ADDENDUM to be inserted at the end of 7.5.3, page 82.

The Risk Identification Checklist should also include consideration of the frequency with which individual manual handling tasks are performed. This investigation did not analyse the frequency with which SAMFS firefighters perform the manual handling tasks assessed. It is probable that the frequency of injury associated with a particular task is a function of both its "intrinsic risk" and the frequency with which the task is performed. Since the Risk Identification Checklist does not include any reference to frequency with which a task is performed (as distinct from the frequency with which components *within* the task are performed), the panellists' conclusions could only have been based on their judgement of the "intrinsic risk" of the particular task. It is possible that if the Checklist were to include a question on the frequency of the task, the predictive capacity of the panel would be improved.

The firefighters may or may not have taken task frequency into account when they completed the Questionnaire on the risk involved associated with the manual handling task. However, the panel who were not familiar with the firefighting industry would not have been able to do so.

This deficiency in the Checklist does not affect the conclusion. Indeed, it is partly because the Checklist itself takes no account of the frequency with which tasks are performed it remains true that the injury statistics, and not the Checklist scores, are the best predictor of the risk associated with particular manual handling tasks.

An Evaluation of the Risk Identification Checklist from the Manual Handling Code of Practice

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Awarded 1993

DECLARATION

This report contains no material which has been accepted for the award of any other degree or diploma in any university, and to the best of the author's knowledge and belief, it contains no material previously published or written by another person, except where due reference is made in the text.

Rosetta Anne Boucaut

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I give consent to this copy of my thesis, when deposited in the University Library, being available for photocopying and loan.

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ABSTRACT

Manual Handling Regulations and a Code of Practice which were introduced in South Australia in January 1991, are aimed at reducing the frequency and severity of manual handling injuries sustained at work. The Code of Practice is a practical guide for employers to follow in order to comply with the Regulations, and consists of three phases: risk identification, risk assessment and risk control.

The risk identification procedure involves three stages: a review of the manual handling injury statistics to determine manual handling injuries which have occurred at the workplace, consultation with employees to determine their perceptions of manual handling hazards at the workplace, and the evaluation of manual handling hazards (identified in the two preceding processes) using a Risk Identification Checklist. The Checklist is comprised of 18 questions about manual handling risk factors and is designed so that the higher the score is for a task the higher is its priority for risk assessment and control.

This thesis examined the validity of the Risk Identification Checklist as a predictor of the risk of manual handling injuries by applying it to tasks performed by firefighters employed at the South Australian Metropolitan Fire Service (SAMFS).

The study involved the following distinct stages: first, a review of the SAMFS injury statistics was undertaken to identify the tasks giving rise to manual handling injuries, and to categorise them according to their frequency and severity. Secondly, a manual handling questionnaire, based on the National Skills Audit of firefighter duties, was designed and administered to a representative sample of 125 SAMFS firefighters. From this, the manual handling tasks were graded according to the risk of injury as perceived by the firefighters. Thirdly, a video was produced of 23 manual handling firefighter tasks. The tasks selected for the film included tasks of a range of injury frequency and severity according to SAMFS injury statistics and of a range of hazard ratings according to the firefighters. Fourthly, the 23 manual handling tasks were shown and subsequently scored by a panel of 15 occupational health professionals using the Risk Identification Checklist. Panel members were blinded to the injury frequency, severity and firefighter hazard ranking of the tasks viewed on the video. Checklist scores for each of the tasks were obtained from each of the 15 panel members.

Finally, performance of the Checklist was examined in the following ways. Intra-rater reliability was assessed by comparing the ratings of the same panellist on two separate viewings of the video. Inter-rater agreement of Checklist scores was assessed by examining the range of Checklist scores given by each of the panel members for each individual task. Subsequently, comparisons of Checklist scores were made with both the SAMFS manual handling injury statistics and the SAMFS firefighter perceptions of manual handling hazards.

Results showed there was high intra-rater reliability between test/re-test gross scores (Spearman correlation coefficients ranged from 0.83 to 0.88), that is, the three panel members were consistent in their hazard ranking in separate viewings of the tasks. However although the panel members had a highly correlated rank order of the tasks, the manner in which two panellists arrived at the total score was inconsistent between viewings, that is, the 18 individual questions in the Checklist were answered differently.

The inter-rater agreement of the 15 panellists was low as shown by a wide range of Checklist scores for each task. The Friedman non-parametric analysis of variance showed no significant agreement between the panel members' scores ($p<0.001$).

There was low correlation between Checklist scores and injury frequency for the panellists as a group (Spearman correlation coefficient 0.17) and for the individual panellists (Spearman correlation coefficients ranged from -0.04 to 0.38).

The majority of the panel did differentiate the tasks on the basis of severity, but the difference in the medians given to the "severe" and the "non-severe" tasks was not statistically significant for any member of the panel.

The correlation of the firefighters' risk perception of the manual handling tasks and injury statistics was low both for injury frequency and for injury severity (Spearman correlation coefficients 0.35 and 0.19, respectively).

There was high correlation between the firefighters' perception of hazards and the manual handling Checklist scores (Spearman correlation coefficient 0.76).

The performance of the Risk Identification Checklist from the Manual Handling Code of Practice has been assessed and has been shown to perform poorly at the SAMFS. It is concluded that neither the use of the Risk Identification Checklist nor employees perceptions of risk as proposed in the Manual Handling Code of Practice are valid predictors of manual handling injuries. It is proposed that priorities for manual handling risk assessment and control should be determined from analysis of injury statistics, if the frequency and severity of manual handling injuries are to be reduced.

CHAPTER ONE

INTRODUCTION

1.1 GENERAL INTRODUCTION

1.1.1 Manual Handling and Firefighters

Over 25 percent of work injuries are caused by manual handling activities (Health and Safety Commission (U.K.), 1991). The magnitude of both the number of manual handling injuries and their costs in Australia have caused authorities considerable concern and for this reason, the National Occupational Health and Safety Commission has targeted manual handling injuries as one of its top priorities for control. The result has been the production of a National Standard and Code of Practice for Manual Handling (National Occupational Health and Safety Commission, 1990).

This new legislation aimed at reducing both the number and the severity of manual handling injuries has been introduced recently throughout Australia (January 1st, 1991 in South Australia). The legislation requires all employers in South Australia to follow the Manual Handling Code of Practice or to achieve a similar result by their own initiatives.

The first requirement of the Code of Practice is the risk identification of manual handling hazards at the workplace, and includes a Manual Handling Risk Identification Checklist. The Checklist has been designed to identify hazardous components of manual handling tasks carried out in the workplace, and to give a priority order for tasks which require risk assessment and control. The identification of such worksite hazards is potentially of use in the prevention of injuries.

A firefighter's work is physically demanding in nature, and there are anecdotal reports of a high number of work related manual handling injuries. This, coupled with the introduction of new manual handling legislation, provided an opportunity to identify manual handling hazards within the firefighting industry and to place them in priority order for risk assessment and control using the Risk Identification Checklist. This investigation was undertaken to determine the validity of the Risk Identification Checklist as a predictor of the risk of manual handling injuries. The worksite studied was the South Australian Metropolitan Fire Service (SAMFS).

1.1.2 Definition of Manual Handling

The definition of manual handling used in this study is from the Approved Code of Practice for Manual Handling (1990). It describes manual handling as:

"any activity requiring the use of force exerted by a person to lift, push, pull, carry or otherwise move or restrain any animate or inanimate object."

The wearing of heavy clothing or equipment is also considered to be a form of manual handling and this is of particular relevance in the firefighting industry. As can be seen from the above definition and comment, there are obviously few firefighter activities which do not involve some form of manual handling.

1.2 EXTENT OF THE MANUAL HANDLING PROBLEM

1.2.1 In Australia

In Australia in 1986-87, of the estimated 300,000 compensable injuries resulting in five or more days of lost time, more than 55,000 resulted from manual handling, (Worksafe, 1989). Sixty percent of these manual handling injuries affect the back (Buis, 1990). It has been emphasised by Worksafe (1989) that back disorders account for nearly a quarter of the total annual workers compensation bill of some $4.3 billion.

The South Australian Occupational Health and Safety Commission (1992) reported that 10,000 South Australians sustain manual handling injuries each year at an estimated cost of $80 million per annum.

1.2.2 Worldwide

The manual handling problem is not peculiar to Australia. The magnitude of the problem is known to be of the same order in the United Kingdom, Europe and

North America (Health and Safety Commission, 1988). In the United Kingdom more than a quarter of the occupational injuries reported each year are associated with manual handling. Of all the injuries reported in 1988/89 which resulted in three or more days off work, 33% were caused by manual handling, and about half (47%) of these manual handling incidents resulted in back injuries (Health and Safety Commission, 1991).

In 1978 Snook reported that, in the United States, 23% of all the compensated work injuries were associated with the manual handling of objects, and 79% of these affected the lower back.

1.3 LEGISLATION

1.3.1 Australian Legislation

Prior to the introduction of the current Australian legislation, weight limits restricted the load women and minors were permitted to handle in the workplace. In 1987, the National Sex Discrimination Act invalidated those existing regulations (based on gender and age). For this reason, together with the perception that those regulations were not containing the manual handling injury problem, a working party was established to draft new legislation (Buis, 1990). New legislation adopted in Victoria in 1989 has been the basis for the national legislation now in place. This incorporates a new ergonomic, or "total systems", approach to the problem (Buis, 1990; Caruso, 1986) taking into consideration all the factors involved in a manual handling job including: the components of the task, the workplace environment, the characteristics of the worker and any equipment involved.

In South Australia, new manual handling legislation, the Occupational Health, Safety and Welfare (Manual Handling) Regulations 1990, became effective in January, 1991. An Approved Code of Practice for Manual Handling has been produced to provide practical guidance to meet the requirements of the new

Regulations.

This Code of Practice "provides minimum standards of health and safety and is designed to be used in addition to the Act and Regulations." (South Australian Occupational Health, Safety, and Welfare Act, 1986).

The new legislation requires employers to identify hazards, anticipate problems, and as far as is practicable ensure that the workplace is hazard free, hence taking a pro-active approach to Occupational Health and Safety. This is in contrast to the pre-existing legislation where the employer acted only to comply with existing rules and regulations, rather than actively to promote health and safety at the workplace.

The Manual Handling Code of Practice is comprised of three phases - risk identification, risk assessment and risk control.

1. The purpose of risk identification is to identify the hazardous manual handling tasks at the workplace and to place them in a priority order for risk assessment and control using the Manual Handling Risk Identification Checklist (Appendix A).

2. Risk assessment follows risk identification and in this phase all risk factors previously noted in the identification phase are examined in specific detail by consideration of further questions about the task. These questions are set out in the Code of Practice.

3. Risk control involves the employer taking steps to eliminate or control the risk factors associated with the task. For some tasks the ideal risk control may involve redesign of the task. For other tasks, or those where redesign is not appropriate, the employer may need to investigate the possibility of providing mechanical aids, personal protective equipment, and/or employee

training to reduce the hazard.

Further consultation with employees after modifications to the task have been made is required to assess whether the changes made were appropriate. The Checklist may be used again for this.

This study is concerned only with the initial phase of the Code of Practice, that is, risk identification.

1.3.2 Overseas Legislation

New legislation is soon to be introduced in the United Kingdom. In draft form this is similar to the new Australian national legislation. It also requires management to assume a pro-active role in the prevention of injuries and has a Code of Practice to assist in the identification of hazards, their subsequent assessment and control.

1.4 RISK IDENTIFICATION

1.4.1 The Three Phases of Risk Identification

Manual handling risk identification, as outlined in the Code of Practice, consists of three parts.

First, hazards which have resulted in manual handling injuries are identified. Analysis of work-place injury records is undertaken to determine both the frequency and severity of manual handling injuries which have occurred at the workplace. Higher frequency or severity rates indicate priority areas for injury prevention.

Secondly, direct consultation with employees is made to determine their views on manual handling hazards which they may encounter during the course of their duties.

Thirdly, direct observation of tasks which have been identified as hazardous is undertaken using the Risk Identification Checklist provided in the Code of Practice. Checklist scores for each task are determined by adding the number of hazardous components within each task. The scores enable the tasks to be placed in priority order for risk assessment and control.

1.4.2 The Risk Identification Checklist

The Risk Identification Checklist used in the National Standard is taken from the Victorian Manual Handling Regulations and Code of Practice (1988). The working party who compiled the Checklist used a combination of technical information available to them at the time and tempered it with a total systems approach which was considered to be politically acceptable at the time.

The exact origin of the questions is not documented, but the working party who compiled it used the American National Institute for Occupational Safety and Health (NIOSH) Manual Handling Guide (1981) as the basis and coupled this with an ergonomic approach (Buis, 1990; Rawling, 1991, personal communication).

The Checklist has been designed to be used in any workplace by the health and safety representatives (or employees). It consists of 18 questions about common risks which may be encountered during manual handling. The questions relate to four broad aspects of manual handling: -

(1) movements, posture (of the employee) and layout (of the worksite)
(2) task and object
(3) work environment
(4) individual factors

The Checklist is structured so that the respondent answers "Yes" or "No" to each of the eighteen questions, the "Yes" answers indicating an observed risk. The Checklist gives equal weight to all questions so the total number of "Yes" answers indicates the number of risk factors associated with that task.)

The Manual Handling Code of Practice recommends that priorities set according to the number of "Yes" answers: "Generally the more YES answers that result for a particular task then the higher the priority for risk assessment." (Manual Handling Code of Practice, 1990).

The Checklist thus provides a recorded measure of details about the task. These details are necessary for future reference in risk analysis and control. The Checklist can also be used for reassessment purposes after changes have been made to the task.

1.5 FIREFIGHTERS

1.5.1 The Job of the Firefighter

The responsibilities of today's firefighters are much more extensive than purely fighting fires. Firefighters have come to play an increasing role in the provision of emergency rescue, first aid services and the response to incidents involving hazardous substances (National Fire Protection Association, 1987).

The firefighters job may involve high stress, strenuous work and the use of heavy equipment. The protective clothing worn may be heavy and cumbersome. The work environment may have extreme temperatures, and may involve exposure to hazardous substances, including toxic gases (Keena, 1990).

1.5.2 Injuries Sustained by Firefighters

The injury rate in firefighters is amongst the highest of all occupations (Travell, 1983). Firefighting has been recognised as the most hazardous occupation in North America in terms of occupational death and injury statistics (National Fire Protection Association, 1987).

1.5.3 Firefighting in South Australia

The South Australian Metropolitan Fire Service (SAMFS) is responsible for firefighting in the state-gazetted areas of South Australia. The firefighters may be stationed at headquarters, a metropolitan or a country station. There is a total of approximately 1100 personnel employed by the SAMFS, of whom 1000 are firefighters and 100 are civilian staff. There are 750 shift and 50 day work firefighters in Adelaide, and 200 country auxiliary firefighters. The shift workers are on one of four rotating shift rosters (A, B, C or D). The shift work involves the firefighter working two days on (10 hours each) followed by two nights on (14 hours each) followed by 4 days off. Once a person is allocated to a particular shift he or she generally remains in that same shift for the length of his/her career. The firefighter "on shift" spends time performing training exercises, physical education and firefighting. The actual time a firefighter spends at a firecall or incident is a very small proportion of total work time. The day workers work an eight hour day, five day week and may be in one of the following divisions: management, fire safety, fire training, public relations, or country command.

The recruitment procedure involves a rigorous physical test but once employed no further formal fitness testing is required.

Specific manual handling training is not given to the firefighters. However, safe practices are incorporated into the training drills.

1.5.4 The Cost of SAMFS Manual Handling Injuries

All SAMFS injury claims are handled by the State Government Insurance Commission (SGIC). The SGIC provided the investigator with a breakdown of costs for SAMFS manual handling injuries. The SGIC classification system complies with the Australian Bureau of Statistics (ABS) injury recording requirements and the injuries relating to manual handling are classified by the ABS as overexertion injuries in four categories. These categories do not coincide exactly with the definition of manual handling from the Code of Practice, and not all manual handling injuries result from over-exertion. However they give the best available estimate of manual handling injuries and their costs. For the two year period 1/7/88 to 31/6/90, 255 overexertion injuries were sustained (by both firefighting and non firefighting personnel) resulting in 4596 days lost, with direct costs of $1.2 million.

1.6 THE AIM OF THE STUDY

The broad aim of this study is to test the validity of the Manual Handling Risk Identification Checklist in the Approved Code of Practice as a predictor of manual handling injuries. More specifically, the study seeks to determine whether use of the Checklist could differentiate between manual handling tasks of high and low frequency and severity as determined from the injury statistics, and of high and low risk as determined from the perceptions of the SAMFS firefighters.

This required the following steps: -

1. A review of the injury records to categorise manual handling injuries according to their frequency and severity (the latter determined by the amount of time off work).

2. The development and administration of a questionnaire to firefighters to determine their perception of the risk (high or low) of manual handling injury in the range of duties which their work entails.

3a. The production of a video of a selection of manual handling tasks which firefighters may be required to perform during the course of their duties.

3b. The review of this video by an independent panel of 15 occupational health professionals who used the Checklist to give each selected task a hazard score. The panel members were blinded to the level of risk of each task.

4. Evaluation of the Checklist scores by measuring: -

   the intra-rater reliability and the inter-rater agreement of panellists' Checklist scores, the correlation between Checklist scores and injury statistics, and the correlation between Checklist scores and firefighters' perceptions of hazards.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The aim of this study is to evaluate the method of priority setting in the Manual Handling Code of Practice. The basis of the priority setting is a Risk Identification Checklist of 18 questions. This literature search was undertaken to examine the empirical and theoretical justification, if any, for each of the 18 questions.

2.2 ERGONOMIC CHECKLISTS USED IN INDUSTRY

2.2.1 General Checklists

Ergonomic checklists have been produced for general use in industry by the International Ergonomic Association (Bainbridge and Beishan, 1964), and by the Ergonomics Unit of Worksafe Australia for evaluating ergonomic office equipment (National Occupational Health and Safety Commission, 1991). A checklist based on findings from the American National Institute of Occupational Safety and Health (NIOSH) work on manual handling was prepared in Helsinki for the evaluation of manual handling tasks (Luopajarvi, 1990, page 60). No research critically evaluating any of these checklists was found in the literature reviewed.

2.3 THE MANUAL HANDLING RISK IDENTIFICATION CHECKLIST

2.3.1 General Introduction

There has been little written on the Risk Identification Checklist from the Australian National Manual Handling Code of Practice, or how the Checklist questions were selected.

The Australian National Manual Handling legislation is based on the 1988 Victorian Regulations and Code of Practice (Curran, 1990), however there is no documentation of the evolution of the Risk Identification Checklist. Personal communication with Rawling (1991), who was a member of the Victorian working party which produced the Checklist, revealed that the Checklist was based on the technical information about manual handling available at the time and was tempered with modifications to make it politically acceptable. The Checklist is supposed to be used by health and safety representatives at the workplace to evaluate tasks which have been identified as manual handling hazards, and to re-evaluate tasks once changes have been made.

The Manual Handling Code of Practice and the Risk Identification Checklist within it use an ergonomic or systems approach which is quite different to previous legislation. This involves taking all aspects of the worker, workplace and task into account, rather than just considering one aspect, for example the weight of the object to be handled. Various authors have advocated this type of comprehensive integrated approach to the manual handling problem (Caruso, 1986; Kemp, 1986; Ridd, 1986; Edwards, 1987; Ljungberg et al , 1989). An extensive review of compensable work injuries in America was undertaken by Snook (1978) who concluded that one third of compensable back injuries could be prevented through ergonomic job design. Other authors who have more recently advocated designing out hazards are Westgaard and Aaras (1985), Nelson (1987), and Sims and Graveling (1988).

The main difference between the Risk Identification Checklists in the Victorian Code of Practice (1988) and the National Manual Handling Code of Practice (1991) is that some questions in the Victorian Checklist are specific with regard to distances over which the load is moved, and the frequency with which the task is performed.

The four sections of the Checklist follow and literature relating to the questions within each section will be discussed.

2.3.2 Movements, Posture and Layout during Manual Handling

The first five questions of the Checklist all relate to the working posture assumed whilst undertaking the manual handling task. All of these questions begin with "Is there frequent or prolonged...." , but there is no definition given of either "frequent" or "prolonged". According to the South Australian Occupational Health and Safety

Commission manual handling training directives "frequent" and "prolonged" activities must be assessed in relation to the duration of the manual handling task itself (Training course, 1991).

1. Bending below mid-thigh

Is there frequent or prolonged bending where the hands pass below mid-thigh height?

A review of epidemiological studies was undertaken by Andersson (1981) to determine the workplace factors associated with low back pain. He found that there were six vocational factors associated with absence from work due to low back pain: physically heavy work, static work postures, frequent bending and twisting, lifting and forceful movements, repetitive work, and vibration.

In 1975 Nachemson reported the findings of his investigations into the effects of posture on intra-discal pressure. A specially constructed needle which recorded intra-discal pressure was placed into the nucleus pulposus (central portion) of the third lumbar disc in 50 subjects. Nachemson found forward flexion and forward flexion combined with weight lifting caused large increases in intra-discal pressure, compared to the intra-discal pressure in the normal erect posture. From his findings he suggested that patients with low-back pain should be advised to avoid forward bending where possible. Other investigators concurred that sustained flexion is likely to cause disc pathology (Hickey and Hukins, 1980; Twomey and Taylor, 1982).

In summary, the studies reviewed considered lumbar flexion to be a contributing factor to low back pain, although quantification of the time and the frequency involved was not found in the reference material reviewed.

2. Reaching above the shoulder

Is there frequent or prolonged reaching above the shoulder?

In a retrospective study relating symptoms from work injuries with work postures of

50 workers at the Philips company in Holland, van Wely (1970) reported that sustained postures of the arms reaching upwards led to aching and/or painful arms and shoulders. He recommended that for long duration or frequently used positions it was best for joints to be moved in mid-range.

The following report from Finland supports the findings of van Wely. A practical method for identifying poor postures at work was devised by Karhu et al (1977) in order to improve employee comfort at work. This method, called the Ovako Working Posture Analysing System (OWAS), grades postures according to their discomfort as rated by the worker. The OWAS has a four point rating scale from "normal posture with no discomfort..." with a rating of zero, to "extremely bad posture, short exposure leads to discomfort..." with a rating of four. Postures with both arms above shoulder level were given a rating of three on the OWAS scale.

Chaffin and Andersson (1991, page 388) found that repeated or sustained extended arm reaches created load moments at the shoulder that rapidly caused muscle fatigue, tendonitis and bursitis at the shoulder. Their findings have been supported by other studies. Hawkins and Abrams (1987) stated that the people most at risk for shoulder impingement syndromes are those who use their arms excessively above the horizontal position.

An investigation into shoulder joint muscle activity of ten healthy males during handling of light loads whilst sitting was undertaken by Giroux and Lamontagne (1992). It was found that arm elevation was a significant factor in determining the muscular load on the shoulder joint, and that vertical movements induced greater loads than horizontal movements.

In summary, all of the studies reviewed indicated that the shoulder joint was placed at risk in positions of elevation above shoulder level. However, the frequency of elevation or the duration of sustained positions was not specified in the literature reviewed.

3. Bending - forward reach

Is there frequent or prolonged bending due to extended reach forward ?

This question differs from the Victorian Risk Identification Checklist which more specifically asks, "Is forward reaching (more than 30cm away from the body) involved?" There is no reason given for the choice of 30cm, although it is the midway point between 15cm and 45cm which are the lowest values for horizontal distance in the NIOSH (1981) tables.

A recent literature review was conducted by Rose (1991) who found that, "Lifting close to the body provides the single most significant reduction in lifting stress, due to the reduced leverage effects." Therefore even light loads need to be handled close to the body because as the centre of gravity of the object being handled is moved horizontally away from the body a proportional increase in the compressive force on the low-back is created (NIOSH, 1981).

4. Twisting of the back

Is there frequent or prolonged twisting of the back?

Twisting of the back stresses the integrity of the intervertebral disc and when combined with bending or lifting is likely to result in disc pathology (Hickey and Hukins, 1980). The epidemiological review by Andersson (1981) showed that frequent bending, twisting and lifting were the most common combination of movements leading to low back pain. However, Andersson felt that "The association between low-back symptoms and frequent bending and twisting is difficult to evaluate separately, as lifting is usually also involved".

The effects of torsion on cadaveric discs was investigated by Farfan et al (1970), and their findings showed that experimentally induced torsion injuries were similar to those found in naturally occurring disc degeneration. This led the investigators to postulate that *in vivo* degenerative disc changes were the result of torsional loading.

The Ovako Working Posture Analysis System (Karhu et al, 1977) gave work postures involving combined bending and twisting a score of four, which classifies such working postures as being of maximum discomfort.

Ferguson (1990) in a study of 21 male subjects with no history of low back pain found that task asymmetry involving lifting a weight through more than 120 degrees of rotation involved high stresses in the transverse plane. Ferguson interpreted this to mean that such stresses placed the subjects at high risk of suffering a low back injury.

In summary, twisting is a recognised risk factor for the low back due to potential stresses applied to the intervertebral disc, specific reference to the frequency of twist or the time spent in a twisted position was not found in the literature reviewed.

5. Asymmetrical load

Are awkward postures assumed frequently or over prolonged periods, that is, postures that are not forward facing and upright?

For the purposes of this literature review, asymmetrical postures are considered to be those which are not forward-facing and upright.

Serial *in vitro* and *in vivo* studies of normal non-degenerative discs described by Nachemson (1975) in a review paper of his work found a significant increase in intra-discal pressure in positions involving the asymmetric postures of twisting and lateral flexion of the spine.

Bonney et al (1990) conducted a study on 10 individuals with no past history of low back pain to determine the subjective effects of sustained posture. The subjects maintained various postures of the low back for 10 minutes each. It was found that postures which involved a lateral flexion component were the most uncomfortable.

In a trial involving 27 young males with no history of back pain, Genaidy et al (1990) found it was possible to significantly improve the endurance capacity for symmetrical lifting tasks by functional training, whereas the benefits for asymmetrical tasks were not significant.

Several studies have been conducted on muscle strength in asymmetrical postures. Vink et al (1992) found decreased muscle strength of the back extensors in asymmetrical postures. The lowest forces were found in postures which combined rotation and lateral flexion of the spine. Ferguson et al (1992) found dynamic asymmetrical lifting strength to be less than static lifting strength.

Cook et al (1990) compared the electromyographic (EMG) activity of the lumbar paraspinal muscles in symmetrical two-hand stoop lifts and asymmetrical one-hand assisted lifts. Such activities may be performed in the workplace where an employee is required to bend over the side of a container to get objects from the bottom of the container. The two ways of doing this are: first, to stoop over the container to get the object out with two hands, or secondly, bending over the container to grasp the object with one hand whilst taking body weight on the other hand on the upper edge of the container. Their study sample consisted of 24 young males with no history of back pain. Results showed that there was significantly higher EMG activity recorded in the two-handed lift than in the one-handed lift. The investigators pointed out that the assisted one-handed lift is limited by the weight of the object one can safely grasp with one hand; however they felt that lifting loads of up to 14 kg using this technique could have the potential to reduce low-back injury in industry when lifting objects from the bottom of a container.

To summarise, in the literature reviewed, asymmetrical stresses on the spine and surrounding structures were considered to be risk factors to those structures. However, Cook et al (1990) has given evidence to the contrary and postulated that asymmetrical lifting techniques may be less stressful to spinal structures in some situations. The study by Bonney et al (1990) specified times at which prolonged postures became uncomfortable, but none of the studies reviewed specified at what frequency asymmetrical tasks had detrimental effects.

2.3.3 Task and Object

The questions in this section of the Checklist relate to the manual handling task and to the object which is being handled. The questions pertaining to the task are on: frequency and duration involved, and the distance over which the object is moved. The questions on the object concern: the weight of the object, the push/pull forces involved in moving the object, the object size, shape and stability, and the effectiveness of the grip used to handle the object.

In 1981 a "Work Practices guide for Manual Lifting" was produced by NIOSH. This document reviewed and summarised preceding work which had been undertaken on manual handling. Previous studies covered different aspects of manual handling which were categorised in four general areas: epidemiological studies, biomechanical studies, physiological studies, and psychophysical studies or studies on perceived effort (Chaffin and Andersson, 1991, page 303).

Calculations of a lifting Action Limit (AL) and a Maximum Permissible Limit (MPL) were contained in the NIOSH guide. The AL is considered to be within capacity of 99% of the male population and 75% of the female population. The corresponding figures for the MPL are 25% of the men and 1% of the women. The
AL and the MPL were calculated for smooth two handed symmetric lifting of objects of a moderate width (75cm or less), in unrestricted lifting postures with good couplings (handles, shoes floor surfaces) and favourable ambient environments. Hence, these calculations were for ideal lifting conditions. The lifting task variables taken into account for the calculations included: object weight, distance of object from the body, vertical location of the hands from the floor prior to the lift, vertical distance of lift, frequency of lifting and duration of lifting period.

6. Frequency and Duration of the Task

Is manual handling performed frequently or for long time periods by the employee(s)?

The Victorian Checklist asks more specific questions relating to the time involved for the manual handling activity, "Is handling performed for more than one hour at a time?", and, "Is handling performed more than once every five minutes?"

The NIOSH guide to lifting (1981) distinguished between lifting frequency and the duration of manual handling. Lifting frequency was defined in three categories, and the factors limiting each are given below: -

1. Infrequent - occasional or continuous lifting of less than once per three minutes. The limiting factors are biomechanical and relate to a persons' musculo-skeletal strength.
2. Occasional high frequency - once or more times per three minutes for a period of up to an hour. The primary limitations are psychophysical - stress and fatigue.
3. Continuous high frequency - lifting one or more times per three minutes continuously for eight hours. The primary limitations are physiological and are related to cardio-vascular capacity and metabolic endurance.

Karwowski and Ayoub (1984) reported that the psychophysical (perceived effort) approach may not give a reliable estimate of the maximum acceptable load for high frequency tasks because workers tended to overestimate their capabilities.

In 1975 Kelsey conducted an epidemiological study on low-back pain and found no association between the weight lifted or lift frequency and the frequency of herniated lumbar discs in a population of over 200 subjects.

In summary, the literature reviewed does not isolate frequency or duration as a risk factors or give a clear indication of the length of time spent manual handling which is considered to be hazardous.

7. Distance

Are loads moved or carried over long distances ?

The Victorian Checklist (1988) asks, "Is there a long vertical distance of travel (more than 25 cm)?", but does not ask about the horizontal distance involved, whereas the National Checklist could be interpreted as meaning either vertical or horizontal distance, but no distance is specified. The NIOSH (1981) equation includes vertical distance moved, but does not consider carrying over a horizontal distance.

Genaidy et al (1989) compared the time individuals were able to sustain a manual handling activity in their study, which involved carrying a 20 kg object over a distance of four metres at a frequency of eight times/minute, with the time subjects managed to sustain a manual handling activity in a previous study which involved lifting a 20 kg load from floor to table height at the same frequency. The subjects in the study reported by Genaidy et al had an average endurance time of 90 minutes compared to the study where individuals who were doing the vertical lifting had an average endurance time of 67 minutes. Genaidy et al attributed the difference in the results of the two studies to the type of carrying involved in their study, and postulated that it was in fact less stressful for individuals to carry loads some distance than just to lift them.

To summarise, there was no evidence in the literature reviewed that carrying loads over long distances per se constituted a manual handling risk.

8. Weight

Is the weight of the object:
(a) more than 4.5 kg and handled from a seated position?
(b) more than 16 kg and handled in a working posture other than seated ?
(c) more than 55kg ?

The International Labour Organisation in 1967 proposed that limiting occupational weights to maximal "safe" weights would reduce the musculo-skeletal injuries at the workplace (Thacker, 1983 pp. 1290-2). In Australia legislation restricted the maximum weight lifted by women and young men at the workplace until the Sex Discrimination Act of 1987 invalidated this legislation (Buis, 1990).

Keyserling and Chaffin (1986) stated that from an ergonomic viewpoint "....the concept of a maximum "safe" lift is overly simplistic" as it fails to take into consideration the other factors involved in manual handling, such as work environment.

In the current National Code of Practice (National Occupational Health and Safety Commission, 1990) weight is no longer used as the sole criterion for limiting manual handling injuries, as the previous regulations which controlled weight alone did not appear to be adequately preventing manual handling injuries (Buis, 1990).

The question relating to loads handled in the sitting position is supported by a study conducted by Yates et al (1992) who found from electromyographic (EMG) studies that lifting from the sitting position resulted in greater stress, as measured by EMG activity, in the low back, upper back and shoulders than lifting while standing. They also found that subjects were able to lift less in the sitting than in the standing position. The sitting position has been shown by Nachemson (1975) to produce very high intra-discal pressure, a 100% increase from that in standing, so one would expect that loads handled whilst sitting should be less than those handled in standing.

The question of moving loads of 16 kg or more in the standing position may relate to the study undertaken by Chaffin and Park (1973). They monitored 400 workers for a one year period and related work tasks to low-back symptoms. They found that lifting loads greater than 35lb (16 kg) close to the body with two hands in the sagittal plane was associated with an increased incidence of low-back pain.

From a questionnaire completed by 2667 British men and women aged 20 - 59 years, Walsh et al (1991) found that the reported onset of low-back pain was strongly associated with a history of lifting weights of 25 kg or more at work.

The 55 kg limit was the amount recommended by the International Labour Organisation (1967) as the maximum safe weight limit and Snook (1982) reported that the United Kingdom Health and Safety Commission stated "...very few people can regularly handle weights of this order with safety."

The NIOSH report from 1981 gave action limits and maximum acceptable limits for loads. There was limited guidance available for determining recommended weight limits for multi-task lifting jobs, which is often the type of work involved in industry.

Genaidy et al (1989), in psychophysical endurance tests (described previously on page 19) found that subjects were only able to lift 65% of the load they estimated they could lift for an eight hour day when they did perform for an eight hour day.

To summarise, the literature reviewed showed evidence that in manual handling tasks the weight of the object is a risk factor.

9. Push/pull - large forces.

For pushing, pulling, or other application forces: are large push/pulling forces involved ?

Damlund et al in 1986 conducted a study on 57 Danish semi-skilled construction workers where the work performed was observed for a total of 155 person-hours, and was subsequently analysed and categorised according to the postures and movements involved. They used results from a previous epidemiological study which showed workers in this industry to have high incidence of low-back pain and then tried to quantify the risk factors which may have led to the symptoms. They concluded that lifting and pushing/pulling were the most important factors responsible for low back strain in these workers.

In 1978 Snook wrote a review article on previous manual handling studies he had conducted. In the article he presented summary tables of maximum acceptable forces for pushing and for pulling tasks for males and females, at different task frequencies and heights based on the psychophysical data collected in previous studies. Snook noted that performance differences between the sexes was less for pushing and pulling tasks than for lifting tasks.

Chaffin and Andersson (1991, page 317) reviewed literature on pushing and pulling which indicated that 20% of overexertion injuries have been associated with pushing and pulling, and that the foot-slip potential is very high whilst performing such activities. They suggested the important factors to consider when pushing/pulling are: handle height, whether bracing of feet is undertaken, and the effect of floor friction. They called for further research to be undertaken in this area.

Haselgrave et al (1988) and Daams (1990) drew attention to the different results obtained when testing subjects' push-pull strength in free postures compared with standardised postures. Daams recommended that it is preferable to use results obtained from studies using free-style postures for design purposes.

In summary, various authors have considered the effects of push/pull forces in manual handling and have agreed that these forces constitute a risk factor.

10. Size/Shape

Is the load difficult to handle, for example, due to its size, shape, temperature, instability or unpredictability?

Drury (1980) reviewed literature on the influence of handles on manual handling and suggested that any factors which decrease the predictability of a loads responses to applied forces will contribute to human error, for example a shifting change of gravity where the contents of a container move during manual handling or an offset centre of gravity. The United Kingdom Health and Safety Commission (1991) has also recognised the problem of manual handling loads where the centre of gravity is not in the centre of the object. The Health and Safety Commission recommends that for lifting loads such as a Visual Display Unit the location of the centre of gravity should be marked on the box the object is to be transported in.

Drury (1980) also noted that a container must not be so big that it impedes vision or leg movement.

Parnianpour et al (1987) developed a lifting stress calculator based on a two-dimensional model of static lifting to establish recommendations for the optimum method of lifting given the anthropometry and clinical symptoms of 53 subjects. They found the different postures which can be used to lift an object are limited and are dependent on the physical characteristics of the load. They postulated that this may explain why there is limited success with teaching lifting techniques and greater success with task or workplace redesign because "The physical characteristics of the load are a more significant predictor of joint forces than the lifting technique."

In his article on the NIOSH prevention strategies to reduce musculoskeletal injuries arising from manual handling Nelson (1987) called for laboratory investigations into container design to be undertaken, with comments that the ultimate goal is for container manufacturers to design containers which will reduce musculoskeletal stress for the manual materials handler.

Rose (1991) in a paper discussing the traditional lifting method in terms of physical stress modelling stated that when lifting with the "bend the knees" method "Horizontal distance of the load from the body will be increased by knee interference if objects exceed about 350 x 500 mm (width x length). This factor will increase low back stress significantly." The Victorian Code of Practice (1988) specifically asks the physical dimensions of the load, "Is the object bulky or awkward (more than 75cm in two dimensions)?". These dimensions are larger than those discussed by Rose, but may have been based on the dimensions of the "ideal" object from the NIOSH (1981) guidelines where the object was assumed to be less than 75cm wide.

Ostrom et al (1990) investigated the effects of container shape on the maximum acceptable weight limit of a rigid load. Previous psychophysical lifting capacity studies had been undertaken using boxes although in industry raw materials are often stored in rigid cylinders. A comparison was made between 10 subjects lifting cylinders and boxes at different frequencies through different lift ranges, and it was found that the shape of the container did not influence the subjects lifting capacity.

On balance the studies reviewed suggest that load size and instability may influence the ease of manual handling. Load shape may also influence manual handling (Drury, 1980; and Parnianpour et al, 1987); however this is not always so (Ostrom et al 1990).

11. Grip

Is it difficult or unsafe to get adequate grip of the load ?

Drury in 1980 wrote a comprehensive article reviewing literature available on handles for manual handling. Criteria relating to grip could be grouped into four broad categories:

1. Anthropometric factors - taking into consideration the size of the person's hand.
2. Force/torque production - the ability to control forces and torques accurately.
3. Fatigue minimisation - of local hand muscles, and minimisation of general fatigue (heart rate, blood pressure and oxygen consumption), and subjective preference for handles.
4. Safety performance - reduction in accidents/injuries due to handles and their design features.

Other factors which may influence handling of an object are its texture and whether it has sharp edges (Drury, 1980). A review of literature concerning grip by Chaffin and Andersson (1991, page 424) revealed that some studies showed dexterity and grip to be altered by the wearing of gloves.

Drury and Deeb (1986) investigated the hand position of 30 manual handling workers lifting a box with various handle positions through several different lifting and lowering distances. Their findings showed loads being moved close to the floor were most often gripped with symmetrical hand placement whereas loads being moved on a higher level were gripped with the hands placed asymmetrically.

In summary, the literature reviewed showed that grip is an important aspect of manual handing.

2.3.4 Work Environment

The Checklist questions in this section relate to the physical characteristics of the work environment: work space, temperature, lighting and floor surface. Other environmental factors which Herrin et al (1974) felt may influence manual handling performance were: noise, vibration and seasonal toxic agents, but there are no questions relating to these factors in the Checklist.

Keyserling and Chaffin (1986), when analysing experimental studies performed by early pioneers in ergonomics in the late 1800's and early 1900's, concluded that "..the level of human performance can be positively or negatively affected by relatively small changes in the work environment and work methods.".

In a Norwegian factory improved workplace design was found by Westgaard and Aaras (1985) to result in reduced sick leave due to musculo-skeletal injuries and a reduction in labour turnover.

Training miners to cope with poor working conditions, such as low headroom, poor illumination, and slippery footing which compound the problems associated with manual handling was not effective in reducing their manual handling injuries (Gallagher, 1989). He postulated that alternative strategies were required and made recommendations including the identification of risks and subsequent task analysis.

12. Confined spaces

Is the task performed in a confined space?

Drury (1985) defined three categories of confined spaces related to work performance:

1. Where work cannot be undertaken due to anthropometric limitations, that is where the person cannot physically fit in the space to perform the work.
2. Where the space limits the persons performance.
3. Where increasing the space does not improve the persons performance.

Ridd (1985) conducted a study to determine the effects of spatial constraints when manual handling. He measured the intra-abdominal pressure of 54 male subjects, using radio pressure pills, and found that manual handling with spatial constraints raised the subjects' intra-abdominal pressure resulting in an increased risk of injury associated with the task. He observed that spatial constraints may force the lifter into a stooped position and hence may raise the risk of a manual handling injury.

Sims and Graveling (1988) investigated the effects of restricted headroom on the free-style manual handling tasks of eight mining instructors. The expected rise in intra-abdominal pressure in some of the tasks tested was not found and the authors felt this may have been due to the individual's ability to compensate either by holding the load close to the body and using asymmetrical foot placement or by more attention to lifting technique. A rise in intra-abdominal pressure found in one of the tasks was attributed to the vehicle design, which was different to that used in the other tasks. The vehicles onto which the load was placed in the first two tasks were flat-bottomed whereas the vehicle in the third task had raised sides over which the load had to be lifted.

Drury (1985) also investigated the influence of restricted space on manual handling and found that limited room decreased the operator's ability to vary working method, therefore the operator was not able to rest muscle groups, as would have been done in an unrestricted space, leading to a more rapid deterioration in performance. Drury also found that restricted room required a greater accuracy of object placement which meant more static holding postures were needed by the operator to successfully accomplish the task.

A study was conducted by Mital and Wang (1989) to determine the effects of spatial constraints on the placement of an object at its destination. This may arise in a work situation, for example when packing objects in a warehouse where shelf space is limited. They found that the maximum acceptable weight declined significantly as the clearance between the shelf opening and the object moved, a box, narrowed.

Endurance times were found to be reduced in restricted working postures such as lying on the stomach without elbow support (Lee et al 1990).

To summarise, the studies reviewed indicate that when a task is carried out in a confined space, manual handling performance may be compromised.

13. Lighting

Is the lighting inadequate for safe manual handling ?

The literature reviewed did not reveal any studies investigating the effects of lighting on manual handling performance. A summary of information on lighting from Boyce (1988, page 56) revealed the following :

Most tasks have three components: visual, cognitive and motor. Different tasks have different combinations of these components and it is the visual component which is affected by lighting conditions. The significance of the visual component varies with the nature of the task and the consequences of an error, and the nature of the visual component can be expressed on a number of different dimensions such as size, contrast and colour. Individual visual capacities vary and may show the effects of age or disease

The 1981 NIOSH document stated that for safe manual handling of an object the operator needed adequate vision of the object, the workplace around the object and the floor surface. The type of lighting is important for depth and surface texture perception, and there needs to be sufficient visual contrast for safe operation (Pages 109/150). A luminance of 150 lux was recommended for manual handling tasks.

To summarise, no specific studies were found in the literature reviewed which investigated the effects of lighting on manual handling performance. However it would seem from the literature on lighting that inadequate lighting may adversely affect manual handling.

14. Climate

Is the climate particularly hot or cold ?

The 1981 NIOSH (page 110) document discussed the relationship of working temperature stating that the work accident rate increased as the temperature deviated from the comfort zone. Hot environments were generally regarded as worse from a manual handling injury point of view (with overexertion etc). The problem of reduced dexterity in the cold was recognised, although workers may tend to wear personal protective equipment and therefore be safer.

Snook (1978) investigated the effects of heat stress on the manual handling performance of unacclimatized subjects and found that their workload was reduced by 20% for lifting, by 16% for pushing, and by 11% for carrying. (cited previous study by Snook and Ciriello 1974) at 27°C Wet Bulb Globe Temperature (WBGT). (WGBT is an integrated index of radiant temperature, humidity, and air movement).

Ramsey et al (1983) reported that a minimum of unsafe behaviour indices occurred in the preferred temperature zone of 17°C to 23°C and that there was a significant increase in unsafe behaviour as the ambient temperature varied from the comfort zone.

The psychophysical effects of lifting in a hot environment were tested on 6 acclimatized subjects by Hafez and Ayoub (1985) in a laboratory experiment, where subjects lifted from floor to knuckle height at three different temperatures (22°C, 27° C and 32°C WBGT) and at three different frequencies of lift (0.1, 3, and 6 lifts per minute) The subjects were allowed to adjust the weight so they could comfortably perform the task. They found that temperature as well as frequency of lift had a significant effect on the weight selected, but that frequency of lift had a greater effect on all dependent variables than did environmental temperature. They therefore concluded that efforts should be directed at reducing the energy required to perform the manual handling task prior to changing the environmental conditions.

In summary, the literature reviewed indicates that manual handling may be adversely affected by working temperatures which are away from the comfort zone.

15. Floor surface

Are the floor working surfaces cluttered, uneven, slippery or otherwise unsafe ?

The largest single category of industrial accidents in the United Kingdom is "falling accidents", and a major proportion of these are due to slipping. There may be a large degree of under-reporting of such accidents because if for example a person "slips and falls onto a hot stove" the accident is classified as a burn rather than a slip (Kime, 1991).

Similarly in Australia 20% of compensable accidents in New South Wales from 1982 to 1985 were due to falls on the same level (Stevenson et al, 1989 cited Australian Bureau of Statistics 1987).

Factors involved in slipping accidents are: surface roughness, friction, the presence of a lubricant and body movement. Slip resistance is related to the dynamic coefficient of friction, step length, surface roughness and time (Kime, 1991).

Chaffin and Andersson (1991, page 214) noted that studies have shown that the dynamic coefficient of friction may vary considerably from the static coefficient of friction with certain combinations of floor material, shoe material and surface conditions.

Stevenson et al (1989) stressed the importance of good housekeeping in relation to maintaining a safe work floor because a work shoe cannot always provide adequate protection against slippery contaminants (such as oil or detergent) even if the floor is particularly slip resistant.

The importance of a safe floor working surface in the prevention of slipping injuries has been shown in the literature reviewed.

2.3.5 Individual Factors

Andersson (1981) in his paper on the epidemiological aspects of low back pain in industry listed the individual factors to take into consideration as: age and sex, anthropometry, posture, muscle strength and physical fitness, spine mobility, psychological factors and psychiatric problems, social factors, and radiological factors. Additional individual factors from NIOSH (1981) included individual lift technique and training.

16. Return to work/new employee

Is the employee new to work or returning from an extended period away from work?

Snook in 1988 stated that some jobs which are difficult to design and control, for example firefighting, required greater dependence on pre-employment screening than jobs such as those in the manufacturing industry. Generally, however, ergonomic intervention leading to safe work systems is preferable to pre-employment screening (Stubbs et al 1983; Caruso, 1986). In some countries pre-employment screening is not permitted by the unions (Bullock, 1990, page 7).

Gledhill and Jamnik (in press) have recently conducted research on firefighter recruit physical tests and stated that it is "...imperative that fitness screening protocols for firefighter applicants embody the specific physical requirements encountered whilst fighting fires.." thus incorporating the effects of firefighting equipment into their pre-employment fitness test.

Genaidy et al (1989) tested whether the manual handling endurance of 11 untrained young male subjects could be improved with a training course. The subjects were tested carrying a 20 kg load from conveyor A to conveyor B, a distance of 4 metres, 8 times per minute. Results showed that the psychophysical endurance of subjects could be increased by almost 100% (from 45 to 90 minutes) in the eight training sessions over a two and a half week period. The authors attributed the improvement in performance to both improved endurance and improved carrying technique.

Post-injury there may be a physical limitation to prevent the employee from returning to work, however, if a simple modification could be made to the work or work-site, return to work may be accomplished without compromising the worker's physical safety (Isernhagen, 1990, page 284).

In summary, pre-employment screening, training and fitness are all factors which the literature reviewed indicates may influence manual handling task performance.

17. Personal characteristics

Are there any temporary or permanent personal characteristics that may affect task performance ?

Herrin et al (1974) listed the major components affecting manual handling, including eight categories of worker characteristics, these were:-physical characteristics for example age, sex, anthropometry; sensory characteristics such as visual, tactile and proprioceptive capabilities; motor characteristics such as strength, endurance and range of motion; psychomotor characteristics such as reaction time and coordination;

personality traits including job satisfaction, risk acceptance; level of training and experience; health status including past medical history; and leisure time activities including physical activities or holding a second job.

Many manual handling injuries are of a recurrent nature (United Kingdom Health and Safety Commission, 1991), so a pre-existing injury may influence a person's task performance.

In summary, there are many factors of both a temporary and a permanent nature which may affect manual handling performance.

18. Protective clothing

Does the employee's clothing or personal protective equipment interfere with manual handling performance?

Wearing of personal protective equipment is a form of manual handling (Manual Handling Code of Practice, 1990). The protective clothing routinely worn by firefighters is both bulky and heavy (Keena, 1991).

Research into the design of firefighter turnout coats has been undertaken by Huck (1991) with regard to range of upper limb movement. Huck found in the 9 subjects tested that there was a subjective difference between ease of movement when wearing the two different garments tested, and there was more elbow movement in the prototype turnout coat than in the traditionally worn turnout coat. Huck also found that the use of breathing apparatus was extremely restrictive to mobility and made the ensemble less acceptable to wearers (who were university students and not firefighters). Huck concluded that a firefighter's mobility on the fireground may be severely restricted by his turnout gear and that this may actually contribute to certain types of injuries. He recommended that modifications to improve the design of the breathing apparatus and to reduce its weight were needed.

Marr (1990) reported results of a study on firefighters' boots. Firefighters were filmed performing various duties when wearing boots with steel caps and boots without. The report concluded that the steel capped boot restricted the firefighters' range of movement at the great toe joint in activities such as walking, crouching and climbing and that the necessity for wearing steel-capped boots should be reviewed.

In summary, personal protective clothing may reduce a person's active range of movement and may not be comfortable to wear during manual handling activities, as studies in the firefighting industry have shown.

CHAPTER THREE

METHODS

3.1 GENERAL INTRODUCTION

This chapter outlines the methods used to: -

1. collect and classify SAMFS manual handling injury statistics,
2. develop and administer a questionnaire to ascertain manual handling hazards perceived by SAMFS firefighters,
3. produce a video of selected manual handling tasks to be viewed by a panel who scored the tasks using the Checklist from the Code of Practice,
4. assess the performance of the Checklist in terms of intra-rater reliability and inter-rater agreement, and compare Risk Identification Checklist scores for selected tasks with SAMFS injury statistics and firefighter perceptions of those tasks.

3.2 COLLECTION AND CLASSIFICATION OF SAMFS INJURY STATISTICS

3.2.1 Introduction

The Code of Practice requires that injury reports should be examined in order to identify manual handling hazards which have occurred in the workplace. To identify the most frequent and the most severe SAMFS manual handling injuries the SAMFS injury report forms were reviewed.

3.2.2 Ethical Considerations

Clearance for access to employees' injury records was obtained from the Chief Officer of the SAMFS and also the United Firefighters Union Secretary (SA Branch) at meetings with the investigator organised by the SAMFS Occupational Health and Safety Officer (Appendix B).

3.2.3 Collection of Incident Reports at SAMFS

All employees of the SAMFS are actively encouraged to complete incident report forms if they injure themselves at work or are placed in a situation where their health may be affected. For example, if a firefighter attends a call where a victim is either an AIDS or hepatitis B carrier, (whether or not the firefighter has actually been in contact with that person), an injury report form is completed so that documentation is available if required at a later date. Hence injury report forms are completed for all reported incidents irrespective of whether they result in workers compensation claims.

The incident report form is the standard "Workcover Notice of Disability Form" used by employers throughout the state of South Australia. This form is kept at all stations and is usually completed by the injured firefighter or if he/she is unable to do so, the senior officer or a witness (Appendix C). The incident report forms are all filed by the Leave Records Clerk and in addition some of the information is recorded on the SAMFS computer.

3.2.4 Method of Examining SAMFS Injury Reports

The Fire Service injury records were studied to establish the frequency and severity of reported manual handling incidents. All reported injuries are recorded, regardless of whether compensation is claimed, and the records are filed in the order in which the completed forms arrive at the Leave Records Clerk's desk (as distinct from chronological order).

Investigation of the injury reports was done manually for several reasons: firstly, to ensure that injuries classified as manual handling complied with the definition of manual handling from the Code of Practice, and secondly to acquire a complete picture of what the incident reported involved, as the SAMFS computerised data did not give all the information required for this study.

In addition the review of the actual report forms rather than the computerised information was necessary because: firstly, records have only been computerised since 1988; secondly, the records from the computer are archived six monthly and practice has shown that it is easier to access these records manually; and thirdly, injury data have not been entered on the computer since February 1990 (this ceased in view of the pending legislation which will revise the requirements for recording work injuries).

3.2.5 Information Sought from the Records

The initial review of the records differentiated the manual handling injuries from the non-manual handling ones. It was established whether the injury scenario described in the report complied with the definition of manual handling from the Code of Practice (see 1.1.2). Further examination of the non-manual handling injuries was not required.

From reports which were classified as manual handling incidents the following information was sought: -

- The injury report number - in order to identify records.
- The pay number - in order to easily identify the injured person, in case it was necessary to contact them for further information about the incident reported. (This was necessary where the records were incomplete or needed further clarification.)
- The body area injured or involved - classification of injuries was made according to the Australian "Workplace Injury and Disease Recording Standard" (AS 1885.1 - 1990), so that future investigations will be able to incorporate the findings of this study if required.
- The work area where the incident occurred - station, fireground, training area, or travel to or from work.
- The incident scenario - that is the equipment involved and the activity related to it, for example, ladder (equipment) and lifting or ascending or carrying (activity).
- The shift worked by the firefighter - only firefighters were included in this study.
- Workers compensation - whether or not compensation was claimed for the

injury.

- Time off work - this was used as the criterion for determining the severity of injuries.

3.2.6 Exclusion Criteria

Reported incidents which were excluded from this study were those which involved:-

- Non manual handling incidents.
- Recurrent injuries. The new Australian recording standard (AS1885.1) recommends that, "Cases of recurring injury or disease should be recorded and cross-referenced to the original record but not counted as a separate occurrence unless there was a separate identifiable incident associated with the recurrence." The new standard was released after this study had started, by which time the investigator had decided to exclude recurrences. Recurrent injuries were determined from the information sought from the records (3.2.5).
- Injuries sustained by non-firefighting personnel.
- Incidents where the firefighter concerned could not be contacted to clarify the injury reported.
- Incidents where the firefighter could not recall the incident when contacted.

Where the injury report was unclear for whatever reason, as it was in 146 cases, the firefighter involved was notified in writing (Appendix D) prior to contact by telephone to clarify the incident reported. Successful telephone contact was made with firefighters concerning 126 of the incidents. Of these, 21 incidents could not be included, five being recurrences, seven due to lack of recall and nine as they were not manual handling incidents. In the 20 remaining cases which could not be included the firefighter could not be contacted for various reasons, for example because the firefighter was on leave or had retired from firefighting.

3.2.7 Frequency of Manual Handling Injuries

Reported incidents from the financial years 1988/89 and 1989/90 were studied to establish the frequency of manual handling injuries during that time. This involved the review of 899 records for that period. The manual handling injuries were classified for analysis by characteristics such as work area, body area and equipment involved.

Tasks were classified according to the firefighting activity that was being undertaken at the time of injury, for example donning breathing apparatus or getting in/out of a fire appliance (vehicle).

Frequency of manual handling injuries was determined by counting the number of injuries which occurred when the firefighters were undertaking a particular task.

3.2.8 Severity of Manual Handling Injuries

To analyse manual handling injuries according to severity, injury reports from each year over a four year period were examined. The four year time span was chosen to give a broad representation of the injuries sustained. Hence the review of additional incident reports from 1987 and the second half of 1990 was required (a further 605 records). This involved going through the Leave Record Clerk's books and ranking the injuries by their severity, that is by the number of hours of work lost. The original records were then checked to establish whether the injury was a manual handling one or not. These injuries were recorded using the same method as all the other manual handling injuries, so that both their frequency and severity could be determined.

3.3 QUESTIONNAIRE ON HAZARDS AS PERCEIVED BY FIREFIGHTERS

3.3.1 Purpose of the Questionnaire

The Code of Practice recommends that employees be actively involved in the risk identification of manual handling hazards encountered during their job. The involvement of workers in the identification and control of hazards is consistent with the philosophy underlying most Occupational Health and Safety legislation current in Australia.

The purpose of using a questionnaire was to establish the perceived manual handling hazards at the workplace. This was done for two reasons: firstly to compare the injury risk of various tasks measured from the injury statistics with the risk as perceived by firefighters, and secondly to identify tasks as high/low risk for possible inclusion in the range of tasks for the video. The video of selected manual handling tasks was to be shown to a panel of occupational health professionals who would assess the manual handling tasks using the Risk Identification Checklist.

3.3.2 Design of the Questionnaire

To canvass employees' views on the manual handling hazards which exist in the workplace a formal questionnaire was designed. The questionnaire was adapted from the National Skills Audit for Firefighters (Eglinton, 1991). This Skills Audit was conducted following the Australian Federal Government initiatives of workplace reform (National Training Board, 1991), and was undertaken as a joint venture conducted by the United Firefighters Union of Australia and the Australian Assembly of Fire Authorities.

The Skills Audit is a comprehensive list of all the tasks which firefighters may encounter during the course of their duties. In order to adapt the lengthy Skills Audit and transform it into a questionnaire, any non-manual handling tasks had to be eliminated. To do this, meetings were convened with the Station Officers concerned with Occupational Health and Safety and the Skills Audit. At these meetings, each task listed on the Skills Audit was discussed to see whether it complied with the definition of manual handling from the Code of Practice and should thus be included. As expected, nearly all of the tasks on the Skills Audit did involve some form of manual handling. Thus few tasks were omitted, and the questionnaire remained lengthy.

The questionnaire was designed to be self administered. The first page defined manual handling, and described the risk categories to be used when completing the questionnaire. The subsequent pages were each made up of 17 different duties, each duty then having a varying number of tasks associated with it (Appendix E). The person completing the questionnaire was asked to give each task a manual handling hazard risk score from 0, or no perceived risk, to 4, or maximum risk. The firefighters were asked "...to what extent are you at risk of getting hurt " when undertaking the manual handling activity, and were not asked to differentiate between the perceived risk of injury frequency and the perceived severity of injury associated with the tasks on the questionnaire.

Each duty was on a separate page so that the pages could be collated using a table of random numbers, thus removing any bias due to the order of the duties. No attempt was made to arrange the tasks randomly within each duty as the scoring was performed manually and it was considered that this could lead to confusion and errors with data entry.

3.3.3 Pilot Study of the Preliminary Questionnaire

The preliminary questionnaire was piloted on 20 firefighters from both the day and the shift rosters. These firefighters were rostered at headquarters and suburban stations, and were from: the Occupational Health and Safety Committee, State Council of the United Firefighters Union, and from the Training Division. Comments regarding format and content of the pilot questionnaire were taken into consideration and some changes were made to the final questionnaire.

3.3.4 Distribution of the Questionnaire

The questionnaire was given to 135 firefighters at the Metropolitan Fire Service and 125 of these were completed. A sample of firefighters from all shifts (A, B, C and D shifts) completed the questionnaire at their morning meeting - "The nine o'clock news". These shifts were chosen in order of their roster once a starting date was decided upon, the aim being to get a representative sample from each shift. In order to get a sample of firefighters who were not based at headquarters, several groups from outlying stations were also asked to complete the questionnaire whilst undergoing training courses. In addition, a sample of firefighters from each of the four shifts at a large suburban station completed the questionnaire.

For logistic reasons, no attempt was made to include firefighters from the country. The questionnaires completed at the large suburban station were answered at the time of an industrial dispute. For this reason it was necessary to get verbal permission from the United Firefighters Union to allow the firefighters to fill out the questionnaires at the scheduled time.

Thus the firefighters who completed the questionnaires in this study can be considered to be broadly representative of metropolitan firefighters from the SAMFS.

3.3.5 Collation of Questionnaire Results

Data entry and collation of the results were undertaken and the mean score for each task was calculated. From these scores firefighters' perceptions of the 30 most hazardous tasks and the 30 least hazardous tasks were established.

3.4 EVALUATION OF RISK OF INJURY BY EXPERT PANEL USING THE RISK IDENTIFICATION CHECKLIST.

3.4.1 Production of a Video of Manual Handling Tasks

A selection of manual handling tasks was recorded on a video camera. Practical difficulties which needed to be overcome in this phase of the study were organising the fire crews to undertake the drill to be filmed (interrupted by fire calls), and organising a person to do the filming.

The investigator edited the video and placed the tasks filmed in a random sequence (using a table of random numbers) on a master tape. This was considered necessary to eliminate any bias which may have unintentionally been caused by the investigator.

The video of the manual handling tasks was shown to a panel of occupational health professionals who used the Risk Identification Checklist from the Manual Handling Code of Practice to assess each task.

All those who saw the video tape saw the tasks in the same order and independently completed the Checklist.

3.4.2 The Tasks Selected for the Video

Twenty three tasks were videoed. All of these tasks may be performed at the station during a drill. The tasks chosen for the video were selected to include:-

1. Some of the lowest scoring and some of the highest scoring tasks (from the 30 least and the 30 most hazardous tasks) that the firefighters identified from the questionnaire.
2. Some tasks where injuries occurred with a high, a medium and a low frequency, as established from the injury records. High frequency injury tasks were defined as activities where most of the injuries occurred (Table 4.1). Low frequency injury tasks were defined as activities which had resulted in few or no injuries. The remaining tasks were classified as medium frequency tasks.
3. Some tasks which had resulted in the most severe injuries (that is resulting in the most lost time) and some which had not.

All of the tasks with the exception of two were video-recorded at the station during drill time. Firefighters undertake drill on a daily basis unless interrupted by a firecall. Drills are scheduled to occupy approximately two hours per day.

3.4.3 Limitations of the Video

Filming was undertaken at drill time for the following reasons: -

- Prior to filming the tasks it was known from the injury reports that approximately one-half of the manual handling incidents occurred at the fireground (Table 4.7). However, time constraints made it impracticable to video manual handling tasks at actual firecalls.
- Clearance to attend firecalls to film tasks was discussed with the Occupational Health and Safety officer who said SAMFS management would be unlikely to grant permission for this. There were also obvious logistic difficulties that would have been encountered in obtaining film footage at the fireground - for example, trying to film sequences at an incident where smoke limited visibility.
- Television footage of firecalls from the SAMFS library proved to be unsuitable for the video as often the film segment did not show the firefighter's whole body, which was necessary for the task analysis (Checklist). Other television footage was available from the television networks but was not viewed as it was only available at a price that was not within budget limits. The television footage viewed suggested that appropriate film from a firecall would have been useful, as the method of carrying out tasks in a training exercise may differ from the way that task is performed on the fireground.
- All fireground incidents will have different scenarios; for example night versus day or terrain variations. By filming most of the tasks at headquarters the environment was controlled to a certain extent. Hence the Checklist questions pertaining to environment were not applicable in some instances.

- Firefighting takes up a very small percentage of firefighters' time compared with training exercises (drills) which are performed daily for approximately 2 hours (this time can be interrupted by fire calls).

3.4.4 The Review Panel

A panel of 15 people, comprising physiotherapists, occupational therapists, university occupational health lecturers, post-graduate students and manual handling trainers assessed the tasks on the video and scored each one using the Risk Identification Checklist from the Manual Handling Code of Practice. Panel members were blinded as to the injury frequency, injury severity and firefighter hazard rating of the tasks viewed on the video.

For each task the panel members decided whether there were hazardous aspects of the task by answering "Yes" or "No" to each of the 18 Checklist questions. The number of "Yes" answers was taken as the individual panellist's score for that task. Thus, a hazard score for each task was calculated from each panel members' score sheets (Appendix F).

3.5 EVALUATION OF THE CHECKLIST

The performance of the Checklist as used in this study was assessed in four ways:- intra-rater reliability, inter-rater agreement, Checklist score correlation with the SAMFS injury statistics, and Checklist score correlation with the firefighters' perception of risk.

3.5.1 The Intra-rater Reliability

The intra-rater reliability of three panel members was evaluated. These panel members saw all of the tasks and completed the Checklist on two occasions, approximately six months apart (the maximum time recommended for test/re-test (Anastasi, 1988)). For each task, each panellist's Checklist scores for the two viewings were compared. Spearman's correlation coefficients were obtained to measure each panel member's ability to rank the tasks in the same order on both occasions.

The differences in individual panel members' scores given to each task on view one and view two were examined to determine whether there was overall agreement between the two scores on each occasion (that is, whether the median difference in the scores was zero). The Wilcoxon signed rank test was used for this analysis.

The individual responses to Checklist questions were examined to determine whether the panel members answered individual questions in the same manner for the same task on each view. Kappa statistics were used to measure the degree of agreement, corrected for chance, between individual Checklist answers (that is, "Yes"/"No" answers) on the two views (Fleiss, 1981).

3.5.2 Inter-rater Agreement

The inter-rater agreement of the panel was assessed as follows. Firstly, the minimum, maximum and median score given by the panel members for each task were determined to show the range of variation between panel members. Secondly, Friedman's non-parametric two-way analysis of variance was used to test the hypothesis that there was no difference between the panellists overall ranking of the tasks.

3.5.3 Checklist Validity

It is proposed in the Code of Practice that the Checklist scores be used to determine which tasks are most hazardous and will thus be given priority for risk minimisation. It is therefore reasonable to expect that Checklist scores for tasks should correlate with the frequency of injuries associated with performing those tasks and that the Checklist scores should be able to discriminate tasks which are associated with severe injuries from those associated with non-severe injuries.

The rank correlation between the median of the panellists' scores on the Checklist and the frequency of injury from the review of injury statistics was calculated using the Spearman non-parametric correlation coefficient.

The Mann Whitney test was used to test for a difference in the median Checklist scores between the group of injuries classed as "severe" and the group classed as "non-severe".

The correlation between the mean firefighters' perception of hazard and the injury frequency and the injury severity was calculated using Spearman's correlation coefficient. In addition the correlation between the firefighters' mean hazard perception and the Checklist scores was calculated.

CHAPTER FOUR

SAMFS MANUAL HANDLING INJURY STATISTICS

4.1 GENERAL INTRODUCTION

The SAMFS injury records were reviewed to determine the frequency and severity of manual handling injuries sustained by SAMFS firefighters. A selection of tasks of varying frequency and severity were subsequently chosen to be filmed for the manual handling video. These tasks were later seen by a panel of occupational health professionals who used the Risk Identification Checklist to give each task a hazard score.

Classification of the injury records was initially made according to the firefighting activity or equipment involved at the time of injury. The categories of the most frequently occurring causes of injury were then classified further according to the activity involved at the time of injury.

4.2 TASK IDENTIFICATION ACCORDING TO INJURY FREQUENCY

4.2.1 Introduction

Over the two year period from 1st July 1988 to 30th June 1990, a total of 899 incidents and injuries were reported by SAMFS personnel. These reports were examined to determine the frequency with which manual handling injuries occurred during that period. From the reports reviewed, 360 manual handling injuries were found which could be included in this study. (That is, where the injury was by definition a manual handling injury sustained by a firefighter and was not a recurrence. Most of the remaining injuries were sport- related, sport being part of the firefighters' routine daily activities.)

4.2.2 Description of the Manual Handling Injury

Classification of manual handling injuries was made according to the equipment involved at the time of injury. Initially this classification was made in broad categories (Table 4.1). A further, more detailed breakdown of the most frequent categories was subsequently made (Tables 4.2 to 4.5).

Equipment/Activity Involved	Freq	%*
Appliances (vehicles)	66	18.3%
Breathing apparatus	37	10.3%
Hand held equipment	29	8.1%
Station fixtures	29	8.1%
Exposure to body fluid	25	6.9%
Ladders	16	4.4%
Hoses	15	4.2%
Protective clothing	15	4.2%
Gym	14	3.9%
Slip fall or trip	13	3.6%
Dummy/person/animal	10	2.8%
Other vehicles (not appliance)	10	2.8%
Drums	9	2.5%
Forced entry or venting	9	2.5%
Combination	7	1.7%
Terrain	3	0.8%
No equipment involved	2	0.6%
Rescue rope	2	0.6%
Temperature reading	2	0.6%
Sprinkler block	1	0.3%
Other	34	9.4%
Total	360	100.0%

Legend
%* - percentage rounded to nearest decimal place

Table 4.1 Broad classification of equipment involved in manual handling incidents.

The most frequently occurring manual handling incidents involved equipment used very frequently by firefighters, namely the fire appliance and breathing apparatus (B. A.).

To establish a more detailed breakdown of those tasks the firefighters were performing at the time of injury, a further analysis of the most frequent causes of injury was conducted with the fire appliance, breathing apparatus, hand held equipment and station equipment as shown in the following tables.

4.2.3 The Fire Appliance

Table 4.2 shows the number of manual handling injuries sustained during activities involving the fire appliance, and the activity the firefighter was undertaking at the time of injury.

Appliances (18.3%)	Freq	%*
Getting in/out	41	62.1%
Locker doors	9	13.6%
Check gear	1	1.5%
Getting in/out of snorkel	1	1.5%
Into appliance, tally tag in appliance	1	1.5%
Other	13	19.7%
Total	66	100.0%

Legend
%* - percentage rounded to nearest decimal place

Table 4.2 Frequency of manual handling injuries involving appliances.

There were 41 incidents identified where the firefighter sustained injuries when getting into or out of the appliance. Firefighters usually get in and out of the appliance in a standard manner, that is by coming down the steps whilst facing the vehicle cabin (that is, backwards). However, at a fire call the firefighter must get out quickly and therefore the individual may jump out facing forwards. The fire appliances which are built on a standard chassis have a cabin floor height of approximately 1 metre from the ground.

Nine injuries were sustained when firefighters opened or closed appliance locker doors. The appliance lockers contain the small firefighting equipment needed at fire calls (for example, breathing apparatus). The relative ease with which the appliance doors open and close on all the vehicles varies, hence it is difficult for the firefighter to anticipate how much effort is required. The locker doors may roll up and down too quickly or be stiff and require a good deal of force to manoeuvre.

The locker doors on one appliance (the International) have a rear ledge which is about 0.3 metre deep at a height of 0.5 metre off the ground (about knee height) which has to be leant over to reach the locker door handle. This arrangement is a hazard for all operators even before they start to move the locker door.

4.2.4 Breathing Apparatus

Table 4.3 gives a specific breakdown of injuries sustained whilst firefighters were using the breathing apparatus (B. A.).

Breathing apparatus (10.3%)	Freq	%*
Wearing	14	37.8%
Donning or removal	12	32.4%
Airline - demand valve exploded	2	5.4%
Tunnel	1	2.7%
Other (e.g. lifting)	8	21.6%
Total	37	100.0%

Legend
%* - percentage rounded to nearest decimal place

Table 4.3 Frequency of manual handling injuries involving breathing apparatus.

Fourteen injuries were sustained by firefighters when wearing the self contained breathing apparatus (B. A.). The B. A. which weighs 16kg. may be worn in any of the situations in which the firefighter has to work. The firefighters work postures vary depending on the worksite, and for this reason training is undertaken to include work in confined spaces (for example, the B. A. tunnel). The working time of the B. A. is 35 minutes with an additional 10 minutes available to exit the fire scene. The actual time spent wearing the B. A. may be longer than this as it is often worn without the face mask in situ, but with the cylinders still on.

Twelve injuries occurred when firefighters were donning their breathing apparatus.

Donning the B. A. is performed in a routine manner from either the ground or a bracket which is mounted on the appliance or a wall (for example, in the training area). When an air set is put on from the ground, the method involves picking it up and swinging it over one's shoulder to get it into position on the back and then bending forward slightly from the waist whilst doing up the belt and performing various checks. The helmet must also be placed somewhere during this procedure (usually on the ground) and replaced once the B. A. is on and ready for use. The donning method in each case is initially quite different, until the airset is actually on the firefighter's back.

4.2.5 Hand Held Equipment

The different items of hand held equipment most commonly involved in manual handling incidents were identified (Table 4.4).

The hand held equipment most frequently involved in injury scenarios was the Hurst spreader, a cumbersome piece of equipment used in motor vehicle rescues as are the Holmatro spreaders (the weight range of these units is from 15kg. to 32 kg.).

The sledge hammer and hammer are used in situations requiring some force: for example, they may be used when removing plate covers prior to shipping the standpipe (activity and equipment used to access water from underground mains supply).

The Angus Turbex generator is a portable high expansion foam generator which is a large awkward piece of equipment weighing 55kg. It requires two people to manoeuvre or carry it.

The Honda generator is a small portable generator which is kept in the appliance locker. It is used to provide power for lighting at incidents when required.

Hand held equipment (8.9%)	Freq	%*
Hurst spreader◆	4	13.8%
Sledge hammer	4	13.8%
Foam generator(Angus Turbex)	2	6.9%
Hammer	2	6.9%
Holmatro spreaders◆	2	6.9%
Honda generator	2	6.9%
Plug testing (unspecified)	2	6.9%
Crowbar◆	1	3.4%
Disc cutter◆	1	3.4%
Flow meter	1	3.4%
Hydraulic rams◆	1	3.4%
Lathe	1	3.4%
Leak stop putty	1	3.4%
Oxy equipment◆	1	3.4%
Plate cover lifter*	1	3.4%
Standpipe*	1	3.4%
Turncock key*	1	3.4%
Weda pump	1	3.4%
Total	29	100.0%

Legend
%* - percentage rounded to nearest decimal place
* - Equipment used in shipping a standpipe
◆ - Equipment used in vehicle accident rescue

Table 4.4 Frequency of manual handling injuries involving hand held equipment.

4.2.6 Station Fixtures

The station fixture most frequently involved in injuries was the station pole (Table 4.5). The only fire stations with station poles are headquarters and two suburban stations.

The station pole is used by firefighters to get from upper levels of the fire station to the appliance bay (where the fire appliances are parked) as quickly as possible (rather than running down stairs). The floor at the bottom of the pole is padded to soften the landing. The pole itself is metal and anecdotal reports from firefighters are that if the pole is wet the speed of descent cannot be controlled in the usual manner and therefore injuries are more likely to occur.

Station fixtures (8.1%)	Freq	%*
Station pole	12	41.4%
Engine room door	4	13.8%
Mess	4	13.8%
Gardening	2	6.9%
Office equipment	2	6.9%
Gate	1	3.4%
Up/down stairs	1	3.4%
Other	3	10.3%
Total	29	100.0%

Legend
%* - percentage rounded to nearest decimal place

Table 4.5 Frequency of manual handling injuries involving station fixtures.

4.3 TASK IDENTIFICATION ACCORDING TO INJURY SEVERITY

4.3.1 Introduction

Injury records from the four year period of January 1987 to December 1990 were examined to determine the ten most severe manual handling injuries that occurred in each of those years. The most severe manual handling injuries were those where the most time off work was incurred. The four year time frame was chosen for this part of the study so that the severe injury records analysed covered a broader spectrum of injuries than the two year period used to establish the manual handling injury frequency. It was anticipated that these data would give a more representative picture of severe manual handling injuries sustained by firefighters.

One record was deleted because it was found to be a recurrence. Thus the total number of severe injuries was reduced from 40 to 39.

4.3.2 Equipment Involved in Severe Manual Handling Injuries

The equipment involved in the severe manual handling incidents was identified

(Table 4.6). It was found that as with the most frequent injuries, the most frequently occurring severe injuries were sustained when firefighters were working with appliances, breathing apparatus or station fixtures.

Of the nine incidents involving appliances, seven were caused by getting in/out of the appliance. All of the incidents involving breathing apparatus occurred when the firefighter concerned was wearing it. Two of the injuries attributed to station fixtures involved the station pole.

Equipment	Freq	%*
Appliances (Vehicles)	9	23.1%
Breathing Apparatus	4	10.3%
Station fixtures	4	10.3%
Hose	3	7.7%
Combination *	2	5.1%
Dummy/person/animal	2	5.1%
Hand held equipment	2	5.1%
Forced entry or venting	1	2.6%
Ladders	1	2.6%
Lifting	1	2.6%
Protective clothing	1	2.6%
Rescue rope	1	2.6%
Terrain	1	2.6%
Other	7	17.9%
Total	39	100.0%

<u>Legend:</u>
%* - percentage rounded to nearest decimal place
Combination * - several types of equipment involved (for example, hose and ladder).

Table 4.6 Firefighting equipment involved in the 10 most severe manual handling injuries from each of the years 1988 - 1991.

The category "exposure to body fluid" which featured in the frequent injuries (Table 4.1), did not appear in the severe injuries, because as was mentioned earlier, most of these were notification only and did not involve any lost time.

4.4 THE WORK AREA INVOLVED WHEN MANUAL HANDLING INJURIES WERE SUSTAINED

4.4.1 Introduction

Filming was restricted to the station and training drills, and no manual handling videos were filmed at the fireground. Therefore the work location where manual handling injuries occurred was analysed to determine what proportion of work injuries occurred at the fireground, the station and in training. In America the National Fire Protection Society Fire Analysis and Research Division reports indicate that the fireground is where most injuries to firefighters occur (Karter and Leblanc, 1989). The work location was analysed for all manual handling injuries, and the following tables show the work location of injuries selected on the basis of task frequency (Table 4.7) and on the basis of task severity (Table 4.8).

4.4.2 Work Location of Manual Handling Injuries Selected on the Basis of Task Frequency

Work area	Freq	%*
Fireground	154	42.8%
Station	119	33.1%
Training	67	18.6%
Other	20	5.6%
Total	360	100.0%

Legend
%* - percentage rounded to nearest decimal place
Other = Inspections/Tests(7), To/from work(4), and Missing values(9).

Table 4.7 The area where the firefighter was working at the time of the manual handling injury.

One hundred and fifty four of the 360 manual handling incidents (42.8%) occurred at the fireground, 119 occurred at the station (33.1%), and 67 during training(18.6%).

The amount of time a firefighter spends in action at the fireground is in reality a very small proportion of the total time worked. SAMFS figures show that the average total time each firefighter spent at incidents where action was taken (that is where tasks were performed as opposed to false alarms and inspections only) in the year 1988/89 ranged from 4.5 hours to 64.5 hours. As a percentage of the firefighters total time at work this equates to a range from 0.25% to 4% of the years work. Hence, the percentage of injuries that occur at the fireground is very high for the relatively small amount of time spent there.

Training drills are conducted for two hours each day, and 67 (18.6%) of the injuries occurred during training, and 119 manual handling injuries (33.1%) occurred at the station. Prevention of these injuries should be aimed for, and should be achievable to some degree, as they occur in non-emergency situations.

4.4.3 Work Location of Manual Handling Injuries Selected on the Basis of Task Severity

The work area where the severe injuries occurred was examined (Table 4.8).

Work area	Freq	%*
Station	15	38.5%
Fireground	11	28.2%
Training	8	20.5%
Other	5	12.8%
Total	39	100.0%

<u>Legend</u>
%* - percentage rounded to nearest decimal place

Table 4.8 The work areas where the severe manual handling injuries occurred.

Two thirds of the severe manual handling injuries were at either the station or at a drill (on or off the station) and nearly one third occurred at the fireground.

Of the 360 manual handling injuries selected for analysis according to task frequency, nearly 43% occurred at the fireground (Table 4.7). On the other hand, of the 39 manual handling injuries selected on the basis of severity, nearly 39% occurred at the station.

Body part injured	Frequency	Percent
Low back	75	20.8 %
Knee	44	12.2 %
Other & multi-systemic conditions	27	7.5 %
Hand	21	5.8 %
Eyeball	19	5.3 %
Fingers	16	4.4 %
Shoulder	15	4.2 %
Neck	14	3.9 %
Foot	13	3.6 %
Upper back	13	3.6 %
Ankle	12	3.3 %
Other (specified multiple areas)	10	2.8 %
Lower leg	8	2.2 %
Wrist	8	2.2 %
Thumb	6	1.7 %
Upper limb (multiple areas)	6	1.7 %
Abdomen	5	1.4 %
Elbow	5	1.4 %
Head (unspecified areas)	5	1.4 %
Upper leg	5	1.4 %
Forearm	4	1.1 %
Upper & lower limbs	4	1.1 %
Trunk & limbs	3	0.8 %
Upper limb (unspecified areas)	3	0.8 %
Lower limb (multiple areas)	2	0.6 %
Toes	2	0.6 %
Trunk (multiple areas)	2	0.6 %
Upper arm	2	0.6 %
Abdomen (other and multiple)	1	0.3 %
Abdomen (unspecified)	1	0.3 %
Chest muscles	1	0.3 %
Chest (unspecified)	1	0.3 %
Ear	1	0.3 %
Hand/fingers/thumb (other/multiple)	1	0.3 %
Head & other	1	0.3 %
Neck & trunk	1	0.3 %
Nose	1	0.3 %
Stomach	1	0.3 %
Trunk (unspecified)	1	0.3 %
Total	360	100.0%

Table 4.9 The body part injured when manual handling injuries were sustained by SAMFS firefighters, 1988 - 1990.

CHAPTER FIVE

MANUAL HANDLING HAZARDS PERCEIVED BY SAMFS FIREFIGHTERS

5.1 INTRODUCTION - QUESTIONNAIRE TO SAMFS FIREFIGHTERS

One hundred and twenty five firefighters from the SAMFS completed the manual handling Questionnaire. This was not a random sample but was broadly representative of those firefighters working for the SAMFS in the metropolitan area. No country firefighters completed the questionnaire.

The Questionnaire was derived from the National Skills Audit for Firefighters (Eglinton, 1991). The firefighters were asked to give each of the firefighting tasks listed a hazard rating in order to identify which manual handling tasks they perceived as hazardous. The Questionnaire allowed respondents to give manual handling tasks a grading with a range from 0, or no perceived risk, to 4, the maximum perceived risk.

The purpose of establishing the perceived manual handling hazards was: firstly so that some tasks which firefighters considered to be high and low risk activities (identified from the Questionnaire) could be chosen for the video. A variety of high and low risk tasks perceived by the firefighters and also determined from the actual injury statistics was needed for the video. The video was to be subsequently viewed by the panel of experts and the filmed tasks evaluated using the Risk Identification Checklist from the Code of Practice. Secondly, so that a comparison could be made between the manual handling hazards perceived by the firefighters and the actual hazards where manual handling injuries had occurred (identified from the injury records).

Once the results were collated the mean score for each task was determined. The highest scoring mean was 3.41 for the task "ventilating structures" and the lowest scoring task was "donning or wearing gloves" with a mean of 0.72.

5.2 DUTIES PERCEIVED AS THE MOST AND THE LEAST HAZARDOUS

The 30 duties which were identified as being the most hazardous manual handling jobs are shown in Table 5.1, and the least hazardous in Table 5.2.

Generally, the manual handling tasks which the firefighters felt were the most hazardous were those which involved heavy manual work or work in difficult positions.

In Canada a recent study by Gledhill and Jamnik (in press) was undertaken to identify the tasks a random sample of 57 experienced firefighters considered to be the most physically demanding. Some of the tasks they identified as physically demanding were the same as the tasks the SAMFS firefighters identified as manual handling hazards. These tasks included ventilation and overhaul, hose laying operations, ladder work, forced entry, extrications, and motor vehicle rescue. Other tasks which also featured in the Canadian report were related to work in high rise buildings. These did not show in our results because there were no questions relating to high rise building work in the Questionnaire, rather there were questions relating to work on aerial appliances.

The tasks which the firefighters perceived to pose the least manual handling risks were generally those which involve little physical exertion. One of these tasks did appear in the injury reports, this was : filling out the nominal roll tally.

For the purposes of this study the activities to which the firefighters gave a medium ranking comprised all tasks not included in the 30 most or the 30 least hazardous tasks.

Rank	Task	Mean
1.	Ventilate structures to remove smoke etc	3.41
2.	Removal of roof cladding	3.31
3.	Hose line removal aloft/descent	3.26
*4.	Lifting victims/training dummy	3.23
5.	Extrication of trapped/injured persons	3.21
6.	Search wall cavity/roofs	3.08
7.	Ladder hinge rescue technique	2.99
8.	Hose line movement in obstructed areas	2.98
*9.	Turning over/overhaul	2.83
*10.	Work in confined spaces	2.82
11.	Forcible entry techniques	2.81
* 12.	Perform self rescue safely	2.79
13.	Ladders on/off appliance	2.77
*14.	Drill-tower exercises	2.77
* 15.	Use rescue equipment jack/spread/lifting	2.73
16.	Removal of debris	2.72
17.	Handling of transport drums/overdrums	2.70
* 18.	Moving/shifting foam drums	2.67
19.	Extinguish ignition sources	2.67
20.	Carrying ladders	2.66
*21.	Lifting gear from top of appliance	2.66
22.	Various single and two person carries, use other equip blankets/ropes/chairs	2.65
23.	Transport/dispose of dangerous substance	2.64
24.	Operate forcible entry tools	2.64
25.	Loading hose boxes into appliance	2.64
26.	Operate pneumatic/electric hammer tools	2.59
27.	Placement/pitching/footing ladders	2.58
28.	Vertical (roof),lateral (windows,doors) forced (electric fan) venting	2.54
29.	Pump out basement,cellar,ship's holds	2.54
30.	Remove decontamination shower from appliance	2.52

Legend:
Rank - tasks in order of decreasing severity
Mean - mean score from questionnaire
* - tasks included on the video

Table 5.1 The 30 most hazardous manual handling tasks perceived by the firefighters.

Rank	Task	Mean
*1.	Donning/wearing gloves	0.72
*2.	Obtain nominal roll and air set tallies	0.73
3.	Operate cabin controls	0.75
4.	Using/reaching to use electrical communications (handset)	0.80
*5.	Donning/wearing bunker coat	0.84
*6.	Check oil, radiator water, tank water, tyres, start engine	0.86
7.	Check coolant, oil, lights, equipment on the foam truck	0.88
*8.	Donning/wearing boots	0.89
9.	Conduct building inspections	0.89
10.	Cleaning, lubricating small gear	1.05
11.	Service/clean/inspect vehicle	1.06
12.	Engage valves, levers on the pump panel	1.06
13.	Clean station	1.07
14.	Set up entry control points	1.07
15.	Clean bathroom areas	1.08
16.	Add soluble oil and circulate to tank etc. operate valves, clean	1.08
17.	Testing and maintenance procedures on chemical resistance enclosures	1.10
18.	Getting on and off forklift	1.10
19.	Carrying out the routine checks	1.18
20.	Operate appliance pump as per weekly test routine	1.20
21.	Entering lift, use of F/F's lift keys	1.22
*22.	Donning/wearing helmet	1.24
23.	Other (specify)	1.25
24.	Access to check batteries	1.25
25.	Donning clothing after incidents/ decontamination	1.26
26.	Operate devices fitted to vehicles	1.26
27.	Mowing lawns, pruning, weeding	1.27
28.	Cordoning off area	1.27
29.	Check batteries on appliances	1.28
30.	Siting/extending skyjet	1.29

<u>Legend:</u>
Rank - tasks in order of increasing severity
Mean - mean score from questionnaire
* - tasks included on the video

Table 5.2 The 30 least hazardous manual handling tasks perceived by the firefighters.

CHAPTER SIX

RISK IDENTIFICATION CHECKLIST VALIDATION

6.1 THE MANUAL HANDLING VIDEO AND THE REVIEW PANEL

6.1.1 Selection of Tasks for Inclusion in the Study

A video was made of twenty-three firefighter tasks involving manual handling so that each member of the review panel could assess each task using the Risk Identification Checklist from the Manual Handling Code of Practice. The tasks were selected for the manual handling video on the basis of the results obtained in Chapters Four and Five. The firefighter tasks chosen to be filmed comprised of a variety of tasks of high and low injury frequency and severity (Table 6.1). Also included were tasks with a range of high and low hazard scores identified from the firefighter questionnaire. The tasks selected were chosen in collaboration with the SAMFS Occupational Health and Safety Officer with regard to practicability and ease of filming.

6.1.2 Review Panel Composition

The review panel comprised 15 occupational health and safety professionals who were known to the investigator and willing to participate in the study. The panel members were not aware of the frequency or the severity of injuries associated with the tasks, or of the firefighters' perceptions of hazardous tasks.

6.1.3 Performance of the Checklist

The following indices of performance of the Checklist were investigated: -

- Intra-rater reliability
- Inter-rater agreement
- Correlation of Checklist scores with injury statistics
- Correlation of firefighter perceptions with injury statistics
- Correlation of Checklist scores with firefighter perceptions.

Firefighting Task	Frequency	Severity	F/F Score
1. Donning turnout gear at the station	0	NS	0.92#
2. Donning turnout gear in the appliance	0	NS	1.8
3. Remove ladder from appliance	3	NS	2.77
4. Check appliance oil (over wheel)	0	NS	0.86
5. Check appliance oil (under bonnet)	0	NS	0.86
6. Move 200 litre drums	5	NS	2.67
7. Remove ground monitor from appliance	2	NS	2.51
8. Go down fire pole	12	S	2.17
9. Fill out nominal roll	1	NS	0.73
10. Fill out air tag tallies	0	NS	0.73
11. Open/close locker doors	9	NS	1.65
12. Move hose aloft	0	NS	3.26
13. Roll hose aloft	0	NS	3.26
14. Getting in/out of appliance	41	S	1.77
15. Shipping standpipe	3	NS	1.86
16. Remove small gear (generator) from locker	2	NS	2.16
17. Move training dummy	5	S	3.23
18. Drill tower exercises	8	NS	2.77
19. Donning B.A.* from appliance bracket	5	NS	2.31
20. Donning B.A.* from the ground	7	NS	2.31
21. Vehicle rescue	10	S	2.73
22. Using a fire extinguisher	1	NS	1.68
23. Overhaul	6	NS	2.83

Legend
Frequency - Frequency of injuries
Severity - Severity of injuries: S = severe, NS = not severe
F/F Score = Mean hazard score from the questionnaire to firefighters
B.A.* - Breathing apparatus
- average score for donning helmet, boots, coat and gloves

Table 6.1 Tasks selected for the video, showing the number of injuries sustained, whether injuries sustained were severe, and firefighter perceptions of the hazard associated with the task.

6.2 INTRA-RATER RELIABILITY

6.2.1 Introduction

Three of the 15 panel members were shown the video presentations of the tasks on two occasions, six months apart. The Checklist, which consisted of 18 questions, was used by these panel members to assess each of the 23 firefighting tasks on each occasion. The answers each panel member gave on the second viewing were compared with those given by that panel member on the first viewing. The reliability was assessed by Spearman's non-parametric correlation coefficients and the level of agreement by Wilcoxon signed rank tests. Kappa statistics were used to measure agreement between viewings of responses to questions within individual tasks.

6.2.2 Correlation of Panellists' Scores on Two Views

The 23 tasks were rank ordered according to total Checklist score, and the rank orders between the two viewings compared for each of the three panel members. Rank correlations of each panellist's total score on each of the 23 tasks between the first and second viewing were strongly positive (Table 6.2).

Panellist	Spearman's correlation coefficient*
Panellist 8	0.88•
Panellist 9	0.86•
Panellist 2	0.83•

Legend
* - corrected to two decimal places
• - statistically significant at 0.1% level

Table 6.2 The correlation between the panellist's rank order of tasks according to Checklist scores on the first and second viewing.

6.2.3 Agreement of Individual Panellists' Checklist Scores for Individual Tasks, between the Two Viewings

Table 6.3 shows the scores the three panellists gave each task on the first and the second views. A Wilcoxon signed rank test was used for each panellist to test the agreement between scores given on the first and second views. This tested the null hypothesis that the median difference in the scores was zero. Panellist 8 tended to score each task higher on the first viewing. The median of the differences in task scores between viewings was 2, which was statistically significant ($p < 0.001$). Panellist 9, on the other hand, scored consistently lower on the first viewing, the median of the differences again being 2, which was statistically significant ($p < .001$). Panellist 2 tended to score the same between viewings, the median of the differences in task scores being 0.5, which was not significantly different from zero.

	Panellist 2		Panellist 8		Panellist 9	
Task	V1	V2	V1	V2	V1	V2
1	3	1	7	2	2	1
2	3	4	7	4	2	5
3	7	7	4	3	6	11
4	4	4	3	2	4	4
5	4	2	3	0	0	5
6	9	10	7	6	8	9
7	10	14	6	4	7	12
8	2	2	1	0	1	3
9	3	5	2	1	3	8
10	3	5	2	1	4	5
11	4	7	2	1	6	8
12	14	12	11	7	13	15
13	15	11	10	6	10	13
14	2	4	6	2	2	9
15	7	10	5	3	7	12
16	4	6	1	2	2	6
17	14	12	12	9	13	15
18	12	14	13	6	12	12
19	4	3	0	0	2	8
20	9	8	4	4	7	11
21	13	14	7	3	13	14
22	2	5	0	1	4	4
23	14	12	9	5	12	14

Table 6.3 The scores given to each task by the three panellists on the first and second viewings (V1 and V2).

Thus, although all 3 panellists were consistent in the rank ordering of task scores between viewings, only Panellist 2 was consistent in scores for each task; Panellist 8 scored tasks significantly more highly on the first viewing, and Panellist 9 significantly more highly on the second.

6.2.4 Measuring Agreement Between Viewings of Responses to Questions within Individual Tasks.

Kappa statistics were used to measure the agreement of the "Yes"/"No" scores to the 18 Checklist questions between the two views for each of the 23 tasks. Kappa gives a measure of agreement which has been corrected for the chance agreement in a 2x2 table.

Results were tabulated according to the criteria of Fleiss (1981), that is: a kappa value of more than 0.75 shows "excellent" agreement, of 0.4 to 0.75 shows "fair to good" agreement and below 0.4 shows "poor" agreement. Table 6.4 shows, for each panellist, the number of tasks yielding values of kappa in the categories defined by Fleiss.

	<0.4 (poor)	.4 - 0.75 (fair/good)	>0.75 (excellent)	*	Total
Panellist 8	9	9	1	4	23
Panellist 9	5	13	4	1	23
Panellist 2	12	11	0	0	23
Total	26	33	5	5	69

<u>Legend</u>
* Pattern of responses for these tasks did not result in a 2x2 table.

Table 6.4 The level of agreement of the panellists on individual questions within each task.

Table 6.4 shows that the panellists scored most frequently in the "fair to good" category. The number of responses in the "poor" category was also high, whilst the number of responses in the "excellent" category was low. Thus, the agreement between the views of each panellist on individual questions within each task was seldom "excellent" and there were no tasks where the level of agreement on individual questions was "excellent" for all panellists.

6.2.5 Summary of Intra-Rater Reliability Results

The three panel members who completed the Checklist on two occasions were found to have a high correlation between their rankings (total score) of the tasks, but the kappa statistic shows this was achieved despite marked differences in the answering of individual Checklist questions. That is, the panellists were consistent in giving high or low Checklist scores to the same tasks on each viewing, but the high or low scores resulted from different "Yes" or "No" answers to the Checklist questions. Panellist 8 tended to score consistently higher on view one whereas Panellist 9 tended to be give consistently lower scores on the second view compared with the first. Panellist 2 showed a significant level of intra-rater reliability. Examination of answers to individual questions for each task on the two views also showed that the panel members rarely had "excellent " agreement.

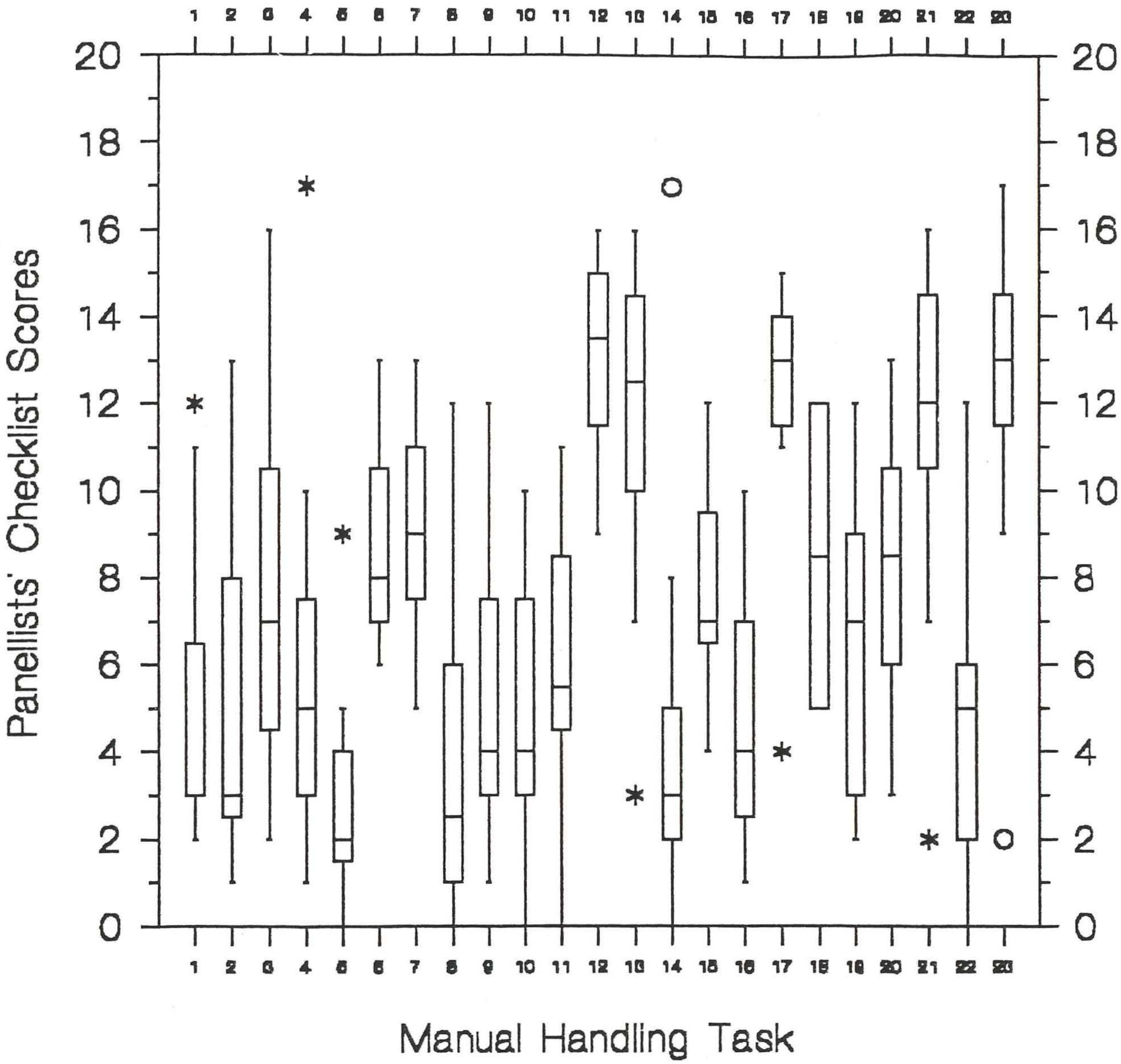
6.3 INTER-RATER AGREEMENT

6.3.1 Introduction

The level of agreement between the 15 panel members across the 23 tasks filmed was determined by analysing their Checklist scores.

6.3.2 Variation in Scores for Each Task

For each task the median and the range of scores given by members of the panel was established. The variability of panellists' scores is shown graphically by the box and whisker plots for each task (Figure 6.1). The box and whisker plots show that there was a wide range of scores for each task and that there was a low level of agreement between panellists for the score given to each task.



Legend:
The median is represented by a horizontal line within a box whose right and left limits are boundaries of the interquartile range of scores.
The whiskers extend to 1.5 times the interquartile ranges below the 25th and above the 75th percentiles, rolled back if necessary to existing data.
Outlying values are denoted by asterisk (*) or "O".
Manual handling tasks numbered according to Table 6.1

Figure 6.1 Box and whisker plot of panellists' scores for each of the 23 tasks.

The Friedman non-parametric analysis of variance was used to determine whether the panellists formed a homogeneous group, that is whether the panellists showed agreement in their scores over the 23 tasks. There was no significant agreement between panellists (Friedman Chi square test statistic 137.62, $p < 0.001$)

6.3.3 Summary of Inter-Rater Agreement Results

The inter-rater agreement of the panel of panellists was poor. There was considerable variation amongst the individual panel members in the Checklist scores for each task. These scores are tabled in Appendix F.

6.4 COMPARISONS OF CHECKLIST SCORES WITH INJURY STATISTICS AND FIREFIGHTER PERCEPTIONS

6.4.1 Introduction

The 23 tasks which were filmed were seen by the panel and each of the 18 questions on the Checklist were answered "Yes" or "No" for each task. A composite score, equal to the number of "Yes" answers was calculated for each task, for each panel member. The maximum possible score for each task was 18 and the minimum score possible was zero. Panel members' scores were aggregated to give a median score for each task (Table 6.5).

Firefighting task		Median Score
12.	Move charged hose aloft	14
17.	Move training dummy	13
21.	Vehicle rescue	13
23.	Overhaul	13
13.	Roll charged hose aloft	12
18.	Drill tower exercises	12
7.	Remove ground monitor	9
20.	Don B.A. from ground	9
6.	Move 200 litre drums	8
3.	Remove ladder from appliance	7
15.	Shipping standpipe	7
4.	Check appliance oil over wheel	4
11.	Open/close locker doors	5
22.	Using a fire extinguisher	5
9.	Fill out nominal roll	4
10.	Fill out air tag tallies	4
16.	Remove small gear from locker	4
19.	Don B.A. from appliance mounted bracket	4
1.	Donning turnout gear at the station	3
2.	Donning turnout gear in the appliance	3
14.	Getting in/out of appliance	3
5.	Check appliance oil under bonnet	2
8.	Go down fire pole	2

Table 6.5 Median Checklist scores of firefighting tasks ranked in descending order.

6.4.2 Correlation of Checklist Scores with Injury Frequency

The rank correlation between the median score given by the panel and the injury frequency for each task was determined. The Spearman correlation coefficient for this was 0.17 showing low correlation between the panel's Checklist scores and the injury frequency.

The Checklist scores given by the individual panellists for each task were examined to determine their correlation with the injury frequency for those tasks. For each panellist a Spearman correlation coefficient was calculated, and these ranged from -0.04 to 0.38 (Table 6.6), showing low individual correlation for each panellist's

Checklist scores with the injury frequency.

Panellist	Spearman correlation coefficient*
Panellist 8	0.11
Panellist 9	0.05
Panellist 2	0.08
Panellist 4	0.14
Panellist 5	0.38
Panellist 6	0.30
Panellist 7	0.18
Panellist 8	-0.01
Panellist 9	0.17
Panellist 10	0.24
Panellist 11	0.32
Panellist 12	-0.04
Panellist 13	0.22
Panellist 14	0.09
Panellist 15	0.09

Legend
* - corrected to two decimal places

Table 6.6 Correlation coefficients for each panellist and the injury frequency for the 23 tasks.

6.4.3 Differentiation of Severe Injuries and Non-severe Injuries using Checklist Scores

Four tasks classified as "severe" (that is giving rise to high severity injuries) were presented on the video, the remaining 19 were classified as "non-severe". The Mann Whitney test was used to determine if panellists' scores on the Checklist discriminated "severe" from "non-severe" tasks. If this were so, then it might be expected that the median score given to severe tasks would be greater than that given to non-severe tasks.

Of the 15 panellists, 11 gave lower medians to the non-severe tasks and higher medians to the severe tasks. (see Table 6.7). There were no significant differences in median scores between "severe" and "non-severe" tasks for any of the 15 panellists.

(Mann Whitney test for difference in median scores yielded p = 0.97). This may be related to the small number of severe tasks (four) available for analysis.

Panellist	Median Checklist score Non-severe tasks	Median Checklist score Severe tasks	P value
1	6	9.5	0.81
2	4	7.5	0.74
3	6	7.0	1.00
4	5	6.5	0.57
5	7	13.5	0.19
6	6	10.5	0.29
7	8	9.0	0.63
8	4	6.5	0.54
9	6	7.5	0.81
10	6	7.0	0.97
11	4	6.5	0.68
12	5	4.5	0.87
13	9	9.0	0.90
14	11	8.5	0.78
15	12	11.5	0.77

Table 6.7 Panellists median Checklist scores for the severe and non-severe manual handling injuries.

6.4.4 Correlation of Firefighter Perceptions with Injury Statistics

Of the 23 tasks filmed for the video only 19 could be used for analysis of the firefighters perceptions as the questionnaire did not differentiate the tasks of "donning breathing apparatus from the ground and from the appliance", and the tasks "moving a hose aloft and rolling a hose aloft". The firefighters' perceptions of risk were analysed to determine their correlation with the injury frequency and the injury severity. Correlation with the injury statistics was low for both injury frequency and severity (Spearman correlation coefficients 0.35 and 0.19, respectively), showing that the firefighters were poor at discriminating between tasks of different injury frequency and severity.

6.4.5 Correlation of Checklist Scores with Firefighters' Perceptions

There was moderate to strong correlation over the 19 tasks between the panel members' Checklist scores and the mean of the firefighters perception (Spearman correlation coefficient 0.76).

CHAPTER SEVEN

DISCUSSION OF RESULTS

7.1 INTRODUCTION

This chapter discusses the results from Chapter 6, the wider implications of using the Risk Identification Checklist from the Manual Handling Code of Practice, the limitations of the study and suggestions for further study. It concludes with a summary of the results.

7.2 INTRA-RATER RELIABILITY OF CHECKLIST SCORES

The correlation between the Checklist scores from the two views of the tasks was high for each of the three panel members who saw the video twice. Occupational health professionals using the Checklist on more than one occasion are therefore likely to assign tasks the same rank order and thus the same priority for risk assessment and control.

However, in relation to individual questions on the Checklist, agreement between separate video viewings was low for two of the three panellists. This is difficult to explain. These two panel members may have made their own decision about how hazardous the task was and then ticked the "Yes" boxes on the Checklist. That is, they had their own predetermined idea as to the overall hazard ranking of the task prior to completing the individual questions on the Checklist. Presumably their rating of the task would have been influenced by their previous occupational health experience.

The panellist who had significant agreement between the individual Checklist questions on the first and second viewings had used the Checklist frequently whereas the other two panellists had limited experience with the Checklist. Therefore training prior to using the Checklist may enhance intra-rater reliability.

7.3 INTER-RATER AGREEMENT OF CHECKLIST SCORES

The large variation in the scores for individual tasks given by panel members may be partly explained by the fact that although all of the panel were occupational health and safety professionals, they had different areas of expertise. They also had varying experience in the use of the Risk Identification Checklist from the Code of Practice and this may have contributed to the range of Checklist scores. Two of the panel were trainers from the South Australian Occupational Health Commission whose jobs were to "train the trainers" in how to use the Manual Handling Code of Practice, and may therefore be considered to be very experienced in using the Checklist. In contrast, several of the panel members had not used the Checklist before.

Another explanation for the variation in task scores may be attributed to the Checklist questions themselves. There was lack of definition or quantification in most of the Checklist questions. For example, in questions which began with "Is there frequent or prolonged...", there was no given definition of either "frequent" or "prolonged". Another example is the question "Are loads moved or carried over long distances?", where no quantification is given for the term "long". Therefore, one can postulate that there could have been considerable variation in each panel member's interpretation of these terms, which would have influenced the way they answered the Checklist questions.

In summary, the variation in the expertise of the panel members in their professional careers and their experience of using the Checklist combined with the subjective nature of the individual questions may have been responsible for the broad range of Checklist scores which was found for the individual tasks.

Evans and Moore (1991) examined answers given by a panel of 15 experts, 14 of whom had ergonomic qualifications, who saw a video of 10 work tasks and completed a stressor summary sheet for each task. They found that experts had good agreement on the categories of static loading, joint angles and tissue contact, but poor agreement on the categories of dynamic loading, lift/lower, push/pull, frequency and duration. They also found the panel agreed more on sitting or non-ambulatory tasks with respect to the stressor and the body segment involved. None of the tasks included on the video of SAMFS manual handling tasks were non-ambulatory and all involved dynamic tasks, some of which had static components, so in this respect the present study agrees with the findings of Evans and Moore. Some of the categories on the Checklist could be considered to relate to joint angles, for example reaching above the shoulder, however individual questions were not analysed so it is not possible to directly compare Checklist results with the results of Evans and Moore.

However, even if the panel were in total agreement it would not necessarily mean the panel was correct. Such was the case with the 100 physicists who attempted to discredit Einstein's theory of relativity (Rothman, 1988, page 6); panel consensus does not mean correctness.

7.4 COMPARISONS OF CHECKLIST SCORES, INJURY STATISTICS AND FIREFIGHTER PERCEPTIONS

7.4.1 Checklist Scores and Injury Statistics

The Checklist scores showed a poor correlation with the injury frequency. It was anticipated that the panellists using the Checklist may have been able to differentiate tasks on the basis of either injury frequency, injury severity, or both. There was no evidence panellists were able to differentiate tasks on the basis of injury frequency. In the case of injury severity, although the majority of panellists gave higher scores to the severe tasks, the differences in median scores were not statistically significant.

From these results therefore, no benefit can be seen in this study from using the Checklist as the basis for setting priorities for injury prevention aimed at reducing injury frequency. Checklist use in setting priorities for reducing injury severity is open to question.

7.4.2 Firefighter Perceptions and Injury Statistics

The firefighter perceptions of the most hazardous manual handling tasks had a poor correlation with the actual injury statistics, both with injury frequency and injury severity. There are two reasons which could account for this. Firstly, firefighters may not be aware of some of the manual handling hazards that exist in the work place. Secondly, perhaps the firefighters are aware of some of the existing manual handling hazards and modify their behaviour accordingly so that injuries do not occur in some of the hazardous situations. This has been found elsewhere as reported by Griffiths (1985), who stated that, "It may seem paradoxical, but simply for the very reason that these are the main hazards, they do not cause the majority of our accidents. Because these hazards are well known a lot of thought goes into basic design of plant and equipment, procedures are written to guard against them and training and propaganda emphasise the risks."

Relating this to the SAMFS, perhaps more attention is paid to safe work practices in situations which are regarded as dangerous than to the routine activities which are undertaken during training drills and station activities. For example, procedures involved in the control of dangerous substances may be more strictly adhered to than the correct manner of getting out of a fire appliance. This may mean that the firefighter takes more care when dealing with the dangerous substance as the consequences of a work injury may be life threatening whereas the task of getting out of an appliance is not really even considered to be hazardous. However, as Viner (1991) stated, it is the simple tasks performed the most frequently which are most likely to result in injuries, although they may be relatively minor in nature, and getting in and out of a fire appliance occurs several times daily, whereas participating in the control of a dangerous substance is a relatively rare event.

7.4.3 Checklist Scores and Firefighter Perceptions

The Checklist scores showed a high correlation with the perceptions of the SAMFS firefighters; that is, the panel members and the firefighters agreed on the hazardous tasks in the workplace. It can be inferred that consultants using the Checklist are likely to have similar views on manual handling hazards at the workplace to the employees. However, this study has shown that using Checklist results for setting priorities for prevention clearly does not reflect the priorities which would be established from analysis of the injury statistics. Therefore targeting the tasks given priority by the Checklist for prevention (risk control) could not necessarily be expected to lead to a reduction in either the frequency or severity of workplace injuries.

The difference between employee perceptions and actual injury statistics raises various issues for prevention. Increased employee awareness of the tasks known (from the injury statistics) to result in frequent and severe injuries may result in employees being more careful when undertaking those tasks. Raised employer awareness of those same tasks may encourage preventive action by task redesign, change in technique, or the purchase of equipment to reduce the manual handling involved.

7.5 PUBLIC HEALTH IMPLICATIONS

7.5.1 Checklist Use in Other Industries

The Risk Identification Checklist from the Code of Practice needs to be tested in other industries. Should similar results be found elsewhere it raises the question as to whether all employers should be required to use the Checklist, given that using the Checklist may not give appropriate priority to tasks which have resulted in manual handling injuries, and subsequently implementing preventive strategies based on the Checklist results therefore may not decrease the number of manual handling injuries.

A recent retrospective controlled manual handling study was conducted at Telecom Australia which followed the principles of the Manual Handling Code of Practice, and a cost-benefit analysis of the study was undertaken. Intervention was focused on redesign of equipment and work practices rather than on lifting technique. Results showed that there was no significant difference in reduction of the rate or cost of manual handling injuries between the groups. However it was concluded that the cost of implementing the project was offset by savings from increased productivity due to the ergonomic interventions (Hocking, 1991). Hocking therefore proposed that there was a need to properly evaluate codes of practice prior to mandating them. This study supports the recommendation of Hocking. More thorough validation of the usefulness of the Checklist needs to be undertaken before employers are required to implement it at their workplace.

7.5.2 Checklist Use, the Employee and the Employer Perspective

The principle of the Code of Practice is intuitively desirable as it aims to get employers and employees communicating about hazardous tasks at the workplace. However, to date, no published results have shown the effectiveness of following the Code of Practice in reducing the frequency or severity of manual handling injuries. This study has shown that any effort other than reviewing the injury statistics is unproductive in establishing priority order of tasks for risk assessment and control.

The risk identification stage of the Code of Practice is easy to follow and should involve discussions about manual handling hazards between management, employees and the occupational health and safety committee. However, the use of the Risk Identification Checklist and consultation in a process unlikely to reduce injuries may lower worker morale and may antagonise management-staff relationships. The result of such consultation may easily be negative if prevention strategies are targeting the wrong tasks.

Employers should be informed that using the Risk Identification Checklist to give priority to manual handling tasks requiring risk assessment and control may not appropriately reflect tasks which the injury statistics dictate as needing priority for prevention. Therefore even if appropriate control strategies are put in place for the hazards identified there may not be a decrease in the number of workplace injuries. Employers would therefore be justified in questioning the implementation of the Code of Practice if following it will not lead to a decrease in the number of manual handling injuries, as the cost of implementing the Code of Practice is considerable.

In the current economic climate it is imperative that employers use the resources allocated to occupational health and safety in the most efficient way. The results of the present study indicate that priorities established by the Checklist may well be inappropriate as they do not concur with priorities established from the injury statistics. Employers should direct their resources to prevention strategies which will target hazardous tasks identified from the injury statistics rather than those which are shown to be hazardous when using the Risk Identification Checklist.

To summarise, use of the Risk Identification Checklist by employers in the current form is not warranted and should therefore not be mandatory. Employers should be notified that the Checklist may target inappropriate tasks for preventive strategies so they may allocate resources in more useful ways.

7.5.3 General Comments on the Risk Identification Checklist

The low reproducibility of the Checklist is of concern as the Checklist is supposed to be used for both "before and after" evaluations of a manual handling task. If it is not possible to arrive at a consistent initial Checklist score for a manual handling task, comparing the Checklist scores before and after risk control measures are implemented would also be invalid. This study did show that the tasks considered high on the first view were also considered high on the second view but the individual question repeatability was poor.

Consideration could be given to weighting the Checklist questions, for example the temperature of the work environment may differ in importance from the posture of the person performing the manual handling task.

In addition, consideration should be given to the inclusion of other questions, for example a question relating to changes in energy transfer could be included to incorporate the energy theory of accidents as proposed by Haddon (1970). In the present study such a question would have been likely to give the tasks of "sliding down the station pole" and "getting out of a fire appliance" higher scores, which would have been more realistic with regard to the known injury frequency and severity of these tasks.

7.6 LIMITATIONS OF THE STUDY

Limitations of the study include: -

1. The specificity of the workplace is not representative of work conducted in any other industry such as the manufacturing industry, therefore extrapolating the findings to other industries should be done with caution until further studies in those industries are conducted.
2. In some cases, SAMFS injury statistics were not specific with regard to the manner in which the task was performed, therefore these tasks could not be analysed to determine correlation with Checklist scores.
3. The SAMFS injury reports were used to give the investigator a comprehensive overview of the nature of manual handling injuries sustained by firefighters. There is no formal reporting of near-miss incidents at the SAMFS and the level of under-reporting of injuries could not be determined. However, injuries which resulted in lost time and those that did not were included in the study.
4. The video of the manual handling tasks was not taken at fire scenes for logistical reasons.
5. The panel had a range of occupational health experience and some members were

not specifically trained in the use of the Checklist.

6. Two questions were frequently answered as "non-applicable" by panellists, these were: "Is the employee new or returning from an extended period on leave'" and "Does the employee have any temporary or permanent characteristics which may affect task performance?".

7. Using consultants rather than employees to answer the Checklist may be seen by some as inappropriate, as in a work situation often it will be the occupational health and safety officer or committee who complete the Checklist, and they will have a better working knowledge of the task being assessed.

7.7 DIRECTIONS FOR FURTHER STUDY

The Checklist provides a comprehensive list of questions on some of the risk factors involved in manual handling. However it should be determined whether there are some questions on the Checklist which are better indicators of factors leading to manual handling injuries than others. If this is found to be so, the effect of weighting these questions more heavily should be examined.

The usefulness of adding other questions to help identify hazardous tasks should be examined. For example, in this investigation a question relating to changes in velocity or changes in energy in activities such as sliding down the fire pole or getting out of a vehicle cabin would have given these tasks a higher Checklist score and therefore a higher priority for prevention. From the injury statistics we know that these tasks should have been given a higher priority for risk assessment and control.

Investigation should be conducted to determine whether quantification and definition of terms such as "frequent" or "prolonged" would enhance both intra- and inter-rater reliability. Should this be the case, the Checklist should be modified accordingly

7.8 SUMMARY OF RESULTS

The Risk Identification Checklist from the Manual Handling Code of Practice was shown to have: -

- High intra-rater reliability of ranking of checklist scores but low intra-rater reliability of answers to individual questions.
- Low inter-rater agreement of Checklist scores.
- Low correlation between judges scores for individual tasks and injury frequency. However, the majority of panel members were able to differentiate "severe" from "non-severe" tasks, albeit not statistically significantly.
- Low correlation between Checklist scores and the firefighter perceptions as determined from the questionnaire.
- High correlation between firefighters perceptions and panellists Checklist scores of manual handling tasks.
- The Checklist was therefore found to perform poorly at the workplace where this study was undertaken, the South Australian Metropolitan Fire Service.

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Legislation

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Occupational Health and Safety (Manual Handling) Regulations and Code of Practice 1988 (Vic)

Occupational Health, Safety and Welfare (Manual Handling) Regulations 1990 (SA)

Standards

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APPENDIX A

APPENDIX A

SAFE MANUAL HANDLING CHECKLIST
GENERAL RISK IDENTIFICATION

Description of Work Location ______________________ Date ___/___/___

Task Description ______________________

Assessed by ______________________

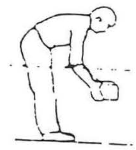
Employee(s) ______________________

Health and Safety Representative ______________________

The existence of any one of the following key risk factors, that is, a 'Yes' answer, indicates the need for further assessment as outlined in Section 4—Risk Assessment in the Code of Practice.

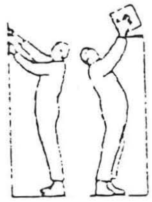
MOVEMENTS, POSTURE AND LAYOUT DURING MANUAL HANDLING

1. Is there frequent or prolonged bending down where the hands pass below mid-thigh height?
   If Yes see 4 *(a)*, 4 *(b)*, 4 *(c)*



Yes ☐ No ☐

2. Is there frequent or prolonged reaching above the shoulder?
   If Yes see 4 *(a)*, 4 *(b)*, 4 *(c)*

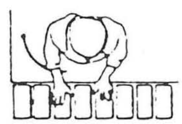


Yes ☐ No ☐

3. Is there frequent or prolonged bending due to extended reach forward?
   If Yes see 4 *(a)*, 4 *(b)*, 4 *(c)*

Yes ☐ No ☐

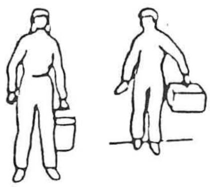
4. Is there frequent or prolonged twisting of the back?
   If Yes see 4 *(a)*, 4 *(b)*, 4 *(c)*



Yes ☐ No ☐

5. Are awkward postures assumed frequently or over prolonged periods, that is, postures that are not forward facing and upright?
   If Yes see 4 *(a)*, 4 *(b)*, 4 *(c)*

Yes ☐ No ☐



TASK AND OBJECT

6. Is manual handling performed frequently or for long time periods by the employee(s)? Yes ☐ No ☐
   If Yes see 4 *(d)*, 4 *(e)*, 4 *(h)*

7. Are loads moved or carried over long distances? Yes ☐ No ☐
   If Yes see 4 *(d)*, 4 *(e)*

8. Is the weight of the object:

   (a) More than 4.5 kg and handled from a seated position? Yes ☐ No ☐
   If Yes see 4 *(f)*

   (b) More than 16 kg and handled in a working posture other than seated? Yes ☐ No ☐
   If Yes see 4 *(f)*

   (c) More than 55 kg? Yes ☐ No ☐
   If Yes see 4 *(f)*

   Note:

   Weight is not used to prescribe absolute limits, but is one of the important factors to be considered when identifying, assessing and controlling risk.

9. For pushing, pulling, or other application of forces: are large push/pulling forces involved? Yes ☐ No ☐
   If Yes see 4 *(f)*

10. Is the load difficult to handle, for example, due to its size, shape, temperature, instability or unpredictability? Yes ☐ No ☐
    If Yes see 4 *(g)*

11. Is it difficult or unsafe to get adequate grip of the load? Yes ☐ No ☐
    If Yes see 4 *(g)*

WORK ENVIRONMENT

12. Is the task performed in a confined space? Yes ☐ No ☐
    If Yes see 4 *(i)*

13. Is the lighting inadequate for safe manual handling? Yes ☐ No ☐
    If Yes see 4 *(i)*

14. Is the climate particularly cold or hot? Yes ☐ No ☐
    If Yes see 4 *(i)*

15. Are the floor working surfaces cluttered, uneven, slippery or otherwise unsafe? Yes ☐ No ☐
    If Yes see 4 *(h)* and 4 *(i)*

INDIVIDUAL FACTORS

	Yes	No
16. Is the employee new to the work or returning from an extended period away from work? If Yes see 4 *(h)*, 4 *(j)*, 4 *(k)*	☐	☐
17. Are there any temporary or permanent personal characteristics that may affect task performance? If Yes see 4 *(h)*, 4 *(j)*, 4 *(k)*	☐	☐
18. Does the employee's clothing or personal protective equipment interfere with manual handling performance? If Yes see 4 *(l)*	☐	☐

APPENDIX B

S.A. METROPOLITAN FIRE SERVICE

99 WAKEFIELD STREET ADELAIDE
TELEPHONE (08) 228 0633
FAX (08) 228 0838

IN REPLY
PLEASE QUOTE
JRG/AP
DVN. Chief Officer

Inquiries Mr. Galton
Telephone 228 0767

Date 25th May 1990

Ms Rose Boucaut,

Dear Rose,

RESEARCH ACTIVITIES

As discussed at our recent meeting, I am pleased to confirm that facilities at the Headquarters Fire Station will be made available to you for the purpose of conducting research activities. Appropriate staff have been advised and I am sure every assistance will be given during your period with us.

I would like to take this opportunity of wishing you every success with your tertiary studies.

Yours faithfully

(D.A. Grubb)
CHIEF OFFICER

United Fire Fighters Union of South Australia In

. 148 South Ro
Torrensvi
South Australia 50
Telephone: (08) 352 72
Fax: (08) 234 10

Secretary: M. DOYLE

Our ref.
MJD:GW
Your ref.
15th June, 1990

Mrs. R. Boucaut,
C/- S.A. Metropolitan Fire Service,
99 Wakefield Street,
ADELAIDE 5000

Dear Mrs. Boucaut,

Please be advised that State Council supports your thesis proposal to evaluate the worksafe risk identification check list (for manual handling hazards) using hazards and perceived hazards at the S.A. Metropolitan Fire Service in Adelaide. We believe that your study will provide valuable insight to potentially avoid work related accidents associated with manual handling.

We wish you all the best in your investigation.

Yours faithfully,

M.J. DOYLE
SECRETARY

APPENDIX C

WorkCover
Corporation

FOR S.A. GOVERNMENT
EMPLOYEES ONLY

NOTICE OF DISABILITY

ABOUT THE WORKER

Given or Christian Names

Family Name

Residential Address

Post Code

Telephone No.	Sex	Date of Birth

Name and Address of Employer at time of accident

Post Code

Is the employer your current employer? Yes/No	Was time lost from work due to injury? Yes/No

INJURY DETAILS

Date of injury	Time of injury	am/pm

If you stopped work due to injury—Date stopped work	Time

Place where injury occurred (e.g. machine shop).

What injury(ies) or condition did you suffer?

Name of certifying Doctor (if applicable)

What parts of the body were affected? (e.g. upper arm, lower back)

WHAT HAPPENED? How did the accident occur, and what were you doing at the time? (e.g. slipped while climbing a ladder.)

*Country of Birth	*English Proficiency

*Years of Residence in Australia (if born overseas)

Language spoken at home	Interpreter required	Yes/No

DECLARATION

I,

the undersigned, declare that the details above and any details specified on the pink page are specified to the best of my knowledge, information and belief.

Date	Signature

Injured worker or person

BEFORE FILLING IN THIS FORM PLEASE NOTE!

If you **do not** intend claiming for any expenses or time lost **at this stage** but wish to give notice of a disability (injury) just complete the green page and give it to your employer as soon as possible. Keep the pink and blue copies **to make a claim** should you need to do so at a later date.

If you **do** intend claiming for any expenses or time lost, complete the pink page and give it to your employer as soon as possible, together with a WORKCOVER medical certificate supporting the claim. **Keep the blue copy for your own record.**

PLEASE DO NOT WRITE IN THIS AREA

*S.A. Government Employees only.

EMPLOYER'S SECTION

TO BE COMPLETED BY THE EMPLOYER

Employer Reg. No.	Location No.

Signature of Employer

Date	Date Notice Received

Name of person to whom notice was given

WorkCover Corporation

FOR S.A. GOVERNME
EMPLOYEES ONLY

COMPENSATION CLAIM

ABOUT THE WORKER

Given or Christian Names

Family Name

Residential Address

Post Code

Telephone No. | Sex | Date of Birth

Name and Address of Employer at time of accident

Post Code

Is the employer your current employer? Yes/No

Was time lost from work due to injury? Yes/No

INJURY DETAILS

Date of injury

Time of injury am/pm

If you stopped work due to injury—Date stopped work | Time

Place where injury occurred (e.g. machine shop).

What injury(ies) or condition did you suffer?

Name of certifying Doctor (if applicable)

What parts of the body were affected? (e.g. upper arm, lower back)

WHAT HAPPENED?

How did the accident occur, and what were you doing at the time? (e.g. slipped while climbing a ladder.)

*Country of Birth

*English Proficiency

*Years of Residence in Australia (if born overseas)

Language spoken at home

Interpreter required Yes/No

DECLARATION

I,

the undersigned, declare that the details above and any details specified on the pink page are specified to the best of my knowledge, information and belief.

Date | Signature

Injured worker or person

OTHER SIMILAR INJURIES

Have you previously suffered any similar work-related injury or condition? Yes No

If yes, give details

1 Date | Name of Employer

Nature of Injury

2 Date | Name of Employer

Nature of Injury

Non work-related injury details

OTHER CURRENT EMPLOYERS

Do you have any other employment? Yes No

If yes give details

1 Name of Employer — in full

Address

2 Name of Employer — in full

Address

JOURNEY INJURIES

Complete only if the injury was caused while travelling to or from place of employment

What mode of transport were you using? (e.g. on foot, car, bus.)

Vehicle Reg. No (if applicable)

Where were you travelling from?

Time you

Where were you travelling to?

Medical Certificate attached Yes No

EMPLOYER'S SECTION

TO BE COMPLETED BY THE EMPLOYER

Employer Reg. No.

Location No.

Signature of Employer

Date

Date Notice Received

Name of person to whom notice was given

WorkCover Corporation

EMPLOYEES ONL.

WORKERS COPY

ABOUT THE WORKER

Given or Christian Names

Family Name

Residential Address

Post Code

Telephone No. | Sex | Date of Birth

Name and Address of Employer at time of accident

Post Code

Is the employer your current employer? Yes/No

Was time lost from work due to injury? Yes/No

INJURY DETAILS

Date of injury | Time of injury am/pm

If you stopped work due to injury—Date stopped work | Time

Place where injury occurred (e.g. machine shop).

What injury(ies) or condition did you suffer?

Name of certifying Doctor (if applicable)

What parts of the body were affected? (e.g. upper arm, lower back)

WHAT HAPPENED?

How did the accident occur, and what were you doing at the time? (e.g. slipped while climbing a ladder.)

*Country of Birth | *English Proficiency

*Years of Residence in Australia (if born overseas)

Language spoken at home

Interpreter required Yes/No

DECLARATION

I,

the undersigned, declare that the details above and any details specified on the pink page are specified to the best of my knowledge, information and belief.

Date | Signature

Injured worker or person

OTHER SIMILAR INJURIES

Have you previously suffered any similar work-related injury or condition?

If yes, give details Yes No

1 Date | Name of Employer

Nature of Injury

2 Date | Name of Employer

Nature of Injury

Non work-related injury details

OTHER CURRENT EMPLOYERS

Do you have any other employment? Yes No

If yes give details

1 Name of Employer — in full

Address

2 Name of Employer — in full

Address

JOURNEY INJURIES

Complete only if the injury was caused while travelling to or from place of employment

What mode of transport were you using? (e.g. on foot, car, bus.) | Vehicle Reg. No (if applicable

Where were you travelling from? | Time you

Where were you travelling to?

Medical Certificate attached Yes No

EMPLOYER'S SECTION

TO BE COMPLETED BY THE EMPLOYER

Employer Reg. No. | Location No.

Signature of Employer

Date | Date Notice Received

Name of person to whom notice was given

APPENDIX D

S.A. METROPOLITAN FIRE SERVICE

99 WAKEFIELD STREET ADELAIDE
TELEPHONE (08) 228 0633
FAX (08) 228 0838

IN REPLY
PLEASE QUOTE
MGS:SDH
DVN. Training

Inquiries M.G. Smith
Telephone
Date

Dear *Firefighter*,

As you may have read in the June Edition of Wordback, I am currently undertaking a Research Study of manual handling injuries within the Fire Service which have occurred since October, 1987.

Initially the study involves separating manual handling injuries from other injuries which have been reported. Next the manual handling injuries are classified into activity subgroups e.g. firefighting, drill, and sport. These groups are further divided to indicate what the injured person was doing at the time e.g. drill - using B/A, getting on/off an appliance, using hose, standpipe etc.

By classifying the mode of injury in this way, the statistics will be more specific and meaningful, and therefore the prevention strategy to be implemented as a result of this study will be more effective.

Your injury reported on the Workcover Form needs further clarification before I can categorise it into one of the subgroups mentioned above.

I would be most grateful if you could assist me when I ring you for this confidential information, however you are under no obligation to.

The United Firefighters Union supports my research, as it should reduce both the number and severity of manual handling injuries.

Your help would be greatly appreciated.

Yours sincerely

ROSE BOUCAUT

APPENDIX E

MANUAL HANDLING is defined as "any activity requiring the use of force exerted by a person to lift, push, pull, carry or otherwise move or restrain any animate or inanimate object". Wearing of heavy clothing or equipment is also a form of manual handling. There are few jobs which do not involve some form of manual handling.

(Worksafe Australia, 1989)

The following tasks from the Fire Fighters Skills Audit have been selected as they all involve manual handling.

When doing this activity, to what extent are you at risk of getting hurt : -

RISK CATEGORIES - Please CIRCLE

NIL	0	I would not be at any risk
	1	
MOD.	2	I would be at moderate risk
	3	
HI	4	I would be very much at risk

Duty: **STATION ROUTINE (1)**

Tasks:		RISK NIL		RISK MOD		RISK HI	
1.1	CLEAN STATION AREAS INCLUDING MESS ROOM AND APPLIANCES	0	1	2	3	4	1.1
1.2	CLEAN BATHROOM AREAS	0	1	2	3	4	1.2
1.3	CLEANING ENGINE ROOM FLOORS, WINDOWS AND WET AREAS	0	1	2	3	4	1.3
1.4	MOWING LAWNS PRUNING WEEDING	0	1	2	3	4	1.4
1.5	STACKING AND MOVING STORES	0	1	2	3	4	1.5
1.6	CLEAN INTERIOR/EXTERIOR OF APPLIANCE INCLUDING ALL EQUIPMENT	0	1	2	3	4	1.6
1.7	PUMP TESTING & EQUIPMENT TESTING	0	1	2	3	4	1.7
1.8	CHECK ALL FACETS OF VEHICLE OPERATION TOOLS/LIGHTS/ASSOCIATED EQUIP	0	1	2	3	4	1.8
1.9	HOSE WASHING HOSE DRYING HOSE TESTING HOSE TAGGING FOR REPAIRS	0	1	2	3	4	1.9
1.10	OBTAIN NOMINAL ROLL & AIR SET TALLIES	0	1	2	3	4	1.10
1.11	CLIMBING OUT OF APPLIANCE	0	1	2	3	4	1.11
1.12	APPLIANCE ACCESS - CABIN	0	1	2	3	4	1.12
1.13	APPLIANCE ACCESS - ROOF	0	1	2	3	4	1.13
1.14	LOADING HOSE BOXES INTO APPLIANCE	0	1	2	3	4	1.14
1.15	DRILL- TOWER EXERCISES - CLIMBING	0	1	2	3	4	1.15
1.16	STAIRS	0	1	2	3	4	1.16
1.17	LIFTING GEAR FROM TOP OF APPLIANCE	0	1	2	3	4	1.17
1.18	USING FIRE POLES IN STATIONS WHERE FITTED	0	1	2	3	4	1.18
1.19	REMOVING GEAR FROM / REPLACING GEAR IN LOCKERS (E.G. GENERATOR)	0	1	2	3	4	1.19
1.20	OTHER (SPECIFY)...	0	1	2	3	4	1.20

Duty: ***COMMUNICATIONS*** (2)

Tasks:		NIL		RISK MOD		HI	
2.1	CLIMBING ONTO ROOF OF BUS (900)	0	1	2	3	4	2.1
2.2	INSTALLING RADIO AERIAL ON COMMUNICATIONS BUS	0	1	2	3	4	2.2
2.3	ERECTING AERIALS (IN GENERAL)	0	1	2	3	4	2.3
2.4	USING / REACHING TO USE ELECTRICAL COMMUNICATIONS (HANDSET)	0	1	2	3	4	2.4
2.5	MOVING GENERATOR ONCE SET UP AND RUNNING	0	1	2	3	4	2.5
2.6	OTHER (SPECIFY)...	0	1	2	3	4	2.6

Duty: ***ADMINISTRATION (3)***

Tasks:		NIL					
3.1	MOVING OFFICE AND TRAINING EQUIPMENT	0			3	4	3.1
3.2	OTHER (SPECIFY)..	0	1	2	3	4	3.2

Duty: **FIRST AID (4)**

Tasks:		NIL		MOD		HI	
4.1	OPERATE ALL PIECES OF EQUIPMENT	0	1	2	3	4	4.1
4.2	CONDUCT BASIC FIRST AID TREATMENT D.R.A.B.C.	0	1	2	3	4	4.2
4.3	TRANSPORT EQUIPMENT	0	1	2	3	4	4.3
4.4	CONDUCT TREATMENT TO AVOID INFECTIOUS DISEASES	0	1	2	3	4	4.4
4.5	OTHER (SPECIFY)...	0	1	2	3	4	4.5

Duty: **OCCUPATIONAL HEALTH & SAFETY (5)**

Tasks:		NIL		RISK MOD		HI	
5.1	OPERATE USE AND WEAR ALL SAFETY EQUIPMENT & GEAR	0	1	2	3	4	5.1
5.2	FITNESS ACTIVITIES - GYM	0	1	2	3	4	5.2
5.3	FITNESS ACTIVITIES - SPORT	0	1	2	3	4	5.3
5.4	OTHER (SPECIFY)...	0	1	2	3	4	5.4

Duty: **PERSONAL PROTECTION (6)**

Tasks:		NIL		RISK MOD		HI	
6.1	DONNING/ WEARING BREATHING APPARATUS	0	1	2	3	4	6.1
6.2	DONNING/WEARING HELMET	0	1	2	3	4	6.2
6.3	DONNING/WEARING BUNKER COAT	0	1	2	3	4	6.3
6.4	DONNING/WEARING BOOTS	0	1	2	3	4	6.4
6.5	DONNING/WEARING GLOVES	0	1	2	3	4	6.5
6.6	DONNING/WEARING CHEMICAL/GAS/SPLASH SUITS	0	1	2	3	4	6.6
6.7	TESTING & MAINTENANCE PROCEDURES ON CHEMICAL RESISTANCE ENCLOSURES	0	1	2	3	4	6.7
6.8	CORRECT USE OF COMPRESSOR & OPERATIONAL PROCEDURE FOR RECHARGING CYLINDERS	0	1	2	3	4	6.8
6.9	OPERATING AIRLINE EQUIPMENT	0	1	2	3	4	6.9
6.10	OTHER (SPECIFY)..	0	1	2	3	4	6.10

Duty: **FIRE PREVENTION** (7)

Tasks:		NIL		MOD		HI	
7.1	CONDUCT FLOW TESTS ON HYDRANT SYSTEMS	0	1	2	3	4	7.1
7.2	CONDUCT BUILDING INSPECTIONS	0	1	2	3	4	7.2
7.3	USING EXTINGUISHERS	0	1	2	3	4	7.3
7.4	USING HOSE LINES IN BUILDING STAIRWELLS - TESTING	0	1	2	3	4	7.4
7.5	EQUIPMENT HANDLING - DEMONSTRATIONS	0	1	2	3	4	7.5
7.6	OTHER (SPECIFY)..	0	1	2	3	4	7.6

Duty: **FIRE GROUND OPERATIONS (8)**

Tasks:

		RISK					
		NIL		MOD		HI	
	LADDERS						
8.1	CORRECT PLACEMENT PITCHING AND FOOTING LADDERS	0	1	2	3	4	8.1
8.2	REMOVING/REPLACING LADDERS FROM APPLIANCES	0	1	2	3	4	8.2
	SALVAGE						
8.3	OPERATING THE PRESERVAC UNIT	0	1	2	3	4	8.3
8.4	REMOVAL OF DEBRIS	0	1	2	3	4	8.4
8.5	TURNING OVER/OVERHAUL	0	1	2	3	4	8.5
	OPERATION OF SMALL GEAR						
8.6	SHIP WATER GEAR	0	1	2	3	4	8.6
8.7	REMOVE THE MONITOR FROM THE APPLIANCE AND SET	0	1	2	3	4	8.7
8.8	EXTINGUISH IGNITION SOURCES	0	1	2	3	4	8.8
8.9	USING EXTINGUISHING AGENTS	0	1	2	3	4	8.9
8.10	EFFICIENTLY USE BRANCH	0	1	2	3	4	8.10
8.11	USING FIRST AID LINES	0	1	2	3	4	8.11
	PUMP						
8.12	PUMP OPERATIONS AND OBTAINING WATER EQUIPMENT	0	1	2	3	4	8.12
8.13	CONNECTING TO PUMP PANEL	0	1	2	3	4	8.13
8.14	PUMP TO BOOSTER POINTS	0	1	2	3	4	8.14

Duty : **FIRE GROUND OPERATIONS (8).(cont).**

		RISK					
		NIL		MOD		HI	
	HOSE OPERATION						
8.15	BACKING UP HOSE LINES	0	1	2	3	4	8.15
8.16	HOSE LINE MOVEMENT OVER FLAT GROUND	0	1	2	3	4	8.16
8.17	HOSE LINE MOVEMENT IN OBSTRUCTED AREAS	0	1	2	3	4	8.17
8.18	HOSE LINE MOVEMENT ALOFT/DESCENT	0	1	2	3	4	8.18
8.19	LAYING HOSE TO PUMPS FOR CONNECTION I.E.RELAYS/REVERSE HOSE LAYS ETC.	0	1	2	3	4	8.19
	FORCED ENTRY						
8.20	FORCIBLE ENTRY TECHNIQUES	0	1	2	3	4	8.20
	VENTILATION						
8.21	REMOVAL OF ROOF CLADDING	0	1	2	3	4	8.21
8.22	VENTILATE STRUCTURES TO REMOVE SMOKE & FLAME GASES	0	1	2	3	4	8.22
	OTHER EQUIPMENT						
8.23	USING ROPES	0	1	2	3	4	8.23
8.24	USING STRETCHERS	0	1	2	3	4	8.24
8.25	USING EXTINGUISHERS	0	1	2	3	4	8.25
8.26	USING SHOVELS / RAKES	0	1	2	3	4	8.26
8.27	SET UP PLANT START GENERATOR MAKE CONNECTIONS	0	1	2	3	4	8.27
8.28	DEFINE COMBATANT ZONE, EVACUATE PUBLIC	0	1	2	3	4	8.28
8.29	LAYOUT ROAD CONES	0	1	2	3	4	8.29
	FIRE CAUSE						
8.30	IDENTIFY THE CAUSE(S) OF INCIDENTS	0	1	2	3	4	8.30
8.31	INDICATE POINT OF ORIGIN OF A FIRE	0	1	2	3	4	8.31
8.32	INDICATE EVIDENCE OF ORIGIN OF FIRE	0	1	2	3	4	8.32
8.33	OTHER (SPECIFY)..	0	1	2	3	4	8.33

Duty: **SALVAGE (9)**

Tasks:

		RISK					
		NIL		MOD		HI	
9.1	SET UP AIR EXTRACTOR	0	1	2	3	4	9.1
9.2	PUMP OUT BASEMENT, CELLAR, SHIPS HOLDS	0	1	2	3	4	9.2
9.3	REMOVING LIQUIDS WITH SCOOPS AND SQUEEGEES	0	1	2	3	4	9.3
9.4	ASSEMBLE EJECTOR PUMP, PLACE IN AREA, OPERATE	0	1	2	3	4	9.4
9.5	USING SALVAGE SHEET	0	1	2	3	4	9.5
9.6	SET UP ANGUS TURBEX WATER TURBINE	0	1	2	3	4	9.6
9.7	OPERATE SALVAGE & SCAVENGER PUMPS	0	1	2	3	4	9.7
9.8	USE VERTICAL (ROOF) LATERAL (WINDOW, DOORS) FORCED (ELECTRIC FAN) VENTING	0	1	2	3	4	9.8
9.9	SHOVELLING, RAKING DURING OVERHAUL	0	1	2	3	4	9.9
9.10	OPERATE FORCIBLE ENTRY TOOLS	0	1	2	3	4	9.10
9.11	OPERATE PNEUMATIC AND ELECTRIC HAMMER TOOLS	0	1	2	3	4	9.11
9.12	MANUAL PUMPS - USING RUST INHIBITORS	0	1	2	3	4	9.12
9.13	OTHER (SPECIFY)..	0	1	2	3	4	9.13

Duty: **DANGEROUS SUBSTANCE (10)**

Tasks:		NIL		RISK MOD		HI	
10.1	DONNING CLOTHING AFTER INCIDENTS/DECONTAMINATION	0	1	2	3	4	10.1
10.2	SETTING UP DECONTAMINATION EQUIPMENT	0	1	2	3	4	10.2
10.3	SET UP ENTRY CONTROL POINTS	0	1	2	3	4	10.3
10.4	SET UP ZONE DECONTAMINATION	0	1	2	3	4	10.4
10.5	UNDRESSING PERSONNEL DURING DECONTAMINATION	0	1	2	3	4	10.5
10.6	CORDONING OFF AREA	0	1	2	3	4	10.6
10.7	TRANSPORT & DISPOSE OF DANGEROUS SUBSTANCE	0	1	2	3	4	10.7
10.8	LOCATE DRAINS OR CONTAIN SUBSTANCES	0	1	2	3	4	10.8
10.9	ASSIST WEARERS DURING DONNING OF PROTECTIVE CLOTHING	0	1	2	3	4	10.9
10.10	TRANSPORTING DANGEROUS SUBSTANCE EQUIPMENT TO AND FROM INCIDENTS	0	1	2	3	4	10.10
10.11	HANDLING OF TRANSPORT DRUMS/OVERDRUMS	0	1	2	3	4	10.11
10.12	LIFT AND REPLACE AIRSETS USED AT INCIDENTS	0	1	2	3	4	10.12
10.13	REMOVE DECONTAMINATION SHOWER FROM APPLIANCE	0	1	2	3	4	10.13
10.14	OTHER (SPECIFY)...	0	1	2	3	4	10.14

Duty: **EQUIPMENT TESTING (11)**

Tasks:

		NIL		RISK MOD		HI	
11.1	SERVICE/CLEAN/INSPECT VEHICLE (INITIAL CHECKS)	0	1	2	3	4	11.1
11.2	OPERATE APPLIANCE PUMP AS PER WEEKLY TEST ROUTINE	0	1	2	3	4	11.2
11.3	ADD SOLUBLE OIL & CIRCULATE TO TANK ETC. OPERATE VALVES CLEAN	0	1	2	3	4	11.3
11.4	TEST ALL SMALL GEAR VISUALLY AND MANIPULATE ALL TOOLS ETC.	0	1	2	3	4	11.4
11.5	EXTENDING INSPECTING GREASE CLEANING OF LADDERS	0	1	2	3	4	11.5
11.6	CLEANING LUBRICATING SMALL GEAR	0	1	2	3	4	11.6
11.7	CHECK 464 OPERATIONS LUBRICATE & CLEAN	0	1	2	3	4	11.7
11.8	OPERATE ALL MOVING PARTS VISUAL CHECK FOR DAMAGE ON HYDRAULIC RESCUE EQUIPMENT	0	1	2	3	4	11.8
11.9	OPERATE ALL MOVING PARTS VISUAL CHECK FOR DAMAGE ON MANUAL RESCUE EQUIPMENT	0	1	2	3	4	11.9
11.10	CHECK OIL RADIATOR WATER TANK WATER TYRES START ENGINE	0	1	2	3	4	11.10
11.11	ACCESS TO CHECK BATTERIES	0	1	2	3	4	11.11
11.12	OPERATE ALL MOVEMENTS CHECK FUEL OIL ON THE RAPID INTERVENTION EQUIPMENT	0	1	2	3	4	11.12
11.13	OPERATE CHAINSAWS / DISC CUTTERS	0	1	2	3	4	11.13
11.14	OPERATE ENERPAC AT INCIDENTS	0	1	2	3	4	11.14
11.15	OTHER (SPECIFY)...	0	1	2	3	4	11.15

Duty: **DRIVING & SITING (12)**

Tasks:		NIL		RISK MOD		HI	
12.1	OPERATE DEVICES FITTED TO VEHICLES	0	1	2	3	4	12.1
12.2	OPENING LOCKERS ON VEHICLES	0	1	2	3	4	12.2
12.3	DONNING GEAR WHILE IN APPLIANCE	0	1	2	3	4	12.3
12.4	DRIVING NON-POWER STEERING VEHICLES	0	1	2	3	4	12.4
12.5	MANUAL GEAR CHANGING OF APPLIANCE	0	1	2	3	4	12.5
12.6	OTHER (SPECIFY)..	0	1	2	3	4	12.6

Duty: **GENERAL APPLIANCES (13)**

Tasks:		NIL		RISK MOD		HI	
13.1	PHYSICAL ASPECTS OF APPLIANCE OPERATION	0	1	2	3	4	13.1
13.2	CONNECT SUPPLY LINES REQUIRED (IE 1,2 ETC)-OPERATE PUMP	0	1	2	3	4	13.2
13.3	REMOVE & REPLACE IN CORRECT SEQUENCE HP REELS CHECK HOSE & COUPLINGS	0	1	2	3	4	13.3
13.4	ENGAGE VALVES LEVERS ON THE PUMP PANEL	0	1	2	3	4	13.4
13.5	DISCONNECT COUPLINGS /CONNECT COUPLINGS/SUPPLY WATER EQUIPMENT	0	1	2	3	4	13.5
13.6	COMPLETE HOSE LAYS FORWARD AND REARWARD	0	1	2	3	4	13.6
13.7	OBTAIN A LIFT FROM OPEN WATER USING SUCTION HOSE	0	1	2	3	4	13.7
13.8	OPERATE CABIN CONTROLS	0	1	2	3	4	13.8
13.9	SITING / EXTENDING SKYJET	0	1	2	3	4	13.9
13.10	CARRYING LADDERS	0	1	2	3	4	13.10
13.11	CLEAN & CHECK ALL EQUIPMENT CARRIED ON GP PUMPS	0	1	2	3	4	13.11
13.12	OTHER (SPECIFY)...	0	1	2	3	4	13.12

Duty : **AERIAL AND SPECIAL APPLIANCES** (14)

Tasks :		NIL		MOD		HI	
	AERIAL APPLIANCES						
14.1	OPERATING AERIAL APPLIANCES	0	1	2	3	4	14.1
14.2	USING SAFETY GEAR	0	1	2	3	4	14.2
14.3	CARRYOUT THE ROUTINE CHECKS	0	1	2	3	4	14.3
14.4	CHECK BATTERIES ON APPLIANCES	0	1	2	3	4	14.4
14.5	CLIMBING ON/OFF PULPITS OF AERIAL APPLIANCES	0	1	2	3	4	14.5
14.6	OTHER (SPECIFY)..	0	1	2	3	4	14.6
	FOAM TRUCK						
14.7	CARRYOUT LOADING/OFF LOADING & TRANSPORTING	0	1	2	3	4	14.7
14.8	OPERATE RATCHETS AND STRAPS	0	1	2	3	4	14.8
14.9	USING ELECTRIC TAIL GATE	0	1	2	3	4	14.9
14.10	SHIFTING EQUIPMENT ON FOAM TRUCK	0	1	2	3	4	14.10
14.11	USING TIE DOWNS	0	1	2	3	4	14.11
14.12	MOVING/SHIFTING FOAM DRUMS	0	1	2	3	4	14.12
14.13	CORRECT PLACEMENT OF DRUMS ON TRAY OF VEHICLE	0	1	2	3	4	14.13
14.14	CHECK COOLANT, OIL, LIGHTS, EQUIPMENT ON THE FOAM TRUCK	0	1	2	3	4	14.14
14.15	RETRIEVE EQUIPMENT FROM INSIDE THE FOAM POD ON THE FOAM TRUCK	0	1	2	3	4	14.15
14.16	OTHER (SPECIFY)..	0	1	2	3	4	14.16
	FORKLIFT						
14.17	GETTING ON AND OFF FORKLIFT	0	1	2	3	4	14.17
14.18	DRIVING OPERATING AIMING FORKLIFT	0	1	2	3	4	14.18
14.19	ADJUSTING FORK WIDTH	0	1	2	3	4	14.19
14.20	CHANGE GAS CYLINDER AS REQUIRED ON THE FORKLIFT	0	1	2	3	4	14.20
14.21	OTHER (SPECIFY)..	0	1	2	3	4	14.21

Duty: **RESCUE (15)**

Tasks:

		RISK					
		NIL		MOD		HI	
15.1	OPERATE RESCUE HARNESSES	0	1	2	3	4	15.1
15.2	USE RESCUE EQUIPMENT JACKING SPREADING LIFTING	0	1	2	3	4	15.2
15.3	LAY GUIDELINES FOR ROOM SEARCHES AREA SEARCHES	0	1	2	3	4	15.3
15.4	STABILISE VEHICLE	0	1	2	3	4	15.4
15.5	OPERATE FOAM EQUIPMENT	0	1	2	3	4	15.5
15.6	SET UP GUIDELINES/BA ENTRY CONTROL POINTS	0	1	2	3	4	15.6
15.7	LIFTING/REMOVING VICTIMS	0	1	2	3	4	15.7
15.8	LADDER HINGE RESCUE TECHNIQUE	0	1	2	3	4	15.8
15.9	SEARCH WALL CAVITY/ROOFS	0	1	2	3	4	15.9
15.10	EXTRICATION OF TRAPPED/INJURED PERSONS	0	1	2	3	4	15.10
15.11	PERFORM SELF RESCUE SAFELY	0	1	2	3	4	15.11
15.12	ENTERING LIFT USE OF F/F'S LIFT KEYS	0	1	2	3	4	15.12
15.13	USE ROPES/KNOTS/LINES/WINCHING TECHNIQUES	0	1	2	3	4	15.13
15.14	VARIOUS SINGLE & TWO PERSON CARRIES & USE OTHER EQUIP BLANKETS/ROPES/CHAIRS	0	1	2	3	4	15.14
15.15	SHORING TECHNIQUES	0	1	2	3	4	15.15
15.16	WORK IN CONFINED SPACES	0	1	2	3	4	15.16
15.17	OTHER (SPECIFY)..	0	1	2	3	4	15.17

Duty: **SPECIAL SERVICES** (16)

Tasks:		NIL		MOD		HI	
16.1	ERECT AND TIE DOWN TENTS	0	1	2	3	4	16.1
16.2	USE OF KNAPSACKS/HOSES/RAKES ETC FOR BUSHFIRES	0	1	2	3	4	16.2
16.3	OTHER (SPECIFY)..	0	1	2	3	4	16.3

Duty: **SMALL GEAR (17)**

Tasks:		NIL		RISK MOD		HI	
17.1	ASCEND DESCEND LADDERS	0	1	2	3	4	17.1
17.2	OPERATE LADDER COMPONENTS RECOGNISE DEFECTS WHILE SERVICING	0	1	2	3	4	17.2
17.3	COVERING/ TIEING DOWN SALVAGE SHEET	0	1	2	3	4	17.3
17.4	USE CROWBAR	0	1	2	3	4	17.4
17.5	USE OF HAMMERS	0	1	2	3	4	17.5
17.6	USE OF SCREWDRIVERS	0	1	2	3	4	17.6
17.7	USE OF ECLIPSE SAWS	0	1	2	3	4	17.7
17.8	USE OF PLIERS	0	1	2	3	4	17.8
17.9	WIELD A SLEDGE HAMMER	0	1	2	3	4	17.9
17.10	OTHER (SPECIFY)...	0	1	2	3	4	17.10

APPENDIX F

TASKS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Don turnout gear from ground																		
2. Don turnout gear in appliance																		
3. Remove ladder from appliance																		
4. Check oil (above wheel)																		
5. Check oil (under bonnet)																		
6. Move 200L drums																		
7. Remove ground monitor																		
8. Go down fire pole																		
9. Fill out nominal roll																		
10. Fill out air tag tallies																		
11. Open/close locker doors																		
12. Move charged hose aloft																		
13. Roll charged hose aloft																		
14. Get in/out of appliance																		
15. Shipping standpipe																		
16. Remove small gear (generator) from locker and start it up																		
17. Move training dummy = 45kg																		
18. Drill tower exercises																		
19. Donning breathing apparatus from appliance bracket																		
20. Donning breathing apparatus from ground																		
21. Vehicle Rescue																		
22. Using a fire extinguisher																		
23 Overhaul																		

Task	Judge1	Judge2	Judge3	Judge4	Judge 5	Judge 6	Judge 7	Judge 8	Judge 9	Judge 10	Judge 11	Judge 12	Judge 13	Judge 14	Judge 15
1	3	3	4	3	3	3	6	7	2	3	2	2	5	11	12
2	3	3	1	3	4	3	6	7	2	3	1	2	9	11	13
3	9	7	4	4	2	5	8	4	6	8	7	6	12	12	15
4	6	4	7	3	7	2	1	3	4	3	4	8	7	9	10
5	2	4	1	2	2	2	1	3	0	3	0	5	4	2	9
6	8	9	10	6	12	8	8	7	8	7	7	7	11	10	13
7	10	10	9	9	9	5	13	6	7	10	7	8	9	12	13
8	1	2	4	1	12	3	7	1	1	0	1	1	5	4	10
9	4	3	3	3	2	8	8	2	3	5	4	1	6	10	7
10	4	3	6	4	2	4	8	2	4	3	4	0	7	8	10
11	4	4	5	5	6	6	9	2	6	5	5	0	9	8	10
12	16	14	16	13	15	15	16	11	13	10	9	11	12	14	15
13	13	15	15	14	12	12	13	10	10	7	3	7	11	13	15
14	4	2	2	2	3	7	3	6	2	3	2	0	4	4	8
15	11	7	9	7	7	9	9	5	7	6	7	4	10	10	12
16	5	4	6	5	9	4	3	1	2	3	2	2	10	8	9
17	15	14	15	13	15	14	13	12	13	11	11	11	14	13	13
18	12	12	12	16	17	9	11	13	12	12	10	11	13	16	17
19	4	4	4	5	7	3	2	0	2	3	2	3	7	12	11
20	9	9	10	7	12	7	9	4	7	8	5	5	11	13	13
21	15	13	10	11	16	14	11	7	13	11	11	8	13	15	16
22	5	2	6	6	9	6	2	0	4	6	0	3	5	9	12
23	14	14	14	16	15	13	10	9	12	13	13	11	13	15	17

Judge (n) = Panellist (n)

Individual panel members checklist scores for each firefighting task on the video.