to the next shift; and
- Less care taken during delicate tasks such as assembling sensitive equipment, cleaning difficult-to-reach areas, tightening small fasteners.

This is partial list based on the knowledge of how fatigue affects people, and the nature of the tasks. Actual research on the extent of how these tasks are affected by varying levels of fatigue should be conducted to fully determine the actual level of risk.

The impact of errors in any of these types of tasks could lead to operational problems that may develop into a serious incident or disaster. Reducing fatigue can lower the risk that these errors pose to air operations.

2. Background

Over the past decade several fatigue studies have been conducted focusing on aviation. They include a series of studies by NASA on commercial pilots (see Gander et al., 1998a; 1998b, for a description of the studies and a synthesis of the work), air traffic controllers (Rhodes et al., 1994; 1996; Luna et al., 1997), and aviation maintenance technicians (Bosley, 1999; Sian & Watson, 1999; Johnson et al., 2001). This research was initiated as a result of the recognition that many accidents attributed to human error were caused by fatigue-related performance deficits. The National Transportation Safety Board, the Canadian Aviation Safety Board (now the aviation division of the Transportation Safety Board of Canada), the U.S. Federal Aviation Administration (FAA) and the Civil Aviation Authority (CAA) in Britain have acknowledged that fatigue in aviation is a serious and pervasive problem, and must be better understood. These organizations have frequently recommended research on fatigue in aviation. The FAA in particular has undertaken several research efforts examining fatigue and its effects on aviation maintenance technicians (Watson, 1999).

2.1 Origin of the Project

In 1996 the Safety of Air Taxi Operations (SATOPS) task force recommended that Transport Canada "*...initiate a Canadian Aviation Regulation Advisory Council (CARAC) review to determine if AME duty times should be regulated, and if so, determine appropriate limitations*". The present study was commissioned as a direct result of the SATOPs task force and represents the initial step in addressing the issue of fatigue in the aircraft maintenance environment.

Transport Canada views this project as Phase 1 of a multiphase project, which will include the following component phases:

- Phase 1: Assessment of Aviation Maintenance Engineers' Hours of Work;
- Phase 2: Human Factors Investigation and Fatigue Risk Analysis of Aviation Maintenance Engineers' Tasks;
- Phase 3: Development of Fatigue Management Program (FMP) guidelines; and
- Phase 4: A trial of an FMP prototype based on the guidelines.

The approach taken for this study borrows on some of the FAA's work, but is tailored for the Canadian AME work environment. The study focuses on the extent of hours of work, the impact of these hours on potential and reported levels of fatigue, and the amount of sleep obtained by AMEs. The study was conducted using a questionnaire and interviews. This report documents the extensive base of information obtained.

2.2 Definition of Fatigue

Fatigue is an umbrella term for various meanings (Stokes & Kite, 1994). It can refer to physical or mental fatigue. The fatigue most important in the AME working environment is the mental form of fatigue, although AMEs do also experience varying levels of physical fatigue. In fact, physical fatigue may have an impact on their levels of mental fatigue. However, for the purposes of this research and system safety, the survey does not make a distinction between the two forms. Fatigue may be a state that is manifested by feelings of sleepiness, disorientation, inability to think clearly, slow mental reflexes, reduced short-term memory, reduced motivation, muscle ache, sluggishness and generally poor mental and physical performance. It also may be an actual physiological state that can be determined by measuring heart rate, brainwave activity, direct neural activity and eye response. It can be subjective (such as feelings of sleepiness and reduced alertness), or it can be objective (e.g. decrements in performance of fatigue-sensitive tasks or measurement of physiological response).

3. Objectives and Purpose

3.1 Program Objective

The program objective is to establish and validate a set of guidelines for fatigue management that may be adapted by the maintenance services of air carriers in Canada. This set of guidelines may be developed into a fatigue management program or may be used to guide the development of a set of regulations, if Transport Canada deems that regulatory control is necessary.

3.2 Program Sub-objectives

The sub-objectives of the program are:

- Collect and analyze information regarding the number and timing of the hours worked by AMEs, the duration and timing of shifts worked, the duration and timing of rest periods, and the nature of the working conditions, and report the findings.
- Produce a set of recommendations that focus on the best approach for a fatigue management program and associated regulations that may be required.
- Implement the fatigue management program through a pilot test to validate its effectiveness.

3.3 Objectives of the Present Study

This study examines the hours worked by AMEs and the possible risks of fatigue that these hours may cause. The study attempts to determine how these hours of work may affect the amount of sleep obtained and the subjective levels of fatigue reported. It compares the work and sleep patterns that exist for AMEs at different types of facilities, for those who work under different work structures (shiftworker, work on-demand, work a standard day or combinations thereof), and for different bases for pay (part-time, salaried or hourly). The research is the first step in the development of fatigue management approaches for AMEs. The information gathered through the questionnaire (see Appendix A for a sample questionnaire) and interviews will be used to develop guidelines for educational, evaluative (for the FMP itself), and scheduling components. These guidelines may be tested in a selection of facilities that represent the different work structures, facility types, and working locations.

This final report contains the method, findings and conclusions of the AME Hours of Work survey, including questionnaire and interview information. The entire data set includes information from 1209 respondents for the questionnaire and 12 AMEs who were formally interviewed (3 rotary [helicopter], 2 stand alone, 2 regional airlines, 2 major airlines, 2 charter airlines, and 1 general aviation). Two more rotary AMEs were interviewed informally. The interviews were conducted to augment the questionnaire data. This report contains the results of demographic information, comparative analysis of schedules, amount of sleep, hours of work, fatigue coping strategies, and performance, as well as conclusions. Recommendations for guidelines on hours of work and scheduling are also included.

Some respondents did not answer some questions. Hence, the total sample “n” for each of the analyses was different. However, most of the analysis includes responses from over 1150 AMEs.

4. Methodology

The research is based on the use of a questionnaire to survey AMEs across Canada. A sample of 5000 was chosen on the basis of age, gender, geographic region and official language. The survey was pilot tested with 6 AMEs, who completed the questionnaire and provided feedback on what should be modified to improve response and validity. Many parts of the questionnaire were revised according to the feedback, but it is clear from the difficulties that the AMEs encountered while completing the final questionnaire, much more rework was warranted. The lesson learned here is that more than one pilot test may be necessary for such a diverse population of professionals. The variation in work structures and working conditions is very broad and may even have deserved more than one questionnaire, i.e. a separate, tailored one for each group. This would have increased the cost and time to perform the analysis, and great care would be needed to ensure comparability.

The questionnaire was mailed to AMEs in the sample of 5000 direct to their homes and a self-addressed (R&A address), stamped envelope was enclosed. The AME was requested to complete the confidential questionnaire, refold it, place it into the envelope provided and mail it back to Rhodes & Associates Inc.

The data were entered into an Excel spreadsheet initially, then converted into a statistical database (for use with the NCSS statistical package). All statistical analyses were performed using NCSS. Graphs were created with Excel using the NCSS data.

The questionnaire can be found in Appendix A. See Appendix B for detailed tables containing statistical information.

4.1 Research Questions and Goals

The research involves the use of a survey questionnaire, and follow-up interviews to collect information on the hours that AMEs work, the conditions of the work environment, and the effect these may have on sleep and potential fatigue.

4.1.1 The Objectives of This Research

The objectives of this research is to determine:

- the actual number of hours of work that AMEs do within a 24-hour period on a daily basis, and within the entire weekly period;
- the actual number of days of consecutive work;
- when these hours of work are done;
- the extent of "extra" work occurring outside of the regular shift, including overtime at their regular work, and any other work not considered aviation maintenance;
- how work performance is affected by overtime;
- how much sleep AMEs obtain, particularly during the work cycle;
- the potential for fatigue according to the sleep data; and
- the reasons for working extra hours.

4.1.2 Groups to be Compared

Groups to be compared (independent variables):

- Facility types;
- Role/position;
- Environment AME works in;
- Frequency groups for outdoor work;
- Geographical location;
- Type of employee; and
- Type of work schedule.

4.1.3 The Main Research Questions

The main research questions to be answered are:

- What is the state of hours worked by AMEs – just enough or too many – as determined by the amount of time off and the amount of sleep obtained?
- When do these work hours occur – during times compatible with the circadian rhythm or outside this period – what is the distribution?
- What groups have the higher risk of fatigue?
- Who is working at extra jobs? How many do this?
- How much time are those working at other jobs spending at this extra work?
- When are they working at this extra job?
- How are overtime hours distributed?
- What groups have the greatest negative impact of overtime on their work performance?
- What experience have the groups had regarding their drives to and from work?
- How much sleep do the various groups of AMEs get?
- How is this sleep distributed, according to the shifts worked?
- Who splits their sleep?
- Who naps? How often do they nap on days off? How long are the naps on days off?
- What strategies do the different groups use to stay alert on the job?
- Who gets to have planned naps at work?
- What conditions contribute most to fatigue?
- How do the groups feel about working more or fewer hours?

5. Results

5.1 Demographics

The response rate out of the original mail-out to 5000 AMEs was about 21% (total of 1209). Of these questionnaires, 1166 were complete enough for most of the analysis. This is a respectable rate, although most surveys shoot for 30% to achieve a reasonable level of representation. Representation is discussed below. The demographic information is presented as follows:

- Breakdowns for Gender, Age, Children, Marital Status and AME and Present Position Experience for the overall sample and for facility type, shift type and responsibility;
- Breakdowns of demographic information for the following groups:
- Facility Type
- Role/Position
- Location of Duties
- Working Environment
- Outdoors Work
- Geographic Location
- Rural/Non-rural
- Employee Type
- Responsibility
- Shift Type

Gender, Marital Status, Children

Table 1 provides the percentage response for the basic demographic information.

Table 1: Response to the Survey (n=1166)

Response

Gender		Marital Status				Children	
Female	Male	Married	Single	Widowed	Divorced	Yes	No
0.76%	99.2%	80.7%	10.9%	0.8%	7.5%	73.2%	26.8%

The sample is mostly representative for gender (proportion for all AMEs is 99.1 % for males; and 0.9 % for females as indicated in the database for the 5000 AMEs who received a survey), although it is slightly under-representative of female AMEs.

Age, Aviation Experience, Years in Present Position

Table 2 shows the overall means for age, years of aviation experience, and years spent in their present position.

Table 2: Means for Age and Experience

	Mean	Min.	Max
Age (yrs.)	43.86	23	71
Aviation Experience (yrs.)	22.24	3	53
Years in Present Position (yrs.)	11.42	0.1	44

The mean age for the 5000 AMEs who received a questionnaire was 46 years. The mean age for the sample of respondents was similar at almost 44 years. The respondents are a slightly younger population. Although we cannot extrapolate to other variables, we can use gender and age as a reasonable indicator of representation.

Facility Type, Role/Position, Work Location, Work Environment, Outdoor Work and Geographic Location

The following tables (3a through 3g) show the percentage rate for several work-related variables (study groups). The total response rate for the survey is a maximum of 1197, since some respondents did not provide some of the basic demographic information.

Table 3: Distributions for the Study Groups

Table 3a: Facility Type

	Count	Percentage	Graph of Percentage
Major	390	33.45	|||||||||||||
Regional	132	11.32	||||
Charter	69	5.92	||
Air Taxi	46	3.95		
Stand Alone	240	20.58	||||||||
General	126	10.81	||||
Rotary (Helicopter)	163	13.98	|||||
	1166		

Table 3b: Main Role/Position

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>Airframe (AF)</td><td>175</td><td>14.72</td><td>|||||</td></tr>
<tr><td>Avionics (AV)</td><td>134</td><td>11.27</td><td>||||</td></tr>
<tr><td>Other (OT)</td><td>128</td><td>10.77</td><td>||||</td></tr>
<tr><td>Power Plant (PP)</td><td>27</td><td>2.27</td><td>|</td></tr>
<tr><td>Quality Assurance (QA)</td><td>132</td><td>11.10</td><td>||||</td></tr>
<tr><td>Shop (SH)</td><td>24</td><td>2.02</td><td>|</td></tr>
<tr><td>Various (VA)</td><td>569</td><td>47.86</td><td>||||||||||||||||||</td></tr>
<tr><td>Breakdown of “Various”</td><td></td><td></td><td></td></tr>
<tr><td>AF&AV&PP</td><td>59</td><td>10.37</td><td>||||</td></tr>
<tr><td>AF&AV&PP&QA</td><td>26</td><td>4.57</td><td>|</td></tr>
<tr><td>AF&PP</td><td>213</td><td>37.43</td><td>||||||||||||||</td></tr>
<tr><td>AF&PP&QA</td><td>81</td><td>14.24</td><td>|||||</td></tr>
<tr><td>AF&QA</td><td>22</td><td>3.87</td><td>|</td></tr>
<tr><td>Other Combinations</td><td>168</td><td>29.53</td><td>|||||||||</td></tr>
</table>

Table 3c: Work Location

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>Line</td><td>259</td><td>21.86</td><td>||||||||</td></tr>
<tr><td>Shop</td><td>83</td><td>7.00</td><td>||</td></tr>
<tr><td>Hangar</td><td>694</td><td>58.57</td><td>|||||||||||||||||||||</td></tr>
<tr><td>Other</td><td>149</td><td>12.57</td><td>|||||</td></tr>
<tr><td></td><td>1185</td><td></td><td></td></tr>
</table>

Table 3d: Work Environment

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>Main Base</td><td>871</td><td>73.19</td><td>|||||||||||||||||||||||||||||</td></tr>
<tr><td>Sub-Base</td><td>161</td><td>13.53</td><td>|||||</td></tr>
<tr><td>Field</td><td>116</td><td>9.75</td><td>|||</td></tr>
<tr><td>Other</td><td>42</td><td>3.53</td><td>|</td></tr>
<tr><td></td><td>1190</td><td></td><td></td></tr>
</table>

Table 3e: Outdoor Work

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>Most of the Time</td><td>220</td><td>18.38</td><td>|||||||</td></tr>
<tr><td>Often</td><td>242</td><td>20.22</td><td>||||||||</td></tr>
<tr><td>Sometimes</td><td>626</td><td>52.30</td><td>||||||||||||||||||||</td></tr>
<tr><td>Never</td><td>109</td><td>9.11</td><td>|||</td></tr>
<tr><td></td><td>1197</td><td></td><td></td></tr>
</table>

Table 3f: Geographic Location

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>Atlantic</td><td>69</td><td>5.87</td><td>||</td></tr>
<tr><td>Quebec</td><td>223</td><td>18.92</td><td>|||||||</td></tr>
<tr><td>Ontario</td><td>302</td><td>25.66</td><td>||||||||||</td></tr>
<tr><td>Prairies</td><td>254</td><td>21.60</td><td>||||||||</td></tr>
<tr><td>BC</td><td>307</td><td>26.11</td><td>||||||||||</td></tr>
<tr><td>North of 60</td><td>21</td><td>2.05</td><td>|</td></tr>
<tr><td></td><td>1176</td><td></td><td></td></tr>
</table>

Table 3g: Rural/Non-rural Work

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>No</td><td>825</td><td>69.92</td><td>|||||||||||||||||||||||||||</td></tr>
<tr><td>Yes</td><td>355</td><td>30.08</td><td>||||||||||||</td></tr>
<tr><td></td><td>1180</td><td></td><td></td></tr>
</table>

Employee Type, Responsibility and Shift Type

Tables 4a through 4c provide the percentage response for personnel related variables. Standard day refers to about 7.5-8 hours worked during the day; on demand means that the hours are worked according to workload demands; shiftworkers are considered to be those working any time outside the standard day, but according to a preset schedule.

Table 4: Distributions for Personnel-related Information

Table 4a: Employee Type

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>Hourly</td><td>381</td><td>32.04</td><td>||||||||||||||</td></tr>
<tr><td>Salary</td><td>778</td><td>65.43</td><td>||||||||||||||||||||||||</td></tr>
<tr><td>PT Salary</td><td>30</td><td>2.52</td><td>|</td></tr>
<tr><td></td><td>1189</td><td></td><td></td></tr>
</table>

Table 4b: Responsibility

<table>
<tr><th></th><th>Count</th><th>Percentage</th><th>Graph of Percentage</th></tr>
<tr><td>Apprentice</td><td>7</td><td>0.59</td><td>|</td></tr>
<tr><td>AME</td><td>409</td><td>34.25</td><td>|||||||||||||</td></tr>
<tr><td>ACA/SCA</td><td>646</td><td>54.10</td><td>|||||||||||||||||||||</td></tr>
<tr><td>Inactive</td><td>87</td><td>7.29</td><td>||</td></tr>
<tr><td>Pilot/Engr.</td><td>45</td><td>3.77</td><td>|</td></tr>
<tr><td></td><td>1194</td><td></td><td></td></tr>
</table>

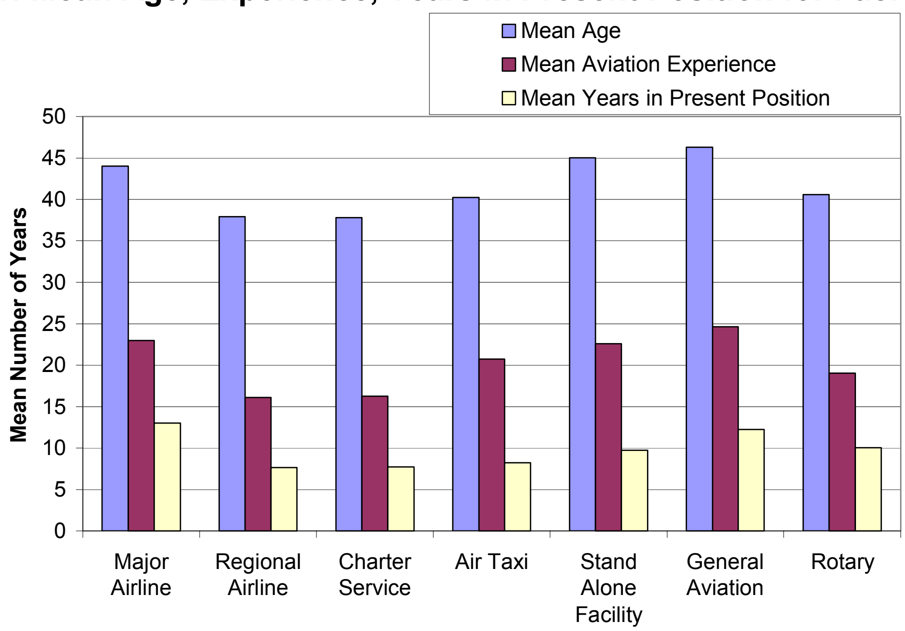
Table 4c: Type of Shift

	Count	Percentage	Graph of Percentage
Shiftworker (SW)	378	31.98	|||||||||||
On-Demand (OD)	55	4.10		
Standard Day (SD)	192	17.77	|||||||
SD/OD	380	30.07	|||||||||||
SW/OD	177	16.63	|||||
	1182		

Breakdown of Demographic Information by Facility

Figure 1 shows the breakdown for age, years of experience and years in present position for each type of facility. Most of the differences in mean age of AMEs, aviation experience and years in the present position, between each facility, are statistically significant.

Figure 1: Mean Age, Experience, Years in Present Position for Facility Type



Key for Figure 1.

Facility Type	Description
Major Airline	Maintenance facility operated by a major airline providing air service for main routes
Regional Airline	Maintenance facility operated by a regional airline providing short-haul air service
Charter Service	Maintenance facility for an airline providing charter service for long and short-haul flights
Air Taxi	Maintenance facility operated by an air taxi service
Stand Alone Facility	Facility that provides aircraft maintenance service to aircraft operators
General Aviation	Facility located in a small airport providing maintenance services to general aviators
Rotary (Helicopter)	Maintenance facility/operation that supports rotary (helicopter) operations

5.2 Hours of Work

This section deals with the hours worked by AMEs and comparisons between the various groups. The analysis looks at the average hours worked daily and weekly, total average working hours including overtime, longest shift/assignment, greatest number of consecutive days worked, work at other tasks outside of AME work and work outside of the job. This section aims to provide an idea of the potential for fatigue by considering the maximum daily and weekly averages for work and rest. The approach involves comparing the groups for their balance of hours worked and time off between. The analysis is based on the premise that fatigue will be beyond acceptable levels if certain "rules" are violated:

1. Night work should be as short and as infrequent as possible and practicable.
2. A rest period of at least 24 hours should be provided at least once per 7-day work period.
3. Sustained work should be no longer than 12 hours.

Night Work

According to many fatigue management, shiftwork and sleep researchers, working nights comes with a cost in performance, job satisfaction and health, because we are trying to work at a time when the body wants to be sleeping. Working nights also means sleeping during the day. Day sleep is never as good as night sleep, since our bodies want to be awake during the day. This is a natural response of the body. Each day sleep is usually 1.5 to 3 hours shorter than the sleep one would normally get during the night. This translates into 7.5 hours to 15 hours of sleep debt over a 5-day work week. Research shows that working 7 or more of these nights, consecutively, will result in considerable sleep debt that will degrade performance severely.

Consecutive Work Days

Consecutive work days without a proper rest between will result in some sleep loss and increased fatigue, simply because we will shorten our sleep to do all of those things that we usually save for our days off. It is very difficult to meet our responsibilities to family and ourselves when there are no days off to deal with them. This is one instance when errors are made. In addition, it is clear, from the research discussed at the beginning of this report, that humans need at least 24 hours off following several nights working. This allows us to obtain at least one good night of sleep every work cycle. If too many nights pass, the sleep debt incurred will reach a point where performance is below standard.

Long Work Periods

Long work periods greater than 12 hours will result in significant drops in performance. Many recent studies have shown this to be directly comparable with the effects of alcohol on performance. Twenty-three hours of sustained wakefulness will result in performance decrements equivalent to having 0.05% Blood Alcohol Content (BAC) in the body. After 27 hours, performance is equivalent to that occurring with 0.10% BAC in the body (Lamond and Dawson, 1999; Arnedt et al., 2001). Furthermore, if certain classes of cognitive tasks are considered, serious degradation in performance can be expected even after 8 hours of sustained wakefulness (Williamson et al., 2000). If we consider getting ready for work, commute times, meals and other tasks required to get to and from work, the 12-hour workday is more like 14 to 15 hours or more. Then there is the wind-down time, and sleep time becomes compressed to a few hours.

5.2.1 Total Average Hours of Work – Comparison of Facilities

Figures 2 to 14 compare the means for each facility for each of the responses for the several hours of work questions in the survey. Table 8 (8a to 8g) in Appendix B lists the mean, standard deviation, standard error, maximum, and minimum for each facility group for several questions that attempted to gather information on the extent of working hours. The most hours worked, on both a daily and weekly basis, were reported by AMEs working in regional airline and rotary operations (Figures 2 and 3). The mean for hours worked in 24 hours (Figure 2) represents many AMEs who also worked shorter days and those who definitely exceeded the maximum recommended (rule number 3, section 5.2). Days averaging between 9 and 11 hours were a result of many operations using a 12-hour day rotation (12-hour day and night shifts) for 4 to 7 days with from 3 to 7 days off in between. Weekly values are therefore more reliable, since they will capture most shifts worked in these types of rotations (see Figures 2 and 3).

AMEs interviewed confirmed that shifts are often 10 to 12 hours in duration, and are worked according to a schedule whereby a given number of days are worked and a block of days are taken off between cycles. AMEs liked this arrangement since they felt they could put those days off to good use. When asked if this includes resting, the response was that the first day off was used for recovery from the work cycle (particularly after nights), the rest were for whatever else needed to be done. Those working 12-hour shifts found that these days off were the only time they got to see family and friends.

Figure 2: On-Demand Hours Worked in 24 hours for Facilities (n=994)

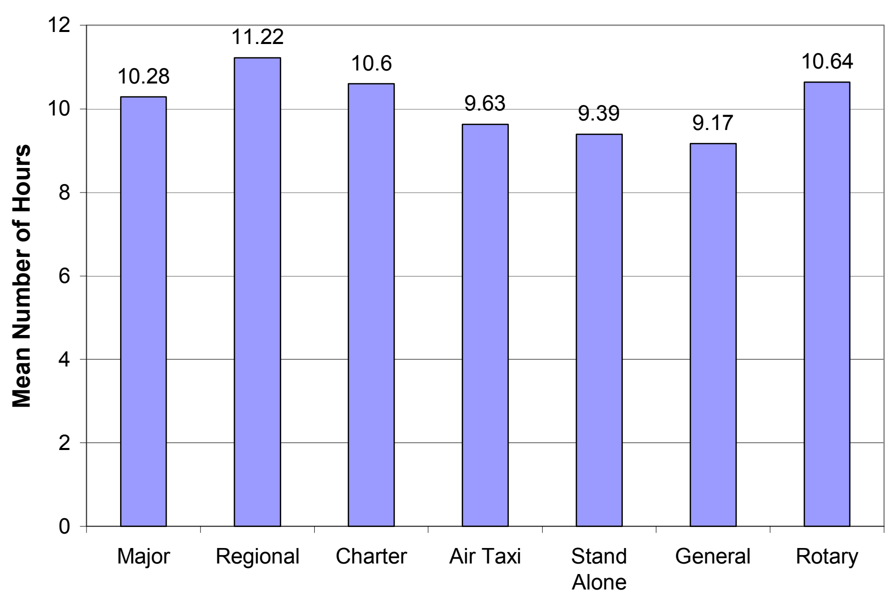


Figure 3: On-Demand Hours in 7-Day Period for Facilities (n=986)

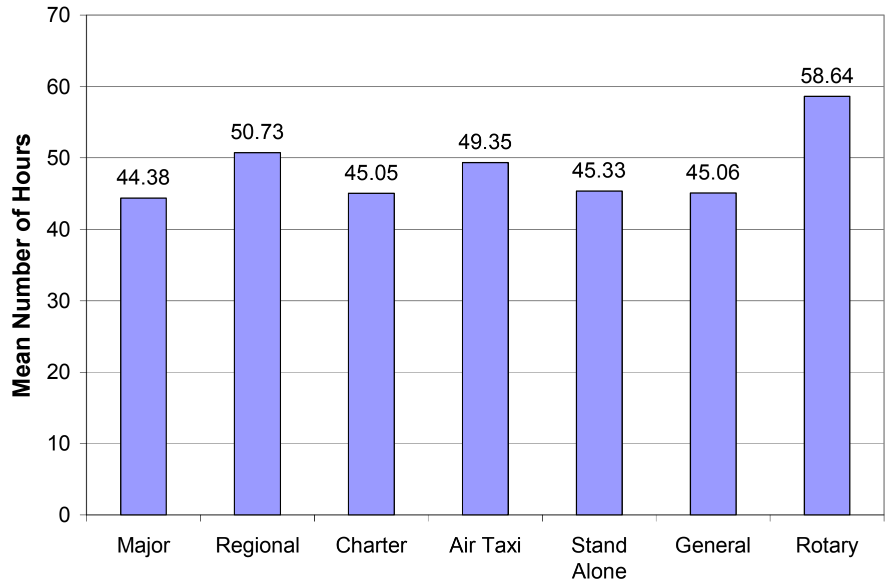


Figure 4 shows the distribution of grouped hours of work (for each facility) not including overtime. Figure 5 shows the same hours-of-work groups for the total sample. Note that 40% of the AMEs at regional facilities are working over 48 hours per 7-day period. An even larger percentage (60%) of the AMEs at rotary operations are working over 48 hours, while a full 20% are working over 75 hours per 7-day period. Overall, 32% of AMEs are working over 48 hours per 7-day period.

Figure 4: Distribution of Grouped Hours Worked for Facilities

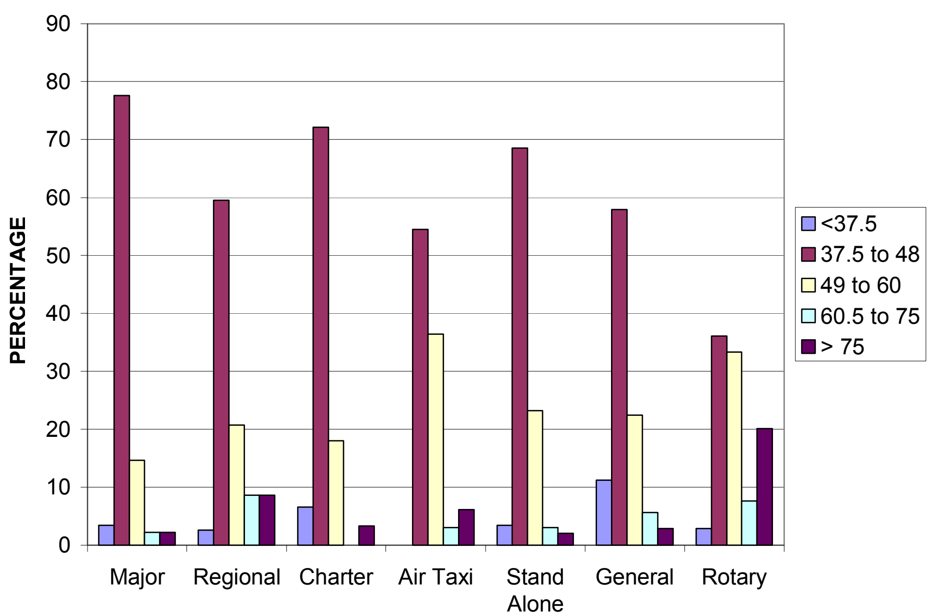
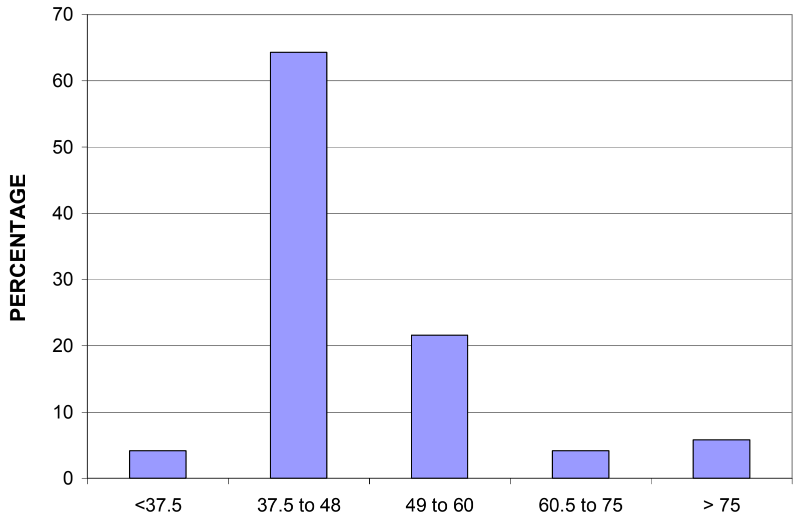


Figure 5: Distribution for Grouped Hours of Work for the Total Sample



Rotary AMEs reported significantly higher duty times than other AMEs (Figure 6). The AMEs working at rotary facilities appear to work much longer days when overtime is added. The AMEs at regional, air taxi, charter, stand alone and general facilities also show a significantly longer day, when overtime is added, than those in the major airline facilities, although to a lesser extent than the rotary AMEs.

Figure 6: Total Duty Time + Overtime for Facilities (n=653)

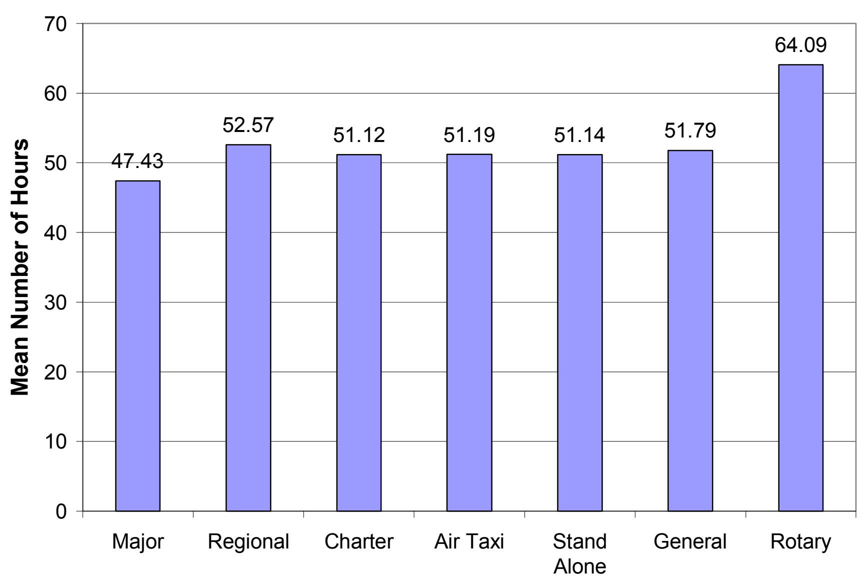
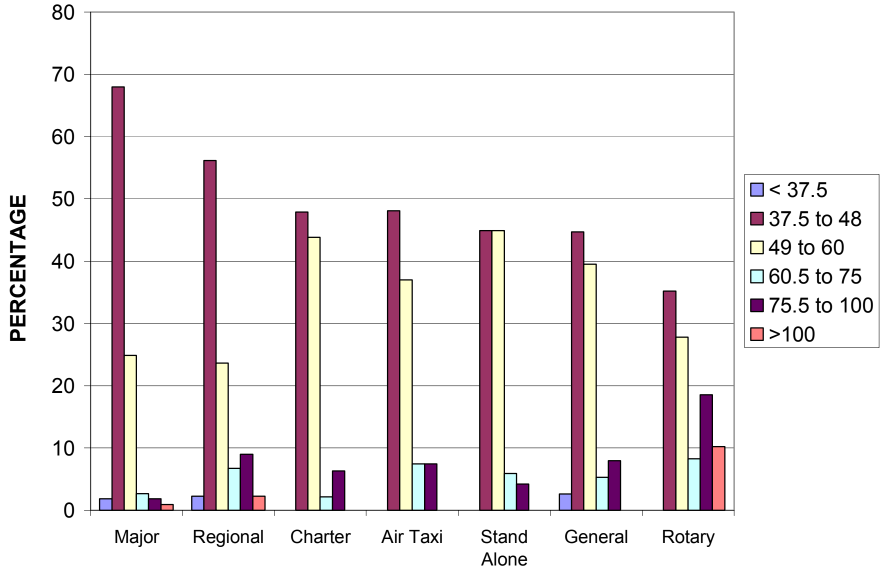


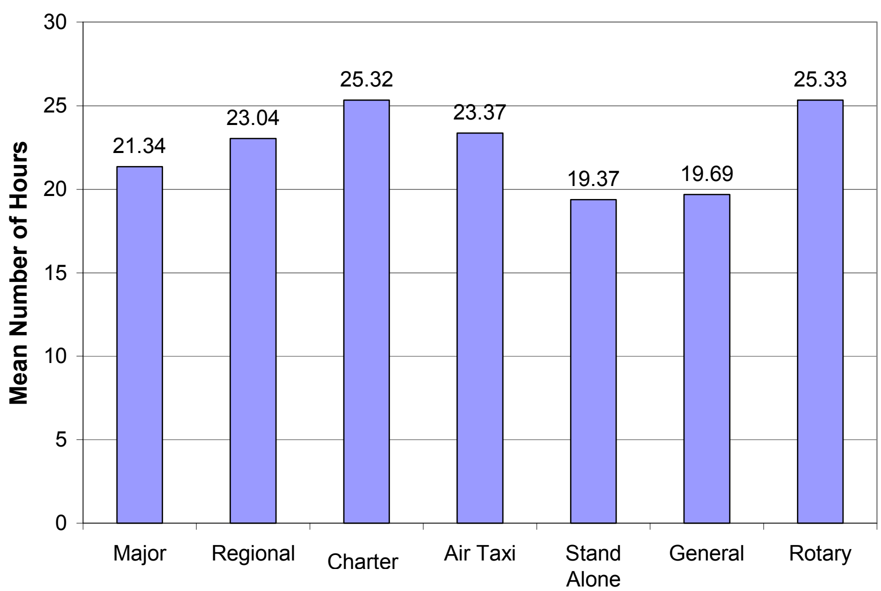
Figure 7 shows the breakdown for grouped hours worked <u>including</u> overtime. Note that the over 10% of the AMEs at rotary operations are working over 100 hours per 7-day period, once overtime is included, while another 20% are working between 75.5 and 100 hours. Almost 10% of the AMEs at regional airline facilities are working between 75.5 and 100 hours per 7-day period. Some AMEs (8%) at general aviation facilities are also working over 75 hours per 7-day period.

Figure 7: Distribution of Grouped Hours Worked Including Overtime for Facilities (n=1095)



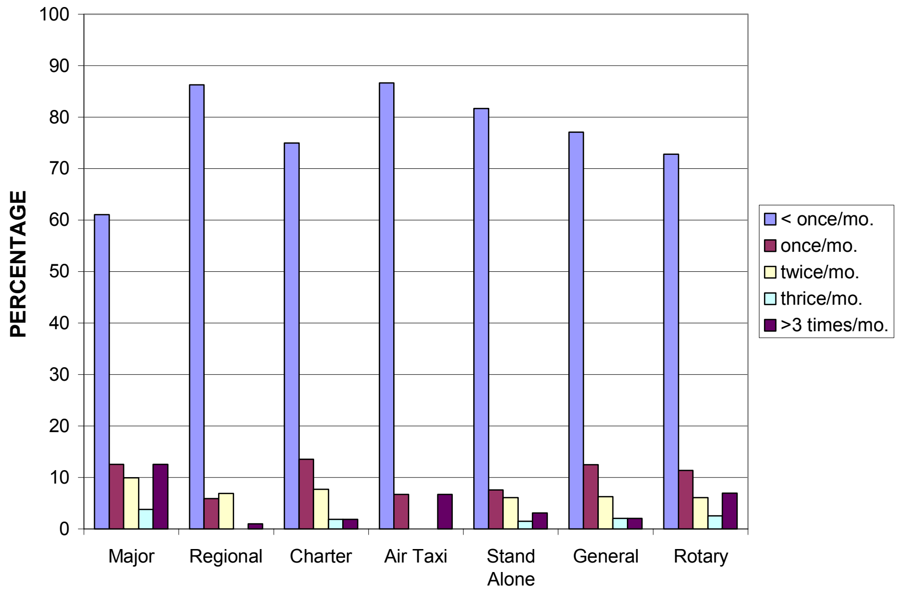
AMEs were asked to report the longest shift worked. Figure 8 shows the results for this question. It is clear that AMEs in all facility types have had to work some very long shifts. Through interviews it is apparent that such long shifts are rare in most operations and can occur occasionally in rotary field operations. Most of the larger operations are staffed well enough to accommodate long jobs through the hand-over of work to the next shift. Smaller operations may find this less feasible and AMEs may find they have to stay to finish the job. Of course, AMEs servicing aircraft on a fire-line may have to work day and night on a damaged aircraft.

Figure 8: Longest Shift for Facilities (n=750)



Rotary and charter AMEs had significantly higher mean duration for the longest shift than did the rest of the AMEs (Figure 8). Figure 9 shows the percentage of AMEs reporting their frequency for working such long shifts. Note that over 10% of the AMEs at the major airlines work their maximum shift time more than three times per month. Similarly 8% of the AMEs at the air taxi services are working their maximum shift length more than three times per month, and another 8% are working their longest shift at least once per month. Although not directly related, these two figures do reveal that excessively long shifts are surprisingly common for a substantial proportion of the AME population.

Figure 9: Breakdown of the Frequency for Working Longest Shifts (739)



Figures 10 and 11 represent the results for a set of questions that asked for the same information as above, but specified during the last year. The numbers are similar to those seen above for number of hours worked during each 24-hour and weekly period. Some individuals reported working over 300 days in the last year. Presumably these AMEs were working almost every day, and obtained very little rest. The means for maximum days worked show that, from time to time, AMEs do have to work many days in a row (between 14.6 and 35.2) with little sleep. Interviews revealed that for some operations, such as rotary facilities during peak times, it is common for AMEs to work for weeks in the bush with little time for adequate restorative sleep.

The estimates for the average number of hours worked during each 24-hour cycle over the past year is highly consistent with those for on-demand estimates (question 3.1), probably because most of the AMEs entered their hours in the on-demand section. This may be an indication that many AMEs do work according to workload demands, even if they have a set work cycle of hours designated by their employers. Another reason may be that the questionnaire was not clear enough to lead the respondents to the correct sections. Unfortunately, this situation precludes any direct comparison of means between on-demand work and shift work. However, since respondents were asked to indicate whether they were on-demand or shiftworkers, or both, these groups can be compared for hours of work, the topic of the next section.

Figure 10: Hours per Cycle in Last Year for Facilities (n=1095)

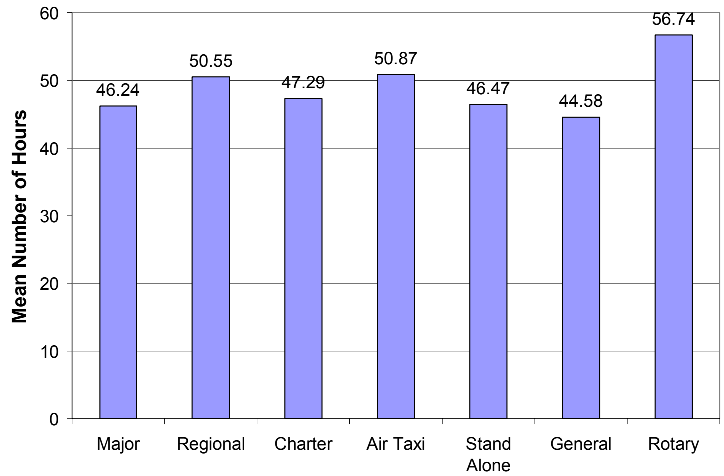


Figure 11: Hours Worked per 24-hour Period Within Last Year for Facility Types (n=1086)

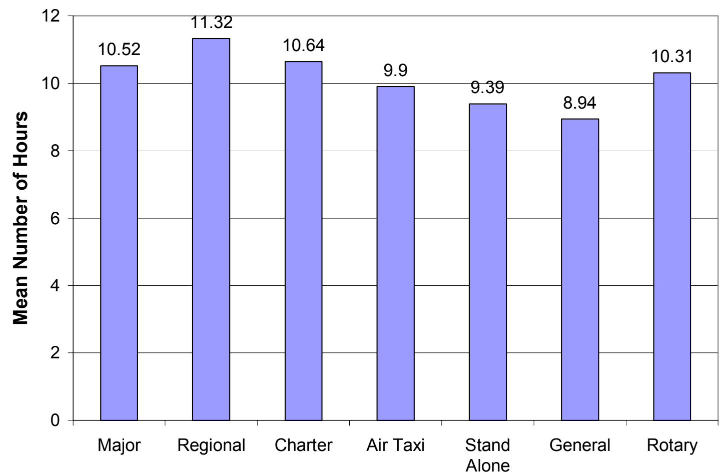
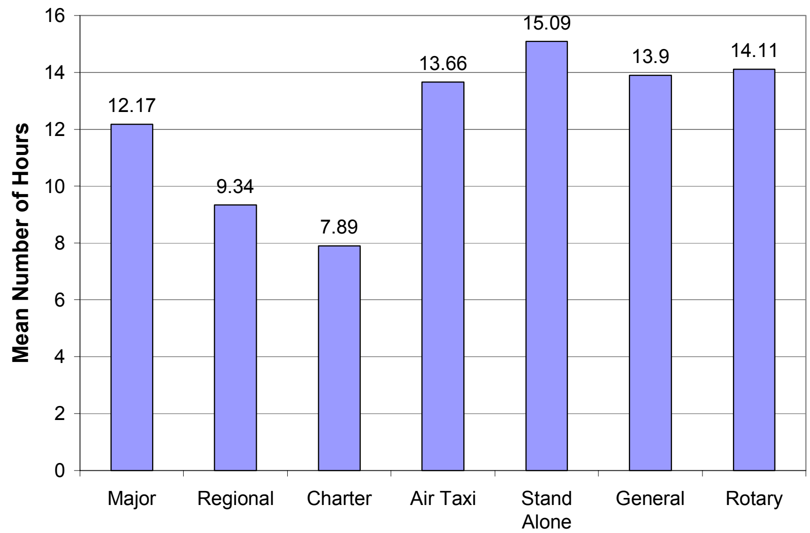


Figure 12 shows the number of mean hours AMEs are spending on work other than their AME job tasks. This includes other jobs outside work. AMEs in stand alone, rotary, general and air taxi facilities reported that they were averaging over 13 hours a week in work outside their AME job. This is in addition to between 44 and 59 hours per week spent at their AME job (Figure 3). If we consider overtime added to this (Figure 6), the mean amount of time spent working per week is between 60 and 78 hours.e.g. mean of 14 hours other work +64 hours for total duty time = 78 hours for the rotary AMEs (see Figure 13). Many individuals are working more than this.

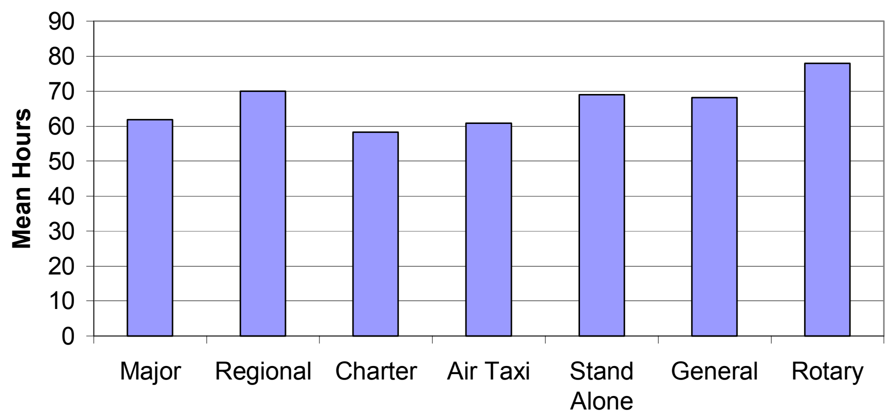
This indicates that, on average, AMEs are working well beyond the average 42 hour work-week. On the other hand, these numbers are typical of those found in other industries relying on highly trained workers in operations that are understaffed.

Figure 12: Hours per Week Spent on Duties Other Than AME Tasks
(Note only 305 AMEs responded to this question)



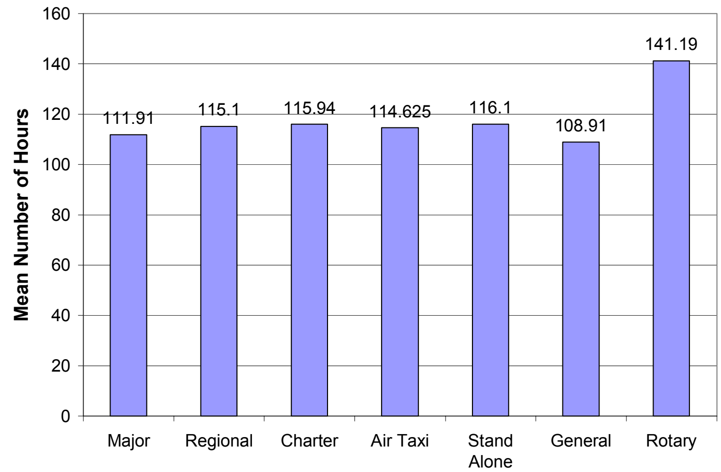
If we add the means for the hours for total duty time (including overtime) to the time spent working at other work (Figure 13), the 7-day means are considerably larger. Of the 196 AMEs (16.8 % of the sample) that answered both questions, those at major, regional, stand alone, general aviation, and rotary facilities all show a mean of over 60 hours per 7-day period. AMEs at the charter facilities reported slightly less than 60 hours.

Figure 13: Total Work Hours (duty time + overtime + other work) (n=196)



The 14-day period maximum hours worked shown in Figure 14 indicate a possibility that AMEs are working some long days with little time off, particularly those AMEs working for rotary facilities (their mean for maximum hours is significantly higher than the rest). Although some of the hours logged as work may include some “idle” time between “turning wrenches”, the AMEs in these situations still must be ready to respond to emergencies, clean equipment and tools, do the paper work and rest if possible. Sometimes the conditions for sleeping are less than ideal (e.g. a tent in the bush) and short sleep sessions may have to be obtained during the day, when the aircraft is aloft. Day sleep is always poorer than night sleep, particularly in a noisy camp.

Figure 14: Maximum Hours Worked in 14-Day Period for Facilities (n=889)



Even the means for the other facilities are high, averaging over 11 hours per day if 5-day weeks are considered, or almost 8 hours daily if these AMEs were working 14 days straight. It is evident that these maximums are consistent with the "norm" for AMEs if we look back at the numbers given for average daily hours and weekly cycles.

5.2.2 Hours of Work for Types of Work Structures

The AMEs working on an on-demand basis spend significantly more time on other work (Figure 15). AMEs working a standard shift, or standard shift with on-demand hours, work about 1 hour to 1.5 hours fewer on-demand hours per 24-hour period than those working in other work structures (Figure 16) or working more days (Figure 17).

Figure 15: Hours per Week per Cycle Spent on Duties other than AME Tasks for Work Structure (n=314)

Figure 16: Average On-Demand Hours Worked in 24-Hour Period for Work Structure (n=1002)

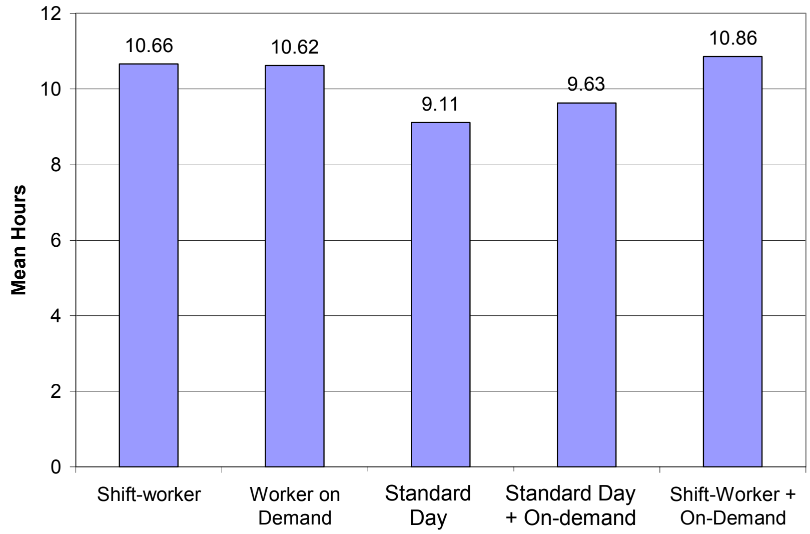


Figure 17: Average Number of Days Worked per Weekly Cycle (n=996)

AMEs working on-demand hours, wholly or in part, work significantly more hours than those working just a standard day or straight shifts. Those AMEs working on demand only averaged more hours than any other work-structure group (Figure 18). When we consider overtime added to their regular hours over a 7-day period, AMEs working on demand report much greater numbers of hours than those working in any other work structure (Figure 19). This is also consistent with their reports of longest shifts (Figure 20) where it is clear that AMEs working on demand work much longer shifts as well.

Figure 18: Average On-Demand Hours Worked in 7-Day Period for Work Structure (n=993)

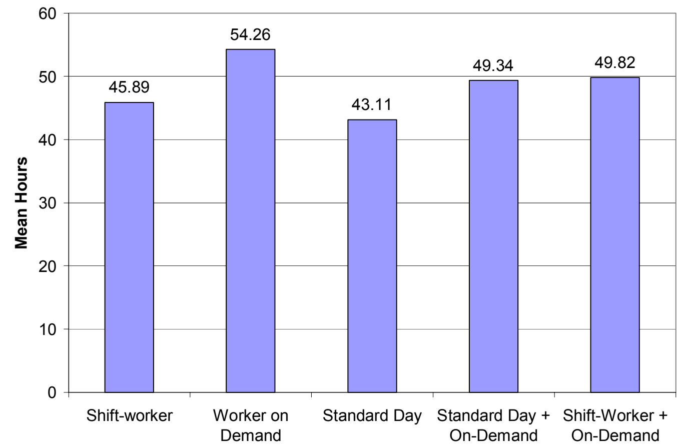


Figure 19: Average On-Demand Hours in 7-Day Period <u>Including</u> Overtime for Work Structure (n=663)

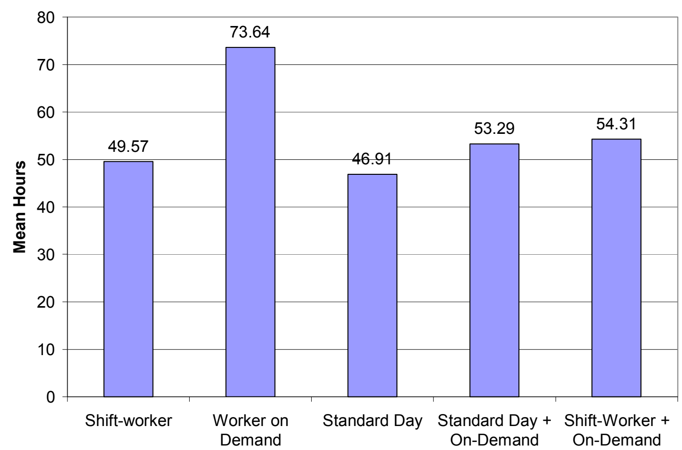
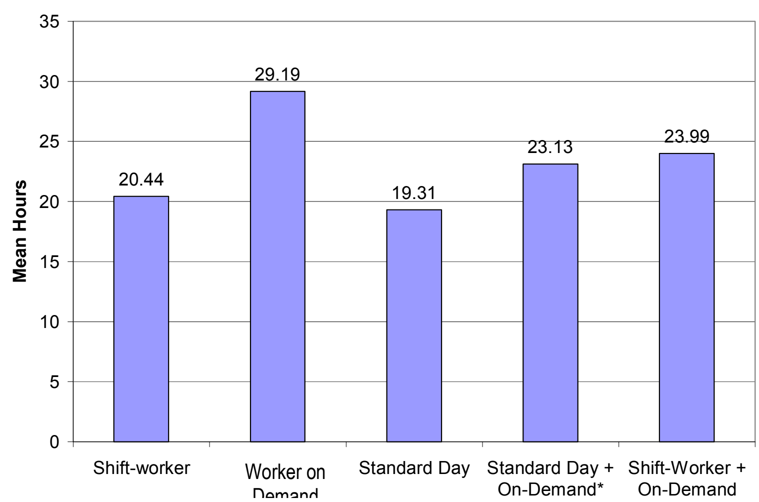


Figure 20: Longest Shift Worked for Work Structure Groups (n=762)



AMEs working on-demand hours reported more hours per week (Figure 21), although shift workers were reporting more hours than those working a standard shift, who reported the lowest number of hours.

AMEs working on demand or a standard shift plus on-demand hours reported a higher number of maximum days worked in a row, without a break (Figure 22). One of these AMEs reported working 363 days straight without a day off. Another reported 300 days in a row. That is virtually working a year without a day off. All of these days were worked with less than 5 hours of sleep in between. Figure 23 shows a similar trend for the maximum hours worked over a 14-day period, for AMEs working on demand or working a combination of on-demand and shifts.

Figure 21: Average Hours Worked Per Week over the Last Year for Work Structure (n=1111)

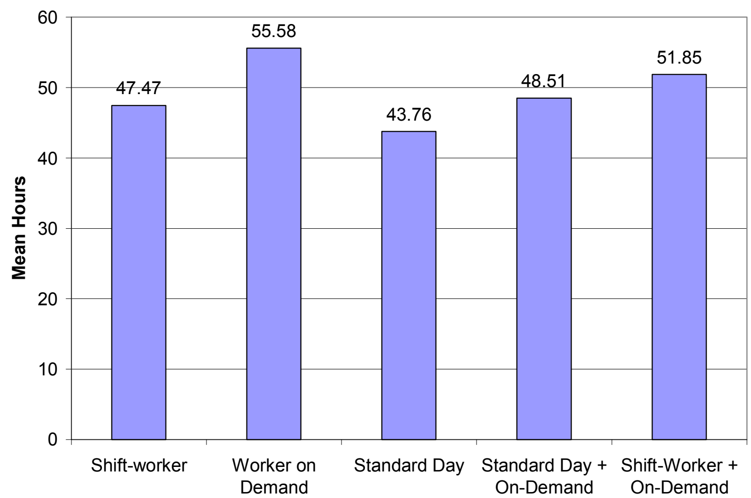
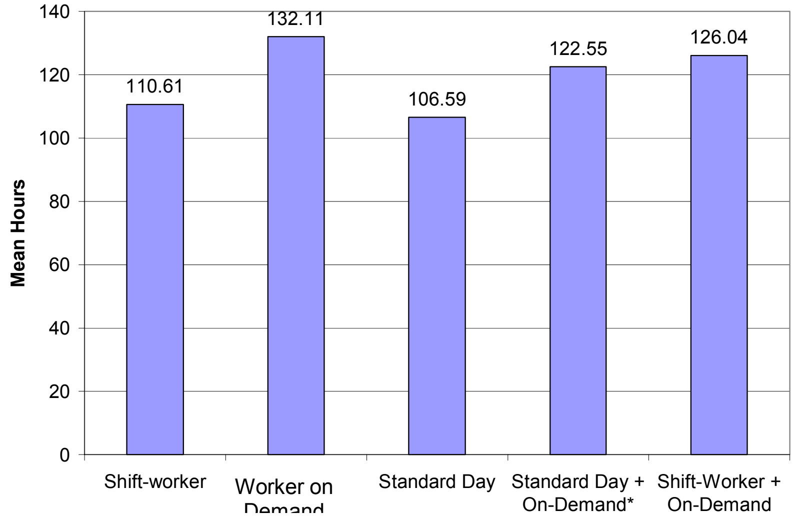


Figure 22: Maximum Number of Days, over 7, Worked in a Row, Without a Day Off, Within the Last Year for Work Structures (n=493)

Figure 23: The Maximum Number of Hours Worked for a 14-Day Period Within the Last Year (n=898)



The AMEs working in an on-demand work structure, in full or in part, report higher numbers of hours worked than do the AMEs working other shift structures. Those working a standard day or shifts appear to have a workload that is similar to most other industries where overtime is common, i.e. 52-55 hours a week, with maximums during busiest periods. However, some of the maximum reported values for individuals are extremely high, and may be considered excessive (between 80 and 144 hours per week). These extreme numbers may be paid booked time which may have included rest and down periods where little actual work was done, although the AME was "on call" the entire time. However, the fact that maximum means are well over 100 hours for a 14-day period indicates that at times AMEs must work very long hours for several days in a row. Sleep and rest during these times may not be adequate, although the data below on sleep do not reflect this.

5.2.3 Discussion of Hours of Work

The data derived from this study concerning hours of work clearly show that, overall, the AMEs in this survey do work more hours than the standard 8-hour day. More than half work shifts or fully or partly on demand, which can often include working nights. The combination of long hours and night work can lead to serious levels of fatigue. It has been shown in many field-based studies (Rhodes et al., 1993; 1996; Luna, 1997; Folkard, 1996) that the combination of night work with sleep deprivation will consistently lead to serious deficits in mental and physical performance.

Furthermore, the consistently greater numbers of hours worked by the AMEs who are working in rotary facilities and air taxi services can lead to high levels of fatigue. The long days that go into the night to meet the demands of peak periods could potentially be a problem from the perspective of safety. This can be particularly critical if the work is carried on through the night, non-stop until morning. According to Lamond and Dawson (1999), and Arnedt et al. (2001), you perform as if drunk (equivalent to at least 0.05 percent blood alcohol – the legal limit in Canada) after being awake for 18 hours, and considerably worse (equivalent to at least 0.1 percent blood alcohol content) after another 12 hours (30 hours).

Williamson et al. (2000) found that some cognitive tasks are affected even after only 11 hours (equivalent to 0.05% BAC). Long days can be dangerous and may lead to mistakes and injuries. The mean for the longest shift for some groups is close to or more than 24 hours, which means at some time these individuals were working as if legally drunk. Also, considering that this is the mean, many had worked a shift that was much longer than this, and were likely performing as if under the influence of significant levels of alcohol in the blood.

The data shows that some AME groups are working, on average, 12-14 hours per day for at least 5 days a week. This leaves very little time for getting sleep, attending to domestic responsibilities, personal hygiene and social activities. This self-reported data indicate that there is a problem with inadequate rest time between shifts and with work periods that may be excessive. The nature of the AMEs' work demands that people are well rested and able to perform at high levels of skill and ability. Long shifts have been shown to be a positive solution in many situations where complex information must be passed from one shift to the next, and where the work packages are large enough to surpass the regular eight-hour day (Axelsson et al., 1998; Heslegrave et al., 2000; Lowden et al., 1998; and Smith et al., 1998). However, they only retain this positive effect when combined with adequate rest between work cycles (Axelsson et al.; 1998; Heslegrave et al., 2000). Also, some researchers found that performance is significantly degraded on 12-hour night shifts, compared with 8-hour night shifts (Axelsson et al., 1998; Gillberg, 1998; Rosa et al., 1989; and Rosa, 1991). Another finding from the research on longer shifts is that long day shifts starting earlier than 07:00 resulted in high levels of sleepiness while on the job, and consequently reduced alertness (Gillberg, 1998).

5.3 Overtime

This section investigates the pervasiveness of overtime and the effect of overtime on sleep. Figure 24 shows that most AMEs at all facility types, except general aviation, work overtime. This is consistent with the data on duty times, above. More than half of the AMEs working at major, regional, charter, air taxis, stand alone and rotary operations work some overtime. Interviews with AMEs in general aviation facilities indicate that the use of part-time AMEs and the ability to plan most repairs mostly preclude the need for overtime. However, those AMEs working part-time can in fact be those working at other facilities for a full shift, then continuing to work for a few hours at another facility. Figure 25 indicates how many AMEs are working at another job beyond their main employer. Almost 20% of AMEs at regional and rotary operations are working at other operations, as well as for their main employer. Looking at the responses for the amount of "other work" hours given earlier (see Figure 12), the range of time per week for these "other" jobs is roughly 8 to 15 hours.

Figure 24: Distribution of AMEs Working Overtime for Facility Types (n=990)

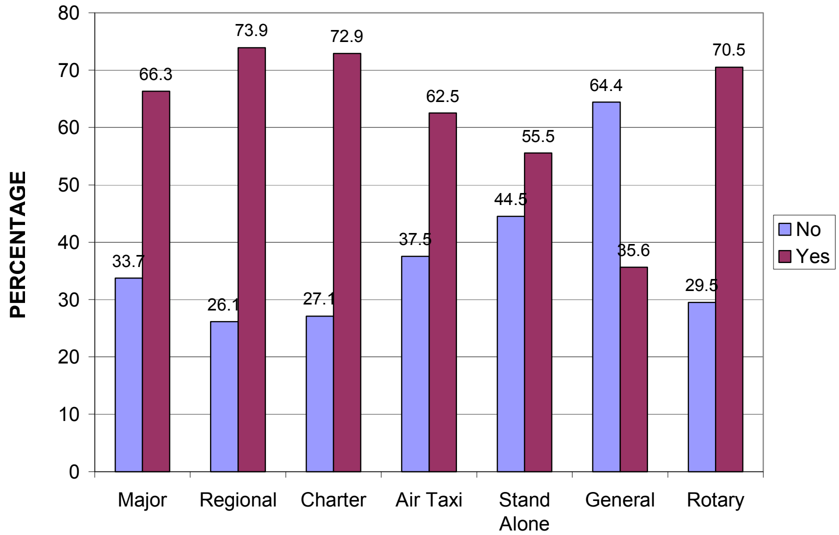
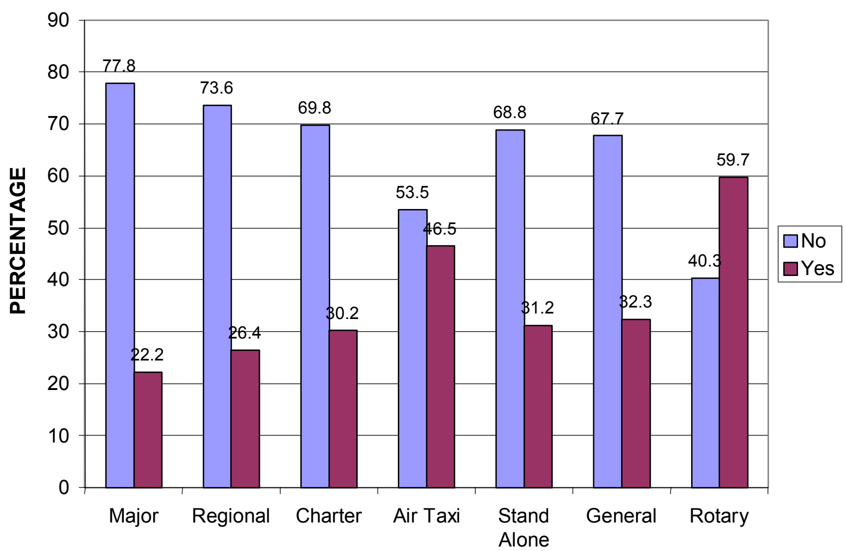


Figure 25: Distribution of AMEs Working at Other Jobs (n=1069)



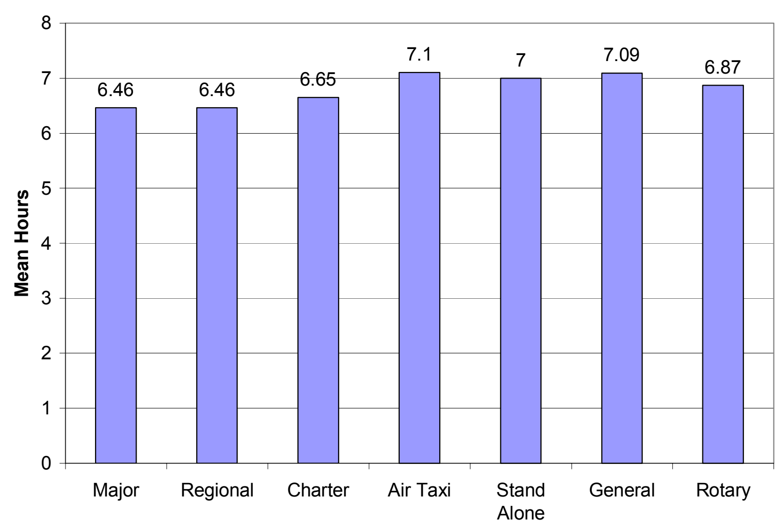
5.4 Sleep

The following figures portray the results for the various groups for sleep obtained on work days and days off. Also, the amount of sleep obtained prior to day, evening, and night shifts is shown.

5.4.1 Sleep Results for the Facility Type Groups

The AMEs working at major and regional airline facilities reported getting less sleep than the rotary, stand alone, general and air taxi services facilities (Figure 26). The data on hours worked might suggest that the AMEs at the rotary and air taxi services facilities would be the most likely to have the lower estimates of sleep. This was not the case. However, the question did ask for an estimate of average sleep, such that the figures reported by the AMEs may be a middle ground between a wide range in the duration of their sleep. It is possible that the arrangement of shifts is such that those working 10-12-hour shifts are mostly just working and sleeping on work days, and then catching up on other responsibilities on days off, which range between 3 and 7 days. Such a strategy works well on day shifts but may be less effective on night shifts.

Figure 26: Average Sleep on Work Days for Facility Type (n=1151)



The regional and rotary groups reported higher means for sleep duration on days off (Figure 27) than the other facility groups although the difference, less than 30 minutes, may be indicative of repaying a sleep debt incurred during the work cycle, particularly on nights. Day sleep may be as long in duration as night sleep, but may be less refreshing and less efficient than night sleep.

AMEs from rotary, general, stand alone and air taxi facilities all reported higher amounts of sleep prior to day shifts (sleep that occurs between approximately 22:00 and 06:00) than those from facilities at the major airlines (Figure 28). The question asked AMEs to indicate how much sleep was obtained prior to a day shift. The start time for the day shift will influence how much sleep can be obtained. If the start time is very early in the morning, most people will sleep less, keeping a "normal" bedtime. Hence, early start times often lead to day workers complaining about day-time sleepiness.

Figure 27: Average Sleep on Rest Days for Facility Type (n=1145)

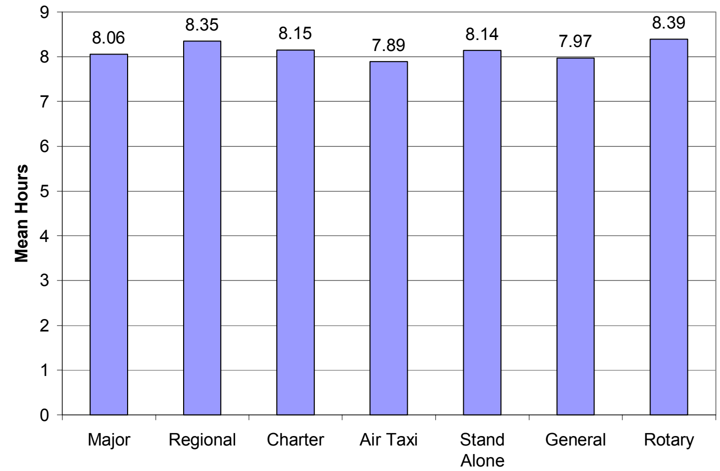
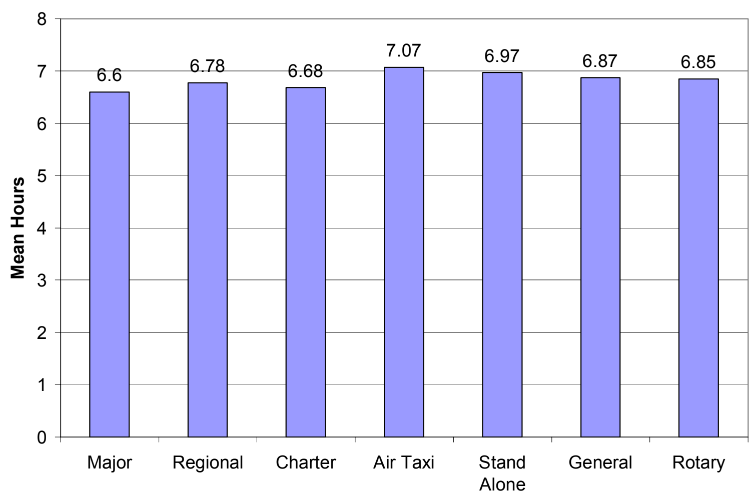
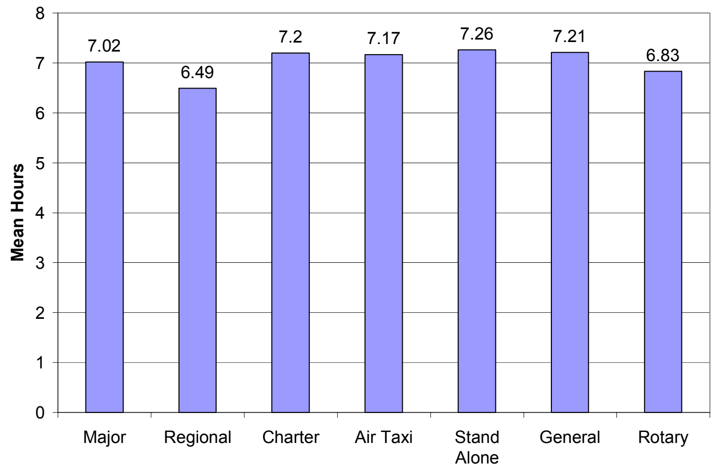


Figure 28: Average Sleep Obtained Prior to Shifts Occurring Between 06:00 and 18:00 for Facility Type (n=847)



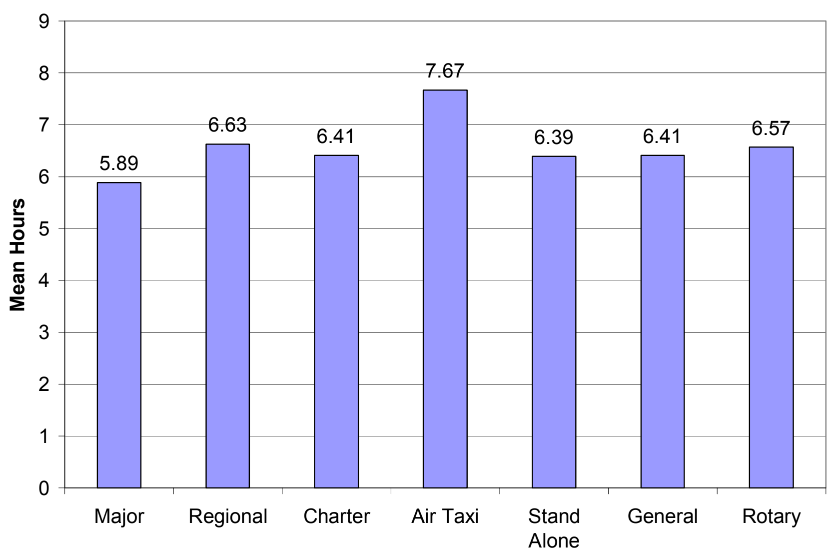
Sleep obtained prior to evening shifts is always greater in duration (Figure 29). Many shiftworkers and those who like to work irregular shifts sleep better between 00:00 and 10:00. They are considered to be owls or night-hawks. Going to bed late and sleeping in late is “natural” for them. The duration of sleep for pre-evening shift reported by AMEs shows this trend, except for the AMEs working at regional airlines and rotary facilities. More information is required to determine why this is the case.

Figure 29: Average Sleep Obtained Prior to Shifts Occurring Between 13:00 and 01:00 for Facility Type (n=458)



The amount of sleep obtained prior to night shifts is less, as shown in Figure 30. This is expected, since sleeping during the day often results in a shorter sleep period. Even with naps added on, it still may be less than that obtained at night. However, one group doesn't fit the expected trend: the AMEs working in air taxi operations. Those who work night shifts in these operations have reported a mean sleep duration that is longer than that for sleep prior to days or evenings. Since only 9 AMEs in air taxi operations answered this question, the data may be biased toward a few individuals who happen to obtain lengthy sleep periods during the day. Other explanations may exist.

Figure 30: Average Sleep Obtained Prior to Shifts Occurring Between 22:00 and 10:00 for Facility Type (n=423)



5.5 Napping and Other Coping Strategies

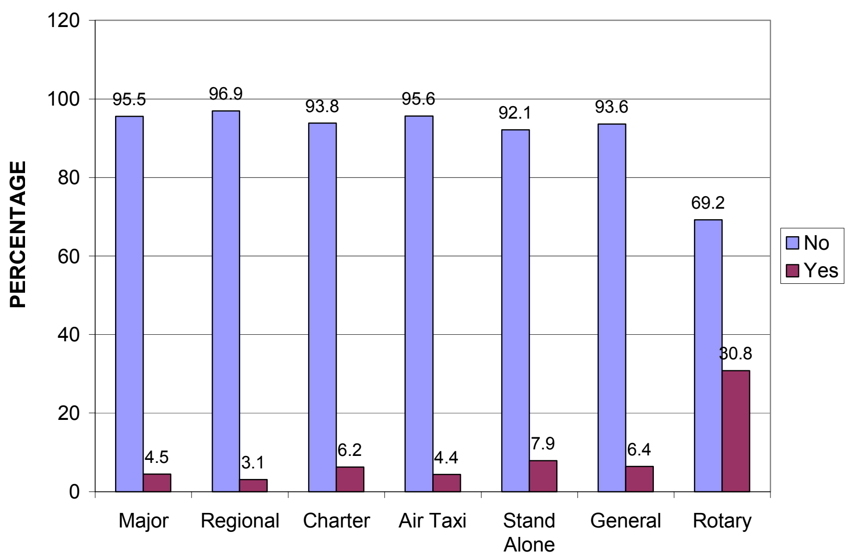
This section shows the results for questions pertaining to the use of napping and other strategies to cope with the irregular schedules worked by AMEs.

5.5.1 Naps

The section first examines the proportion of AMEs using naps and the proportion of companies allowing planned naps in the workplace.

The rotary operations appear to be more inclined to allow planned napping (Figure 31). This is consistent with the interview data. AMEs working for rotary operations who were interviewed (n=4) all stated that they were able to nap during the day while the aircraft was flying, often for an hour at a time, although sometimes longer. This is an effective strategy for these AMEs to make up for lost sleep through the night, after completing major work on the aircraft, or to make up for the very short sleep period they must have because of the late-night completion of tasks and early start in the morning. Although they get only a few hours of sleep at night, the AMEs can recover some of this sleep loss during these naps. Without the naps, AMEs working in the field assigned to an aircraft would not be able to function effectively. Hence, the prevalence of planned naps, as well as opportunistic napping, in rotary operations.

Figure 31: Planned Naps for Each Facility (n=1110)



AMEs at other facilities may not have the same opportunities for naps, and the attitude toward napping in these facilities may be less tolerant. Some AMEs interviewed did say that a few companies have acknowledged the value of planned napping, particularly at times when overtime is required, and employees may be tired. The fact that a number of facilities have 10 and 12-hour shifts for up to 7 days in a row may be reason enough to investigate this strategy further. Seven night shifts in a row may be very fatiguing for individuals having difficulty sleeping during the day. Many studies have shown that multiple night shifts do result in greater fatigue (Folkard, 1996; Heslegrave et al., 1998; Rhodes et al., 1996; and

Tepas, 1982). These AMEs may be better able to perform their tasks through a night shift if, at the low point in their circadian rhythm, they can take a 15 to 20 minute break and nap. It has been shown by a number of researchers (Dinges et al., 1988; Horne and Reyner, 1996; Stampi, 1992; and Zulley & Bailey, 1988) that this is an effective strategy.

Figure 32 shows that when AME tasks are performed mostly in the field, napping is permitted. This is consistent with the results for facilities, since most rotary AMEs work in the field. However, some stand-alone operations will send AMEs to service an aircraft in the field. It is likely that on a long difficult job during poor weather, the AME may take a nap to recover before continuing.

Figure 32: Planned Naps for Location Where Job is Performed (n=1135)

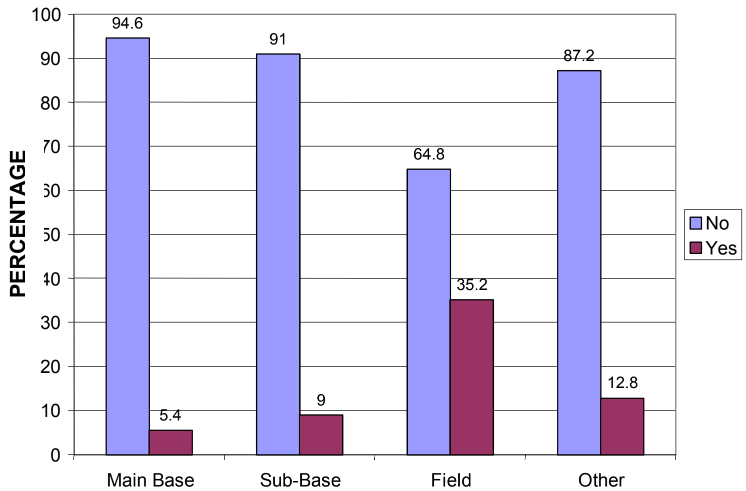


Figure 33 shows the proportion of AMEs in each facility who nap on days off. All facilities show a similar result, about 20% napping on days off. AMEs in air taxi operations do less napping on days off than those of other facilities, and a few more AMEs in the facilities at major airlines nap on days off.

Figure 33: Proportion of AMEs in Each Facility Napping on Days Off (n=511)

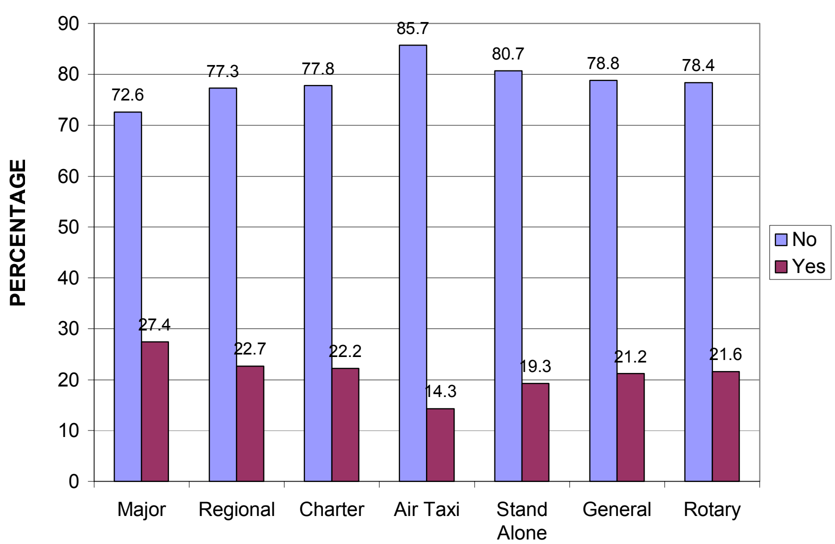
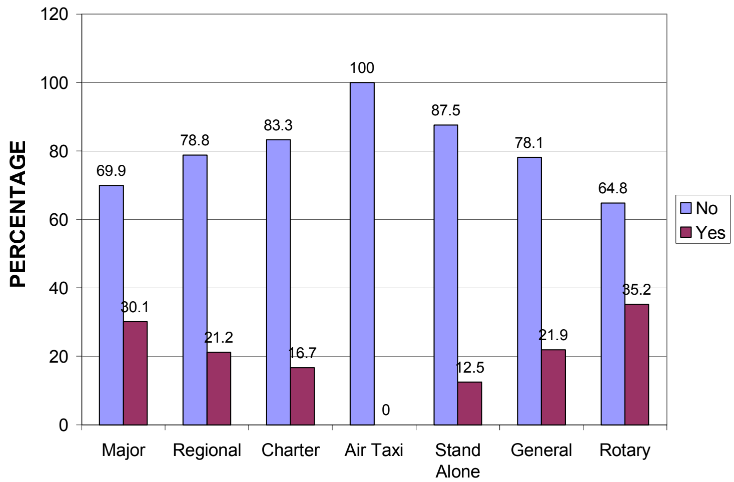


Figure 34 shows the response for napping at work. It appears that many AMEs whose companies do not allow napping were indeed napping. This may indicate that planned naps may be a consideration. Many of these naps may occur at night; however, the time of day for the rest was not requested in this survey. Other concerns may include amounts of overtime, very early starts for day shifts, and a lack of days off.

Figure 34: Proportion of AMEs Who Nap at Work for Each Facility (n=510)



5.5.2 Use of Other Coping Strategies

Some coping strategies such as alerting medications (Figure 35) were rarely used by AMEs. However, some coping strategies used by more than half of the AMEs included exercise (Figure 36) and caffeine (Figures 37 and 38), while others were moderately used (diet and bright light – Figures 39 and 40). Several of the AMEs who were interviewed mentioned the use of coping strategies to reduce fatigue. Use of light blocking blinds to keep the room dark; fans to mask outside noises; napping prior to the night shift to help them get through the early morning dip in alertness; getting exercise to keep going through long 12-hour shifts; using caffeinated drinks to keep alert while at work, particularly at night; and making sure that they got their normal amount of sleep.

Figure 35: Proportion of AMEs in Each Facility Type Reporting Use of Alerting Medications for Strategy (n=509)

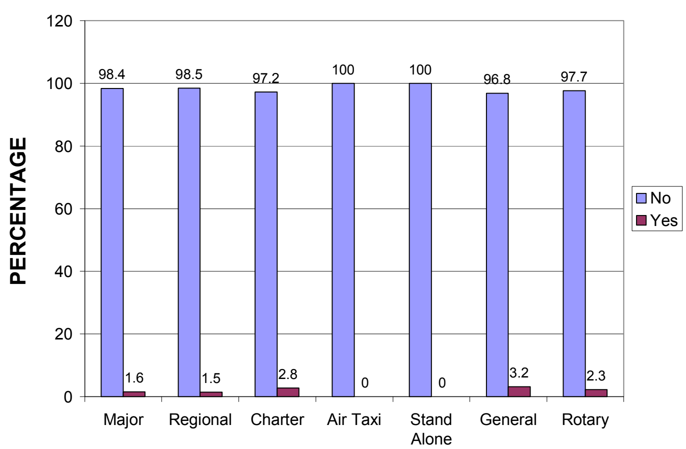
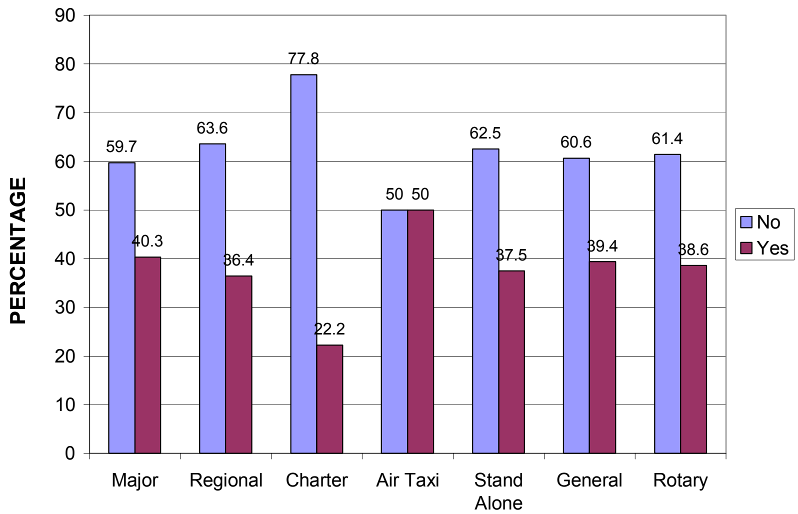
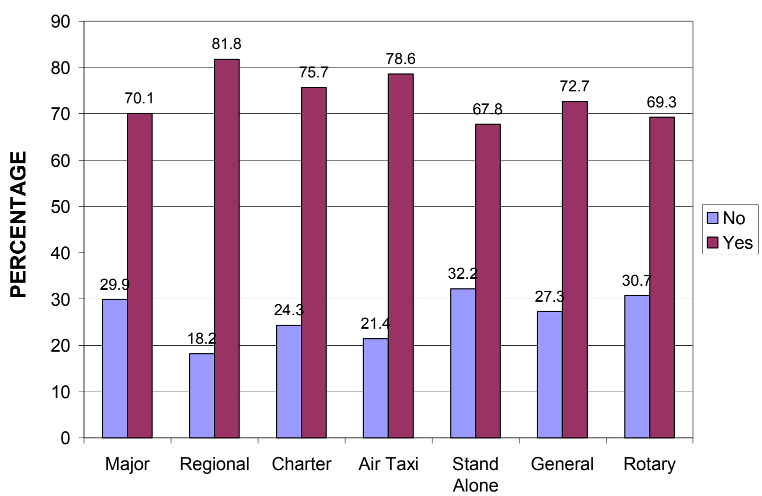


Figure 36: Proportion of AMEs in Each Facility Type Reporting Use of Exercise for Strategy (n=511)



AMEs in charter operations reported less use of exercise as a strategy to cope with their work structure, as did those north of 60. Caffeine, however, was reportedly used by almost everyone as a strategy. Those conducting their work in shops showed less use of caffeine than those working in other work locations. An interesting finding was that those who reported greater levels of fatigue on the night shift also reported using caffeine as an alerting strategy. Interview data supports this, many AMEs reporting that they use caffeine to help get through the night shift, a common strategy used by shift workers everywhere, particularly when they are carrying a substantial sleep debt.

Figure 37: Proportion of AMEs Reporting Use of Caffeine for Strategy, by Each Facility (n=515)



Diet was used less as a strategy by the charter AMEs than those in other facilities, and bright light was used most in air taxi, general and rotary facilities. It is ironic from a circadian rhythm point of view that of all of those from north of 60 (n=10) who answered this question, none uses bright light as a strategy (Figure 40). Over the last few years the use of bright light to combat Seasonal Affective Disorder (SAD) has had some success in the North, where nights can be long and can cause depression in some people. Bright light can also be used to shift rhythms and to induce alertness during night operations.

Figure 38: Proportion of AMEs Reporting Use of Caffeine for Strategy, by Work Location (n=514)

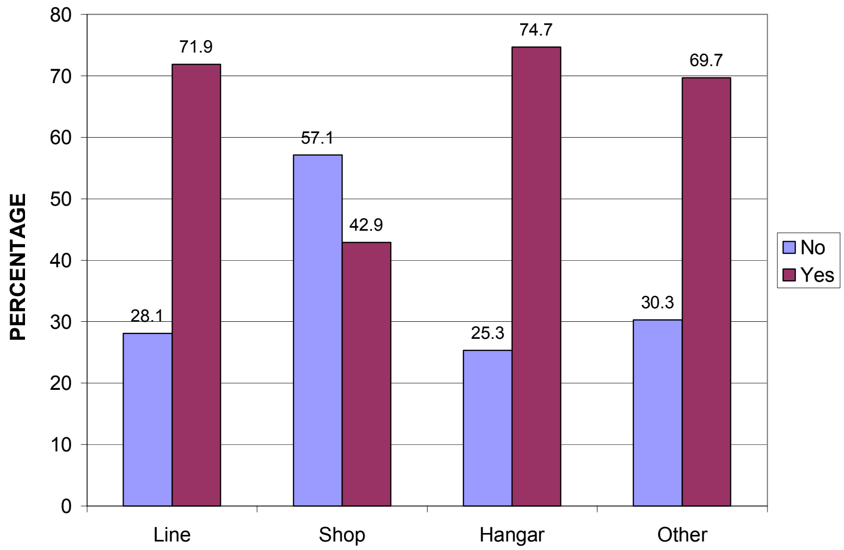


Figure 39: Proportion of AMEs Reporting Use of Diet for Strategy, by Facility Type (n=511)

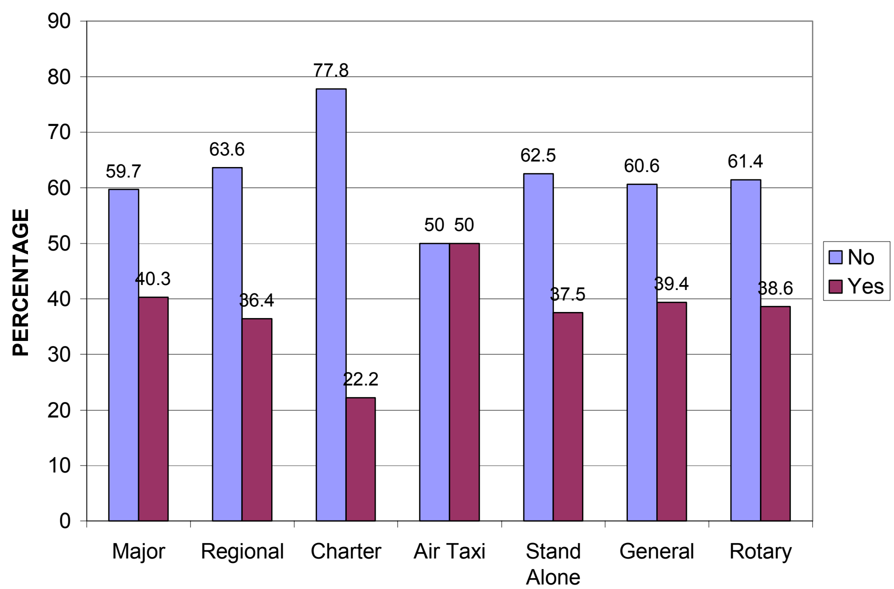
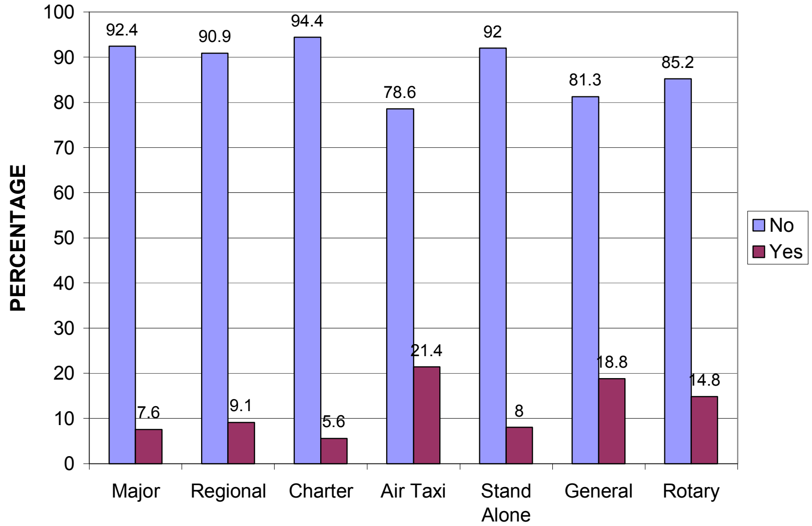


Figure 40: Proportion of AMEs Reporting Use of Bright Light for Strategy, by Facility Type (n=509)



Some AMEs interviewed who practiced several coping strategies that kept them alert and well rested, reported having fewer problems with fatigue. They treated sleep as an important element in their responsibility to their job and their families. They ensured that they have a sleep environment that, for them, is conducive to sleep, particularly during the daytime. They followed the rule that no workday ever exceeds 14 hours, and that days of this length are rare, followed by a recovery period (shorter work day immediately following, or time off). They accepted limited amounts of overtime, avoiding back-to-back overtime shifts, and working only a few hours of overtime per week. They kept regular mealtimes and maintained routines in domestic activities. Only use of caffeine appeared to be associated with increased levels of fatigue. This was likely because those who were fatigued to begin with required the stimulating effects of caffeine to function.

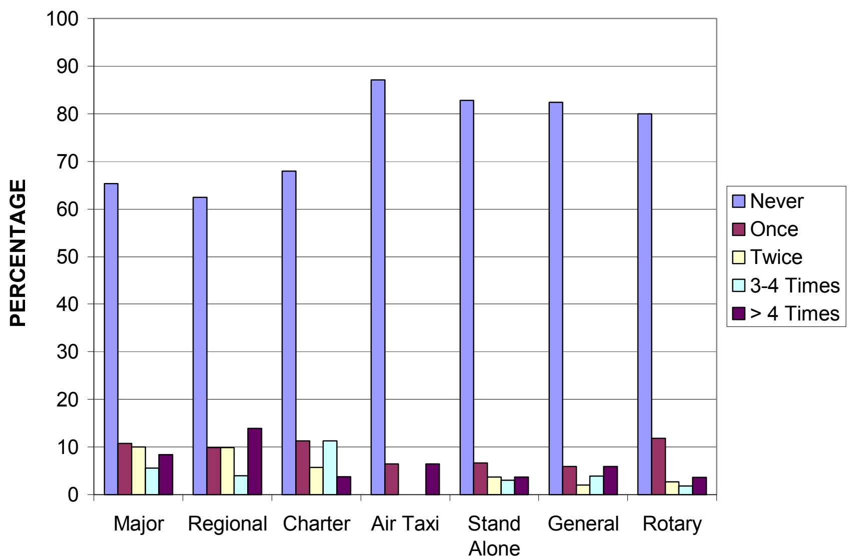
5.6 Human Performance

The reported level of performance during certain shifts and circumstances can indicate where fatigue may be affecting AMEs. If driving to and from work results in increases of falling asleep at the wheel, or if working certain shifts is reported to affect performance, an idea of the level of risk can be surmised. Typically, 30% of respondents in other surveys asking questions similar to that in question 4.9 of the present survey indicate that they have nodded off while driving to or from work (Heslegrave & Rhodes, 1997; Rhodes et al., 1993). This is considered to be only a small representation of the actual proportion of workers working shifts or irregular hours who have nodded off. A smaller proportion (18%) will admit to actually falling asleep, and even fewer will admit to having an accident (8%). According to the National Transportation Safety Board (1995) such incidents and accidents are underreported.

Although no conclusive evidence exists at the moment, subjective reports of performance may also be an underestimate. However, such reports can be revealing. It is typical to see those working shifts indicate greater negative impact on their work performance. The least reported effect of a shift on work performance usually tends to be on afternoon/evening shifts. Since many AMEs work longer shifts that are based on daytime or night-time periods (e.g. nights from 18:00 to 06:00 and days 06:00 to 18:00), or extended days while in the field such as 05:00 to 01:00, a great deal of night work is performed. Higher levels of fatigue will increase the impact on performance while working nights.

Figure 41 shows the distribution of the frequency of falling asleep at the wheel while driving to or from work. Note that between 9 and 14% of AMEs at airline facilities report that they have fallen asleep more than 4 times. Over 10% of those at charter operations report three times. The overall proportion for falling asleep for this population is on a par with that reported by other populations. Since the AMEs at airlines (charter, major and regional) work the most overtime and get the least sleep on work days, is not surprising that these AMEs also have the higher incidence of falling asleep at the wheel. More AMEs working on the line and in locations other than in shops and hangars, reported more incidents of falling asleep at the wheel.

Figure 41: Proportion of AMEs Falling Asleep at the Wheel for Each Facility (n=731)



The AMEs at airline facilities and charter operations reported a greater incidence of nodding off while driving (Figure 42). This is consistent with the results reported above in Figure 41 (falling asleep). A negative impact of less sleep and more overtime may be reflected in these results. Other factors that are consistent with earlier results also include the fact that the AMEs at airlines and charter operations are mostly shiftworkers (see Figure 43). This may reflect the impact of working shift rotations (swinging back and forth between nights, evenings and days), combined with less sleep and more overtime.

A greater proportion of AMEs working shifts and on demand reported a higher incidence of nodding off at the wheel. Those working a standard day reported fewer incidents. This clearly supports the theory that working nights is likely the main contributor to the possible fatigue that may be causing a higher incidence of nodding off. Very few AMEs reported having even a single accident caused by falling asleep or nodding off (under 3%). This is consistent with other populations. Again, however, this type of accident is probably underreported (NTSB, 1995).

Figure 42: Proportion of AMEs Nodding Off at the Wheel for Each Facility (n=760)

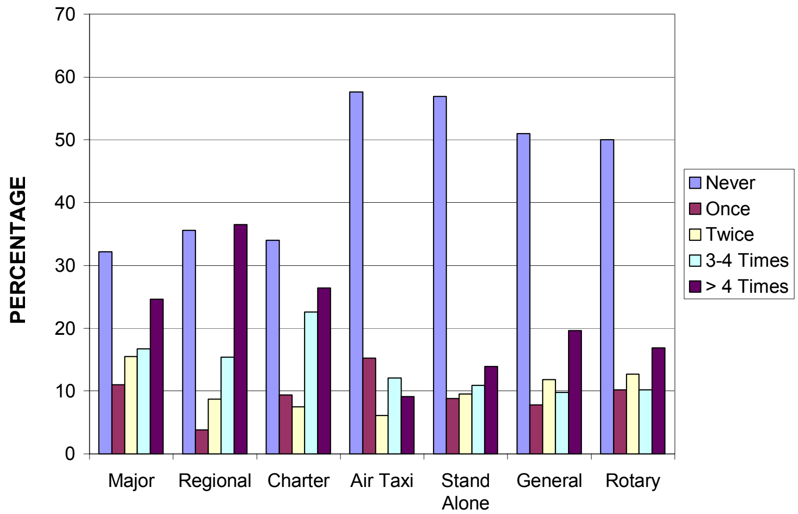
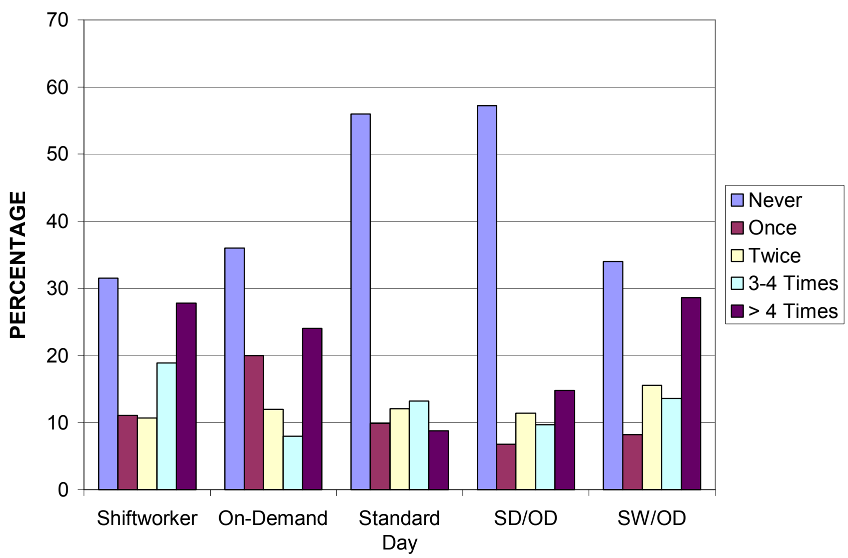


Figure 43: Proportion of AMEs Nodding Off at the Wheel for Each Work Structure (n=769)



5.7 Fatigue

Subjective impressions of fatigue can be useful indicators of how personnel view their working environment with respect to their ability to perform. Indications of high levels of subjective fatigue for certain situations should be heeded and plans for improvement pursued.

Figure 44 provides the baseline for expected levels of fatigue. Note that the majority of AMEs reported that they feel wide awake or mostly alert. Also note that more AMEs working for airline operations reported that they felt tired or very tired at the end of a standard shift. In all facility types there were some AMEs reporting that they found it difficult to stay awake after a standard shift. This may be indicating chronic fatigue where any shift will become difficult to complete.

Figure 44: Impact of Standard Shift on Fatigue for Each Facility Type (n=1033)

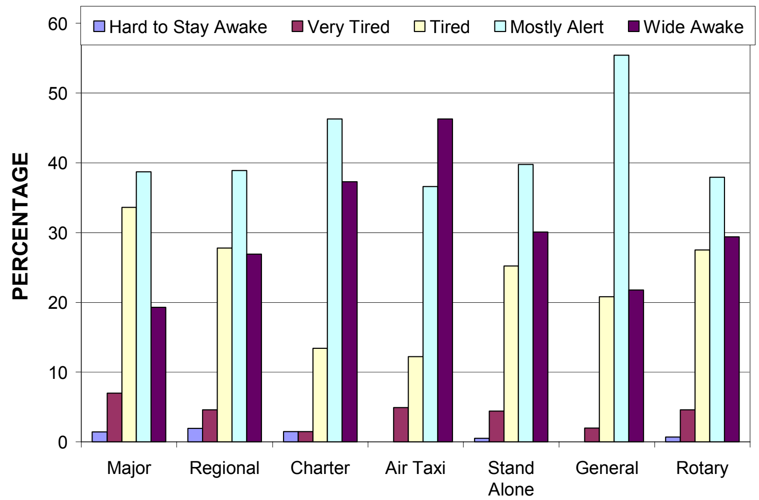


Figure 45 shows the subjective responses for estimates of fatigue that are experienced during an extended night shift (more than 12 hours). As expected, the reported levels are very high and indicate that such situations should be avoided as much as possible. In particular, the AMEs from the airlines and rotary operations indicated significantly more fatigue during these kinds of shifts. Such levels are likely to be extremely risky and should be cause for concern. Because several night shifts in a row often result in sleep debts and fatigue, extending any one of these shifts will increase the levels of fatigue personnel will experience.

The impact of cold while working extended nights appears to be not as fatiguing as just working extended nights (Figures 46 and 47). No explanation for this result is apparent, but it may be because a colder temperature may initially have an alerting effect. This is usually a short-term effect, so AMEs may not be considering the whole impact of cold on their fatigue.

The impact of heat combined with extended night shifts seems similar to that of cold in combination with extended night shifts (see Figure 48). However, the heat appears to be slightly less taxing than straight extended nights, with fewer AMEs reporting that they have difficulty staying awake. Still, this combination does appear to increase subjective fatigue considerably. According to AMEs interviewed, cold and heat do seem to increase fatigue and make doing the job more difficult. Handling tools with bare hands in sub-zero temperatures is very difficult and increases the time to complete tasks. Bulky clothing increases physical exertion and the risk of frostbite is high. This is reflected in the results according to the work environment, where it is clear that AMEs working in field operations reported higher levels of fatigue for the impact of cold during extended nights (Figure 49).

Figure 45: Impact of Extended Nights on Fatigue for Each Facility Type (n=838)

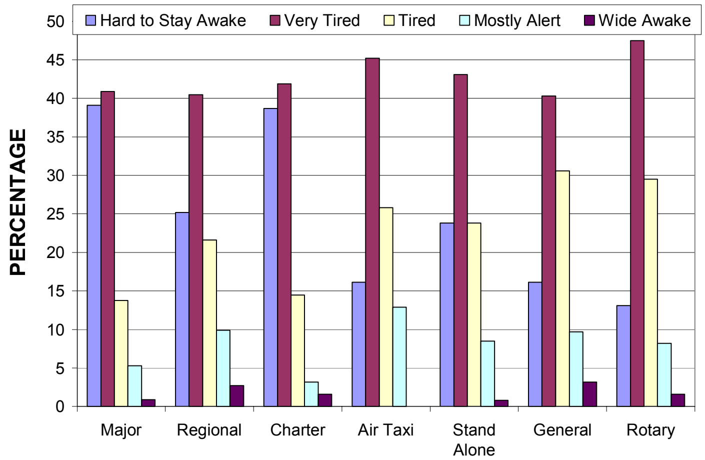


Figure 46: Impact of Cold & Extended Nights on Fatigue for Each Facility Type (n=902)

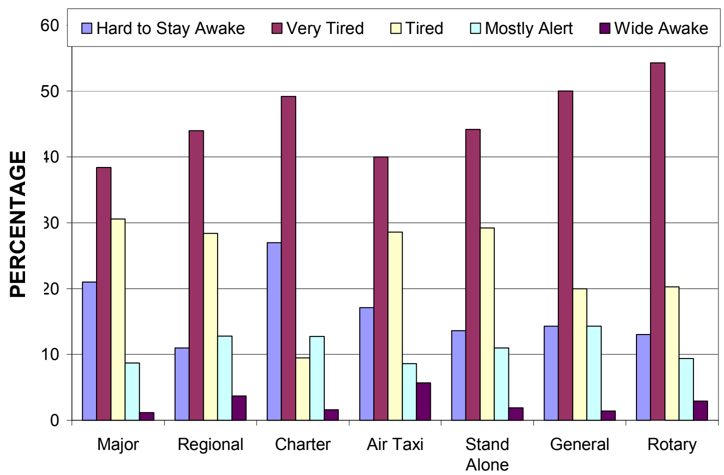


Figure 47: Impact of Cold & Nights on Fatigue for Each Work Environment (n=918)

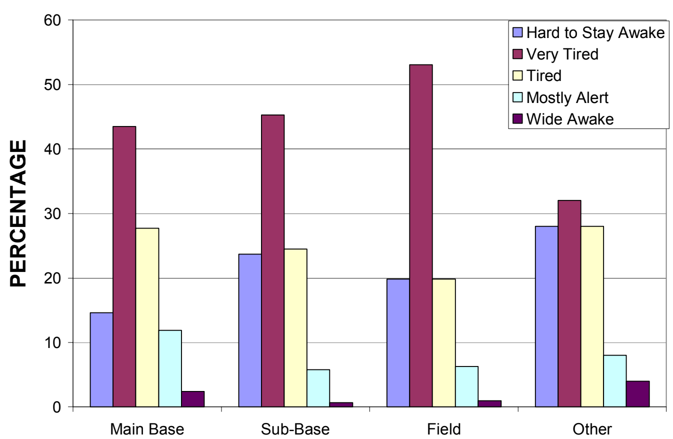
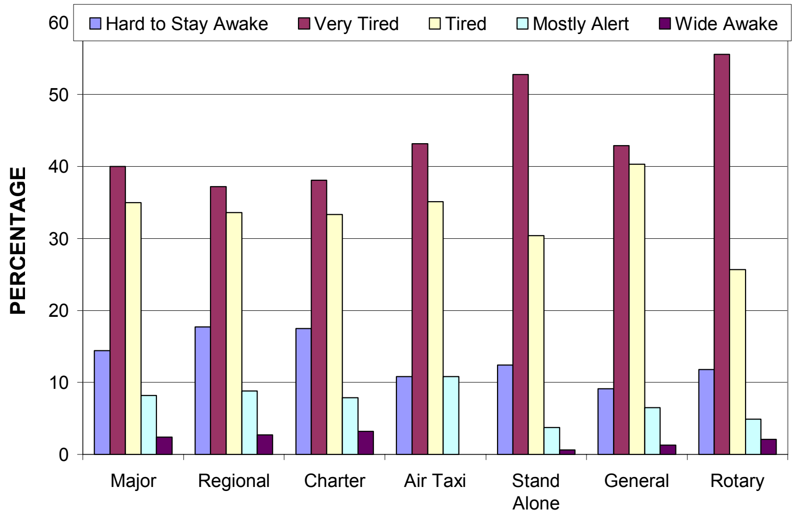


Figure 48: Impact of Heat & Extended Nights on Fatigue for Each Facility (n=935)



Like heat and cold, poor weather does not seem to worsen the level of fatigue (Figure 49). However, in Figure 50 we see that the level of fatigue reported by AMEs indicates that the poor weather does increase the fatigue levels on a standard shift. Probably, the fatigue normally experienced on a night, extended night or extended day shift masks the impact of weather, heat or cold. Figure 51 shows the effect of an extended shift. Note that more AMEs reported levels of fatigue higher than shown in Figure 44, for standard shifts.

Figure 49: Impact of Poor Weather and Extended Nights on Fatigue for Each Facility (n=912)

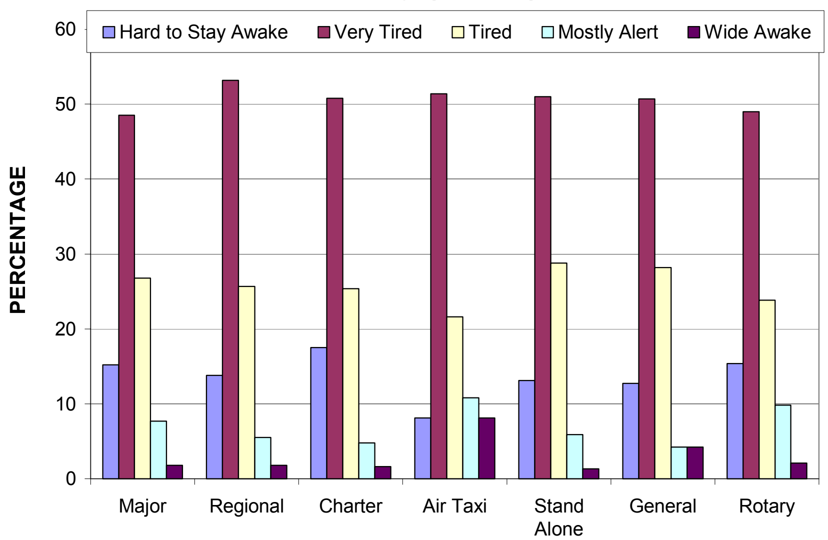


Figure 50: Impact of Poor Weather and Standard Shift on Fatigue for Each Facility (n=930)

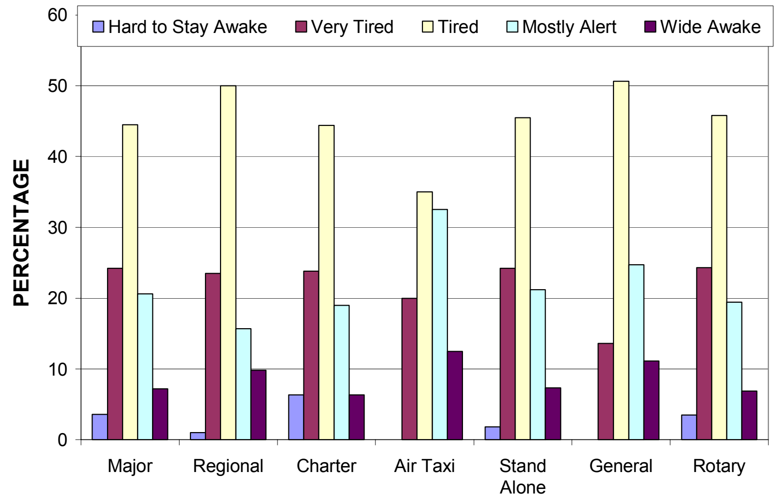
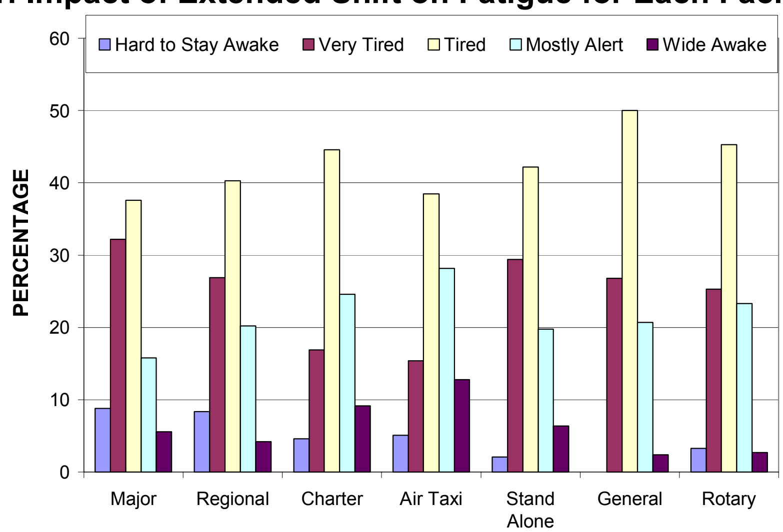


Figure 51: Impact of Extended Shift on Fatigue for Each Facility (n=996)



6. Conclusions

6.1 Hours of Work

The results of the questionnaire and interview analysis show that AMEs are generally working more than the standard 40-hour week. Most are working, on average, 48 hours per week, and often work demands push this as high as 70 hours during peak times, for some operations such as rotary, stand alone and taxi services. Interviews revealed that some operations have their own rules against this kind of overtime, limiting AMEs to daily and weekly amounts below this. The philosophy of some companies is to limit days to 14 hours, which can be worked only occasionally, and 6 days maximum, even if the hours worked amount to 48. These kinds of policies protect both the company and the AME from liability and promote a safe operation. There is evidence to suggest, however, that other, smaller operations will push the limit of hours worked by their AMEs to meet the demands of the customer. Unfortunately, this results in several long days in a row with minimal sleep and little rest. Both the interview and questionnaire data showed that these days could be as long as 14 hours, particularly when they worked on large maintenance projects, such as changing an engine. Often the AME must remain to see the job through, since passing on the responsibility to the next shift is usually too difficult to do, or there is no opportunity to pass the job on to the next shift (i.e. the next shift arrives later in the day). Where there is overlap between shifts, the AME passing on the work cannot leave until the relieving AME can proceed. In rotary operations the AME responsible is usually the only one available, so large jobs must be handled by the single AME until they are finished. This almost always means the AME must work through the night after being up most of the day. The prevalence of extended shifts is notable. Almost 10% of the AMEs are working these long shifts at least once per month. Over 12% of those at major airlines are working these long shifts more than 4 times per month. Two percent of AMEs at charter airline facilities work over 25 hours more than four times per month, while 8% of those at rotary operations work this many hours more than four times per month.

AMEs at rotary operations work on average 141 hours for each 14-day period, the highest number of hours worked overall. This translates into over 70 hours per week. A substantial number of those were beyond this amount and some even reported working almost every day of the year. Salaried AMEs work 4 hours per week more, on average, than those who are paid hourly.

6.2 Sleep

Most of the AMEs reported that they obtained adequate sleep (ranging from 6 to 8 hours) during workdays. This may not be the case, since most of these AMEs would require from 7 to 8.5 hours of sleep (the range according to most sleep researchers) to feel fully refreshed and at peak performance. On the other hand, researchers (Naitoh, 1992, provides a review of this research) studying people in continuous operations such as military or disaster response teams, found that 4.5 to 5.5 continuous hours of sleep were required to maintain minimal performance. However, only reaction time and vigilance tasks were involved. Probably, adequate performance on memory, decision-making and reasoning tasks may not be maintainable during such reduced sleep periods (Rhodes et al., 1996; Dinges & Kribbs, 1991). Short naps would likely be necessary to reduce the effects of lost sleep (Stampi, 1992). Unfortunately, napping for a few minutes every few hours in order to maintain adequate performance may not be convenient.

Sleep obtained prior to a night shift was less than that obtained during the night, and was probably barely enough. AMEs in rotary operations were sometimes able to get some sleep when they had finished cleaning and repairing equipment at the base, doing their paperwork and attending to other chores. This sleep wasn't always restful, and sometimes would be obtained in a noisy camp. Sleep at night, after getting the aircraft ready to fly in the morning, would be short, since the aircraft had to be ready to fly at daybreak. Since many rotary operations are flying north of 60, the nights would be extremely short.

In addition, on-call situations are common for many operations, and rules must be applied to ensure that AMEs obtain the rest they need. Since work hours are usually high, the added stress of waiting to be called has been known to lead to fatigue. Sleep during a period where an AME is on call is usually less restful and less efficient. Hence, AMEs must alternate this responsibility so that at least the half of their work days are free from this kind of pressure. Many AMEs are working 10 to 12 hour shifts that rotate such that one cycle is a string of nights or days, and the next is the opposite, with as many days between for rest. This may be 4 days on, 4 days off, 5 days on, 5 days off, or 7 days on, 7 days off, for example. This kind of work structure includes several nights in a row and can lead to a building sleep debt if sleep during the day is inadequate. Interview data showed that those AMEs who could obtain sleep close to the "natural" amount of sleep they need to function well managed better than those who could not get enough day-time sleep.

6.3 Performance

Generally, AMEs reported that work performance is degraded on extended shifts and nights. Over 30% indicated that their performance was seriously affected when having to work overtime, particularly on night shifts. This is a common response from personnel working shifts and irregular hours. It is clear, also, that long shifts, combined with many consecutive nights, affects AME performance, as shown by the fact that those working in shift-based and on-demand work structures face the highest incidence of falling asleep or nodding off while driving.

6.4 Napping and Other Coping Strategies

Napping is allowed by rotary operations, where more opportunities for naps occur, and the long workdays, with much of the work occurring at night, can lead to fatigue and poor performance. The AMEs in rotary operations have found that getting sleep when possible is critical for maintaining performance during their irregular work hours. Many AMEs in operations where napping is not allowed report that, in fact, they do nap. This indicates that AMEs in such operations generally sustain a certain level of sleep deprivation. It is likely that several factors are involved, including overtime levels, early morning starts, many nights worked in a row and the prevalence of work hours outside their main job, as well as personal activities that interrupt sleep (a newborn in the family, for example). For AMEs, caffeine is the strategy of choice for coping with fatigue. Exercise, napping and diet are the second, third, and fourth most commonly used strategies.

6.5 Modification of Sleep on Days Off

Over 60% of AMEs working shifts or shifts in association with on-demand hours modify their sleep on days off, and maintain different sleep-patterns from those followed during work days. Only those working on-demand hours or a standard day shift do not modify their sleep on days off. That means that most of those working nights are going back to night-time sleeping on their days off. This precludes any beneficial shift in circadian rhythm, resulting in a certain amount of circadian disrhythmia. Those AMEs interviewed acknowledged that if they slept too long during the day immediately following their last midnight, they were unable to sleep that night, and were somewhat “out of sorts” for the first two days of their days off. However, if they slept for only a couple of hours on the first day off and got a good sleep that night, the slight feelings of disorientation were effectively reduced.

6.6 Fatigue

During extended shifts or shifts during poor weather, cold or heat, the majority of AMEs reported that they were very fatigued by the end of the shift. About 10% of the AMEs indicated that they found it hard to stay awake after an extended night shift. This is in sharp contrast to the ratings AMEs gave for standard shifts, where the majority of AMEs were mostly alert or wide awake. Most AMEs also reported that they are tired at the end of midnight shifts, while another 20% reported that they are very tired at the end of their night shift.

7. Discussion of Findings

The effect of fatigue on aircraft maintenance operations is not well understood at this time, but preliminary information is available (Sian & Watson, 1999). However, the impact of fatigue on personnel and operations in aviation and other industries has been studied and the results are clear. Poor and inadequate sleep, prolonged periods of wakefulness, and heavy workloads do lead to fatigue that will degrade performance. Working through the night results in degraded performance compared to day work. A sleep debt (sleep loss) combined with night work results in degraded performance. Even more severe degradation in performance will occur for those working extended shifts into the night.

The chances are good that an AME may experience situations where these conditions occur. Many AMEs work half their shifts at night. The night operation in an airline or stand-alone facility, for example, is often busier than the day operation. The scheduling often requires that the AME work a 12-hour day or night, for 4 to 7 days in a row. This often results in sleep loss due to poorer sleep during the day, if working nights. This sleep debt becomes progressively worse as the work cycle wears on. Add overtime to the end of the shift, or during a day off, and the opportunity for sleep may be diminished, while increased fatigue may occur from the additional workload.

Rest days are sometimes the only time an AME has to recover lost sleep, meet domestic responsibilities and socialize. Working on days off, after working long shifts during a work cycle, may not leave enough time to catch up. Studies have shown that this may increase stress at home and at work. It can lead to chronic fatigue that will affect performance at work and outside work. Mood can be depressed, and physical health may be compromised. Working after the completion of a work shift, such as at another job, risks working beyond the limit where performance becomes seriously degraded. This is particularly true for AME operations, since certain maintenance jobs do require a push to complete job tasks, because of scheduling constraints or the nature of the job itself (e.g. continuity in the job tasks is crucial, or special expertise is required).

The findings of this study indicate that there is evidence to suggest that some AMEs in Canada are at times fatigued and may be pushing the limit. Their fatigue may be chronic, as evidenced in the results for AMEs at airline facilities, or both acute and chronic, as may be the case for bush and rotary operations. Napping strategies for field operations is a feasible approach to reducing fatigue caused by irregular, long-duration work periods. It is less clear if napping might be incorporated into hangar or shop environments. The preferred alerting strategy by most AMEs is the use of caffeine drinks to get through the night. Some of the AMEs who were interviewed commented that they used many of the strategies mentioned in the questionnaire (e.g. good sleep preparation techniques) to get to sleep and to plan for their sleep periods. These individuals also stated that they found these strategies helped them maintain better alertness at work. Improving the sleeping environment, ensuring that the body and mind are ready for sleep, and making sure that sleep is obtained at the optimal time are important elements for obtaining restful sleep. Many AMEs appear to be aware of some of these strategies, but would benefit from information on others, to allow them to tailor their approach to their own requirements.

In addition, the companies need to look at scheduling practices and rules for overtime. Where some control over these aspects of the work environment exists, maintenance operations need to consider the human limits of their personnel. Where appropriate, companies need to consider providing adequate food storage and preparation facilities, properly equipped napping areas, napping/rest periods built-in to the night-time schedule, and well-lit work areas that are maintained at a comfortable temperature and humidity. Where these kinds of strategies are not feasible (e.g. in the field or in smaller operations) greater attention must be paid to work and rest hours, staff levels and work demands.

A fatigue management program that consists of educational, scheduling, and evaluation components may be necessary to reduce the risks of fatigue-related mishaps and errors. The need to find ways to reduce fatigue in AME operations is real and of a magnitude that deserves attention. Further justification, besides the present study results, for investment in a fatigue management program could come from a fatigue-risk analysis. This type of analysis can identify those critical tasks that are susceptible to fatigue effects, the types of errors that could occur and the likely frequency of their occurrence. This information would allow Transport Canada to estimate the level of risk posed by fatigue-related errors.

However, any program developed for AME operations should be tailored for AMEs and their unique circumstances. This may mean having different versions of the program, each geared toward certain types of operations: rotary/bush operations; large maintenance facilities; and smaller stand-alone operations.

8. Future Options

The following options are suggested to help alleviate the fatigue issues indicated by the results of the survey.

- Assessment of AME tasks that are susceptible to fatigue in all types of work environments;
- Development of FMP guidelines for AMEs, tailored for the different types of operations; and
- Pilot testing of the FMP guidelines, using the evaluative component to ascertain its effectiveness.

Each of the FMPs guidelines should consist of the following components:

- FMP planning guidelines;
- Educational components for:
  - AMEs;
  - Supervisors and Managers; and
  - Trainers;
- Guidelines for schedule development;
- Evaluation component (using pre-post questionnaires, interviews, measurement of relevant statistics); and
- Duty-time requirements.

References

Arnedt, J., Wilde, G., Munt, P., & MacLean, A. (2001) How do prolonged wakefulness and alcohol compare in the decrements they produce on a simulated driving task*? Accident, Analysis and Prevention*, 33 (3): 47-54.

Axelsson, J., Kecklund, G., Åkerstedt, T., & Lowden, A. (1998) Effects of alternating 8- and 12-hour shifts on sleep, sleepiness, physical effort, and performance. *Scand. J. Work Environ. Health*, 24 (suppl 3): 62-68.

Bosley, G., Miller, R., & Watson, J. (1999) *Evaluation of aviation maintenance working environments, fatigue, and human performance*. FAA report. Federal Aviation Administration.

Dawson, D. & Reid, K. (1997) Fatigue, alcohol, and performance. *Nature*, 388: 235.

Dinges, D. & Kribbs, N. (1991) Performing while sleepy: effects of experimentally-induced sleepiness. In Monk, T. (ed.) *Sleep, Sleepiness, and Performance*. New York; John Wiley & Sons.

Dinges, D., Whitehouse, W., Orne, E., & Orne, M. (1988) The benefits of a nap during prolonged work and wakefulness. *Work Stress*, 2:139-153.

Folkard, S. (1996) Effects on performance efficiency. In Colquhoun, W.P, Costa, G., Folkard, S., & Knauth, P. (eds.) *Shiftwork: Problems and Solutions*. pp 65-88 New York; Peter Lang.

Foushee, H., Lauber, J., Baetage, M., & Acomb, D. (1986) *Crew factors in flight operations – III: The operational significance of exposure to short-haul air transport operations*. NASA Technical Memorandum 89452. Moffett Field, CA; NASA Ames Research Center.

Gander, P., Graeber, C., Connell, L., Gregory, K., Miller, D., & Rosekind, M. (1998a) Flight crew fatigue I: objectives and methods. *Aviat. Space and Environ. Med.*, 69 (9) – Section 2: B1-7.

Gander, P., Rosekind, M., & Gregory, K. (1998b) Flight crew fatigue VI: a synthesis. *Aviat. Space and Environ. Med.*, 69 (9) – Section 2: B49-60.

Gillberg, M. (1998) Subjective alertness and sleep quality in connection with permanent 12-hour day and night shifts. *Scand. J. Work Environ. Health*, 24 (suppl 3): 76-81.

Heslegrave R.J, & Rhodes W. (1997) Impact of varying shift schedules on the performance and sleep in air traffic controllers. *Sleep Research,* 26: 198.

Heslegrave, R., Gil, V., & Rhodes, W. (1998) *Survey of Plant Shiftworkers Changing from 9.5-Hour to 12-Hour Shifts*: Final Report. For Hydro Québec.

Heslegrave, R.J., Rhodes, W., & Gil, V. (2000). A prospective study examining the changes to worker health and safety after shifting from 9 to 12.5-hour shifts. In S. Hornberger, P. Knauth, G. Costa, and S. Folkard (Eds.), *Shiftwork in the 21st Century: Challenges for Research and Practice*. Frankfurt, Berlin, Bern, New York, Paris, Vienna: Peter Lang.

Horne, J. & Reyner, L. (1996) Counteracting driver sleepiness: effects of napping, caffeine, and placebo. *Psychophysiology,* 33: 306-309.

Johnson, W., Mason, F., Hall, S., & Watson, J. (2001) *Evaluation of aviation maintenance working environments, fatigue, and human performance*. FAA Report. Federal Aviation Administration.

Lamond, N. & Dawson, D. (1999) Quantifying the performance impairment associated with fatigue. *J. Sleep Res*., 8: 255-262.

Lowden, A., Kecklund, G., Axelsson, J., & Åkerstedt, T. (1998) Change from an 8-hour shift to a 12-hour shift, attitudes, sleep, sleepiness, and performance. *Scand. J. Work Environ. Health*, 24 (suppl 3): 69-75.

Luna T., French J., & Mitcha J. (1997) A study of USAF air traffic controller shiftwork: sleep, fatigue, activity, and mood analyses, *Aviat. Space and Environ. Med.,* 68(1):18-23.

Nagel, D. (1988) Human error in aviation operations. In Weiner, E. & Nagel, D. (eds.) *Human Factors in Aviation*. New York; Academic Press.

Naitoh, P. (1992) Minimal sleep to maintain performance: the search for sleep quantum in sustained operations. In Stampi, C. (ed.) *Why We Nap*. Boston; Birkhaüser.

National Transportation Safety Board (1995) *Safety study: Factors that affect fatigue in heavy truck accidents*. NTSB report PB95-917001/NTSB/SS-95/01.

Rhodes, W., Heslegrave, R., Ujimoto, K.V., Hahn, K., Zanon, S., Marino, A., Côté, K., Szlapetis, I., & Pearl, S. (1996) *Impact of Shiftwork on Air Traffic Controllers, Phase II: Analysis of Shift Schedule Effects on Sleep, Performance, Physiology and Social Activities*. TP 12816E Transportation Development Centre Report.

Rhodes, W., Szlapetis, I., Hahn, K., Heslegrave, R., & Ujimoto, K.V. (1993) *Impact of Shiftwork on Air Traffic Controllers, Phase I: Determining Appropriate Research Tools and Issues*. TP 12257E Transportation Development Centre Report.

Rosa, R. (1991) Performance, alertness, and sleep after 3.5 years of 12-hour shifts: a follow-up study. *Work Stress,* 5: 107-116.

Rosa, R., & Colligan, M. (1989) Extended workdays: effects of 8-hour and 12-hour rotating shift schedules on performance, subjective alertness, sleep patterns, and psychosocial variables. *Work Stress*, 3: 21-32.

Rosekind, M., Gander, P., Gregory, K., Smith, R., Miller, D., Oyung, R., Webbon, L., & Johnson, J. (1996) Managing fatigue in operational settings I: Physiological considerations and countermeasures. *J. of Behav. Med.*, 21:157-165.

Sian, B. & Watson, J. (1999) Chapter 11: Study of fatigue factors affecting human performance in aviation maintenance. In *FAA Research 1989 - 2001/Human Factors in Aviation Maintenance and Inspection/FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase Reports (1991-1999)*. Federal Aviation Administration.

Smith, P., Wright, B., Mackey, R., Milsop, H., & Yates, S. (1998) Change from slowly rotating 8-hour shifts to rapidly rotating 8-hour and 12-hour shifts using participative shift roster design. *Scand. J. Work Environ. Health*, 24 (suppl 3): 55-61.

Stampi, C. (1992) The effects of polyphasic and ultrashort sleep schedules. In Stampi, C. (ed.) *Why We Nap*. Boston; Birkhaüser.

Stokes, A. & Kite, K. (1994) *Flight Stress: Stress, Fatigue, and Performance in Aviation*. Brookfield; Ashgate.

Tepas, D. (1982) Work/sleep time schedules and performance. In Webb, W. (ed.) *Biological Rhythms of Sleep and Performance*. Chichester; John Wiley & Sons.

Watson, J. (1999) Introduction. In *FAA Research 1989 - 2001/Human Factors in Aviation Maintenance and Inspection/FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase Reports (1991-1999)*. Federal Aviation Administration.

Williamson, A., Feyer, A.-M., Friswell, R., & Finlay-Brown, S. (2000) *Demonstration Project for Fatigue Management Programs in the Road Transport Industry: Summary Findings*. Road Safety Research Report CR-192; Australian Transport Safety Bureau.

Zulley, J. & Bailey, J. (1988) Polyphasic sleep/wake patterns and their significance to vigilance. In Leonard, J. (ed.) *Vigilance: Methods, Models, and Regulation*. Frankfurt; Peter Lang, 167-180.

APPENDIX A: AME HOURS OF WORK QUESTIONNAIRE

Evaluation of Duty Times Worked by Personnel in the Aircraft Maintenance Industry

This survey is a Transport Canada Civil Aviation initiative, and is being conducted by an impartial third party (Rhodes & Associates Inc., Human Factors Consultants). All information obtained by this survey is confidential. Do not submit your name, or the name of the company you work for.

Only Rhodes & Associates Inc. will see the information you provide, and only group data will be reported. The results of this survey are for information purposes only and will be used to make up a profile of the aviation maintenance industry. The questionnaire will take about 30 minutes to complete. Please try to return the completed questionnaire to Rhodes & Associates Inc. by March 30, 2001.

1. Objective of the Survey:

Transport Canada has contracted a company that specializes in shiftwork issues and human fatigue. This survey will help these researchers determine the level of fatigue experienced by aircraft maintenance workers. The information will help maintenance staff, their companies and Transport Canada better understand what operational policies, procedures and programs make sense from point of view of safety.

The data collected will be used to assess average shift times, working conditions and hours of work in the industry. The intent is to use this information to determine the type of educational and awareness activities that may be required to better ensure worker and public safety.

2. Point of Contact:

Transport Canada

Jacqueline Booth-Bourdeau
Aircraft Maintenance & Manufacturing (AARPC)
330 Sparks Street, floor 2
Ottawa, ON
K1A 0N8
Tel: (613) 952-7974
Fax: (613) 952-3298
E-mail: boothbj@tc.gc.ca

Rhodes & Associates Inc.

Wayne Rhodes, Ph.D., C.P.E.
President
177 Jenny Wrenway
Toronto, ON
M2H 2Z3
Tel: (416) 494-2816
Fax: (416) 494-0303
E-mail: wayne-rhodes@home.com

3. Where to Send the Questionnaire

Please use the enclosed postage-paid envelope to return the questionnaire, by mail, to Rhodes & Associates Inc. (Rhodes & Associates Inc.'s address is printed on the enclosed envelope). Please do not give the completed questionnaire to anyone else, or you may compromise the confidentiality of your data.

NOTE: In preparing this survey we have identified your language of choice based on the AMEs Licensing database. If you would like this survey in another official language please contact Wayne Rhodes immediately.

NOTE: Lors de la préparation de ce sondage, le choix de langue a été identifié d'après l'information retrouvée dans la base de données des licences TEA. Si vous désirez compléter ce sondage dans l'autre langue officielle, contactez Wayne Rhodes sans délai.

Please read the following information carefully and thoroughly. All responses must be anonymous. Try to answer each question. However, if any questions make you uncomfortable, you may skip them. Thank you for your time.

Section 1. General Information

1.1 Personal Information: Please check all of the appropriate boxes:

Gender: Male Female

Age: ______

Have Children?: Yes No

Marital Status:

Married/Living with Partner Single

Widowed Divorced/Separated

1.2 Which facility type best applies to your current job? (Please check only one box)

Major Airline

Regional Airline

Major Airline (Charter Operation)

Air Taxi Operation

Stand alone Approved Maintenance Organization

General Aviation

Rotary Operation

1.3 Please indicate your Primary Role/Position. (Please check the appropriate box(es))

Airframe

Avionics

Shop/Component

Other

Powerplant

Quality Assurance, Inspection

1.4 Number of years of aviation experience? ____________ years

1.5 Number of years of experience in current position? ____________ years

1.6 Any previous experience working shifts? Yes No

1.7 In which location do you perform most of your duties? (Please check only one box)

Line Shop Hanger Other (please specify) __________________

1.8 What kind of environment do you work in most of the time: (Please check only one box)

Main base Sub-base Field Other (please specify) __________________

1.9 How often do you work outdoors (exposed to the elements)? (Please check only one box)

Most of the Time Often Sometimes Never

1.10 Which geographic location do you work in? (Please check only one box)

Atlantic Quebec Ontario Prairies British Columbia North of 60

1.11 Do you work in a rural area: Yes No

1.12 What type of employee are you)? (Please check only one box)

Hourly worker

Full-time Salaried (40 or more hours a week)

Part-time (less than 40 hours per week)

1.13 What is your responsibility? (Please check only one box)

Are you an apprentice/student?

Are you an Aviation Maintenance Engineer (AME) license holder?

Are you an AME exercising Aircraft Certification Authority/Shop Certification Authority?

Are you an AME **not** exercising the privileges of your license?

Are you a pilot/engineer?

1.14 Are you a : (Please check only one box)

Shiftworker

Worker on demand

Work a Standard Day (8-10 hours between

Work standard day and on demand when needed

Work shifts and on demand when needed

NOTE: ***Please answer the following questions that are appropriate to your work arrangements. For example, if you work both shifts and on-demand, please answer questions in both sections 2 and 3.***

Section 2. Duty Time Information: Workers of Scheduled Shifts (including standard day shifts)

The following questions gauge your duty time and the amount you work. Please fill out the survey completely and honestly. All responses will remain anonymous.

2.1 Indicate the shift(s) you work and state the start and finish times, and estimate the percent of time spent working that particular shift during an entire week (7 days).

Shift (e.g. day shift)	**Start Time** (e.g. 06:00)	**Finish Time** (e.g. 16:00)	**Percent** (e.g. 40%)
1)			
2)			
3)			
4)			
5)			
6)			
7)			

2.2 In the past twelve months have you worked simultaneously, on a regular basis (more than once a week), for more than one employer?

Yes No

2.3 Do you work on rotating shifts? (Please check the appropriate box)

Yes No

If **yes**, indicate the type below.

Check only one below	**Check only one below**
I change to a new shift:	Shifts rotate:
Weekly (shifts change once a week)	Forward (your new shift starts at a later time of day than your previous shift.)
Bi-weekly (shifts change every two weeks)	Backward (your new shift starts at an earlier time of day than your previous shift.)
Monthly (shifts change once a month)	
Other (please specify)____________________	Other (please specify)_________________________

2.4 Please circle which days you should normally be scheduled to work (without overtime). A "normal" workweek is defined as working 40 hours). If you work with Rotating Days Off (RDOs), please check this box , and skip to the question (2.7).

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

2.5 Day of week your shift-cycle begins (mark only one please):

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

2.6 Day of week your shift-cycle ends (mark only one please):

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

2.7 Do you perform other duties in addition to your aircraft maintenance activities? Yes No If <u>Yes</u>, how many hours during a 7-day weekly period (in addition to your regular hours) does this typically occupy? ________________ hours. **If you answered <u>No</u>, please skip to Section 3.**

2.8 In the table below, indicate how these hours for additional duties are typically distributed throughout your weekly work cycle.

	Shift (for entire weekly cycle)						
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**
Number of hours for aviation maintenance duties							
Number of hours for additional duties							

2.9 Are the times listed here a representative sample of the normal hours you have worked in the past 12 months?

Yes No

2.10 If you answered <u>No</u> to question 2.9 please describe what different circumstances existed. Use reverse side if you need more room.

____

____

Section 3. Duty Time Information: "On-Demand" Workers

The following questions gauge your duty time and the amount you work. Please fill out the survey completely and honestly. All responses will remain anonymous.

3.1 How many hours do you work during each typical 24-hour period (include all types of work)?__________ hours

3.2 How many days do you work during the typical weekly work period?
_________ days.

3.3 How many hours do you work in a typical weekly work period?______ hours

3.4 Do you work on a seasonal basis? Yes No

3.5 In the past 12 months have you worked more than seven days in a row, at least once a month?
Yes No

3.6 Do you perform other duties in addition to your aircraft maintenance activities? If Yes, how many hours a day (in addition to your regular hours) does this occupy? _______________ hours.

3.7 Are you working according to an "hours averaging program"? Yes No

3.8 If you answered yes to 3.7, please indicate how many days in a row you would typically have to work without an adequate sleep period (ie. >5 hours sleep during each 24 hour period)? _____days.

Section 4. Overtime Information

This section estimates the amount of overtime you work in an average week.

4.1 If you do not typically work overtime, check this box and go to Section 5.

4.2 Please estimate your *actual* total duty time per weekly work cycle (in hours) ________ hours

4.3 If you work with rotating days off (RDOs), please check this box , and skip to question 4.5.

If not, please circle which days you actually work (including overtime):

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

4.4 Please indicate the day of week your shift-cycle begins when you are working overtime:

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

4.5 Please indicate how long it takes you to commute to/from work.
less than 10 min. 11-20 min. 21-30 min. 30-45 min. 46-60 min. 60-120 min over 120 min.

4.6 What is the longest duration for a shift you have worked? __________ hours

4.7 How often per month do you work shifts of the duration given in 4.6 ? (Please check one box only)

less than once once twice three more

4.8 Please state the times of your *actual* daily shift (including overtime).

Shift (e.g. day shift)	**Start Time** (e.g. 06:00)	**Finish Time** (e.g. 16:00)	**Percent** (e.g. 40%)
1)			
2)			
3)			
4)			
5)			
6)			
7)			

4.9 Please answer the following questions by indicating your response in the appropriate circle. Note that these questions refer to times when you were at the wheel while driving to/from work.

	Never	Once	Twice	3-4 Times	> 4 Times
I have fallen asleep at the wheel driving home to/from work.	○	○	○	○	○
I have momentarily nodded off while driving home to/from work.	○	○	○	○	○
I have fallen asleep and had an accident while driving to/from work.	○	○	○	○	○
I have momentarily nodded off and had an accident while driving to/from work.	○	○	○	○	○

4.10 Please estimate, on the scale below, the impact of overtime on your work performance, during each shift you work:

	Effect on Work Performance				
Shift	**Strong Negative Effect**	**Weak Negative Effect**	**No Effect**	**Weak Positive Effect**	**Strong Positive Effect**
Morning (Day)	○	○	○	○	○
Afternoon (Evening)	○	○	○	○	○
Midnight (Night)	○	○	○	○	○

4.11 Please indicate your agreement/disagreement with the following statements:

	Strongly Disagree	Disagree	Agree	Strongly Agree
I often work more than 40 hours per 7-day period.	○	○	○	○
I would like to work more hours than I do now.	○	○	○	○
I would like to work less hours than I do now.	○	○	○	○
I work more hours in order to earn more money.	○	○	○	○
I work more hours because I feel it is my responsibility.	○	○	○	○
I have to work more hours because management expects it.	○	○	○	○
I have to work more hours because my peers expect it.	○	○	○	○

4.12 How often <u>per week</u> do you work shifts that are longer than 8 hours in duration? (check <u>one</u> box)

less than once   once   twice   three   more

Section 5. Previous 12 month's information

This section relates to your last 12 months employment.

5.1	**During the last 12 months, on average, how many hours (total) did you work per weekly period? -** _____ hours per week
5.2	**If you have worked more than 7 days consecutively, at least once a month in the past 12 months, please indicate the maximum number of consecutive days worked:** ________ days
5.3	**What is your total estimated average daily hours worked per 24-hour period:** ______hours/24-hour per.
5.4	**In the last 12 months, what has been the most hours you have worked within a 14 consecutive-day period?** ________hours per 14-day period.

Section 6. Sleep and Rest Information

This section asks various questions that relate to the amount of rest you get.

6.1 Estimate the average amount of sleep you get per 24 hours on a work day (in hours.) ________ hrs.

6.2 Estimate the average amount of sleep you get per 24 hours on a day off (in hours.) _______hrs.

6.3 Do you generally get all of your sleep at one time?

Yes No

6.4 If you answered "No" to 6.3 above, please indicate the number of sleep periods per day _________ and the approximate duration of each sleep episode:

1st ______ 2nd ______ 3rd ______

6.5 What is the average total number of hours of sleep you obtain prior to each of the three shift times shown in the following table (please indicate the number of hours where applicable):

Shift Time Period	**Average total Number of Hours of Sleep**
Shift times occurring between 06:00 and 18:00	
Shift times occurring between 13:00 and 01:00	
Shift times occurring between 22:00 and 10:00	

6.6 Do you employ specific strategies for staying alert on the job? Yes No

6.7 If you answered "Yes" to question 6.6, please indicate which strategies you use. (Check the appropriate box(es))

Caffeine	Naps on days off	Alerting Medication (e.g. No-doze)	Exercise
Special Diet	Naps on the job	Bright Light	Other (please specify)___________

6.8 Does your employer allow planned napping while on duty? Yes No

6.9 Do you modify your sleep routine on your days off?

Yes No

6.10 If you answered "Yes" to 6.9 above, please describe in the table below, how you modify your sleep routine on your days off.

Hours

Day Off	Total Avg. Sleep	Main Sleep 1	Main Sleep 2	Nap 1	Nap 2
1st day off					
2nd day off					
3rd day off					
4th day off					

Section 7. Subjective Fatigue

This section allows you to indicate your subjective assessment of your level of fatigue under various circumstances.

7.1 Please indicate the level of fatigue you typically endure under the following circumstances.

	Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake
Toward the end of an extended midnight shift (approx. 12-16 hours in duration).	○	○	○	○	○
Toward the end of a midnight shift (approx. 7-9 hours in duration).	○	○	○	○	○
While working in very cold weather conditions toward the end of an extended shift (approx. 12-16 hours).	○	○	○	○	○
While working in very hot weather conditions toward the end of an extended shift (approx. 12-16 hours).	○	○	○	○	○
While working in very poor (rain, snow, etc.) weather conditions toward the end of an extended shift (approx. 12-16 hours).	○	○	○	○	○
While working in very poor (rain, snow, etc.) weather conditions toward the end of a standard length shift (approx. 7-9 hours).	○	○	○	○	○
While working in very awkward body postures toward the end of an extended shift (approx. 12-16 hours).	○	○	○	○	○
While working in very awkward body postures toward the end of a standard length shift (approx. 7-9 hours in duration).	○	○	○	○	○
Toward the end of standard shift (approx. 7-9 hours in duration).	○	○	○	○	○
Toward the end of extended shift (approx. 12-16 hours in duration).	○	○	○	○	○

Thank you very much for taking the care and time to complete the survey.
Your responses will be kept completely confidential and only group results will be reported.
The results of the survey will help ensure a safe civil aviation system.

Évaluation des heures de service travaillées par le personnel de l'industrie de l'entretien d'aéronefs

Ce sondage est une initiative de l'Aviation civile de Transports Canada, et est mené par une tierce partie impartiale (Rhodes & Associates Inc., consultants en ergonomie). Tous les renseignements recueillis dans le cadre de ce sondage demeureront confidentiels. N'inscrivez pas votre nom, ni celui de la compagnie pour laquelle vous travaillez.

Les renseignements fournis seront consultés par Rhodes & Associates Inc. uniquement, et seules des données de groupe seront divulguées. Les résultats de ce sondage ne serviront qu'à des fins informatives et seront utilisés pour dresser un profil de l'industrie de l'entretien d'aéronefs. Il faut environ 30 minutes pour remplir ce questionnaire. Veuillez le retourner dûment rempli à Rhodes & Associates Inc., d'ici le 30 mars 2001.

1. Objectif du sondage :

Transports Canada a fait appel aux services d'une compagnie spécialisée dans les questions de quarts de travail et de fatigue chez les humains. Le présent sondage permettra aux chercheurs de déterminer le niveau de fatigue vécue par les travailleurs de l'entretien d'aéronefs. Ces renseignements permettront au personnel de l'entretien, à leur compagnie et à Transports Canada de mieux comprendre les politiques, procédures et programmes d'exploitation qui ont le plus de valeur en matière de sécurité.

Les données recueillies aideront à évaluer la moyenne de la durée des quarts de travail, les conditions et les heures de travail de l'industrie. Le but consiste à déterminer le type d'activités d'éducation et de sensibilisation qui pourraient être nécessaires pour assurer la sécurité des travailleurs et du public.

2. Personnes-ressources :

Transports Canada

Jacqueline Booth-Bourdeau
Gestionnaire des programmes techniques
de l'Aviation civile (AARPC)
330, rue Sparks, 2e étage
Ottawa, Ontario K1A 0N8
Tél. : (613) 952-7974
Télécopieur : (613) 952-3298
Courriel : boothbj@tc.gc.ca

Rhodes & Associates Inc.

Wayne Rhodes, Ph.D., C.P.E.
Président
177 Jenny Wrenway
Toronto, Ontario
M2H 2Z3
Tél. : (416) 494-2816
Télécopieur : (416) 494-0303
Courriel : wayne-rhodes@home.com

3. Retourner le questionnaire :

Utiliser l'enveloppe à port payé ci-jointe pour retourner votre questionnaire à Rhodes & Associates Inc. (l'adresse est inscrite sur l'enveloppe). Ne remettez pas votre questionnaire rempli à d'autres personnes, car vous risqueriez de compromettre la confidentialité de vos données.

NOTE: In preparing this survey we have identified your language of choice based on the AMEs Licensing database. If you would like this survey in another official language please contact Wayne Rhodes immediately.

NOTE : Lors de la préparation de ce sondage, le choix de la langue a été établi selon les renseignements consignés dans la base de données de délivrance des permis des TEA. Si vous désirez remplir ce sondage dans l'autre langue officielle, contactez Wayne Rhodes sans délai.

Veuillez lire attentivement et minutieusement les renseignements suivants. Toutes vos réponses doivent demeurer anonymes. Tentez de répondre à chacune des questions. Cependant, si vous êtes inconfortable avec l'une de celles-ci, n'y répondez pas. Merci de votre collaboration.

Section 1. Renseignements généraux

1.1 Renseignements personnels : (Cocher toutes les cases appropriées)

Sexe : Homme Femme

Âge : ______

Avez-vous des enfants? Oui Non

État matrimonial :

Marié/Conjoint de fait Célibataire

Veuf Séparé ou divorcé

1.2 Quel type d'installations correspond le mieux à votre emploi présent? (Cocher une seule case)

Compagnie aérienne de premier plan

Organisme d'entretien indépendant et autorisé

Transporteur régional

Aviation générale

Compagnie aérienne de premier plan (services à la demande)

Opération rotative

Exploitation de taxi aérien

1.3 Veuillez indiquer votre rôle ou position principale. (Cocher une seule case)

Cellule

Groupe moteur

Avionique

Inspection, assurance de la qualité

Atelier/Pièces

Autre

1.4 Nombre d'années d'expérience en aviation? ____________ années

1.5 Nombre d'années d'expérience dans votre position actuelle? ____________ années

1.6 Avez-vous une expérience antérieure de travail par quarts? Oui Non

1.7 Où effectuez-vous la majorité de vos tâches? (Cocher une seule case)

Ligne Atelier Hangar Autre (spécifier) __________________

1.8 Dans quel type d'environnement travaillez-vous le plus souvent? (Cocher une seule case)

Base principale Base secondaire Sur le terrain Autre (spécifier)

1.9 À quelle fréquence travaillez-vous à l'extérieur (exposé aux éléments)? (Cocher une seule case)

La majeure partie du temps Souvent Parfois Jamais

1.10 Dans quelle région géographique travaillez-vous? (Cocher une seule case)

Atlantique Québec Ontario Prairies Colombie-Britannique Nord du 60 parallèle

1.11 Travaillez-vous dans une région rurale? Oui Non
1.12 Quel est votre statut d'employé? (Cocher <u>une seule</u> case) Travailleur horaire Temps plein (40 heures ou plus par semaine) Temps partiel (moins de 40 heures par semaine)
1.13 Quel est votre titre? (Cocher <u>une seule</u> case) Êtes-vous un apprenti/étudiant? Êtes-vous un technicien d'entretien d'aéronef (TEA) titulaire d'une licence? Êtes-vous un TEA exerçant un pouvoir de certification en aéronef ou de certification en atelier? Êtes-vous un TEA n'exerçant **<u>pas</u>** les privilèges que lui confère sa licence? Êtes-vous un pilote/ingénieur?
1.14 Êtes-vous un : (Cocher <u>une seule</u> case) Travailleur de quarts Travailleur à la demande Travailleur régulier (8 à 10 heures entre 6 h et 18 h) Travailleur régulier à la demande, au besoin Travailleur de quarts à la demande, au besoin

NOTE : ***Dans les sections suivantes, répondez aux questions qui correspondent à vos dispositions de travail. Par exemple, si vous travaillez sur des quarts et à la demande, répondez aux questions des sections 2 et 3.***

Section 2. Renseignements sur les heures de service : Travailleurs de quarts de travail planifiés (incluant les quarts de travail réguliers de jour)

Les questions suivantes mesurent vos heures de service et le temps que vous travaillez. Veuillez remplir le sondage complètement et honnêtement. Toutes vos réponses demeureront anonymes.

2.1 Indiquez le(s) quart(s) que vous travaillez ainsi que leurs heures de début et de fin. Estimez le pourcentage de temps travaillé dans chaque quart durant une semaine complète (7 jours).

Quart (par ex. : quart de jour)	**Heure de début** (ex. : 6 h)	**Heure de fin** (ex. : 16 h)	**Pourcentage** (ex. : 40 %)
1)			
2)			
3)			
4)			
5)			
6)			
7)			

2.2 Au cours des douze derniers mois, avez-vous travaillé simultanément, sur une base régulière, (plus d'une fois par semaine) pour plus d'un employeur?

Oui Non

2.3 Travaillez-vous sur des quarts rotatifs? (Cocher la case appropriée)

Oui Non

Si **Oui**, indiquez le type ci-dessous.

Cocher une seule case	**Cocher une seule case**
Le changement de mon quart est :	La rotation des quarts :
Hebdomadaire (les quarts changent une fois par semaine)	Avance (votre nouveau quart débute plus tard dans la journée que votre quart précédent)
Bihebdomadaire (les quarts changent deux fois par semaine)	Recule (votre nouveau quart débute plus tôt dans la journée que votre quart précédent.)
Mensuel (les quarts changent une fois par mois)	Autre (spécifier)________________________
Autre (spécifier)____________________	

2.4 Veuillez encercler les jours que vous devez travailler normalement (sans heures supplémentaires). Une semaine de travail «normale» est définie comme comptant 40 heures de travail. Si vos journées de repos sont rotatives, cochez cette case et passez à la question 2.7.

lundi mardi mercredi jeudi vendredi samedi dimanche

2.5 Jour de la semaine ou votre cycle de quarts de travail débute (Encercler une seule journée) :

lundi mardi mercredi jeudi vendredi samedi dimanche

2.6 Jour de la semaine ou votre cycle de quarts de travail se termine (Encercler une seule journée) :

lundi mardi mercredi jeudi vendredi samedi dimanche

2.7 Accomplissez-vous d'autres tâches en plus de vos activités d'entretien d'aéronef? Oui Non
Si oui, combien d'heures ces tâches occupent-elles habituellement durant une semaine de 7 jours (en plus de vos heures régulières)? _______________ heures
Si vous avez répondu Non, passez à la Section 3.

2.8 Dans le tableau ci-dessous, indiquez comment les heures pour ces tâches additionnelles se distribuent habituellement à travers votre cycle de travail hebdomadaire.

	Quart (pour le cycle de travail hebdomadaire complet)						
	1er	**2e**	**3e**	**4e**	**5e**	**6e**	**7e**
Nombre d'heures pour les tâches d'entretien d'aéronef							
Nombre d'heures pour les tâches additionnelles							

2.9 Les temps que vous rapportez ici sont-ils représentatifs des heures de travail normales que vous avez travaillées au cours des 12 derniers mois? Oui Non

2.10 Si vous avez répondu Non à la question 2.9, veuillez décrire les circonstances différentes qui ont pu être présentes. Utilisez le verso si vous avez besoin de plus d'espace.

____

____

Section 3. Renseignements sur les heures de service : Travailleurs «à la demande»

Les questions suivantes mesurent vos heures de service et le temps que vous travaillez. Veuillez remplir le sondage complètement et honnêtement. Toutes vos réponses demeureront anonymes.	
3.1	**Combien d'heures travaillez vous au cours d'une période habituelle de 24 heures (incluant tous les types de tâches)?** __________ heures
3.2	**Combien de jours travaillez vous au cours d'une période hebdomadaire habituelle?** _________ jours
3.3	**Combien d'heures travaillez vous au cours d'une période hebdomadaire habituelle?** ______ heures
3.4	**Travaillez-vous sur une base saisonnière?** Oui Non
3.5	**Au cours des 12 derniers mois, avez-vous travaillé plus de sept jours consécutifs, au moins une fois par mois?** Oui Non
3.6	**Accomplissez-vous d'autres tâches en plus de vos activités d'entretien d'aéronef? Si <u>oui</u>, combien d'heures par jour y consacrez-vous (en plus de vos heures régulières)?** _______________ heures
3.7	**Travaillez-vous selon un «programme de moyenne d'heures»?** Oui Non
3.8	**Si vous avez répondu <u>oui</u> à la question 3.7, indiquez combien de jours consécutifs vous pourriez avoir à travailler sans bénéficier d'une période de sommeil <u>adéquate</u> (c'est-à-dire de plus de 5 heures de sommeil pour chaque période de 24 heures)? _____ jours.**

Section 4. Renseignements sur les heures supplémentaires

Cette section estime la quantité d'heures supplémentaires que vous travaillez au cours d'une semaine habituelle.

4.1	**Si vous ne faites pas d'heures supplémentaires habituellement, cochez cette case et passez à la Section 5.**
4.2	**Veuillez estimer votre temps de travail *réel* par cycle de travail hebdomadaire (en heures) :** ________ heures
4.3	**Si vos journées de repos sont rotatives, veuillez cocher cette case et passez à la question 4.5.** **Si ce n'est pas le cas, veuillez encercler les jours que vous travaillez en réalité (incluant les heures supplémentaires) :** lundi mardi mercredi jeudi vendredi samedi dimanche
4.4	**Veuillez indiquer le jour de la semaine où votre cycle de quarts de travail débute lorsque vous travaillez des heures supplémentaires :** lundi mardi mercredi jeudi vendredi samedi dimanche

4.5 Veuillez indiquer la durée du déplacement entre votre domicile et votre travail.

moins de 10 min. 11-20 min. 21-30 min. 31-45 min. 46-60 min. 61-120 min. plus de 120 min.

4.6 Quelle a été la plus longue durée d'un quart que vous avez travaillé? __________ heures

4.7 Combien de fois <u>par mois</u> travaillez-vous des quarts de la durée indiquée en 4.6?
(Cocher <u>une seule</u> case)

moins d'une fois par mois une fois deux fois trois fois plus que trois fois

4.8 Veuillez indiquer les heures de votre quart de travail *réel* (incluant les heures supplémentaires).

Quart (par ex. : quart de jour)	**Heure du début** (ex. : 6 h)	**Heure de fin** (ex. : 16 h)	**Pourcentage** (ex. : 40 %)
1)			
2)			
3)			
4)			
5)			
6)			
7)			

4.9 Veuillez répondre aux questions suivantes en cochant le cercle approprié. Ces questions portent sur les moments où vous étiez au volant pour vous rendre au travail ou en revenir.

	Jamais	**Une fois**	**Deux fois**	**3-4 fois**	**> 4 fois**
Je me suis endormi(e) au volant en conduisant pour me rendre au travail ou en revenir.	O	O	O	O	O
Je me suis assoupi(e) brièvement en conduisant pour me rendre au travail ou en revenir.	O	O	O	O	O
Je me suis endormi(e) au volant et j'ai eu un accident en conduisant pour me rendre au travail ou en revenir.	O	O	O	O	O
Je me suis assoupi(e) brièvement et j'ai eu un accident en conduisant pour me rendre au travail ou en revenir.	O	O	O	O	O

4.10 Veuillez estimer sur l'échelle ci-dessous, l'impact des heures supplémentaires sur votre rendement au travail au cours de chaque quart que vous travaillez :

	Effet sur le rendement au travail				
Quart	**Fort effet négatif**	**Faible effet négatif**	**Pas d'effet**	**Faible effet positif**	**Fort effet positif**
Matin (jour)	O	O	O	O	O
Après-midi (soirée)	O	O	O	O	O
Minuit (nuit)	O	O	O	O	O

4.11 Veuillez indiquer votre accord ou votre désaccord avec les énoncés suivants :	**Fortement en désaccord**	**En désaccord**	**En accord**	**Fortement en accord**
Je travaille souvent plus de 40 heures dans une période de 7 jours.	○	○	○	○
J'aimerais travailler plus d'heures que présentement.	○	○	○	○
J'aimerais travailler moins d'heures que présentement.	○	○	○	○
Je travaille plus d'heures afin de gagner plus d'argent.	○	○	○	○
Je travaille plus d'heures car je crois que c'est ma responsabilité.	○	○	○	○
Je dois travailler plus d'heures car la direction s'y attend.	○	○	○	○
Je dois travailler plus d'heures car mes collègues s'y attendent.	○	○	○	○

4.12 Combien de fois par semaine travaillez-vous des quarts qui ont une durée de plus de 8 heures? (Cocher une seule case)

moins d'une fois par semaine   une fois   deux fois   trois fois   plus de trois fois

Section 5. Renseignements sur les 12 derniers mois

Cette section porte sur vos 12 derniers mois de travail.

5.1 Au cours des 12 derniers mois, en moyenne, combien d'heures (au total) avez-vous travaillé par période hebdomadaire? _______ heures par semaine

5.2 Si vous avez travaillé plus de 7 jours consécutifs, au moins une fois par mois au cours des 12 derniers mois, veuillez indiquer le nombre maximum de journées consécutives travaillées :
________ jours

5.3 Quelle est la moyenne (estimée) de vos heures travaillées par période de 24 heures? ________ heures

5.4 Au cours des 12 derniers mois, quel a été le plus grand nombre d'heures que vous avez travaillé au cours d'une période de 14 jours consécutifs? ________heures par période de 14 jours.

Section 6. Renseignements sur le sommeil et le repos

Cette section porte sur la quantité de repos dont vous bénéficiez.

6.1 Estimez la durée moyenne de votre sommeil par 24 heures lors d'une journée de travail (en heures) : ________ heures.

6.2 Estimez la durée moyenne de votre sommeil par 24 heures lors d'une journée de repos (en heures) :
_______ heures.

6.3 Généralement, prenez-vous votre sommeil en une seule fois? Oui Non

6.4 Si vous avez répondu Non à la question 6.3, indiquez le nombre de périodes de sommeil que vous avez par jour ________ et la durée approximative de chaque période de sommeil :

1re ______ 2e ______ 3e ______

6.5 Quelle est la moyenne du nombre total d'heures de sommeil que vous obtenez avant chaque quart de travail indiqué dans le tableau suivant (indiquez le nombre d'heures pour les quarts qui s'applique à vous)?

Période de quart de travail	Moyenne du nombre total d'heures de sommeil
Quart de travail se déroulant entre 6 h et 18 h	
Quart de travail se déroulant entre 13 h et 1 h	
Quart de travail se déroulant entre 22 h et 10 h	

6.6 Employez-vous des stratégies particulières pour demeurer alerte au travail? Oui Non

6.7 Si vous avez répondu Oui à la question 6.6, indiquez quelle(s) stratégie(s) vous utilisez. (Cocher les cases appropriées)

Caféine Siestes pendant les jours de repos Médication stimulante (ex. : No-doze) Exercice

Régime spécial Siestes au travail Lumière vive Autre (spécifier)____________

6.8 Est-ce que votre employeur permet des siestes planifiées pendant le service? Oui Non

6.9 Est-ce que vous modifiez vos habitudes de sommeil pendant vos journées de repos? Oui Non

6.10 Si vous avez répondu Oui à la question 6.9, décrivez dans le tableau ci-dessous comment vous modifiez vos habitudes de sommeil pendant vos journées de repos.

Heures

Jour de repos	Total d'heures de sommeil (moyenne)	Période de sommeil 1	Période de sommeil 2	Sieste 1	Sieste 2
1er jour de repos					
2e jour de repos					
3e jour de repos					
4e jour de repos					

Section 7. Fatigue subjective

Cette section vous permet d'indiquer votre évaluation subjective de votre niveau de fatigue dans diverses circonstances.

7.1 Veuillez indiquer le niveau de fatigue que vous ressentez habituellement dans les circonstances suivantes.

	Difficulté à rester éveillé	**Très fatigué**	**Fatigué**	**Assez alerte**	**Très éveillé**
Vers la fin d'un <u>quart de nuit étendu</u> (environ 12 à 16 heures).	○	○	○	○	○
Vers la fin d'un <u>quart de nuit</u> (environ 7 à 9 heures).	○	○	○	○	○
En travaillant par un <u>temps très froid</u> vers la fin d'un <u>quart étendu</u> (environ 12 à 16 heures).	○	○	○	○	○
En travaillant par un <u>temps très chaud</u> vers la fin d'un <u>quart étendu</u> (environ 12 à 16 heures).	○	○	○	○	○
En travaillant par un <u>très mauvais temps (pluie, neige, etc.)</u> vers la fin d'un <u>quart étendu</u> (environ 12 à 16 heures).	○	○	○	○	○
En travaillant par un <u>très mauvais temps (pluie, neige, etc.)</u> vers la fin d'un <u>quart de durée normalisée</u> (environ 7 à 9 heures).	○	○	○	○	○
En travaillant dans de <u>très mauvaises postures</u> vers la <u>fin d'un quart étendu</u> (environ 12 à 16 heures).	○	○	○	○	○
En travaillant dans de <u>très mauvaises postures</u> vers la <u>fin d'un quart de durée normalisée</u> (environ 7 à 9 heures).	○	○	○	○	○
Vers la fin d'un <u>quart normalisé</u> (environ 7 à 9 heures).	○	○	○	○	○
Vers la fin d'un <u>quart étendu</u> (environ 12 à 16 heures).	○	○	○	○	○

Merci beaucoup d'avoir pris le temps de remplir ce sondage.

Vos réponses sont entièrement confidentielles et seuls des résultats de groupes seront divulgués.

Les résultats de ce sondage contribueront à assurer la sécurité du système d'aviation civile.

APPENDIX B: TABLES WITH STATISTICS

B.1 Breakdowns for gender, facility and geographic location.

The following sections provide breakdowns of gender, age, experience and years in present position for the three main work-related variables.

Gender

Table B1shows the breakdown for age, years of experience and years in present position for each gender.

Table B1: Breakdown of means for age, experience and years in present position for each gender.

Gender	Mean Age	Mean Aviation Experience	Mean Years in Present Position
Male	43.92	22.34	11.45
Female	36.75	10.37	7.12

Facility

Table B2 shows the breakdown for age, years of experience, and years in present position for each type of facility. Most of the differences in mean age of AMEs, aviation experience, and years in the present position, between each facility, are statistically significant.

Table B2: Breakdown of means for age, experience and years in present position for each facility.

Facility Type	Mean Age	Mean Aviation Experience	Mean Years in Present Position
Major Airline	44.00	22.96	13.03
Regional Airline	37.92	16.11	7.67
Charter Service	37.81	16.27	7.77
Air Taxi	40.24	20.76	8.23
Stand Alone Facility	45.05	22.58	9.72
General Aviation	46.29	24.65	12.24
Rotary (Helicopter)*	40.57	19.04	10.05

* NOTE: The term "Rotary" is the aviation industry-wide name for helicopter operations (rotary wing aircraft), distinguishing such facilities from those that handle "fixed wing" aircraft.

Geographic Location

Table B3 provides the breakdown for the basic demographic information for each geographic area. Many of the differences between the locations for mean age are statistically significant. All others are not.

Table B3: Demographic information for each geographic location.

Geographical Location	Mean Age	Mean Aviation Experience	Mean Years in Present Position
Atlantic	42.40	20.86	10.44
Quebec	41.57	20.00	10.28
Ontario	42.32	21.44	11.26
Prairies	43.30	21.39	9.65
British Columbia	43.98	22.24	11.29
North of 60	38.16	20.00	8.21

B.2 Total average hours of work.

Total Hours of Work - Comparison of Facilities

Table B4 (B4a to B4k) lists the means, standard deviation, standard error, maximums, and minimums for each facility group for several questions that attempted to gather information on the extent of working hours. The general focus and number for each question is given (see the questionnaire in Appendix A for the actual questions).

Table B4: Breakdown of hours of work for each facility type.

Table B4a: Question 2.7 – Hours per week spent on duties other than AME tasks. (Note only 305 AMEs responded to this question)**.**

Question 2.7	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	12.17	9.34	7.89	13.66	15.09	13.90	14.11
SD	9.82	7.33	4.70	9.19	10.89	11.78	13.86
SE	1.26	1.97	2.51	2.74	1.45	2.03	1.24
Max	40	30	21	40	40	60	80
Min	1.5	2	2	3	2	1	1
N	75	31	19	16	57	29	78

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	1334.265	222.3776	1.85	0.088651	0.688176
S	298	35754.08	119.9801			
Total (Adjusted)	304	37088.35				
Total	305					

Table B4b: Question 3.1 – Average On-Demand hours worked in each 24-hour period.

Question 3.1	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	10.28	11.22	10.60	9.63	9.39	9.17	10.64
SD	2.05	1.98	1.90	1.74	1.81	2.33	2.45
SE	0.12	0.19	0.27	0.36	0.14	0.20	0.17
Max	19	17	18	14	18	19	17.5
Min	4	7.5	6	7.5	4.5	4	4
N	324	119	59	34	205	107	146

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	419.7618	69.9603	16.30	0.000000*	1.000000
S	987	4237.037	4.292844			
Total (Adjusted)	993	4656.798				
Total	994					

Most of the differences between the facility types for the mean hours worked in a 24-hour period are statistically significant at the $p<0.05$ level.

Table B4c: Question 3.2 – Average number of days worked per weekly cycle.

Question 3.2	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean days	4.55*	4.89*	4.70*	5.27*	5.13*	5.22*	5.83*
SD	0.82	1.11	0.91	0.67	0.84	0.81	1.00
SE	0.00	0.00	0.12	0.16	0.00	0.00	0.00
Max	7	7	7	7	7	7	7
Min	0.75	1	3	4	1	3	3
N	327	114	60	33	203	106	145

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	186.4762	31.07937	39.17	0.000000*	1.000000
S	981	778.4355	0.7935122			
Total (Adjusted)	987	964.9117				
Total	988					

* Significance level of P<0.05

Table B4d: Question 3.3 – Average On-Demand hours worked in each 7-day period.

Question 3.3	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	44.38	50.73*	45.05	49.35*	45.33	45.06	58.64*
SD	9.81	13.76	9.60	12.59	9.68	12.15	21.42
SE	0.72	1.19	1.65	2.24	0.91	1.24	1.08
Max	98	112	84	84	84	90	130
Min	18	36	25	37.5	13.5	18	25
N	322	116	61	33	203	107	144

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	24267.76	4044.626	24.22	0.000000*	1.000000
S	979	163487.5	166.9944			
Total (Adjusted)	985	187755.2				
Total	986					

* Many of the differences between the facility types for the mean hours worked in a 7-day period are statistically significant at the $p<0.05$ level.

Table B4e: Question 4.2 – Average hours worked in each 7-day period <u>including</u> overtime (actual duty time).

Question 4.2	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	47.43	52.57	51.12	51.19	51.14	51.79	64.09*
SD	11.66	15.40	10.40	12.47	10.85	11.60	23.80
SE	0.98	1.56	2.12	2.83	1.35	2.39	1.42
Max	126	112	84	84	96	84	126
Min	30	30	40	37.5	37.5	36.7	37.5
N	225	89	48	27	118	38	108

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	20620.67	3436.778	15.88	0.000000*	1.000000
S	646	139806.1	216.4181			
Total (Adjusted)	652	160426.8				
Total	653					

* Rotary AMEs have significantly higher duty times than the other AMEs.

Table B4f: Question 4.6 – Longest shift worked.

Question 4.6	Facility						
	Major	Regional	Charter*	Air Taxi	Stand Alone	General	Rotary
Mean hours	21.34	23.04	25.32*	23.37	19.37	19.69	25.33*
SD	10.33	14.39	10.23	15.70	7.83	7.41	16.31
SE	0.72	1.17	1.62	2.15	1.02	1.67	1.10
Max	84	110	56	96	56	48	140
Min	8	10	11	12	8	10.5	7
N	267	102	53	30	133	50	115

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	3320.464	553.4107	3.99	0.000608*	0.973222
S	743	102991	138.615			
Total (Adjusted)	749	106311.4				
Total	750					

* Rotary and charter AMEs had significantly higher mean duration for the longest shift than the rest of the AMEs.

Table B4g: Question 4.7 – Percentage of AMEs working a given number of times per month where the maximum duration shift was worked, for each facility.

Facility	< once	once	twice	three times	> three	Total
Major	61.1	12.6	9.9	3.8	12.6	100.0
Regional	86.3	5.9	6.9	0.0	1.0	100.0
Charter	75.0	13.5	7.7	1.9	1.9	100.0
Air Taxi	86.7	6.7	0.0	0.0	6.7	100.0
Stand Alone	81.7	7.6	6.1	1.5	3.1	100.0
General	77.1	12.5	6.3	2.1	2.1	100.0
Rotary	72.8	11.4	6.1	2.6	7.0	100.0

Table B4h: Question 5.1 – Average hours worked per week over the last year.

Question 5.1	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	46.24	50.55	47.29	50.87	46.47	44.58	56.74*
SD	9.06	11.08	6.80	13.54	8.49	7.87	18.81
SE	0.58	1.00	1.35	1.65	0.74	1.02	0.90
Max	90	85	65	98	96	70	120
Min	30	37.5	27.5	40	20	24	20
N	368	123	67	45	224	117	151

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	15689.48	2614.914	21.45	0.000000*	1.000000
S	1088	132611.5	121.8855			
Total (Adjusted)	1094	148300.9				
Total	1095					

* The greater number of hours worked by the Rotary respondents is statistically significant.

Table B4i: Question 5.2 – Maximum number of days, over 7, worked in a row, without a day off, within the last year.

Question 5.2	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean # of days	15.42	14.69	27.31	35.2*	22.43	21.83	33.00*
SD	8.68	8.07	28.31	63.81	20.40	19.67	38.04
SE	2.52	4.09	4.80	6.07	2.64	4.05	2.42
Max	61.2	42	120	300	165	110	365
Min	7	7	7	8	7	7	7
N	116	44	32	20	106	45	126

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	25804.03	4300.671	5.83	0.000007*	0.997990
S	482	355311	737.1599			
Total (Adjusted)	488	381115.1				
Total	489					

Table B4j: Question 5.3 – The average number of hours worked per 24-hour period within the last year.

Question 5.3	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	10.52*	11.32*	10.64*	9.90*	9.39*	8.94*	10.31*
SD	2.20	1.95	1.54	1.89	1.90	1.72	2.25
SE	0.11	0.18	0.25	0.31	0.14	0.19	0.16
Max	24	19	15	16	20	15.5	17
Min	5.33	6	6	8	3.5	5	4
N	361	126	64	44	217	118	156

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	541.7679	90.29465	21.99	0.000000*	1.000000
S	1079	4430.957	4.106541			
Total (Adjusted)	1085	4972.725				
Total	1086					

* Significance level of P<0.05

Table B4k: Question 5.4 – The maximum number of hours worked for a 14-day period within the last year.

Question 5.4	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	111.91	115.10	115.94	114.625	116.10	108.91	141.19*
SD	26.99	29.53	29.42	32.20	30.26	31.21	42.84
SE	1.89	3.14	4.65	5.35	2.50	3.57	2.97
Max	230	228	225	225	205	218	300
Min	54	56	60	80	52	50	50
N	279	113	53	40	184	90	130

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	89788.73	14964.79	15.06	0.000000*	1.000000
S	882	876632.5	993.9144			
Total (Adjusted)	888	966421.3				
Total	889					

* Significance level of P<0.05

Total Average Hours of Work – Comparisons for the Areas of Responsibility

Table B5 (a – l) shows the comparisons for the areas of responsibility broken down according to areas of responsibility.

Table B5: Breakdown of Hours of Work by Area of Responsibility.

Table B5a: Question 2.7 – Hours per week spent on duties other than AME tasks. (Note only 310 AMEs responded to this question)**.**

Question 2.7	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	12.10	10.63	14.33	15.00	10.49	30	13.16
SD	9.16	7.50	11.81	11.05	6.03	N/A	12.03
SE	1.98	2.76	1.84	4.93	1.89	N/A	0.81
Max	30	32	40	32	30	N/A	80
Min	2	2	2	5	2	N/A	1
N	31	16	36	5	34	1	187

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	701.0756	116.8459	0.96	0.452025	0.379346
S	303	36851.3	121.6214			
Total (Adjusted)	309	37552.38				
Total	310					

Table B5b: Question 3.1 – Average on-demand hours worked in each 24-hour period.

Question 3.1	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	10.03	10.13	9.93	9.95	9.58	8.62	10.39
SD	2.32	1.82	2.02	1.86	1.84	1.33	2.31
SE	0.18	0.20	0.20	0.48	0.20	0.45	0.00
Max	19	16	17	14	16	12	19
Min	4	6	4	7.5	7.5	7.5	4
N	144	111	107	20	112	23	490

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	127.2441	21.20735	4.57	0.000138*	0.987949
S	1000	4639.49	4.63949			
Total (Adjusted)	1006	4766.734				
Total	1007					

* Significance level of P<0.05

Table B5c: Question 3.2 – Average number of days worked per weekly cycle.

Question 3.2	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean days	4.94	4.66	5.02	4.98	5.02	5.00	5.10
SD	0.88	0.81	1.03	0.92	0.68	0.31	1.10
SE	0.00	0.00	0.00	0.22	0.00	0.21	0.00
Max	7	7	7	7	7	6	7
Min	3.5	3	0.75	3	3	4	1
N	146	109	108	20	110	22	486

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	18.68682	3.11447	3.25	0.003630*	0.931976
S	994	953.1645	0.958918			
Total (Adjusted)	1000	971.8513				
Total	1001					

* Significance level of P<0.05

Table B5d: Question 3.3 – Average on-demand hours worked in each 7-day period.

Question 3.3	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	45.93	43.62	47.42	44.88	46.25	41.74	49.98
SD	12.97	7.42	13.10	8.97	9.94	6.61	16.09
SE	1.16	1.31	1.31	3.07	1.30	2.86	0.62
Max	130	84	100	72	84	63	122.5
Min	25	30	20	37.5	24	37.5	13.5
N	141	110	109	20	111	23	484

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	6009.783	1001.63	5.32	0.000020*	0.995905
S	991	186531.4	188.2254			
Total (Adjusted)	997	192541.2				
Total	998					

* Significance level of P<0.05

Table B5e: Question 4.2 – Average hours worked in each 7-day period <u>including</u> overtime (actual duty time).

Question 4.2	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	49.86	47.82	49.79	46.35	50.67	44.30	55.00
SD	13.82	9.22	13.01	7.85	9.28	7.85	18.43
SE	1.47	1.79	1.95	4.26	1.86	4.86	0.85
Max	125	94	120	60	81	62.5	126
Min	30	37.5	37.2	37.5	37.5	37.5	30
N	110	74	62	13	68	10	329

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	6175.812	1029.302	4.35	0.000254*	0.983405
S	659	155800.6	236.4197			
Total (Adjusted)	665	161976.4				
Total	666					

* Significance level of P<0.05

Table B5f: Question 4.6 – Longest shift worked.

Question 4.6	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	21.66	20.92	23.54	17.13	20.77	18.30	22.73
SD	11.16	9.47	19.27	6.17	10.83	8.32	11.61
SE	1.47	1.79	1.95	4.26	1.86	4.86	0.85
Max	84	84	140	28	81	10	362
Min	10	10.5	10	8	7	12	8
N	126	88	78	15	81	10	370

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	1112.606	185.4343	1.26	0.275160	0.498451
S	761	112284.9	147.5492			
Total (Adjusted)	767	113397.5				
Total	768					

Table B5g: Percent of AMEs in each facility working "n" number of times per month at the maximum number of daily hours.

	1 time/mo.	2 times/mo.	3 times/mo.	4 times/mo.	> 4 times/mo.
Major	61.1	12.6	9.9	3.8	12.6
Regional	86.3	5.9	6.9	0.0	1.0
Charter	75.0	13.5	7.7	1.9	1.9
Air Taxi	86.7	6.7	0.0	0.0	6.7
Stand Alone	81.7	7.6	6.1	1.5	3.1
General	77.1	12.5	6.3	2.1	2.1
Rotary	72.8	11.4	6.1	2.6	7.0

Chi-Square Statistics Section

Chi-Square	50.625351	
Degrees of Freedom	24	
Probability Level	0.001178	Reject Null Hypothesis (Ho)

Table B5h: Question 4.7 – Percentage of AMEs working a given number of times per month maximum duration shift was worked, for each area of responsibility.

Area of Responsibility	< once	once	twice	three times	> three	Total
Airframe	81.1	8.2	4.9	1.6	4.1	100.0
Avionics	57.0	17.4	9.3	5.8	10.5	100.0
Other	76.6	11.7	6.5	5.2	0.0	100.0
Power Plant	60.0	20.0	6.7	0.0	13.3	100.0
QA	72.5	10.0	7.5	2.5	7.5	100.0
Shop	66.7	0.0	11.1	0.0	22.2	100.0
Various	74.0	9.8	7.7	1.4	7.1	100.0

Table B5i: Question 5.1 – Average hours worked per week over the last year.

Question 5.1	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	48.77	46.25	47.75	45.70	47.59	41.29	49.25
SD	13.11	8.42	10.52	8.07	9.40	5.09	12.53
SE	0.89	1.03	1.06	2.30	1.06	2.35	0.50
Max	120	80	100	72	84	60	110
Min	25	32	28	37.5	25	37	20
N	167	126	119	25	119	24	534

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	2487.022	414.5036	3.13	0.004836*	0.921430
S	1107	146803.3	132.6136			
Total (Adjusted)	1113	149290.3				
Total	1114					

* Significance level of P<0.05

Table B5j: Question 5.2 – Maximum number of days, over 7, worked in a row, without a day off, within the last year.

Question 5.2	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean # of days	20.52	19.82	21.43	14.90	24.36	13.40	25.61
SD	11.79	27.93	18.56	8.71	20.52	4.67	33.58
SE	3.27	4.56	3.84	8.76	3.64	12.40	1.70
Max	60	165	95	37	120	20	365
Min	7	7	7	8	7	7	7
N	72	37	52	10	58	5	265

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	3838.087	639.6813	0.83	0.544942	0.331682
S	492	377952.5	768.1961			
Total (Adjusted)	498	381790.6				
Total	499					

Table B5k: Question 5.3 – The average number of hours worked per 24-hour period within the last year.

Question 5.3	Area of Responsibility Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	10.09	10.41	10.01	9.62	9.64	8.96	10.31
SD	2.22	2.22	2.16	1.66	1.74	2.63	2.13
SE	0.17	0.19	0.20	0.43	0.19	0.43	0.00
Max	24	16	19	12.5	16	20	19
Min	5	6	4	7.45	7.5	7.5	3.5
N	164	123	117	24	119	24	534

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	96.15518	16.02586	3.56	0.001697*	0.953800
S	1098	4943.952	4.502688			
Total (Adjusted)	1104	5040.107				
Total	1105					

* Significance level of P<0.05

Table B5l: Question 5.4 – The maximum number of hours worked for a 14-day period within the last year.

Question 5.4	Area of Responsibility Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	116.09	113.05	115.57	111.33	116.47	93.30	120.64
SD	31.38	27.34	30.84	25.48	30.21	15.93	35.76
SE	2.76	3.23	3.59	7.70	3.20	7.30	1.57
Max	220	205	228	168	225	135	300
Min	50	70	60	80	50	75	50
N	140	102	83	18	104	20	434

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Grouped_Role	6	19370.82	3228.469	3.03	0.006199*	0.911182
S	894	953863.1	1066.961			
Total (Adjusted)	900	973233.9				
Total	901					

* Significance level of P<0.05

Total Average Hours of Work – For the Types of Employees

Table B6 (a - i) shows the comparisons for the same questions, but this time broken down according to the type of employee.

Table B6: Breakdown of Hours of Work by Type of Employee.

Table B6a: Question 2.7 - Hours per week spent on duties other than AME tasks. (Note: only 313 AMEs responded to this question)

	Employee Type		
Question 2.7	**Hourly**	**Salary**	**Part Time**
Mean hours	13.46	12.22	27.65
SD	11.93	9.85	18.73
SE	1.11	0.74	3.81
Max	68	80	60
Min	1	1	6
N	94	211	8

Analysis of Variance Table

Source Term	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (Alpha=0.05)**
A: Employ. Type	2	1858.213	929.1066	7.98	0.000416*	0.954513
S	310	36082.23	116.3943			
Total (Adjusted)	312	37940.45				
Total	313					

* Significance level of P<0.05

Table B6b: Question 3.1 – Average on-demand hours worked in each 24-hour period.

Question 3.1	Employee Type		
	Hourly	Salary	Part Time*
Mean hours	10.10	10.20	8.37
SD	2.11	2.17	2.53
SE	0.12	0.01	0.43
Max	18	19	14
Min	6	4	4
N	323	663	25

* Part-time AMEs work significantly fewer hours than hourly or salaried AMEs.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	81.28963	40.64481	8.68	0.000184*	0.969231
S	1008	4721.608	4.684135			
Total (Adjusted)	1010	4802.898				
Total	1011					

* Significance level of P<0.05

Table B6c: Question 3.2 – Average number of days worked per weekly cycle.

Question 3.2	Employee Type		
	Hourly	Salary*	Part Time
Mean hours	4.85	5.10	5.04
SD	0.95	0.98	1.07
SE	5.45	0.04	0.20
Max	7	7	7
Min	0.75	1	3
N	320	659	24

Although the difference between the number of days worked by salaried AMEs is only slightly more, it is significant ($p<0.05$).

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	12.13523	6.067614	6.39	0.001747*	0.902112
S	1000	949.4738	0.9494737			
Total (Adjusted)	1002	961.6089				
Total	1003					

* Significance level of P<0.05

Table B6d: Question 3.3 – Average on-demand hours worked in each 7-day period.

Question 3.3	Employee Type: Hourly	Salary*	Part Time
Mean hours	45.72	49.01	40.66
SD	11.20	14.81	17.35
SE	0.77	0.54	2.77
Max	98	130	75
Min	18	25	13.5
N	319	657	25

* Salaried AMEs are working significantly more hours than hourly or part-time AMEs ($p<0.05$).

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	3609.008	1804.504	9.43	0.000088*	0.979471
S	998	190945.7	191.3283			
Total (Adjusted)	1000	194554.7				
Total	1001					

* Significance level of P<0.05

Table B6e: Question 4.2 – Average hours worked in each 7-day period <u>including</u> overtime (actual duty time).

Question 4.2	Employee Type: Hourly	Salary*	Part Time
Mean hours	49.47	53.45	51.04
SD	12.97	16.76	11.72
SE	1.05	0.74	6.37
Max	126	126	70
Min	30	30	40.25
N	221	442	6

* Salaried AMEs are working significantly more hours than hourly AMEs ($p<0.05$).

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	2324.954	1162.477	4.78	0.008683*	0.794844
S	666	161956.6	243.1781			
Total (Adjusted)	668	164281.5				
Total	669					

* Significance level of P<0.05

Table B6f: Question 4.6 – Longest shift worked.

	Employee Type		
Question 4.6	**Hourly**	**Salary**	**Part Time**
Mean hours	21.56	22.26	20.14
SD	11.94	12.30	6.44
SE	0.76	0.54	4.60
Max	101	140	32
Min	8	7	14
N	255	506	7

There is no significant difference in the mean duration of the longest shift; however, the salaried AMEs have a mean duration that is slightly higher. This is consistent with the greater number of hours these AMEs work.

Analysis of Variance Table

Source Term	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (Alpha=0.05)**
A: Employ. Type	2	107.4511	53.72554	0.36	0.694855	0.108670
S	765	112842.5	147.5065			
Total (Adjusted)	767	112949.9				
Total	768					

Table B6g: Question 5.1 – Average hours worked per week over the last year.

	Employee Type		
Question 5.1	**Hourly***	**Salary***	**Part Time***
Mean hours	46.79	49.09	41.38
SD	9.20	12.47	13.50
SE	0.61	0.43	2.58
Max	98	120	70
Min	20	27.5	20
N	363	735	20

* All three of the means are significantly different ($p<0.05$) from one another.

Analysis of Variance Table

Source Term	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (Alpha=0.05)**
A: Employ. Type	2	2234.489	1117.244	8.41	0.000238*	0.964570
S	1115	148174.8	132.8922			
Total (Adjusted)	1117	150409.3				
Total	1118					

* Significance level of P<0.05

Table B6h: Question 5.2 – Maximum number of days, over 7, worked in a row, without a day off, within the last year.

	Employee Type		
Question 5.2	Hourly	Salary	Part Time
Mean # of days	20.67	25.12	13.63
SD	17.11	31.64	7.23
SE	2.22	1.51	9.78
Max	120	365	28
Min	7	7	7
N	156	334	8

The widely different means for maximum days are not significantly different from a statistical point of view; however, this may be due to the extreme variation in answers within each group.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	2913.319	1456.66	1.90	0.150323	0.395294
S	495	379050.5	765.7587			
Total (Adjusted)	497	381963.8				
Total	498					

Table B6i: Question 5.4 – The maximum number of hours worked for a 14-day period within the last year.

	Employee Type		
Question 5.4	Hourly*	Salary*	Part Time*
Mean # of days	114.75	119.20	95.23
SD	31.04	33.50	35.20
SE	1.89	1.34	9.08
Max	230	300	161
Min	54	50	50
N	301	597	13

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	10432.14	5216.072	4.87	0.007877*	0.803152
S	908	972574.2	1071.117			
Total (Adjusted)	910	983006.3				
Total	911					

* Significance level of P<0.05

Hours of Work for Types of Work Structures

Table B7: Breakdown of Hours of Work for Each Type of Work Structure.

Table B7a: Question 2.7 – Hours per week spent on duties other than AME tasks. (Note only 314 AMEs responded to this question).

Question 2.7	Work Structure: Shift-worker	Worker on Demand*	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	11.21	24.44	12.14	12.21	13.38
SD	9.19	19.69	8.96	9.41	12.02
SE	1.29	2.52	1.78	0.95	1.35
Max	36	80	40	56	68
Min	1.5	2	2	1	2
N	69	18	36	128	63

* The AMEs working on an on-demand basis spend significantly more time on other work.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	1858.213	929.1066	7.98	0.000416*	0.954513
S	310	36082.23	116.3943			
Total (Adjusted)	312	37940.45				
Total	313					

* Significance level of P<0.05

Table B7b: Question 3.1 – Average on-demand hours worked in each 24-hour period.

Question 3.1	Work Structure: Shift-worker	Worker on Demand	Standard Day*	Standard Day + On-Demand*	Shift-Worker + On-Demand
Mean hours	10.66	10.62	9.11	9.63	10.86
SD	1.98	3.20	1.89	1.98	2.22
SE	0.12	0.30	0.17	0.11	0.16
Max	19	18	19	18	18
Min	7.5	4	4	5.5	4
N	307	50	143	339	163

AMEs working a standard shift, or standard shift with on-demand hours, work about 1 to 1.5 fewer on-demand hours per 24-hour period than those working in other work structures. This is statistically significant at the $p<0.05$ level.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	81.28963	40.64481	8.68	0.000184*	0.969231
S	1008	4721.608	4.684135			
Total (Adjusted)	1010	4802.898				
Total	1011					

* Significance level of P<0.05

Table B7c: Question 3.2 – Average number of days worked per weekly cycle.

	Work Structure				
Question 3.2	Shift-worker	Worker on Demand	Standard Day	Standard Day + On-Demand*	Shift-Worker + On-Demand*
Mean hours	4.57*	5.85*	5.00*	5.36*	4.86*
SD	0.85	1.20	0.65	0.84	1.18
SE	0.00	0.00	0.00	0.00	0.00
Max	7	7	7	7	7
Min	3	3	3	1	1
N	305	48	142	340	161

Most of the differences above are significant, although the differences are small.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	12.13523	6.067614	6.39	0.001747*	0.902112
S	1000	949.4738	0.9494737			
Total (Adjusted)	1002	961.6089				
Total	1003					

* Significance level of P<0.05

Table B7d: Question 3.3 – Average On-Demand hours worked in each 7-day period.

Question 3.3	Work Structure: Shift-worker	Worker on Demand	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	45.89	54.26	43.11	49.34	49.82
SD	11.18	22.29	7.35	14.95	15.96
SE	0.78	1.98	1.14	0.74	1.08
Max	110	105	80	130	112
Min	35	13.5	28	18	25
N	304	48	143	339	159

The differences between the AME work structures groups for the mean hours worked in a 7-day period are statistically significant at the p<0.05 level.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	3609.008	1804.504	9.43	0.000088*	0.979471
S	998	190945.7	191.3283			
Total (Adjusted)	1000	194554.7				
Total	1001					

* Significance level of P<0.05

Table B7e: Question 4.2 – Average hours worked in each 7-day period including overtime (actual duty time).

Question 4.2	Work Structure Shift-worker	Worker on Demand	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	49.57	73.64*	46.91	53.29*	54.31*
SD	14.02	24.13	7.81	15.45	17.35
SE	1.01	3.21	1.70	1.02	1.35
Max	120	120	80	126	126
Min	30	40	37.5	37.5	30
N	224	22	78	215	124

* AMEs working on-demand hours, wholly or in part, work significantly more hours than those working just a standard day or straight shifts. Those working on demand only averaged more hours than any other work-structure group.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	2324.954	1162.477	4.78	0.008683*	0.794844
S	666	161956.6	243.1781			
Total (Adjusted)	668	164281.5				
Total	669					

* Significance level of P<0.05

Table B7f: Question 4.6 – Longest shift worked.

Question 4.6	Work Structure Shift-worker	Worker on Demand*	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	20.44	29.19	19.31	23.13	23.99
SD	9.71	26.51	11.63	13.41	10.41
SE	0.72	2.62	1.27	0.78	1.01
Max	96	140	84	110	84
Min	8	12	7	10	10.5
N	275	21	90	234	142

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	107.4511	53.72554	0.36	0.694855	0.108670
S	765	112842.5	147.5065			
Total (Adjusted)	767	112949.9				
Total	768					

Table B7g: Question 5.1 – Average hours worked per week over the last year.

Question 5.1	Work Structure: Shift-worker	Worker on Demand	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	47.47*	55.58*	43.76	48.51*	51.85*
SD	10.58	20.87	6.41	10.61	14.52
SE	0.60	1.71	0.84	0.60	0.87
Max	110	105	84	120	110
Min	30	24	32	20	20
N	356	44	182	359	170

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	2234.489	1117.244	8.41	0.000238*	0.964570
S	1115	148174.8	132.8922			
Total (Adjusted)	1117	150409.3				
Total	1118					

* Significance level of P<0.05

Table B7h: Question 5.2 – Maximum number of days, over 7, worked in a row, without a day off, within the last year.

Question 5.2	Work Structure: Shift-worker	Worker on Demand	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	15.10	31.06	19.49	28.97	20.55
SD	7.80	48.95	12.01	33.76	21.52
SE	2.59	4.68	3.61	1.93	2.86
Max	73	300	61.2	363	166
Min	7	7	7	7	7
N	111	34	57	200	91

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	2913.319	1456.66	1.90	0.150323	0.395294
S	495	379050.5	765.7587			
Total (Adjusted)	497	381963.8				
Total	498					

Table B7i: Question 5.4 – The maximum number of hours worked for a 14-day period within the last year.

Question 5.4	Work Structure				
	Shift-worker	Worker on Demand*	Standard Day	Standard Day + On-Demand*	Shift-Worker + On-Demand*
Mean hours	110.61	132.11	106.59	122.55	126.04
SD	27.08	48.01	27.13	35.38	34.04
SE	1.89	1.28	2.71	1.89	2.67
Max	230	240	210	300	255
Min	54	60	52	50	58
N	288	37	140	288	145

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	10432.14	5216.072	4.87	0.007877*	0.803152
S	908	972574.2	1071.117			
Total (Adjusted)	910	983006.3				
Total	911					

* Significance level of P<0.05

Breakdown for Work Structure by Employee Type

Table B8: Results of cross-tabulation of AME work structure groups by their employee type.

	Work Structure				
Employee Type	**Shift-worker**	**Worker on Demand**	**Standard Day**	**Standard Day + On-Demand**	**Shift-Worker + On-Demand**
FREQUENCIES					
Hourly	160	13	50	92	62
Salary	214	22	140	278	109
Part Time	1	16	1	6	4
TOTAL	375	51	191	376	175
ROW PERCENTAGES					
Hourly	42.5	3.4	13.3	24.4	16.4
Salary	28.0	2.9	18.3	36.4	14.3
Part Time	3.6	57.1	3.6	21.4	14.3
TOTAL	32.1	4.4	16.4	32.2	15.0
COLUMN PERCENTAGES					
Hourly	42.7	25.5	26.2	24.5	35.4
Salary	57.3	43.1	73.3	73.9	62.3
Part Time	0.3	31.4	0.5	1.6	2.3

Table B9: Breakdown of work structures by facility type.

	Work Structure				
Employee Type	Shift-worker	Worker on Demand	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
FREQUENCIES					
Major	228	0	53	35	67
Regional	65	0	10	22	32
Charter	22	7	5	14	7
Air Taxi	1	3	10	25	7
Stand Alone	35	11	53	112	25
General	11	13	28	64	6
Rotary	8	19	24	90	18
TOTAL	370	53	183	362	175
ROW PERCENTAGES					
Major	59.5	0.0	13.8	9.1	17.5
Regional	50.4	0.0	7.8	17.1	24.8
Charter	32.4	10.3	7.4	20.6	29.4
Air Taxi	2.2	6.5	21.7	54.3	15.2
Stand Alone	14.8	4.7	22.5	47.5	10.6
General	9.0	10.7	23.0	52.5	4.9
Rotary	5.0	11.9	15.1	56.6	11.3
TOTAL	32.4	4.6	16.0	31.7	15.3
COLUMN PERCENTAGES					
Major	61.6	0.0	29.0	9.7	38.3
Regional	17.6	0.0	5.5	6.1	18.3
Charter	5.9	13.2	2.7	3.9	11.4
Air Taxi	0.3	5.7	5.5	6.9	4.0
Stand Alone	9.5	20.8	29.0	30.9	14.3
General	3.0	24.5	15.3	17.7	3.4
Rotary	2.2	35.8	13.1	24.9	10.3

B.3 Overtime

Table B10: Percent of AMEs working overtime (n=990).

Row Percentages Section

	Work OT		
Facility	**N**	**Y**	**Total**
Major	33.7	66.3	100.0
Regional	26.1	73.9	100.0
Charter	27.1	72.9	100.0
Air Taxi	37.5	62.5	100.0
Stand Alone	44.5	55.5	100.0
General	64.4	35.6	100.0
Rotary	29.5	70.5	100.0
Total	37.5	62.5	100.0

The number of rows with at least one missing value is 218

Chi-Square Statistics Section

Chi-Square	50.858361	
Degrees of Freedom	6	
Probability Level	0.000000	Reject Ho

Table B11: Percent of AMEs working at other jobs (n=1069).

Row Percentages Section

	> 1 Employer		
Facility	**N**	**Y**	**Total**
Major	90.9	9.1	100.0
Regional	82.0	18.0	100.0
Charter	89.2	10.8	100.0
Air Taxi	91.1	8.9	100.0
Stand Alone	85.8	14.2	100.0
General	87.7	12.3	100.0
Rotary	81.4	18.6	100.0
Total	87.2	12.8	100.0

The number of rows with at least one missing value is 139

Chi-Square Statistics Section

Chi-Square	12.995936	
Degrees of Freedom	6	
Probability Level	0.043101	Reject Ho

B.4 Sleep

Table B12: Breakdown of sleep data for each facility type.

Table B12a: Question 6.1 – Average sleep on work-days.

Question 6.1	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	6.46*	6.46*	6.65	7.10*	7.00*	7.09*	6.87*
SD	1.06	1.05	1.01	0.97	0.94	0.95	1.02
SE	5.18	8.88	0.12	0.15	6.60	9.16	7.98
Max	10	10	9	9	11	10	10
Min	4	4	4	4	4.5	4	4
N	385	131	67	46	237	123	162

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	79.70073	13.28345	12.87	0.000000*	1.000000
S	1144	1180.755	1.032129			
Total (Adjusted)	1150	1260.456				
Total	1151					

* Significance level of P<0.05

Table B12b: Question 6.2 – Average sleep on rest-days.

Question 6.2	Facility						
	Major	Regional*	Charter	Air Taxi	Stand Alone	General	Rotary*
Mean hours	8.06	8.35	8.15	7.89	8.14	7.97	8.39
SD	1.24	1.30	1.08	1.32	1.23	1.08	1.27
SE	0.06	0.11	0.15	0.18	8.10	0.11	9.70
Max	12	13	11	10	16	12	14
Min	3	4	4	2	5	5	6
N	385	131	67	45	233	123	161

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	25.19488	4.199147	2.78	0.010987*	0.882474
S	1138	1720.488	1.511853			
Total (Adjusted)	1144	1745.683				
Total	1145					

* The regional and rotary groups reported significantly higher means for sleep duration on days off than the other facility groups (p<0.05).

Table B12c: Question 6.5a – Average sleep obtained prior to shifts occurring between 06:00 and 18:00.

	Facility						
Question 6.5a	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	6.60	6.78	6.68	7.07*	6.97*	6.87*	6.85*
SD	1.13	0.99	0.99	0.85	1.00	0.99	1.08
SE	6.19	0.11	0.14	0.17	7.75	0.11	0.10
Max	10.0	10.0	9.0	9.0	9.0	8.5	9.0
Min	1.5	4.0	4.5	5.5	0.75	2.0	2.0
N	285	92	56	37	182	87	108

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	20.26584	3.37764	3.09	0.005302*	0.917825
S	840	917.184	1.091886			
Total (Adjusted)	846	937.4499				
Total	847					

* AMEs from rotary, general, stand alone and air taxi facilities all reported significantly higher amounts of sleep prior to day shifts (approximately 06:00 to 18:00) than those from facilities at the major airlines (p<0.05).

Table B12d: Question 6.5b – Average sleep obtained prior to shifts occurring between 13:00 and 01:00.

	Facility						
Question 6.5b	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	7.02	6.49	7.20	7.17	7.26	7.21	6.83
SD	1.25	1.68	1.60	1.29	1.27	1.27	1.85
SE	9.54	0.23	0.21	0.35	0.17	0.27	0.20
Max	10.5	10.0	10.0	10.0	10.0	10.0	9.0
Min	1	3	2	5	5	5	0.5
N	216	37	44	16	72	26	47

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	19.0602	3.1767	1.62	0.140484	0.621034
S	451	885.8243	1.964134			
Total (Adjusted)	457	904.8846				
Total	458					

Table B12e: Question 6.5c – Average sleep obtained prior to shifts occurring between 22:00 and 10:00.

Question 6.5c	Facility						
	Major	Regional	Charter	Air Taxi	Stand Alone	General	Rotary
Mean hours	5.89*	6.63	6.41	7.67*	6.39	6.41	6.57
SD	1.34	1.63	1.56	2.12	1.15	1.43	1.74
SE	0.10	0.17	0.22	0.49	0.22	0.36	0.24
Max	10	10	10	12	9	8	8
Min	1.5	1.5	4	5	4.5	4	2
N	197	77	44	9	44	16	36

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Facility	6	46.31029	7.718382	3.62	0.001628*	0.955495
S	416	886.3354	2.130614			
Total (Adjusted)	422	932.6457				
Total	423					

* Significance level of P<0.05

Table B13: Breakdown of sleep data for employee type.

Table B13a: Question 6.1 – Average sleep on work-days.

Question 6.1	Employee Type		
	Hourly	Salary	Part Time
Mean hours	6.65	6.76	7.32*
SD	1.09	1.01	0.85
SE	0.05	0.00	0.20
Max	11	10	9
Min	4	4	5
N	376	773	26

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	12.00712	6.003562	5.64	0.003650*	0.860867
S	1172	1247.564	1.064474			
Total (Adjusted)	1174	1259.571				
Total	1175					

* Part-time AMEs reported getting over ½ hour more sleep on work days than hourly or salaried AMEs (p<0.05).

Table B13b: Question 6.2 – Average sleep on rest-days.

	Employee Type		
Question 6.2	Hourly	Salary	Part Time
Mean hours	8.07	8.20	7.88
SD	1.26	1.22	0.98
SE	0.00	0.00	0.24
Max	16	14	10
Min	5	2	6
N	374	770	26

The difference between groups for sleep during days off is not significant, statistically.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	6.070956	3.035478	2.01	0.134161	0.416711
S	1167	1760.482	1.508554			
Total (Adjusted)	1169	1766.553				
Total	1170					

Table B13c: Question 6.5a – Average sleep obtained prior to shifts occurring between 06:00 and 18:00.

	Employee Type		
Question 6.5a	Hourly	Salary	Part Time
Mean hours	6.69	6.82	7.10
SD	1.11	1.02	0.71
SE	0.00	0.04	0.27
Max	10	10	8
Min	0.75	1.5	6
N	294	561	15

The difference between groups for sleep prior to day shifts is not significant, statistically.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	5.042277	2.521139	2.28	0.102493	0.465019
S	867	957.0351	1.103847			
Total (Adjusted)	869	962.0773				
Total	870					

Table B13d: Question 6.5b – Average sleep obtained prior to shifts occurring between 13:00 and 01:00.

	Employee Type		
Question 6.5b	Hourly	Salary	Part Time
Mean hours	7.02	7.05	6.67
SD	1.31	1.49	0.58
SE	0.11	0.00	0.82
Max	10.5	10	7
Min	2	0.5	6
N	181	276	3

The difference between groups for sleep prior to day shifts is not significant, statistically.

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	0.375983	0.1879915	0.09	0.910492	0.064270
S	457	916.0101	2.004399			
Total (Adjusted)	459	916.3861				
Total	460					

Table B13e: Question 6.5c – Average sleep obtained prior to shifts occurring between 22:00 and 10:00.

	Employee Type		
Question 6.5c	Hourly	Salary	Part Time
Mean hours	5.98	6.26	5.70
SD	1.57	1.46	0.84
SE	0.12	0.00	0.67
Max	12	10	7
Min	1.5	1.5	5
N	146	274	5

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	8.040681	4.02034	1.80	0.166376	0.376207
S	422	941.9446	2.232096			
Total (Adjusted)	424	949.9853				
Total	425					

Table B14: Breakdown of sleep data for area of responsibility.

Table B14a: Question 6.1 – Average sleep on workdays.

Question 6.1	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	6.66	6.61	7.03	7.08	6.82	6.94	6.70
SD	1.02	1.06	0.98	1.08	0.91	1.01	1.08
SE	0.00	0.00	0.09	0.02	0.00	0.21	0.00
Max	9	10	10	9	9	9	11
Min	4	4	4	5	4	4	4
N	175	131	125	26	129	24	564

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Responsibility	6	19.41749	3.236248	2.99	0.006686*	0.907746
S	1167	1263.793	1.082942			
Total (Adjusted)	1173	1283.21				
Total	1174					

* Significance level of P<0.05

Table B14b: Question 6.2 – Average sleep on rest-days.

Question 6.2	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	8.15	8.25	8.08	8.44	8.17	7.92	8.15
SD	1.10	1.24	1.12	1.28	1.20	0.88	1.31
SE	0.00	0.11	0.11	0.24	0.11	0.25	0.00
Max	13	12	12	12	12	9	16
Min	5	5	4	6	5	6	2
N	175	130	125	26	128	24	560

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A Responsibility	6	5.351313	0.8918856	0.59	0.740867	0.237571
S	1161	1763.728	1.519146			
Total (Adjusted)	1167	1769.08				
Total	1168					

Table B14c: Question 6.5a – Average sleep obtained prior to shifts occurring between 06:00 and 18:00.

	Area of Responsibility						
Question 6.5a	**Airframe**	**Avionics**	**Other**	**Power Plant**	**QA**	**Shop**	**Various**
Mean hours	6.60	6.86	7.01	6.66	6.88	6.68	6.76
SD	1.02	0.96	0.92	1.47	0.96	1.09	1.10
SE	0.00	0.11	0.11	0.22	0.10	0.24	0.00
Max	8	9	10	8.5	9	9	10
Min	2	4	4	1.5	4	4	0.75
N	132	91	93	22	108	20	397

Analysis of Variance Table

Source Term	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (Alpha=0.05)**
A: Responsibility	6	11.52902	1.921503	1.74	0.109011	0.662089
S	856	945.9376	1.105067			
Total (Adjusted)	862	957.4666				
Total	863					

Table B14d: Question 6.5b – Average sleep obtained prior to shifts occurring between 13:00 and 01:00.

	Area of Responsibility						
Question 6.5b	**Airframe**	**Avionics**	**Other**	**Power Plant**	**QA**	**Shop**	**Various**
Mean hours	7.18	7.34	7.18	7.00	6.97	8.00	6.87
SD	1.24	1.05	1.36	1.75	1.13	N/A	1.57
SE	0.16	0.19	0.24	0.39	0.21	N/A	0.00
Max	10	10.5	10	9	10	N/A	10
Min	2	5	4	2.45	5	N/A	0.5
N	80	56	36	13	44	1	233

Analysis of Variance Table

Source Term	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (Alpha=0.05)**
A: Responsibility	6	14.59009	2.431682	1.22	0.295117	0.481723
S	456	909.7217	1.995004			
Total (Adjusted)	462	924.3118				
Total	463					

Table B14e: Question 6.5c – Average sleep obtained prior to shifts occurring between 22:00 and 10:00.

Question 6.5c	Area of Responsibility						
	Airframe	Avionics	Other	Power Plant	QA	Shop	Various
Mean hours	6.30	6.17	5.89	6.43	6.21	N/A	6.13
SD	1.39	1.35	1.38	1.27	1.51	N/A	1.57
SE	0.18	0.19	0.26	0.56	0.28	N/A	0.00
Max	10	10	8	8	10	N/A	12
Min	3	3	4	5	2	N/A	1.5
N	70	59	32	7	29	N/A	231

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Responsibility	5	4.481442	0.8962883	0.40	0.847048	0.156163
S	422	939.5762	2.226484			
Total (Adjusted)	427	944.0577				
Total	428					

Table B15: Breakdown of sleep data for work structure.

Table B15a: Question 6.1 – Average sleep on workdays.

Question 6.1	Work Structure				
	Shift-worker	Worker on Demand*	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	6.41	7.01	7.10	6.93	6.57
SD	1.04	1.97	0.86	0.94	1.16
SE	0.00	0.14	0.00	0.00	0.00
Max	10	10	10	10	11
Min	4	4	5	4	4
N	375	52	189	378	174

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	12.00712	6.003562	5.64	0.003650*	0.860867
S	1172	1247.564	1.064474			
Total (Adjusted)	1174	1259.571				
Total	1175					

* Significance level of P<0.05

Table B15b: Question 6.2 – Average sleep on rest-days.

Question 6.2	Work Structure				
	Shift-worker	Worker on Demand*	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	8.14	7.97	8.05	8.20	8.21
SD	1.26	1.42	1.05	1.13	1.53
SE	0.06	0.17	0.00	0.06	0.00
Max	12	12	12	14	16
Min	3	2	5	5	4
N	375	51	190	375	173

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	6.070956	3.035478	2.01	0.134161	0.416711
S	1167	1760.482	1.508554			
Total (Adjusted)	1169	1766.553				
Total	1170					

Table B15c: Question 6.5a – Average sleep obtained prior to shifts occurring between 06:00 and 18:00.

Question 6.5a	Work Structure				
	Shift-worker	Worker on Demand*	Standard Day	Standard Day + On-Demand	Shift-Worker + On-Demand
Mean hours	6.69	7.24	7.08	6.79	6.52
SD	1.02	0.89	1.03	1.07	1.07
SE	0.06	0.17	0.00	0.06	0.00
Max	10	9	10	10	9
Min	4	5.5	1.5	0.75	4
N	271	33	145	276	137

Analysis of Variance Table

Source Term	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (Alpha=0.05)
A: Employ. Type	2	5.042277	2.521139	2.28	0.102493	0.465019
S	867	957.0351	1.103847			
Total (Adjusted)	869	962.0773				
Total	870					

Table B15d: Question 6.5b – Average sleep obtained prior to shifts occurring between 13:00 and 01:00.

	Work Structure				
Question 6.5b	**Shift-worker**	**Worker on Demand**	**Standard Day**	**Standard Day + On-Demand**	**Shift-Worker + On-Demand**
Mean hours	7.12	6.96	7.26	6.81	6.87
SD	1.22	2.08	1.73	1.40	1.59
SE	0.00	0.38	0.24	0.16	0.14
Max	10.5	9	10	9.5	10
Min	3	0.5	2	2	1
N	224	14	34	76	110

Analysis of Variance Table

Source Term	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (Alpha=0.05)**
A: Employ. Type	2	0.375983	0.1879915	0.09	0.910492	0.064270
S	457	916.0101	2.004399			
Total (Adjusted)	459	916.3861				
Total	460					

Table B15e: Question 6.5c – Average sleep obtained prior to shifts occurring between 22:00 and 10:00.

	Work Structure				
Question 6.5c	**Shift-worker**	**Worker on Demand**	**Standard Day**	**Standard Day + On-Demand**	**Shift-Worker + On-Demand**
Mean hours	6.08	6.73	6.68	6.2	6.13
SD	1.39	1.67	1.78	1.54	1.62
SE	0.00	0.39	0.32	0.19	0.15
Max	10	10	12	9	10
Min	1.5	4	3	2	1.5
N	225	15	22	65	97

Analysis of Variance Table

Source Term	**DF**	**Sum of Squares**	**Mean Square**	**F-Ratio**	**Prob Level**	**Power (Alpha=0.05)**
A: Employ. Type	2	8.040681	4.02034	1.80	0.166376	0.376207
S	422	941.9446	2.232096			
Total (Adjusted)	424	949.9853				
Total	425					

B.5 Naps

The following tables are cross tabulations for question 6.8 – Does your employer allow planned napping while on duty?

Table B16a: Planned naps for each facility.

Counts Section

	Planned Naps		
Facility	**No**	**Yes**	**Total**
Major	362	17	379
Regional	125	4	129
Charter	61	4	65
Air Taxi	43	2	45
Stand Alone	209	18	227
General	102	7	109
Rotary	108	48	156
Total	1010	100	1110

The number of rows with at least one missing value is 98

Row Percentages Section

	Planned Naps		
Facility	**N**	**Y**	**Total**
Major	95.5	4.5	100.0
Regional	96.9	3.1	100.0
Charter	93.8	6.2	100.0
Air Taxi	95.6	4.4	100.0
Stand Alone	92.1	7.9	100.0
General	93.6	6.4	100.0
Rotary	69.2	30.8	100.0
Total	91.0	9.0	100.0

The number of rows with at least one missing value is 98

Chi-Square Statistics Section

Chi-Square	108.067156	
Degrees of Freedom	6	
Probability Level	0.000000	Reject Null Hypothesis (Ho)

Table B16b: Planned naps for location where job is performed.

Counts Section

	Planned Naps		
Work Environ.	**N**	**Y**	**Total**
Main Base	791	45	836
Sub-Base	141	14	155
Field	68	37	105
Other	34	5	39
Total	1034	101	1135

The number of rows with at least one missing value is 73

Row Percentages Section

	Planned Naps		
Work Environ.	**N**	**Y**	**Total**
Main Base	94.6	5.4	100.0
Sub-Base	91.0	9.0	100.0
Field	64.8	35.2	100.0
Other	87.2	12.8	100.0
Total	91.1	8.9	100.0

The number of rows with at least one missing value is 73

Chi-Square Statistics Section

Chi-Square	103.347887	
Degrees of Freedom	3	
Probability Level	0.000000	Reject Ho

Table B16c: Planned naps for work structure.

Counts Section

	Planned Naps		
Shift Type	**N**	**Y**	**Total**
Shiftworker	353	16	369
On-Demand	28	16	44
Standard Day	178	4	182
SD/OD	319	40	359
SW/OD	151	22	173
Total	1029	98	1127

The number of rows with at least one missing value is 81

Row Percentages Section

	Planned Naps		
Shift Type	**N**	**Y**	**Total**
Shiftworker	95.7	4.3	100.0
On-Demand	63.6	36.4	100.0
Standard Day	97.8	2.2	100.0
SD/OD	88.9	11.1	100.0
SW/OD	87.3	12.7	100.0
Total	91.3	8.7	100.0

The number of rows with at least one missing value is 81

Chi-Square Statistics Section

Chi-Square	67.165796	
Degrees of Freedom	4	
Probability Level	0.000000	Reject Ho

Table B17a: Naps on days off for facilities.

Counts Section

	Naps - off		
Facility	**N**	**Y**	**Total**
Major	135	51	186
Regional	51	15	66
Charter	28	8	36
Air Taxi	12	2	14
Stand Alone	71	17	88
General	26	7	33
Rotary	69	19	88
Total	392	119	511

The number of rows with at least one missing value is 697

Row Percentages Section

	Naps - off		
Facility	**N**	**Y**	**Total**
Major	72.6	27.4	100.0
Regional	77.3	22.7	100.0
Charter	77.8	22.2	100.0
Air Taxi	85.7	14.3	100.0
Stand Alone	80.7	19.3	100.0
General	78.8	21.2	100.0
Rotary	78.4	21.6	100.0
Total	76.7	23.3	100.0

The number of rows with at least one missing value is 697

Chi-Square Statistics Section

Chi-Square	3.444467	
Degrees of Freedom	6	
Probability Level	0.751343	Accept Ho

Table B17b: Naps on days off for work structure.

Counts Section

	Naps - off		
Shift Type	**N**	**Y**	**Total**
Shiftworker	139	49	188
On-Demand	22	7	29
Standard Day	50	7	57
SD/OD	111	33	144
SW/OD	71	23	94
Total	393	119	512

The number of rows with at least one missing value is 696

Row Percentages Section

	Naps - off		
Shift Type	**N**	**Y**	**Total**
Shiftworker	73.9	26.1	100.0
On-Demand	75.9	24.1	100.0
Standard Day	87.7	12.3	100.0
SD/OD	77.1	22.9	100.0
SW/OD	75.5	24.5	100.0
Total	76.8	23.2	100.0

The number of rows with at least one missing value is 696

Chi-Square Statistics Section

Chi-Square	4.778745	
Degrees of Freedom	4	
Probability Level	0.310762	Accept Ho

Table B18a: AMEs napping at work for each facility.

Counts Section

	Naps - job		
Facility	**N**	**Y**	**Total**
Major	130	56	186
Regional	52	14	66
Charter	30	6	36
Air Taxi	14	0	14
Stand Alone	77	11	88
General	25	7	32
Rotary	57	31	88
Total	385	125	510

The number of rows with at least one missing value is 698

Row Percentages Section

	Naps - job		
Facility	**N**	**Y**	**Total**
Major	69.9	30.1	100.0
Regional	78.8	21.2	100.0
Charter	83.3	16.7	100.0
Air Taxi	100.0	0.0	100.0
Stand Alone	87.5	12.5	100.0
General	78.1	21.9	100.0
Rotary	64.8	35.2	100.0
Total	75.5	24.5	100.0

The number of rows with at least one missing value is 698

Chi-Square Statistics Section

Chi-Square	21.723345	
Degrees of Freedom	6	
Probability Level	0.001359	Reject Ho

Table B18b: AMEs napping at work for each work environment.

Work Environ.	N	Y	Total
Main Base	277	76	353
Sub-Base	62	20	82
Field	33	24	57
Other	17	6	23
Total	389	126	515

The number of rows with at least one missing value is 693

Row Percentages Section

	Naps - job		
Work Environ.	**N**	**Y**	**Total**
Main Base	78.5	21.5	100.0
Sub-Base	75.6	24.4	100.0
Field	57.9	42.1	100.0
Other	73.9	26.1	100.0
Total	75.5	24.5	100.0

The number of rows with at least one missing value is 693

Chi-Square Statistics Section

Chi-Square	11.276695	
Degrees of Freedom	3	
Probability Level	0.010320	Reject Ho

Table B18c: AMEs napping at work for each work structure.

Counts Section

	Naps - job		
Shift Type	**N**	**Y**	**Total**
Shiftworker	131	57	188
On-Demand	19	10	29
Standard Day	46	10	56
SD/OD	121	23	144
SW/OD	70	24	94
Total	387	124	511

The number of rows with at least one missing value is 697

Row Percentages Section

	Naps - job		
Shift Type	**N**	**Y**	**Total**
Shiftworker	69.7	30.3	100.0
On-Demand	65.5	34.5	100.0
Standard Day	82.1	17.9	100.0
SD/OD	84.0	16.0	100.0
SW/OD	74.5	25.5	100.0
Total	75.7	24.3	100.0

The number of rows with at least one missing value is 697

Chi-Square Statistics Section

Chi-Square	12.118806	
Degrees of Freedom	4	
Probability Level	0.016489	Reject Ho

B.6 Other Coping Strategies

Table B19a: AMEs at each facility using alerting medication.

Counts Section

	Alert. Med.		
Facility	**No**	**Yes**	**Total**
Major	182	3	185
Regional	65	1	66
Charter	35	1	36
Air Taxi	14	0	14
Stand Alone	88	0	88
General	31	1	32
Rotary	86	2	88
Total	501	8	509

The number of rows with at least one missing value is 698

Row Percentages Section

	Alert. Med.		
Facility	**No**	**Yes**	**Total**
Major	98.4	1.6	100.0
Regional	98.5	1.5	100.0
Charter	97.2	2.8	100.0
Air Taxi	100.0	0.0	100.0
Stand Alone	100.0	0.0	100.0
General	96.8	3.2	100.0
Rotary	97.7	2.3	100.0
Total	98.2	1.6	100.0

The number of rows with at least one missing value is 698

Chi-Square Statistics Section

Chi-Square	17.223392	
Degrees of Freedom	12	
Probability Level	0.141386	Accept Ho

Table B19b: AMEs exercising for each facility.

Counts Section

	Exercise		
Facility	**No**	**Yes**	**Total**
Major	111	75	186
Regional	42	24	66
Charter	28	8	36
Air Taxi	7	7	14
Stand Alone	55	33	88
General	20	13	33
Rotary	54	34	88
Total	317	194	511

The number of rows with at least one missing value is 697

Row Percentages Section

	Exercise		
Facility	**No**	**Yes**	**Total**
Major	59.7	40.3	100.0
Regional	63.6	36.4	100.0
Charter	77.8	22.2	100.0
Air Taxi	50.0	50.0	100.0
Stand Alone	62.5	37.5	100.0
General	60.6	39.4	100.0
Rotary	61.4	38.6	100.0
Total	62.0	38.0	100.0

The number of rows with at least one missing value is 697

Chi-Square Statistics Section

Chi-Square	5.213666	
Degrees of Freedom	6	
Probability Level	0.516716	Accept Ho

Table B19c: AMEs exercising for geographic region.

Counts Section

	Exercise		
Geog. Loc.	**No**	**Yes**	**Total**
Atlantic	16	14	30
Quebec	53	28	81
Ontario	88	43	131
Prairies	69	47	116
BC	79	60	139
North of 60	9	1	10
Total	314	193	507

The number of rows with at least one missing value is 701

Row Percentages Section

	Exercise		
Geog. Loc.	**No**	**Yes**	**Total**
Atlantic	53.3	46.7	100.0
Quebec	65.4	34.6	100.0
Ontario	67.2	32.8	100.0
Prairies	59.5	40.5	100.0
BC	56.8	43.2	100.0
North of 60	90.0	10.0	100.0
Total	61.9	38.1	100.0

The number of rows with at least one missing value is 701

Chi-Square Statistics Section

Chi-Square	8.058201	
Degrees of Freedom	5	
Probability Level	0.153057	Accept Ho

Table B19d: AMEs at each facility using caffeine.

Counts Section

	Caffeine		
Facility	**No**	**Yes**	**Total**
Major	56	131	187
Regional	12	54	66
Charter	9	28	37
Air Taxi	3	11	14
Stand Alone	29	61	90
General	9	24	33
Rotary	27	61	88
Total	145	370	515

The number of rows with at least one missing value is 693

Row Percentages Section

	Caffeine		
Facility	**No**	**Yes**	**Total**
Major	29.9	70.1	100.0
Regional	18.2	81.8	100.0
Charter	24.3	75.7	100.0
Air Taxi	21.4	78.6	100.0
Stand Alone	32.2	67.8	100.0
General	27.3	72.7	100.0
Rotary	30.7	69.3	100.0
Total	28.2	71.8	100.0

The number of rows with at least one missing value is 693

Chi-Square Statistics Section

Chi-Square	5.150042	
Degrees of Freedom	6	
Probability Level	0.524718	Accept Ho

Table B19e: AMEs at each work location using caffeine.

Counts Section

	Caffeine		
Work Location	**No**	**Yes**	**Total**
Line	38	97	135
Shop	12	9	21
Hangar	74	218	292
Other	20	46	66
Total	144	370	514

The number of rows with at least one missing value is 694

Row Percentages Section

	Caffeine		
Work Location	**No**	**Yes**	**Total**
Line	28.1	71.9	100.0
Shop	57.1	42.9	100.0
Hangar	25.3	74.7	100.0
Other	30.3	69.7	100.0
Total	28.0	72.0	100.0

The number of rows with at least one missing value is 694

Chi-Square Statistics Section

Chi-Square	10.041518	
Degrees of Freedom	3	
Probability Level	0.018216	Reject Ho

Table B19f: AMEs using caffeine, for work structures.

Counts Section

	Caffeine		
Shift Type	**No**	**Yes**	**Total**
Shiftworker	60	129	189
On-Demand	12	17	29
Standard Day	24	35	59
SD/OD	31	113	144
SW/OD	20	75	95
Total	147	369	516

The number of rows with at least one missing value is 692

Row Percentages Section

	Caffeine		
Shift Type	**No**	**Yes**	**Total**
Shiftworker	31.7	68.3	100.0
On-Demand	41.4	58.6	100.0
Standard Day	40.7	59.3	100.0
SD/OD	21.5	78.5	100.0
SW/OD	21.1	78.9	100.0
Total	28.5	71.5	100.0

The number of rows with at least one missing value is 692

Chi-Square Statistics Section

Chi-Square	13.656050	
Degrees of Freedom	4	
Probability Level	0.008478	Reject Ho

Table B19g: AMEs for each facility, using diet as a strategy.

Counts Section

	Diet		
Facility	**No**	**Yes**	**Total**
Major	160	26	186
Regional	57	9	66
Charter	32	4	36
Air Taxi	12	2	14
Stand Alone	74	14	88
General	29	4	33
Rotary	74	14	88
Total	438	73	511

The number of rows with at least one missing value is 697

Row Percentages Section

	Diet		
Facility	**No**	**Yes**	**Total**
Major	86.0	14.0	100.0
Regional	86.4	13.6	100.0
Charter	88.9	11.1	100.0
Air Taxi	85.7	14.3	100.0
Stand Alone	84.1	15.9	100.0
General	87.9	12.1	100.0
Rotary	84.1	15.9	100.0
Total	85.7	14.3	100.0

The number of rows with at least one missing value is 697

Chi-Square Statistics Section

Chi-Square			0.838411
Degrees of Freedom			6
Probability Level	0.991004	Accept Ho	

Table B19h: AMEs for each facility, using bright light as a strategy.

Counts Section

	Bright Light		
Facility	**No**	**Yes**	**Total**
Major	171	14	185
Regional	60	6	66
Charter	34	2	36
Air Taxi	11	3	14
Stand Alone	81	7	88
General	26	6	32
Rotary	75	13	88
Total	458	51	509

The number of rows with at least one missing value is 699

Row Percentages Section

	Bright Light		
Facility	**No**	**Yes**	**Total**
Major	92.4	7.6	100.0
Regional	90.9	9.1	100.0
Charter	94.4	5.6	100.0
Air Taxi	78.6	21.4	100.0
Stand Alone	92.0	8.0	100.0
General	81.3	18.8	100.0
Rotary	85.2	14.8	100.0
Total	90.0	10.0	100.0

The number of rows with at least one missing value is 699

Chi-Square Statistics Section

Chi-Square	9.440577	
Degrees of Freedom	6	
Probability Level	0.150274	Accept Ho

Table B19i: AMEs for geographic region, using bright light as a strategy.

Counts Section

	Bright Light		
Geog. Loc.	**No**	**Yes**	**Total**
Atlantic	24	6	30
Quebec	76	4	80
Ontario	120	11	131
Prairies	104	12	116
BC	119	19	138
North of 60	10	0	10
Total	453	52	505

The number of rows with at least one missing value is 703

Row Percentages Section

	Bright Light		
Geog. Loc.	**No**	**Yes**	**Total**
Atlantic	80.0	20.0	100.0
Quebec	95.0	5.0	100.0
Ontario	91.6	8.4	100.0
Prairies	89.7	10.3	100.0
BC	86.2	13.8	100.0
North of 60	100.0	0.0	100.0
Total	89.7	10.3	100.0

The number of rows with at least one missing value is 703

Chi-Square Statistics Section

Chi-Square	8.948286	
Degrees of Freedom	5	
Probability Level	0.111145	Accept Ho

Table B19j: AMEs for each facility type, who modify their sleep on days off.

Counts Section

	Modify Sleep		
Facility	**No**	**Yes**	**Total**
Major	174	212	386
Regional	46	86	132
Charter	34	33	67
Air Taxi	30	16	46
Stand Alone	153	81	234
General	89	29	118
Rotary	81	81	162
Total	607	538	1145

The number of rows with at least one missing value is 63

Row Percentages Section

	Modify Sleep		
Facility	**No**	**Yes**	**Total**
Major	45.1	54.9	100.0
Regional	34.8	65.2	100.0
Charter	50.7	49.3	100.0
Air Taxi	65.2	34.8	100.0
Stand Alone	65.4	34.6	100.0
General	75.4	24.6	100.0
Rotary	50.0	50.0	100.0
Total	53.0	47.0	100.0

The number of rows with at least one missing value is 63

Chi-Square Statistics Section

Chi-Square	68.892365	
Degrees of Freedom	6	
Probability Level	0.000000	Reject Ho

Table B19k: AMEs for each facility type, who modify their sleep on days off.

Counts Section

	Modify Sleep		
Work Location	**No**	**Yes**	**Total**
Line	124	134	258
Shop	61	16	77
Hangar	360	324	684
Other	75	71	146
Total	620	545	1165

The number of rows with at least one missing value is 43

Row Percentages Section

	Modify Sleep		
Work Location	**No**	**Yes**	**Total**
Line	48.1	51.9	100.0
Shop	79.2	20.8	100.0
Hangar	52.6	47.4	100.0
Other	51.4	48.6	100.0
Total	53.2	46.8	100.0

The number of rows with at least one missing value is 43

Chi-Square Statistics Section

Chi-Square	23.961606	
Degrees of Freedom	3	
Probability Level	0.000025	Reject Ho

Table B19l: AMEs for each work structure, who modify their sleep on days off.

Counts Section

	Modify Sleep		
Shift Type	**No**	**Yes**	**Total**
Shiftworker	142	233	375
On-Demand	31	21	52
Standard Day	136	49	185
SD/OD	240	134	374
SW/OD	68	108	176
Total	617	545	1162

The number of rows with at least one missing value is 46

Row Percentages Section

	Modify Sleep		
Shift Type	**No**	**Yes**	**Total**
Shiftworker	37.9	62.1	100.0
On-Demand	59.6	40.4	100.0
Standard Day	73.5	26.5	100.0
SD/OD	64.2	35.8	100.0
SW/OD	38.6	61.4	100.0
Total	53.1	46.9	100.0

The number of rows with at least one missing value is 46

Chi-Square Statistics Section

Chi-Square	99.975510	
Degrees of Freedom	4	
Probability Level	0.000000	Reject Ho

B.7 Performance

Table B20a: Falling asleep at the wheel as reported by AMEs for each facility type.

Counts Section

	Fall Asleep					
Facility	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Major	164	27	25	14	21	251
Regional	63	10	10	4	14	101
Charter	36	6	3	6	2	53
Air Taxi	27	2	0	0	2	31
Stand Alone	111	9	5	4	5	134
General	42	3	1	2	3	51
Rotary	88	13	3	2	4	110
Total	531	70	47	32	51	731

The number of rows with at least one missing value is 477

Row Percentages Section

	Fall Asleep					
Facility	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Major	65.3	10.8	10.0	5.6	8.4	100.0
Regional	62.4	9.9	9.9	4.0	13.9	100.0
Charter	67.9	11.3	5.7	11.3	3.8	100.0
Air Taxi	87.1	6.5	0.0	0.0	6.5	100.0
Stand Alone	82.8	6.7	3.7	3.0	3.7	100.0
General	82.4	5.9	2.0	3.9	5.9	100.0
Rotary	80.0	11.8	2.7	1.8	3.6	100.0
Total	72.6	9.6	6.4	4.4	7.0	100.0

The number of rows with at least one missing value is 477

Chi-Square Statistics Section

Chi-Square	47.859942	
Degrees of Freedom	24	
Probability Level	0.002627	Reject Ho

Table B20b: Falling asleep at the wheel as reported by AMEs for each work location.

	Fall Asleep					
Work Location	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Line	114	16	11	11	20	172
Shop	26	1	3	0	1	31
Hangar	352	43	27	17	16	455
Other	54	9	5	5	12	85
Total	546	69	46	33	49	743

The number of rows with at least one missing value is 465

Row Percentages Section

	Fall Asleep					
Work Location	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Line	66.3	9.3	6.4	6.4	11.6	100.0
Shop	83.9	3.2	9.7	0.0	3.2	100.0
Hangar	77.4	9.5	5.9	3.7	3.5	100.0
Other	63.5	10.6	5.9	5.9	14.1	100.0
Total	73.5	9.3	6.2	4.4	6.6	100.0

The number of rows with at least one missing value is 465

Chi-Square Statistics Section

Chi-Square	30.558533	
Degrees of Freedom	12	
Probability Level	0.002299	Reject Ho

Table B20c: Nodding off at the wheel as reported by AMEs for each facility.

	Nod Off					
Facility	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Major	85	29	41	44	65	264
Regional	37	4	9	16	38	104
Charter	18	5	4	12	14	53
Air Taxi	19	5	2	4	3	33
Stand Alone	78	12	13	15	19	137
General	26	4	6	5	10	51
Rotary	59	12	15	12	20	118
Total	322	71	90	108	169	760

The number of rows with at least one missing value is 448

Row Percentages Section

	Nod Off					
Facility	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Major	32.2	11.0	15.5	16.7	24.6	100.0
Regional	35.6	3.8	8.7	15.4	36.5	100.0
Charter	34.0	9.4	7.5	22.6	26.4	100.0
Air Taxi	57.6	15.2	6.1	12.1	9.1	100.0
Stand Alone	56.9	8.8	9.5	10.9	13.9	100.0
General	51.0	7.8	11.8	9.8	19.6	100.0
Rotary	50.0	10.2	12.7	10.2	16.9	100.0
Total	42.4	9.3	11.8	14.2	22.2	100.0

The number of rows with at least one missing value is 448

Chi-Square Statistics Section

Chi-Square	57.845273	
Degrees of Freedom	24	
Probability Level	0.000128	Reject Ho

Table B20d: Nodding off at the wheel as reported by AMEs for each work location.

Counts Section

	Nod Off				
Work Location	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Line	58	15	19	31	56	179
Shop	16	4	4	2	5	31
Hangar	221	42	63	66	82	474
Other	39	9	9	9	23	89
Total	334	70	95	108	166	773

The number of rows with at least one missing value is 435

Row Percentages Section

	Nod Off					
Work Location	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Line	32.4	8.4	10.6	17.3	31.3	100.0
Shop	51.6	12.9	12.9	6.5	16.1	100.0
Hangar	46.6	8.9	13.3	13.9	17.3	100.0
Other	43.8	10.1	10.1	10.1	25.8	100.0
Total	43.2	9.1	12.3	14.0	21.5	100.0

The number of rows with at least one missing value is 435

Chi-Square Statistics Section

Chi-Square	25.219382	
Degrees of Freedom	12	
Probability Level	0.013817	Reject Ho

Table B20e: Nodding off at the wheel as reported by AMEs for each work structure.

Counts Section

	Nod Off				
Shift Type	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Shiftworker	85	30	29	51	75	270
On-Demand	9	5	3	2	6	25
Standard Day	51	9	11	12	8	91
SD/OD	135	16	27	23	35	236
SW/OD	50	12	23	20	42	147
Total	330	72	93	108	166	769

The number of rows with at least one missing value is 439

Row Percentages Section

	Nod Off					
Shift Type	**Never**	**Once**	**Twice**	**3-4 Times**	**> 4 Times**	**Total**
Shiftworker	31.5	11.1	10.7	18.9	27.8	100.0
On-Demand	36.0	20.0	12.0	8.0	24.0	100.0
Standard Day	56.0	9.9	12.1	13.2	8.8	100.0
SD/OD	57.2	6.8	11.4	9.7	14.8	100.0
SW/OD	34.0	8.2	15.6	13.6	28.6	100.0
Total	42.9	9.4	12.1	14.0	21.6	100.0

The number of rows with at least one missing value is 439

Chi-Square Statistics Section

Chi-Square	62.375885	
Degrees of Freedom	16	
Probability Level	0.000000	Reject Ho

Table B20f: Falling asleep and having an accident as reported by AMEs for each facility type.

Counts Section

	Asleep Accident			
Facility	**Never**	**Once**	**Twice**	**Total**
Major	236	10	0	246
Regional	95	3	1	99
Charter	48	1	0	49
Air Taxi	30	0	0	30
Stand Alone	130	2	0	132
General	49	2	0	51
Rotary	104	3	0	107
Total	692	21	1	714

The number of rows with at least one missing value is 494

Row Percentages Section

	Asleep Accident			
Facility	**Never**	**Once**	**Twice**	**Total**
Major	95.9	4.1	0.0	100.0
Regional	96.0	3.0	1.0	100.0
Charter	98.0	2.0	0.0	100.0
Air Taxi	100.0	0.0	0.0	100.0
Stand Alone	98.5	1.5	0.0	100.0
General	96.1	3.9	0.0	100.0
Rotary	97.2	2.8	0.0	100.0
Total	96.9	2.9	0.1	100.0

The number of rows with at least one missing value is 494

Chi-Square Statistics Section

Chi-Square	9.481623	
Degrees of Freedom	12	
Probability Level	0.661335	Accept Ho

Table B20g: Impact of overtime on job performance during the day shift as reported by AMEs for each facility type.

Counts Section

	Morn. Perf.						
Facility	**Strong Negative**		**Weak Negative**	**No Effect**	**Weak Positive**	**Strong Positive**	**Total**
Major	16	88	106	9	6	225	
Regional	7	23	45	7	3	85	
Charter	4	11	29	5	1	50	
Air Taxi	3	8	13	3	1	28	
Stand Alone	6	40	61	5	9	121	
General	1	15	25	3	3	47	
Rotary	8	34	53	5	3	103	
Total	45	219	332	37	26	659	

The number of rows with at least one missing value is 549

Row Percentages Section

	Morn. Perf.						
Facility	**Strong Negative**		**Weak Negative**	**No Effect**	**Weak Positive**	**Strong Positive**	**Total**
Major	7.1	39.1	47.1	4.0	2.7	100.0	
Regional	8.2	27.1	52.9	8.2	3.5	100.0	
Charter	8.0	22.0	58.0	10.0	2.0	100.0	
Air Taxi	10.7	28.6	46.4	10.7	3.6	100.0	
Stand Alone	5.0	33.1	50.4	4.1	7.4	100.0	
General	2.1	31.9	53.2	6.4	6.4	100.0	
Rotary	7.8	33.0	51.5	4.9	2.9	100.0	
Total	6.8	33.2	50.4	5.6	3.9	100.0	

The number of rows with at least one missing value is 549

Chi-Square Statistics Section

Chi-Square	21.947104	
Degrees of Freedom	24	
Probability Level	0.582424	Accept Ho

Table B20h: Impact of overtime on job performance during the afternoon (evening) shift as reported by AMEs for each facility type.

Counts Section

Facility	**After. Perf.** **Strong Negative**		**Weak Negative**	**No Effect**	**Weak Positive**	**Strong Positive**	**Total**
Major	24	94	76	7	4	205	
Regional	3	22	36	1	4	66	
Charter	3	24	17	3	0	47	
Air Taxi	1	13	9	0	1	24	
Stand Alone	8	55	36	4	3	106	
General	8	12	13	3	1	37	
Rotary	13	36	37	2	2	90	
Total	60	256	224	20	15	575	

The number of rows with at least one missing value is 633

Row Percentages Section

Facility	**After. Perf.** **Strong Negative**		**Weak Negative**	**No Effect**	**Weak Positive**	**Strong Positive**	**Total**
Major	11.7	45.9	37.1	3.4	2.0	100.0	
Regional	4.5	33.3	54.5	1.5	6.1	100.0	
Charter	6.4	51.1	36.2	6.4	0.0	100.0	
Air Taxi	4.2	54.2	37.5	0.0	4.2	100.0	
Stand Alone	7.5	51.9	34.0	3.8	2.8	100.0	
General	21.6	32.4	35.1	8.1	2.7	100.0	
Rotary	14.4	40.0	41.1	2.2	2.2	100.0	
Total	10.4	44.5	39.0	3.5	2.6	100.0	

The number of rows with at least one missing value is 633

Chi-Square Statistics Section

Chi-Square			32.271379
Degrees of Freedom			24
Probability Level	0.120404	Accept Ho	

Table B20i: Impact of overtime on job performance during the night shift as reported by AMEs for each facility type.

Counts Section

	Night Perf.						
Facility	**Strong Negative**		**Weak Negative**	**No Effect**	**Weak Positive**	**Strong Positive**	**Total**
Major	91	67	43	4	1	206	
Regional	31	30	21	5	2	89	
Charter	23	11	8	3	1	46	
Air Taxi	6	9	4	0	1	20	
Stand Alone	36	22	20	0	4	82	
General	16	7	5	1	1	30	
Rotary	47	22	16	2	2	89	
Total	250	168	117	15	12	562	

The number of rows with at least one missing value is 646

Row Percentages Section

	Night Perf.						
Facility	**Strong Negative**		**Weak Negative**	**No Effect**	**Weak Positive**	**Strong Positive**	**Total**
Major	44.2	32.5	20.9	1.9	0.5	100.0	
Regional	34.8	33.7	23.6	5.6	2.2	100.0	
Charter	50.0	23.9	17.4	6.5	2.2	100.0	
Air Taxi	30.0	45.0	20.0	0.0	5.0	100.0	
Stand Alone	43.9	26.8	24.4	0.0	4.9	100.0	
General	53.3	23.3	16.7	3.3	3.3	100.0	
Rotary	52.8	24.7	18.0	2.2	2.2	100.0	
Total	44.5	29.9	20.8	2.7	2.1	100.0	

The number of rows with at least one missing value is 646

Chi-Square Statistics Section

Chi-Square	26.406884	
Degrees of Freedom	24	
Probability Level	0.332848	Accept Ho

Table B21a: Impact of extended night shifts on fatigue as reported by AMEs for each facility type.

Counts Section

Facility	Extend. Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Major	125	131	44	17	3	320
Regional	28	45	24	11	3	111
Charter	24	26	9	2	1	62
Air Taxi	5	14	8	4	0	31
Stand Alone	31	56	31	11	1	130
General	10	25	19	6	2	62
Rotary	16	58	36	10	2	122
Total	239	355	171	61	12	838

The number of rows with at least one missing value is 370

Row Percentages Section

Facility	Extend. Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Major	39.1	40.9	13.8	5.3	0.9	100.0
Regional	25.2	40.5	21.6	9.9	2.7	100.0
Charter	38.7	41.9	14.5	3.2	1.6	100.0
Air Taxi	16.1	45.2	25.8	12.9	0.0	100.0
Stand Alone	23.8	43.1	23.8	8.5	0.8	100.0
General	16.1	40.3	30.6	9.7	3.2	100.0
Rotary	13.1	47.5	29.5	8.2	1.6	100.0
Total	28.5	42.4	20.4	7.3	1.4	100.0

The number of rows with at least one missing value is 370

Chi-Square Statistics Section

Chi-Square	60.338540	
Degrees of Freedom	24	
Probability Level	0.000057	Reject Ho

Table B21b: Impact of extended night shifts on fatigue as reported by AMEs for each work location.

Counts Section

Work Location	Extend. Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Line	84	92	38	13	1	228
Shop	9	11	5	3	0	28
Hangar	132	220	102	36	11	501
Other	18	37	30	9	0	94
Total	243	360	175	61	12	851

The number of rows with at least one missing value is 357

Row Percentages Section

Work Location	Extend. Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Line	36.8	40.4	16.7	5.7	0.4	100.0
Shop	32.1	39.3	17.9	10.7	0.0	100.0
Hangar	26.3	43.9	20.4	7.2	2.2	100.0
Other	19.1	39.4	31.9	9.6	0.0	100.0
Total	28.6	42.3	20.6	7.2	1.4	100.0

The number of rows with at least one missing value is 357

Chi-Square Statistics Section

Chi-Square	25.198917	
Degrees of Freedom	12	
Probability Level	0.013908	Reject Ho

Table B21c: Impact of extended night shifts on fatigue as reported by AMEs for each work structure.

Counts Section

Shift Type	Extend. Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Shiftworker	128	134	50	22	5	339
On-Demand	6	16	6	3	2	33
Standard Day	18	44	19	9	0	90
SD/OD	44	103	60	18	4	229
SW/OD	45	64	40	8	1	158
Total	241	361	175	60	12	849

The number of rows with at least one missing value is 359

Row Percentages Section

Shift Type	Extend. Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Shiftworker	37.8	39.5	14.7	6.5	1.5	100.0
On-Demand	18.2	48.5	18.2	9.1	6.1	100.0
Standard Day	20.0	48.9	21.1	10.0	0.0	100.0
SD/OD	19.2	45.0	26.2	7.9	1.7	100.0
SW/OD	28.5	40.5	25.3	5.1	0.6	100.0
Total	28.4	42.5	20.6	7.1	1.4	100.0

The number of rows with at least one missing value is 359

Chi-Square Statistics Section

Chi-Square	43.699073	
Degrees of Freedom	16	
Probability Level	0.000219	Reject Ho

Table B21d: Impact of night shifts on fatigue as reported by AMEs for each facility type.

Counts Section

Facility	Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Major	52	100	126	26	11	315
Regional	7	24	32	24	11	98
Charter	4	19	26	7	4	60
Air Taxi	1	4	13	9	2	29
Stand Alone	11	32	59	21	4	127
General	1	16	30	9	3	59
Rotary	9	25	52	23	6	115
Total	85	220	338	119	41	803

The number of rows with at least one missing value is 405

Row Percentages Section

Facility	Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Major	16.5	31.7	40.0	8.3	3.5	100.0
Regional	7.1	24.5	32.7	24.5	11.2	100.0
Charter	6.7	31.7	43.3	11.7	6.7	100.0
Air Taxi	3.4	13.8	44.8	31.0	6.9	100.0
Stand Alone	8.7	25.2	46.5	16.5	3.1	100.0
General	1.7	27.1	50.8	15.3	5.1	100.0
Rotary	7.8	21.7	45.2	20.0	5.2	100.0
Total	10.6	27.4	42.1	14.8	5.1	100.0

The number of rows with at least one missing value is 405

Chi-Square Statistics Section

Chi-Square	63.726796	
Degrees of Freedom	24	
Probability Level	0.000019	Reject Ho

Table B21e: Impact of night shifts on fatigue as reported by AMEs for each area of responsibility.

Counts Section

Grouped_Role	Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Airframe	12	46	55	17	7	137
Avionics	16	23	48	8	3	98
Other	11	14	34	13	3	75
Power Plant	0	3	6	4	0	13
QA	14	24	28	10	2	78
Shop	3	3	4	0	0	10
Various	30	114	168	68	26	406
Total	86	227	343	120	41	817

The number of rows with at least one missing value is 391

Row Percentages Section

Grouped_Role	Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Airframe	8.8	33.6	40.1	12.4	5.1	100.0
Avionics	16.3	23.5	49.0	8.2	3.1	100.0
Other	14.7	18.7	45.3	17.3	4.0	100.0
Power Plant	0.0	23.1	46.2	30.8	0.0	100.0
QA	17.9	30.8	35.9	12.8	2.6	100.0
Shop	30.0	30.0	40.0	0.0	0.0	100.0
Various	7.4	28.1	41.4	16.7	6.4	100.0
Total	10.5	27.8	42.0	14.7	5.0	100.0

The number of rows with at least one missing value is 391

Chi-Square Statistics Section

Chi-Square	38.136395	
Degrees of Freedom	24	
Probability Level	0.033573	Reject Ho

Table B21f: Impact of night shifts on fatigue as reported by AMEs for each area of responsibility.

Counts Section

Shift Type	Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Shiftworker	54	94	127	33	18	326
On-Demand	1	6	19	3	3	32
Standard Day	5	25	45	11	2	88
SD/OD	16	53	99	47	9	224
SW/OD	9	47	58	23	10	147
Total	85	225	348	117	42	817

The number of rows with at least one missing value is 391

Row Percentages Section

Shift Type	Midnight Hard to Stay Awake	Very Tired	Tired	Mostly Alert	Wide Awake	Total
Shiftworker	16.6	28.8	39.0	10.1	5.5	100.0
On-Demand	3.1	18.8	59.4	9.4	9.4	100.0
Standard Day	5.7	28.4	51.1	12.5	2.3	100.0
SD/OD	7.1	23.7	44.2	21.0	4.0	100.0
SW/OD	6.1	32.0	39.5	15.6	6.8	100.0
Total	10.4	27.5	42.6	14.3	5.1	100.0

The number of rows with at least one missing value is 391

Chi-Square Statistics Section

Chi-Square	44.629502	
Degrees of Freedom	16	
Probability Level	0.000158	Reject Ho

Table B21g: Impact of cold on extended night shifts on fatigue as reported by AMEs for each facility type.

Counts Section

	Cold - ext. shift					
Facility	**Hard to Stay Awake**	**Very Tired**	**Tired**	**Mostly Alert**	**Wide Awake**	**Total**
Major	70	128	102	29	4	333
Regional	12	48	31	14	4	109
Charter	17	31	6	8	1	63
Air Taxi	6	14	10	3	2	35
Stand Alone	21	68	45	17	3	154
General	10	35	14	10	1	70
Rotary	18	75	28	13	4	138
Total	154	399	236	94	19	902

The number of rows with at least one missing value is 306

Row Percentages Section

	Cold - ext. shift					
Facility	**Hard to Stay Awake**	**Very Tired**	**Tired**	**Mostly Alert**	**Wide Awake**	**Total**
Major	21.0	38.4	30.6	8.7	1.2	100.0
Regional	11.0	44.0	28.4	12.8	3.7	100.0
Charter	27.0	49.2	9.5	12.7	1.6	100.0
Air Taxi	17.1	40.0	28.6	8.6	5.7	100.0
Stand Alone	13.6	44.2	29.2	11.0	1.9	100.0
General	14.3	50.0	20.0	14.3	1.4	100.0
Rotary	13.0	54.3	20.3	9.4	2.9	100.0
Total	17.1	44.2	26.2	10.4	2.1	100.0

The number of rows with at least one missing value is 306

Chi-Square Statistics Section

Chi-Square	39.893238	
Degrees of Freedom	24	
Probability Level	0.021958	Reject Ho

Table B21h: Impact of cold on extended night shifts on fatigue as reported by AMEs for each work environment type.

Counts Section

	Cold - ext. shift					
Work Environ.	**Hard to Stay Awake**	**Very Tired**	**Tired**	**Mostly Alert**	**Wide Awake**	**Total**
Main Base	96	286	182	78	16	658
Sub-Base	33	63	34	8	1	139
Field	19	51	19	6	1	96
Other	7	8	7	2	1	25
Total	155	408	242	94	19	918

The number of rows with at least one missing value is 290

Row Percentages Section

	Cold - ext. shift					
Work Environ.	**Hard to Stay Awake**	**Very Tired**	**Tired**	**Mostly Alert**	**Wide Awake**	**Total**
Main Base	14.6	43.5	27.7	11.9	2.4	100.0
Sub-Base	23.7	45.3	24.5	5.8	0.7	100.0
Field	19.8	53.1	19.8	6.3	1.0	100.0
Other	28.0	32.0	28.0	8.0	4.0	100.0
Total	16.9	44.4	26.4	10.2	2.1	100.0

The number of rows with at least one missing value is 290

Chi-Square Statistics Section

Chi-Square	21.706256	
Degrees of Freedom	12	
Probability Level	0.040947	Reject Ho

Table B21i: Impact of awkward posture on fatigue as reported by AMEs for each work environment type.

Counts Section

	awk. posture - std.					
Facility	**Hard to Stay Awake**	**Very Tired**	**Tired**	**Mostly Alert**	**Wide Awake**	**Total**
Major	17	116	155	44	11	343
Regional	6	22	51	16	6	101
Charter	4	17	30	10	3	64
Air Taxi	0	9	23	7	3	42
Stand Alone	0	21	45	19	8	93
Rotary	5	41	65	28	10	149
Total	41	285	457	143	51	977

The number of rows with at least one missing value is 231

Row Percentages Section

	awk. posture - std.					
Facility	**Hard to Stay Awake**	**Very Tired**	**Tired**	**Mostly Alert**	**Wide Awake**	**Total**
Major	5.0	33.8	45.2	12.8	3.2	100.0
Regional	5.9	21.8	50.5	15.8	5.9	100.0
Charter	6.3	26.6	46.9	15.6	4.7	100.0
Air Taxi	0.0	21.4	54.8	16.7	7.1	100.0
Stand Alone	4.9	31.9	47.6	10.3	5.4	100.0
General	0.0	22.6	48.4	20.4	8.6	100.0
Rotary	3.4	27.5	43.6	18.8	6.7	100.0
Total	4.2	29.2	46.8	14.6	5.2	100.0

The number of rows with at least one missing value is 231

Chi-Square Statistics Section

Chi-Square	29.954327	
Degrees of Freedom	24	
Probability Level	0.186270	Accept Ho