NEW ZEALAND FIREFIGHTERS

Injured on the job or at the station

by

Daniel Stephen Coward

Graduate Diploma Occupational Safety and Health

A thesis submitted for the degree of

Occupational Safety and Health

Adelaide University

2004

TABLE OF CONTENTS

LIST OF TABLES

Number *Page*

GLOSSARY

Accident Frequency Rate	Term used for the equation used in determining the number of accidents per hours worked against a million work hours within an organisation to determine average accident rates
Alarm Activations	Term referred to within New Zealand Fire Service when describing an alarm system within a structure i.e. heat or smoke detectors, sprinkler systems that have been activated by an individual or environmental factor
Accident Compensation Corporation	Government Department that provides personal injury cover for all New Zealand citizens, residents and temporary visitors to New Zealand. In return people do not have the right to sue for personal injury, other than for exemplary damages.
Breathing Apparatus Training Building	Term used when referring to a structure built and designed to provide a training environment with heat, darkness and furniture to resemble property fires in a controlled environment
Career firefighters	Term referred to within New Zealand Fire Service for firefighters who are in paid employment.
Drill Yard	Term referred to when describing set area within a station compound that has been established for training
Fire Appliance	Term used within New Zealand Fire Service when referring to a fire truck
Fire District	A gazetted area that defines an area that fire cover/response is provided by that fire brigade, a legislative requirement under the Fire Services Act 1975
Structure fire	Term referred to within New Zealand Fire Service when describing a property, house, warehouse or building that is on fire or has a fire within that structure
Incident Ground	Term referred to within New Zealand Fire Service when describing an area where fire service activities are taking place following an emergency response i.e. house fire, motor vehicle accident
Partnership Programme	Employer becomes responsible for the management of all work place injuries from the Accident Compensation Corporation
Severity	Value or weighting placed on an injury by an organisation
Vegetation Fire	Term used within New Zealand Fire Service when referring to a fire involving scrub, grass, forests vegetation

DECLARATION

I declare that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text.

Sign date

ACKNOWLEDGMENTS

New Zealand Fire Service (NZFS)

Vince Arbuckle

Director Human Resources, National Headquarters

Sally Weatherley

Human Resource Information Management Systems Business Analyst, National Headquarters

Bill Beale

Chief Fire Officer, Gisborne Fire District

Western Fire Region Office Palmerston North

Accident Compensation Corporation

John Kearns

Injury Prevention Consultant, Palmerston North

Janelle and Ayla Coward

ABSTRACT

Limited research has been undertaken into the injuries and the nature of the injuries firefighters of the New Zealand Fire Service face. The perceived rate of injuries is high and often associated with the hazardous vocation of firefighting. Significant research has taken place into the exposure of hazardous substances firefighters face with significant changes and improvements to policy and procedures, personal protective equipment and clothing and an increase in the quality of health monitoring.

Often perceived as hazardous the role of firefighting is only one of many tasks firefighters undertake. The locations that these tasks are undertaken are varied. What was not known were the locations that have a higher frequency of injuries. Research into firefighter injuries and their locations is a vital component of an effective injury prevention programme within an organization. Reviewing the data held by the New Zealand Fire Service provided an insight into the location and nature of injuries experienced by New Zealand Firefighters. Comparing the findings of the New Zealand Fire Service with that of the findings held internationally into firefighter injuries, was undertaken. This process highlighted the limited research that has been undertaken internationally into firefighter injuries.

Further findings showed firefighter injuries were greater on station than attending emergency incidents. This was in direct comparison with international research which indicated emergency incident injuries were more common. The nature of injuries were similar regardless of what country and what task were being carried out.

Identifying work environments and whether they exist as a significant contributing factor to the frequency of injuries could further identify injury causation and ultimately shape the future of fire appliance design, station and work environments, policy and procedure and the tools provided to undertake the role of firefighting in an injury consciences era.

Chapter I

INTRODUCTION

New Zealand Firefighters attend on average in excess of 60,000 emergency incidents each year. These range from structure fires, motor vehicle crashes, floods and alarm activations. Within the New Zealand Fire Service there are 1690 career firefighters and some 9000 volunteer firefighters providing a service 24 hours a day, seven days a week. With 496 career firefighters on duty every day, a perceived accident frequency rate could be high, based again on the perception of a hazardous work environment. What is currently not known is exactly where the risk of injury lies.

During 1 July 2001 and 30 June 2002, the New Zealand Fire Service attended 63,162 emergency incidents with only 156 career firefighters injured at these emergency incidents, yet 406 injuries whilst carrying out some form of routine work on or about the fire station. A significant 72% of all injuries, involved career firefighters away from the perceived 'hazardous work environment'.

Accident Frequency Rates (AFR) within the New Zealand Fire Service forms an integral basis for injury prevention programmes, incident trend analysis and performance reviews for senior managers. Commonly perceived as a high-risk vocation in a hazardous work environment, firefighter injuries are also perceived as reflecting the vast role they undertake within society.

With injuries to career firefighters costing the organsiation in excess of half a million dollars each year [1] the incentive for senior management to reduce injuries occurring forms part of their job performance and the overall goal to reduce costs in this field.

[1] Source: New Zealand Fire Service Claims Management Unit

To determine areas where savings and reduction in accidents can occur, an understanding of specific statistics is required. Having identified the location where the majority of injuries occurred, the influence to change, can reduce the accident frequency rate, severity and ultimately cost. Key factors in identifying accident trends are the sources of accident data and their accuracy.

Chapter II

AIM AND OBJECTIVE

Through the following process:

- Research literature in the form of journal articles and research studies undertaken in the past 15 years to establish what is known of the topic
- Determine the location where firefighters are most likely to be injured, at the incident ground or a non incident ground location
- Establish specific locations that firefighters are injured within the identified locations
- Establish the probability of being injured either at an incident or non incident location
- Identify by location those accidents determined significant by organisational standards
- Compare the established location of injuries of firefighters with the results of the literature review

The aim is to identify where New Zealand Fire Service Firefighters are most likely to be injured and the correlation of this data with current international trends.

The objectives;

- Identify and understand the data held by the New Zealand Fire Service and how it can be interpreted for a reduction in injuries
- Determine whether trends within the New Zealand Fire Service are a reflection of international trends
- Establish the level of knowledge and research undertaken in this field.

Chapter III

METHODOLOGY

The references reported in this thesis are based on two key approaches that were taken in the design of the methodology are:-

1. Accident data statistical review
2. Literature review/research,

Accident data statistical review

A collection of 12 month's accident data were reviewed, 1 July 2001 to 30 June 2002. This period of time was selected as a number of key legislative changes that occurred to the Health and Safety in Employment Act 1992 with the introduction of the Amendment Act 2002 and the Injury Prevention Rehabilitation and Compensation Act 2001 that resulted in a change in the way accident data was collected for the New Zealand Fire Service. Also taken into account was the availability of accident data for career firefighters of the New Zealand Fire Service on a national basis as a result of the accident reporting mechanism in use.

Detailed below are the steps taken with the accident data received from the New Zealand Fire Service:-

- Establish number of accidents that occurred on an incident ground and those accidents that occurred on a non–incident ground
- Determine what locations within both the incident ground and non-incident ground locations contributed to total accidents occurred
- Establish the most significant location in relation to frequency of accidents
- Determine the significance (by organisational standards) of the location of accidents

Literature review/research

A parameter placed on the literature review was limiting the literature to within the past 15 years. This was to reflect the most recent and significant legislative changes internationally in the field of Health and Safety and Accident Compensation.

Other limitations of note are the accident frequency results obtained from the New Zealand Fire Service. These were limited to 1 July 2001 to 30 June 2002 because of changes in legislation, accident recording procedures within the organisation and the introduction of an internal claims management unit responsible for the collection of accident details.

Chapter IV

LITERATURE REVIEW

It is necessary to summarise the way the law governing injury data and the culture of the organisation has developed, to provide an understanding of the legal and cultural background, to the concept of firefighter injuries.

The Injury Prevention, Rehabilitation, and Compensation Bill was passed by the New Zealand Parliament on 19 September 2001. The introduction of the 2001 Legislation and resulting changes to self managing work related injuries followed a decade of significant changes in accident and rehabilitation legislation. The government established Accident Compensation Corporation, who was the primary provider for accident compensation, until the legislation governing this underwent significant changes in 1998. The Accident Insurance Act of 1998 introduced private insurers to compete with the Accident Compensation Corporation. This allowed the New Zealand Fire Service to enter into insurance contracts of their own choice.

With a change in government the Accident Insurance (Transitional Provisions) Act 2000 was introduced. The purpose of this act was to:

- *"Remove the provisions for competitive workplace accident insurance so the entire accident insurance scheme could be delivered by ACC; and*
- *Cancel all existing insurance contracts issued by private insurers with effect 30 June 2000."*

These changes resulted in several sources of firefighter accident data influencing the period of time accident data was researched. Also passed was the Accident Insurance Amendment Act 2000. This provided a weekly compensation and re-introduced the accredited employer programme available under the 1992 Act and renamed it the Partnership Programme.

With this change in legislation, the New Zealand Fire Service joined the Partnership Programme and become an accredited employer with the responsibility for self managing work related accidents. In undertaking this role, the emphasis of reducing the accident frequency rate of firefighters moved from the Accident Compensation Corporation to the New Zealand Fire Service including the recording requirement. This change also placed a greater responsibility on senior management to reduce injuries within their work environment.

The Health and Safety in Employment Act 1992 came into force in April of 1993. This was a great advance in the regulation of Health and Safety in workplaces in New Zealand. The introduction of this Act repealed or amended some 100 Acts. There now existed a legislative requirement to report and record all accidents within the workplace. Further advances to the Health and Safety in Employment Act 1992 came about in 2002 with the introduction of the Health and Safety in Employment Amendment Act 2002. This Act extended a number of provisions of the existing Act too volunteers, which affected the 9000 volunteer firefighters of the New Zealand Fire Service.

The key change to the Act, was the recognition of volunteers as employees for several provisions of the Act. This influenced the New Zealand Fire Service from an accident reporting and recording perspective with the introduction of a nationally based accident reporting and recording system. Whilst reporting work related accidents became a legislative requirement, the process for compensation and claims management of these injuries, sustained by volunteers were still covered by the Accident Compensation Corporation and not by the New Zealand Fire Service Claims Management Unit. This again influenced the data that was available from the New Zealand Fire Service and another change in sources of accident data for all firefighters.

The New Zealand Fire Service is constituted under part 3 of the Fire Service Act 1975. The statutory role of the New Zealand Fire Service is Fire Safety,

Fire Prevention and Emergency Response. The Fire Service is under the control of the New Zealand Fire Service Commission, which is a Crown entity that reports to the Minister of Internal Affairs. It is funded by a fire service levy, which is paid by householders and commercial organisations through insurance premiums. This is the service's principal source of funding and therefore not reliant or influenced by payments when attending emergency incidents.

Since 1997, the Fire Service has had eight fire regions headed by a Fire Region Manager. The Fire Service currently has about 2,000 career staff of which about 1690 are career firefighters and some 9000 volunteer firefighters. Career fire fighters provide fire prevention, emergency response and safety education to 80% of New Zealand's population in 19 urban centres.

The history of the New Zealand Fire Service is a common one, a reflection of fire services throughout the world, with the initial development spurred by insurance companies. By 1946 there were 60 fire districts each with their own Fire Board and brigade. Another 99 fire brigades existed in boroughs that were not Fire Districts.

In 1949, two years after the disastrous 'Ballantyne's Fire' [2] in Christchurch, the Fire Services Act established the Fire Service Council with a Chief Fire Officer, Secretary and other officials. The Fire Services Act 1975 established a New Zealand Fire Service Commission that was charged with the restructuring of the Fire Service from a local-authority-based organisation into a service with centralised control.

On 1 April 1976, all fire authorities were dissolved and the Commission was vested with full responsibility for the Fire Service throughout New Zealand.

[2] Ballantynes fire occurred on the 18 November 1947 in Christchurch New Zealand and killed 41 people within the department store fire.

The New Zealand Fire Service has:

- 348 fire districts (urban)
- 800 fire appliances (approx)

Of the some 60,000 odd emergency incidents attended, 22,290 fires were attended, with 3,570 being house fires. Another staggering figure is the 4,834 vegetation fires[3]. Both these work environments are rugged and often beyond the normal controls or influence of firefighters, from a hazard management perspective.

Firefighters work a shift pattern commonly referred to as the '4 on 4 off' roster, the hours worked averaged to 42 hours/week over an 8 week cycle. Four shifts are required to facilitate 24-hour cover under this roster system. Hours of work are two 10-hour day shifts starting at 0800 hours and finishing at 1800 hours, followed by two 14-hour night shifts commencing at 1800 hours and finishing at 0800 hours. Four days off work are then taken.

Previous research into firefighter injuries has often focused on the occupational health aspect of firefighters as a result of the incidents attended and the overall vocation. This form of research has lead to the introduction ofsignificant health monitoring for firefighters and advances in the level of protective clothing that is now worn. Limited research has been undertaken in the field of firefighter injuries leading towards a perception based theory of firefighter injuries.

A study carried out in 1999 on the New Zealand Fire Service showed an overall trend downwards in the frequency of accidents reported. An analysis of the data held by the Accident Compensation Corporation and the New Zealand Fire Service for the years 1992-1993 and 1998-1999 by GMV Associates was conducted.

[3] Annual report for the New Zealand Fire Services Commission 2001 Incidents and Statistics

The objective of the analysis (GMV Associates 1999) carried out was;

- *"Analyse New Zealand Fire Service Claims history to assist in quantifying their risk to a private insurer*
- *Identify injury trends*
- *Quantify costs of accidents to the company in order to pro-actively reduce the number of injuries to employees and cost of claims*
- *Recommend interventions and procedures for the reduction of injuries and claim costs."*

What this research (GMV Associates 1999) indicated was a general downward trend in cost and quantity of accident claims during the seven-year period. It was identified that an early and voluntary severance scheme that was offered to 300 older firefighters during 1996 may have contributed to the period identified as a 'peak' in costs.

Figures indicated that existing injuries by body part outnumbered new injuries by body part. During 1992/1993, 40% of the injuries reported were to the back/spine area. In contrast only 4% were reported during 1998/1999, yet the existing injuries to the back/spine were still high. Newly reported injuries to the knee stayed at a consistent level during the seven-year period with no changes to existing injuries in this category which was opposite to the overall downward trend of new injuries being reported.

The incidence data held by the New Zealand Fire Service and collected by GMV Associates was

> "*equally as useful in developing a health and safety injury management plan."* (GMV Associates 1999)

and was utilised in the development of a Health Management Programme. This research reflective of the international research carried out into the accident data of firefighters, from a health management focus as apposed to a reduction of injuries.

The data collected indicated a difference between the activity and the lost time. What was highlighted was; the lost days or severity against location,

> "*the data clearly showed that though injuries on the incident ground were high the time lost was 15% less than the percentage of injuries during this activity"* (GMV Associates 1999).

The severity of injuries on the incident ground appeared to be less than those occurring elsewhere. The injuries that occurred during routine activities at the non-incident ground locations i.e. station or training facility had an incidence rate lower than the incident ground, but more time spent off work, indicating a higher severity rate. This was the first indication that within the New Zealand Fire Service the severity of accidents occurring on station was greater than those on the incident ground.

Significant in establishing a process to reduce accident frequency is the ability to collect and review accident data. Noted during research (GMV Assoicates 1999) were the accuracy of reporting systems operated by New Zealand Fire Service at that time

> *"reporting systems and accuracy in these areas should be investigated in the future"*. (GMV Associates 1999)

With the introduction of the Health and Safety in Employment Act 1992, a standard accident reporting form was introduced into the organisation. Over time, the ability to report nationally on all accidents occurring diminished with several regions establishing independent reporting database.

Findings from the 1999 research;

- highlighted that the incidence of injuries were declining,
- the severity of incident ground injuries was lower than others,

- reporting systems needed to be more accurate to ensure successful implementation of injury prevention strategies such as health monitoring and health and safety management programmes

Research (Erwin 1993 pg 2) carried out in Texas, indicates that firefighting is not the

"*nation's [USA] most hazardous occupation*".

Statistics collected from the NFPA during 1991 shows a fatality rate of 13.8 per 100,000 firefighter employees, a third less than employees of Mining and Agriculture, Transportation and Public Utilities and less than half of those in construction.

Further research (Leigh 1987 pg 36) goes into more detail of the relative fatality rate of career firefighters. The project "Estimate of the Probability of Job-Related Death in 367 Occupations" carried out at the San Jose State University rated firefighters at 6th. Later reviews of the data showed a flaw in the equation and new figures rated firefighters at 36th. Whilst this research focused on the fatality rate of firefighters, it provided or contradicted the perception that firefighting was a significantly hazardous vocation.

Unlike fatalities, firefighter injuries are often considered "difficult to analyse" as Leigh continues with his findings (Leigh 1991 pg 36):"

1. *There is difficulty in determining what constitutes an injury. For example, is an injury only something that requires time off from the job?*
2. *Firefighters are more likely to file an injury claim today than a decade ago. For example AIDS and Hepatitis fears prompt injury reports by firefighters as a precautionary measure although exposure to bodily fluids may not have occurred.*
3. *Firefighters can use injury reports indicating an unsafe workplace as a way to retaliate against a Fire Chief."*

Leigh believed these were the several reasons that the accuracy of identifying injuries and trends was lacking.

The International Association of Firefighters (IAFF) has produced an annual study of firefighter deaths and injuries from 1960. Statistics cover lost work time, disability, retirements, and physical fitness injuries. Another organisation, National Fire Protection Association (NFPA) collect data on career firefighters and produce an annual report. A sample is selected to represent the various sized populations served by fire departments and is used to project (with a high confidence level) a national firefighter injury rate. The statistics provided by the National Fire Protection Association (NFPA) show (Fahy, LeBlanc 1999 pg 50) a continuing downward trend of firefighter fatalities throughout the 1990s, yet a continuance of injuries at a rate significantly higher. This data reflects the growing international trend of incident ground fatalities dropping significantly yet injuries at the incident ground at a higher frequency than those on station

A comparison study undertaken on a 1972 paper into accidents, injuries and illnesses suffered by firefighters in Great Britain, (Almond 1972) was undertaken in 1995. Amongst the findings (Almond 1997 pg 20), an indication that a significant drop in average number of days lost for Lost Time Injury per employee and also the frequency of firefighters injured from each brigade.

However, (Almond 1997 pg 21) findings showed that 56% of all injuries occurred at an incident ground location, with only 44% occurring on the non-incident ground location. This was a rise from his 1972 finding. These findings were early indications that internationally, incident ground injuries were significantly higher than those that occurred on station. This was in line with the findings undertaken within the New Zealand Fire Service (GMV Associates 1999).

Further findings showed (Almond 1997 pg 21) that slips and trips accounted for 12.7% of all types of accidents that occurred but was still consistent with the overall reduction in total accident numbers. The significant reduction of injuries related to fire appliances was identified (Almond 1997 pg 23) and was attributed to engineering designs that incorporated an ergonomic approach to locker and step design and low level lighting on appliances. This showed a

direct link to the earlier research undertaken (Almond 1972) and the findings being incorporated into an overall health and safety management plan for the Fire Service.

In 1991, the Fire Research and Development Group (FRDG) investigated the number, type and cause of injuries to firefighters in the UK (Marriott, Lillicrap 1994). It was thought that the frequency of accidents was increasing and the study was to concentrate on the extent and severity of the problem throughout the UK.

The frequency of injuries by location showed more than 50% occurring at the incident ground by the Fire Research Development Group (FRDG). This finding is also one that the National Fire Protection Association (NFPA) reports (Karter, Molis 2003 pg 62) for the year 2001 (excluding World Trade Centre and Pentagon incidents). The total number of incident ground injuries accounted for 68% of all injuries reported by fire departments.

The Fire Research Development Group (FRDG) and Health & Safety Executive (HSE) were two of the sources used in the analyses of data by Marriott and Lillicrap. They further showed (Marriott, Lillicrap 1994 pg 3) that fatalities were dropping whilst injuries rising consistently each year.

A conclusion reached by the Fire Research Development Group (FRDG) was (Marriott, Lillicrap 1994 pg 4)

> "*it would appear that the number of firefighter injuries at fires increased proportionally with the number of incidents attended*".

This is the first indication that firefighter injuries and the emergency incidents attended were in fact linked. No further research or data supporting this statement was discovered.

Another conclusion reached by the Fire Research Development Group (FRDG) regarding the injuries to firefighters, followed international trends of a relationship between the incidence of a body part injury with the overall incidence of total injuries (Marriott, Lillicrap 1994 pg 3)

> "*frequency of injuries to the different parts of the body usually follows a similar trend to the overall injuries totals."*

The concept that an increase in the incidence of a body part injured would cause the accident frequency rate to increase as a whole was not presented within any further research reviewed.

Further findings of interest were the body part and nature of injury. Most commonly affected were leg injuries, of which ankles were most frequent, followed by back injuries, fingers, thumbs and eyes. The biggest finding was (Marriott, Lillicrap 1994 pg 3)

> "*the analysis showed that the two most frequently occurring injuries (ankle and back) were generally the result of sprains or strains."*

An article in the NFPA Journal Jan/Feb 2003 (Karter, Molis 2003) looked at firefighter injuries in 2001. The four major types of injuries incurred were sprains and strains that accounted for 39.6%. Superficial injuries 22.2%, burns 7.9% and smoke/gas inhalation accounted by 6.2% which were also consistent with those recorded for non-incident ground locations (Karter, Molis 2003 pg 62).

During the 12-month period in 2002, data held by the Metropolitan Fire and Emergency Services Board of Melbourne, Australia, showed 75% of all diagnosed injuries to be sprains and strains. The second most significant injury diagnosis was cuts and abrasions 12% and bruises 7%. The other significant finding from the data is the incident ground to non-incident ground location injuries. On average, incident ground injuries were significantly higher than those that occurred at a non-incident ground location within the Metropolitan Fire and Emergency Services Board.

Further statistics held by the Metropolitan Fire and Emergency Services Board indicate the body part most affected by injury to be the back/lumbar, shoulder/arm and knee.

The international trend that sprains and strains are the most significant diagnosed 'nature of injury' for firefighters is repeated within the New Zealand Fire Service. The Accident Compensation Corporation of New Zealand holds statistics of claim related accidents of the New Zealand Fire Service. During the period 1994 to 1999, a significant number of sprain and strain diagnosed injuries were recorded.

Total number of strain and sprains ranged from 75–85% of all diagnosed injuries, with puncture wounds and burns taking 20% respectively and all remaining injuries combining to 5%. These statistics are not restrictive to the vocation of firefighting. Data held by the Accident Compensation Corporation indicates that sprains and strains are New Zealand's most common injury across all vocations. This provides credence to the view that firefighting is not as hazardous as perceived.

Whilst a number of articles discuss injury frequency and firefighters, very few discuss what is an acceptable and realistic level of accident frequency. Analyses of firefighter accident statistics show a reduction in fatalities on an international scale and an increase of accidents resulting in some form of injury. Introduction of Health & Safety legislation has influenced the approach fire services are taking but no indication of a realistic level of acceptance.

An article in the Fire Engineers Journal, (Klein 2001 pg 14) 'Risk Assessment' indicates

> "*zero risk is both unrealistic and unattainable.*"

Klein goes on to (Klein 2001 pg 14) state

> "*One must accept some risk as part of daily life*."

Klein refers to this, following the introduction of Health & Safety legislation and its impact on firefighting techniques and compliance to legislation within

the United Kingdom. The approach of eliminating all firefighter injuries through risk management without defining the acceptable thresholds forms the basis of his article.

The legislative requirement to identify the risks involved within the task and where possible eliminate or minimise them, has been part of the practicable steps undertaken for years (Klein 2001 pg 15). Klein goes on to discuss (Klein 2001 pg 15)

> "*important part of the mechanism for justifying the life and major injury risk to firefighters, offsetting this against the main benefit of an increase in public safety and the public's perception*"

to be often the basis of the risk management approach to dealing with accident frequency amongst firefighters.

To meet this expectation, the most important means of reducing risk and overall injury risk during fire service operations is through training (Klien 2001 pg 15). A competent firefighter is exposed to less risk or to a controlled risk environment than that of a firefighter who is less trained. Again, (Klein 2001 pg 15)

> *"the importance of training to produce a 'safe and competent' person as well as a specific training for competence*"

provides an approach that may decrease accidents reported. This being a reflection of both the competent levels of firefighters and the enhanced safety culture imposed through legislation. Klein believes that the perceived risks associated with firefighting are ones that can be justified and minimised significantly through the level of competence directly attributed to the level of training firefighters receive.

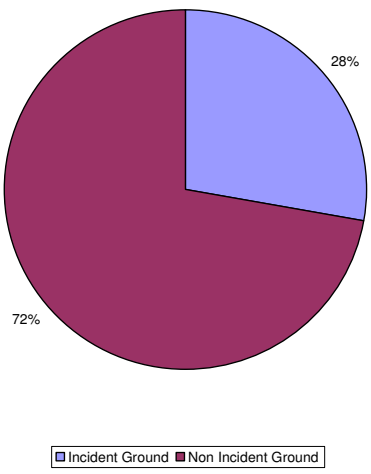
Throughout the literature review, the international findings were consistent on a number of levels with the level of research undertaken in similar fields, reaching in most cases the same conclusions. Noticeable from the literature review was the lack of information pertaining to the New Zealand Fire Service and injury data.

Chapter V

STATISTICAL FINDINGS

The risk of being injured while attending an incident is considerable lower than those that occur at a non-incident ground location.

Table 1: Incident Ground to Non Incident Ground Injuries
July 01 to July 02



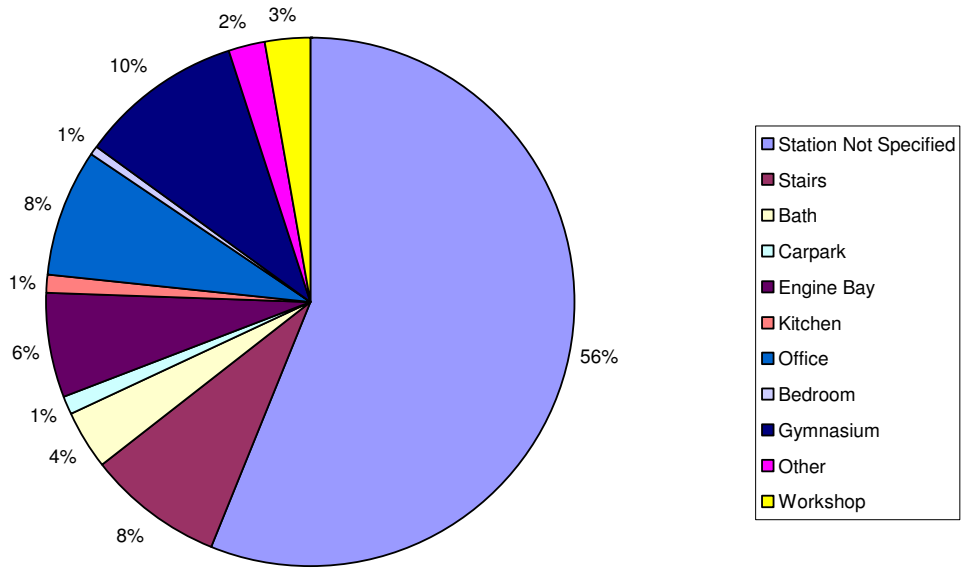
Source: NZFS Human Resources Information Management Systems (HRIMS)

Of the 562 accidents that occurred during 1 July 2001 and 30 June 2002, 156 of the accidents occurred at an incident ground location with 406 accidents at a non-incident ground location. Within the incident ground location, it was identified that 79% of all accidents occurred at a fire ground location, 11% at a motor vehicle crash, 2% while responding to an incident within the appliance and 8% at other incident grounds such as hazardous substances and rescue locations.

With some 60,000 incidents attended each year, with only 156 injuries being sustained at these sites, the argument that firefighting is a dangerous vocation is not supported by these findings.

Within the non-incident ground locations it was identified that station injuries were by far the most frequent location for an accident. With 46% of injuries occurring on station, 21% on the training ground, 19% in or around the appliance and 14% off station, identifying where on station injuries occur could provide the basis for injury prevention strategies aimed at reducing the injuries within specific work environments or tasks.

Table 2: Non Incident Ground Injuries by Station Location
July 01 to July 02



Source: NZFS HRIMS

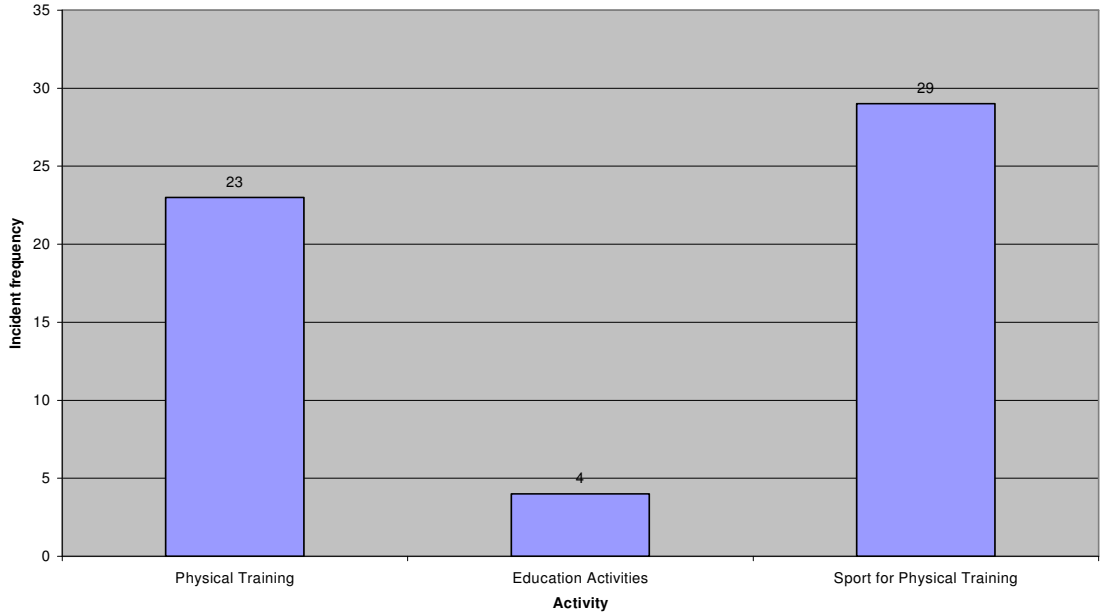
As identified, a significant proportion of injuries occurred on station but the specific location not specified. This accounted for just over half of all injuries. Significant in the frequency, the inability to further identify the specific area on station that these injuries occurred impacted on the overall findings. Those sites within the station that were identified and that had a significant frequency were the stairs with 8%, engine bay 6%, office 8% and gymnasium 10%.

The remaining sites were bathroom 4%, car park 1%, kitchen 1%, bedrooms 1%, other 2% and workshop 3% respectively. These sites reflect the environment worked in by the on duty firefighters for the majority of time while on duty. The non-incident ground locations also had a significant high frequency of accidents. As identified, 21% of accidents on a non-incident ground location were at the training ground. Further analysis showed exactly were these injuries took place. A total of 73 accidents occurred on the training ground itself, 83% of all accidents that occurred on the training ground

Within the Breathing Apparatus Training Block (BATB) 11 accidents occurred, reflecting 12%, the tower accounted for 3% and confined space 2% of all accidents attributed to training location. These figures reflect the frequency of training that occurs on the drill or training yard during duty hours and could be attributed to or reflect the nature of emergency incidents attended and the need to often simulate these during training. This again lends itself to the argument that firefighting is not as hazardous as perceived.

The other location of interest were the off station locations. What activity was being undertaken when off station that attributed to the frequency of injuries is reflected below.

Table 3: Non Incident Ground Injuries for Off Station Activity
July 01 to July 02



Source: NZFS HRIMS

Physical training accounted for 41% of accidents, with education activities only 8%, but sport for physical training 51%. This highlighted the significant number of injuries attributed annually to physical training off station as a whole.

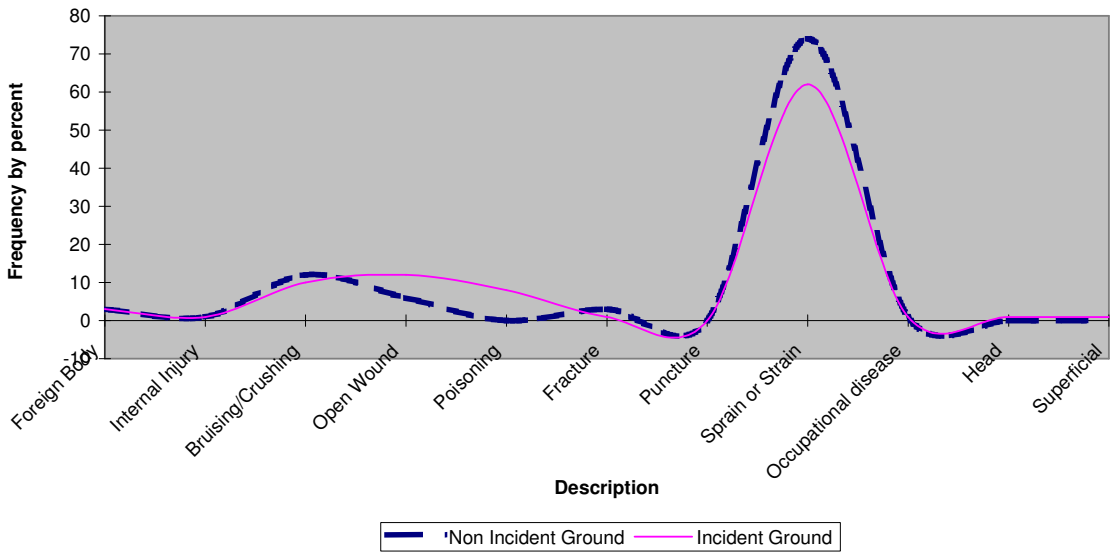
The data reviewed provided an insight into the locations that New Zealand Firefighters were most likely to be injured. As identified the station attributed for the majority of injuries to firefighters, in contrast to the international findings that indicated, the incident ground was the site where the incidence of injury was greater.

As highlighted by the literature review, sprains and strains were the most frequent nature of injury to firefighters. Within the New Zealand Fire Service, the data also suggested that this was the greatest nature of injury likely to be diagnosed for firefighters.

In both cases, the incidence of sprains or strains occurring at either the incident ground or non-incident ground location was extreme with 62% and 74% respectively. This figure reflective of national statistics held by the Accident Compensation Corporation, which indicated sprains and strains to account for the majority of all diagnosed injuries.

Source: NZFS HRIMS

Table 4: Nautre of Injury
July 01 to July 02

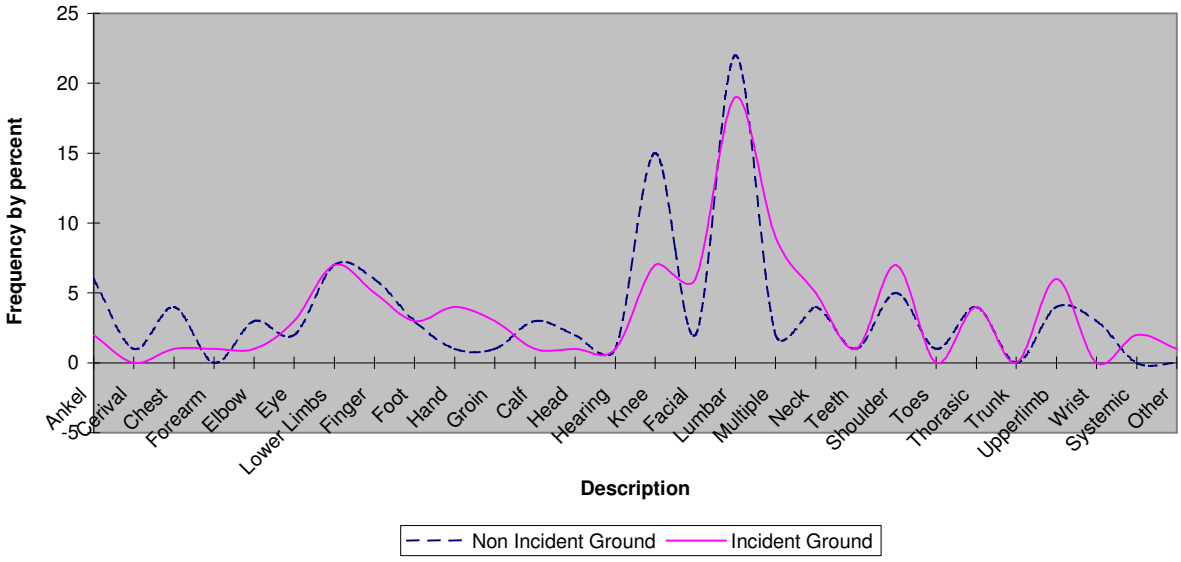


A significant yet predictable difference was found in Poisoning. With 8% attributed to the incident ground, there were no reported cases at non-incident ground locations, this, a reflection of the increased exposure to chemicals during firefighting operations at the incident ground. Another example was Open Wound injuries. With 12% of these accidents occurring at the incident ground, only 6% occurred at non-incident ground locations.

The remaining differences were bruising injuries 12%, slightly higher at non-incident ground locations than those at incident ground 10%, Head and Superficial injuries both 1% at the incident ground only. Other similarities between the two locations were foreign body 3%, Internal injury 1% and Occupational disease 1%.

In conjunction with the nature of injury were the body parts effected. Again, similarities were identified between incident ground and the non-incident ground locations.

Table 5: Injuries by Body Part
July 01 to June 02

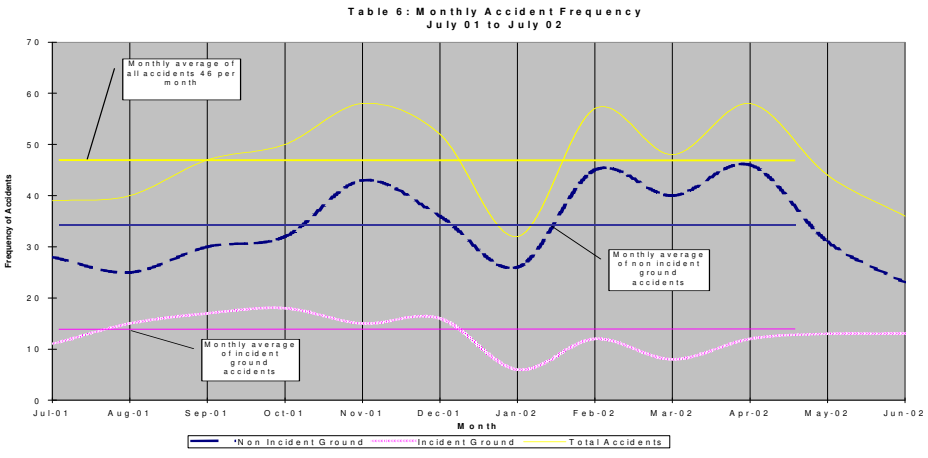


Source: NZFS HRIMS

The most common body part effected was the lumber with 22% attributed to non-incident ground locations and 19% to the incident ground location. Also significant were injuries to the knee, a non-incident ground frequency of 15% and the incident ground frequency of 7%. The remaining body parts effected were again similar with only ankle and chest injuries higher at the non-incident ground location than that of the incident ground.

International trends indicated that sprains and strains were the most common injury with the lumbar and knees being the most significant body part effected. Data held by the New Zealand Fire Service also supported this view and mirrored the data held by the Accident Compensation Corporation, reinforcing the view that firefighting is not as hazardous as perceived.

When comparing the frequency of accidents that occurred at either locations, both monthly averages followed similar lines with the overall average, with only several differences. During the month of November, accidents increased at non-incident ground locations while dropping at the incident ground reflecting the greater workload on station preparing for the summer period that has a characteristically higher incidence rate of emergency incidents. This is again reinforced during the month of December when incident ground accidents rise but on station accidents decline. This is the only indication that incident ground injuries being greater than those suffered on station due to the frequency of emergency incidents attended and not reflective of the overall frequency of emergency incidents attended.



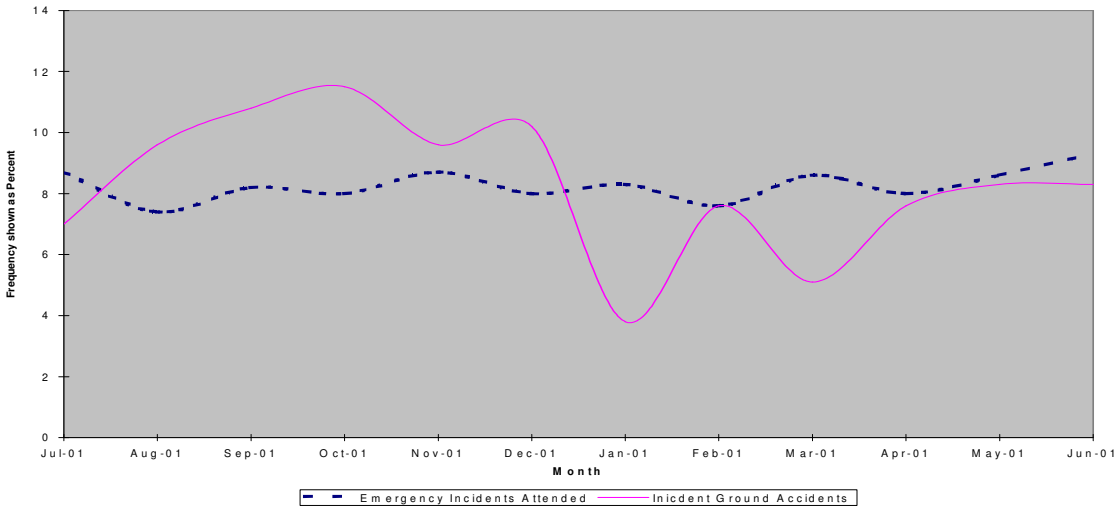
Source: NZFS HRIMS

The only other difference of note is the consistent level of accidents reported at the incident ground during April through to June despite the significant drop at non incident ground locations.

In the following graph, the number of incidents attended each month do not vary greatly (with a median of 5,205) in contrast to injuries that firefighters sustain on a monthly basis. The graph portrays the monthly total of emergency incidents attended (by percentage) along with the incident ground accidents that occurred (by percentage). Clearly this graph shows that there is no clear relationship with the frequency of incidents attended and the frequency of accidents that occur on the incident ground despite reference to this relationship by Marriott and Lillicrap (Marriott Lillicrap 1994 Pg 4) in their research.

This can be shown clearly in the month of October, where 8% of emergency incidents attended occurred, but 11.5% of accidents to firefighters occurred. In stark contrast, during January 8.3% of emergency incidents took place, only 3.8% of accidents to firefighter occurred. This may indicate that accidents are irrespective of the frequency of calls attended and not dependent on the frequency of emergency incidents.

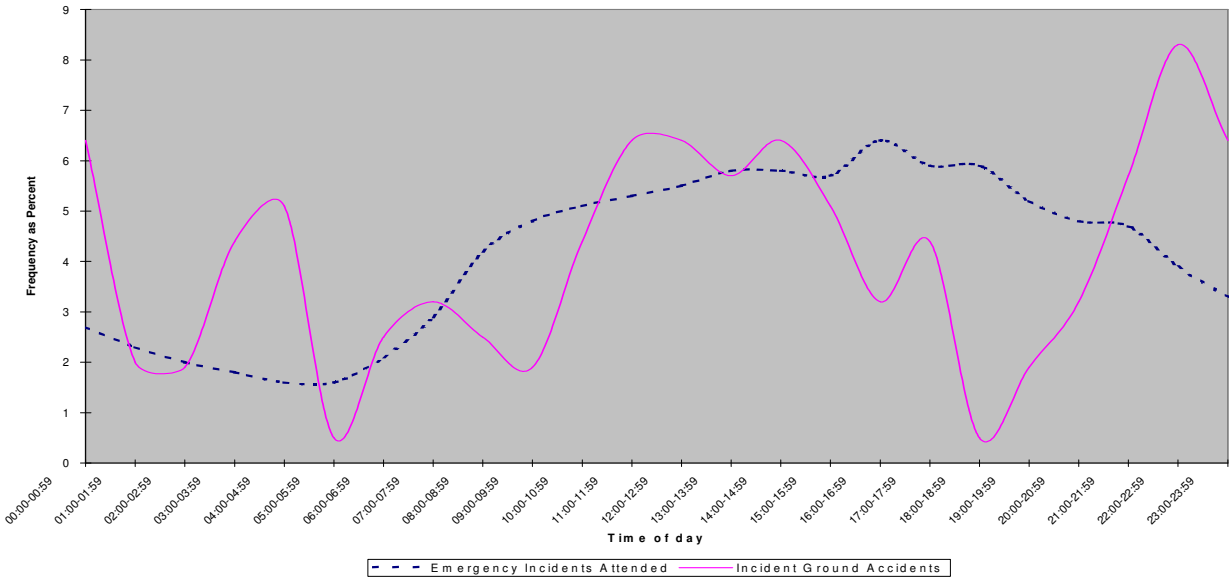
Table 7: Emergency Incidents Attended against Incident Ground Injuries



Source: NZFS Annual Report 2003 & HRIMS

What is also of importance is the time of day that these incidents occurred and the frequency of accidents. Again, initial assessment of this data indicates again that there is no reflection of the incidents attended and the accidents that occur. What the data did highlight was the time of day that the injuries did occur. The relationship between the time of day, frequency of accidents and the circadian rhythm is significant and discussed later.

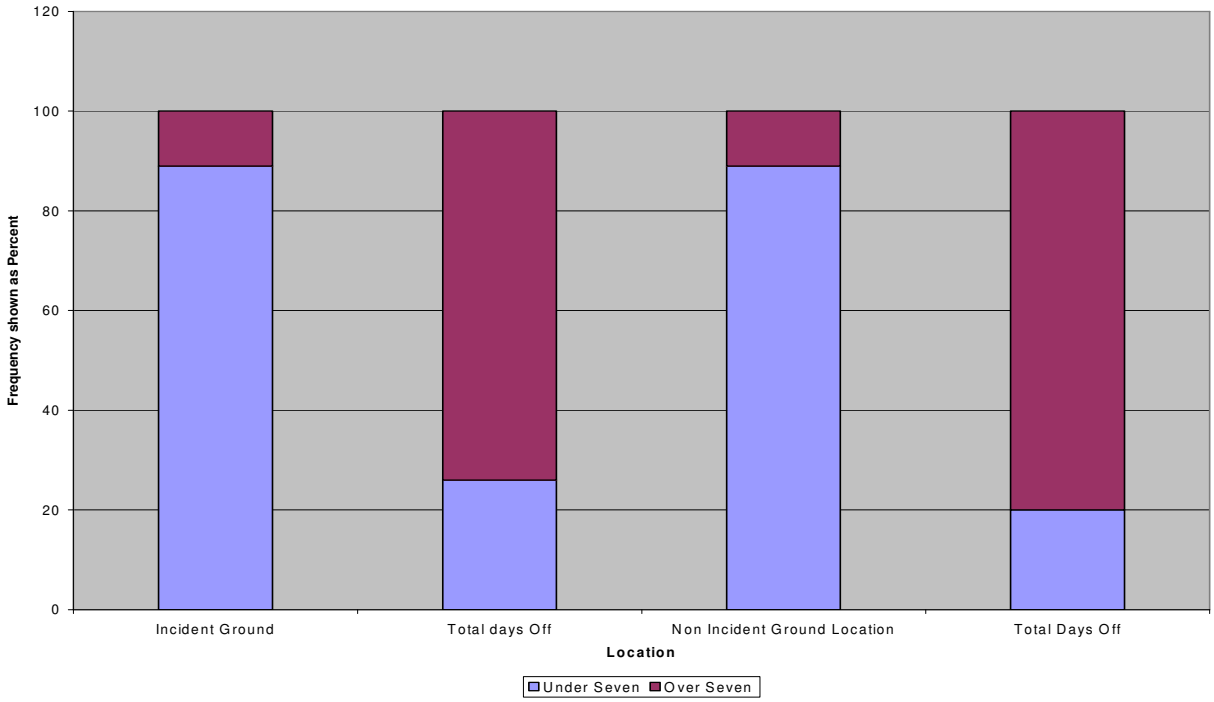
Table 8: Time of Day for Emergency Incidents and Accidents



Source: NZFS Annual Report 2003 & HRIMS

Significant was the lost time associated with the identified locations. Lost time under seven days accounted for 89% of total accidents that occurred both on the incident ground and non incident ground location. Yet, the days lost contributed for only 26% of total days spent from work.

Table 9: Lost days



Source: NZFS HRIMS

In comparison, the 11% of accidents that incurred more than seven days (period of time New Zealand Fire Service places on severity) accounted for 74% of the lost days from incident ground injuries and 80% of the lost days from the non-incident ground locations. Whilst there is only a 6% difference between the two groups, the data re-enforces the view that the most significant location from the organisation's perspective on severity, were those accidents that occurred on the non-incident ground location.

To summarise the findings of the accident data reviewed; -

- 562 accidents occurred during the period 1 July 01 to 30 June 02 to career firefighters
- Non incident ground locations attribute 72% of all accidents that occur, with only 28% of accidents at the incident ground

- Of the Non incident ground location accidents, 46% will occur on station, 21% on the training ground, 19% on or around the appliance and 14% off station
- When off station 96% of accidents occur when carrying out some form of physical training
- Irrespective of the location, career firefighters are significantly likely to suffer from a sprain or strain
- The most common body part affected are the knees and lumbar
- Irrespective of the location, 89% of all accidents result in lost days less than seven days, with 11% greater than seven days
- The accidents that occur at non-incident ground locations that result in more than seven days from work account for a total of 80% lost days.

Chapter VI

DISCUSSION

The accuracy of capturing accident data features in research into firefighter injuries (GMV Associates 1999) with reference for the need for accurate reporting systems. This was also a finding (Almond 1997 pg 19) that was documented in a paper into the United Kingdom Fire Services and the accuracy of their accident reporting system.

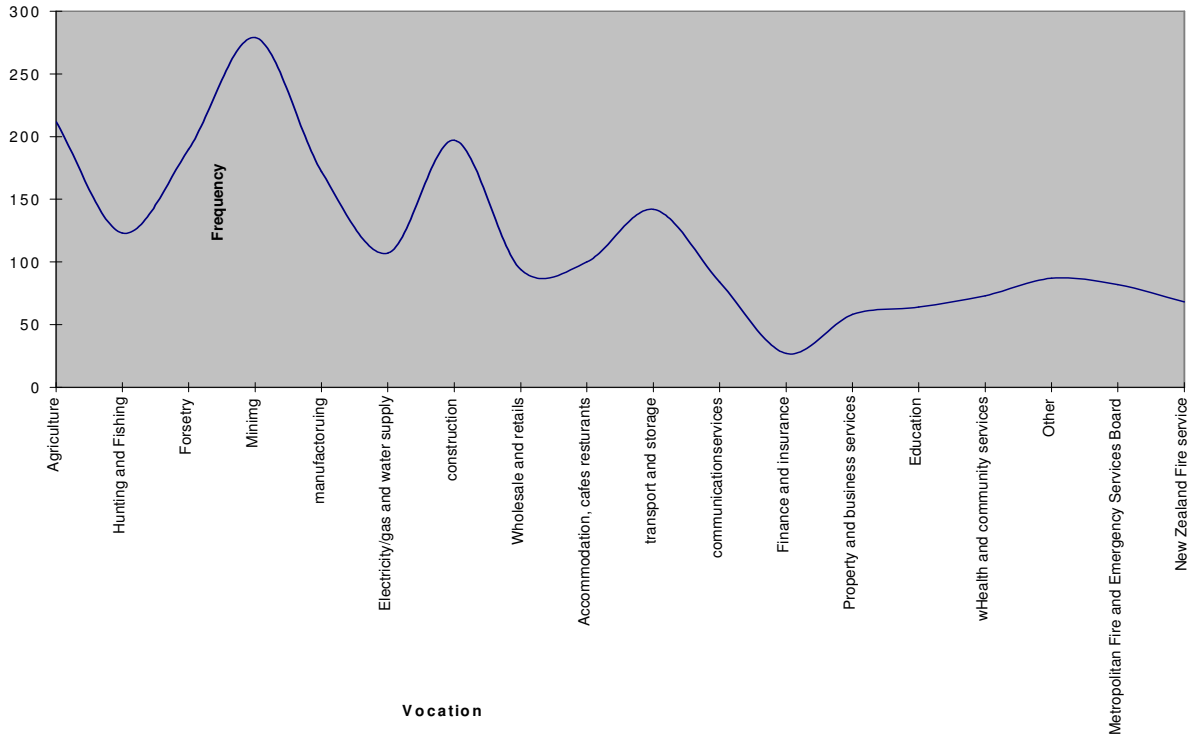
The need for accurate records impacts on the ability to identify trends, develop injury prevention strategies, changes to plant process or equipment and the ability to implement them successfully with all interested parties. Limited to those that resulted in a claim to career firefighters, the data reviewed did not indicate any near miss or non-injury accidents that may of occurred. The ability of reviewing total accident statistics to identify trends is paramount in reducing those accidents that result in a cost to an organisation.

The perception that firefighting is a hazardous vocation is one that within New Zealand, can not be substantiated with the injury data held. Whilst in the United Kingdom and United states, incident ground locations feature predominately as the location for injuries that firefighters receive, studies are also indicating that firefighting is not as hazardous as perceived, when using injury frequency as the weighting.

Overall, international trend for incident ground fatalities are reducing significantly with firefighter injuries consistent in their increase. Rated at 36 on the chart for probability of job related death out of 367 occupations was the result of one review carried out in the United States. Within New Zealand, comparing the accident frequency rate of the New Zealand Fire Service

against other industries, provides an insight as to the perceived 'risk' factor with firefighting.

Table 10: ACC Accident LTI



Source: ACC Annual Report 2002 & MFESB

In New Zealand, lost time injuries are used to reflect the accident rating or a vocation. When portraying our Accident Frequency Rate/Lost Time Injury (AFR/LTI) frequency rate, we can make comparisons against other organisations or other Fire Services. The above graph details AFR/LTI of other organisations within New Zealand and that of the Metropolitan Fire and Emergency Services Board (number of accidents/person hours worked x 1,000,000 hours). This again clearly reinforces the view that firefighting is not as hazardous as perceived when utilising accident statistics as the reporting measure.

The incidence rate of sprains and strains as the nature of injury within the New Zealand Fire Service is significantly higher than any other injury suffered or diagnosed. Sprains and strains feature predominately as the single, most

frequently diagnosed nature of injury both within the United Kingdom and through the National Fire Protection Association data. The National Fire Protection Assocation figures (Fahy, LeBlanc 1999 pg 49) indicate that 39.6% of all injuries diagnosed were also sprains and strains.

Accident Compensation Corporation figures also place sprains and strains as the most prolific injury suffered on average within several occupations. The common theme is sprains and strains featuring predominately as the injury suffered. The risk of suffering this injury within the New Zealand Fire Service is high. This is consistent with international Fire Services and the New Zealand industry injury average.

Table 10: **Percentage of Work-related Injuries by Type of Injury or Illness/Disease**

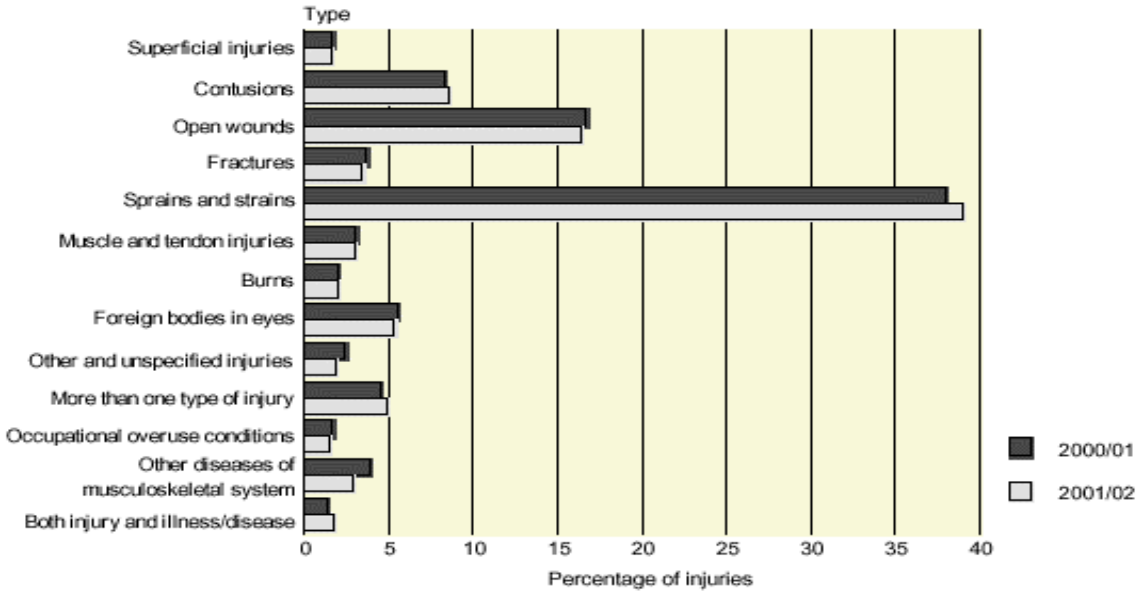


Table 11 Source: ACC Annual Report 2002

A consistent finding amongst all research was the body part most likely to be injured. These being in the order of most frequent body part;

- Lumbar/back
- Knee
- Shoulder
- Ankle

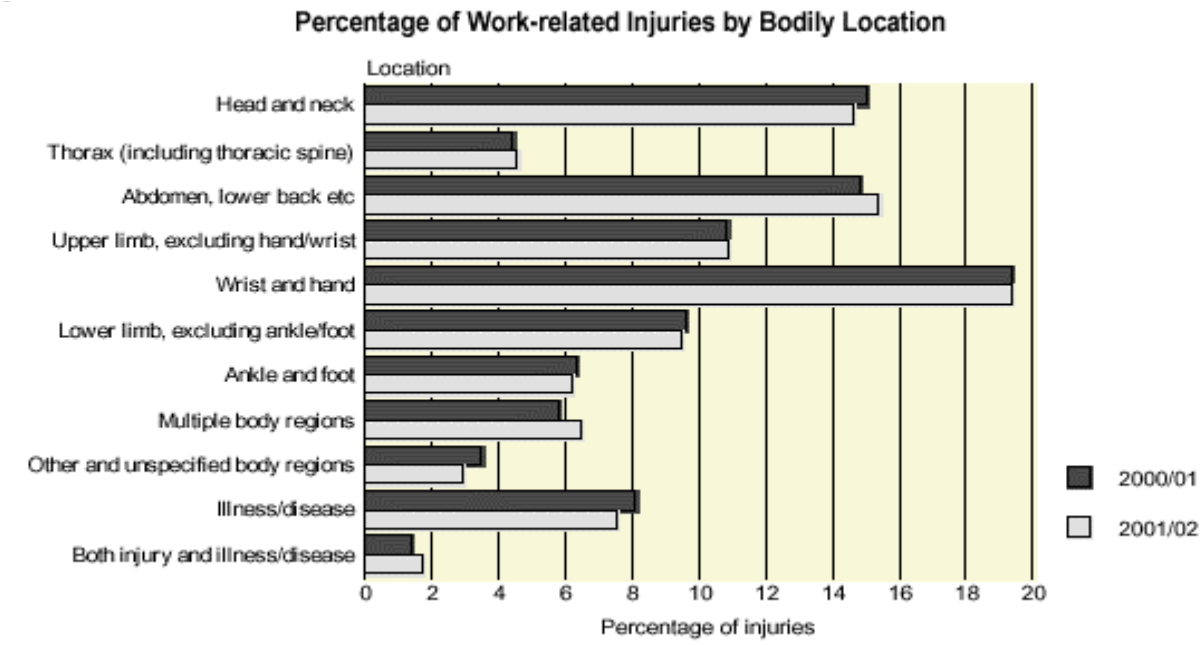


Table 12 Source: ACC Annual Report 2002

Identified by both United Kingdom and National Fire Protection Association data were the lumber and the knee, as the most prolific body part injured with a diagnoses of a sprain and strain. The frequency of injuries to the lumbar/back that resulted in less than seven days lost time was high, 83% yet only accounted for 207 lost days from work. The remaining 17% of injuries that resulted in more than seven lost days resulted in a staggering 1,118 lost days. These figures again reflected in the remaining body parts injured.

Identified as early as 1992, (GMV Associates 1999) the lumbar/back area accounted for 40% of firefighter injuries. During the late 1990s, there was a drop in injuries being reported to the lumbar/back, with only 4% being reported in 1998/1999. This figure is now back to the significant numbers, recorded back in the early 1990's.

The significance identified with sprain and strains to the body part is influenced by the mechanism of injury. With 73% of the injuries suffered to the lumbar, the result of muscular stress while lifting or handling an object, the remaining 27% were identified as fall, slip or trip factors. Further investigation

of the mechanism of injury, indicated that 50% of all injuries, were caused by some form of muscular stress, 28% of injuries from falls, slips or trips and 10% by being hit from a moving or falling object.

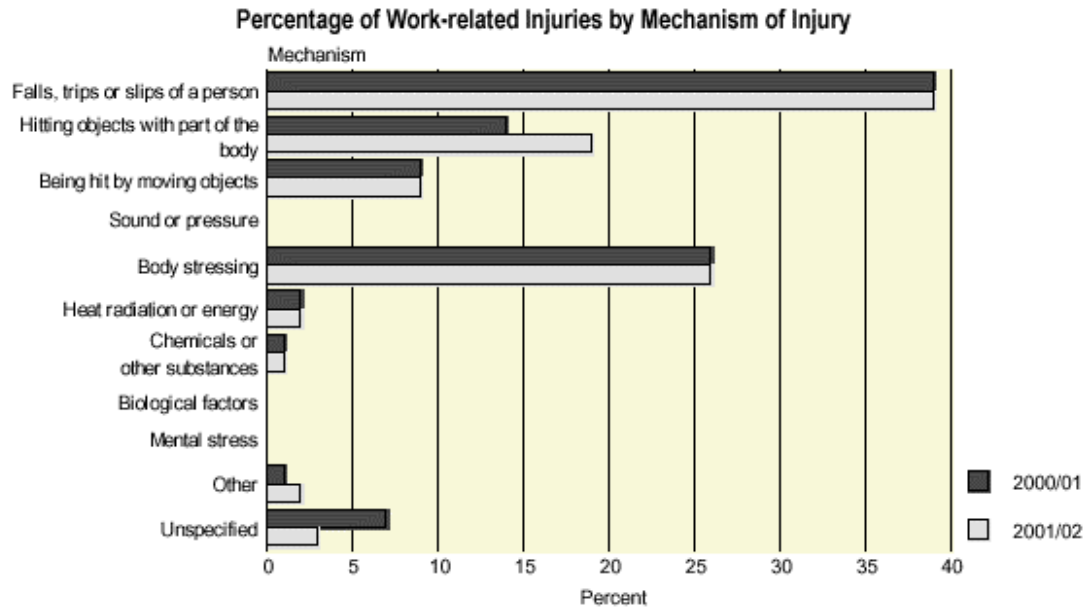


Table 13 Source: ACC Annual Report 2002

These figures were inconsistent with statistics provided by the Accident Compensation Corporation of total work related injuries by mechanism yet consistent with those established by the National Fire Protection Association for firefighters.

Identified by comparing injury frequency with time of day/night in conjunction with emergency incidents attended, highlighted a close relationship with the body's circadian rhythm. We spend a third of our lives sleeping; a process made up of several stages. The pattern of different states and stages across a typical night's sleep follows a cycle, approximately ninety minutes in duration. Sixty minutes attributed to Non Rapid Eye Movement (NREM) sleep followed by 30 minutes of Rapid Eye Movement (REM).

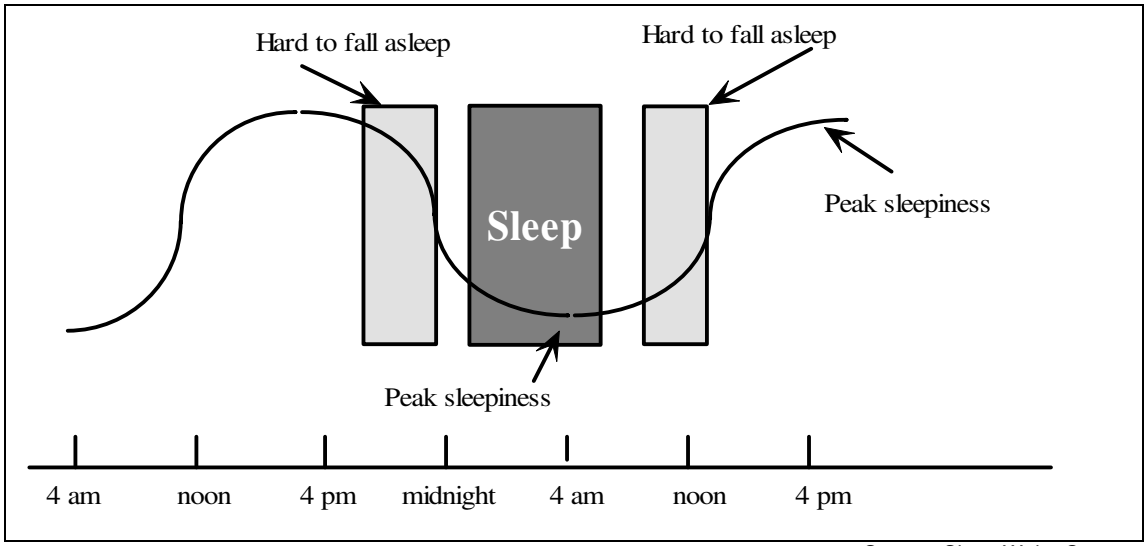
Non rapid eye movement results in a slower heart rate, regular and slower breathing and is often called deep sleep. Rapid eye movement is often associated with dreams, high brain activity and some muscular paralyse. Quality of sleep can be as important as the quantity of sleep. Disruption to

sleep by emergency incidents can contribute towards a sleep debt which often is recognized by sleepiness. This can decrease our capacity to perform basic tasks and increase the possibility of injury. Again highlighted by the time of night and day that injuries occur.

Often long sleeps are perceived as the answer for catching up on sleep, but often all that is required is two undisturbed nights of sleep. We require sleep just as much as food and water to function. There are eighty-four recognised sleep disorders (Sinclair 1997 Pg). The average sleep for an adult is 7-8 hours per night. Firefighters, during their two night shifts, can incur as much as 16 hours of sleep debt. If catch up sleep is not taken, the brain will eventually disengage and microsleeps occur. These can last from 3 seconds to 3 minutes.

The disruption to sleep patterns relates to the circadian rhythm, a biological clock that co-ordinates our daily cycles, programmes us to sleep at night and be awake during the day. Regulating our digestion, body temperature, blood pressure and other body functions, the circadian rhythm is helped by environmental factors such as light, dark, social factors and cultural influences.

Table 14: Circadian Rhythm



Source: Sleep Wake Centre

Key relationships between sleep quantity and quality, as provided in the above graph, is shown with a low point between 3am – 5am. During this time,

performance is at its lowest, thus becoming vulnerable to making errors. Another time during the day, 3pm – 5pm is considered to be the secondary peak in sleepiness. Though not the worst physical or mental performance considered to result in a drop in performance in some tasks. During the peaks of sleepiness 3am-5am as identified in the above chart, firefighter injuries reach one of three peaks during a 24-hour period when attending an emergency incident.

During another low point between 11am-1pm, firefighter injuries again peak at the incident ground, but also peak with non-incident ground location injuries. The only other significant period of the day begins at 9pm-11pm. When the body is naturally wanting to sleep and process the food taken in at meal times, firefighter injuries peak again.

The dilemma faced by firefighters is trying to over ride or beat the body clock and maintain a high level of competency while attending to the rugged and unknown work environment. The resistance of the body clock to shifting or aligning to hours of shift work and emergency incidents attended is hampered by the shift workers reverting to normal activities during their days off. The consistent attempt to change the body clock from work to days off results in the body never adapting fully to the shift pattern or the ability to cope with incidents at these periods during the day.

Whilst some figures were identified as being significantly higher than that of other Fire Services, one astounding figure identified, was a lower injury rate to New Zealand Fire Service firefighters at an incident ground location to their colleagues within the United Kingdom and United States. As identified, incident ground injuries only accounted for 28% of all injuries suffered by New Zealand Fire Service firefighters. In stark contrast, National Fire Protection Association figures (Fahy, LeBlanc 1999 pg 49) indicate that over 50% of all injuries were a result of the incident ground and only 35% occurred at a non-incident ground location. Within the United Kingdom, 56% of injuries are attributed to the incident ground.

Research undertaken within the United Kingdom suggests that the injury frequency for the incident ground has a direct link to the number of emergency incidents attended. A conclusion reached by the Fire Research Development Group (Marriott, Lillicrap 1994 pg 4)

> "*number of firefighter injuries at fires increased proportionally with the number of incidents attended*"

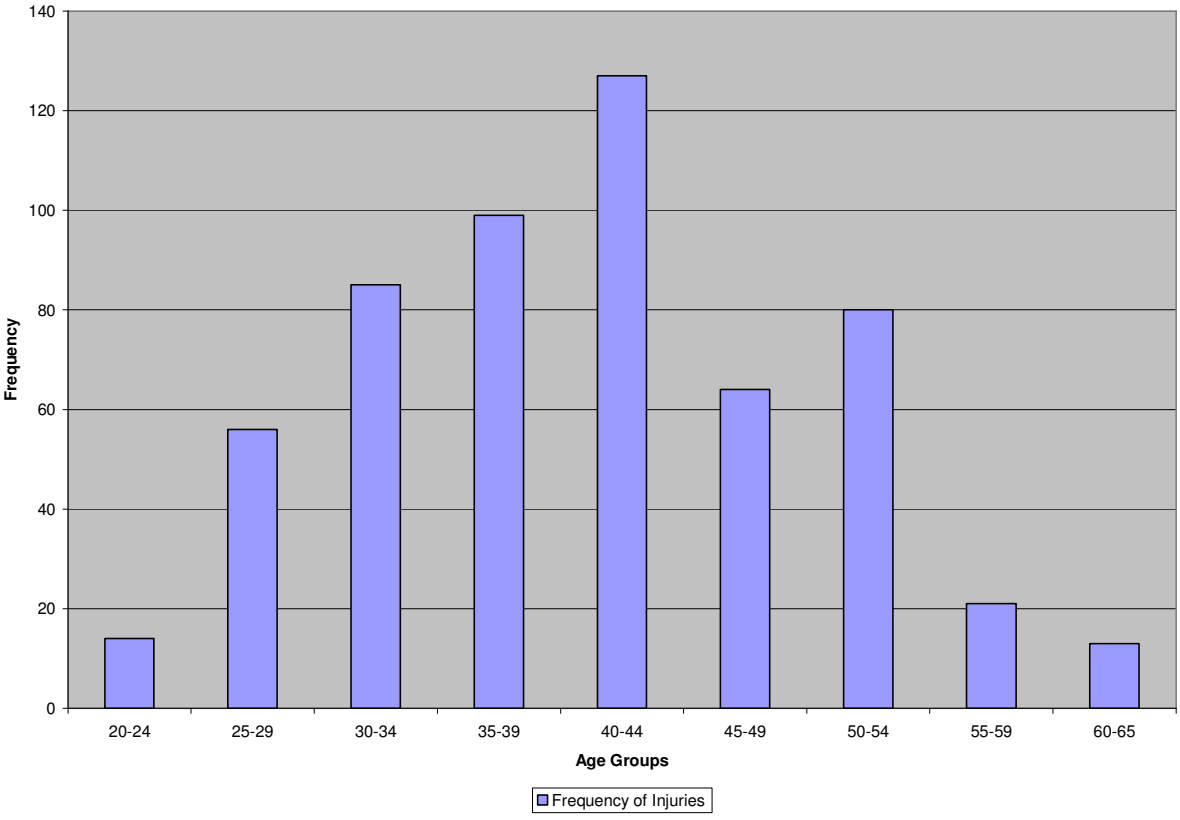
based on the statistics available. In comparison data from the New Zealand Fire Service, indicates no correlation between the emergency incidents attended during the 12-month period 1 July 2001 to 30 June 2002 and the injury data for the same period. No further information was discovered that could support the claim made by Marriott and Lillicrap.

Injuries that resulted in more than 'seven lost days' identified by previous research (GMV Associates 1999), accounted for a small percent of the total injuries recorded, yet the total lost days were significantly high. From the data reviewed, the total number of days spent away being greater than seven, accounted 80% of lost days.

The area of 'lost days' determines a significant portion of the reporting functions within the New Zealand Fire Service. Injuries are considered severe when greater than seven lost days, in comparison, the United Kingdom rates those injuries that incur more than three lost days. This is one limitation of the research reviewed and reference to severity of injuries. The organisation/country that comparison is made within New Zealand when reporting of lost days is Singapore, who currently utilise seven days as the margin for severity. Lost days are associated with cost and therefore impact on an organisation injury statistics and ultimately performance.

Identifying the location of injury, body part affected and nature of injury, all combine to develop injury prevention strategies. What cannot be determined is the link between the age and/or length of service with the accident frequency. As the chart below indicates, the middle-aged firefighter appears frequently in accident statistics. A further research paper may establish whether any link with age and service exists, with injury frequency.

Table 15: Frequency of Firefighter Injuries by Age Groups
July '01 -June '02



Source: NZFS HRIMS

Overall findings from the literature review and statistical review indicate a strong relationship between firefighter injuries irrespective of the country. Firefighters internationally are likely to have a sprain or strain, to the lumbar or knee, irrespective of this occurring on the incident ground or on station. The only point of difference is that New Zealand firefighters are more likely to be injured at the fire station than their counterparts in the United Kingdom, United States and Australia. Findings from the literature review indicate international firefighters are being injured on the incident ground more than their

counterparts in New Zealand, in terms of accidents per 1,000,000 person hours of exposure.

Chapter VII

CONCLUSION

Firefighters are more likely to be injured while on station than when they attend an emergency incident. Despite the fact that incident ground locations can be hazardous and in most cases uncontrolled, these locations are a safer work environment from an injury perspective than the fire station. Injuries to firefighters at the incident ground whilst significantly lower than those elsewhere can not be reduced without incorporating investigations into each incident. The results could provide vital clues to the correlation between staffing levels and injuries at the major fires or those that injuries occur at. Reviewing the incident ground injuries in conjunction with the emergency incident data could again highlight correlation between greater alarms or specific incident types.

Fire stations have historically been multi-level buildings that provide accommodation and work space for routine activities for career firefighters over the years. From the accident data reviewed, it was identified that 34% of all accidents occurred on or in the fire station. A limitation of this study has been to determine the location where firefighters are most likely to be injured without conducting further investigation as to whether the identified location contributed significantly to injury statistics i.e. fire stations.

With a number of ageing buildings, this dissertation has not identified whether the 34% of identified injuries taking place can be attributed to the ageing stations and not the new or recently developed station for the modern firefighter. The influence on future station development is unknown, with a number of policy constraints being imposed on the location, purchase, design and subsequent building of fire stations, despite the possibility of future fire

stations contributing to the lowering of the frequency of accidents faced by career firefighters.

In addition to fire station development, the emphasis that is placed on hazard management within fire stations, may lead to the identification of hazards, that potentially contribute towards the frequency of accidents. The outcome is the development of education programmes, identifying building maintenance priorities based on severity and frequency of injury and lastly raising the awareness that firefighters take when living and working in their fire station. Further research could identify what stations have a significant accident frequency in an attempt to identify any correlation between age and condition of station, nature of injury and location of the accident on station.

With 21% of the non-incident ground location injuries occurring on the training ground, this rate is comparable to operational (incident ground) conditions and many hazardous situations. This frequency suggests that either the training is very dangerous, those involved are unusually careless or the training grounds are in an unsafe state. With training taking up to one quarter (on average) of the working day, the injury frequency should be as high if not higher than that of the incident ground injuries. The training ground environment is a controlled one in contrast to the varying states of the incident ground. All identified risks should be identified and some form control in place in keeping with the aims of the training being undertaken.

The high incidence of injuries on the training ground were not reflected in statistics within the United Kingdom. A review of injury statistics of the United Kingdom Fire Services in 1995 indicated drill ground injuries accounting for 12%. This was attributed to an increased awareness of safety issues, changes in footwear to non-slip shoes and the inclusion of non-slip flooring.

The immediate goal must be to reduce the incident rate of injuries on the training ground to as low as reasonably practicable, given the constraints of the need for realistic training. With a reduction of injuries in the training arena, the flow on effect may include a reduction of injuries on the incident ground.

Sprains and strains to the lumbar and knee as a result of body stressing or muscular stress are the most frequent, identified injury. Both statistical findings and literature review has indicated this as the most likely injury, body part and mechanism. It is clear that the majority of these injuries reflect the activity firefighters carry out on a daily basis. Whilst firefighting, personal protective equipment worn by firefighters can weigh up to 25kg, with firefighting hose lines weighing anything up to 200kg (not taking into account friction factors). These weights alone will contribute to muscular stressing of the lumbar and knees. When carrying out routine work, equipment utilised again ranges from 25kg to 125kg for portable pumps, hose and personal protective equipment are worn when carrying out training, fire appliance design requires climbing in and out of the cabs with physical training also claiming a number of sprains and strains.

The nature of injury and ultimately the mechanism of injury can offer up questions to those involved with equipment design, purchase and review. If injury statistics are incorporated into these steps within an organisation, the ability to minimise or lower a certain percentage of injuries within a specific category i.e. appliance injuries, will occur. The link in with other facets of an organisation will receive the 'ripple' effect of reduction in one area and so begins a cycle of injury reduction.

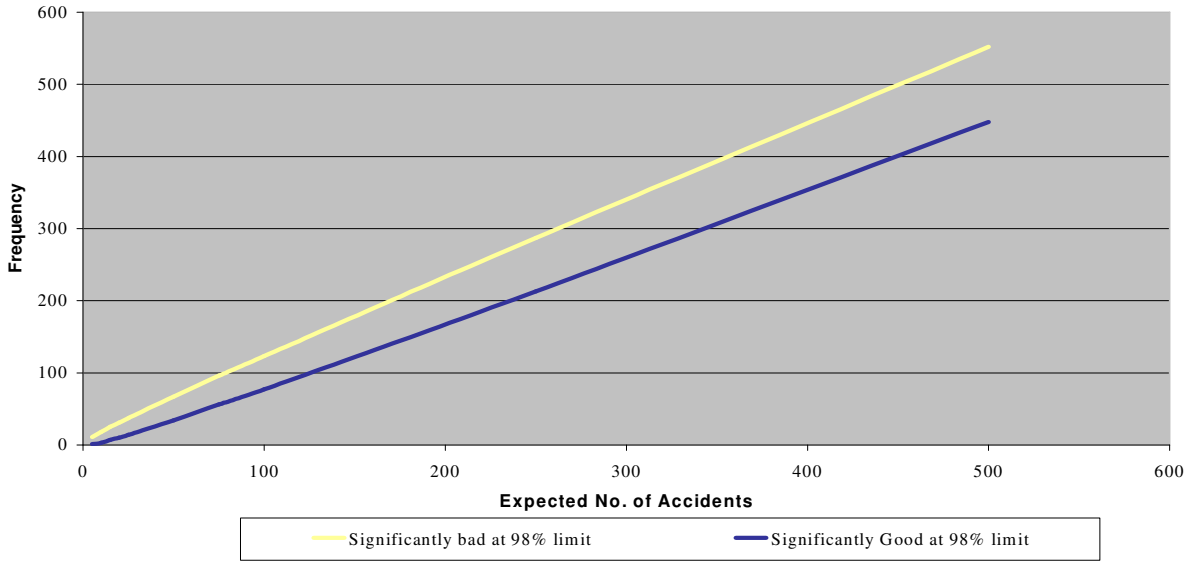
The New Zealand Fire Service has chosen a lost time injury frequency of 60 per 1,000,000 hours worked. This has been incorporated into the performance agreements that the region managers have for their work environment. This places a significant emphasis on the need to reduce the injury frequency both on the incident ground, but more significantly when on station or carrying out non-emergency related activities. With identifying the significant proportion of sprains and strains, body part effected and the mechanism of injury, there lies the ability to implement injury prevention strategies to combat the high incidents. Whether this involves developing specific training packages or utilising the government funded training packages provided by the country's

Accident Compensation Corporation Injury Prevention consultants is an organisation issue.

Determining what accident rate is an acceptable level of achievement or under achievement must be clearly incorporated into performance indicators. The below chart indicates what is significantly good and bad at a 98% confidence limit for the number of accidents.

The concept of zero risk is counter productive when establishing an achievable level of injury risk management. In an attempt to reduce an accident frequency rate, to a specific level, the adoption of confidence levels may provide an avenue or guide when determining the success or failure of the achieved level.

Table 16: Upper and Lower 98% Confidence Limit for Expected No. Accidents



Change in accident statistics can be achieved. Research (Klein 1996, pg 276) states

> "*The fire department experiences a paradigm shift through the implementation, development and use of a solid and effective written safety and health program*".

This being the key building blocks for reducing the accident frequency within operational firefighters.

Overall, firefighter injuries has had limited research or commitment from a number of organisations. While effort has been placed on the health aspects and fitness of firefighters resulting in some comprehensive health monitoring programmes, structured fitness programmes and research articles.

From the literature reviewed, focus has also been towards firefighter deaths primarily, with injury prevention specific to firefighters being somewhat down graded. Research (Almond 1997) into the United Kingdom showed a significant drop in injuries associated with appliance design and modifications. This is a clear example of the usefulness of consistently reviewing injury statistics to see where improvements can be made.

The inclusion of down lights to the steps and lockers of the fire appliances resulted in a drop of ankle injuries. The inclusion of appropriate footwear reduce further ankle and leg injuries from slips and trips as a result of non slip soles. The opportunity to reduce injuries and ultimately costs over a lengthy period is often overlooked for the initial cost to the organisation.

Injury prevention will reduce injuries and will result in a reduction of costs for an organisation, but more importantly, a reduction in pain and suffering for personnel.

Chapter VIII

RECOMMENDATIONS

The concept of zero risk is counter-productive. A result brought on by over reaction, diversion of resources from more cost-effective areas and a false impression of industry practices. With a lost time or accident frequency rate of 60 being the target for the New Zealand Fire Service, how, why and where did we obtain this figure? This must be portrayed to all staff to demystify the management approach to injuries and offer an incentive or by in from personnel to achieve the goal. Also imperative is an acceptable threshold or confidence level to ensure some relativity to the end result. As with all objectives, they must be specific, measurable, achievable, realistic and time bound.

Only 28% of all injuries occur on the incident ground, at a ratio of one accident every 404 emergency incidents attended. With all accidents being recorded on one system there lies the opportunity to raise personnel awareness of these accidents that are occurring. An approach to this would be the introduction of an incident ground accident alert notice issued through the organisations Intranet service, is a cost effective and immediate response to raising the awareness of accidents.

With this ability to inform personnel that an accident has taken place, an opportunity to reduce the likelihood of a small percent occurring elsewhere. The flow on effect is an increased awareness for Health and Safety, hazard management and accident reporting.

As identified, station injuries account for 46% of all non-incident ground location injuries. Whilst half of the injury locations are identified, the remaining

injury location/s have not been identified. Injury prevention can only be as good as the injury data entered. The emphasis placed on accurate reporting must not be over looked.

With the existence of a standard accident-reporting programme, there lies the ability to only select specified station locations. This would then provide more accurate statistics that can be used for injury prevention strategies and structured building repair or maintenance.

In addition to the changes recommended to the accident reporting process, further research must be undertaken to identify whether the station location is a contributing factor to the accident occurring. Establishing the specific locations on station is the first step in the process. Further identifying the station design/type, age and construction may provide vital details for establishing contributing factors for future station development.

Having identified specific locations such as the gymnasium or workshops, the ability to assess whether they are actually part of the core business of the organisation and therefore do they form part of a firefighters station work environment. This in turn may influence or provide a further opportunity to reduce accident statistics. Accidents within this location can be reduced and due to the high frequency, must be addressed.

With identifying further research of specific station location injuries, the ability to address the option of on station gymnasium or off station physical training can be undertaken. Currently off station physical training accounts for 13% of all non-incident ground location injuries. Again there is a need to establish the current need for this activity with station gymnasiums and the introduction of a structured physical training programme.

Further research will again establish whether this is a generic issue for the organisation or district specific. This will lead to further cost analyses for the

location of gym equipment on station with adherence to the structured training programme or the introduction of supervised physical training.

Having identified the most common injury, body part effected and mechanism of injury the need to begin injury prevention strategies such as education programmes is paramount. The process to undertake can involve developing a specific programme for the organisation.

To ensure a comprehensive programme is developed, the utilisation of the Accident Compensation Corporation resources would be recommended. The in depth knowledge and access to enormous resources can not be matched by the New Zealand Fire Service and would be an example of diverting resources into an area without comprehensive research, knowledge or ability to sustain this approach.

The topic of injury prevention is one that can encompass many areas of injury data. A further look at the correlation between length of service, age, location and injury frequency of firefighters may indicate again, further injury prevention strategies with a number of potential changes to the approach taken.

To summaries the recommendations that were identified through literature review and statistical reviews are;

- determine confidence limits for significantly good and significantly bad accident frequency results and demystify the process to encourage by-in from personnel
- introduce an accident alert process to raise the awareness of accidents promptly amongst all personnel
- review the reporting programme to ensure specific station locations can only be selected to increase the accuracy of accident data
- conduct further review of on station accident data to establish further common themes such as building age and condition, district
- monitor the incident rate for accidents in the gymnasium and off station physical training

- utilise current resources of the Accident Compensation Corporation for injury prevention programmes, resources and knowledge of sprains and strains, lumbar and knee injuries and muscular stress
- establish further research into the correlation between age, length of service, location and frequency of injury to firefighters.

These recommendations have been based on the literature reviewed, statistics reviewed and the conclusions drawn form those sources.

Bibliography

Almond, G H. ***Accidents, injuries and illnesses to firefighters in Great Britain. / 1997*** Fire Engineers Journal, v57 no189 (Jul 97) p19-24

Almand, Lloyd B ; Sykes, Kevin. ***Fitness pays off + Fitness at last + Firefighter fitness : a before-and-after study. / 1983+1984.*** Fire Chief + Fire Command + Fire International v27 no10 (Oct 83) p18 + v51 no4 (Apr 84) p38-41 + v8 no87 (Jun-Jul 84) p22-25

Almond, G H. Cheshire : G H Almond, ***Report on accidents, injuries and illnesses to firemen in Great Britain : a project undertaken as the result of a United Kingdom Fire Engineering Scholarship / 1972***

Cady, Lee D/; Bischoff, David P ; O'Connell, Eugene R ; Thomas, Phillip C ; Allan, John H ***Strength and fitness and subsequent back injuries in firefighters.. 1979.*** Journal of Occupational Medicine v21 no4 (Apr 79) p269-272

Boult, M and Pitbado, R (1996) *Individual risk of death in UK industries* (1996) Fire Engineers Journal 56(180), 44 January

Donnan, SPD *Study of causes of death in firemen* Research report No.20 Joint Committee on Fire Research, Central Fire Brigades Advisory Councils for England and ales and Scotland, Home Office London

Dunn, Vincent. ***50 causes of firefighter death and injury /*** 2001. Article Firehouse, v26 no3 (Mar 2001) p26-36

Dunn, Vincent. ***Firefighter death and injury : fifty causes and contributing factors. / 1990.*** Fire Engineering v143 no8 (Aug 90) p35-52

Erwin, Joe ***Firefighters see red + Firefighter safety : an update + Census of fatal occupational injuries + The most dangerous profession? /. 1993-1996.*** Public Management + Internet + Fire Chief v75 no1 (Jan 93) p2-5 + v77 no12 (Dec 95) p10-15 + (Sep 98) + (Feb 93) p36-38

Fahy, Rita F. ; LeBlanc, Paul R ***Report on 1999 firefighter fatalities /. 2000.*** NFPA Journal, v94 no4 (Jul/Aug 2000) p46-61

Fire Brigades Union *A fighting chance* FBU discussion paper regarding the safety of firefighters. Fire Brigades Union, Kingston upon Thames, Surrey (1995)

Gancarskie, Joan L; Karter, Michael J; Harlow, David W; Washburn, Arthur E. ***U.S. firefighter injuries: 1983 + U.S. firefighter injuries: 1985 / 1986.*** Fire command v51 no2 (Nov 84) p21-31, v53 no11 (Nov 86) p22-35

Giraud, Andre. ***Accident analysis averts injuries to firefighters /*** 1999**.** Fire International + Fire (Europe) no166 (Jan 99) p13-14 + v91 no1125 (Mar 99) p11-12

GMV Associates Ltd. ***Analysis of workplace injuries: New Zealand Fire Service*** **Wellington: GMV Associates, 1999.**

Health and Safety Executive *Training for hazardous occupations a case study of the Fire Service* HSE Occupational Paper Series OP8 HMSO London (1984)

Health and Safety in Employment Act 1992,

Injury Prevention, Rehabilitation and Compensation Act 2001

Karter, Michael J; LeBlanc, P R. ***U.S. firefighter injuries: 1996 / 1997.*** NFPA Journal v91 no6 (Nov-Dec 97) p66-77

Karter, Michael J; LeBlanc, P R. ***U.S. firefighter injuries: 1997 / 1998.*** NFPA Journal v92 no6 (Nov-Dec 98) p48-56

Karter, Michael J; LeBlanc, P R. ***U.S. firefighter injuries: 1998 / 1999.*** NFPA Journal v93 no6 (Nov-Dec 99) p46-56

Karter, Michael J; Badger, Stephen G ***U.S. firefighter injuries: 1999 /. 2000.*** NFPA Journal, v94 no6 (Nov/Dec 2000) p41-49

Karter, Michael J. ; Badger, Stephen G. ***U.S. Firefighter injuries : 2000 / 2001.*** NFPA Journal, v95 no6 (Nov/Dec 2001) p49-54

Karter, Michael J. ; Molis, Joseph ***U.S. firefighter injuries : 2001 / L. 2003.*** NFPA Journal, v97 no1 (Jan-Feb 2003) p62-65

Karter, Michael ; LeBlanc, Paul. ***Fire fighter injuries at an 18-year low. / 1995.*** NFPA Journal v89 no6 (Nov/Dec 95) p63-70.

Kipp, Jonathon D ; Loflin, ***Emergency incident risk management : safety and health perspective / Murrey E. New York : Van Nostrand Rheinhold***, 1996.

Klein, R A. ***Accidents to firefighters : zero risk - a chimaera. / 1996*** Fire Engineers Journal v56 no181 (Mar 96) p40-45**.**

Klein, Roger A ***Risk assessment and firefighter safety: patterns of injury in the UK - the UK and USA compared /. 2001.*** Fire Engineers Journal, v61 no215 (Nov 2001), p 13-23

Marriott, M D ; Lillicrap, D C. London : ***Accidents to firefighters /*** Central Fire Brigades Advisory Council, 1994.

Muckett, Martin ***Developing a National Safety Event Database /. 1999.*** Fire, v91 no1123 (Jan 99) p22-23

NFPA ***Firefighter injury statistics. / 1993*** Fire Engineering v146 no3 (Mar 93) p56**.**

A profile of fire in the United States 1985-1994 / 9th ed. National Fire Data Centre, FEMA. USA : United States Fire Administration, 1997

Orris, Peter ; Melius, James ; Duffy, Richard M (Editors) ***Firefighters safety and health / Philadelphia, PA : Hanley and Belfus, 1995.*** Occupational Medicine: State of the Art Reviews v10 no4 (Oct-Dec 95) **Star** ***Fire poles on the slide / 1996.*** no6 (Aug 96) p16

Sager, Jon S ***Firefighting experience and the perception of danger /. 1989.*** Fire engineering v142 no5 (May 89) p47-50

Sandinata, Veronika ***Reporting firefighter injuries. /. 1995.*** Fire News / NSW Fire Brigades v17 no1 (Mar 95) p19

Sinclair R *Getting a good nights sleep in a days work* New Zealand Doctor August (1997)

Slappendel C *Health and Safety in New Zealand Work Places* Palmerston North Dunmore Press (1995)

Thorpe, Dan ***Injuries and fatalities during night-time firefighting operations /. 2003*** Fire Management Today, v63 no2 (Spring 2003) p26-30

Washburn, Arthur E; LeBlanc, Paul R; Fahy, Rita F. ***1996 firefighter fatalities /*** 1997. NFPA Journal v91 no4 (Jul/Aug 97) p46-60

Washburn, Arthur E ; LeBlanc, Paul R ; Fahy, Rita F. ***1997 firefighter fatalities /*** 1998**.** NFPA Journal v92 no4 (Jul-Aug 98) p50-62

Wilbur, Michael ***Emergency vehicle operators' top 10 list /. 1997.*** Firehouse, v22 no7 (Jul 97) p52

Wilbur, Michael ***1995: another year of tragedy. /.*** 1996. Firehouse v21 no9 (Sep 96) p18-20

Williams, Garry ***Merseyside's "preaching and profiling" safety strategy /. 1999.*** Fire v92 no1132 (Oct 99) p40