ALAEA
Australian Licensed Aircraft Engineers Association

Submission to the House of Representatives Standing Committee on Communications Transport and the Arts

Awake to the danger

MANAGING

FATIGUE IN TRANSPORT

Contents

Executive summary

The Australian Licensed Aircraft Engineers Association (ALAEA) is concerned that increasing commercial pressure within the aviation industry has the potential to lower the level of aviation safety in this country unless the effects of fatigue are recognised and addressed.

Deregulation and the impact of competition is forcing companies to explore cost efficiencies through altered working arrangements. The changes in working arrangements raise in our view serious questions about their sustainability in terms of the worker and the quality of work being performed, in the absence of any regulations governing shift work or hours of duty.

The ALAEA proposes that there is a compelling case for the Civil Aviation Safety Authority (CASA) to incorporate into the Australian regulations requirements of Human Factors in Aviation Maintenance for all certifying licence holders to deal with fatigue.

Further the ALAEA emphasises the pressing need for CASA to establish regulations limiting duty hours of certifying Licensed Aircraft Maintenance Engineers (LAMEs).

The ALAEA has identified that shiftwork and rostering are major causes of fatigue for LAMEs and that the lack of regulations governing shiftwork and rostering has resulted in inferior outcomes for all stakeholders - employers, employees and the Australian travelling public. A legislatively binding *"Code of Practice for Shift Work Rostering in the Transport industry"* is an important initiative which should be pursued urgently.

Introduction

The Australian Licensed Aircraft Engineers Association (ALAEA) represents certifying Licensed Aircraft Maintenance Engineers throughout the Australian airline and aviation industry.

The ALAEA has actively promoted an understanding of the negative effects of fatigue on companies, aviation workers and the travelling public. Fatigue in aviation maintenance is primarily a consequence of shiftwork but can also be attributed to the lack of any regulatory controls over duty time for Licensed Aircraft Maintenance Engineers (LAMEs) who have a prime responsibility to ensure that aircraft are airworthy on a day-to-day basis.

This paper has drawn from academic papers on this subject and actual industry practice in Australia in 1999. The ALAEA is aware that a number of LAMEs are independently making submissions to this standing committee, which testifies to the level of concern among aviation workers regarding certain trends within the industry.

The ALAEA welcomes the House of Representatives Standing Committee Inquiry into Fatigue in the Transport Industry as there are a number of serious issues requiring action on the part of government to put in place structures that safeguard the health and well-being of the Australian community.

The US Federal Aviation Administration (FAA) in its "Human Factors Guidelines for Aviation Maintenance" has identified the following health effects which are observable in workers performing rotating shiftwork:

- chronic fatigue syndrome
- sleep disruption and deprivation (LAMEs average 4.5 hours of effective sleep per day when working night shift)
- depression
- moodiness
- family and social dislocation leading to high divorce rate
- gastrointestinal problems
- immune system dysfunction

- alcohol and drug abuse
- infertility
- high blood pressure
- increased cardiovascular mortality
- increase in work-related accidents and errors
- increased traffic accidents while commuting to and from work.

In 1991, the US Office of Technology Assessment reported that one out of every five workers in the United States work according to some type of non-standard schedule. For those whose working hours include a night shift the issue of fatigue is a serious one. A recent study in the United States estimated that 75% of those working at night experience sleepiness ***every night.***. Some 20% of these workers actually fall asleep on their work shift.

The LAME's role requires mental alertness and concentration as well as organising and coordinating ability of a high order to properly accomplish the maintenance and inspection tasks that are to be performed during the night. This is why it is so important that government impress on industry the serious nature of fatigue and the need to properly manage fatigue and its causes rather than deny any responsibility. It is all too easy after the fact to claim the worker should have realized their fatigued condition and removed themselves from the maintenance task. By this time it may be too late.

Submission

The causes and contributing factors of fatigue

The central problem in airline maintenance is that most maintenance tasks are performed during night hours so that the aircraft can fly and produce revenue during the daytime. Recent changes in the industrial relations legislation have led to a decentralisation of the process whereby shift systems are negotiated, implemented and assessed. Consequently a myriad of roster types currently exist in aviation in Australia.

The aviation industry is increasingly a very competitive global industry due to the deregulation of airspace. Deregulation and the pressure of competition are forcing companies to explore cost efficiencies through working arrangements. The changes in working arrangements raise serious questions about their sustainability in terms of the worker and the quality of work being performed in the absence of any regulations governing shift work or hours of duty.

The lack of duty hour limitations in aviation has allowed airline companies to continue using a number of practices which totally ignore fatigue implications and their duty of care to the individual and the community. An example of this is the emergency rescue of a broken-down aircraft in a minor station or a specific maintenance task requiring specialized experience. Should an aircraft breakdown occur at Uluru, licensed aircraft maintenance engineers are flown in to assess the problem, identify any equipment or parts required which would then be transported to the site. The engineers would continue on duty without sleeping breaks until the problem is fixed and the aircraft no longer "Aircraft On Ground" (AOG). This may be 24 hours, 36 hours or a longer period of duty. Following this period the engineers may then be required to return to duty after only a 10-hour rest break. Even in this 10-hour break period, there is no regulation or award provision which would prevent the LAME returning to work, other than a financial penalty on the employer (payment at the overtime rate of pay) until a 10-hour break had been provided.

Another example is an aircraft that has returned from flight with an engine shutdown to a port where that particular aircraft type is not normally maintained. An engineer on duty in the main maintenance port would be sent to that port to troubleshoot the problem and be expected to continue working until the problem had been solved. The ALAEA is aware of cases where individuals have carried out critical engine test procedures, including maximum power assurance and maximum acceleration checks, when they have been on continuous duty for more than 24 hours. As a consequence, incorrect determinations as to the airworthiness of the aircraft engine they have been working on have been made.

The shift patterns in the airline industry include almost every variation of shift pattern including 8-hour, 9.5-hour, 10-hour, 11-hour and 12-hour day and night shifts. This even includes permanent 12hr night shifts which require workers to attend for 12 hours between 6:00pm and 6:00am rotating through 2 nights on-1 day off-2 nights on followed by a 4 day hour break period. The pattern can be illustrated as follows:

Mon	Tues	Wed	Thur	Fri	Sat	Sun	Mon	Tues	Wed
Night	**Night**	**Rest**	**Night**	**Night**	**Rest**	**Rest**	**Rest**	**Rest**	**Night**
6pm-6am	**6pm-6am**		**6pm-6am**	**6pm-6am**					**6pm-6am**

The evidence would suggest that at least 36 hours of the rest period is required physiologically and mentally to recover a daytime orientation.

Worrying developments are the consistent push from airlines to adopt rosters weighted to night shift or permanent night rosters solely on commercial grounds without knowledge of roster design or sufficient understanding of the potential negative consequences. Proposals for 3 or 4 consecutive 12-hour night shifts are common even though information about the high fatigue level this shift arrangement would create is readily available.

It has been demonstrated that some aspects of human performance improve over the course of the day, climaxing when body temperature peaks. The research also

indicates that this correlation varies according to the nature of the task. Several factors, including perceptual involvement, the use of memory and the amount of logical reasoning required, appear to be important in determining when particular types of performance peak during the circadian cycle.

Performance of tasks involving manual dexterity, simple recognition and reaction time appears to parallel the circadian rhythm of body temperature, peaking when body temperature is highest, in the late afternoon. Many aspects of human performance decline to minimal levels at night, reflecting not only the influence of the circadian cycle, but also the effect of lack of sleep. Sleep deprivation, even for one night, is one of the most important disrupting factors in human mental and physiological function. Sleep loss influences several aspects of performance, leading to slowed reaction time, delayed and false responses, failure to respond when appropriate and reduced conceptual ability including slowed thinking and diminished memory, among others.

The LAME's role requires mental alertness and concentration as well as organising and coordinating ability of a high order to properly accomplish the aircraft maintenance and inspection tasks that are to be performed during the night. This is why it is so important that government impress on industry the serious nature of fatigue and the need to properly manage fatigue and its causes rather than deny any responsibility. It is all too easy after the fact to claim the worker should have realized their fatigued condition and removed themselves from the maintenance task. By this time it may be too late.

Sleep disruption and fatigue

Shiftwork schedules which require work during night time hours are associated with sleepiness and fatigue. Studies in the United States indicate that about 60 to 70 per cent of workers on rotating shifts complain of sleep disruption and sleepiness, and general fatigue is reported more frequently by shiftworkers than by day workers. The most common complaint is the inability to sleep as long as necessary during the day.

The net effect of these sleep disruptions is the obvious but serious one of lack of sufficient sleep, which often results in a state of semi-permanent fatigue and sleepiness referred to as sleep debt. This is especially true for rotating shiftworkers while they are on the night shift, permanent night workers, and individuals who are routinely subjected to long and irregular hours of work that extend into the night. Sleep debt has important implications for worker performance, safety and health.

The recent Australian Railways Shiftwork and Workload Study Final Report by the Centre for Sleep Research found that more sleep is accumulated in breaks during the night than in breaks during the day. This indicated that time off during the night had greater recovery value than time off during the day. So where there is a minimum length of breaks between shifts the potential is that a minimum break may be sufficient between day shifts but not sufficient between consecutive night shifts.

Shift roster design and fatigue - What the consultants have to say

Airline companies are typically more interested in the long-term financial "health" of the organisation than the health and safety implications of rosters on their employees. There is also the real risk that employers and employees with little knowledge of the biomedical and psychological-social impact of shiftwork could implement shift systems that significantly compromise not only employee health and safety but the safety of the airline's operations.

In the past, many organisations addressed the question of optimum shiftwork design through the use of consultants who were employed to design, implement and evaluate systems. While more enlightened than the complete denial approach to shiftwork management, this approach still reflects a typical Taylorist approach to shift management. That is, the roster is still conceptually constructed as a machine to which individual workers must conform in order to maximize efficiency.

One of the more important assumptions implicit within this Taylorist approach to shiftwork management is that there is an optimum single work schedule. This assumption, or promise, of a single solution often reflects the need of the consultant to come up with an expert solution rather than the actual needs of the shiftworkers in those organisations.

Similarly, there are mythical invocations by shiftwork consultants concerning the benign effects of certain types of shiftwork. Certain types of rosters are considered more "biocompatible" than others and are therefore to be preferred. We have seen that many of these rules of good rostering are based on extremely limited experimental and experiential data and are more likely to reflect a consultant's personal view of which factors are, or are not, important in designing rosters.

It is apparent that many consultants assign primacy to biological adaptation over financial, social, cultural, or psychological factors. In contrast, recent work in the field has clearly shown that shiftworkers do not consider biological adaptation as a critical factor in designing the best roster. In considering a 12-hour rotating roster one consultant's suggestion was to work 2 night shifts followed by a 24 hour break before working 2 day shifts as a person would be better adjusted biologically for their leisure time. The real life experience as opposed to the theoretical position has been that people working shiftwork find it very difficult to properly perform their day shift work under such an arrangement.

The catch-cry "employers prerogative" with respect to shift rosters is inappropriate and dangerous. Rosters should not be imposed on those who are required to work (and live) with the daily effects of the roster. The time has come for all authorities both Federal and State to put in place regulations about how rosters should be developed recognizing the sizable amount of evidence which statistically proves a causal relationship between fatigue, health and shiftwork. Shiftwork is not of itself unhealthy and fatigue-causing; however shiftwork must be properly designed and managed to avoid fatigue and other negative health effects.

Consequences of fatigue in the aviation industry

The effects on the organisation

A 1995 study found maintenance and inspection error to be a contributing factor in 15% of the aircraft accidents from 1982 to 1993. In these accidents 23% involved removal/installation of components, 49% involved maintenance or inspection.

Maintenance error caused 20% to 30% of in-flight shutdowns (IFSDs) at a cost of $750,000 per IFSD. Additionally 50% of flight delays due to engine problems at a cost of $15000 per hour were linked to maintenance error. While not all these maintenance errors can be attributed directly to fatigue it is certain that fatigue would have been a causal factor in many of these maintenance errors.

Performance

The effect of work schedules is one of a number of factors which shape a person's ability to perform in a given situation. They also include the type of task to be performed, motivational effects, the work schedule being employed, and individual differences among workers and how they adjust to changes in routine. Unlike health effects, performance degradation may occur soon after exposure to a work schedule.

There is a large and growing body of literature regarding the effects of fatigue and sleep deprivation on performance; these factors clearly have a negative effect on the performance of most tasks. While there is fairly extensive research on the circadian component of performance and the effects of sleep deprivation on performance, much less research has been done on the complex interaction of variables that occur in a work setting that can also affect worker performance. However, the relatively few studies that have recorded 24-hour real-task data in the field demonstrate decreased performance at night. These studies have shown that the speed with which a task can be completed decreases at night, and that the probability of making an error, missing a warning signal, or nodding off while operating machinery is highest at night.

The ALAEA sought the advice of academic experts with respect to the appropriateness of shift patterns for the aviation working environment with the introduction of 12-hour shifts. The recommendations were that the shifts were appropriate where the workloads were not excessive in the Line Maintenance areas but that Heavy Maintenance tasks should not be carried out during the 0200am to 0600am period. (Line Maintenance involves carrying out checks and rectification on aircraft transitting a port for a short period, with often less than one hour spent on the ground. Heavy Maintenance comprises detailed and thorough checking of all major aircraft systems including replacement of components and usually takes place while the aircraft is in the hangar.)

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sustainability in terms of the worker and the quality of work being performed in the absence of any regulations governing shift work or hours of duty.

The ALAEA is conscious of practices to achieve quicker turnaround times in Heavy Maintenance. Maintenance tasks that would have normally been carried out in a heavy maintenance checks are deferred and then rescheduled during the shorter overnight maintenance period in the Line Maintenance environment. This means that visual inspections and other heavy maintenance type tasks are being performed by Line Maintenance engineers between the hours of 0200am and 0600am. Even with the best trained and most experienced LAME, the quality of inspection will in all probability be less intensive and detailed than had it been done during daylight hours. Members try to avoid these situations when they arise, however the commercial pressure is to carry out the scheduled task planned for that night irrespective of the fatigue level of the individual performing the task.

Public safety

A common complaint heard in the aviation community, among those who work 12-hour night shifts, is the danger experienced while driving home in a fatigued state. Without exaggeration it would be a rare individual who could truthfully claim that they have not at some stage either fallen asleep at the wheel momentarily or gone through a red traffic light and not realized it until after the event. Of real concern are proposals from companies to finish night shifts later than 0700am or the more common practice of asking LAMEs to work overtime to cover the morning peak period. Later finish times place individuals in peak traffic conditions.

In contrast to the dearth of information regarding mishaps at the workplace, examination of factors contributing to aviation maintenance errors shows the role of circadian disruption, sleep loss and fatigue. These three factors have been noted in specific incidents involving every mode of transportation, including airline, railway, maritime and road. In these incidents, the strain of extended duty hours and the time of day may have led to errors in attention, decision-making

and response to relevant information. Events such as these can threaten hundreds of lives and seriously affect the well-being of surrounding communities.

Based on the available data it is reasonable to conclude that degradation in performance at the Line Maintenance and Heavy Maintenance areas caused by sleepiness, circadian disruption or distraction by family problems will translate into a higher incidence of accidents. These accidents will compromise the safety of the individual worker and, depending on the nature of the job, public safety as well.

Boeing has identified that the major cause of aircraft accidents has changed from being 80% due to machine faults in 1920 to 80% due to human causes in 1990.

There are a number of common work practices which require immediate, urgent attention by CASA and the Bureau of Air Safety (BASI). Clearly the common practice of having licensed engineers at the end of a 12 hour night shift perform a "Preflight" on an aircraft scheduled to take off on its first flight of the day in their last hour of duty or on overtime when they are fatigued is fraught with danger. The LAME concerned may have had no rest period (other than brief meal breaks) during the previous 12 hours night work and may have been involved in completing a major aircraft check. Also unacceptable is the common practice of assigning the Preflight task to the same individual who has previously performed the ROA (Receipt of aircraft) check or "A" check on the aircraft during the course of the evening. It is highly probable that if in the course of their first visual inspection a maintenance discrepancy was missed the same individual will miss it again in a fatigued state.

Social and domestic disturbance

Non-standard work schedules may induce stress for the worker by preventing the worker from fulfilling important family roles. Social companionship, parenting and sexual partner roles can all be adversely affected by work schedules. In some cases these effects can be major and can severely affect mood, motivation and sleep, therefore having consequential effects on performance and safety. Marital

problems, excessive domestic load and community alienation are all well-documented results of the strain placed on workers by work schedules.

In the United States, a survey of 1023 married couples found that shiftwork is associated with lower quality family life and more frequent family conflicts. Another study found that shiftwork increased the probability of divorce from 7 to 11 percent over the 3-year period of the study. Similar findings have been reported in Europe. A 15-year study of 504 Swedish paper-mill workers found that the divorce rate among shiftworkers was double that of day workers.

In Australia there is a direct correlation between working in aviation engineering and divorce. Sometimes referred to as the "Airlines Syndrome" it can be attributed to a range of factors related to the working environment and shift work. Fatigue from shift work and the recovery period during family social hours lead to general disharmony with family activity.

Ways to achieve a greater level of responsibility

Overseas examples - The Human Factors approach

The European and United States regulatory administrations are researching the Human Factors aspects of aviation maintenance and inspection. Fatigue and its causes are key elements of the Human Factors program.

Currently the European aviation regulations JAR66 and JAR 145 require initial and continuing Human Factors training for certifying staff. There are moves to further increase the obligations on Approved Organisations to be aware of Human Factors and have in place safe systems of work.

FAR 66 does not yet include Human Factors in the regulations but an Advisory Circular encourages the use of this material.

Many European states have limitations on shift lengths, for example, Germany limits shift length to 11 hours and imposes restrictions on the amount of overtime that can be reasonably worked in a defined period. Interestingly in Germany there is no tax on night shift penalties. Additional paid annual leave is accrued according to the number of hours worked past midnight. At Lufthansa Airlines night shifts are voluntarily applied for by staff allowing a changing of personnel according to personal preference and adaptation to working night shift.

In Japan, night shift work has been held to be a legally compensable cause of premature death. There are also specific additional conditions such as leave, increasing shift penalties and resting environments provided for night workers.

Shift roster development

In the past, the difference between the expert's view of rostering and the employee's has been attributed, somewhat patronizingly, to employee ignorance of the effects and consequences of shiftwork. While this may sometimes be true, it is not always so.

In fact, many employees still do not consider biological adaptation an important consideration, even after significant educational intervention. The somewhat sobering realisation that consultants bring assumptions and prejudices to their job has led to a re-evaluation of best practice approaches to shiftwork. It has led to an abandonment of the traditional model of the consultant as an expert in roster design and a realisation that the people most suited to designing shiftwork rosters are the people who have to work them.

It is the ALAEA's experience that a consultative approach results in all parties involved developing a better appreciation of the other's perspective and a shared vision of the full-range of assessment criteria. It is only through such an inclusive approach that commitment to trial and implement new rosters can successfully be achieved. A shift roster becomes a medium to long-term part of the working environment once it is accepted. To spend additional time at the beginning of the process is a valuable investment repaid by delivering the best roster for the business and the employees.

Fatigue-modifying initiatives

The United States Federal Aviation Authority (FAA) in its Human Factors Guide for Aviation Maintenance suggests the introduction of a nap policy for employees experiencing fatigue at work.

"Once a person reaches a certain level of fatigue and sleepiness, it is impossible for him or her to stay awake by an act of willpower. Although it is very difficult for most managers to accept the idea that workers should be paid for sleeping, at least one study of cockpit crew on long, over-water flights has shown that performance decrements associated with sleepiness and fatigue can be drastically reduced when crew members are allowed to take a short nap during their shift. Fatigue effects were reduced when crew members were allowed to sleep as little as one half-hour during their watch."

Recommendations

1. That the Civil Aviation Safety Authority incorporate into Australian regulations the requirement for the inclusion of Human Factors in Aviation Maintenance for all certifying licence holders.

2. That the Civil Aviation Safety Authority should incorporate into Australian regulations limitations for the duty hours of Licensed Aircraft Maintenance Engineers.

3. That the Federal Government should initiate a legislatively binding *Code of Practice for Shift Work Rostering in the Transport Industry*. The Code should be developed by a joint industry task force set up specifically for the purpose.

4. That the duty of care implications for Federal and State governments, employers and employees for fatigue in transport be clearly enunciated by the House of Representatives Standing Committee in its recommendations arising from this inquiry.

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