

DISCUSSION PAPER: THE HEALTH AND SAFETY IMPACTS OF 24 HOUR SHIFTS IN FIRE DEPARTMENTS

**Ontario Association of Fire Chiefs
and
Ontario Municipal Human Resources Association**



March, 2011

Discussion Paper: The Health and Safety Impacts of 24 Hour Shifts in Fire Departments

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EXECUTIVE SUMMARY

This discussion paper examines the health and safety impacts of 24 hour shifts in fire departments. It is a follow up to the 2006 Ontario Association of Fire Chiefs/Ontario Municipal Human Resources Association discussion paper, "24-Hour Shifts in Fire Departments".

This paper reviewed more than 60 published research studies which focused solely on the health and safety impacts of extended work shifts on employees. Most of these are peer-reviewed studies published in scientific journals.

The reviewed studies were consistent in their conclusions that night shifts and extended shifts (those over 16 hours) present safety and health risks for workers. Combining long shifts with night time work compounds the risks.

The studies found that the rate of accidents and injuries increase with hours on the job. After 16 hours on the job, fatigue has a major impact. If work tasks require alertness, sleeping on the job may present a safety risk due to sleep inertia or 'grogginess' upon waking.

Shift workers working extended shifts face an increased risk of sleep disorders, gastrointestinal disorders, diabetes, cancers and heart disease.

Under health and safety legislation the employer must take every precaution reasonable for the protection of workers. If a critical injury or fatality occurs and it was later attributed to the new shift, the Employer could be liable under the Ontario Health and Safety Act (OHSA).

This report recommends that further empirical research needs to be done to determine if the 24 hour shift constitutes a greater risk to the health and safety of firefighters than the existing 10-14 shift pattern. Also, research should be conducted to determine if there is a healthier way to construct the shift pattern for fire departments. Furthermore, research needs to be undertaken to determine what measures or procedures can be implemented in a fire department to minimize or mitigate the adverse health and safety impacts of night and/or extended shifts.

This paper concludes by recommending that fire departments should not commit to changing to a 24 hour shift pattern until the recommended research has been completed.

1. PROJECT PURPOSE

In Ontario the majority of full time fire departments have traditionally worked a shift pattern of 10 hour days and 14 hour nights. Over the past five years seven fire departments have converted to a 24 hour shift pattern as a result of firefighter association requests during collective bargaining. Currently in Ontario there are 13 fire departments working the 24 shift schedule.

This study was undertaken by the Ontario Association of Fire Chiefs, and the Ontario Municipal Human Resource Association to investigate the impact of the 24 hour shift pattern on public safety and on the health and safety of firefighters. It is a follow up to and should be read in conjunction with, the 2006 OAFCA/OMHRA 24-hour shift report.

This paper is not specifically evaluating the different shift patterns. It is trying to assist fire departments by providing information on the impact of 24 hour shifts on public safety and on the health and safety of firefighters.

2. METHODOLOGY

This paper is based on a review of more than 60 published research studies which focused on the health and safety impacts of extended work shifts on employees. Most of these are peer-reviewed studies published in scientific journals. Most have been written in the past ten years although shiftwork has been studied since the 1970s and hundreds of studies on shiftwork have been published.

Conversations were also held with a number of prominent researchers studying in this field.

It must be stated that there are very few scientific studies specifically focusing on the impacts of the 24 hour shift on the fire service. There are however extensive studies on the impact of 24-hour shifts on other professionals, such as doctors, in addition to many studies on the impact of different shift patterns across a range of professions and industries. This paper is reporting on those findings which seem to be of most relevance to the Fire Service.

3. BACKGROUND

There are 466 Fire and Emergency Services Departments across Ontario. In 2009 they employed 30,015 firefighters and responded to over 485,000 calls for help – roughly equivalent to about one call every minute of every day throughout the year.

Community size:	% of Ontario Population	# of Fire Depts	Calls for help	Number of Full Time Firefighters	Number of Volunteer Firefighters
Under 25,000	19	406	58,093	519	14,502
25,000 – 100,000	16	37	73,243	1,744	2,902
Over 100,000	65	23	353,996	8,666	1,682
TOTAL		466	485,332	10,929	19,086

Office of the Fire Marshall 2009 statistics

In addition to fire related emergency calls, fire departments may also respond to motor vehicle collisions, life-critical medical calls, floods, building collapses, uncontrolled releases of contaminants into the environment (chemical spills), ice and water rescue, trench rescue, high angle rescue, ice storms, tornados, and other emergencies as defined in their Establishing and Regulating By-laws.

This report focuses on the mid size and larger fire departments which rely on full time firefighters for the majority of their responses.

While in the past, fire incidents made up the largest percentage of emergency calls, that is no longer the case. Today the demand for emergency response in Ontario is on average, for all mid to large size fire departments, approximately 45% medical incidents, 40% motor vehicle-related incidents, 13% fire and 2% other. The percentages will vary from department to department with some large urban departments experiencing 50% medical calls and only 5% fire calls.

An examination of the call distribution by time of day, of a sample of 12 mid to large size full time fire departments in Ontario, reveals the following pattern of calls:

Distribution of Fire Department Emergency Calls by Time of Day	
Time of Day	Percentage of calls
Morning: 6:00 am – 12:00 noon	29%
Afternoon: 12:00 noon – 6:00 pm	32%
Evening: 6:00 pm - midnight	22%
Night: Midnight – 6:00 am	16%

Office of the Fire Marshal – Standard Incident Reporting and Statistics ⁱⁱ

Although the afternoon and morning periods are the busiest there are still a significant number of calls during the night period.

The most common shift pattern in Ontario for career fire departments (full time firefighters) has been a combination of 10 hour days and 14 hour nights. They typically work seven 10 hour days (8:00 am - 6:00 pm) and seven 14 hour nights (6:00 pm – 8:00 am) in a 28 day period, with the firefighters rotating from days to nights to time off.

Duties and training are normally carried out on the day shift. The night shift has duties assigned but in many cases they may be minimal. There are usually no assigned duties after 10:00 pm at night. If there are no calls firefighters are allowed to sleep, but there is no guarantee that they will get any sleep at all on any particular shift.

Lately the request to move to a 24 hour shift schedule has appeared during collective bargaining.

The Fire Chief’s job is to organize and deploy resources provided by Council, such that the fire department can effectively and efficiently respond to emergencies at any time, day or night. On a particularly busy day or night, any combination of shorter duration calls and extended duration emergencies may be encountered. In other words, the shift pattern would ideally be designed such that the firefighters are awake and on active duty throughout the entire shift, such that preparation times can be reduced to the minimum possible, thereby reducing overall response times. The shift also has to be designed to cope with the maximum typical workload in a day, such that on-duty personnel are able to work efficiently and safely.

When considering a change to a 24 hour shift schedule the Fire Chief needs to consider the following:

1. What is the impact on public safety and the fire department's response capability?
2. What is the impact on the health and safety of the firefighters?
3. What are the potential legal liabilities surrounding the movement to this new shift?
4. What are the administrative impacts?
5. What is the impact on the budget?

To assist the Fire Chief the Ontario Association of Fire Chiefs (O AFC) and the Ontario Municipal Human Resources Association (OMHRA) released a discussion paper in December 2006 entitled, "24-Hour Shifts in Fire Departments". The paper reported on the impact of switching to a 24 hour shift schedule in four areas: health and safety, personal impact; legal risks and operational issues. Operational issues were the main focus of the paper.

At that time, there were only 5 fire departments in Ontario that were operating with the 24-hour shift. In the intervening years the number of fire departments with this shift pattern (permanently or on a trial basis) have increased to 13 (Windsor Fire and Rescue, London Fire Department, Woodstock Fire Department, Oakville Fire Services, Mississauga Fire & Emergency Services, Toronto Fire Services, Richmond Hill Fire Department, Barrie Fire Services, Kingston Fire Department, Peterborough Fire Department, Kitchener Fire Department, Ottawa Fire Services and Belleville Fire Department).

As the 24 hour shift has spread to other departments, concerns have been raised. There are concerns about performance and safety, operational logistics for training, maintaining on-duty compliment strength, and the health impacts on firefighters.

This paper will examine the impact of 24 hour shifts on public safety and on the health and safety of firefighters.

3.1 Legal Considerations

Consideration of the health and safety impacts of changes in the workplace is not only good management practice, but is a legal responsibility.

The Ontario Occupational Health and Safety Act states:

"Duties of employers

25. (2) Without limiting the strict duty imposed by subsection (1), an employer shall,

(h) take every precaution reasonable in the circumstances for the protection of a worker;

Additional duties of supervisor

27(2) Without limiting the duty imposed by subsection (1), a supervisor shall,

- a) advise a worker of the existence of any potential or actual danger to the health or safety of the worker of which the supervisor is aware;*
- b) where so prescribed, provide a worker with written instructions as to the measures and procedures to be taken for protection of the worker; and*
- c) take every precaution reasonable in the circumstances for the protection of a worker. R.S.O. 1990, c. O.1, s. 27.”*

Federal Legislation Bill C – 45, which amended the Canadian Criminal Code and became law on March 31, 2004, states that the employer has a responsibility to protect the health and safety of its workers. The Bill imposes serious penalties for violations that result in injuries or death and it provides new rules for attributing criminal liability to organizations and those who direct the work of others.

"217.1 Every one who undertakes, or has the authority, to direct how another person does work or performs a task is under a legal duty to take reasonable steps to prevent bodily harm to that person, or any other person, arising from that work or task." iii

When changing an employee's work duties or procedures, or the scheduling of their work, the employer has a legal responsibility to insure that the changes do not negatively impact the health and safety of the worker.

The fire department, acting as an agent of the Employer, must also consider the Fire Protection and Prevention Act (FPPA), 1997, which restricts the hours of work of a firefighter.

“Hours of work

43. (1) In every municipality having a population of not less than 10,000, the firefighters assigned to firefighting duties shall work according to,

(a) the two-platoon system where the firefighters are divided into two platoons, the hours of work of which shall be,

(i) for each platoon 24 consecutive hours on duty followed immediately by 24 consecutive hours off duty, or

(ii) for one platoon in day-time ten consecutive hours on duty followed immediately by 14 consecutive hours off duty and for the other platoon in night-time 14 consecutive hours on duty followed immediately by 10 consecutive hours off duty,

and the platoons shall alternate at least every two weeks from night work to day work and vice versa;

(b) the three-platoon system where the firefighters are divided into three platoons, the hours of work of which shall be eight consecutive hours on duty followed immediately by 16 consecutive hours off duty, and the platoons shall rotate in their periods of duty and time off as may be arranged for the purpose of changing shifts at least every two weeks; or
(c) any other system of platoons or hours of work under which the maximum hours of work or hours on duty on average in any work week are not more than 48 hours.

Maximum hours

(3) No firefighters shall be required to be on duty on average in any work week more than 48 hours.

Off duty

(6) The hours off duty of firefighters shall be free from fire department duties.

Exception for emergencies

(7) Despite subsections (1) to (6), the fire chief may call in off-duty firefighters if, as a result of a major emergency, the fire department needs the services of more firefighters than are on duty. 1997, c. 4, s. 43.”

When considering alternative shift patterns the FPPA may limit the fire departments flexibility and its ability to call back firefighters to fill in on overtime, or for training.

3.2 Shift Schedules

The vast majority of the fire services were originally staffed by volunteers. As call volumes grew, it became necessary to have full time firefighters.

The present 10-14 hour shift schedule was adopted in Ontario in the 1950's without thorough knowledge of the effects of shift work on the health and safety of the firefighters. It was however administratively convenient and it did align the firefighters work shifts more closely with societal norms, so that they had time with their families etc.

The majority of fire departments utilizing full time paid firefighters use some variation of the 10-14 shift pattern.

Fire departments are now receiving collective bargaining proposals to change to a 24 hour shift pattern.

As part of the justification for the change, reference has been made to the fact that many fire departments in the United States are working 24 hour shifts.

The United States arrived at the 24 hour shift not due to science but due to history. When fire departments staffed by paid firefighters were first established in many parts of the South, Midwest and West, the firefighters were on duty for six to seven days in a row. Over time their schedule shifted to an 86 hour duty week with one 24 hour work period followed by a 24 hour period off. Over the decades duty schedules continued to be reduced to 72, 67, 63, 56 and then 42 hour weeks. The duty schedules continued to be designed using a combination of the 24 hour work shift with 24 hours off.

According to a 1999 report prepared by the International Association of Firefighters (IAFF) on work hours and shift schedules, the two most common lengths of fire department work week in the United States are:

- 29.4% have a 42 hour work week,
- 28.3% have a 56 hour work week.

The most commonly used schedules among fire departments with full time firefighters are:

- 67.7% use some variation of the 24 Hour work shift
- 28.7% use a 10/14-hour shift

There are a wide variety of 24 hour shift patterns in use. They vary the number of 24 hours on/off duty, the spacing between work days and the number of days off in a row.

- Chicago Pattern: 24 on/24 hours with varying number of days off.
- California Pattern: 24 on/24 off/24 on/24 off/24 on/96 hours off.
- Seattle or Modified: 24 on/48-hours off with additional 12 or 24 hour days off to balance the total hours worked in a cycle.
- 48 hours on/96 hours off.

These varying shift patterns make it difficult to draw clear conclusions about the impact of specific 24 hour shifts patterns from high level United States national data.

Despite the wide use of 24 hour shifts there is not universal support within the Fire Service. There are now articles appearing in Fire Chief and Fire Engineering magazines that are suggesting that fire departments in the United States should be moving to a 10-14 hour shift pattern for health and safety reasons. In 2007 there was enough general concern about the impact of the lack of sleep on firefighters that the International Association of Fire Chiefs released a report on "The Effects of Sleep Deprivation on Firefighters and EMS Responders".

Firefighting is an inherently dangerous task and extensive safety measures and safety equipment have been put in place to protect firefighters. Despite these measures firefighters continue to die on the job.

The United States Fire Administration publishes an annual report entitled “Firefighter Fatalities in the United States”. Between the year 2000 and 2009 an average of 109 firefighters (37 of which are career firefighters) died each year in the United States, while on active duty.

This study focuses on the career firefighters as they are the ones who are working shiftwork (24 hours and night shifts).

A summary of ten years of fatalities (presented below) was summarized in a presentation by Dr. Steven Lockley (the deaths that occurred during 9-11 were not included as part of this analysis). A review of the ‘cause of death’ data for 2008 and 2009 revealed that the principle causes of death remain the same.

Percentage of Fatalities Among Career Firefighters by Cause/Contributing Cause United States, 1994 – 2004 ^{iv}	
Cause of Death	Total Number of Deaths 388
Heart Attack	39%
Motor vehicle	12%
Asphyxiation	20%
Other	29%

51% of firefighter fatalities are due to heart attack or motor vehicle accidents. As is discussed later, shiftwork and extended duration work hours create health impacts that may have contributed to these fatalities.

While there are few studies that have focused specifically on shiftwork and health in firefighters, the biological factors that may underlie the detrimental effects of shiftwork on health and safety are the same, regardless of profession, and therefore the extensive studies conducted in other highly motivated, highly trained, safety-sensitive professions are equally applicable to the fire service.

4. RESEARCH FINDINGS

There is a considerable amount of research that has been conducted regarding the adverse consequences of shift work (and particularly those that include night work) on the health and safety of workers.

A shift schedule that includes night work... “is recognized to be a serious risk factor for workers’ health and interferes with at least the following four main spheres of human life: basic biological functions, work ability, social relations and psycho-physical health conditions”. ^v

According to the Institute for Work and Health, shift workers are at a higher risk for the following health problems that are most commonly cited in the research literature: ^{vi}

- sleep disorders – insomnia, increased fatigue
- gastrointestinal disorders
- diabetes
- workplace injury – increased error rates and accident rates
- psychological distress – social problems, divorce, minor psychiatric disorders
- pregnancy complications
- cancer
- cardiovascular disease

Although scientific opinion varies regarding the type and severity of these problems, the research demonstrates that significant issues do exist for shift workers. In addition to standard shifts (i.e. 8-14 hours), extended work shifts beyond 16 hours also have an additional negative impact.

“...the net results [of these factors] have been chronic ill health, inherent safety issues, broken families (i.e. higher divorce rates), and reduced performance.” ^{vii}

Our findings below are grouped into 4 categories: physiological reaction to shift work, performance and safety impacts, short-term health impacts and long-term health impacts.

4.1 Physiological Response to Shift Work

Key Points

1. Night shiftwork disturbs circadian rhythms (24 hour body clock), causes chronic sleep deprivation and has significant adverse effects on alertness, performance, mood, health, workplace accident rates, and a worker's personal life.
2. The combination of sleep deprivation and circadian misalignment during a nightshift, particularly an extended duration shift, greatly increases the risk of accidents and injuries at work and on the commute home.
3. There tends to be a decrease in performance during night shifts and during longer shifts for workers over 40 years of age.
4. Failure to get a good night's sleep after training may impact a person's ability to consolidate the new knowledge into memory and negatively effects the development of 'insight' or experience.

4.1.1 Circadian Rhythms: the 24 hour body clock

It is important to understand the nature of circadian rhythms in order to fully comprehend the impact on health and safety that shift work can have.

The circadian rhythm is the natural rhythm of our body. It is ... *"an internal body clock that is synchronized to a 24 hour period. It regulates a number of physiological functions such as body temperature, hormone secretion, heart rate, blood pressure, respiration, digestion and mental alertness. It lets us know, among other things, when to sleep and when to eat."*^{viii}

In other words human beings have evolved to be:

- awake during the day and to sleep during the night; and
- to be active for 16 hours and to sleep for 8 hours per day

When this internal clock is disturbed health problems may arise because the circadian rhythms are no longer synchronized.

Empirical evidence shows that working throughout the night disturbs the circadian rhythm in the human body and that shift workers can have health problems as a result.

“Disruption of the body’s circadian rhythms is thought to be the main pathway for adverse health effects from shift work, particularly for work schedules that include night work.”^{ix}

Shifts that include nighttime and early morning hours are not considered optimal for performance, as brain and body functions slump during these hours, with sleepiness, mood and performance problems reaching their lowest point around 3:00 am - 6:00am. Sleep in the day following night work is shorter, of poorer quality than and not as refreshing as, sleep during the normal nighttime hours. This is due to the circadian rhythm which promotes wake during the day, and sleep at night. Night shifts are particularly dangerous, as they often combine working at the body’s low-point with acute and chronic sleep loss. This dramatically increases fatigue and sleepiness and increases the risk of accident and injury.

Linda Glazner’s papers on shift work and circadian rhythms are often referred to by firefighters seeking to change to a 24 hour shift.

In a 1992 study she determined that maladaptation and negative health effects did occur in some firefighters working shift work (Glazner, 1992). In a later study, conducted with firefighters in three departments working a 10/14-hour shift, fatigue, especially on the night shift, and disruption of eating disorders, resulted in increased injuries (Glazner, 1996). The conclusions of these studies are supported by other researchers, as discussed later in this report.

In a later study (Toronto 2006) and at presentations to various firefighter associations, Glazner states that the 24 Hour shift helps to better maintain circadian rhythm however; other reviewers have found this study inconclusive. We did not find any other studies that supported her position.^x

There is extensive literature that reports that there are negative impacts to workers’ health and safety when they work beyond 16 hours (the second component for circadian rhythm). Glazner herself states at the end of her 2006 study, that there is a need to capture data on both short and long term effects of the 24 hour shift on firefighters’ health and wellness.

The underlying issue is sleep, how much a worker gets and when.

One study that looked at the altered characteristics of circadian rhythms of ambulance personnel, found that night-time naps greater than 4 hours seemed to have a favourable effect in averting changes to their circadian rhythms.^{xi}

In scheduling a department to adapt to shift work, Dr Harold Thomas said that you need to consider the number of consecutive night shifts as well as shift length. He says that from a circadian perspective the standard is to never rotate shifts. The other strategy,

which is often used in Europe, is to work as few night shifts in a row as possible to maintain a constant diurnal orientation.

The European shift pattern, which is also used by Air Traffic Controllers, uses 8 hour shifts scheduled 2 mornings, 2 late afternoons, 2 nights, followed by 4 days off.^{xii}

Depending on the shift pattern, it may take the brain and body many days to recover from one night's sleep disruption. In particular, problems can be caused when night shiftworkers, who may be adapted to night work, undo their adaptation by returning to a 'day' schedule on days off and during vacation.

Fatigue and sleepiness can make it more difficult to perform tasks and to do so safely, which in turn can increase the risk of accidents. When extended shifts are combined with night shifts these problems are intensified.

“Extensive, decades-old data from across occupations have established that sleep deprivation and circadian misalignment greatly increase the risk of industrial errors and accidents”.^{xiii}

4.1.2 Sleep

The amount of sleep that an individual requires varies and may be related to genetic or hereditary factors. Scientists consider 6-10 hours of sleep a normal range, with most people requiring 7.5 to 8.5 hours of sleep in a 24 hour period. At least 4-5 hours of uninterrupted core sleep is necessary to maintain minimum performance levels. The amount of sleep required may change slightly with age and can be affected by general health. Illness, stress and depression cause the body to require more sleep to heal and recuperate.

Sleep progresses through distinct stages and a phase known as rapid eye movement (REM).

- Stage 1: A relaxed, semiconscious state in which a person may be vaguely aware of his or her surroundings. This stage may last 5-10 minutes
- Stage 2: The actual beginning of sleep. Muscular activity decreases, heart rate slows and conscious awareness of the external environment disappears. This stage occupies 45–55% of total sleep in adults.
- Stages 3 and 4: Deeper sleep, during which body temperature drops; metabolic activity slows; and hormones responsible for growth, development, and tissue repair are secreted. Stage 4 is the deepest phase of sleep, when the body recovers and heals.

- Sleep then moves into the REM phase. During REM, the eyes move rapidly, breathing and heart rates become irregular, blood pressure fluctuates, and muscles become virtually paralyzed.

REM plays a major role in memory storage and retention, new learning, and mental performance. It is also the stage of sleep where the most dreaming occurs.

The first period of REM sleep usually lasts 10 minutes, but it increases in length during the night. With age the first REM stage lengthens. Older people commonly enter REM sleep quicker and stay there longer.

At the end of REM, sleep progresses back to the lighter stages of sleep, and the sequence begins again.

A sleep cycle, whereby a person goes through all of the stages of sleep, lasts approximately 90 to 110 minutes. During a 'good night's' sleep a person may go through 4-5 cycles a night.^{xiv}

Sleep problems occur when these sleep cycles are interrupted and if there is an insufficient length of sleep.

If a person is awakened during Stage 1 or 2 they are more likely to wake up feeling alert and refreshed. (These would be naps in the 20-45 minute range.)

If they are awakened suddenly during Stage 3 or 4 (a deep sleep) they may experience sleep inertia, a state of mental confusion and diminished performance.

If sleep patterns are interrupted too many times per night, a person will wake up feeling tired and exhibit the symptoms of lack of sleep.

Sleep deprivation also affects a person's ability to develop memory, 'insight' and experience. Information absorbed during the day is consolidated at night while sleeping. Lack of sleep may mean that the new information is never stored.^{xv}

Loss of sleep is cumulative and creates a sleep debt. Studies have proved that decreasing sleep time by one hour a night for seven consecutive nights, is equivalent to staying up for 24 hours straight once a week. Performance will suffer until that sleep debt is overcome. To overcome a sleep debt, a longer period of restorative sleep is required to return the body and mind to its normal rested levels.

The more hours that a person is awake the greater the sleep debt. The more their sleep is interrupted the greater the sleep debt.

A 24 hour shift with no sleep will create a sleep debt that may require two days of regular sleep to recover.

A 24 hour shift with interrupted sleep may create the same sleep debt.

A 14 hour night with no sleep provides an opportunity for uninterrupted sleep in the following 10 hour off duty period. The shorter time on duty, with a closer opportunity to engage in restorative sleep, will minimize the sleep debt.

4.1.3 Ageing

Age is another factor which comes into play during an extended-duration work shift. Physical stamina tends to diminish with age and older workers may not have the energy to work extended shifts.

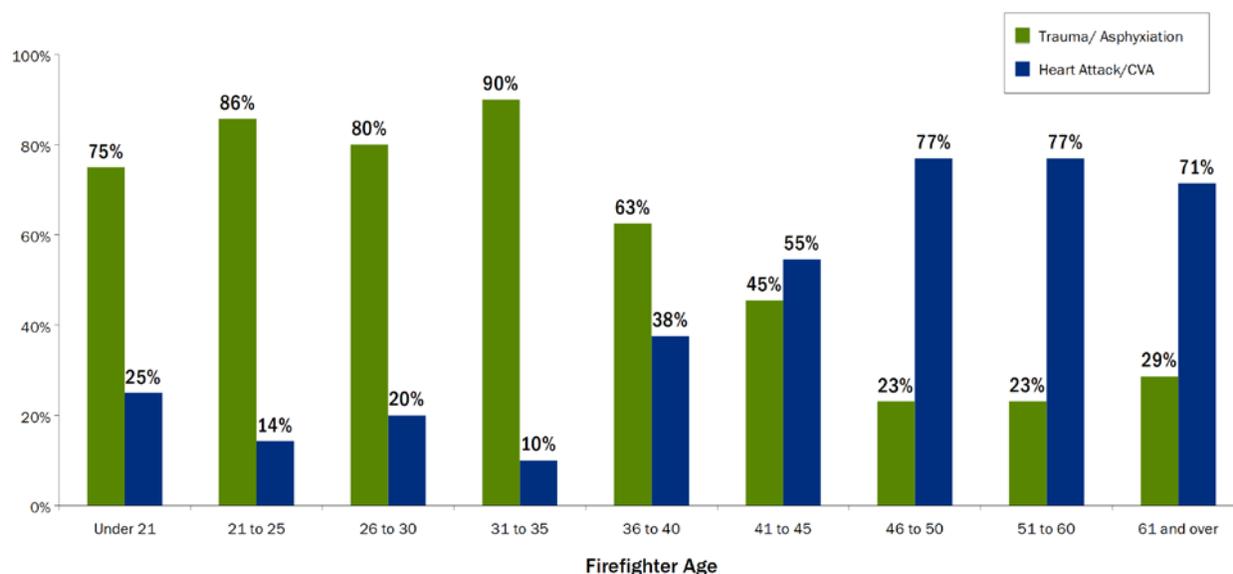
“Ageing may be associated with a progressive intolerance to shift work due to reduced psycho-physical fitness, the decreased restorative properties of sleep, and a higher proneness to the internal desynchronization of circadian rhythms.”
xvi

Research studies conducted with older shift workers show that they do not respond as well as their younger counterparts ...*“it is physiologically more difficult for someone in their mid 50’s or 60’s to sustain vigilance for longer periods of time than it is for someone younger.”* xvii

In other words longer shifts will have a greater impact on older workers.

The following analysis of firefighter fatalities in the United States provides some insight.

Fatalities by Age and Nature (2006)



The first bars are trauma deaths, which represents most of the fatalities which occur fighting the fire (i.e. floor or roof collapse etc.) The second bar is heart attacks and strokes, which represents the body's ability to deal with the stress. Although stress-related deaths are present in every age range in the 2006 data, stress plays an increasing role in firefighter deaths as age increases. Workers over the age of 40 have a much higher risk of heart attack.

An analysis of firefighter deaths by time of day over a ten year period is shown in the following table:

1987-1996 Firefighter Deaths by Time of Alarm

Time of Day	Percentage of Deaths
7:00 am - 1:00 pm	24.2%
1:00 pm - 7:00 pm	26.6%
7:00 pm - 1:00 am	29.0%
1:00 am - 7:00 am	20.1%

The worse two hour period over 24 hours was 11:00 pm – 1:00 am when 15.6% of all deaths occurred.

If the distribution of emergency calls follow the same distribution as Ontario, i.e. the greatest percentage of calls are in the afternoon, followed by the morning, then this data shows that there are a disproportionate number of fatalities during the evening and night

periods, when firefighters are most most likely to be fatigued. (Evening 22% of calls 29% of fatalities. Night 16% of calls 20% of fatalities).

It has to be noted that no studies were found that correlated the incidence of heart attacks to how long the firefighter was on duty. Given that 67% of the full time departments are using some pattern of 24 hour shifts, the length of shift may be a factor. By 11:00 pm to 1:00 am the firefighters may have been on duty for 16 – 18 hours.

Data is presented later in this report shows a similar correlation between firefighter injuries and time of day.

Age is a factor. Not everyone is able to adjust to working 24 hours straight. One Fire Chief said, “We find the younger people can handle it, but the experienced people in their 50s find it’s too much... We’ve had eight retirements since we made the change. Not all of them were related to going to the 24-hour rotation, but some definitely were.”^{xviii}

Overall the research findings show that for workers over the age of 40 work performance tends to decrease over the night shift and decrease over longer shifts. This is cause for concern as the average age of firefighters in Ontario in 2005 was 41.^{xix} It will become of increasing concern as the workforce ages.

4.2 Performance and Safety Impacts

Key Points:

Performance Impacts

1. People working extended hours are at increased risk of suffering from sleepiness, fatigue and acute and chronic sleep deprivation.
2. Cognitive and physical performance noticeably declines after 16 hours without sleep. After 19 hours without sleep, performance is equivalent to that with a 0.05% blood alcohol concentration (BAC) and after 24 hours awake, is the same as a 0.1% BAC.
3. Risk of workplace accidents increases the number of hours worked, and all effects are exacerbated in night shifts.
4. When waking up to respond to a call it may take up to 20-30 minutes for the brain to become alert, and up to 2-4 hours to reach its peak efficiency, due to sleep inertia.
5. Workers who are fatigued cannot estimate their own sleepiness and tend to under estimate the impact that fatigue has on their performance.
6. Napping prior to an overnight shift helps to reduce fatigue and the buildup of acute and chronic sleep deprivation. It may also reduce the risk of fatigue-related accidents overnight.

4.2.1 Fatigue

Firefighting is a dangerous and demanding job that in times of crisis requires intense physical exertion, mental concentration and a high level of teamwork. Working extended work shifts firefighters are at increased risk for sleepiness, fatigue and sleep deprivation. This raises cause for concern when these factors are coupled with the demands of their job in a time of crisis. The Canadian Centre for Occupational Health and Safety states that ... *“heavy physical jobs and/or jobs that demand sustained attention throughout the workday do not lend themselves well to extended workday schedules.”*^{xx}

Major industrial disasters have occurred in the middle of the night, such as the Chernobyl and Three Mile Island nuclear leaks, the chemical leak at Bhopal, India and the Exxon Valdez crash. These events have been attributed to critical errors related, at least in part, to long work hours and sleepiness.^{xxi}

“It is estimated that fatigue results in \$8.5 billion dollars in accident damage, \$79.9 billion in lost productivity and \$28.3 billion in associated health-care costs. Some will argue that workplace fatigue holds true for any profession to some degree; however, fatigue becomes a critical factor for emergency responders who must make split-second decisions that can affect the lives of civilians, as well as their colleagues”.^{xxii}

Fatigue goes beyond being tired as it can also affect a person’s ability to perform. It can be revealed in both physical and mental ways. Physical fatigue is usually experienced by diminishing strength or muscle weariness, whereas mental fatigue can be experienced as lowered ability to solve problems and perform tasks.

The effects most commonly associated with fatigue are:

- Lack of concentration
- Poor judgment
- Reduced vigilance
- Slower reaction times
- Reduced capacity for effective interpersonal communication
- Reduced hand-eye coordination
- Reduced visual perception
- Impaired recollection of timing and events
- Irritability

These effects can be particularly dangerous for firefighters when performing tasks that demand continuous attention such as driving an apparatus, fire suppression, conducting a search and rescue, and treating emergency medical patients.

There are 4 physiological factors which determine the amount of fatigue:

1. The time of day (or circadian rhythm in sleepiness)
2. The number of hours awake (acute sleep deprivation)
3. Sleep deficit (chronic sleep deficiency)
4. Sleep inertia (‘grogginess’ upon waking)

1. The time of day:

The natural 24-hour circadian rhythm determines how sleepy we are. Sleepiness is obviously much higher at 3 am in the morning as compared to 3 pm in the afternoon. Usually, we would be asleep at night at the time of peak sleepiness but night shiftworkers are required to be awake during this time. The circadian system also helps us stay awake during the day so when a night shiftworker tries to sleep in the day, they are also going against their natural body rhythm and their sleep is therefore different, short and of poorer quality.

2. The number of hours awake:

The risk of fatigue increases with the number of consecutive hours that one is awake, and therefore the number of hours worked. Under normal circumstances, our circadian system promotes sleep after 16 hours awake. After 16 hours awake performance and alertness falls quite rapidly and continues to fall with increasing time awake. Even if a 'second wind' is experienced during a 24-hour extended duration work shift, alertness and performance are never as good as the same time the day before, due to sleep deprivation.

Impairment of performance due to number of hours awake has been equated to that associated with blood alcohol concentration. Cognitive performance after 19 hours of sustained wakefulness is equivalent to performance with a 0.05% blood alcohol concentration (BAC), and after 24 hours, performance is equivalent to approximately 0.10% blood alcohol concentration.^{xxiii} Drivers with a blood level of 0.05 would have their license immediately suspended. Driving with a BAC in excess of 0.08 is a criminal offence.

3. Sleep deficit:

“Some of the most serious and persistent problems shift workers face are frequent sleep disturbance and associated excessive sleepiness. Sleepiness/fatigue in the work place can lead to poor concentration, absenteeism, accidents, errors, injuries, and fatalities. The issue becomes more alarming when you consider that shift workers are often employed in the most dangerous of jobs, such as firefighting, emergency medical services, law enforcement and security.”^{xxiv}

Acute sleep deprivation can result from missing a single night's sleep. However a sleep deficit, or chronic sleep deficiency, is more commonly built up by repeatedly not getting sufficient sleep every night.

Several lines of evidence suggest that young people need 8.5 hours per day and older people 7.5 hours per day. Failure to achieve these totals and the lost sleep will quickly accumulate and become chronic sleep debt if the pattern of losing sleep persists. For example, after less than two weeks with only 6 hours in bed per night, performance levels are equivalent to those observed after 24 hours of acute sleep deprivation. At four hours in bed per night, it takes only seven days to reach that level and after two weeks, performance is equivalent to 48 hours without sleep.^{xxv}

Acute sleep deprivation is defined as less than 4 to 6 hours sleep in a 24 hour period (Belenky et al., 2003).^{xxvi}

While firefighters who are on duty throughout the night are allowed to sleep, that sleep is not guaranteed. Often their sleep may be interrupted or denied altogether depending on how many calls for help are received.

Data on the distribution of emergency calls to Ontario fire departments (provided earlier) shows that fire departments receive 16% of their calls between midnight and 6:00 am. As our society moves more and more to around the clock services this percentage of calls will likely increase. This means that a firefighter cannot bank on getting a long period of uninterrupted sleep during the night while on duty.

At least four to six hours of uninterrupted core sleep is necessary every 24 hours to maintain minimum performance levels.

Because uninterrupted sleep is not guaranteed at the fire hall, firefighters must get their uninterrupted sleep before or after they come on duty. The 10/14 shift pattern allows for this to happen. When on day duty they sleep their normal nights at home. For the night shifts they should have a nap at home before coming on shift, or go home 14 hours later and sleep in the morning. Failure to take the time to sleep after being on duty will contribute to the sleep deficit and impact performance on subsequent shifts.

On a 24 hour shift workers come in after a normal night's sleep. Given their circadian rhythms, their performance will start to lag after 16 hours (10:00 pm to 12:00 am) and affect them for the next 8 hours. The risk is that a busy evening and night may mean that they do not get any sleep at all. This creates fatigue and a serious sleep deficit that will require several days for recovery.

There is a correlation between the amount of sleep a person gets and their overall level of performance. Note that work hours are not necessarily the important factor here but wake hours. The commute to and from work contributes to the duration of continuous wakefulness and off-duty activities could contribute to both acute and chronic sleep deprivation. These factors effectively add hours to the work day and compound the fatigue.

These factors have to be considered when examining workplace performance. Failure to achieve sufficient sleep before coming to work questions an individual's fitness for duty, just the same way as coming to work drunk would make someone unfit for duty.

4. Sleep inertia:

Regardless of the timing or duration of sleep, alertness and performance are impaired upon waking. Sleep inertia refers to the time it takes to get your brain going after waking. According to sleep expert, Dr. Charles Czeisler, there is a transitional period between the time you wake up and the time your brain becomes fully functional...*“the part of your brain responsible for memory consolidation doesn't function well for five to 20 minutes after you wake up and doesn't reach its peak efficiency for a couple of hours. This is why you never want to make an important decision as soon as you are suddenly awakened”*.^{xxvii}

Unfortunately, the first few minutes after waking are precisely the time that firefighters must take action and make crucial decisions. Most fire departments allow their firefighters to sleep during the night if there are no calls. When an alarm does come in they wake up and are driving the fire truck out of the fire hall within 80 seconds. They arrive at the scene in less than 6.1 minutes (average response time for all calls across Ontario). At the scene they may need to make decisions which impact the lives and safety of both the public and their fellow firefighters. Sleep inertia may interfere with their need to be clear headed and functioning at peak efficiency.

“Sleep inertia is a consideration when naps are used in an operational setting. This factor should be considered if an operator is likely to have a nap interrupted by an emergency requiring a quick response with a high level of performance”.^{xxviii}

Taking a nap before coming on duty overnight is a good way to try and reduce sleepiness while at work, as sleeping while at work brings the additional risk of sleep inertia, particularly for firefighters. Firefighters who are sleeping for several hours overnight and waking out of deep sleep to respond to an alarm, are battling the symptoms of sleep inertia - grogginess and disorientation – and will not be able to perform to peak efficiency.

Ideally, a workplace nap should be limited to 20-45 minutes (sleep stage 1 & 2) to get the benefits of sleep while minimizing the risk of sleep inertia.

To see if sleep inertia has an impact on response times, 12 Ontario fire departments were examined. The data was taken from the Standard Incident Reporting forms for the full year of 2008 (representing 222,670 calls). Response time is the time from receipt of emergency call until the wheels of the fire vehicle stop at the scene. The analysis compared the response time between midnight and 3:00 am with that between 9:00 am and 12:00 noon. The results show that night emergency responses are on average 14% longer, or an additional 45 seconds slower.

The variable most likely to account for this increase in response time is the time it takes firefighters to wake up and get going.

Sleep inertia also effects performance. Fire fighting requires reliance on others as part of a team; therefore, one sleepy firefighter can affect the safety of others. Fire crews tend to sleep at the same time which means that all of them may be suffering from sleep inertia at the same time.

Scientific studies have shown that individuals under estimate their own sleep inertia and the impact that it has on their performance, i.e. they do not think that their performance is reduced. This may expose the whole crew to a danger which they do not recognize. This may also result in the under reporting of fatigue related errors or accidents.

These four factors (time of day, hours awake, sleep deficit and sleep inertia) all contribute to fatigue. The high risk times for fatigue are: ^{xxix}

- Midnight to 6:00 am – sleepiness is maximal due to circadian rhythms
- Early hours of day shifts – due to sleep inertia
- End of a shift and driving home after work, particularly after a night shift – due to acute sleep deprivation which is combined with an adverse circadian phase in night shiftworkers
- First night shift after a break – as workers tend to stay awake all day before going to work, inducing high levels of acute sleep deprivation
- Change of roster – due to lack of circadian adaptation and risk of acute sleep deprivation as for the first night

4.2.2 Mental Errors

Fatigue has an impact on mental acuity. Lack of concentration, poor judgment, reduced vigilance, reduced capacity for effective interpersonal communication and impaired recollection of timing and event are some of the mental effects most commonly associated with fatigue. Experiencing one or more of these effects can lead to mistakes that could have dire consequences.

One of the findings of a meta-analytic examination of 959 physicians and 1,028 non – physicians was that *“even sleep deprivation of 24 to less than 30 hours, leads to extreme degradation of residents’ cognitive and clinical performance”*. ^{xxx}

Clear evidence of this can be found in the following statistics. Doctor's working 24 hour extended duration work shifts:

- make 36% more **serious** medical errors overall; ^{xxx}i
- make 21% more medication errors; ^{xxx}ii
- make 27% more intercepted serious errors; ^{xxx}iii
- make 5 times more **serious** diagnostic errors; ^{xxx}iv
- have twice the rate of attention lapses overnight; ^{xxx}v

as compared to when the same doctors were working 16-hour scheduled shifts^{xxxvi}.

Furthermore, surveys of medical residents showed that they have:

- 'needle stick' injuries twice as often when working overnight as compared to the day. ^{xxxvii}
- have a 2.3-fold increased risk of having a confirmed motor vehicle crash on the drive home after working a 24-hour shift as compared to when they drive home from a non-24-hour shift. ^{xxxviii}
- they report making 300% more fatal adverse events when working 24-hour shifts. ^{xxxix}

Given that approximately 50% of firefighter responses are medically-related, it is likely that their medical performance similarly suffers when working 24 hour shifts.

4.2.3 Injuries and Accidents

Key Points:

Safety Impacts

1. Extended work shifts increase fatigue.
2. Fatigue has an impact on mental acuity and leads to a lack of concentration, poor judgment, and reduced vigilance.
3. Extended work shifts are associated with an increased risk of injuries and accidents.
4. The risk for personal injury increases with the number of hours worked and increases dramatically after more than 8 hours on the job.
5. Rates of injuries for firefighters from 12:00 midnight to 6 AM are more than doubled those of mid-afternoon.
6. Heavy or dangerous work that demands sustained attention at the end of a 12-hour shift or in the early morning hours increases the risk for accidents and injuries.
7. Employers have been held legally liable for fatigued employees who have been involved in motor vehicle accidents on the journey home from work.

Empirical evidence indicates that a correlation exists between the risk of injuries and accidents, the time of day/night and the number of consecutive hours worked. It shows that the risk for personal injury increases with the number of hours worked per shift and coincides with the decline in performance.

The highest risk time for injuries and accidents is during the night followed by the afternoon and morning hours.

By every measure research studies show that “... *performance decreases at the beginning of early morning shifts, during the post lunch hours, and during overnight shifts particularly during the pre-dawn hours*”.^{x1}

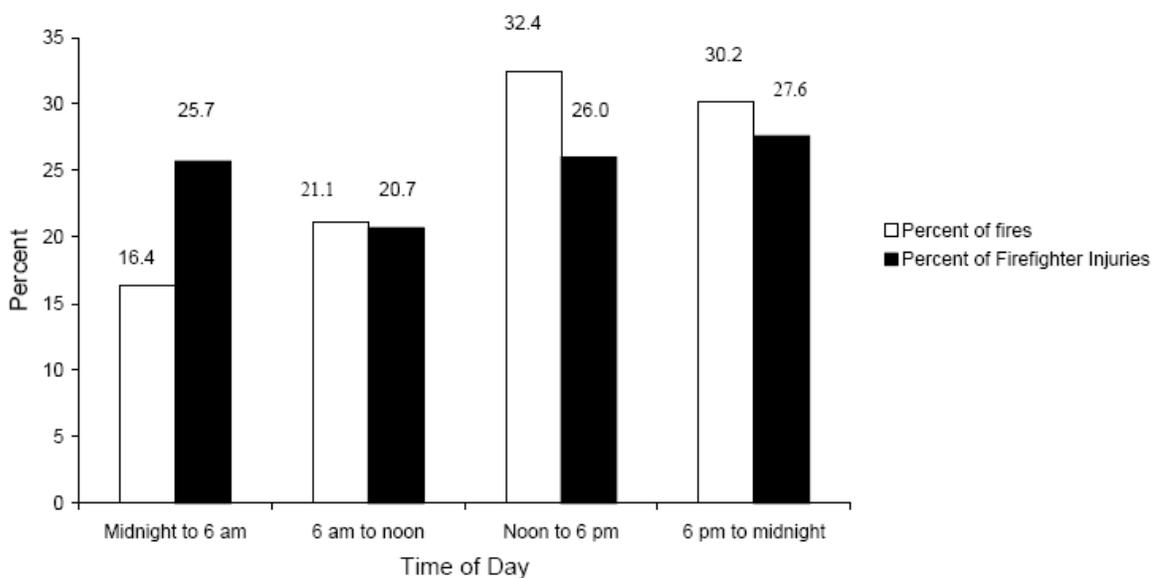
Numerous studies have revealed that the longer the shift the more accidents and injuries occur. In an article entitled, *“Modelling the impact of the components of long work hours on injuries and accidents”*, the researchers found that *“relative to eight hour shifts, ten hour shifts were associated with a 13.0% increased risk of injuries and accidents, and twelve hour shifts exhibited a 27.5% increased risk.”*^{xli}

The same trends hold for firefighters, as shown by the data from the United States.

The chart below shows that the peak period for structure fires attended by fire departments was noon to midnight (62.6%). The quietest time is the early morning from midnight to 6:00 AM (16.4%)

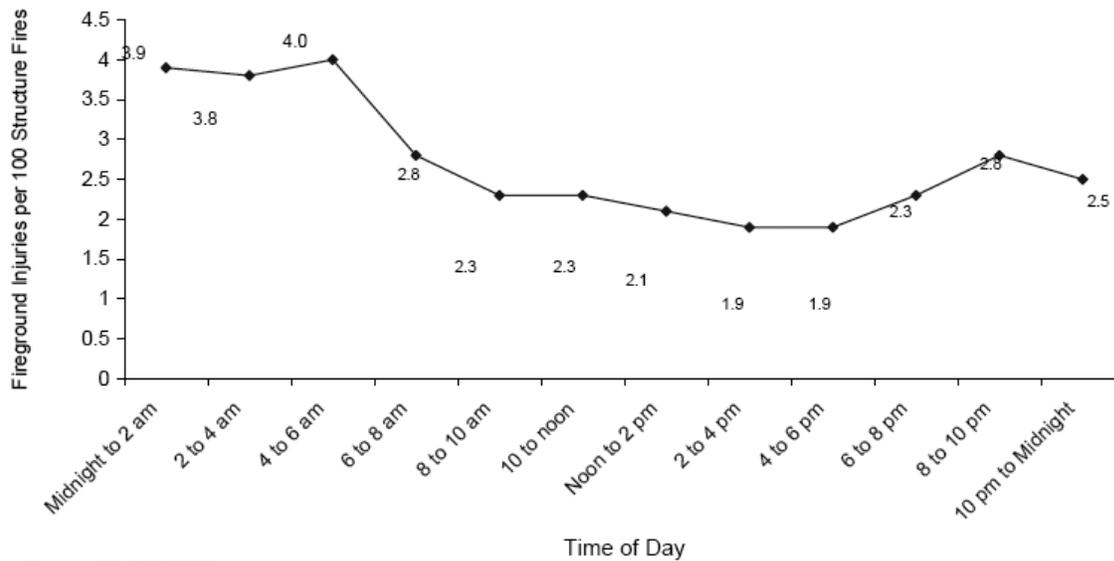
The second bar shows that there is a disproportionate increase in injuries during the midnight to 6:00 AM time period (25.7% of injuries but only 16.4% of fires) when there is less activity.

Comparison Times of Injuries and Times of Fires^{xliii}



This point is further illustrated in the next chart when fireground injuries per 100 structure fires are examined. The highest injury rate is 3.9 to 4.0 injuries per 100 fires, which occurred during the night (midnight to 6:00 am). This firefighter injury rate is more than double that of mid afternoon. Speculation by the report author was that finding a higher injury rate during the nighttime hours could relate to lack of visibility, cold temperatures and lower alertness of fire fighters.^{xliiii}

Times and Injuries per 100 Structural Fires ^{xliv}



Source: 1994-98 NFIRS

The author of the study did not correlate the injury rate with the number of hours on duty, but it should be remembered that 67% of the full time fire departments in the United States are working some version of the 24 hour shift.

Sleep deficit accumulates and so does the risk. On average, when working 4 nights in a row, the risk of an accident was:

- about 6% higher on the second night,
- 17% higher on the third night, and
- 36% higher on the fourth night.^{xlv}

Thus, there is evidence that there is an increase in risk over successive workdays, irrespective of the type of shift; but also evidence that this increase is substantially larger on the night shift than on the morning/day shift.

As a general principle it would appear that for any given length of work week, a long span of short shifts i.e. six 8 hr shifts, is likely to be safer than a short span of long shifts i.e. four 12 hr shifts, and Dr. Charles A. Czeisler recommends that “companies institute corporate sleep policies that discourage scheduled work beyond 16 consecutive hours”... ^{xlvi}.

Night shift workers experience greater injury and accident rates and extended shift workers experience greater injury and accident rates. The combination of the two intensifies the problem.

4.2.4 Driving

We know that sleep deprivation is not only an individual health hazard but can be a public safety hazard when driving is involved. Sleep deprivation can make it easier to fall asleep or have a micro nap while driving a vehicle. Being sleepy can compromise a person's ability to concentrate fully on the task at hand which is what driving requires us to do.

Driver fatigue accounts for millions of automobile accidents. *"In the past five years, driver fatigue has accounted for more than 1.35 million automobile accidents in the United States alone".*^{xlvi}

Safety-sensitive industries such as aviation and trucking have done extensive research and have recognized the risks of long hours on the job. Legal time limits for consecutive hours on duty were legislated. Under Canadian law:

- Air craft pilots can be on duty for 14 hours or up to 17 hours if there are unforeseen circumstances.
- The rules for commercial truck drivers are that no driver can drive after accumulating 13 hours of driving time in a day or 14 hours of on-duty time in a day.

A firefighter on a 24 hour shift is on duty for a 70% longer work period than that allowed for pilots and truck drivers.

Current trends in litigation demonstrate that companies are being held liable in cases where sleepy employees (both on and off duty) are victims of fatigue-related motor vehicle accidents. The courts are favoring employees in cases where they can show that the employer did nothing to mitigate the risk of drowsy driving. Four cases are cited in the 2006 OAFIC paper.

The companies who have fared the best with these kinds of lawsuits are those that have fatigue management training programs, napping policies and other measures in place to prevent fatigue-related incidents from happening.

4.3 Short Term Health Impacts

Key Points

1. Fatigue is the most common complaint among shift workers.
2. Extended shift workers have an increased risk for sleep disorders, gastrointestinal disorders, psychological distress, pregnancy complications and breast cancer and may also be at increased risk for diseases such as diabetes, prostate cancer and colorectal cancer.
3. Several days of work followed by four- to seven-day “mini-vacations” can increase disruption of circadian rhythm, sleep disorders and chronic sleep deprivation.
4. Shift workers report significantly higher burnout, emotional exhaustion, job stress and psychosomatic health problems.
5. There is an increased risk of adverse pregnancy complications with shift work.

A considerable amount of research exists regarding the adverse impacts of shift work (and particularly those that include night work) on health. These impacts primarily stem from the disturbance these shifts make to our circadian rhythm (24 hour cycle) and in particular the light/dark/wake/sleep cycle that affect the main areas of our life.

Regular disturbance to the daily 24 hour cycle can lead to fatigue. The disturbance can come from night shifts and from long extended shifts. The two together appear to compound the problems/risks.

Fatigue is cited as the number one complaint amongst shift workers and chronic fatigue leads to increased risk of health problems.

According to the Institute for Work and Health, shift workers are at a higher risk for the following health problems that are most commonly cited in the research literature: ^{xlviii}

- circadian rhythm sleep disorders – a family of sleep disorders affecting, among other things, the timing of sleep and including insomnia, increased fatigue, sleep apnea etc.
- gastrointestinal disorders
- diabetes
- workplace injury – increased error rates and accident rates

- psychological distress – social problems, minor psychiatric disorders
- pregnancy complications
- cancer
- cardiovascular disease

Although scientific opinion varies regarding the type and severity of these health problems, the fact remains that significant issues do exist for shift workers and shifts do have an impact on their health.

Both short term and long term health problems have been attributed to the circadian rhythm sleep disorder. Short term problems include sleep disorders, digestive disturbances, pregnancy complications and psychological symptoms such as anxiety and irritability. Long term problems can include more severe disorders such as *“chronic sleep, gastrointestinal, neuropsychic, cardiovascular disorders”, pregnancy complications^{xlix} and “hypertension, depression, diabetes and other chronic diseases.”^l*

4.3.1 Sleep Disorders

Fatigue seems to be the primary complaint of extended shift workers and especially night shift workers. This is because the length of sleep and the quality of sleep can vary considerably according to different sleeping and waking times. Many shift workers are constantly tired because they have a tendency to revert to the “normal” day schedule on their days off. When this is done the circadian rhythm flips back and forth and doesn’t stabilize to a consistent pattern. Several days of work followed by four- to seven-day “mini-vacations” can increase disruption of circadian rhythm, sleep disorders and chronic sleep deprivation.

The studies show that working at night disturbs our “normal” sleep/wake, dark/light cycle.

“The change from day to late evening and night work compels the worker to modify his normal ‘activity–rest’ cycle, forcing him/her to adjust his body functions to the duty periods. This involves a progressive phase shift of circadian rhythms across the successive night shifts, but a complete inversion is never reached... In most cases, the human body is exposed to continuous stress from attempts to adjust as quickly as possible to the varying working hours, while at the same time being invariably frustrated by the continuous shift rotation. Consequently people suffer from so-called ‘jet lag’ or, more precisely, ‘shift-lag’ syndrome, which is characterized by feelings of fatigue, sleepiness, insomnia, disorientation, digestive troubles, irritability, poorer mental agility and reduced performance efficiency.”^{li}

The International Classifications of Sleep Disorders has labelled shift work disorder a circadian rhythm sleep disorder because of the regularity with which people suffer from sleep disruption and excessive sleepiness in trying to adjust to a shift work schedule.

Shift work, both night shift and extended shifts, is a given for both police and fire. Recent studies conducted by Dr. Steven Lockley, of the Harvard Medical School, show that 39% of police officers suffer from sleep disorder, and his current research reveals the same level of risk for fire fighters.^{lii} His reports also show that working longer hours i.e. greater than 16 hours, increases the risk of sleep disorders.

4.3.2 Psychosocial Impacts

4.3.2.1 Increased Stress

Strong evidence exists to support the fact that shift workers experience more health problems than people who work during the day. A 2004 Canadian study of 376 full-time workers, found that *“shift workers report significantly higher burnout, emotional exhaustion, job stress and psychosomatic health problems (such as headaches, upset stomach, difficulty falling asleep) than workers on a regular day schedule”*.^{liii}

Many studies exist that show an association between shift work and psychological distress, depression, anxiety and burnout. In a 2008 study researchers *“focused on the possibility of work-family conflict: that shift work may interfere with participation in family life, because of both scheduling and fatigue, which may increase the risk of depression”*.^{liiv}

The studies report that extended shift work increases fatigue, lowers the body’s ability to cope with stress and exacerbates these problems.

4.3.2.2 Behaviourial

As discussed in the section on sleep disorders, it is very common for shift workers to suffer from sleep disturbances and the physiological consequences that result from them. Fatigue stems from chronic sleep disturbances and often leads to irritability, which in turn can have a negative impact on personal relations. The social effects of fatigue often extend to family and friends.

The National Sleep Foundation found that people who do not get enough sleep *“are more likely to get impatient or agitated, and they have difficulty getting along with others. Increased irritability and stress negatively influences personal, work, and family relationships, resulting in inadequate/ineffective communications, and correlating with increased absenteeism and turnover as well as reduced morale and poorer labor relations”*.^{liv}

When responding to calls firefighters are required to deal with members of the public who may be in highly charged emotional states. Firefighter’s job is to not only deal with the emergency but to deal with the victims and their families. This requires high levels of

communication, compassion and patience. Stated another way inadequate/ineffective communication or irritability due to lack of sleep will impede their ability to carry out their jobs as required.

Fatigue is a common complaint amongst shift workers. Extending work shifts to 24 hours increases the negative behavioural impacts that result from lack of sleep.

4.3.3 Pregnancy Complications

The research studies report a moderate to strong association between pregnancy complications and shift work. The pregnancy complications include premature delivery, low birth weight and miscarriages.

In a 2007 review of eight studies where the researchers pooled the results, there was “a 26 per cent increased risk of preterm delivery for shift/night workers than for day workers”.^{lvi}

It is thought that the risk ratios for pregnancy complications differ for the various types of shift work (no studies were found that examine the impact of 24 hour shifts) but the studies are clear that there is increased risk of adverse effects with night shifts.

4.4 Long Term Health Impacts

Key Points:

1. There are more gastrointestinal and digestive problems among extended shift workers.
2. Some studies have reported the prevalence of diabetes in relation to extended shift work.
3. Night shift work has been classified by the International Agency for Research on Cancer as a probable human carcinogen.
4. Female night shift workers are at an increased risk of developing breast cancer.
5. Rotating shift workers have a significantly higher risk of prostate cancer.
6. Some studies show that extended shift work increases the risk for cardiovascular disease.

4.4.1 Gastrointestinal Disorders

Numerous studies report more gastrointestinal and digestive problems among shift workers than day workers. Indigestion, heartburn, stomachache and loss of appetite seem to be more common among rotating shift workers and night workers.

A 1977 research paper noted that “*gastric and intestinal dysfunctions predominate in shift workers.*”^{lvii}

Digestion also follows a circadian rhythm. People who work “normal” hours (i.e. 9:00 am – 5:00 pm) are used to eating at regular times throughout the day. Shift work throws this rhythm off and hinders regular eating and digestive patterns. Lack of nutritious food can also be a factor contributing to gastrointestinal disorders as more unhealthy food tends to be consumed on evening and night shifts.

In a 2003 review of various health disorders associated with shift work, it was concluded that the “...*strongest evidence supported an association between shift work and gastrointestinal disease*”...^{lviii}

With evidence showing a predominance of gastrointestinal problems among shift workers, the 24 hour shift could lead to greater increased risk for these dysfunctions.

4.4.2 Diabetes and Metabolic Disturbances

Although not conclusive, some studies have reported the prevalence of diabetes in relation to extended shift work.

One such study by Suwazono et al. found that *“the risk of developing diabetes was significantly higher for workers on rotating shifts than it was for regular day workers”*.^{lix}

In a large double cohort study (*“The Nurses’ Health Study Cohorts”*), conducted in 1988 and 1999 respectively, researchers found that *“evidence suggests there is a detrimental effect on shift work ...and diabetes.”*^{lx}

4.4.3 Cancer

Based on the published data, night shift work has been classified by the International Agency for Research on Cancer (IARC) as a probable human carcinogen. This classification was made on the basis of *“limited evidence in humans for the carcinogenicity of shift work that involves night work [and] sufficient evidence in experimental animals for the carcinogenicity of light during the daily dark period (biological night)”*.^{lxi}

The scientific belief is that the disruption of the circadian cycle can alter the timing of the release and regulation of hormones that are specifically relevant to cancer. In particular, the combination of being exposed to light at night (LAN) and suffering from sleep disruption alters the regulation of melatonin.

The hormone melatonin is vitally important as it *“inhibits the development and/or growth of tumors, [has] anti-proliferative effects on cancer cells and detoxifies carcinogens via activation of antioxidative pathways.”*^{lxii}

The results of a 2005 study conducted by Burch et al. show *“night shift workers ...had lower sleep: work ratio of melatonin production than did other shifts... 2.3 (10:00 pm 6:00 am), 4.5 (2:00 pm – 10:00 pm) and 4.2 (6:00 am – 2:00 pm) respectively”*.^{lxiii}

Although no conclusive evidence exists that night shift work increases the risk of cancer per se, there is increasing evidence that suggests that continuous and prolonged night work may result in adverse health problems that include breast, prostate and other forms of cancer.

This could be particularly worrisome for the Fire Service. It is already assumed that firefighters suffer from higher levels of 8 types of cancer than the general population. This has been recognized by the government in Ontario's Presumptive Legislation for firefighters. What the science to date has not investigated is whether there is a correlation between shiftwork, or length of shift and the elevated cancer rate for firefighters.

4.4.3.1 Breast Cancer

In a recent presentation in Toronto, at the Institute for Work and Health's Scientific Symposium, Dr. Blask reported that *"light at night-reduced melatonin suppression is a new risk factor for breast cancer."*^{lxiv} He goes on to say that female night shift workers are at a 50% – 80% increased risk of developing breast cancer and that the risk increases with the number of years worked on this shift.

At the same symposium Dr. Eva Schernhammer presented findings from one of the largest double cohort studies to date (the 1988 & 1999 "Nurses' Health Study Cohorts") regarding female night shift workers and the risk for cancer. In the 1988 cohort 121,700 nurses registered between the ages of 30-55 and in the 1999 cohort 116,678 nurses registered between the ages of 25-42. One of the findings from this study was *that "for cancer risk, significant associations were observed for breast, colon, and endometrial cancer risk"*.^{lxv}

4.4.3.2 Prostate Cancer

According to Prostate Cancer Canada, prostate cancer is the most common cancer to strike Canadian men. For men in Ontario, it is the most frequently diagnosed type of cancer. This year, in Ontario, *"an estimated 10,200 men will be diagnosed with prostate cancer and an estimated 1,650 men will die of prostate cancer"*.^{lxvi} (Prostate cancer develops as a result of dietary, environmental and heredity factors.)

In his recent presentation at the Institute for Work Health's Scientific Symposium in Toronto, Dr. Blask said that prostate cancer is *"the second leading cause of death for men and that "rotating night shift workers have a threefold increased risk as compared with day shift workers."*^{lxvii}

The biggest prostate research study to date was conducted in 2006 by Kubo et al. His team *"looked at the incidence of prostate cancer among 14,052 working men in Japan who were initially interviewed between 1988 and 1990, and then followed up until the end of 1997. After adjustment for other factors that may affect cancer risk, the authors found that those working rotating shifts had a significantly higher risk of prostate cancer than day workers..."*^{lxviii}

4.4.4 Cardiovascular Disease

Numerous studies exist that point to a detrimental effect of shift work on cardiovascular disease (CVD) risk.

In the 1988 and 1999 “Nurses’ Health Study Cohorts” there were findings associated to heart disease. In these two studies it was found that *“rotating night shift work was associated with a 4% increased risk of ischemic stroke for every 5 years of shift work [but that this] may be confined to women with a history of 15 or more years or more rotating shift work”*.^{lxi}

One paper, published in 1999, reviewed 17 studies on shift work and cardiovascular disease and concluded that *“shift workers had a 40% excess risk for CVD compared with day workers.”* The author went on to say that *“there is rather strong evidence in favour of an association between shift work and coronary heart disease”*.^{lxx}

Studies suggest that heart problems occur more often among night shift workers than day workers. In one particular study, Swedish researchers studied paper mill workers for a number of years. The mill was the only employer in town. Most of the employees had done shift work for the bulk of their lives. Researchers found that *“the longer people worked shifts, the more likely they were to develop heart disease.”*^{lxxi}

Another study suggested that getting less than six hours of sleep per night increases the risk of heart disease comparable to that of smoking a pack of cigarettes a day.^{lxxii} (Akerstdt et al., 1984).

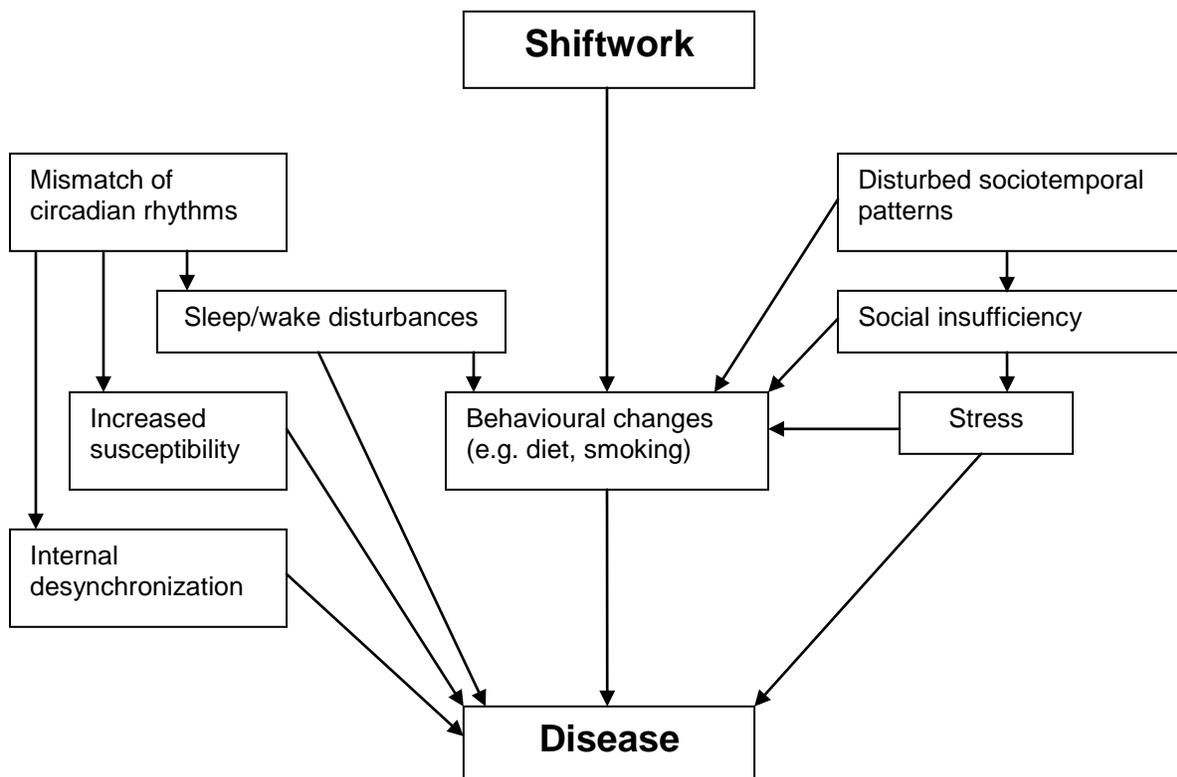
In the introduction to the section on cancer we discussed the importance of the hormone melatonin with respect to its cancer inhibitor properties. Melatonin also has properties that can inhibit negative cardiovascular effects. These properties include pro-inflammatory, insulin resistance and reduction of blood pressure (hypertension) properties. It is generally accepted that working at night reduces the regulation of melatonin.

This is of particular import to the Fire Service as heart attacks is the number one killer of firefighters in the United States and heart attacks, within 24 hours of an emergency response, are one of the diseases identified in Ontario’s Presumptive Legislation for firefighters.

4.4.5 Chart - Disease Mechanisms in Shift Workers

The following chart shows how the impact of extended shift work leads to disease and how the disruption of the 24-hour circadian rhythm has a domino like effect. It triggers sleep/wake disturbances, lowers the immune system and increases susceptibility to disease and internal desynchronization on the one hand and disturbed sociotemporal patterns, social inefficiency, and stress on the other hand all of which, in combination, lead to disease.

Disease Mechanisms in Shift Workers ^{lxxiii}



The research shows that disruption to the 24 hour body clock in combination with night shifts, longer hours and sleep deficit, leads to a higher risk of health problems such as sleep disorders (insomnia, increased fatigue), gastrointestinal disorders, diabetes, psychological distress (social problems, minor psychiatric disorders) and pregnancy complications, and can lead to chronic ill health (cancer, cardiovascular disease), higher divorce rates and reduced performance.

5. Summary

The studies show that there are significant health and safety impacts that result from night shift work and from extended shifts. Having the two together, i.e. 24 hour shifts with a night component, appears to compound the risks. There may be problems with the 10-14 shift pattern but 24 hour shifts may not be the solution. The risks are not only for the safety of the public but to the health and safety of the firefighters.

The research studies show that there is a correlation between the amount of sleep a person gets and their overall level of performance. Sleep deprivation results in lower levels of performance.

Sleep deprivation can result from lack of quantity of sleep (not enough hours) and from lack of quality of sleep (uninterrupted sleep).

It needs to be restated that sleep deprivation can just as easily be the result of off duty activities as it can be from on duty activities. Focusing solely on shift schedules and work hours ignores the fact that lifestyle changes, both off the job and on the job, may be required to manage health and safety.

In the United States, which has a long tradition of working 24 hour shifts, there are now calls to change to a shorter shift pattern for health and safety reasons.

There is probably not one best schedule that will work for every fire department. Each department has to determine the most efficient and effective overall schedule pattern for their department based on an evaluation of many factors, including their needs and circumstances. However whatever schedule is chosen must acknowledge and deal with the health and safety issues identified in this report.

Fire departments working 24 hour shifts have found it challenging to manage fatigue when:

- The call volumes are high, so that the firefighters are not able to get an uninterrupted sleep;
- The fire department does not have a sufficient number of firefighters on duty to manage short term fatigue by rotating crews off during a long fire incident;
- The fire department does not have a sufficient number of firefighters on duty to manage short term fatigue by providing a guaranteed sleep time while on duty.

What has been manageable in the past may not be as manageable in the future. Over the past 10 years, the population of Ontario has increased by 13% and the volume of 911 calls to the Fire Service has grown by 38%. As fire departments have become the all hazards emergency first responders, it is expected that the call rate will continue to grow faster than the population.

As modern society continues to evolve into a global 24 hour operation, more businesses will be open around the clock and more people will be on the roads during the night hours. This means that fire department's call volume will increase over the night period. This will reduce firefighters opportunity to have uninterrupted sleep during the night while on duty.

Increasing the total number of calls in a 24 hour period and increasing the volume of calls at night, means that firefighter fatigue will become a greater concern and extended shifts will pose a greater health and safety risk.

Fire departments facing requests to convert to a 24 hour shift need to do their due diligence. The Occupational Health and Safety Act (OHSA) requires that the employer must take every precaution reasonable for the protection of workers. If a critical injury or fatality occurs and it was later attributed to the new shift, the Employer could be liable under OHSA.

This report recommends that the fire service as a whole should address the research referenced in this report, by undertaking a thorough investigation of the health and safety impacts of the 24 hour shift and the consideration of alternative shift patterns.

Further research is required to determine the following:

- Does the 24 hour shift constitute a greater risk to the health and safety of firefighters than the existing 10-14 hour shift pattern? Data analysis of long term health impacts from comparable fire departments working different shift patterns should be undertaken;
- Is there a healthier way to construct the shift pattern? Based on the studies that have been done, is there an alternative, to the 10-14 or 24 hour shift patterns that are currently in use, that is safer and healthier for the firefighters and the public (including the length of shifts, the pattern of on-shift and off-shift times, the start and stop times of shifts, etc.); and
- What measures or procedures can be implemented in a fire department to minimize or mitigate the adverse health and safety impacts of night and/or extended shifts?

Until such time as the research has been completed, organizations should not commit to changing to a 24 hour shift pattern. Locking a shift pattern into a collective agreement, or even implanting it on an interim or “trial basis”, may make it difficult to implement mitigation measures. It may also make it very difficult to modify the shift pattern in the future, based on a solid scientific rationale. Furthermore, it may jeopardize the health and safety of its employees and increase the employer’s exposure to liability. This is not something that should be undertaken in haste or without full consideration and examination of the risks involved and the potential alternatives.

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