Slip, trip and fall accidents during the delivery of mail: risk factors and interventions

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Slip, trip and fall accidents during the delivery of mail: risk factors and interventions

by

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1998
Abstract

This thesis considers the problem of slip, trip and fall accidents (STFA) occurring during the delivery of mail. Its aims are to identify key risk factors and effective countermeasures. 'Falls outdoor' are the largest cause of accident and lost time within the delivery function of the Royal Mail, making up approximately 28% of accidents at work. The Royal Mail also has a poor safety record compared to other organisations for this type of accident.

The research project comprised five studies. The first four studies examined the role of individual, task-related and environmental (physical and organisational) factors in delivery STFA risk. The final study considered the selection, design and implementation of a programme of intervention to impact on key risk factors identified in earlier research. The entire project was undertaken within the Midlands Division of the Royal Mail.

The first study involved analysis of in-house accident data relating to 1734 delivery STFA cases reported during a two year period, and a sample of 237 accident reports. Nearly two-thirds of delivery STFA occurred while the employee was walking on the level, and 19% while ascending or descending steps. Over 50% of falls resulted from slips, with ice, snow and wet underfoot surfaces the main hazards. Accidents involving ice and snow tended to cluster into relatively short time periods. Approximately one-quarter of delivery STFA resulted from trips, with major hazards including uneven paving, obstacles on the walking surface and kerbs. Female Postal Delivery Officers (PDO) incurred incidence rates significantly higher than those of their male colleagues. Analysis of accident reports revealed delivery STFA occurred most commonly on householders' premises.

Accident-independent investigations undertaken in the second study involved a series of focus groups with PDO, interviews with senior management and safety personnel, and a 'short questionnaire' survey of PDO and delivery office managers. In all cases, respondents were asked to provide information regarding factors they believed increased the risk of delivery STFA. This research was exploratory in nature, and identified a range of possible behavioural, task-related and management risk factors.
The third study involved detailed interviews with 40 STFA-involved PDO. The main purpose of the study was to consider the role of risk factors identified in accident-independent research. Interviews took place at the site of the accident. 'Avoidable' environmental hazards, such as damaged paving and inadequate lighting, were involved in 38% of delivery STFA. Footwear used by employees who had slipped had completely worn tread in 75% of cases. Some form of unsafe behaviour or work practice was being used at the time of the accident in 60% of cases. At the time of the accident, one-third of accident-involved PDO were rushing in slippery conditions, and 40% reading letter addresses for the next delivery point while walking.

The fourth study investigated the use of safety practices relevant to delivery STFA by Delivery Office Managers (DOM). Telephone interviews with managers of 20 'matched' high and low accident-incidence rate offices were undertaken to investigate DOMs' use of 'desirable' safety practices. Managers of low accident-incidence rate delivery offices were found to undertake more thorough accident investigations, to more often take preventive actions, and to spend more time communicating safety issues to PDO. Management actions to protect PDO from exposure to hazardous conditions during severe weather were found to be limited to changes in working practices which did not affect quality of service for the first delivery round.

The final study was concerned with the selection, design and implementation of a programme of intervention. Intervention measures were research-led; designed to reduce the impact of key risk factors identified in previous project research. Participative methods used for the selection and design of interventions included senior safety and operations management focus groups, and 'intervention comment questionnaires' with senior safety managers and DOM. Recommended intervention measures targeted STFA risks at three levels: slip resistance (superior occupational footwear and footwear attachments), exposure to hazardous conditions (e.g. adverse weather practice, hazard reporting and feedback form) and employee behaviour in the face of hazardous conditions (e.g. training workshops and behaviour modification techniques). The use of a participative approach to intervention selection and design allowed safety measures to be placed successfully within the organisational context of the Royal Mail.
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Chapter One

INTRODUCTION

1.1 Chapter summary

This chapter introduces the research problem and research presented in the thesis. It begins with the problem statement, outlining the scale of the slip, trip and fall accident problem within the delivery function of the Royal Mail. A brief description of the Royal Mail organisation follows, and key aspects of the job and tasks of the postal delivery employee are described. Next, the research aims are specified, and the project committee and its various roles introduced. The approach taken to project research is considered and project methodology described. Finally, a chapter by chapter outline guide to the thesis is provided.

1.2 Problem statement

The Royal Mail's in-house accident data show 'falls outdoors' (slip, trip and fall accidents during the delivery of mail) to be the largest cause of accident and lost time within the delivery function. Figures 1.1 and 1.2 show the distribution of accident types and days lost for the delivery function of Royal Mail Midlands (the project sponsors) for a 12 month period: April 1994 to March 1995. These figures are typical of those produced annually for all nine Royal Mail divisions, showing 'falls outdoors' to comprise 28% of accidents, and to be the cause of 36% of days lost due to injuries incurred by postal delivery officers (PDO).

The extent of the slip and trip problem among PDO may be considerably greater than these figures suggest, however. 'Falls indoors' make up approximately 4% of accidents to PDO. Moreover, a large proportion of accidents which involve slipping or tripping are recorded by administration personnel under different accident categories. For example, it is known that many accidents recorded as 'stepping on/striking against' have a slip or trip as the initiating event. Falls while working with a vehicle or cycle are also usually classified as non-fall accidents.
Figure 1.1. Distribution of accidents by 'cause' for delivery function of Royal Mail Midlands, for the period April 1994-March 1995

Figure 1.2. Distribution of days lost by accident cause for delivery function of Royal Mail Midlands, for the period April 1994-March 1995
Based on these arguments, it is suggested slip and trip and fall accidents (STFA) may comprise up to 50% of accidents within the delivery function of the Royal Mail.

The Royal Mail also appear to compare poorly with other organisations for slipping, tripping and falling accidents on the level (STFL). According to Health and Safety Executive figures (HSE, 1994), for those industries where a significant number of over 3 day injuries caused by STFL were reported, highest incidence rates occurred in postal services and telecommunications.

Royal Mail Midlands estimate 'falls outdoors' cost the business approximately £400,000 per year in direct costs (1994 prices), and up to five times this figure when indirect costs (e.g. compensation costs) are taken into account. It is thought the national annual cost of such accidents to the Royal Mail might be as much as £3 million in direct costs alone.

Apart from the financial effect, a number of human and quality issues are associated with delivery STFA. The more serious of these accidents can cause permanent injury, and the propensity for such accidents to occur is not conducive to employment satisfaction. From the point of view of quality of service, falls occurring to one or more PDO at a local delivery office can seriously affect delivery performance on the day in question.

STFA during the delivery of mail are, therefore, a major problem for the Royal Mail. The business' understanding of why these accidents occur in such numbers is limited, although senior management hold the belief that falls are viewed by many employees and managers as an inevitable consequence of the task PDO are set. The major purpose of the project was to provide a clear understanding of the main risk factors which cause STFA among PDO, and recommendations for measures to reduce the incidence of these accidents.
1.3 The Royal Mail

1.3.1 The organisation
The Royal Mail is responsible for the collection, sorting and delivery of letters and parcels throughout the UK, as well as in a number of overseas countries. The business handles an average of approximately 63 million letters each working day, and a total of 15.7 billion letters per year. Mail is collected from over 120,000 points daily, and delivered to all the UK's 25 million addresses. The quantity of mail items handled by the Royal Mail has increased by over 50% during the past decade, despite the decline in the use of the letter as a means of social communication. This growth has been achieved largely as a result of the increase in the Royal Mail's business customer base.

The Royal Mail provides priority, insured and other specialist services, in addition to first and second class service deliveries, for business and private customers in the UK and abroad. There is a statutory obligation on the Royal Mail to provide a basic postal service to all UK addresses, however remote.

The Royal Mail business is currently undergoing large scale organisational and cultural changes, necessary in the face of the challenge from emerging competition from other delivery services and new information technology systems. These changes have affected both technical and social components of the organisation (e.g. improved national mail distribution network, high-speed mail processing technologies and the introduction of employee and management productivity initiatives). The strong Communication Workers Union (CWU) has had increasing influence over changes to working conditions and practices following recent industrial action.

1.3.2 The business structure
The Royal Mail is divided into nine regional Divisions, each with its own Director and General Manager. Royal Mail Midlands, the project hosts and sponsors, has its headquarters in Birmingham, and covers an area of 9,500 square miles. More than 80 million letters are handled each week, and nearly 20,000 staff are employed in the region to collect, sort and deliver this mail. Approximately 11,000 of these staff are PDO. The business has 125 delivery offices, serving 7.6 million social, and 55,000 business customers.
Each division is divided into three main functions: delivery, distribution and processing. Within the delivery function (with whom this project is primarily interested), the management structure is headed by a Director of delivery. Beneath the Director are several Area Operations Managers (having responsibilities within the delivery function, as well as for distribution and processing functions). Each main delivery area (based on county boundaries) within the Division has a Delivery Area Manager (DAM), who is responsible for all delivery offices within their area. Each delivery office is managed locally by a Delivery Office Manager (DOM). In all but the smallest offices the DOM is assisted by one or more Operations Managers or Higher Grade Postmen (PHG). Each delivery office has both full and part-time PDO who are responsible for 'walk' sorting (sorting the mail in the correct order for their delivery) and undertaking delivery rounds. The area served by each delivery office is divided into delivery routes ('walks'), known by number, and each walk is assigned to a PDO. Office sizes vary considerably, from several hundred PDO in city or town centre offices to just two or three PDO in remote rural districts.

1.3.3 Quality of service standards
Mail must be delivered in accordance with legislated standards of service and quality. Thus, delivery offices have to ensure at least 90% of first class mail items are delivered on the first working day following collection, and deliver a target percentage of first class mail before 9.30 am. The delivery process is part of a large distributed system, however, and is at the end of a long chain of processes and events which are beyond its control. Any delays in the arrival of mail to the delivery office from sorting offices around the country, or other system problems (e.g. adverse weather conditions), must be coped with by the DOM to ensure quality of service standards are achieved.

1.3.4 The work of postal delivery employees
The majority of 'falls outdoor' accidents are incurred by PDO. This section considers the nature of the work these employees undertake. Full-time PDO usually work 6 days per week, Monday to Saturday. The working day commences at about 5.30 am, and concludes around 12 noon. Daily tasks undertaken by PDO are outlined in the hierarchical task analysis diagram shown in figure 1.3, and include 'walk' sorting and two delivery rounds. Further comments on key aspects of the job and tasks of PDO are provided in table 1.1.
Figure 1.3. Postal delivery tasks
Table 1.1. Notes on the postal delivery job and tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>1. Walk sort mail for first delivery</td>
<td>Mail is sorted mechanically right down to the level of the individual walk. At this stage PDO are responsible for manually sorting mail into the order of their walks. Letters are distributed according to address into a sorting frame. Letters for the same address, or for groups of closely located addresses, are bundled together using elastic bands. Mail items are then loaded into a number of mail pouches. Each pouch should weigh no more than 16 kg. Mail pouches which cannot be transported around the walk by the PDO are given to drivers to transport to strategic 'drop points' on the walk.</td>
</tr>
<tr>
<td>2. Deliver sorted mail</td>
<td>Approximately 90 to 95% of daily mail items are delivered on the first delivery round. Deliveries commence from 6.45 am and finish at approximately 9.30 am. Tasks other than simple delivery may include emptying post boxes at designated collection times, and obtaining customers' signatures for special deliveries.</td>
</tr>
<tr>
<td>2.1. Travel to the start of walk</td>
<td>A number of methods are used to travel to the start of the delivery route. These include: walking, van, bicycle, private vehicle, scooter and public transport. Having arrived at the start of the walk, PDO will either walk around the delivery route or use a bicycle. Trolleys to carry mail are also used by some PDO working in areas close to the delivery office.</td>
</tr>
<tr>
<td>2.2. Deliver contents of first mail pouch</td>
<td>PDO identify delivery points on their routes by following the order of mail in their pouch: letter bundles are removed from the pouch and examined to determine the next delivery point. For deliveries to private dwellings, post is usually placed through a letter box situated on the front door (this is a different practice to that used by postal services in other countries, where mail is usually delivered to a box situated on the pavement or wall outside the residence). Business customers may expect mail to be brought into a premises and handed to a member of staff.</td>
</tr>
<tr>
<td>2.3. Pick up 2nd (and subsequent) pouch</td>
<td>Having delivered the first mail pouch PDO proceed to where subsequent pouches have been left at various 'drop points' en-route. These pouches are picked up and delivered. PDO rely on managers and van drivers to organise timely distribution of mail pouches at drop points. If the PDO is using a trolley, bicycle or vehicle, it may not be necessary to arrange such drops on the delivery route, as all pouches may accompany the PDO from the start of the round.</td>
</tr>
<tr>
<td>2.5. Return to office</td>
<td>Following delivery of the last letter PDO should return to the delivery office. The target time for delivery of the last letter is 9.30 am. PDO usually use the same method of travel as was used to get to the start of the walk. This may involve waiting for lifts or catching public transport.</td>
</tr>
<tr>
<td>3. Walk-sort mail for second delivery</td>
<td>Having had a break PDO sort the mail for second delivery. It is unusual for more than one pouch to be required, as only about 5% of mail is delivered on second delivery.</td>
</tr>
<tr>
<td>4. Delivery mail (second round)</td>
<td>Deliveries usually commence between 11 and 11.30 am, and conclude once the last item has been delivered. On completion of the second round PDO are free to go directly home, without returning to the office ('job and finish' practice).</td>
</tr>
</tbody>
</table>

### 1.4 The project

This section describes general and specific research aims. The project committee is introduced, and the roles of the committee outlined. The approach of the project and project methodology are summarised.

#### 1.4.1 Research aims

The general aims of the research were to provide a clear understanding of the main factors (or combinations of factors) which cause postal PDO to incur STFA, and to suggest measures to reduce the incidence and severity of these accidents. These general aims were agreed with the project committee (see
1.4.2) at the outset of the project. The project also had a number of specific objectives, formulated on the basis of the ergonomics approach to occupational accidents: i.e. accidents are a consequence of some mismatch between components of the worker-task-environment (social and organisational) system.

The specific objectives were as follows:

1) To identify employee population groups at greatest risk of incurring STFA and injuries from falls during the delivery of mail.

2) To identify the involvement of personal behaviour and working practices in STFA during the delivery of mail.

3) To identify features of the physical and ambient environment commonly involved in STFA during the delivery of mail.

4) To identify the suitability of footwear and equipment currently used by employees for the delivery task, with respect to the risk of STFA during the delivery of mail.

5) To identify the influence of management and organisational factors on delivery STFA risk

1.4.2 The project committee
The project committee was formed at the outset of the project, and met quarterly to review progress. The committee comprised six members:

1) The researcher
2) The researcher's university supervisor
3) Director of Personnel, Royal Mail Midlands
4) Delivery Director, Royal Mail Midlands
5) Divisional Safety Manager, Royal Mail Midlands
6) Head of Safety, Royal Mail HQ, London
The project committee had a number of roles:

1) To provide necessary information and resources to support project research activities.

2) To represent the interests of the research sponsors (the Royal Mail), Loughborough University and the researcher, regarding the nature of the research, methods used, and dissemination of research findings.

3) To consider quarterly progress reports from the researcher.

4) To provide a forum in which research findings could be discussed, and ideas concerning interventions considered from the view of existing business practice, systems and resources.

1.4.3 A participative approach to project research

In order to secure commitment to the project, an early presentation was made to the project committee. During discussions which followed the presentation, study aims were clarified, proposed study methods outlined, and project resources considered. Following this, further informational presentations were made to key members of the organisation who were likely to be involved in the study. These personnel included members of the Communications Workers Union (CWU), safety personnel of various levels and Delivery Area Managers (DAM). Finally, information about the study was disseminated throughout the organisation using letters from senior management. The letter introduced the study and researcher, outlined likely research activities, asked for co-operation from those asked to participate, and assured participants of confidentiality.

Employee and management participation was encouraged at all subsequent stages of the project. The advantages of such an approach are well recognised, and include the provision of a broad base of experience from which assessment and intervention can be developed, encouraging ownership of solutions, and ensuring co-operation (e.g. Haines and McAtamney, 1995; Wilson, 1995).
1.4.4 *An overview of project methodology*

The general approach of the project was based on an ergonomics systems model of occupational accidents: occupational accidents are viewed as a product of some mismatch between the individual worker, their task and equipment, and the environment (physical and organisational) in which they undertake their task. From this approach it was necessary to identify risk factors (and their interactions) for STFA during the delivery of mail as they relate to each of these system components. To achieve this, a variety of accident-centred and accident-independent, qualitative and quantitative, methods and techniques were used. A flow chart of project research and methods used is presented in figure 1.4.

1.5 *Outline of the thesis*

This section outlines the contents of remaining thesis chapters. A review of published literature related to STFA is presented in chapter two. The review focuses on STFA on the level, rather than falls from heights, as these are most relevant to the research problem. The chapter is organised around the central features of a general STFA model (Buck and Coleman, 1985), and considers STFA risk factors as they relate to the individual, their movement and task, and features of the physical and ambient environment. Chapter two concludes by outlining aspects of human information processing relevant to the research problem, and risk factors which are thought to be particularly relevant to the problem of STFA during the delivery of mail.

Chapters three to seven describe the five research studies which comprise the project (see figure 1.4). Chapter three reports the analysis of 1734 delivery STFA cases (Royal Mail Midland accident data for 'falls outdoor' for the period April 1994-March 1996), and a sample of 237 accident reports for delivery STFA occurring in three Midlands counties over a period of one year. Utilising information coded from 'one-line' descriptions of accident circumstances, activities of accident-involved employees, fall initiating events and hazards involved in delivery STFA were identified. In addition, the analysis considered employee population groups at greatest risk, and the time and location of delivery STFA.
Analysis of in-house accident data and reports to determine the involvement of 'fall initiating events' and hazards, the time and location of STFA, and staff at greatest risk.

Accident-independent investigations: interviews questionnaires and focus groups to identify possible behavioural, task, equipment, environmental and organisational factors.

Interviews with STFA-involved postal delivery officers to determine the contribution of risk factors identified in accident-independent research to a sample of delivery STFA.

Interview survey of local management safety practices to identify safety practices used by managers of very high and low accident rate delivery offices.

Key risk factors for delivery STFA: individual, task, equipment, environmental and organisational.

Selection of possible interventions - to impact on key risk factors.

Intervention survey

Focus group and questionnaire survey of senior management, safety managers and delivery office managers to determine views on possible interventions.

Intervention program design: content, materials, implementation plan, etc.

Figure 1.4. An overview of project methodology
Chapter four reports findings from accident-independent investigations, involving a series of focus groups with PDO, interviews with senior management and safety personnel, and a 'short questionnaire' survey of PDO and delivery office managers. In all cases, respondents were asked to provide information regarding factors they believed increased the risk of delivery STFA. This research was exploratory in nature, and identified a range of possible behavioural, task-related and management risk factors for STFA during the delivery of mail.

Chapter five presents findings from interviews with 40 fall accident-involved PDO. The main purpose of the study was to consider the role of risk factors identified in accident-independent research (chapter four) in delivery STFA. Specifically, the role of 'avoidable' environmental hazards, lighting, footwear, pouch weight, unsafe working practices, and management safety practices were considered. Detailed interviews took place as soon as possible after the accident occurred, and at the site of the accident. Accident events and contributory factors were recorded on 'events and contributory factors charts'. The chapter concludes by highlighting key risk factor interactions.

Research findings discussed in chapters four and five suggested management safety practice to have an important influence on the incidence of STFA during the delivery of mail. Chapter six reports a study investigating the use of safety practices relevant to delivery STFA prevention by DOM. In stage one of the study 'desirable' management safety practices were identified from preliminary interviews with senior managers and DOM, and a review of relevant literature. In stage two, telephone interviews with managers of 20 'matched' high and low accident-incidence rate offices were undertaken to considered managers' use of 'desirable' safety practices. Additional investigative methods included an analysis of managers' accident report forms to determine the quality of accident investigations. 'Desirable' safety practices considered in the study included accident investigation and prevention activities, adverse weather practice, hazard management, safety communications, supervision and equipment management.

Chapter seven is concerned with the selection, design and implementation of a programme of intervention to reduce the incidence of STFA during the delivery of mail. Interventions were research-led; designed to reduce the impact of key risk factors identified in previous project research. Methods for
the selection and design of interventions included consideration of published literature, focus groups and intervention comment questionnaires with senior management and safety personnel. The use of a participative approach to intervention selection and design allowed safety measures to be placed successfully within the specific organisational context of the Royal Mail.

Chapter eight provides a summary of project research. Key findings are reviewed in relation to the project aims outlined earlier in this chapter. Contributions to knowledge and directions for future research are suggested.
2.1 Chapter summary

A review of published literature related to STFA is presented in this chapter. The coverage of literature is weighted toward material which is considered relevant to the problem of STFA occurring during the delivery of mail. For this reason emphasis is given to STFA occurring on the level and in the outdoor environment. The review starts by considering the scale of the STFA problem within the United Kingdom and elsewhere. Next, accident data for STFA occurring across different industries are examined, and common features of high STFA risk occupations highlighted. Finally, statistics illustrating injuries resulting from STFA are presented.

The review continues by presenting a model for STFA (Buck and Coleman, 1985). The model is based on ergonomics and epidemiological approaches to accident causation: accidents are assumed to involve a series of events, and to be a product of some mismatch between the individual, their task and the environment in which they undertake their task. The key components of the model provide a framework for the subsequent discussion of literature: the review firstly considers the extent to which initiating events such as slips and trips are involved in STFA accidents; and secondly, factors related to the individual, their movement or task and the location of the accident.

Literature related to the movement of the accident-involved person is presented first. Much of this material is related to the problem of slipping. 'Walking normally' is identified as the most common activity immediately preceding STFA. The mechanics of human locomotion are briefly illustrated, and crucial gait cycle features for slipping and tripping accidents presented. Finally, the effects of common industrial tasks such as load carriage and manual exertion (e.g. pushing or pulling) on slipping and falling potential are considered.
Factors related to the individual are identified from published epidemiological studies concerned with the relative risk associated with various personal and lifestyle factors. In addition, the perceptual factors of vision and subjective assessment of slipperiness are considered, followed by an outline of psychophysiological theories of STFA.

The final section of the review outlines physical and ambient environmental factors associated with STFA location. The review considers the extent to which STFA occur indoors and outdoors, with particular reference to the effect of season on this factor. Next, the discussion focuses on slipping hazards, including snow, ice and liquid contaminants. The extent of involvement of these hazards in slipping accidents is considered, and measures for their control outlined. Other physical and environmental STFA hazards discussed are tripping hazards, particularly uneven walking surfaces, lighting and steps and stairways.

The chapter concludes by briefly outlining aspects of human information processing, not considered in the STFA literature, but thought relevant to the problem of falls to PDO. Finally, a summary of task and environmental risk factors considered most relevant to the problem of STFA among PDO is presented.

2.2 Terms and definitions

2.2.1 Slip, trip and fall accident terms
A number of terms are used in the published literature when talking about falling accidents. These include: slip, trip and fall accidents (STFA); slip, trip and fall accidents occurring on the level (STFL); slip and fall accidents; falling accidents; and underfoot accidents, which are defined as when the first unforeseen event is an interaction between the victim's foot and the substrate (Manning, 1983). These terms will be used interchangeably when discussing specific articles, although the term STFA will be used in general discussion.

2.2.2 Definition of 'falling'
Woodall and Cox (1993) describe STFA as common hazardous events. They point out that it is hard to find an adequate definition of STFA in the published literature, perhaps because of the diverse nature of this category of
accidents. For example, STFA may involve slipping, tripping or other initiating events, may or may not result in a fall, and may occur on the level or from a height. Definitions are provided for the term 'fall'. Thygerson (1977), for example, defines a fall as 'the act of dropping or descending in obedience to the laws of gravity, caused by either a loss of balance or loss of support from the environment.' Surry (1979) defines a fall as where 'an individual's centre of gravity moves, under the influence of gravity, to a lower position without the willingness of the victim.'

2.2.3 Definition of 'accident'
Most dictionary definitions state accidents are 'unintentional', 'unexpected' or 'chance' acts or events (Sanders and McCormick, 1993; Brown, 1995), although Brown (1995) notes accidents are often predictable, or at least explainable. For this reason it has been suggested the term 'incident' should replace 'accident'. Accident definitions also usually refer to the outcome or consequence of the accident event. For example, Salminen (1997) provides the following definition: 'an occupational accident is an unexpected and unintentional series of events leading to a physical injury of a person at work. This approach, while accounting for the sequential nature of accident events (Heinrich 1980), does not address the issue of causation. Brown (1995) argues the definition of an accident should be based on the fact that accidents may result from a combination of human, equipment and environmental factors. This approach is based on epidemiological and ergonomics theories of accident causation, in which the 'host' (the accident-involved person), an agent (a tool or technological system) and an environment (physical or social) act in conjunction to cause the accident. A definition which accommodates the notion of an accident as a sequence of events, having multiple causal factors and various possible outcomes is suggested: an occupational accident is an unexpected and unintentional series of events, that occurs through a combination of contributory factors; it may result in one of a number of possible outcomes, including physical harm, to an individual, damage to property, or a near miss.
2.3 Slip, trip and fall accidents: the scale of the problem at work, home and during leisure

Before turning to a review of published literature which considers factors relevant to STFA, the scale of the problem is illustrated, using occupational, home and leisure STFA statistics. Occupations in which STFA are most prevalent are identified, and reasons for the increased risk within these industries considered. Finally, statistics detailing injury type and location as a result of STFA are presented.

2.3.1 Statistics for occupational STFA

STFA make up a considerable proportion of all accidents at work. Health and Safety Commission (HSC) figures for 1995/6 show STFL to be the largest cause of injury to employees, representing approximately 35% of all major injuries and 20% of over 3 day injuries (HSC, 1996). The Health and Safety Executive (HSE, 1996) estimate the annual cost of STFL to employers to be £300 million, inclusive of damage costs, extra production costs, administration and insurance costs. The estimated cost to society is between £810 and £840 million annually.

Buck and Coleman (1985), from an analysis of accidents notified to the HSE in 1981 and 1982, estimate nearly 75,000 over 3 day injuries occur annually as a result of STFL. They note official figures for STFL underestimate the scale of the slipping and tripping problem, however, as injuries resulting from slips and trips are often classified under other accident types (e.g. slipping into the path of an on-coming vehicle, or tripping on an elevated platform and falling to a lower level). Substantial under reporting of occupational accidents to the HSE contributes further to this underestimation. The HSE (1994) report findings from the 1990 Labour Force Survey which suggests about one-third of non-fatal injuries are reported under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, 1985 (RIDDOR).

Other estimates of the annual scale of the STFA problem suggest Buck and Coleman's estimate may be too modest. Manning et al (1988), for example, calculated an estimate of the number of underfoot accidents (mostly slips, trips and ankle twists) occurring each year in the UK. By relating the number of lost-time injuries reported amongst a sample of 10,000 working Merseyside people to the working population of the UK, an estimate of 1.955 million
annual underfoot accidents was produced. Manning et al (1988) note this figure does not include the older population who are more vulnerable.

Table 2.1 shows the proportion of major injuries caused by a STFL for the years 1986/7-1993/4 (as reported to all enforcement authorities). The proportion of major injuries caused by STFL can be seen to have increased each year. This is largely due to a reduction in other accident types, but suggests major injury rates for STFL have not shown the same downward trend.

Table 2.1. Major injuries to employees caused by a slip, trip or fall on the same level (source: HSE, 1996).

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</tr>
</thead>
<tbody>
<tr>
<td>Major injuries caused by slip, trip or fall (n)</td>
<td>5480</td>
<td>5452</td>
<td>5563</td>
<td>5852</td>
<td>6396</td>
<td>5628</td>
<td>5513</td>
<td>5962</td>
</tr>
<tr>
<td>Slip, trip or fall as a proportion of all major injuries</td>
<td>26 %</td>
<td>27 %</td>
<td>28 %</td>
<td>29 %</td>
<td>32 %</td>
<td>32 %</td>
<td>33 %</td>
<td>36 %</td>
</tr>
</tbody>
</table>

Industry's failure to impact effectively on occupational STFA may be explained in part by the fact many employees from high STFA risk occupations work in unpredictable, uncontrolled and variable outdoor environments (see section 2.3.2). General acceptance of STFA, and other 'everyday' accidents, may provide a further explanation. Saari (1990), for instance, argues "slipping makes people laugh rather than implement preventive measures". He suggests normal accidents do not motivate people and as such are "the major challenge for safety work in companies". On the same theme, Leamon and Murphy (1995) suggest there is a lack of serious public concern and commitment to reducing slips and falls. They argue this tolerance of slips and falls as "unfortunate incidents" results from a lack of awareness of the human and financial costs associated with such accidents. Lord Porritt (1995), in his introduction to the 1985 STFA conference, highlighted the problem of public apathy towards falls, arguing such attitudes inhibit the collection of "sufficient information about falls to establish causes and hence arrive at effective methods of prevention".
STFA are equally prevalent throughout the rest of Europe. For instance, STFA constitute the largest category of external causes of injury leading to medical consultation in Finland, making up about one-third of all injuries (Honkanen et al, 1983). STFA also contribute to about 40% of fatal accidents that occur annually in Sweden (Strandberg and Lanshammar, 1981), and were registered as 'main causes' of 26% of all occupational sickness days during 1975. In West Germany, falls are the leading cause of death at work, contributing to 35% of all worker deaths (Hoyos and Zimolong, 1988). In Austria, slips and falls represent 27% of all accidents registered with the Austrian Workers Compensation Board (Körpert, 1997).

STFA are also a major cause of injury and death in the United States. Leamon and Murphy (1995), reporting National Safety Council figures, note falling is the second highest cause of work-related fatalities in the United States, making up more than 12% of worker fatalities in 1992, and over 17% of all work-related injuries in 1988. Based on a human capital approach, the cost of falls in the USA in 1985 was estimated at $37.3 billion (Leamon and Murphy, 1995).

2.3.2 STFA incidence across industries
National data for the STFA experience of different UK industries is produced by the HSE. Based on an analysis of trends in injury patterns for the year 1992/3, highest STFA incidence rates for major injuries were reported to occur within forestry (HSE, 1994) (figure 2.1a). Of those industries where a significant number of major injuries were reported, the highest rates were for the food, drink and tobacco industry (71.6 per 100,000), the repair of consumer goods and vehicles (57.2), and the postal services and telecommunications (54.9). For over 3 day injuries, highest incidence rates occurred in postal services and telecommunications (580.2 per 100,000), and the food, drink and tobacco industry (540.9) (figure 2.1 b).

STFL formed the greatest proportion of reported major injuries in banking and finance (60%) and hotels and catering (60%), and the greatest proportion of reported over 3 day injuries in insurance (38%) and postal services and telecommunications (35%) (HSE, 1994).
Buck and Coleman (1985), from an analysis of HSE data for the year 1982, presented STFL incidence for employment sectors based on the Standard Industrial Classification (SIC, 1968). They found incidence rates to vary widely, with extremes being mining and quarrying (22.65 per 1000 employees) and insurance and banking (0.44 per 1000 employees). The top five employment sectors for STFL incidence were mining and quarrying, local government services, bakeries, forestry and the food, drink and tobacco industry.

Leamon and Murphy (1995) presented an analysis of workers' compensation claims made to a major US insurance company for the years 1989 and 1990. STFA incidence rates and costs per capita for eight US industries are shown in table 2.2. Incidence rates for same level and elevation falls were found to vary considerably by industry sector, as did per capita cost arising from fall injury.
compensation claims. Highest incidence for STFL were observed for trucking, restaurant, food manufacturing and construction. Further analysis showed STFA to be the most frequent claims for clerical and second most frequent for trucking, restaurants and drivers (Leamon and Murphy, 1995).

In Austria, highest incidence rates for slips and falls registered with the Austrian Workers Compensation Board (Körpert, 1997) were found for agriculture, farming and forestry (27.6 accidents per 1000 insured) and transport (24.8). Körpert (1997) also reported highest slip and fall incidence rates were found for blue collar employees.
Table 2.2. STFA: industry rates and costs (Source: Adapted from Leamon and Murphy, 1995).

<table>
<thead>
<tr>
<th>Industry</th>
<th>Incidence rate (No. falls per 100 full-time workers)</th>
<th>Per capita cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>Same level: 0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Elevation: 0.4</td>
<td>22</td>
</tr>
<tr>
<td>Trucking</td>
<td>Same level: 4.7</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>Elevation: 2.7</td>
<td>156</td>
</tr>
<tr>
<td>Construction</td>
<td>Same level: 2.1</td>
<td>174</td>
</tr>
<tr>
<td></td>
<td>Elevation: 2.8</td>
<td>386</td>
</tr>
<tr>
<td>Stores: retail/wholesale</td>
<td>Same level: 1.3</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Elevation: 0.9</td>
<td>31</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Same level: 4.1</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>Elevation: 0.5</td>
<td>13</td>
</tr>
<tr>
<td>Healthcare</td>
<td>Same level: 1.3</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Elevation: 0.2</td>
<td>5</td>
</tr>
<tr>
<td>Food manufacturing</td>
<td>Same level: 2.3</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>Elevation: 0.4</td>
<td>174</td>
</tr>
<tr>
<td>Clerical</td>
<td>Same level: 1.1</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Elevation: 0.4</td>
<td>22</td>
</tr>
</tbody>
</table>

Commonalties are noted between findings for STFA risk by industry in the UK, US and Austrian studies reported above. Notably, STFA incidence rates are highest for industries where work takes place outdoors, or involves the handling of food or drinks. Clearly, workers who are employed in food manufacturing or food and drink service industries will have a high exposure to contaminated floors. This risk was illustrated in a study reported by Proctor and Coleman (1988), which found surface contamination to have been a contributory factor in 56% of slip and fall accidents in the bakery sector of the food industry. Many of the high STFA risk occupations identified above involve work which takes place outdoors, in relatively uncontrolled and unpredictable environments (e.g. postal services, forestry, construction, quarrying, trucking, transport, agriculture and forestry). Employees working in these industries are also more likely to have workplaces which are variable in place and time (Körpert, 1997) and to work in highly unstructured
situations and in variable weather (Leamon, 1992). Managing STFA risks in these industries is problematic as conventional STFA countermeasures such as workplace design, good housekeeping, anti-slip flooring, lighting, etc., cannot readily be applied.

2.3.3 Injuries resulting from occupational STFA
National data is reported by the HSE for the nature and site of injuries resulting from STFA. HSE (1994) reported 96% of all major injuries caused by STFL during 1992/3 involved fractures. Figure 2.2 shows the distribution of over 3 day injuries for STFL. Sprains and strains accounted for half of over 3 day injuries reported, with contusions being the other significant injury type. Fractures were the reported injury in 17% of cases overall (major and over 3 day injuries).

![Figure 2.2. Types of over 3 day injury caused by STFL 1992/3 (Source: HSE, 1994)](image)

Common sites for major injuries (figure 2.3a) and over 3 day injuries (figure 2.3b) are shown below. Figures are based on injuries reported to the HSE during 1992/3.
For major injuries, wrist, arm and ankle are the most common sites of injury. The large proportion of wrist and arm injuries (mostly fractures) might be
explained by STFA-involved employees attempting to break their fall with their hands, placing high levels of stress on the wrist and arm (especially when rigid) on impact with the ground (see Pater, 1985). For over 3 day injuries, back, ankle and leg were the most frequently reported sites of injury.

Manning et al (1988), from an analysis of 823 industrial 'underfoot accidents' in Merseyside (UK), found the most common injury sites to be the lumbar spine, ankle and knee. The study also reported a total of 80 fractures (nearly 10% of underfoot accident injuries), which were most frequently sited at the wrist, ankle, ribs and hand. These findings reflect those of the HSE (1994), and suggest back injuries (lumbar spine) to be a frequent outcome of slipping.

2.3.4 Home and leisure STFA
STFA make up a considerable proportion of accidents at home and during leisure. In Britain, the Consumer Safety Unit (DTI, 1995) estimates STFA comprise 39% of home non-fatal treated accidents (1.1 million falls). Of these, 306,000 are STFL (representing 10.6% of all home accidents). Nearly one-quarter of home STFL occur in the garden, or on the pavement or driveway. STFA also comprise 44% of leisure non-fatal treated accidents. Of these, 679,000 are STFL (representing 19.4% of all leisure accidents). The most common sites for leisure STFL are streets and footpaths.

2.3.5 Section summary: the scale of the STFA problem
STFA are a considerable problem for industry. In the UK, STFL are the largest cause of injury to employees. The proportion of major injuries caused by STFL is rising each year, and reflects industry's failure to impact effectively on STFA compared to other accident types. Industrial STFA incidence rates from a number of countries show highest STFA incidence to be found in industries where work takes place outdoors, where the working environment varies, can change quickly, and cannot easily be managed. Fracture injuries result from occupational STFA in 17% of cases, with these most often sited at the wrist, arm or ankle. Back injuries are frequently a consequence of slipping accidents. STFA also represent 11% of accidents in the home, and 19% of accidents during leisure activity.
2.4 A model for slip, trip and fall accidents

Buck and Coleman (1985) present a general accident model which they argue is relevant to any study of STFA. The model is intended as an aid to industrial accident investigation, reporting and analysis, and was produced for the Health and Safety Executive (HSE, 1985) booklet: 'Watch Your Step'. The model has two sections: the first (figure 2.4 a) shows possible accident events; the second (figure 2.4 b) suggests contributory factors which may be relevant to the accident. From figure 2.4 (a) it can be seen fall initiating events are not restricted simply to 'slipping' and 'tripping'. These are just two of a number of possible first accident events. The initiating event may lead either to a fall to the ground, against an object, or may result in an awkward body movement.

The model is based on an epidemiological/ergonomics approach to accident causation, and suggests a range of factors which may act in conjunction to produce an initiating event (figure 2.4 b). These interacting factors relate to the injured person, the movement of the injured person (and their task) and the accident location (the physical and ambient environment).

An important criticism of Buck and Coleman's model, however, is its failure to recognise the possibility of organisational and management influences on STFA risk. Management and organisational factors have been recognised as key contributory factors in general industrial accident models (e.g. Saunders and Shaw, 1988), as well as in a STFA model put forward by Woodall and Cox (1993). Possible management influences for occupational accidents include policies, production pressure, incentive systems, employee development and management style (Sanders and Shaw, 1988). Given the fact Buck and Coleman's (1985) model is intended to assist the investigation of occupational STFA and identification of remedial measures, consideration of management and organisational influences would seem fundamental to these aims.

The remainder of the review is organised around the central features of the Buck and Coleman (1985) model. Key initiating events are defined and the involvement of each in STFA discussed. Next, a range of STFA risk factors, related to human movement and task, the individual (injured person), and the accident location, are considered.
Figure 2.4 (a). A model for slipping, tripping and falling accidents (Source: Buck and Coleman, 1985)

Figure 2.4 (b). Contributory factors relevant to initiating of slips, trips, etc. (Source: Buck and Coleman, 1985)
2.5 Fall initiating events

This section describes common fall initiating events for STFA. Definitions for slipping and tripping are provided, and a range of other possible fall initiating events are outlined. The extent to which slipping, tripping and other common first events are involved in STFA is examined.

2.5.1 Slipping

Slipping occurs when the friction between shoe and walking surface provides insufficient resistance to counteract the forward, resultant forces (Leamon, 1996). It may occur when friction between the shoe and underfoot surface is low or when the surface is contaminated. The foot may also slip off the underfoot surface (e.g. a step or kerb), or a slip can occur due to movement of the underfoot surface (e.g. a floor mat) (Manning, 1983).

Slipping does not always lead to a fall. Leamon (1996) notes there are three categories of slip, based upon the length of the slip: a micro slip (shorter than about 2 cm), a normal slip (8-10 cm), and a slide (exceeding about 10 cm). Micro slips are most common, and are not usually perceived by the pedestrian. A slip is usually perceived, and the pedestrian reacts by moving the upper body and limbs in an attempt to regain balance. A slide involves a total loss of control, and usually leads to a loss of balance and contact with the underfoot surface (Leamon, 1996).

Research shows slipping to be the most common initiating event in STFA. Manning et al (1988), for example, found 'foot slipped' to be the first event in 75% of underfoot accidents (mostly industrial) occurring among Merseyside people. Andersson and Lagerlöf (1983) presented accident data recorded in the Swedish Information System on Occupational Injuries and Diseases (ISA) for the year 1979. The most frequent pre-event to falls on the same level was slipping (55%). In Swedish occupational, home and leisure STFL, 63% of victims slipped (Lund, 1984). Slipping also leads to a large proportion of accidents which don't involve falling. Andersson and Lagerlöf (1983), for example, reported 37% of non-falling accidents (e.g. contact with a sharp object) recorded in the ISA involved a slip.
2.5.2 Tripping and stumbling

Tripping (or stumbling) is better understood, and easier to define than slipping. A trip can be described as 'a sudden arrest of movement of the foot while the body continues its motion' (Manning, 1983). Similarly, a stumble and fall while walking is due to movement being stopped abruptly and to a decelerating force acting on the body (Negata, 1993).

Tripping is the second largest first event in occupational STFA. Manning et al (1988), for example, found 'foot tripped' to be the first event in at least 17% of underfoot accidents occurring among Merseyside people. Andersson and Lagerlöf (1983) reported tripping to be the first event in 19% of Swedish occupational STFL recorded in 1979. Despite the important role of tripping in accidents it is noted not one article dedicated to the problem of 'tripping' was found in the published literature.

2.5.3 Twisting of foot or ankle

Foot and ankle twists usually result from contact with an object, uneven surface or a surface edge (Manning, 1983). In Manning et al's (1988) study, 'twisted foot/ankle' was reported to be the first event in 12% of underfoot accidents occurring among Merseyside people. It is unclear what proportion of these underfoot accidents resulted in a fall, however. No other studies reporting twisting of foot or ankle initiating events were found.

2.5.4 Lower frequency initiating events

Loss of support from the underfoot surface

Loss of support from the underfoot surface has a similar impact on the victim's body to slipping occurring between foot and walking surface. Balance is disturbed following unexpected movement of an underfoot surface, such as a sliding doormat or a roofing slate (Manning, 1983). This initiating event, when combined with tipping of the supporting surface, was involved in 2.4% of STFA recorded in Sweden during 1979 (Andersson and Lagerlöf, 1983).

Unintentional stepping off the underfoot surface

Unintentionally stepping off platforms, ladders or steps are known as 'treading on air' in Sweden (Manning, 1983; Andersson and Lagerlöf, 1983). This fall initiating event was involved in 1.5% of underfoot accidents among
Merseyside people (Manning et al, 1988), and 1.1% of STFL recorded in Sweden during 1979 (Andersson and Lagerlöf, 1983).

Other fall initiating events
Other, less frequent fall initiating events include: 'stepping into a hole', collision with a person, animal or object causing loss of balance, loss of balance from careless or rapid movement or from disease, alcohol and drugs, and loss of a hand hold from slipping of the hand or breakage of the support (Manning et al, 1983).

2.5.5 Section summary: fall initiating events
In conclusion, slipping is the first event in the majority of STFA, with most statistical studies showing slipping to outnumber the next most frequent event (tripping) by about three to one. Slipping may occur for a number of reasons, the most common of which is lack of friction between shoe and underfoot surface. Slipping also often leads to other accident types, such as being struck by a vehicle or contact with moving machine parts (Andersson and Lagerlöf, 1983), suggesting the scale of the slipping problem is significantly underestimated when measured only in relation to its involvement in falling accidents (Strandberg, 1983). Other major fall initiating events are tripping and twisting of the foot or ankle. The high frequency of injuries resulting from slipping has motivated an increasing amount of research among ergonomists and other scientists. Conversely, no articles were found which were concerned primarily with tripping accidents, or other fall initiating events. As a result, much of the published literature described in this review is related to the problem of slipping.

2.6 Movement and task-related factors
Published literature related to the movement and task of the accident-involved person in STFA is concerned mostly with the problem of slipping. This section begins by looking at common activities of injured persons immediately before STFA, as identified from STFA statistical studies. Next, the mechanics of human locomotion are briefly illustrated, and crucial gait cycle features for slipping presented. Finally, the effects of tasks such as load carriage and manual exertion on slipping potential are considered.
2.6.1 Activities commonly preceding STFA

STFA occur during a range of activities. Negata (1993), for example, suggests such accidents occur 'not only in normal walking, but also in ascending or descending a slope or steps, pushing or pulling something, turning the corner, stopping, jumping down, dashing, etc.' Despite this recognition, and the need to improve understanding of the involvement of pre-fall activities in STFA, few data were found in the published literature concerning the activity of the accident victim immediately before a fall.

The available data show 'normal walking' to be by far the most common activity in STFL accidents. In occupational, home and leisure STFL recorded in Swedish hospitals, 55 % of victims were reportedly 'walking normally' just before the fall (Lund, 1984). Where the victim slipped and fell, the movement before the slip was 'walking normally' in 70 % of cases. Similar figures were reported for falls recorded in Norwegian and Finnish hospitals (Lund, 1984). Buck (1984), in an unpublished analysis of accident data relating to loss of balance accidents in the UK electricity supply industry, found nearly 48 % of over 3 day injuries occurred during walking, running, etc. from one place to another. For 57 % of occupational slipping accidents recorded in Sweden during 1979 the activity of the victim was 'movement on foot (without any object being carried)'. A further 13 % of slipping accidents occurred during 'manual carrying or lifting', and more than 5 % during 'cleaning' (Strandberg, 1983). Other notable activities identified in the literature include 'getting into/out of or working on vehicles (Buck, 1984; Nicholson and David, 1985), and working at machines or vehicles (Grönqvist and Roine, 1993).

The common involvement of normal walking and carrying loads in STFA indicate these to be the most crucial activities for discussion when considering the role of movement and task-related factors in STFA.

2.6.2 Human locomotion and slipping during normal walking

An understanding of the basic mechanics involved in the process of walking is an important first step when explaining human vulnerability to slipping and tripping accidents. A number of researchers (e.g. Davis, 1983; Marletta, 1991) have provided simple accounts of human locomotion. Based on this literature, a brief summary of walking process and the crucial components of the gait cycle is given below.
In human locomotion body weight is transferred naturally from one foot to the other. The activity of each leg can be broken down into two main stages: a swing phase, where the foot is passed forward; and a support phase, during which the foot is on the ground. The support phase is longest, and starts at 'heel strike' as the forward moving heel makes contact with the ground, and ends at 'toe off' as the leg is propelled forward. At heel strike the foot decelerates, and acceleration is transferred to the hip. The heel lands on the floor surface at an angle, with this angle reducing as an increasing proportion of body weight is shifted forward. The forward momentum of the body starts with the raising of the heel, and results in the front ball of the foot contacting the ground. To create forward movement, a force is produced by pushing off the ball of the foot, with weight transferred towards the big toe. During this process of forward propulsion, friction under the sole resists the tendency for the foot to move backwards under the body. Once contact ceases the cycle is repeated. Because the support phase is longer in duration than the swing phase, heel strike of the rear leg occurs during the support phase of the first leg, as the rear propelling leg becomes the forward leg.

2.6.2.1 Critical gait phases for slipping
Grönqvist et al (1989) notes the 2 critical gait phases in normal walking from the viewpoint of slipping are: '1) Shortly after heel contact when only the back edge of the heel is in contact with the ground. 2) At the moment of toe-off when only the forepart of the shoe is in contact with the ground. The first critical gait phase is more hazardous than the second, because the forward momentum of the body maintains the body weight on the slipping foot. Studies of gait biomechanics and of falls confirm the initial heel contact (heel strike) to be the critical point for slipping (Strandberg and Lanshammar, 1981; Redfern and Bidanda, 1994), and peaks in vertical force are found to be present at and after heel strike and towards toe-off. Strandberg (1983) estimates 90 % of slips which lead to falls on the level occur at heel strike. During the second critical gait phase, a slip is less likely to be hazardous, as most of the body weight has been transferred forward from the slipping foot to the opposite leading foot.' Slipping may also be started during a turning movement from the ball of the outer foot (Davis, 1983).

Marletta (1989) points to the role of heel landing angle in slipping occurring at heel strike. The angle at which the heel strikes the ground influences the vertical and horizontal components friction force. As the heel landing angle
decreases, the vertical component friction force is increased and the horizontal component reduced. The angle is dependent on a number of factors, including the length of legs, the length of stride, and the personal characteristics of the walker (Marletta, 1991). Marletta notes people walking quickly take longer strides, which increases the angle between the floor gripping surface and the heel’s contact angle. Thus, longer strides require a higher coefficient of friction (COF) for safe walking, and slipping is more likely on slippery surfaces where the pedestrian is walking quickly. Pedestrians walking on slippery surfaces have been shown to take shorter strides (e.g. Swensen, 1992), thereby reducing heel landing angle and increasing the contact between shoe material and the floor. Heel velocity at heel strike has also found to be critically related to the occurrence of slips and falls, with heel velocity at heel strike ranging from 10 to 20 cm/s for a normal gait, to 50.8 cm/s during a slip (Strandberg and Lanshammar, 1981).

2.6.2.2 The influence of surface slope on human gait and the potential for slipping
Recent research has considered the question of how walking on a sloped surface affects human gait and the potential for slipping. Sun et al (1996) considered the influence of slope and direction of walking (up and downhill) on subject cadence, walking speed and step length. Their studies were based on recordings of gait characteristics of 1,200 male and 1,200 female pedestrians in a natural location (a ramp of naturally varying slope at Sydney’s Circular Quay). The researchers’ most significant finding was that step length decreased with increased angle of slope when walking downhill. Sun et al (1996) argue this may be a mechanism to reduce friction demand at heel strike (the most likely time for slips and falls). Based on a model of friction demand at heel strike during downhill walking, the researchers demonstrated at heel strike both applied foot force and body weight have a shear component directed downhill, requiring a greater resisting friction force than during level walking. When walking on the level the weight component does not affect the frictional requirement as it is perpendicular to the walking surface. During uphill walking, Sun et al (1996) showed frictional requirements at heel strike to be decreased, when compared to walking on the level, while at toe-off they are increased. As heel strike is known to be the more critical gait parameter, slipping is considered as less of a risk during uphill walking. It may be concluded, therefore, that slip and fall accidents are more likely to occur during downhill walking than when walking uphill or
on the level. This is due to the greater frictional demand at heel strike during downhill walking.

2.6.3 The effect of load carrying on stability
Leamon (1996) suggests load carrying has at least two consequences for human gait: 'it results in a shift in the centre of gravity, it increases the vertical load and it may alter the frictional demands on the floor'. Increase in vertical load, just following heel strike, is a significant factor in slipping likelihood (Davis, 1983; Marletta, 1991). Thus, slipping potential may be increased during load carrying. Leamon (1996) also argues stability may be affected where load carrying interferes with the human balancing technique, involving rotation around the hips and arm swings used to maintain the centre of gravity above the appropriate foot.

A number of published studies support the argument that load carrying influences slip and fall potential. Davis (1983), for example, from calculations based on sway angles, found the centre of gravity of the mass above the ankles to be raised when carrying a 40 cm cubical box of various weights. This was the case whether carrying the box in front of the waist, on the shoulder or on the head. He reported stability to be reduced by load holding roughly linearly with the magnitude and height of the weight. Stability decreases for loads held at or above waist height, and the greater the load the less stability.

Myung and Smith (1997) investigated the effect of load carrying on stride length and heel velocity (important parameters in slip and fall accidents - Strandberg and Lanshammar, 1981). Different levels of loads were carried on different levels of floor slipperiness, with and without contaminants. The load carrying method involved holding a tote box against the body. Stride length was found to decrease as load levels increased, with subjects having the longest stride length when walking without a load. Stride length decreased by about 13 cm when a load weighing 40% of body weight (the heaviest load used in the study) compared to when carrying no load. On dry surfaces no significant differences for heel velocity were found for any load level. Thus, dry surfaces did not significantly affect heel velocity relative to load carrying levels. Oily floors did affect heel velocity relative to load carrying level, however, as subjects attempted to land their leading foot as
quickly as possible to compensate for the effect of the oily floor on their stability.

Crosbie, Flynn and Rutter (1994) provided further evidence of a decrease in stride length during load carriage (unilateral loading). Video analysis of subjects carrying side loads at 10 and 20 % of body weight also revealed an increase in cadence; an attempt to maintain velocity as stride length was reduced. Changes in stride length and width with loading were found to be significant only for male subjects, however.

A further risk for falls associated with the carriage of loads concerns the visual environment. Falls are more likely where a person's vision of the ground underfoot and ahead is obscured (Pater, 1985). Loads of sufficient size, carried in front or at the side of the body, can restrict the walker's view of hazards situated on the walking surface.

Load carrying can induce fatigue, which is known to be a factor in occupational accidents (Davis, 1983). Fatigue is characterised by a reduced capability of the body to move muscles strongly or quickly (Surry, 1979). Davis cites Datta et al (1975), who found energy consumption (which influences fatigue) to be linearly related to the weight of the load being carried. Davis (1983) also cites other studies which show fatigue is unlikely for males carrying loads up to the weight of 25 kg. He suggests carriage of loads greater than 25 kg for long periods should be avoided. However, this argument should be qualified by the recognition that loads of considerably less weight may produce fatigue when carried for very long periods (e.g. as with PDO), or when held in a higher position (e.g. elbow height) (Sanders and McCormick, 1992).

In summary, the findings of the above research suggest load carrying to be an important factor in slipping when walking on contaminated or otherwise slippery surfaces (Myung and Smith, 1997). This suggests a particular risk to employees whose work involves carrying loads outdoors (e.g. postal delivery employees), or where loads are carried in potentially slippery indoor areas (e.g. in the food and drinks industry). Load carrying appears to affect stability increasingly as weight and height of the load is increased. The carriage of loads can also increase the risk of loss of balance due to the upper limbs being used to support the load rather than to damp out rotatory torque
on the trunk when turning a corner and in side load carrying (Davis, 1983; Leamon, 1996). Other risks associated with load carriage include obscuring vision of walking surface conditions when carrying large loads, and the increased likelihood of accidents due to fatigue when carrying very heavy loads for a sustained period. One factor related to the carriage of loads which appears to have been ignored by published literature is the effect of load on injury likelihood and severity following a fall. It is argued additional traumatic forces due to the weight of the load being held may increase the severity of injury. Moreover, the fact the fall victim is holding a load may reduce their opportunities for using their hands to break the fall (or grab a surface or handrail).

2.6.4 *The effect of manual exertion on slipping*

Static manual exertion also affects slipping potential. During static manual exertion an unavoidable tangential force will be created at the feet (unless the feet have a wall to brace onto) (Grieve, 1983). A slip will occur where the ratio of the tangential to normal forces at the feet exceeds the limiting coefficient of static friction (Grieve, 1983; Marletta, 1991). As the worker cannot modify their pattern of gait when a slippery underfoot surface is recognised during static manual exertion, Grieve argues footwear and flooring are the only factors which can be modified to reduce slipping potential. Where the worker is exerting force with their feet together, slips are particularly likely, as too little time is available for postural adjustment before control is lost (Grieve, 1983). Grieve concludes manual exertion, such as that involved in pushing or pulling a heavy trolley, is a major slipping risk factor, as exceptional coefficients of friction are required if slips are to be avoided. These types of flooring are unlikely to be found in most working situations.

2.6.5 *Section summary: STFA risk factors related to movement and task*

STFA occur during a range of activities, although data from STFA statistical studies shows 'normal walking' to be by far the most common activity in STFL accidents. Critical components of the gait cycle for slipping are shortly after heel contact when only the back edge of the heel is in contact with the ground, and at the moment of toe-off when only the forepart of the shoe is in contact with the ground. Studies of gait biomechanics and of falls show the initial heel contact (heel strike) to be the most critical point for slipping. Heel velocity at heel strike is critically related to the occurrence of slips and falls.
Heel landing angle at heel strike also has a major effect on slipping potential, as it influences the vertical and horizontal components friction force. People walking quickly take longer strides, thereby increasing their risk of slipping. Slip and fall accidents are more likely to occur during downhill walking than when walking uphill or on the level. This is due to the greater frictional demand at heel strike during downhill walking, to which pedestrians are observed to accommodate by taking shorter strides. Load carriage is an important task-related factor in slipping when walking on contaminated or otherwise slippery surfaces, affecting stability increasingly as weight and height of the load is increased. The carriage of loads can also increase the risk of loss of balance due to the upper limbs being used to support the load rather than to damp out rotatory torque on the trunk when turning a corner and in side load carrying (Davis, 1983; Leamon, 1996). Load carrying can also increase STFA risk due to obscuring vision of walking surface conditions. The likelihood of accidents may be increased due to fatigue when carrying very heavy loads for a sustained period. Manual exertion, such as that involved in pushing or pulling a heavy trolley, is a major slipping risk factor, as exceptional coefficients of friction are required if slips are to be avoided.

2.7 Individual factors

A range of individual factors, identified in the published literature as contributing to STFA, have been suggested by Woodall and Cox (1993). These include: age, sex, size, strength, physical disability, health and agility, natural gait, eyesight, fatigue, emotional state, carelessness/distraction and the effects of alcohol. Findings from epidemiological research are discussed to assess the role of a number of these personal factors in STFA risk. Next, the review considers perceptual factors associated with STFA. Aspects of vision, and the subjective assessment of surface slipperiness are discussed, followed by an outline of psychophysiological theories of slipping and tripping.

2.7.1 Personal factors

2.7.1.1 Age
STFA are particularly prevalent among the elderly. Each year, an estimated 30% of UK citizens over the age of 65 years fall, either spontaneously or from slipping or tripping (Fothergill et al, 1995). Lund (1984) found people over 65
years of age to have incurred nearly one-fifth of STFL incurred in three Nordic countries. Malmivaara et al (1993) have provided evidence of an increasing fall risk with age. From a prospective epidemiological study of risk factors for injurious falls leading to hospital or death in Finland, the researchers found the incidence of falls amongst men and women increased with age. An abrupt rise in incidence was seen after 70 years of age.

A number of studies have considered the effect of age on STFA incidence in industry. Buck and Coleman (1985), from an analysis of injuries reported to the HSE, found a rising trend of incidence rate against age, showing an almost straight line relationship (correlation coefficient $r = 0.97$) for STFL. Employees in the 16-20 years age group had an incidence rate of under three per 1000 employed, while the 56-60 years age group had a rate of nearly five per 1000 employed. This finding was in contrast to incidence rates for all accidents, which showed a general trend to decrease with increasing age.

Leamon and Murphy (1995), reporting US National Safety Council figures for 1991, highlighted the increased risk to older US workers. Fatality rates from falls for workers older than 65 years were over 20 per 100,000 workers, compared to 7.1 for workers aged 15 to 24 years, and 14.5 for ages 45 to 64.

There is also evidence older employees are more likely to incur STFA within specific industries. For example, older Quebec domestic trash collectors were found to be involved less frequently in accidents and mishaps, but were more likely to be victims of STFA (Cloutier, 1994).

In summary, older employees and elderly persons appear to comprise the highest risk group for STFA. The findings discussed above suggest persons may be progressively more likely to suffer STFL as they age, or may be more likely to suffer an injury which results in the accident being notifiable (Buck and Coleman, 1985), or requiring medical treatment. There is some evidence in favour of both hypotheses (e.g. Negata, 1993). It is well recognised older fall victims are more likely to suffer fractures following an injurious fall. Negata (1993), for example, suggests persons over the age of 65 are liable to incur serious injury or die as a result of even light falls, which can cause fractures due to the deterioration of bones. This argument is supported by data from Japanese medical statistics (Negata, 1993). Moreover, the fact occupational injuries from other accident types reduce in incidence with age, probably as a result of experience (Pheasant, 1993), suggests falls are more
likely to produce injuries requiring absence from work among older employees.

2.7.1.2 Sex
Females have been found to incur significantly lower general industrial accident-incidence rates (Surry, 1979). Lower female incidence may be explained by women tending to work in occupations in which they are exposed to fewer accident risks (e.g. office and shop environments). Where war time studies have considered men and women working in the same industries these differences in accident incidence appear to be reversed (Surry, 1979). Surry suggests factors affecting female propensity to incur accidents may include training in work skills, susceptibility to fatigue, rest-time, external housework, etc.

A more recent study of male and female workers employed in the same occupation was presented by Zwerling et al (1993). They found women in their first year of employment had an increased risk for occupational injuries (all types) amongst US letter carriers. To explain these findings Zwerling et al cite NIOSH (1981) Work Practices Guide for Manual Lifting, which argue women are generally of smaller stature than men and have less strength. This causes women to operate at a greater percentage of their capacity and are therefore at increased risk of injury. Other possible explanations suggested by Zwerling et al (1993) include women possibly being more likely to report occupational injuries than men.

 Turning to the problem of male and female STFA risk, Davis (1983), from calculations of sway angles, found males to have slightly better stability than females. However, statistical studies have shown males to incur higher incidence rates for STFA. Malmivaara et al (1993), for example, found incidence rates to be higher for Finnish males of up to 50 years, with female rates being higher thereafter. Leamon and Murphy (1995), from an analysis of workers' compensation data, found males to have a slightly higher incidence rate for falls on the same level (male: 1.6 per 100 workers; females: 1.4). The average cost per claim (a measure of severity) was also greater for male than female workers. The researchers suggest this finding is consistent with the assumption of greater energy exchange between the faller and the environment.
However, a number of studies have found women to be over-represented in the distribution of non-occupational slipping accidents. Lund (1984), for example, reported women to have incurred 61% of slipping accidents recorded in hospitals in Norway, 52% in Swedish hospitals and 58% in Finnish hospitals. Lund (1984) notes these findings are in contrast with other types of accidents, where males are over-represented.

In summary, it appears males have a slightly increased risk of incurring injuries from falls. However, males are more likely to work in high STFA risk occupations such as postal work, forestry, transport and construction (see section 2.5.2). Non-occupational statistics suggest females may be more likely to incur falls than males outside the work setting. Possible explanations for this include: females wearing high-heeled fashion shoes and boots; women experiencing greater exposure to non-occupational STFA environmental risk factors (e.g. slippery roads and pavements, spillages in shops or the home, etc.); and females being more inclined to report injuries due to STFA, and seek medical help (Zwerling et al, 1993).

2.7.1.3 Physical and mental health

The close involvement of physical health with motor activity suggests a number of physiological factors are likely to contribute to falling (Surry, 1979). These include: disturbance to the balance organ, lack of blood or oxygen supply to the brain, loss of kinaesthetic and pressure sense in the limb due to reduced blood supply or damage to the sense organs, and limited mobility due to neuro-muscular diseases.

Malmivaara et al (1993) considered a number of physical health risk determinants for injurious falls. Diabetics were found to have an increased risk of injurious falls, particularly insulin dependent diabetics aged 45-64 years (Relative Risk (RR): men=6.6; women=9.6). Male non-insulin dependent diabetics in the age groups 45-64 years (RR=3.0) and over 65 years (RR=3.5) were also found to have an increased risk. Neither musculoskeletal disorders nor previous history of severe injury nor chronic disease were associated with an increased risk of injurious falls.

Malmivaara et al (1993) found the use of anti-anxiety drugs to be associated with an increased risk for injurious falls, particularly for men between the ages of 45 and 64 (RR=2.3), and persons over the age of 64 (RR: men=2.9;
women=1.7). The use of anti-psychotic drugs was also associated with an increased risk for injurious falls, particularly for women aged between 45 and 64 years (RR=2.7).

2.7.1.4 Body weight
Malmivaara et al (1993) found high relative weight (using the body mass index) to play a dual role as a risk factor for injurious falls. An increased risk of injurious falls was found for over-weight young persons, while having a high relative weight appeared to be a protective factor for the elderly. The authors point out this reduced risk among relatively heavy elderly persons is in line with previous research findings, and suggest possibly explanations for the effect. Weight increase may be protective to the elderly because of its trophic effects on bones. In addition, the amount of adipose tissue a person has is related to relative weight. This tissue is thought to cushion the impact of falls and reduce the incidence of fractures due to brittle bones. Malmivaara et al (1993) argue the increased risk of injurious falls to younger persons with high relative weight is likely to be a result of ‘additional traumatic forces’ during a fall. This effect of being overweight in the young and early middle-aged is likely to overwhelm the possible protective effects enjoyed by elderly persons.

2.7.1.5 The role of alcohol use in STFA risk
Alcohol use is known to be associated with the occurrence of accidents, having the effect of slowing the individual’s reactions and altering their attitude to risk (Pheasant, 1993). Higher alcohol involvement rates have been found for victims of industrial accidents than for uninjured controls (Honkanen et al, 1983).

Honkanen et al (1983) undertook a case-control study to estimate the risk of injury from accidental falls related to blood alcohol concentrations (BAC). The study was conducted during two five week periods: the first under winter conditions, the second under summer conditions. The cases were 313 adults who attended a Helsinki hospital with external injuries caused by accidental falls in public places. Cases were interviewed on reporting their injury, and a blood sample for determination of BAC taken. Controls were selected from adult pedestrians found at the accident site one week after the accident. The relationship between BAC and accident risk was studied by estimating relative risk, and potentially confounding factors controlled by
individual matching. Honkanen et al (1983) found alcohol to be a powerful causal factor in accidental falls. Large differences were found in alcohol intake rates between cases and controls, with 53% of cases and 15% of controls having BACS above 20mg/100ml. The relative risk, if one at zero BAC, was approximately three at BAC of 50-100mg/100ml, about 10 at BACS of 100-150mg and 60 at BACS of 160mg/100ml and higher.

Malmivaara et al (1993) also found alcohol intake to be associated with an increased risk for injurious falls, with the association varying between age and sex groups. After adjustment for other risk determinants, the relative risks in persons with monthly ethanol intake of 100-499 g was 1.43, 2.32 with a monthly intake of 500-999 g, and 3.05 for > 1,000 g. In men under the age of 45, the risk of injurious falls increased in a dose-response manner based on alcohol consumed. Women aged 45-64 who consumed over 500 g ethanol per month had an increased risk, while men and women who drank heavily had a very high risk.

In conclusion, it is clear exposure to alcohol, and possibly factors closely correlated with alcohol use (Malmivaara et al, 1993), strongly contributes to accidental fall risk. These findings are unsurprising as alcohol is known to be a significant factor in other accident types (Surry, 1979), and to severely affect human stability and balance (Honkanen, 1983).

2.7.2 Perceptual factors: recognising STFA hazards

2.7.2.1 Vision

Surry (1979) highlighted the importance of the role of vision in occupational accident prevention. Visual problems related to blindness, vision in dark surroundings, visual acuity, colour vision and depth perception may influence accident potential. For example, Surry considered the role of 'dark adaptation' in occupational safety, noting care should be taken where a job requires a rapid transition from brightly lit to dark areas. Detail and colour cannot be seen in dim light, and the high frequency of night time and twilight accidents on the streets reflect difficulties of vision at low intensity levels (Surry, 1979).

Lack of clear vision may increase the risk of falling accidents (Davis, 1983). Studies of pedestrians crossing roads, for example, demonstrate how
pedestrians alter their pace length several paces before reaching the kerb to allow the feet to clear the kerb safely. Consequently, inadequate illumination can increase a pedestrian's risk of tripping. The importance of visually recognising slippery surfaces is well established (Leamon, 1992). The psychophysiological model of human locomotion proposed by Marletta (1991) demonstrates the importance of clear vision and adequate lighting, indicating slips and trips are most likely when pedestrians fail to accurately recognise changing walking surface conditions (see section 2.7.3).

Depth perception (the ability to judge distance or spatial depth) is important for motor activities such as human locomotion (Surry, 1979). The distance of near objects must be accurately judged if accidents involving tripping, striking against and handling are to be avoided. Clark et al (1996) provided an account of the role of depth perception in STFA. They argued the perception of depth is a complex process involving the 'unconscious interpretation of multiple visual cues and physiological responses'. The way distance is perceived is open to error, and certain factors can increase the likelihood and magnitude of these errors. When depth perception is adversely affected by poor lighting, lack of colour or visual contrast, or deceptive visual patterns, a fall may result from the erroneous information sent by depth cues to the brain regarding a walker's immediate environment. Clark et al (1996) provide examples, using case histories, of how factors such as inadequate lighting and visual cues produce erroneous perception of depth in the injured person. They conclude certain design elements in the built environment can combine to produce false or distorted visual depth cues, which on occasion result in misperceptions, missteps, and resulting STFA injuries.

A further factor related to vision in STFA is the problem of visual obstructions. Negata (1993), for example, described the role of vision in walking down a staircase. A person will slow down the pace of walking just prior to taking their first step, so they can adjust their pace to the width of the steps and can descend at an even pace. Where the staircase is sloped gently the walker can see the bottom while watching the downward target. If, however, the staircase is steep, the walker will not be able to see anything downward until they are over it, and as a result has difficulty adjusting pace. The thigh may also obstruct the walker's view of the step upon which they wish to set their foot as they descend the staircase. Where the staircase is
steep this trend is stronger (Negata, 1993). Other examples of visual obstructions which increase STFA risk include the carriage of large items in front of the body. This common industrial task has the effect of obscuring the worker's line of sight of the walking surface and surrounding environment (Leamon, 1992).

In conclusion, defective vision can interfere with an individual's ability to appraise information from the environment and organise an appropriate motor response (Pheasant, 1993). Accidents such as falls are, therefore, more likely where vision is defective, or where the working environment is inadequately illuminated. Where a worker undertakes their task in an uncontrolled and unpredictable environment, such visual problems present an even greater risk of accidents such as falls and striking against.

2.7.2.2 Subjective assessment of surface frictional properties and the role of experience

An individual's ability to accurately assess the slipperiness or COF of a walking surface is an important factor when considering their likelihood of slipping. Detection of surfaces with low COF levels will allow the pedestrian to adopt the required gait to walk safely on that surface. Accurate subjective evaluations of floor slipperiness in industrial workplaces may be important if preventive measures are to be applied. Swensen et al (1992) compared measured static COF values for a number of different surfaces with subjective ratings of surface slipperiness. Subjects were found to be able to distinguish between surfaces with different COF values; they could identify a difference in slipperiness for the various coatings used in the study. A substantial relationship was also found between COF values and the ratings provided by subjects. These findings suggest subjective judgements of surface slipperiness are a reasonable guide to actual frictional properties. However, Swensen (1992) noted subjective ratings should not be a substitute for actual COF measurement, rather, low ratings should suggest a dangerous situation exists and actual COF measurement should follow.

Swensen (1992) also considered the effect of experience of working and walking on particular surfaces on subjects' ratings of slipperiness. While no differences were found between experienced ironworkers and inexperienced students in ability to rank the coatings, significant differences were found in subjects' ratings. Subjects who were experienced in walking on a surface
provided ratings which were more towards the slippery end of the scale, and
differentiated between each coating more accurately (this was only true of the
dry coatings used in the study). Swensen (1992) hypothesised 'experience
contributes significantly to the ability to detect a potential slip situation'.

In summary, the ability to recognise the frictional properties of a walking
surface will affect an individual's slipping potential. Fortunately, people
appear to have the ability to distinguish fairly accurately between surfaces of
differing slipperiness. However, this ability appears to be influenced by
whether they are experienced in walking on a particular surface (Swensen,

2.7.3 Psychophysiological factors
Other researchers have highlighted the importance of understanding the
psychophysiological mechanisms involved in human locomotion.
Walking is a complex musculoskeletal and neurological process, resulting
from thousands of calculations by the brain in response to information from
the environment and the body, as it co-ordinates the neuromuscular control
required for human locomotion. A change in the walking surface conditions
that is not expected will result in the gait intended by the brain for one set of
conditions being used for another set of conditions. Marietta (1991) argues
where slippery underfoot conditions are anticipated the pedestrian will
adjust their gait to accommodate the conditions. The length of the stride will
be reduced, thus allowing the lead foot to come almost straight down onto
the floor surface. The heel landing angle is reduced as a result of reducing
stride length, thus reducing the horizontal component of force and the
possibility of heel slip, as the area of the foot which comes in contact with the
ground is increased.

Marietta (1991) suggests the reason for many slip falls is the fact the
pedestrian does not expect a change to a lesser COF (the brain cannot,
therefore, adjust the stride). In support of this theory, Marletta points to the
high incidence of slip and fall accidents where the pedestrian has stepped
from a surface of high coefficient of friction to one of reduced friction (e.g.
from a carpet to a polished floor). Leamon (1996) provides further support
for this theory, noting innumerable legal claims arise from customers
unexpectedly encountering a surface with lower friction (e.g. a pool of water
in a supermarket). Where perception is affected by factors such as interfering
task requirements, poor illumination of the walkway, distractions and diversions, changes in walking surface conditions may be overlooked.

Marletta (1991), argues the contradiction of expectation which leads to slipping also explains tripping. Where the trip hazard is perceived by the pedestrian, necessary neuromuscular control actions can be made in order to avoid the hazard. Anytime the surface conditions differ from that expected by the pedestrian, even where the vertical transition is relatively minor in dimension, a hazardous situation is present and the likelihood of trip accidents is increased.

Tisserand (1985) also described the role of psychophysiological factors in slipping accidents. The pedestrian has a mental model of the frictional limits of the surface on which they are walking. This model is updated and revised in response to integrated information (from the environment and body). The walker exerts forces on the underfoot surface on the basis of the information contained in their model, such that these forces do not exceed the limits of the model. Tisserand (1985) argues any fall resulting from a slip is due to a discrepancy between this mental model of the frictional limits and reality.

Both psychophysiological theories outlined above hold that where walking conditions are contrary to those anticipated, the probability of a slipping accident is greatly increased. It is suggested, therefore, it is knowledge of walking surface conditions, rather than the conditions alone, which has greatest impact on slipping potential. It can also be argued slipping is more likely at points where underfoot COF conditions change from relatively high COF to relatively low COF. In support of this view, Tisserand (1985) argues 'the risk of slipping lies more in the gradient of the friction coefficient of the surface than in its absolute value: such as when in a car, a small patch of ground with a low coefficient (e.g. ice patch, for example, on a large surface with a high COF) is more dangerous than a surface with a medium but constant COF.'

2.7.4 Section summary: individual factors
The review has considered the effect of a number of personal factors on STFA risk. Older employees and elderly persons appear to comprise the highest risk group for STFA. It is unclear whether people are progressively more likely to suffer STFA as they age, or are more likely to suffer an injury which
results in the accident being notifiable, although there is some evidence to support both positions. Males have a slightly increased risk of incurring injuries from falls, but are more likely to work in high STFA risk occupations. Females incur more falls outside the work setting. Possible explanations for this include the use of fashion footwear, exposure to STFA hazards at home and in public places, and a greater propensity to report injuries. Diabetics appear to have an increased risk of injurious falls, as do persons who use anti-anxiety and anti-psychotic drugs. An increased risk of injurious falls was found for over-weight young persons, while having a high relative weight appears to be a protective factor for the elderly. Exposure to alcohol also strongly contributes to accidental fall risk.

Factors involved with the perception of STFA hazards have also been considered. A range of visual factors, including dark adaptation, visual acuity and depth perception, are important in STFA risk. Inadequate illumination and other factors which interfere with the pedestrian's ability to recognise walking surface conditions also increase the chance of falls. Another important perceptual skill is an individual's ability to recognise the frictional properties of a walking surface. Research suggests people appear to be able to distinguish fairly accurately between surfaces of differing slipperiness, although this appears to be influenced by whether they are experienced in walking on a particular surface.

Psychophysiological theories of STFA hold that where walking conditions are contrary to those anticipated, the probability of a slipping or tripping accident is greatly increased. This is because the gait appropriate for the new conditions is not adopted by the pedestrian. From this view, it is knowledge of walking surface conditions, rather than the conditions alone, which has greatest impact on slipping risk. Slipping may be most likely at points where underfoot COF conditions change from relatively high COF to relatively low COF.
2.8 Factors related to the accident location: the physical and ambient environment

This section looks at where STFA occur with greatest frequency, and underfoot hazards or agents commonly connected with STFA. While UK national occupational injury statistics do not provide information at this level, Nordic and American data suggest accident location (in terms of indoors versus outdoors) is largely dependent on climate and type of industry. Key underfoot hazards are identified from statistical studies which record the involvement of underfoot conditions and agents connected with STFA. The risk presented by ice and snow, liquid contaminants, tripping hazards, inadequate lighting and steps are discussed, along with measures to reduce the risk they present.

2.8.1 STFA location

The findings discussed in section 2.3.2 show STFL to be most prevalent in occupations where employees work in outdoor environments (e.g. postal services, forestry, construction, quarrying, trucking, transport, agriculture and forestry). A number of Nordic studies have provided information regarding the extent to which slipping accidents occur outdoors. Of Swedish occupational slipping accidents recorded during 1979, 50% occurred outdoors (Strandberg, 1983). Lund (1984) reported Norwegian, Swedish and Finnish slipping accidents to have occurred outside in 73%, 75% and 84% of cases respectively. Accounting for slipping and tripping accidents, Lund (1984) reported approximately 25% of falls to have occurred in homes or inside buildings, and between 23% and 34% in the road or street.

The distribution of outdoor occupational slip and fall accidents appears considerably different in the US, however. Of slips and falls on the level recorded by a major US insurance company, 85% occurred indoors (Leamon and Murphy, 1995). The researchers suggest outdoor weather conditions may affect indoor slips and falls through changes of footwear, contaminants and walked-in water.

The prevalence of outdoor falls appears to be strongly related to seasonal weather conditions. Honkanen (1982), for example, found slipping accidents on the level in Finland to occur outdoors 10 times more often during the winter than the summer months.

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UK research has provided more detailed information on the location of STFA occurring in the home and public places. In the UK, 27 % of STFL recorded as accidents in the home (DTI, 1994) occurred outside the home, with 14 % of 'home' accidents happening in the garden, 9 % on the path or driveway and 1.5 % on the porch. Fothergill et al (1995) considered the role of environmental factors involved in falls in public places incurred by persons who had subsequently attended a UK accident and emergency department. Of 237 injuries following falls, two-thirds occurred on pavements, 27 % while crossing the road, and 9 % in shops.

In conclusion, it appears occupational accidents commonly occur outside the workplace, although this appears to be related to factors such as climate and industry. The large proportion of falls in public places which occur on pavements and roads, and the high incidence of falls on the approach areas to houses and other buildings, suggest a significant risk to employees, such as PDO, who are frequently exposed to these environments.

2.8.2 Features of the accident location: underfoot conditions and agents involved in STFA

In this section the extent of involvement of a number of key STFA hazards is assessed through consideration of data produced from statistical and epidemiological STFA studies. The nature of the risk presented by each hazard, and measures suggested in the literature to reduce the level of risk are discussed. The focus of this section is on hazards which are likely to occur within the working environment of the PDO. For this reason outdoor STFA hazards are highlighted, and a review of steps and stairway safety is included as steps are often encountered on delivery routes.

2.8.2.1 Slipping hazards: snow, ice and liquid contaminants

The precipitating event which leads to a person slipping and falling is usually loss of traction between footwear and floor surface (Swensen et al, 1992). The degree of friction between footwear and walking surface in normal conditions will probably be adversely affected when there is an intervening layer of contaminant, such as a film of water or oil (Proctor and Coleman, 1988). Similarly, where ice or snow come into contact with the shoe soling, dangerous COF values are produced as the area of contact between gripping surfaces is reduced (Marletta, 1991).
In support of the major role of ice and snow in STFA risk, a number of studies have shown a seasonal effect for slip and fall accidents, finding significantly higher proportions of slips and falls during months for which there are expected periods of snowfall and ice. Honkanen (1982), for example, analysed accident cases treated at a Finnish hospital to obtain information on the seasonal variation for injuries due to slipping and to estimate the role of slippery weather conditions in them. Injuries due to slipping on the same level were found to be three times more common during mid-winter (December and January) than in the summer months. Stumblings (trips and stumbles) were slightly more frequent during summer months. Slipping accidents outdoors were also 10 times more common during winter than summer. No differences were found for indoor slips. Honkanen (1982) also considered the proportion of patients who had slipped on the same level to all emergency room patients. Highest proportions of injury due to slipping compared to other accidents were found for the winter months: December (28% of all patients), January (27%), February (24%) and March (22%). A similar effect of season was found for occupational falls reported to a major US insurance company (Leamon and Murphy, 1995). Significantly higher numbers of falls were recorded for the period with expected snowfall and ice (December, January, February and March) than during other months.

Statistical studies show snow and ice to be the main underfoot hazards for outdoor slipping accidents, and a particular problem for Nordic countries. Andersson and Lagerlöf (1983), for example, reported ice and snow to be the most frequently specified agents in Swedish occupational slipping accidents. From the same data, Strandberg (1983) reported 35% of slips to involve snow or ice. In occupational, home and leisure slipping accidents recorded in Norway, Sweden and Finland, snow or ice was recorded as the main type of surface in 73%, 57% and 74% of cases respectively (Lund, 1984).

Studies which have considered the role of liquid contaminants in STFA have suggested water and oil to be involved in a majority of indoor slipping accidents. A study reported by Proctor and Coleman (1988), concerned with STFA within the bakery sector of the food industry, found surface contamination to be involved in 56% of slips and falls. Water inside the building was the most common agent, followed by ice and snow outside the building (15%), and oil (8%). Manning et al (1988) found a total of 28% of underfoot accidents occurring among a working Merseyside population
involved liquid contamination of the underfoot surface, with oil and water the most common agents.

**Increased risk of slipping on sloped surfaces**

Where a walking surface is sloped, the level of risk presented by the slipping hazards discussed above is considerably increased (see section 2.6.2.3). Although no statistical studies were found which considered the risk of falls occurring when walking on a sloped surface, research by Sun et al (1996) provided evidence that slip and fall accidents are more likely to occur during downhill walking than when walking uphill or on the level. This is due to the greater frictional demand at heel strike during downhill walking. The risk appears to increase with angle of slope (Sun et al, 1996).

**Measures to prevent slipping accidents**

Marletta (1991) argues the most important protective measure to reduce the risk of slipping in the presence of snow and ice is to give immediate attention to the proper maintenance of public walking areas. Various maintenance techniques include ploughing, shovelling, de-icing, salting, and sanding. Where snow has been cleared it should be stored downslope, with sufficient drainage capacity, to avoid melting and freezing problems in pedestrian areas. Similarly, spills and liquid contaminants should be cleared up immediately, and good housekeeping practices employed (Proctor and Coleman, 1988; Leamon, 1992; HSE, 1996).

Correct materials should be used for walking surfaces and flooring. The slip-resistance of flooring is affected by the floor's material properties, condition and maintenance, and the footwear of the floor user (Cox and O'Sullivan, 1995). A floor surface specification which is generally recommended is that surface material has a COF greater than 0.5 (e.g. Marletta, 1991; Leamon, 1992). In support of this level of friction, studies on slippery work surfaces show slipping to occur at a COF of 0.20 but not at 0.41 (Swensen, 1992). However, there is conflicting evidence on the level of protection a flooring with a COF of 0.5 might provide to the pedestrian walking or undertaking other activities (Leamon, 1992). Other studies have suggested more conservative COF levels, showing a COF >0.75 to provide excellent slip resistance, whereas a COF<0.2 offers very poor resistance to slipping (Cox and O'Sullivan, 1995). Higher levels will be needed where work or walking must take place on a sloped surface, particularly where the work task
involves pushing or pulling a trolley or other manual exertion while on a sloped surface (Grieve, 1983).

An important determinant of surface slip-resistance has been shown to be surface roughness (e.g. Proctor and Coleman, 1988; Rowland, 1997). On smooth, wet floors aquaplaning can occur, causing slipping. Where there is a degree of surface roughness some asperities break through the liquid film allowing contact between soiling and the underfoot surface, increasing traction (Proctor, 1993). HSE (1985) recommend surfaces such as grooved or ridged tiles are most suitable for areas which are normally wet, such as showers and washrooms. In these areas, and areas where food preparation or other work which may cause spills takes place, tiles with smooth surfaces should be avoided.

Marietta (1991) considered the relative frictional properties of a number of flooring types under wet and dry conditions. Best wet and dry slip-resistant values were obtained from rough concrete surfaces, while worst measures of slipperiness were reported for wet terrazzo and wet marble surfaces. Thus, outdoor walking areas which are paved provide good traction, but the pedestrian must be aware when moving to a surface with a lower COF (e.g. when stepping into a building). Working or pedestrian areas where water or other liquids are likely to come into contact with the floor require mats and other slip-resistant floor controls. This is particularly applicable where smooth, non porous surfaces (e.g. terrazzo, marble and ceramic tiles) are in use. High risk areas include doorway entrances to buildings and supermarket aisles.

Existing building regulations make no reference to flooring slipperiness (see Cox and O'Sullivan, 1995). The lack of standardised methods for slip resistance measurement make it difficult to incorporate slipperiness into building safety regulations. Although a large number of STFA occur on paths and paved areas outside buildings, the Building Regulations also have no requirements regarding building approaches (Cox and O'Sullivan, 1995).

The HSE (1996) guidance to employers regarding STFA suggests footwear to be a second line of defence to reduce slipping risk when housekeeping measures or slip-resistant flooring cannot be used (e.g. where employees
work outdoors. Many STFA researchers have highlighted the importance of footwear in slipping accidents. Manning et al (1988), for example, suggest 45% of underfoot accidents occurring in a sample of working Merseyside people might have been prevented by more slip-resistant footwear.

Legislation supports the use of appropriate footwear in the workplace. The HSE (1996) argue 'employers have a duty to provide, free of charge, all necessary personal protective equipment, including safety footwear.' They further point out 'footwear should be appropriate for the task and floor surface, fit properly and be maintained and renewed as necessary'. However, the HSE point out British and European standards for safety footwear do not include test specification for slip-resistance.

Much work has been undertaken in the assessment of footwear and the development of methods to measure footwear effectiveness on a range of surfaces (e.g. Procter and Coleman, 1988; Redfern and Bidanda, 1994). Slip-resistance evaluation methods measure the COF (in various ways) under different conditions (e.g. wet, dry, oily) and on various surface types (e.g. steel plate, concrete). From these evaluations it has been possible to identify footwear soling material which is likely to be most effective, and flooring which provides best slip-resistance, under various underfoot conditions.

Procter and Coleman (1988) suggest the most important requirement for footwear is effectiveness in combating liquid spills. They argue hydrodynamic (dynamic drainage properties) considerations are important in determining the slip-resistance of footwear and surfaces in the presence of contaminants. On wet surfaces, soling should have a well defined tread pattern (HSE, 1996), as tread pattern is important for dispersing fluid which prevents contact between shoe and substrate (Bruce et al, 1986). Microcellular urethane and rubber is identified by HSE (1996) as the best of three soling materials tested for use on a number of floor surfaces (measured in water-wet conditions), ranging from stainless steel and polished ceramic (most slippery surfaces tested) to concrete and paving stones (least slippery surfaces). These recommendations are supported by findings from extensive slip-testing research which has attempted to rank the grip of industrial footwear on a variety of surfaces (e.g. Manning et al, 1991). Manning and Jones (1994), for instance, identified microcellular polyurethane soling compound (T66/103) as the most slip-resistant soling material for oily and wet floors.
Bruce et al (1986) argues the continued use of slippery shoe materials is likely to lead to increasing numbers of injuries as a result of slipping on icy winter pavements. The researchers developed a rig to allow testing of footwear on ice. A variety of shoes and footwear attachments were tested for dynamic COF on ice, and subjective slipperiness rankings and ratings of test subjects were recorded. The degree of hardness of soling for each footwear was also recorded. Best traction was provided by crampons (COF between 0.24 and 0.31; subjective rating=very good to excellent grip), consisting of steel studs in a rubber strip. The best footwear soling was double density soft microcellular polyurethane (COF between 0.16 and 0.17; subjective rating=good). Least slip-resistance on ice was provided by old PVC solings and leather soles (COF between 0.08 and 0.09; subjective rating=very slippery). Bruce et al (1986) found soling hardness to increase as COF falls \( (r = 0.876) \), with microcellular polyurethane solings having lowest hardness readings and PVC and leather soling having highest readings. Tread pattern did not appear to influence friction on ice. As with footwear for wet conditions, microcellular polyurethane soling compounds appear best suited for working where there is risk of ice. It is also likely the use of crampons, or footwear with studded heels (Grönqvist, 1993), should further reduce slipping risk in these conditions, although more research is required on the effectiveness of footwear attachments on both ice and snow.

In conclusion, snow, ice and water contaminants are the major underfoot hazards for slipping accidents. Research supports this fact, and has shown a large proportion of slipping accidents in Nordic countries involve snow or ice. There is also a seasonal effect for snow and ice slips, with higher proportions of slip falls occurring during winter than in summer. Water and oil contaminants are the main underfoot agents for slips occurring indoors.

A number of measures are discussed in the literature for reducing the risk presented by these hazards. The first step should be to remove the hazard or maintain the walking surface correctly. Snow or ice on walking areas should be cleared or melted, and good housekeeping practice should ensure the prompt clearing of spillages and other surface contaminants. The correct materials should also be used for walking surfaces and flooring. Flooring surface roughness is an important factor for slip-resistance, as it can reduce the risk of aquaplaning which occurs in wet slips. Best walking surfaces for wet and dry conditions include rough concrete and vinyl and quarry tiles for
dry conditions. The greatest level of risk for slipping may occur where a pedestrian passes from a walking surface with a relatively high COF to one with much lower traction, however, and this should be considered in the design of walking areas. A second line of defence against slipping is footwear. Microcellular polyurethane appears to be the most effective all-round soling material for footwear for use in dry, wet or icy conditions. A well defined tread pattern is required for wet underfoot conditions, but not for icy conditions or snow. Best traction on icy surfaces is likely to be provided by crampons, while snow chains offer very poor performance on ice.

2.8.2.2 Uneven paving and other tripping hazards

Common outdoor tripping hazards include projecting paving stones, walkway depressions, kerbs, steps, stair nosings and objects on the floor (Manning, 1983). Indoor hazards include improperly laid or damaged carpet, improperly placed electrical cords, stairways, and the numerous tripping hazards to be found in office environments (Marletta, 1991).

The small number of studies which have looked at the role of tripping hazards in falling accidents have found uneven and damaged underfoot surfaces to be commonly involved in tripping accidents. Trips were most commonly connected with walking surfaces for STFA registered in Sweden during 1979 (Andersson and Lagerlöf, 1983). Considering only falls which occurred in public places, Fothergill et al (1995) reported the underfoot surface to have been uneven in 50% of cases. It should be noted, however, these findings were based on a study period of just 34 days (a longer study period would be expected to produce a larger proportion of slipping hazards as the effect of adverse weather conditions was accounted for). Fothergill (1995) also found repair works to be underway at the site of 10% of falls.

Marietta (1991) highlighted risks presented by uneven paving and other walking surface transitions, arguing abrupt vertical transitions of relatively small dimensions can produce trips where the pedestrian is unaware of the change in walking surface conditions. Analysis of film of a pedestrian foot in transit shows the heel of the foot to skim the floor surface at between 1/4" and 1/2" during normal walking. Studies of human gait have shown changes in the level of the walking surface of a 1/4" are insufficient to induce a trip, while vertical transitions of more than 1/2" constitute a significant trip.
hazard. For transitions of greater than 1/2" a ramp should be used (Marletta, 1991).

Single-step risers are also potential hazards for trippings, due to difficulties pedestrians have in recognising them. Marletta (1991) argues single-step risers are unlikely to be detected by pedestrians where visual cues are absent, such as where there is a lack of contrast between the surface levels, or where no handrail is present. Safe practice is generally to consider a ramp rather than a single step. Direct lighting, handrails or warning signs will reduce the risk of trips involving single-step risers.

2.8.2.3 The visual environment: lighting and visual obstructions

It is well understood bad lighting is an important contributory factor in industrial accidents. Grandjean (1991), for example, reports the US National Safety Council finding that bad lighting was the cause of 5% of all industrial accidents. Grandjean also cites English and French studies which reported drastic reductions in accident rates in shipyards, foundries, etc., when lighting conditions were improved.

Few studies, however, have examined the extent to which inadequate lighting has contributed to STFA. One study, undertaken by Fothergill et al (1995), considered the role of street lighting in STFA occurring in public places in a UK location. Street lighting was judged by victims of falls in public places to have been inadequate in 42% of cases where falls occurred during darkness.

A number of other researchers have suggested lighting as being important in STFA risk. Davis (1983), in a discussion on the role of vision in STFA, notes any lack of visual acuity (at night, or in poor contrast) can cause tripping accidents. Other researchers have pointed out the importance of the pedestrian visually recognising slippery surfaces (e.g. Marletta, 1991; Leamon, 1992). Clearly adequate illumination is necessary if changes in surface condition are to be recognised and adapted to by the pedestrian.

Falls are also more likely where a person's vision of the ground underfoot and ahead is obscured (Pater, 1985). A number of factors can effect a person's ability to see where they are going: loads carried in front or at the side of the body, body parts (e.g. thighs when descending stairways - Negata, 1993), aspects of the built environment, and visual distractions. Negata (1993)
argues people normally look at the walking surface a few metres ahead while they are walking, but sometimes become distracted by some aspect of the visual environment. This can result in stumbles over small projections or falls due to assuming there is another step at the end of a stairway (also see Pauls, 1985).

HSE (1996) guidelines to reduce STFA risks provide advice on lighting for working environments. Employers are encouraged to ensure workers can see obstructions and potentially slippery areas. No specific advice on illumination levels is provided, although Davis (1983) argues illumination intensity should be no less than 300 lux, to allow for adequate contrast if tripping is to be avoided.

Further guidance for employers is provided by the HSE. Lights should be replaced, repaired or cleaned before lighting levels become insufficient for safe working. Lighting should be arranged so as not to cause dazzle or glare. In addition, goods or other obstructions should not be placed where they block light or cast shadows.

Staircases and changes of level require local lighting. This is also recommended for ramps where there are no cues to the change in surface between walkway and ramp (HSE, 1996). Pater (1985) notes stairs which are dimly lighted are especially hazardous.

2.8.2.4 Stairways and steps

Falls on steps and stairways are widely recognised as a leading cause of injury (Pauls, 1991; Templer, 1992). Manning et al (1988) provided evidence of the hazard presented by steps, reporting 11% of underfoot accidents among a Merseyside working population to have occurred on steps. Pauls (1985) cites National Electronic Injury Surveillance System statistics which suggest some 800,000 injuries requiring hospital treatment are incurred annually in the US as a result of stair accidents. About 600 people die each year in Japan as a result of accidental falls on stairs, with the non-fatal injury account estimated as being up to 500 times this number (Negata, 1991).

According to DTI (1995) figures, accidents on stairs in the home account for 28% of fatal UK home accidents and 24% of non-fatal home accidents. When the difference in exposure between level floors and stairs is accounted for, steps and stairways may be seen as a key location for falling accidents.
Stair accidents occur most commonly among young children, persons aged 21-25 and adult women. For female workers, accidents on stairs contributed to 23% of slip and fall accidents reported to the Austrian Workers Compensation Board (Körpert, 1997). Negata (1991) found young female employees wearing high or semi-high heeled footwear to be comparatively likely to incur injuries by misstepping. Falls on stairs among the elderly are also common, and more often result in serious injury. Askham et al (1990) estimated about one third of people aged over 65 years have some type of fall each year, over one-third of which involve stairs. More serious injuries are incurred by the elderly, with persons over the age of 65 years accounting for approximately 85% of the deaths resulting from stair accidents (Pauls, 1985).

Most stairway accidental falls occur while descending stairs, and injuries during stair descent tend to be more serious (Cox and O'Sullivan, 1995). The most common pre-event in stairway falls is 'overstepping', according to Pauls (1985), who cites a number of American stair safety studies conducted during the 1970s. Leading scenarios for stair accidents include: 'adult women in a hurry, elderly people with poor eyesight or those under the influence of alcohol or medication, misjudgement of tread length while descending, overstepping the tread nosing' (Pauls, 1985).

Stairway design and environmental features affecting the risk of stairway falls
Studies of stairway accidents suggest stair geometry is a major factor in accident risk. Marletta (1991) argues a riser which is too high will cause the ball of the foot to land too far out on the step below. Tread depths that are too short will alter the landing position of the ball of the foot, and can cause the foot to slip off the nosing. Negata (1991), from an analysis of occupational injury data related to stairway falls in Tokyo, found significant differences for dimensions between accident and non-accident stairs for tread depth and riser height. For accident stairs, tread depth was found to be lower than for non-accident stairs, while riser height was greater for accident stairs. Templer and Archea (1983), found higher incidence rates for US stairway accidents where stair riser heights exceeded 178 mm and tread depths were less than 254 mm. Studies considering stair geometry requirements to ensure sufficient room for the foot, have found safest stairs to have a maximum effective riser height of 152 mm and a minimum tread depth of 279 mm (Templer and Archea, 1983; Cox and O'Sullivan, 1995).
Studies of stair safety have also considered stair nosings. Nosing projections which exceed 18 mm are associated with greater numbers of missteps (see Cox and O'Sullivan, 1995), and nosing materials which have poor frictional properties are likely to increase STFA on stairs.

Studies have shown handrails to be a key factor in stair fall accidents. Cox and O'Sullivan (1995), for example, reported a study by Miller and Esmay (1961) which found there were no handrails on the part of the stairway where the fall had occurred in 75% of cases. The authors also cite later work which supports the importance of having handrails to stair safety. Handrails are important as they serve to help prevent the occurrence of a misstep or slip in addition to offering a means of recovery once a fall has been initiated (Marletta, 1991). As well as the physical advantage offered by handrails, Marletta notes they are also useful for one and two step risers as they serve as a visual cue to pedestrians for the presence of steps.

The frictional properties of tread coverings is important in stair safety as many stair falls follow slips between shoe and tread surfaces or the tread and its covering (Pauls, 1985; Templer, 1992). Marletta (1991) discusses the problem of slipping and stability when descending a stairway. The COF needed for safe stairway descent is greater than that of a flat walking surface, as the angle at which the ball of the foot contacts the nosing reduces the surface area of the sole contact. The pedestrian is most vulnerable to falling as their weight presses the ball of the foot against the nosing while the other foot is moving towards the tread below. For these reasons, Marletta (1991) notes most building codes require tread materials to be slip-resistant.

Other environmental features which affect stair accident risk include: lighting (Marletta, 1991; Pater, 1985; Templer, 1992; Cox and O'Sullivan, 1995); length of flight (Cox and O'Sullivan, 1995); type of flight (Negata, 1991); and distracting features of the stairway environment (Templer, 1992).

2.8.3 Section summary: factors related to the accident location
Locations for STFA appear to vary depending on the seasonal weather conditions, with outdoor STFA being considerably more common during winter months. Little additional information regarding STFA location is provided in the published literature, although Fothergill et al (1995) found two-thirds of falls in public places occurred on pavements. Common STFA
hazards include ice and snow, liquid contamination of walking surfaces, uneven or damaged paving, steps and inadequate lighting. It is noted many of these hazards can be considered as potentially avoidable. Evidence in support of this assertion was provided by Fothergill et al (1995), who found avoidable environmental factors (i.e. uneven paving and absence of adequate lighting) to be involved in 57% of falls in public places. Proctor and Coleman (1988), and HSE (1996) also note many STFA would be avoided if employers more actively controlled the hazards that contribute to them (e.g. through good housekeeping measures). Other researchers suggest the use of appropriate footwear and flooring materials would have also saved a large proportion of slipping accident victims from their injuries (e.g. Manning et al, 1988).

2.9 Chapter summary and conclusions

This chapter has reviewed published literature concerning STFA. The review focused on material considered relevant to the problem of STFA occurring among PDO, with emphasis given to STFL and outdoor STFA risk factors. Having considered the extent of the STFA problem, citing national and industrial accident data, the remainder of the review was organised around the central features of a model for STFA put forward by Buck and Coleman (1985). Risk factors associated with the individual, their movement and task, and the location of their accident have been discussed.

Below, relevant accident factors not considered previously in the review are briefly outlined. To conclude the chapter, risk factors for STFA which may be particularly relevant to the problem of falls among PDO are highlighted.

2.9.1 Relevant accident factors not considered in the review of STFA literature

This review has drawn information from relevant published STFA research and literature in an attempt to identify risk factors for STFA. It is acknowledged, however, that a wide range of other factors may be relevant to the study of STFA among PDO. For example, underlying management and organisational influences (see section 2.4) should be accounted for when identifying causes and countermeasures for such accidents. Individual behaviour affecting accident risk in the face of danger has also been well
documented (e.g. Surry, 1979; Hale and Glendon, 1987). These researchers have highlighted aspects of human information processing in hazardous situations. Ramsey's (1985) accident sequence model (figure 2.5), adapted by Sanders and McCormick (1992), traces stages in information processing, during which failure to perceive, recognise, decide to avoid and physically avoid a hazardous situation may lead to an accident.

Ramsey's (1985) model suggests many factors may affect each stage of an individual's information processing in a hazardous situation. While the published STFA literature reviewed in this chapter has discussed a number of factors which relate to hazard perception, cognition and ability to avoid the hazard (e.g. vision, health, experience, biomechanics, etc.), factors which concern an individual's recognition, and decision to avoid a hazard have not been addressed. Much research has been dedicated to the important issues of attitudes to safety and organisational safety climate and culture, motivational influences on behaviour, and risk-taking, etc. It is not within the scope of this review to discuss the role of these factors in STFA risk, but the importance of each for the study of STFA during the delivery of mail is recognised.

2.9.2 Key STFA risk factors as they relate to the problem of the risk of falls to postal delivery officers
Postal services (along with telecommunications workers) have highest over 3 day incidence for STFL. Other occupations where a large proportion of work takes place outdoors have similarly high STFA incidence, suggesting the key risks for falls among PDO are related to aspects of the physical and ambient outdoor environment. Assuming PDO share similar personal characteristics with the general working population, other factors of particular relevance for STFA among PDO should relate to the postal delivery task. Drawing on information presented in this review, and information regarding the postal delivery task and working conditions (see section 1.3.4), task and environmental factors considered important to the STFA risk faced by PDO are suggested in table 2.3.
Figure 2.5. Sequential model of accident occurrence (Source: Adapted from Ramsey, 1985, and Sanders and McCormick, 1992)
<table>
<thead>
<tr>
<th>Task-related factors</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Walking</strong></td>
<td>PDO have considerable exposure to the main activity during which falls occur. Most PDO walk for up to four hours per day in uncontrolled and unpredictable outdoor environments.</td>
</tr>
<tr>
<td><strong>Speed of walking</strong></td>
<td>Slipping becomes increasingly likely as the pedestrian increases their walking pace and stride length (Marletta, 1991). PDO must keep to delivery time targets. Walking at pace in slippery conditions increases their risk of slipping.</td>
</tr>
<tr>
<td><strong>Load carrying</strong></td>
<td>Loss of balance accidents appear to be increasingly likely as weight and height of load increases (Davis, 1983). Load carriage is an important factor in slipping risk on slippery surfaces (Myung and Smith, 1997). Many PDO are required to carry heavy loads for long periods. Load carrying can also increase tripping and stair fall risk when the carrier's view is obstructed by the load (Leamon, 1992). This may be problematic for PDO who wear their load towards the front of the body (to facilitate easy access). Load carrying using the hands (as when holding mail or parcels, etc.) may reduce the carrier's ability to use their arms to maintain balance (Pater, 1985; Leamon, 1992), and to break a fall.</td>
</tr>
<tr>
<td><strong>Other activities</strong></td>
<td>Climbing in and out of vehicles is a common activity preceding falls (Nicholson and David, 1985). PDO frequently climb in and out of the side and back of vans. Pulling/pushing pouch trolleys and cycles are common PDO activities. Slipping risk may be increased when pushing or pulling in slippery conditions (Grieve, 1983).</td>
</tr>
<tr>
<td>Factors related to the accident location</td>
<td>Table 2.3 continued</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Exposure to snow and icy underfoot conditions</td>
<td>Snow and ice are commonly involved in slipping accidents (e.g. Andersson and Lagerlöf, 1983; Lund, 1984), and STFA occur in highest incidence during periods of adverse weather (Honkanen, 1982; Leamon and Murphy, 1995). PDO are often exposed to these conditions during winter. Risks may be greatest during the early morning, when deliveries are undertaken, as overnight snow, ice and frost may not have thawed or been cleared.</td>
</tr>
<tr>
<td>Exposure to wet conditions</td>
<td>Slips commonly occur where there is liquid contamination of the underfoot surface (Proctor and Coleman, 1988). PDO often work in wet and muddy conditions (e.g. when crossing grassed areas, wet pavements).</td>
</tr>
<tr>
<td>Exposure to inadequate lighting</td>
<td>Inadequate lighting is an important risk factor for falls in public places (Fothergill, 1995). PDO work during early winter mornings where natural lighting may be poor. They may also have to go into poorly lit buildings.</td>
</tr>
<tr>
<td>Exposure to sloped walking surfaces</td>
<td>Walking down sloped surfaces increases slipping potential (Sun et al, 1996). PDO may be exposed to many steep gradients (e.g. hills and sloped driveways).</td>
</tr>
<tr>
<td>Exposure to tripping hazards</td>
<td>Uneven walking surfaces are commonly involved in falls in public places (Fothergill et al, 1995), and even small transitions in walking surfaces represent a tripping hazard (Marletta, 1991). PDO encounter numerous such tripping hazards on their delivery routes.</td>
</tr>
<tr>
<td>Exposure to steps and stairways</td>
<td>Steps are commonly involved in falling accidents (Manning et al, 1988; Negata, 1991). PDO may encounter many steps and stairways on their routes. Unlit, steep or damaged steps represent greatest risk. Single step risers leading to front doors may also present a risk to PDO preparing to deliver mail.</td>
</tr>
</tbody>
</table>
Chapter Three

ANALYSIS OF IN-HOUSE ACCIDENT DATA AND REPORTS

3.1 Introduction

3.1.1 Outline of research presented in this chapter
Analysis of existing data is an acknowledged starting point for studies concerned with accident analysis and prevention. The purpose of the research presented in this chapter was to identify trends and patterns in accident incidence, through the analysis of accident data gathered by Royal Mail Midlands. Data pertaining to STFA occurring during the delivery of mail for the period April 1994 to March 1996 were considered in the analysis.* The study used a sequence of events framework of analysis, as used in the majority of published statistical STFA studies (e.g. Honkanen, 1982; Andersson and Lagerlöf, 1983; Manning, 1983; Strandberg, 1983; Baxter et al, 1985; Nicholson and David, 1985; Manning et al, 1988). The data allowed identification of the activity of the employee immediately prior to the accident, the fall initiating event and injury event. Identification of surface condition and hazard involved in the accident was also possible from coded 'one-line' descriptions of accident circumstances. In addition, the analysis investigated STFA incidence by age, sex and length of service. Time, day and month of accident was also considered, with particular attention on the propensity for slipping accidents to cluster during short time periods.

The study attempted to extract further details on accident location and contributory factors through analysis of a sample of accident report forms documenting delivery STFA occurring in three Midlands' counties during a 12 month period. Coding of report forms allowed identification of accident location, hazard or underfoot surface and unsafe behaviour in STFA.

* The main findings of this research were presented at the 1st International Applied Ergonomics Conference, Istanbul, 1996 (Bentley and Haslam, 1996a). Research presented in this chapter and chapter four has also been submitted for publication in Ergonomics. Findings from this research and the studies reported in chapters five to seven are to be presented at the STFA '98 Conference, University of Surrey, and have been submitted for publication in Applied Ergonomics.
3.1.2 **Aims**

i) To identify features of the physical and ambient environment commonly involved in delivery STFA.

ii) To identify trends in STFA incidence over time (day, week and month).

iii) To determine patterns of delivery STFA incidence across the postal delivery employee (PDO) population.

iv) To determine common locations for delivery STFA.

v) To identify issues for consideration in further project research.

3.2 **Methods**

3.2.1 **Description of the data**

Accident data were supplied in hard copy form by Royal Mail's Personnel Services Centre and contained information on a total of 1734 cases. These represented all reported delivery STFA occurring between April 1993 and March 1995 in the Midlands division. Details available from the Royal Mail database (table 3.1) included the accident-involved employee's personal and employment details, details of the injury, time and date of accident, and length of absence from work. A 'one-line' description of accident circumstances also featured on the data output.

Table 3.1. Information maintained on the Royal Mail database

| 1. Accident-involved employee's delivery office |
| 2. Cause of accident (e.g. 'Outdoor fall', 'Stepped on/striked against') |
| 3. Function (Delivery, Distribution, Processing) |
| 4. Incident date |
| 5. Absence from work (start and end date and total days absent) |
| 6. Nature and location of injuries (e.g. sprain, ankle) |
| 7. Incident time |
| 8. Name, age, sex and length of service of injured person |
| 9. A 'one line' description of accident circumstances (e.g. "the employee slipped and fell while walking down an ice covered driveway") |
3.2.2 Coding of accident data

Analysis of delivery STFA was based on a 'sequence of events' model of accidents. The 'one-line' descriptions provided sufficient detail to allow coding of the employee's activity at the time of the accident and 'fall initiating event' (FIE), while the data output also contained information on the injury event. Walking surface conditions or hazards connected with the fall could also be determined from the 'one-line' descriptions in the majority of cases. A coding form was produced from the sample analysis (appendix A). For 86% of cases these classifications were possible, with 14% remaining unclassified due to insufficient information. Once coded, accident data were entered to Excel and analysed using SPSS for Windows.

3.2.3 Accident reports: data and coding

A sample of 237 accident report forms were examined. The forms were completed by the accident-involved employee and their office manager at the time the accident was reported. The sample represented all delivery STFA reported in 3 East Midlands counties (Leicestershire, Nottinghamshire, Derbyshire) during a one year period: April 1994 to March 1995. Accident report forms provided sufficient detail to identify the location of delivery STFA, unsafe condition or hazard and the use of unsafe behaviour. A coding form was produced from a sample analysis (appendix B).

3.3 Results: data analysis

3.3.1 Total number of accidents and distribution of days lost

A total of 1734 delivery STFA were reported during the two year period considered in the analysis, 825 for 1993/4 (incidence rate: 80.4 per 1000 employees), and 909 for 1994/5 (incidence rate: 88.5 per 1000 employees). The majority of these accidents did not require a full days absence from work (i.e. the accident-involved employee either had no absence or returned to work at the start of the next day) (61%). More than 25% of delivery STFA required over 3 day absence, and were therefore notifiable under RIDDOR. Over 3 week absence was required by 9% of accident-involved employees, suggesting serious injuries are not an uncommon consequence of STFA during the delivery of mail.
### Activity of accident-involved employee, Fall Initiating Event and surface condition or hazard

Figure 3.1 shows the distribution of delivery STFA by activity of the accident-involved employee immediately preceding the fall, together with FIE and a breakdown of surface conditions or hazards for slipping and tripping FIE.

<table>
<thead>
<tr>
<th>Activity of employee immediately preceeding the fall</th>
<th>Fall Initiating Event (FIE)</th>
<th>Surface condition/hazard</th>
<th>% of falls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking on the level (63 %)</td>
<td>Foot slipped 49</td>
<td>Ice</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Trod in/stepped on 5</td>
<td>Snow</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Unclassified 19</td>
<td>Wet surface or grass</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Foot tripped 27</td>
<td>Leaves</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loose surface</td>
<td>6</td>
</tr>
<tr>
<td>Walking on steps (19 %)</td>
<td>Foot slipped 61</td>
<td>Unevenground</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Foot tripped/missed step 15</td>
<td>Obstacles</td>
<td>28</td>
</tr>
<tr>
<td>Climbing in/out of vehicle (3 %)</td>
<td></td>
<td>Kerb</td>
<td>28</td>
</tr>
<tr>
<td>Climbing on/off bicycle (1%)</td>
<td></td>
<td>Wall/fence</td>
<td>9</td>
</tr>
<tr>
<td>Unclassified (14 %)</td>
<td></td>
<td>Other/Unclassified</td>
<td>24</td>
</tr>
</tbody>
</table>

Figure 3.1. Distribution of delivery STFA by activity, FIE and unsafe condition or hazard

The most common activity immediately preceding the fall was walking on the level between delivery points (63 %), with the other notable activities being ascending or descending steps (19 %) and climbing in or out vehicles (3 %) (usually a van).
Foot slip was the FIE for 50% of all delivery STFA. The proportion of STFA where foot slip was the FIE is likely to be higher than this, however, due to the large proportion of unclassified cases. Foot slip was the largest single category of FIE for STFA occurring while walking on the level (49%) and on steps (61%). Of slips on the level, nearly half occurred on an icy walking surface (46%), one-quarter on a wet or grass surface, and 17% on snow.

Foot trip was the FIE for 24% of delivery STFA (i.e. including falls on the level and on steps). As with slips, this figure would be higher when accounting for unclassified cases. The main walking surfaces or hazards associated with foot trip FIE on the level were uneven ground (35%), obstacle (28%) and kerb (28%).

A large proportion of STFA occurred while ascending or descending steps or stairways (19%). Falls on steps were most frequently the result of slips (61%). The accident-involved employee either tripped or missed a step in 15% of cases.

3.3.2.1 FIE by length of absence from work following a fall
The length of absence from work for slip, trip and step falls were calculated and are shown in figure 3.2.

![Bar chart showing the percentage of FIE by length of absence from work for slip, trip, and step falls.](image)

Figure 3.2 Slip, trip and step falls by days absent from work
Accident-involved employees more often received an injury requiring over 3 day absence from work following a fall on steps (35% with over 3 day absence) compared to employees who had fallen on the level (26% following a trip on the level and 19% following a slip on the level), although the difference was not significant. Over 21 day absence was also most common for step falls. The large proportion of STFA incurred on steps (19%) suggests accident-involved employees are more likely both to fall and to sustain an injury considered worthy of reporting following a step fall.

3.3.2.2 FIE by body part injured
Ankle (23%), knee (17%) and back (16%) were the most frequent body parts injured as a result of delivery STFA, with almost 50% of all days absent due to ankle and back injuries. Ankle and back injuries also most often required over 3 day absence from work.

Figure 3.3 shows the distribution of slip, trip and step falls by main body parts injured (data for type of injury was not supplied for this investigation).

Figure 3.3 FIE by main body parts injured following a fall

Ankle injuries resulted most often from trip falls (30%) or where the fall occurred on steps (35%). Slips most commonly resulted in back injuries.
(28 %). This finding is consistent with studies reported by Manning (1983), in which 'foot slipped' was the first unforeseen event in 47 % of accidents causing back pain, and Manning et al (1988), where the most common site for injury following slipping accidents was to the lumber spine.

3.3.3 Month of STFA

Figure 3.4 shows the distribution of delivery STFA by month.

![Figure 3.4 Distribution of delivery STFA by month](image)

The 'U' shaped distribution suggests delivery STFA incidence is subject to seasonal variation. Approximately 50 % of falls occurred during the four month winter period November to February, suggesting an effect of weather on accident incidence.

Notably few Delivery STFA occurred during the months of December (10 %) compared to the other two main winter months: January (15 % ) and February (16 %). This is, perhaps, surprising when taking account of the additional exposure to STFA hazards PDO experience due to the considerable increase in workload over the Christmas period (double shifts are not uncommon). Possible explanations for these findings include the availability of overtime during this period, and the need for 'all hands on deck' during the busiest working period.
3.3.3.1 Month by FIE

Analysis of month by FIE (snow and ice slips, trips and step falls) is shown in figure 3.5. The large peak in February coincides with a period of severe snow fall during the month of February 1984. Ice falls are spread more evenly throughout the winter months. Trip falls were unaffected by seasonal conditions, being fairly evenly distributed across the months of the year. Nearly 50% of step falls occurred during winter months, November to March.

![Figure 3.5. Month by main FIE](image)

3.3.3.2 Concentration of snow and ice falls during short time periods

During February 1994, 80% of snow slips were reported (n=90). Further analysis revealed 61% of snow slips during this month (n=54) occurred on a single day. The analysis also considered the extent to which ice slips clustered on single weeks and days. Table 3.2 shows the total number of ice slips for each of the main winter months, the proportion of ice slips occurring in any single week within that month (the week with the most frequent count of ice slips), and the proportion of ice slips occurring on any single day during that month (the day with the most frequent count of ice slips). More than 50% of ice slips were concentrated into 1 week for each of the winter months, with the exception of January 1995 (49%). Large proportions were also concentrated on single days.
Table 3.2. Concentration of ice slips during individual weeks and days

<table>
<thead>
<tr>
<th>Month</th>
<th>Total ice slips for each month (n)</th>
<th>Concentration of ice slips in one 7 day period (n)</th>
<th>Concentration of ice slips in 1 day (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 1993</td>
<td>29</td>
<td>17 (59 %)</td>
<td>7 (24 %)</td>
</tr>
<tr>
<td>December 1993</td>
<td>22</td>
<td>17 (77 %)</td>
<td>13 (59 %)</td>
</tr>
<tr>
<td>January 1994</td>
<td>50</td>
<td>39 (78 %)</td>
<td>20 (40 %)</td>
</tr>
<tr>
<td>February 1994</td>
<td>48</td>
<td>27 (56 %)</td>
<td>18 (38 %)</td>
</tr>
<tr>
<td>November 1994</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>December 1994</td>
<td>47</td>
<td>42 (89 %)</td>
<td>11 (23 %)</td>
</tr>
<tr>
<td>January 1995</td>
<td>61</td>
<td>30 (49 %)</td>
<td>17 (28 %)</td>
</tr>
<tr>
<td>February 1995</td>
<td>9</td>
<td>7 (78 %)</td>
<td>6 (67 %)</td>
</tr>
</tbody>
</table>

3.3.4 *Day of week and time of day*

Table 3.3 shows the distribution of delivery STFA for day of week, along with relative workload for each day. There appears to be some relationship between workload and delivery STFA incidence, with the proportion of delivery falls greatest on Wednesday and Thursday. Fewest delivery STFA occurred on the least busy day of the week, Monday. However, this finding may be confounded by Monday following a break day, and the possibility of employees being increasingly likely to report accidents later in the week due to the effects of tiredness, fatigue or boredom.

Table 3.3. Distribution of delivery STFA by day of week and relative workload

<table>
<thead>
<tr>
<th>Day of week</th>
<th>Relative workload</th>
<th>Proportion of delivery STFA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Low</td>
<td>12</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Low</td>
<td>16</td>
</tr>
<tr>
<td>Wednesday</td>
<td>High</td>
<td>19</td>
</tr>
<tr>
<td>Thursday</td>
<td>High</td>
<td>20</td>
</tr>
<tr>
<td>Friday</td>
<td>High</td>
<td>17</td>
</tr>
<tr>
<td>Saturday</td>
<td>High</td>
<td>16</td>
</tr>
</tbody>
</table>
Table 3.4 shows the distribution of delivery STFA by time of day. The main elements of the working day are also shown, noting relative workload for that time.

Table 3.4. Distribution of delivery STFA by time of day, working period and relative workload

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Working period</th>
<th>Relative workload</th>
<th>Proportion of delivery STFA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 8 am</td>
<td>First delivery round</td>
<td>High</td>
<td>29</td>
</tr>
<tr>
<td>(about 6.45-8am)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 to 9 am</td>
<td>First delivery round</td>
<td>High</td>
<td>28</td>
</tr>
<tr>
<td>9 to 10 am</td>
<td>First delivery round/ rest</td>
<td>Moderate</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 11 am</td>
<td>Sorting and rest break</td>
<td>Low</td>
<td>4</td>
</tr>
<tr>
<td>11 to 12 noon</td>
<td>Second delivery round</td>
<td>Low</td>
<td>9</td>
</tr>
<tr>
<td>After 12</td>
<td>Rural and late deliveries/</td>
<td>Low</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>distribution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A total of 74% of delivery falls occurred during the period covering the first delivery round. This finding may be explained by a number of factors. During the early morning in winter months both darkness and weather conditions (e.g. uncleared snow or ice) may increase the risk of STFA. During this period up to 95% of mail is delivered, exposure to hazardous environments is greatest, and employees are subject to time targets for delivery completion.

3.3.5 Sex of accident-involved employee
Two year incidence rates for male and female employees are shown in table 3.5. The incidence rates are based on all delivery STFA reported, and over 3 day and 21 day absence STFA. Female incidence rates are significantly higher than those of their male colleagues for all reported STFA, over 3 day absence STFA, and over 21 day absence STFA. The large differences in over 21 day injuries suggest female staff are more likely to sustain a moderate to serious injury following delivery STFA.
Table 3.5. Two year incidence rates (per 1000 employees) for all reported delivery STFA, and over 3 day and over 21 day absence STFA for male and female PDO

<table>
<thead>
<tr>
<th>Length of absence from work</th>
<th>Male incidence rate</th>
<th>Female incidence rate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>All STFA, regardless of absence from work</td>
<td>154.4</td>
<td>251.3</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Over 3 day absence STFA</td>
<td>37.9</td>
<td>72.1</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Over 21 day absence STFA</td>
<td>11.6</td>
<td>32.5</td>
<td>p&lt;0.01</td>
</tr>
</tbody>
</table>

3.3.5.1 Sex of accident-involved employee by FIE
Further analysis considered whether there were differences in male and female PDOs' propensity to incur slips, trips and step falls. Incidence rates for all reported delivery STFA (regardless of length of absence) are shown in table 3.6. Large differences are observed for slip, trip and falls on steps, with females having almost twice the incidence of tripping accidents.

Table 3.6. Two year incidence rates (per 1000 employees) for all reported slip, trip and step fall accidents for male and female PDO

<table>
<thead>
<tr>
<th></th>
<th>Slip incidence</th>
<th>Trip incidence</th>
<th>Step fall incidence</th>
<th>Other FIE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>59.8</td>
<td>30.7</td>
<td>30.3</td>
<td>33.6</td>
</tr>
<tr>
<td>Females</td>
<td>90.2</td>
<td>59.7</td>
<td>47.4</td>
<td>53.9</td>
</tr>
</tbody>
</table>

3.3.5.2 Sex of accident-involved employee by body part injured
Male PDO more often incurred back injuries as a result of delivery STFA (17% of injuries from falls to males were back injuries, 12.5% of injuries from falls to females were back injuries). The only other notable difference between males and females was for knee injuries (males 16%; females 20%).

3.3.6 Age of accident-involved employee
Table 3.7 shows two year incidence rates per 1000 employees for age group. Significantly lower incidence was found amongst employees in the under 25 years age group for all reported delivery STFA. When considering STFA
resulting in over 3 day absence, however, PDO under 25 years have highest rates, with lowest over 3 day incidence found amongst over 49 year old PDO.

Table 3.7. Two year incidence rates (per 1000 employees) for all reported delivery STFA, over 3 day and over 21 day absence STFA by age group

<table>
<thead>
<tr>
<th>Length of absence from work</th>
<th>Under 25 years</th>
<th>25-49 years</th>
<th>Over 49 years</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>All STFA, regardless of absence from work</td>
<td>128.2</td>
<td>164.6</td>
<td>166.2</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Over 3 day absence STFA</td>
<td>50.7</td>
<td>44.4</td>
<td>35.7</td>
<td>n.s.</td>
</tr>
<tr>
<td>Over 21 day absence STFA</td>
<td>14.8</td>
<td>14.6</td>
<td>15.1</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

3.3.6.1 Age of accident-involved employee by FIE

Slipping, tripping and step fall incidence was considered for the three age groups (Table 3.8). Slipping incidence (all reported delivery STFA, regardless of length of absence) increased with age, with the oldest group incurring a rate over 50% greater than their youngest colleagues. Tripping accidents also increased with age, while step falls reduced in incidence with age.

Table 3.8. Two year incidence rates (per 1000 employees) for all reported slip, trip and step fall accidents by age group

<table>
<thead>
<tr>
<th></th>
<th>Slip incidence</th>
<th>Trip incidence</th>
<th>Step incidence</th>
<th>Other FIE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 25 years</td>
<td>46.3</td>
<td>26.3</td>
<td>35.1</td>
<td>20.5</td>
</tr>
<tr>
<td>25-49 years</td>
<td>61.0</td>
<td>32.9</td>
<td>31.9</td>
<td>38.7</td>
</tr>
<tr>
<td>Over 49 years</td>
<td>70.2</td>
<td>38.2</td>
<td>25.2</td>
<td>32.8</td>
</tr>
</tbody>
</table>

3.3.7 Length of service of accident-involved employee

No effect of experience was found, with very similar delivery STFA incidence (all STFA and over 3 day absence) for PDO in the under 1 year and over 10 years length of service groups.
3.4 Results: analysis of accident reports

3.4.1 Location of STFA and hazard associated with the accident

Figure 3.6 shows the distribution of delivery STFA accidents by location of accident and hazard or underfoot condition involved in STFA.

<table>
<thead>
<tr>
<th>General area</th>
<th>% of falls</th>
<th>Specific area</th>
<th>% of falls</th>
<th>Hazard</th>
<th>% of falls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public area</td>
<td>30</td>
<td>Road</td>
<td>23</td>
<td>Uneven ground</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pavement</td>
<td>70</td>
<td>Obstacle</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grass/steps</td>
<td>7</td>
<td>Ice</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other</td>
<td>30</td>
</tr>
<tr>
<td>Householders' premises</td>
<td>55</td>
<td>Driveway</td>
<td>38</td>
<td>Uneven ground</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pavement</td>
<td>24</td>
<td>Obstacle</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garden</td>
<td>7</td>
<td>Ice</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steps (including door step)</td>
<td>31</td>
<td>Steps</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Driveway</td>
<td>38</td>
<td>Mud/oil</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pavement</td>
<td>24</td>
<td>Wall/fence</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garden</td>
<td>7</td>
<td>Hole</td>
<td>6</td>
</tr>
<tr>
<td>Business property</td>
<td>4</td>
<td>Steps (including door step)</td>
<td>31</td>
<td>Mud/oil</td>
<td>11</td>
</tr>
<tr>
<td>Flats</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Royal Mail premises</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.6. Distribution of delivery STFA by location of accident and hazard involved

Nearly twice as many STFA occurred on householders' property than on pavements, roads or other public areas, with 34% of delivery STFA on private driveways or pavements. A further 17% of delivery STFA occurred on private steps. These findings show private premises to present the greatest risks for delivery STFA. Examination of the types of hazard involved in STFA on householders' premises suggested a large proportion of accidents involved 'avoidable' environmental factors (figure 3.6). These included...
uneven or damaged paving slabs, obstacles left in driveways and on pavements, damaged steps, and ice from frozen drains.

3.4.2 *Unsafe behaviour*
More than 11% of reports mentioned the contribution of unsafe behaviour to the accident occurrence. The practice of reading letter addresses while walking was recorded as being a causal factor in 5% of delivery STFA. A further 4% of reports mentioned taking short-cuts across grass areas or over walls or fences as contributory in STFA. Finally, 2% of reports mentioned running up or down steps as a causal factor in falls. It is suggested the actual contribution of unsafe behaviour and working practices may be considerably greater than these figures indicate, as employees may be unlikely to implicate themselves as blameworthy when describing accident circumstances to managers.

3.5 Discussion

3.5.1 *Key findings and implications for future project research*

3.5.1.1 *Slipping accidents*
One half of delivery STFA involved 'foot slip' FIE. This figure would probably be larger when accounting for unclassified STFA. This finding is in line with that of Manning et al (1988), who found slipping accidents made up 62% of 'underfoot accidents' among a working population of 10,000 Merseyside people. Highest incidence for slipping occurred among older female PDO.

Slipping was the most common FIE for walking on the level and on steps, and was the FIE in almost all 52 accidents incurred while climbing in or out a vehicle. Slipping during tasks associated with vehicles have been highlighted in previous research (Nicholson and David, 1985), which has suggested slipping is most likely while descending from the cab or rear end of the vehicle.

The main underfoot surface conditions for slips were ice and snow. These findings are consistent with those of a number of Nordic studies. Andersson and Lagerlöf (1983), for example, found the most frequent specified agents
associated with occupational slipping accidents in Sweden to be snow and ice, while Lund (1984) found snow and ice were the main type of surface on which home and leisure slipping accidents occurred in nearly 3/4 of Finnish and Norwegian cases.

It was decided further project research should obtain additional data concerning a number of factors which may increase the risk of slipping accidents, including PDO footwear and footwear attachments (snow chains), weight of load carried and walking/work pace.

3.5.1.2 Effect of weather and clustering of slipping accidents involving snow and ice

Approximately 50% of delivery STFA occurred during the four winter months, November through February, suggesting an effect of weather on accident incidence. Other studies have reported a similar seasonal effect for slip and fall accidents (Honkanen, 1982; Leamon and Murphy, 1995), finding a significantly higher proportion of accidents to occur during months for which there are expected periods of snowfall and ice.

During one of the 24 months considered in the analysis, 80% of snow slips occurred, with 61% of snow slips reported on one day. Ice slips were also found to concentrate into single days and weeks for each of the winter months considered.

It was decided subsequent project research should consider further the problem of severe weather conditions, including its effects on PDO safety.

3.5.1.3 Tripping accidents

Tripping was the FIE in 24% of delivery STFA. This figure would probably be larger when allowing for unclassified STFA. This finding is comparable with that of Manning et al (1988), who found tripping accidents comprised 17% of 'underfoot accidents'. Andersson and Lagerlöf (1983) also found tripping to be the first event in 19% of Swedish occupational STFL recorded during 1979. Highest incidence for tripping was found among older and female PDO.

The main hazards associated with tripping accidents were uneven ground and obstacles. Uneven ground has also been reported as the major hazard in previous STFA research (Andersson and Lagerlöf, 1983; Fothergill et al,
1995). A large number of delivery STFA involved 'avoidable' environmental factors, as found by Fothergill et al (1995) in a British study of patients attending an accident and emergency department following a fall in a public place. The analysis of accident report forms suggests 'avoidable' hazards are commonly involved in accidents on householders' premises.

It was decided further project research should consider the role of 'avoidable' environmental hazards in delivery STFA, and the means by which Royal Mail undertake to reduce the risk to PDO from such hazards.

3.5.1.4 Step falls
Near one-fifth of delivery STFA occurred on steps. When accounting for PDO exposure to steps this figure appears particularly high. Highest incidence rates for step falls were found for younger PDO, particularly females. Other authors have reported a similarly high incidence of falls on steps. Manning et al (1988), for example, reported step falls to be involved in 11 % of underfoot accidents among a working Merseyside population.

As well as being more likely to fall on steps than on the level, PDO are also more likely to incur injury requiring absence from work. Step falls required over 3 days absence in 35 % of cases, compared with 26 % of employees who had fallen following a trip and 19 % who had slipped. Falls on steps were most frequently the result of slips (61 %), and step falls were more common during winter months, as found by Negata (1991) for Japanese step falls.

It was determined further research would attempt to produce more information on step fall accidents, and in particular, consider PDOs' views concerning factors which may increase the risk of step falls on delivery.

3.5.1.5 Female propensity to incur delivery STFA
Female PDO incurred significantly higher incidence rates than male colleagues for delivery STFA, and require more absence following a fall (e.g. 13 % of female accident-involved employees required over 21 day absence, compared to 8 % of male PDO). These findings are consistent with those of a 1972 Royal Mail in-house report (Everitt and Harkness, 1972) which found for each of the years 1968, 1969 and 1970, women postal employees incurred a higher proportion of falls than males.
There is limited evidence in the published literature to support the suggestion that females might be more susceptible to falls and accidents on delivery in general. Lund (1984) found females experienced a greater proportion of slipping accidents resulting in injuries recorded in hospitals in Nordic countries. Zwerling et al (1993) found women in their first year of employment had an increased risk for occupational injuries (all types) amongst US letter carriers. Davis (1983), from calculations of sway angles, found males to have slightly better stability than females. Other evidence shows males to have slightly higher incidence rates for STFA, however (Malmivaara, 1993; Leamon and Murphy, 1995), although these findings can be attributed largely to the fact males more commonly work in high STFA risk industries.

A possible explanation for the increased female risk found in the present study is women being more likely to report occupational injuries than men. Female PDO reported the same proportion of less than one day absence STFA as their male colleagues (61 %), however, suggesting an equal willingness to report delivery STFA. It is also possible a proportion of female staff wear fashion shoes with high heels, thereby increasing their risk of STFA (Negata, 1991). Other explanations include women being generally of smaller stature than men and having less strength. This causes women to operate at a greater percentage of their capacity and they are therefore at increased risk of injury (Zwerling et al, 1993).

3.5.1.6 Age
Delivery STFA incidence increased with age for all reported accidents. The opposite was observed, however, when accounting for over 3 day injuries alone. The trend for over 3 day STFA incidence to fall with increasing age is not in line with the trend for the general working population (Buck and Coleman, 1985, reported over 3 day STFL incidence to increase almost linearly with age). There is also evidence older employees are more likely to incur STFA within specific industries. Cloutier (1994) found older Quebec domestic trash collectors to be more likely to be victims of STFA, while incurring fewer accidents of other types than their younger colleagues.

Further analysis in the present study revealed older employees have highest incidence of falls on the level (slips and trips on the level), but lowest rates for falls on steps. It is unclear why this should be the case, although one
suggestion might be that greater experience or reduced mobility encourages older PDO to take less risks on steps than younger colleagues (e.g. jumping down steps, etc.).

3.5.1.7 The involvement of unsafe working practice and behaviour in delivery STFA
Analysis of accident report forms found mention of unsafe behaviour contributing to accident circumstances in 11% of cases. This figure is thought to under-represent the actual involvement of unsafe behaviour and working practices in delivery STFA, as staff may be wary of mentioning use of improper procedure when reporting the accident to their manager. The most commonly reported unsafe behaviour was reading letter addresses while walking (mentioned in 5% of accident report forms). This practice interferes with the employee's ability to monitor the walking surface for hazards, and reduces the possibility of adopting the appropriate gait in the presence of unexpected slippery conditions. In 4% of cases staff were taking short-cuts across lawns or walls, increasing their exposure to potentially hazardous conditions.

It was decided further project research should consider the role of unsafe behaviour and working practices in delivery STFA, and the reasons such practices are used.

3.5.2 Limitations of the data
The findings presented in this chapter need to be interpreted with regard to the nature of the data collected for this research. The data on which the analysis of delivery STFA was based were subject to a number of limitations which are discussed below. The rationale for the use of in-house accident data and report forms was based on the understanding that, despite its limitations, accident data could be useful if treated with detachment and a foreknowledge of its limitations (Drury, 1995). The primary purpose of this analysis was, therefore, to determine trends and patterns in accident incidence, and key factors for further research presented in subsequent chapters.

3.5.2.1 Bias in accident reporting and recording
The data used in the present study related to all reported delivery STFA, regardless of injury incurred or length of absence from work. It is possible, however, that many STFA which do not result in injury remain unreported.
This may be due in part to the apathy and tolerance commonly associated with 'normal', 'everyday' accidents such as slips and trips (Porrit, 1985; Saari, 1990; Leamon and Murphy, 1995). Analysis of a dataset which omits a proportion of accidents not producing injury suggests the possibility for bias in the data, as it is based on injuries reported rather than accidents (Drury, 1995). In defence of the data used in this analysis, 61% of cases resulted in no absence, or less than one day absence from work, suggesting a readiness amongst PDO to report accidents not causing injury requiring absence.

The reporting and recording of accident data used in this study may have been subject to subjectivity, bias and error for a number of reasons. These include: lack of training in accident reporting and recording (accident-involved staff, managers), false reporting or dishonest accounts of accident events (accident-involved employee), biased attributions of blame for the accident (accident-involved employee and manager), and miss-classification of accident events (manager and personnel staff).

3.5.2.2 Single 'cause' category data classifications
Buck (1984), in a report describing analysis of loss of balance accident data in the Electricity Supply Industry, notes a single 'cause' category (e.g. 'Falls outdoor') is often used to try and describe "what is in reality a series of events for most accidents". This is mainly because accident forms tend to collect data on the basic elements of accidents in a form suitable for computer analysis (Sanders and McCormick, 1992). Buck also notes single categories may be inconsistently applied to accident situations. This is known to be the case with Royal Mail accident classification, where 'Falls outdoor' are often mis-classified as 'Stepped on/struck against' accidents and vice-versa). The possibility of including non-STFA accidents in the data was minimised by removing non-STFA at the coding stage. However, it is likely the total number of STFA incurred during the period of the analysis will have been greater than reported as the researcher had no reference to data on STFA wrongly coded under other accident types. Data on slips and trips, for example, may be lost due to the fact they lead to a further event which is likely to be classified under another accident type (e.g. slipping into an on-coming vehicle) (Buck and Coleman, 1985).
3.5.2.3 Limited data concerning the task, equipment and environment

Drury (1995) notes most accident report forms collect information which is strong on medical facts, individual differences and blame-pinning, but weak on details of task, equipment and environment. This is primarily due to the fact that companies tend to only collect information which they are legally required to. Information held in the Royal Mail accident database was characterised in this way (see table 3.1), meaning only a limited analysis was possible. Use of information contained in the 'one-line' description of accident circumstances (as discussed by Buck, 1984), however, allowed information about the environment (e.g. weather conditions, hazards), the employee’s activity immediately before the accident, and the fall initiating event to be coded in the majority of cases.

3.6 Summary and conclusions

This chapter presented the analysis of Royal Mail Midlands' data relating to 1734 STFA occurring during the delivery of mail over a two year period. The 'one-line' descriptions of accident circumstances provided on the data output contained sufficient information for coding of the accident-involved employee’s activity immediately before the accident and fall initiating event. In addition, 'one-line' descriptions produced information concerning the physical environment, particularly the role of weather and other hazardous conditions in delivery STFA. The data also allowed identification of employee groups at greatest risk and the timings of delivery STFA. Analysis of a smaller sample of accident report forms provided information on the location of delivery STFA, and the involvement of hazards and unsafe behaviours and working practices.

The majority of delivery STFA occurred on householders' premises, and 'avoidable' hazards such as obstacles and damaged paving or steps were involved in a large proportion of these accidents. Steps were also identified as a major hazard. PDO appear particularly vulnerable to slipping accidents on ice, snow, grass and steps, with 'slipping' coded as the fall initiating event in 50 % of all classified accident cases. Slipping accidents also tend to cluster on days where weather conditions are particularly severe (e.g. heavy snow fall), suggesting preventive measures should be targeted to these days.
Focusing on the individual, females have been shown to incur significantly more delivery STFA than their male colleagues, while younger employees report significantly fewer falls than older delivery staff, but incur highest rates of over 3 day absence STFA.

Unsafe practices appear to be contributory in a large proportion of accidents. It was determined that further project research should focus on the key hazards and risk factors identified in this study. Specifically, research should consider the role of weather conditions, tripping hazards, steps and unsafe practices in delivery STFA.
Chapter Four

ACCIDENT-INDEPENDENT INVESTIGATION OF CONTRIBUTORY RISK FACTORS

4.1 Introduction

4.1.1 Outline of research presented in this chapter
The purpose of the research presented in this chapter was to identify possible contributory risk factors for STFA occurring during the delivery of mail.* Accident-independent methods were used as part of a composite approach to contributory factor identification (Ramsey, 1973; Purswell and Rumar, 1984), reflecting the need to consider factors other than the immediate accident events (e.g. work and organisational behaviour) (Saari, 1990)

The use of qualitative methods in conjunction with accident analysis has been employed successfully elsewhere for the study of STFA (e.g. Nicholson and David, 1985). The methods used in the present investigation were chosen for two reasons: to provide additional information on factors identified in the accident analysis (chapter three); and to produce exploratory data on behavioural, task-related and organisational factors, which could not be obtained from existing accident data.

Methods included interviews with personnel responsible for safety, focus groups with postal delivery officers (PDO) and a questionnaire survey of PDO and delivery office managers (DOM). These techniques were chosen for their suitability when undertaking preliminary and exploratory investigation into a previously unresearched area (Morgan, 1988), and to draw on the knowledge of the 'subject matter experts' (PDO, managers, safety personnel, etc.). In all cases respondents were asked to provide information regarding factors they believed increased the risk of delivery STFA. Specific factors on which information was sought included the effect of weather conditions on staff safety, tripping hazards, unsafe working practices and delivery methods, footwear and equipment, and the influence of management and organisational factors.

* The main findings of this research were presented at the Annual Conference of the Ergonomics Society, Leicester, 1996. (Bentley and Haslam, 1996b).
4.1.2 Aims

i) To supply additional information on delivery STFA risk factors identified through accident data analysis (chapter three).

ii) To provide exploratory information about possible delivery STFA risk factors (behavioural, task-related and organisational) which could not be obtained from existing accident data.

4.2 Methods

Accident-independent methods used for the investigation of STFA risk factors are presented in table 4.1.

4.2.1 Interviews with personnel responsible for safety
Semi-structured interviews were conducted with 17 members of staff and management who had safety responsibilities within the Royal Mail. Respondents were drawn from all levels within the organisation, including senior managers, union representatives, safety managers and ergonomics consultants. This provided data on issues of interest from a number of perspectives within the organisation. A question guide was used to ensure factors considered by the researcher to be important were covered in interviews.

The sample was chosen on the basis of availability and logistical considerations. In most cases the personnel interviewed represented at least 50% of the total staff employed in that capacity within the Midlands Division of the Royal Mail. For example, four Delivery Area Managers from a possible five were included in the survey. All but one of the respondents were male, and all had a minimum of two years' experience in their current positions. All interviews were held at the workplace of the person being interviewed.

4.2.2 Focus groups with postal delivery officers
Focus groups were used as an efficient method for the collection of large quantities of qualitative data regarding the work experience and knowledge of PDO. Focus groups are thought to be particularly useful when undertaking preliminary or exploratory analysis, as in this study, and for
Table 4.1 Accident-independent methods and information collected

<table>
<thead>
<tr>
<th>Method</th>
<th>Information collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews with personnel responsible for</td>
<td>1. Risks inherent in the delivery task</td>
</tr>
<tr>
<td>safety n=17: Delivery Area Managers (4)</td>
<td>2. Training of new recruits</td>
</tr>
<tr>
<td>Divisional Safety Managers (2)</td>
<td>3. Safety training and safety awareness</td>
</tr>
<tr>
<td>Area Safety Advisors (3)</td>
<td>4. Footwear and equipment (type, quality and use)</td>
</tr>
<tr>
<td>Area Safety Representatives (4)</td>
<td>5. Management safety practice</td>
</tr>
<tr>
<td>Legal and Medical Secretaries (2)</td>
<td></td>
</tr>
<tr>
<td>Ergonomics Consultants (2)</td>
<td></td>
</tr>
<tr>
<td>Focus/discussion groups with PDO n=32</td>
<td>1. Experience of delivery STFA</td>
</tr>
<tr>
<td>3 groups of between 8 and 10 PDO</td>
<td>2. Work behaviours associated with increased risk of delivery STFA</td>
</tr>
<tr>
<td></td>
<td>3. Task factors associated with risk of STFA</td>
</tr>
<tr>
<td></td>
<td>4. Environmental factors associated with increased risk of delivery STFA</td>
</tr>
<tr>
<td></td>
<td>5. Management safety attitudes and activities</td>
</tr>
<tr>
<td></td>
<td>6. Quality and use of footwear and equipment</td>
</tr>
<tr>
<td>Questionnaire survey of PDO and Delivery</td>
<td>1. Reasons PDO/managers believed STFA occurred</td>
</tr>
<tr>
<td>Office Managers</td>
<td>2. Work behaviours associated with increased risk of STFA/ reason for use of unsafe working practices</td>
</tr>
<tr>
<td>Response rates:</td>
<td>3. Actions taken by managers to reduce the risk of delivery STFA</td>
</tr>
<tr>
<td>Office managers 48% (n=25 returns)</td>
<td>4. Ideas for reducing the incidence of delivery STFA</td>
</tr>
<tr>
<td>PDO 39% (n=110 returns)</td>
<td></td>
</tr>
</tbody>
</table>

orienting the researcher to the topic of interest or the organisation concerned. Focus groups are also useful for the development of hypotheses and insights for future project research (Morgan, 1988).

Focus groups were held with three groups of PDO, with between 8 and 12 employees in each group. There were 32 participants in total, 24 of whom were male (this male/female ratio is roughly representative of that of the
actual PDO population). Participants' ages ranged from 20 to 62 years, and length of service from 8 months to 28 years. One local safety representative was present at each meeting, with the remainder of the group comprising PDO selected from large, medium and small sized, urban and rural delivery offices throughout the East Midlands.

Participating employees were given a brief list of issues for consideration and discussion with colleagues prior to the meeting. The meetings were held in a conference room away from the main workplace. Discussions were chaired by the researcher, who took a 'process facilitator' approach (low-involvement in content/ high involvement in process) to group moderation (Millward, 1995). The moderator guided the proceedings in an unobtrusive way, intervening only to maintain the production of focused discussion. Participants were seated in a semi-circle, so each could achieve eye contact with the moderator and other group members (Oppenheim, 1992). Audio recordings were made of each of the sessions, and transcripts made of discussions. Content analysis of the transcripts was qualitative, organising information collected under categories of risk factor (individual, task, equipment, physical environment, management and organisational).

4.2.3 Questionnaire survey of office managers and postal delivery officers
An exploratory questionnaire survey was used to obtain the views of a larger number of PDO and DOM on factors relating to delivery STFA. Questionnaires (appendices C and D) comprised a small number of open questions seeking respondents' views on a range of issues (see table 4.1). The use of a short questionnaire was necessary as it was agreed with management that the questionnaire should take no longer than 10 minutes to complete. In addition, previous questionnaire surveys of PDO undertaken by the Royal Mail produced very poor response rates, and it was felt a short questionnaire would contribute to an improved rate of response.

DOM and PDO short questionnaires were piloted with 30 local PDO and five local DOM. Respondents were asked to note whether they understood each question, and to provide general comments about the questionnaire. Minor changes to question wording to include jargon familiar to PDO were made as a result of the pilot.
All East Midlands DOM (n=52) were posted a short questionnaire, together with a number of short questionnaires for PDO, which they were instructed to randomly distribute amongst their staff. The response rate for DOM was 48% (25 respondents), and 39% (110 respondents) for PDO. The need for anonymity mitigated against measures for increasing the response rate. DOM ages ranged from 31 to 63, and all but three DOM were male. PDO ages ranged from 19 to 61, and length of service from two months to 32 years. Approximately 20% of PDO were female (representative of the PDO population).

4.3 Results

A large quantity of information was generated through the use of accident-independent methods. Key findings were organised under seven general categories: slippery underfoot conditions, non-weather related hazardous environmental conditions, footwear and equipment, unsafe behaviour and working practices, training and safety awareness, management safety practice and organisational factors.

4.3.1 Slippery underfoot conditions
Slippery underfoot conditions were perceived as a significant risk by both DOM and PDO. In questionnaire responses, over 90% of PDO and 80% of DOM listed snow, ice or other weather-related underfoot conditions as one of five factors which most increased the risk of delivery STFA (see table 4.2 for breakdown of PDO and DOM responses to the question concerning factors which increase the risk of delivery STFA).

In focus groups, PDO noted they were at greatest risk of slipping where ice was hidden beneath a layer of snow, and where snow had partially thawed, leaving patches of compacted snow and ice on pavements. Walking down sloped driveways and steps leading to delivery points was described as particularly hazardous. Basement steps in flats and houses were often very slippery due to leaves, algae, etc. PDO argued householders' premises presented the greatest risk during winter working. Drives and pavements leading to the delivery point were often covered in snow, or had patches of ice from car washing or leaking drains, etc. Slippery steps and tiles were described as particularly hazardous.
Table 4.2 Risk factors listed by DOM and PDO in response to the question 'list up to 5 factors you believe increase the risk of delivery STFA'

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Respondents listing factor</th>
<th>DOM (%)</th>
<th>PDO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental conditions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather-related factors (e.g. ice, snow, wet, frost)</td>
<td></td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>Inadequate or absent lighting</td>
<td></td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>Uneven paving / damaged / obstructed walking surfaces</td>
<td></td>
<td>92</td>
<td>86</td>
</tr>
<tr>
<td><strong>Footwear and equipment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision and use of unsuitable footwear</td>
<td></td>
<td>60</td>
<td>41</td>
</tr>
<tr>
<td>Non-use of / ineffective snow chains</td>
<td></td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Weight of delivery pouch</td>
<td></td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td><strong>Individual factors - behavioural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rushing (particularly on slippery surfaces)</td>
<td></td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>Reading address / sorting mail while walking</td>
<td></td>
<td>52</td>
<td>25</td>
</tr>
<tr>
<td>Taking hazardous short-cuts (over walls etc.)</td>
<td></td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Lack of care or concentration</td>
<td></td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Over-confidence or familiarity with task or route</td>
<td></td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Distraction (other than task)</td>
<td></td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td><strong>Organisational factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time pressure / workload</td>
<td></td>
<td>52</td>
<td>63</td>
</tr>
<tr>
<td>Lack of training / other training issues</td>
<td></td>
<td>8</td>
<td>-</td>
</tr>
</tbody>
</table>

Respondents argued risks presented by snow and ice were greater for PDO than for other road and pavement users, as they were among the first to come into contact with walking surfaces in the morning. Overnight snow and ice was rarely cleared from private and public walking areas before 6.45 am when PDO commenced their first delivery round.

PDO argued it was not possible to work at normal pace where slippery conditions were present on delivery routes, and accidents were perceived as particularly likely where work pressure caused them to rush.
Safety personnel believed businesses and shops were less hazardous during periods of adverse weather as they were more aware of their Health and Safety responsibilities towards customers and other visitors to their premises.

4.3.2 Non-weather related hazardous environmental conditions

In questionnaire responses, 86% of PDO and 92% of DOM listed either some form of damaged walking surface (e.g., uneven paving, holes in pavement) or some type of obstacle on pavements or private driveways (e.g., building materials, toys, vehicles) as a factor increasing the risk of delivery STFA. Absent or inadequate lighting was listed by 36% of DOM and 35% of PDO. These findings suggest a high level of perceived risk associated with these hazards.

PDO focus group respondents believed hazards unrelated to the weather which presented greatest risk were uneven paving and other abrupt vertical transitions from the level walking surface. Uneven or damaged paving was commonly encountered on delivery walks, as were obstructions and obstacles. Holes in pavements and obstacles (from building or repair works), and toys or bicycles on private drives and pavements were other tripping hazards identified as both common on walks and as increasing the risk of tripping accidents.

Dark early winter mornings were reported as especially hazardous for PDO. Respondents noted the absence of adequate lighting was particularly hazardous when in conjunction with the presence of tripping or slipping hazards. Greatest risk was associated with steps, particularly to basement flats, and areas around the front doors of houses.

4.3.3 Footwear and equipment

In questionnaire responses, 41% of PDO and 60% of DOM listed either provision or use of unsuitable footwear for heavy and winter working as one of five factors they believed increased the risk of delivery STFA. Carriage or weight of the delivery pouch was listed by 36% of PDO and DOM.

4.3.3.1 Footwear

Royal Mail offer PDO a choice of three types of footwear as part of uniform provision: Dr Martin shoes (air-sole), Clarks shoes and trainers. In focus groups and interviews most respondents agreed footwear supplied to PDO
was unsuitable for working in winter conditions and for heavy use, and increased the risk of accidents involving slippery underfoot conditions. PDO pointed out many employees provide their own footwear, usually walking boots, for winter working.

An inspection of footwear worn by focus group members (n=32) found soling to be almost or completely worn from the heel area in most cases, with employees having worn their footwear for no longer than three months (as far as they were able to recall). Managers and safety personnel were uncertain as to the precise nature of the replacement system for PDO footwear, although most believed the policy for replacement was on the basis of one pair per year unless the footwear was severely damaged. PDO argued replacement of footwear should be on the basis of 'replace as required', and a number of PDO noted they had had requests for replacement footwear turned down by their DOM despite having damaged or worn soling or uppers. A number of PDO respondents expressed the view that the business' footwear policy was a reflection of management's concern for their safety. For example, one focus group respondent noted "they say we shouldn't rush around on delivery, we should lift correctly and so on, but they expect us to work in half a foot of snow without providing us with proper shoes".

PDO and safety personnel suggested a number of ideas for future footwear provision. Walking boots, providing superior grip and ankle support were suggested for winter working, while light-weight shoes might be used during non-winter months. A number of safety personnel respondents argued provision of footwear suitable for adverse conditions should be the starting point for any initiative to reduce slipping accidents on delivery.

4.3.3.2 Snow chains (footwear attachments)
Respondents noted snow chains were provided as protective equipment for working in snow. No focus group members reported having used snow chains on more than one occasion. Respondents believed snow chains were effective only in deepish snow, and dangerous ('ice skates') in icy conditions. Snow chains were also perceived to be uncomfortable and time-consuming to put on and take off (this was particularly a problem for drivers who could not operate pedals wearing chains). Safety personnel were uncertain as to the effectiveness or extent of use of snow chains.
4.3.3.3 Delivery methods: pouch carrying and trolley use
PDO, managers and safety personnel believed carrying of a heavy asymmetric load increased the risk of falling, particularly in slippery conditions. PDO noted there was a tendency to lean against the weight of the pouch, which could increase the risk of slips and falls in the opposite direction to the load. Other PDO believed falls towards the weight of the load were more likely when very heavy loads were being carried (i.e. full pouch). A number of PDO focus group respondents noted a tendency to slip more readily when heavily loaded. The majority of PDO reported carrying their mail pouch, however, despite the fact they were aware trolley use would reduce the risk of falls and back injuries.

Respondents pointed out delivery pouches carried manually could obscure the employee's view of the walking surface, and hence increase the risk of STFA accidents. This tended to occur where the pouch was worn in the Royal Mail's recommended 'over-the-shoulder' position, which in some cases caused the pouch to lie in front of the line of vision, and was particularly hazardous when walking down steps or approaching a front door and bending down.

Trolleys are provided for carrying mail as an alternative to manual pouch carrying. Safety personnel argued the business had done little to increase trolley use, primarily because many walks were unsuitable for trolleys (e.g. walks with steep hills or steps), and trolleys were unpopular with many PDO (slower pace of work; image; security). Ergonomics consultants and safety personnel noted a new trolley had recently been designed which resembled a golf trolley. It was hoped the new design would encourage PDO who were previously concerned with the image of the trolley ('shopping style') to change their method of delivery.

4.3.3.4 Torches
PDO noted the risk of STFA was increased during dark early winter mornings due to the absence of effective torches. Torches supplied as part of uniform provision were described as ineffective, having low power, poor directional control (worn on jacket to keep hands free) and a short battery life. PDO and safety personnel argued the need to use hands for the delivery task reduced the ability of the PDO to make best use of torches in dark areas.
4.3.4 Unsafe behaviour and working practices

A number of forms of unsafe behaviour and working practice were listed as factors which respondents believed increased the risk of delivery STFA (table 4.2). These included: rushing (particularly on slippery walking surfaces), including running, skipping and jumping down steps (DOM 28%; PDO 29%); taking hazardous short-cuts (DOM 16%; PDO 5%); and reading mail addresses for the next delivery point while walking (DOM 52%; PDO 25%). DOM also mentioned lack of care or concentration (60%) and distraction (16%), both of which may refer to the unsafe practice of reading while walking.

PDO were also asked to list up to four things which postmen and women did on delivery which increased their risk of having a STFA. Unsafe behaviours listed included: reading letter addresses while walking (noted by 50% of respondents); rushing (44%); taking hazardous short-cuts over lawns, walls, etc. (24%); carrying over-weight pouches (29%) and wearing footwear unsuitable for winter working (18%).

4.3.4.1 Rushing, taking short-cuts and entering hazardous areas

In focus groups, PDO emphasised rushing, particularly in slippery conditions, as an important factor in delivery STFA. The various forms of rushing described included running, jogging or walking very quickly, skipping or jumping down steps, and taking hazardous short-cuts. All respondents agreed rushing increased the risk of slipping accidents. PDO and safety personnel argued taking short-cuts across lawns and other ‘non-walking’ areas increased the risk of tripping accidents as the employee was exposed to a greater number of tripping hazards.

PDO noted they often attempted to deliver mail to a hazardous delivery point even when forced to walk over dangerous walking areas (e.g. building site rubble), or to climb over walls, etc., where vehicles or other obstructions were blocking the normal point of access. Deliveries to areas such as unlit basement flats were also commonly undertaken. One reason given for this risk taking was the circular problem of needing to deliver a note to the customer explaining why their mail had not been delivered, and where they could pick it up from! PDO were also fearful of upsetting customers and managers if they failed to deliver mail.
4.3.4.2 Reading mail addresses while walking
PDO argued looking at letters (i.e. determining the next delivery point from letter address and separating letters for delivery from letter bundles or pouch) while walking commonly caused tripping accidents involving kerbs, walls, uneven paving and other obstacles. PDO also reported often walking into objects such as lamp posts and walls while they were preparing mail for the next delivery point. Respondents were aware the correct practice was to read the address of the next delivery point and commit it to memory before setting off, but argued to do this would incur unacceptable time costs. A second reason given by respondents for looking at mail while walking was to guard against missed deliveries (letters posted to wrong address and undelivered mail) as this upset customers and led to reprimands from DOM who received customer complaints. Finally, PDO noted addresses were more likely to be read while walking when following an unfamiliar route (e.g. when covering for an absent colleague). Safety personnel were aware of the widespread use of this practice, and agreed it was likely reading while walking was a factor in a large proportion of delivery STFA. PDO respondents noted this practice, like the taking of short-cuts, quickly become a habitual part of their work routine. Other task-related distractions noted by focus group personnel included searching for house numbers and the location of delivery points.

4.3.4.3 Carrying over-weight loads
PDO, managers and safety personnel agreed carrying mail pouches over the official weight limit of 16 kg was a common practice. Many PDO carried more than one pouch, and some even carried three at a time. All respondents believed carrying overweight pouches and more than one pouch increased the risk of accidents as well as back injuries.

4.3.4.4 Bicycle misuse
Safety personnel and PDO pointed out cycles were commonly used as scooters, with the PDO riding with one foot on a pedal and the other foot propelling the cycle by pushing against the pavement. PDO focus group respondents noted this practice was used for convenience and to save time. Once the PDO had reached the start of their delivery walk, it was often preferable to leave the mail pouch attached to the cycle and to push or scoot around the walk, rather than to walk carrying the pouch. Because of the close proximity of delivery points it was impractical to mount the cycle in the correct manner between each delivery point. PDO noted this practice could
increase the risk of STFA as insufficient control of the cycle was maintained while scooting, and the distribution of body weight was unbalanced.

4.3.5 Training and safety awareness
Four main types of training where material related to delivery STFA was included were discussed by respondents: new-entrant training, 'on-the-job' training, safety awareness campaigns and classroom-based safety training.

4.3.5.1 New-entrant training
Safety personnel noted new-entrant training included safety material related to STFA risks. Risks associated with accidents when walking, driving or cycling in slippery conditions were outlined, while training also highlighted correct working practices for the delivery task, particularly the need to read letter addresses before setting off for the next delivery point. No teaching of skills for safe work practices and working safely in adverse conditions was provided, however.

Safety personnel and managers noted new-entrant training was not received by a proportion of new-recruits, and explained PDO joining smaller offices were less likely to be released to attend training than those recruited into the large central offices. The smaller offices had less man-power available to cover the absence of the trainee, and training was usually held at the large central delivery offices and new-recruits from these offices were more readily available to attend training on-site.

A number of focus group members who had experienced new-entrant training commented that training officers were out of touch with the problems experienced by PDO, and training failed to account for new pressures on postal staff since the introduction of delivery targets and heavy business and advertising mail items.

4.3.5.2 On-the-job training
All focus group respondents had received 'on-the-job' training with an experienced colleague. New-recruits were taken out on delivery with an experienced delivery employee for about three days, during which time they were taught the fundamentals of the job. PDO and safety personnel noted this form of training served to perpetuate bad working habits and practices, as the trainer would often show the new-recruit how to complete the delivery
round in the shortest possible time. One focus group member who had been responsible for providing 'on-the-job' training to new-recruits illustrated the problem: "On the first day you show them how to do the job properly, according to the book. On the second day you show them how to save time, which they will need if they're going to get finished in time. On the third day you take half the mail, give them the other half, and you both get finished early". A number of safety personnel respondents believed this represented the worst possible start for new-recruits to the service. Safety managers believed it was vital to teach new recruits safe working methods at the start of their employment before bad habits evolved.

4.3.5.3 Safety awareness campaigns and safety training

In questionnaire responses, 61% of PDO reported receiving no training, talks or team briefs where delivery STFA were a part of the content during the past 12 months. Safety personnel and managers recognised safety training was not received by all PDO, although most were thought to have received the 'Walksafe' training course. This was a booklet plus briefing-based course designed by the delivery function (not safety personnel) to alert PDO to hazards and risks associated with the job. Respondents were unaware of how many staff received this training as records were not available and local office managers varied in their efforts to deliver training briefs.

Classroom-based safety courses were provided for PDO, but safety personnel were uncertain as to the level of attendance. It was thought all centrally-based staff would probably have attended these courses, while PDO employed away from the central offices would be less likely to have received this training. Few focus group respondents reported receiving classroom-based safety training. Respondents argued most safety training was in the form of safety awareness campaigns, delivered by DOM during team-briefs. Seasonal safety awareness campaigns concentrated on the risks of working in snow and icy conditions, informing PDO to be aware of the conditions and to work at a steady pace. Team briefings, delivered by DOM, also discussed the use of safety equipment required in winter conditions such as snow chains and torches. Safety personnel noted safety awareness campaign content varied considerably between delivery areas and divisions, however, as did training and safety briefing provision. Respondents from one focus group highlighted the problem of safety briefs always appearing to be in reaction to
accidents, telling staff to watch out for particular hazards "after the horse had bolted".

4.3.6 Management safety practice
DOM were asked to list up to five things they did to try to reduce the risk of delivery STFA (table 4.3), and to list four factors which they believed most restricted their ability to take action to reduce the risk of delivery STFA (table 4.4).

Table 4.3 Self-reported use of safety activities by local office managers

<table>
<thead>
<tr>
<th>Management safety activity</th>
<th>DOM listing action (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular team briefs where safety was discussed/displaying safety campaign material</td>
<td>100</td>
</tr>
<tr>
<td>Advise to PDO to take care in bad weather/advice to PDO about safe working practice</td>
<td>20</td>
</tr>
<tr>
<td>Encouraging PDO to report hazards/use hazard cards</td>
<td>20</td>
</tr>
<tr>
<td>Hazard control action (e.g. contact council/householders about damaged walking areas)</td>
<td>16</td>
</tr>
<tr>
<td>Checking PDO have correct equipment/footwear</td>
<td>76</td>
</tr>
<tr>
<td>Providing PDO with replacement footwear when required</td>
<td>8</td>
</tr>
<tr>
<td>Introduction of pouch-weighing exercise/advice on pouch weights</td>
<td>16</td>
</tr>
<tr>
<td>Introduction of additional local training</td>
<td>8</td>
</tr>
</tbody>
</table>

All DOM surveyed reported holding regular team briefs with a safety content and displaying safety campaign materials. Over three-quarters of DOM reported checking PDO had correct equipment and footwear. No DOM listed action to protect PDO in severe weather conditions (adverse weather practice), other than to offer advice. Only 18% of DOM reported undertaking hazard management activities. The main factors DOM believed restricted their ability to take safety actions were non-availability of adequate footwear, time and workload pressures, and lack of control over what happened outside the delivery office (e.g. staff actions, hazards and weather conditions).
### Table 4.4 Factors which local office managers believed restricted their ability to take action to reduce the risk of delivery STFA

<table>
<thead>
<tr>
<th>Factors restricting managers' ability to take safety actions</th>
<th>DOM who listed restricting factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of co-operation or interest in safety from PDO</td>
<td>20</td>
</tr>
<tr>
<td>Lack of care from PDO/PDO negligence/human error</td>
<td>12</td>
</tr>
<tr>
<td>PDO wanting to finish early (job and finish practice)</td>
<td>8</td>
</tr>
<tr>
<td>DOM can't control PDO while they are on delivery</td>
<td>20</td>
</tr>
<tr>
<td>Time pressure on DOM/workload/clear-office policy/quality targets</td>
<td>32</td>
</tr>
<tr>
<td>Budget factors</td>
<td>16</td>
</tr>
<tr>
<td>Poor/slow footwear and equipment supply from stores</td>
<td>20</td>
</tr>
<tr>
<td>Poor footwear provided to PDO (especially trainers)/one pair per year policy</td>
<td>40</td>
</tr>
<tr>
<td>Inability to do anything about condition of public and private walking areas</td>
<td>28</td>
</tr>
<tr>
<td>Inability to control weather conditions</td>
<td>20</td>
</tr>
</tbody>
</table>

4.3.6.1 *Perceived attitudes of delivery office managers*

Focus group respondents believed DOM were often more concerned with getting the work out (mail delivered) and achieving quality of service objectives and targets than with the safety and health of PDO. Respondents believed the attitudes of PDO mirrored those of DOM, as it was to the benefit of everyone to meet quality of service targets. PDO accused DOM of turning a blind eye to instances of unsafe work practice, such as carrying more than one mail pouch out of the office or incorrect use of lifting methods or equipment.

4.3.6.2 *Adverse weather practice*

Actions by DOM to reduce the exposure of PDO to adverse weather conditions appear to be limited. PDO argued DOM expected deliveries to be undertaken by a given time, except for very occasional circumstances where extremely severe conditions made walking conditions dangerous. Respondents pointed out this expectation was unrealistic, however, as the pace at which delivery work could be undertaken was also affected by the
presence of less severe conditions such as frost, ice and partially thawed snow on walking surfaces. PDO recalled DOM cancelling second deliveries on a number of occasions when weather was extremely severe, but first round deliveries had never been postponed or delayed, nor alternative delivery methods introduced in the experience of focus group members. Senior managers and safety personnel pointed out DOM were responsible for determining action to be taken in the case where PDO were considered at risk of injury due to adverse weather conditions. Measures at the disposal of DOM included reducing the level of exposure of PDO to adverse conditions by cancelling second deliveries and organising alternative methods of delivery where necessary (e.g. replace cycle deliveries with walks). No formal 'adverse weather policy' was in place, however, to guide DOM in their decision regarding working in adverse conditions, and a number of management and PDO respondents argued the existence of quality of service targets made action by DOM which affected delivery performance unlikely.

4.3.6.3 Safety communication
Safety communications between DOM and PDO are limited. Respondents argued team-briefs rarely covered safety matters, and DOM rarely spoke to PDO informally about issues other than operational matters.

4.3.6.4 Accident investigation and prevention
Accident investigations and follow-up preventive remedial measures undertaken by office managers were described by safety personnel as being of a poor standard (this view was based on the poor quality of accident reports completed by DOM).

4.3.6.5 Hazard management
No PDO respondents recalled DOM efforts to remove hazards situated away from the delivery office. Safety personnel pointed out DOM were responsible for contacting councils and householders when hazards such as damaged paving and absent lighting were reported to them by members of delivery staff. PDO and DOM suggested employees rarely reported the presence of hazards on their delivery route to their managers. PDO noted DOM rarely discussed with them the need to report hazards on delivery routes, and were poorer still at taking action to remove hazards when PDO did report them. This was perceived by some PDO as reflecting poorly on management's concern for their well-being.
4.3.6.6 Uniform and equipment management

Safety personnel and managers noted issue of footwear and equipment is primarily the responsibility of DOM. The DOM is responsible for issue of replacement footwear where the footwear is no longer in a condition suitable for use by the PDO. PDO argued requests for replacement footwear were in their experience rejected by DOM, however. PDO also noted supply of snow chains and other equipment requested from DOM was slow. Safety personnel and management respondents argued it was the responsibility of DOM to order safety equipment for winter working during the summer or autumn as stores were very slow to respond to orders once the bad weather commenced and demand was high. Respondents believed that DOM did not always plan in advance the equipment they would require for winter working, meaning PDO were working in adverse conditions without the necessary safety equipment (e.g. snow chains, tire chains etc.).

4.3.6.7 Supervision

Safety personnel and managers pointed out supervision of PDO was difficult as much of their work was undertaken away from the workplace. While DOM (or their assistants-'operations managers') were meant to undertake occasional observations of PDO on delivery (mainly to determine employees were where they were supposed to be), safety and senior management respondents believed this rarely happened.

Focus group respondents noted DOM tended to ignore the fact PDO carried over-weight pouches or more than one pouch when leaving the office. Respondents believed a level of unsafe practice was accepted because of the need to get the mail out on time. Safety personnel and managers pointed out DOM were responsible for discussing use of safe working practices in team briefs, and bringing to the attention of employees any incidence of unsafe practice observed within the delivery office. Respondents were unsure as to the extent to which DOM took action where instances of unsafe practices were brought to their attention. A number of DOM and safety personnel respondents noted it was in the interests of both DOM and PDO to deliver the mail as quickly as possible. The widespread use of unsafe practices was described by some respondents as the result of a safety culture in which the benefits of unsafe working were perceived to outweigh the possible costs. This was illustrated in the experience of 1 focus group member. "My manager was walking up the steps as I ran past him going down to the car. "The
manager stopped me, and I thought he was going to say something about the
two bags I was carrying, but he asked me where my tie was”. This experience
was similar to those shared by a number of respondents. PDO members of
this focus group noted this attitude reflected a lack of concern for staff safety
on the part of management and the business.

4.3.7 Organisational factors
A number of organisational factors were identified as being contributory in
delivery STFA risk, and to underlie other key risk factors. Some form of time
pressure or workload factor was listed as increasing the risk of delivery STFA
by 52% of DOM and 63% of PDO. Specific organisational factors listed
included quality of service targets, such as delivery time targets and the
‘clear-office policy’ (all sorted mail should be delivered on the first delivery).

4.3.7.1 Organisational factors underlying use of unsafe behaviour and work practice
Figure 4.1 provides a breakdown of unsafe behaviour and time-saving
working practices reportedly used by PDO (section 4.3.4), along with reasons
given for their use and possible underlying organisational influences on the
use of unsafe behaviours and practices. All respondents described the ‘job
and finish’ practice (PDO go home without returning to their office following
their 2nd delivery) as an important reason unsafe working practices and risk-
taking behaviours were used. The more mail an employee delivered on their
first round, the less they were likely to have to deliver on their second round
and the earlier they were able to go home. Some PDO relied on overtime
working, and an early finish gave them a longer break before commencing a
further shift on overtime. Managers suggested delivery route planning and
revisions were carried out on the basis of correct work practice, with timings
for walks based on the PDO walking up and down every drive and working
at an even pace. PDO were therefore able to make time if they used short-
cuts, such as climbing over walls and walking across gardens, and rushed
around their walks.

The other main reason given by PDO for using unsafe practices was
workload. The main factors affecting PDO workload were related to quality
of service targets. Focus group respondents argued it was difficult to achieve
targets for first delivery without rushing, particularly on the busiest days of
the week. The unequal distribution of mail across the day (up to 95% of daily
mail goes out on first deliveries) and week (earlier days of the week are
Unsafe behaviours and working practices used by PDO

Rushing (in slippery conditions)

Taking hazardous short-cuts

Reading and sorting mail whilst walking

Carrying overweight mail pouches or more than one pouch

Time pressure

Workload factors

Habitual/convenience practice

Ensure letters go to correct houses

Following addresses on unfamiliar route

Time pressure

Workload factors

Weight of heavy mail items

Possible management and organisational influences on use of unsafe behaviours and practices

Job and finish policy

Timing of walks

Quality of service targets (e.g., delivery completion time; clear-office)

Unequal distribution of delivery load across day and week

As above

Training

Unequal distribution of delivery load across day and week

Non-use of alternative to pouch for heavy business mail

Figure 4.1 Unsafe behaviour and working practices used by PDO, reasons for their use and possible organisational influences
considerably less busy than later days) was believed to be a further factor in the use of unsafe time-saving practices.

4.3.7.2 Increase in quantity of heavy mail items
PDO were concerned traditional methods of delivery (i.e. manual pouch carrying) were still largely used while heavy business, advertising and magazine mail items were increasingly replacing letter post. PDO, together with a number of safety personnel respondents, argued this change in the business’ customer-base had led to an increased risk of injury to backs, and other accident types, such as STFA. PDO pointed out lighter loads could be achieved if heavy mail items such as magazines and advertising mails (e.g. 'Mailsort' and 'household deliveries') could be taken out on the least busy days of the week.

4.3.7.3 Footwear and equipment provision
Organisational factors related to footwear and equipment were also identified. Failure to provide suitable footwear for use in winter conditions, and an ambiguous footwear replacement policy (managers and PDO were unsure whether replacement was strictly once per year) were described by safety personnel and PDO as major factors in STFA risk. Non-provision of suitable protective equipment for working in adverse conditions was also identified by PDO and a number of safety personnel as a factor in delivery STFA.

4.3.7.4 Management factors
Safety personnel suggested DOM may be restricted in respect of their ability to undertake safety activities as training in safety management was not received by all DOM. Safety personnel also noted no formal policy or guidelines were provided to office managers for action during adverse weather. Managers and safety personnel described time constraints and other work priorities as restricting DOM use of safety practice. A number of respondents believed the introduction of incentive-linked quality of service objectives may have led to safety becoming a lower priority for office managers than activities relating to quality, performance and budgets.
4.4 Discussion of key factors

A summary of key risk factors identified from accident-independent investigations is presented in figure 4.2. Risk factors are summarised under six headings: adverse weather conditions, non-weather related hazardous environmental conditions, footwear and equipment, unsafe behaviour and working practices, job and safety training and management and organisational factors. Figure 4.2 suggests risk factors interact, with management and organisational factors underlying other key factors (indicated by the arrowed lines). A brief discussion of key points related to these factors is presented below.

4.4.1 Slippery underfoot conditions
Slippery underfoot conditions were described as the primary risk factor by all respondents. Adverse weather conditions which appear to present the greatest risk include compact snow and ice, particularly on slopes and steps, and on private premises. These findings are in line with those from the analysis of accident data (chapter three), and from published research on STFA (e.g. Andersson and Lagerlöf, 1983; Lund, 1984; Manning et al, 1988).

Respondents suggested DOM do little to reduce PDO exposure to slippery conditions during periods of adverse weather. PDO argued they were unable to work as quickly as normal in slippery conditions, although this fact was not always recognised by management, and walk timings were based on normal walking conditions. The literature on the biomechanics of walking and slipping (Marletta, 1991) suggests the faster a pedestrian walks the more likely they are to incur a slip on a slippery walking surface.

4.4.2 Non-weather related hazardous environmental conditions
Uneven paving, obstacles on walking surfaces and absence of adequate lighting were the major non-weather related environmental risk factors identified. 'Avoidable' environmental hazards appear to be important in delivery tripping accidents. These findings support those from the analysis of accident data (chapter three), as well as findings from publish research (Fothergill et al, 1995). Safety managers and PDO believed accidents might be avoided if greater efforts were made on the part of DOM to control the presence of these hazards.
Figure 4.2 Summary of key risk factors for delivery STFA
The risk of accidents involving abrupt vertical transitions from the level walking surface appears to be particularly high for PDO, as hazard spotting is undertaken concurrently with the delivery task (reading letter addresses while walking). Saari (1984) describes this problem in terms of disturbances in the flow of information between man and his environment. The monitoring of the hazardous environment (or danger zones) is a secondary task to the performance of productive work (the delivery task). This produces additional information processing demands (Saari, 1984), and the risk of accidents is increased where these dual tasks conflict. Marletta (1991) notes the pedestrian's foot passes across the floor surface as close as 1/4", and a protrusion of greater than 1/2" is likely to cause a trip where the pedestrian is not expecting a change to the normal walking surface conditions. The practice of reading addresses while walking is likely to interfere with the PDO ability to detect such changes in walking surface conditions. Ability to detect changes in surface friction is also likely to be adversely affected by this practice.

4.4.3 Footwear and equipment
A number of researchers have highlighted the importance of slip-resistant footwear as a defence against slipping where employees work in an uncontrolled (e.g. outdoor) environment (Manning et al, 1988; HSE, 1996). Footwear supplied to PDO was generally accepted to be unsuitable for working in winter conditions and for heavy use by foot PDO. Safety personnel pointed out footwear presently supplied to PDO was selected without consideration being given to slip-resistance, comfort, durability or the environment in which the shoe will be worn.

Footwear attachments (snow chains) appear to be ineffective for use in icy conditions and are unpopular with PDO. Research supports this perception that snow chains are ineffective in icy conditions. Bruce et al (1986) tested a variety of shoes and footwear attachments for dynamic COF on ice, finding snow chains to provide very poor performance. Best traction on ice was provided by crampons.

Respondents believed the weight of the delivery pouch to be an important factor in delivery STFA. There is some evidence in the published literature to support an increased risk of loss of balance and slipping accidents due to load carrying (Davis, 1983; Myung and Smith, 1997). Trolleys for carrying pouches
during deliveries appear to be underused. Reasons for underuse appear to include unsuitable terrain on delivery routes, time costs and image associated with trolley use.

4.4.4 Unsafe behaviour and working practices

The findings suggest unsafe behaviour and working practices may be a larger factor in delivery STFA than indicated from the analysis of accident report forms (section 3.4.2). Rushing, particularly on slippery surfaces, and taking short-cuts across hazardous areas were described as major delivery STFA risk factors. Published research has highlighted the increased risk of slipping when walking quickly (Marletta, 1991). Reading letter addresses while walking and carrying over-weight pouches were described by all respondents as in common use by PDO. Reading while walking reduces the opportunities for hazard detection, while carrying overweight loads may increase the risk of slipping and loss of balance.

Other unsafe behaviours mentioned by PDO and other respondents included entering hazardous areas (e.g. building sites, damaged steps), jumping from vehicles and platforms, and scooting on pedal cycles. PDO suggested practices such as taking short-cuts quickly became part of their daily work routine, and were often undertaken without conscious consideration of the risk of injury presented by their use. Two approaches to explaining this unsafe behaviour are considered below.

Sundström-Frisk (1984) argues the unsafe way (or risk-taking) is often experienced to be the 'easier, less time-consuming, less strenuous, more comfortable and productivity increasing way of doing things'. Unsafe behaviour in the context of the PDO may similarly be understood in terms of the risk/benefit ratio. The benefits of using these work behaviours may be perceived by PDO as time-saving and productivity increasing, convenient, comfortable, and socially acceptable, while risks are perceived as accidents and chronic injuries, having relatively low perceived probability of occurrence. In support of this argument, the use of unsafe practice appears to be related to incentives associated with early finish times for quick workers ('job and finish) and quality issues such as target finish times. Short-cut taking (e.g. over walls and across lawns) is both time and effort-saving, and practices such as carrying more than one pouch can also be understood in terms of time-saving and social acceptability: in focus groups PDO described
an office culture in which attributes such as speed and strength commanded
respect from colleagues. The use of trolleys also appeared to be affected by
these attitudes, with some PDO not wanting to be seen using a trolley to
transport their mail while colleagues on similar walks carried their pouches
manually.

An alternative approach (Brehmer, 1993) suggests unsafe behaviour is not
necessarily the result of deliberation (e.g. weighing up the benefits of risk
taking), rather, accident analysis has shown people 'run risks' as opposed to
taking risks. People continue to do what they usually do (e.g. take short-cuts,
rushing, etc.), neglecting slightly altered circumstances which make their
habitual behaviour inappropriate (e.g. icy conditions, damaged stairways).
The implication here is that risks may only be taken at management level,
while at the level of the operator there is little deliberation. While there is
some evidence PDO develop habitual working behaviours (e.g. always
following the same short-cuts across lawns, etc.), however, there is strong
evidence from explanations given by PDO themselves that unsafe behaviour
is motivated by the rewards associated with quick working. Moreover, the
risk/benefit approach to explaining PDO behaviour is the most promising in
terms of producing safety gains through intervention.

4.4.5 New-entrant and safety training
Training is provided for new-recruits in the form of classroom training
followed by 'on-the-job' training with an experienced PDO. Not all new PDO
appear to receive classroom training. Both PDO and safety management
respondents noted 'on-the-job' training can lead to the perpetuation of unsafe
working practices. Classroom-based safety training is also not received by all
PDO, particularly those from non-central offices. Safety awareness
campaigns are designed by safety personnel but are usually presented to
PDO by office managers, who appear to vary in their ability or willingness to
impart safety information.

4.4.6 Management and organisational factors
Organisational policies, quality of service targets and management safety
practice appear to underlie other key risk factors, such as use of unsafe
behaviour and working practice, exposure to hazardous environments and
use of inadequate footwear (figure 4.2). Factors underlying local managers'
propensity to use safety practices appear to include quality of service targets,
attitudes and priorities of senior managers and training in safety management.

4.5 Limitations of the data

The findings presented in this chapter need to be interpreted with regard to the limitations of the data on which they are based. The limitations to which data are subject in this study are related to respondent selection, subjectivity and bias.

Selection of all respondents was based on availability and logistical considerations, rather than any form of random selection. In the case of the sample of personnel with safety responsibilities, however, respondents represented all or most of those employed within the Division. Respondents for employee focus groups were chosen by DOM from a sample of Midlands delivery offices. DOM were asked to select respondents randomly from members of their staff available on the day in question. However, questioning of focus group members suggested it was likely a number of respondents were selected as a result of their willingness to co-operate with management and to involve themselves in discussions about safety matters.

A further source of bias was introduced by the presence of the local safety representative from each of the offices where focus groups were held (selected by managers). It was noted these respondents tended to dominate discussions (see Oppenheim, 1992), due in part to their superior knowledge on the issues being discussed, and their familiarity with group discussion situations. For this reason the researcher (group moderator) had to be careful to ensure all group members were able to have an input to discussions of key factors. The presence of union representatives may have also influenced discussions to the extent that 'anti-management' views were over-represented in findings. These factors were taken into account in the group moderation, data analysis and interpretation of findings.

In focus groups, care was taken to encourage discussion only once issues had naturally arisen (having initially introduced broad topic areas). Interviewer effects were minimised in interviews by allowing respondents time to discuss
any issue they felt relevant in the necessary detail with minimal prompting from the researcher.

The subjective and memory dependent nature of reports of human involvement in accidents is an acknowledged problem when attempting to determine the cause of accidents (Williamson and Feyer, 1990). The use of accident-independent techniques to determine the involvement of unsafe behaviour in STFA had the advantage of respondents not being asked to recall accident events and circumstances, requiring them instead to describe everyday behaviours. Moreover, respondents were able to discuss use of unsafe behaviours and practice in the 'blame-free' context of the accident-independent approach.

4.6 Summary and conclusions
This chapter has presented the findings of accident-independent research undertaken to expand on risk factors identified in the accident analysis (chapter three), and to produce exploratory data on behavioural, task, equipment and organisational factors which could not be obtained from existing accident data. Most of the findings reported in this chapter are based on collaborative evidence from a number of sources (i.e. different staff and personnel groups and different methods of data collection). Methods included interviews with safety personnel, focus groups with PDO and short questionnaires for DOM and PDO. A large amount of data were produced, and organised under key risk factors (figure 4.2). The possible interactions and influences between these factors were also considered. Management and organisational factors appear to underlie the other key factors, and in particular, create the preconditions for the use of unsafe working practices by front-line PDO.

These findings formed the basis for further project research, including consideration of the role of possible key factors in a sample of delivery STFA (chapter five), and the safety practices of first line managers (chapter six).
Chapter Five

INTERVIEWS WITH SLIP, TRIP AND FALL ACCIDENT-INVOlVED POSTAL DELIVERY OFFICERS

5.1 Introduction

5.1.1 Outline of research presented in this chapter
Accident-independent research presented in chapter four identified a number of possible key risk factors for delivery STFA. These included 'avoidable' environmental hazards, provision and use of footwear unsuitable for heavy use and winter working, weight of the delivery pouch, unsafe behaviour and working practices, management safety practices and the influence of organisational policies and practices. The role of most of these factors in delivery STFA risk cannot be determined from analysis of existing accident data (chapter three). The study presented in this chapter was undertaken to determine the contribution of each of the possible key risk factors identified in accident-independent research to a sample of STFA occurring during the delivery of mail.* A detailed accident follow-up interview schedule was produced, with questions designed to provide in-depth information about the factors outlined above. Forty STFA-involved Midlands PDO were interviewed at the site of their accident. Accident circumstances were recorded on 'events and contributory factors charts'. As with the analysis of in-house accident data (chapter three), an event-based analysis of delivery STFA was used, considering activity of the accident-involved employee prior to the fall, fall initiating event (FIE), and contact and injury events. In addition, contributory individual, task, equipment and environmental (physical and organisational) factors were investigated. No other studies of this type were found among the published STFA literature (the majority of published studies consider national or company statistical data only).

5.1.2 Aims
i) To expand on data related to the physical and ambient environment identified in the accident analysis (chapter three), notably slippery underfoot conditions and 'avoidable' environmental hazards.

* The main results of this research were presented at the Triennial Congress of the International Ergonomics Association Tampere, Finland 1997 (Bentley and Haslam, 1997a).
ii) To consider the role of behavioural, task, management, organisational and equipment related risk factors, identified through accident-independent investigations (chapter four), in a sample of delivery STFA.

5.2 Method

5.2.1 Participants
Forty accident-involved employees participated in the study. Participant's ages ranged from 19 to 56 years (mean age = 40 years, 6 months), and their length of service from one week to 27 years (mean length of service = 9 years, 3 months). Full-time employees made up 85% of those interviewed. The proportion of female respondents (22%) was representative of the female PDO population for Royal Mail Midlands (18%).

5.2.2 Sample selection
The sample of accident-involved employees was drawn from accident reports received by Royal Mail's Personnel Service Centre from delivery office managers throughout the division. On receipt of the forms, the employee who was the subject of every tenth accident report form was contacted and an interview requested. Where the accident-involved employee was unavailable for interview, either through absence from work due to their injury or absence for other reasons, the employee who was the subject of the next accident form (the 11th) was contacted.

5.2.3 Data collection
Accident-involved employees were interviewed by the researcher as soon as possible after the accident event (mean time between accident and interview = 9.5 days). Each interview lasted approximately 30 minutes and was carried out during the employee's work hours. All interviews were undertaken at the site of the accident. Accident-involved employees were able to demonstrate accident events within the environmental context in which they took place, with the accident location providing employees with cues to memory ('contextual cues'), and assisting the researcher in understanding the precise nature of accident circumstances. Interviews at the site of the accident also helped the researcher verify the legitimacy of the reported accident (one case was not included in the dataset as the accident-involved employee was
Employees were asked to describe and re-enact the sequence of events leading to their injury. The researcher then completed an accident 'sequence of events chart' (see figure 5.1 for example), and the accident-involved employee was asked to verify whether the chart accurately represented what had happened. The accident-involved employee's activity immediately prior to the accident, initiating event, contact event and subsequent injury were recorded on the chart.

Figure 5.1 Example of sequence of events chart

Having described accident events, the accident-involved employee was asked a number of questions. Questions were designed to provide information on a range of factors relevant to accident circumstances: the accident environment (hazards involved in the accident, lighting conditions, weather conditions, conditions underfoot, etc.); their behaviour (use of unsafe behaviour or working practice); footwear and use of equipment (trolleys, pouches, torches, etc.); work methods (delivery method, etc.); training; safety practices employed by their DOM, etc.

Open and closed format questions were included in the interview schedule, and the employee could expand on any issue considered important. Table 5.1 provides a breakdown of questions contained in the interview schedule.
Table 5.1. Interview schedule summary

<table>
<thead>
<tr>
<th>Information collected</th>
<th>Specific details</th>
</tr>
</thead>
<tbody>
<tr>
<td>(general topic of questions)</td>
<td></td>
</tr>
<tr>
<td>1. Accident site description</td>
<td>Verbal and sketched description of site</td>
</tr>
<tr>
<td>2. Description of accident events</td>
<td>Activity, FIE, contact and injury events</td>
</tr>
<tr>
<td>3. Hazard associated with the fall</td>
<td>Where hazard situated ?</td>
</tr>
<tr>
<td></td>
<td>Responsibility for hazard ?</td>
</tr>
<tr>
<td></td>
<td>Hazard perceived ? Why not ?</td>
</tr>
<tr>
<td>4. Lighting conditions at the accident site</td>
<td>Absent where lighting required ? Inadequate ?</td>
</tr>
<tr>
<td>5. Weather conditions</td>
<td>Conditions underfoot/ other adverse conditions</td>
</tr>
<tr>
<td>6. Footwear</td>
<td>Type (RM issue/ own/ boot/ shoe)</td>
</tr>
<tr>
<td></td>
<td>Date of issue</td>
</tr>
<tr>
<td></td>
<td>Rated condition of tread</td>
</tr>
<tr>
<td>7. Snow chains (PPE for walking in snow)</td>
<td>Worn at the time of the accident (if relevant) ?</td>
</tr>
<tr>
<td></td>
<td>If snow on ground, why not worn ?</td>
</tr>
<tr>
<td>8. Delivery method</td>
<td>How was mail transported? (carry, trolley, bike)</td>
</tr>
<tr>
<td></td>
<td>Contribution of weight to loss of balance</td>
</tr>
<tr>
<td>9. Unsafe behaviour or working practice</td>
<td>Practices which increase the risk of accidents/ acts inappropriate for conditions</td>
</tr>
<tr>
<td>(at the time of the accident)</td>
<td>Reasons unsafe practice used</td>
</tr>
<tr>
<td>10. Unsafe behaviour or practice during</td>
<td>Unsafe practices commonly used / reasons for common use</td>
</tr>
<tr>
<td>normal working</td>
<td>Was employee aware of risk using practice ?</td>
</tr>
<tr>
<td>11. Experience of job and delivery route</td>
<td>Full/ part time</td>
</tr>
<tr>
<td></td>
<td>Length of service</td>
</tr>
<tr>
<td></td>
<td>Time on route</td>
</tr>
<tr>
<td></td>
<td>Familiarity with route</td>
</tr>
<tr>
<td>12. Overtime working/ tiredness/ fatigue</td>
<td>Overtime (weekly)</td>
</tr>
<tr>
<td></td>
<td>Overtime (2 days preceding accident)</td>
</tr>
<tr>
<td>13. Training</td>
<td>New recruit training</td>
</tr>
<tr>
<td></td>
<td>Safety training (during past year)</td>
</tr>
<tr>
<td></td>
<td>Where received; who from; how long ?</td>
</tr>
<tr>
<td>14. Management safety-related practice</td>
<td>Supervision/ Safety communications</td>
</tr>
<tr>
<td></td>
<td>Footwear and equipment management</td>
</tr>
<tr>
<td></td>
<td>Hazard control</td>
</tr>
<tr>
<td></td>
<td>Adverse weather practice</td>
</tr>
</tbody>
</table>
5.2.4 *Data analysis*

Using information collected during the interview, contributory factors and possible underlying organisational influences were added to 'sequence of events charts', allowing a full description of each accident to be modelled on a single diagram. Examples of this descriptive analysis for two of the accidents investigated in the study are presented in figures 5.2 (a) and 5.2 (b).

In figure 5.2 (a) the accident-involved employee's foot tripped on a protruding paving slab, unnoticed because the employee was separating mail for the delivery point from a bundle. The PDO had noticed the hazard on previous occasions, but had not reported it either to the householder or his manager. Possible organisational influences (organisational and management factors believed by the researcher to possibly underlie accident contributory factors) included absence of training in skills for safe working practice.

In figure 5.2 (b) the accident-involved employee slipped while walking down a sloped driveway which was covered with compacted snow. The fact the employee was walking quickly (rather than slowly, taking small steps) increased the likelihood of the slip. Contributory factors included failure of the householder to treat the driveway (which had become very slippery in the area where people walked most often), and lack of grip on the employee's footwear. Possible organisational influences included organisational-based motivations to rush and take risks (e.g. 'job and finish' policy) and footwear policy.

From these diagrams, and the responses to the questions contained in the interview schedule, it was possible to quantify the involvement of factors identified in accident-independent research to the sample of delivery STFA.

The interview procedure was piloted by interviewing four STFA accident-involved PDO from the Loughborough and Leicester area. The pilot interviews confirmed accident events could be represented on 'sequence of events charts', and respondents understood the charts and were able to verify charts accurately represented accident events. The pilot interviews also confirmed full descriptions of accident circumstances could be modelled on 'events and contributory factor charts', from the information collected using the interview schedule.
No training in skills for safe practice/organisational based motivation to rush

Ineffective system for hazard reporting and control?

Absence of training in injury prevention/fall safe techniques

Fails to notice raised slab: separating mail for delivery point from bundle

'Fall safe' techniques not used

Avoidable hazard: not reported following previous non-injury trip

Activity immediately preceding accident

Walking on path to front door - separating mail for address

Foot trips on broken paving slab (3 cm protrusion)

Ankle turns and employee falls forwards

Knees and hands contact paving stone

Twisted ankle and bruised knee

Broken paving not repaired by householder

Figure 5.2 (a) Example of events and causal factors chart
Figure 5.2 (b). Example of events and causal factors chart
5.3 Results

5.3.1 Accident events

Figure 5.3 provides a breakdown of accident-involved employees' activity immediately preceding the accident and FIE. The relationship between activity and FIE is also shown.

<table>
<thead>
<tr>
<th>Activity immediately preceding the fall</th>
<th>Relationship between activity and FIE (% = proportion of falls where FIE followed activity)</th>
<th>Fall initiating event (FIE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking on the level</td>
<td>(70%)</td>
<td>Foot slipped n=33 (83%)</td>
</tr>
<tr>
<td>n=20 (50%)</td>
<td>(20%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(10%)</td>
<td></td>
</tr>
<tr>
<td>Walking down sloped drive</td>
<td>(100%)</td>
<td></td>
</tr>
<tr>
<td>n=12 (30%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking up sloped drive</td>
<td>(67%)</td>
<td></td>
</tr>
<tr>
<td>n=1 (2%)</td>
<td>(20%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td></td>
</tr>
<tr>
<td>Walking down steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=3 (8%)</td>
<td>(100%)</td>
<td></td>
</tr>
<tr>
<td>Turning on steps</td>
<td>(33%)</td>
<td></td>
</tr>
<tr>
<td>n=1 (2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climbing in/out of van</td>
<td>(100%)</td>
<td></td>
</tr>
<tr>
<td>n=3 (8%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.3. Activity of accident-involved employee immediately before the accident, fall initiating event and relationship between activity and FIE
The most common activity immediately preceding the fall was walking on the level (50% / n=20), followed by walking down a sloped driveway (30% / n=12). Falls occurred on steps in 10% (n=4) of cases, and during entry or egress from a van in 8% (n=3) of cases.

Foot slip was the FIE in 83% (n=33) of cases, and foot trip in 10% (n=4) of cases. All falls on a slope, and 70% of falls on the level followed a slip of the foot. In 85% (n=34) of cases the accident-involved employee fell and made contact with the underfoot surface. The remaining employees made contact with the door of their van following a slip while climbing in or out of the van (8% / n=3), or stumbled but managed to avoid striking the ground (8% / n=3).

Injuries were commonly to the ankle (35% / n=14), most of which were sprains or twists, and the knee and multiple lower limb areas (23% / n=9), the majority of which were cuts and bruises.

5.3.2 The physical and ambient environment
Underfoot conditions were most frequently snow (40% / n=16) and ice or frost (30% / n=12), reflecting the winter period during which the study was undertaken. Damaged paving was the underfoot condition in 8% (n=3) of cases.

'Avoidable' environmental hazards were involved in 23% (n=9) of STFA investigated. This included any hazard which, in the opinion of the accident-involved employee and the researcher, could have easily been removed or repaired and was not a normal feature of a well maintained premises or public area. This finding is in line with those from the analysis of accident reports (chapter three), where avoidable environmental hazards were involved in a large proportion of accidents occurring on householders' property. This finding also supports those from accident-independent investigations, which found avoidable hazards such as broken paving and obstacles to be major risk factors according to PDO (see 4.3.2).

Table 5.2 shows 'avoidable' hazards involved in the STFA investigated. A short description of each hazard is provided, along with location details, time the hazard had been at location, and whether the hazard was commonly encountered at other premises or locations on the employee's delivery route.
Table 5.2. 'Avoidable' environmental hazards involved in STFA

<table>
<thead>
<tr>
<th>Description of hazard</th>
<th>Location of hazard</th>
<th>Approx. time in place</th>
<th>Common hazard?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paving slab raised approximately 2 cm.</td>
<td>Private path through garden</td>
<td>12 months</td>
<td>Yes</td>
</tr>
<tr>
<td>Damage to paving. Paving raised approximately 5 cm.</td>
<td>Private drive</td>
<td>18 months</td>
<td>Yes</td>
</tr>
<tr>
<td>Paving slab raised approximately 1.5 cm.</td>
<td>Private driveway</td>
<td>12 months</td>
<td>Yes</td>
</tr>
<tr>
<td>Hole approximately 8 cm deep, left from Council building works</td>
<td>Public pavement</td>
<td>Approx. 2 months</td>
<td>No</td>
</tr>
<tr>
<td>Hole approximately 6 cm deep, left unrepaired by householder</td>
<td>Private drive</td>
<td>Over 12 months</td>
<td>Yes</td>
</tr>
<tr>
<td>Pile of bricks left on drive due to uncompleted building repairs</td>
<td>Private drive</td>
<td>At least 6 months</td>
<td>No</td>
</tr>
<tr>
<td>Uncleared snow and ice on steps (x4) leading down to front door</td>
<td>Private steps</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Uncleared snow on steps (x12) No handrail provided</td>
<td>Steps to business premises</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Uncleared build-up of mud from employee's boots on van door frame</td>
<td>Door frame of delivery van</td>
<td>N/A</td>
<td>Yes</td>
</tr>
</tbody>
</table>

'Avoidable' hazards included uneven paving slabs, snow covered steps leading to domestic and business premises and holes in paving. In 67% of cases (n=6), 'avoidable' hazards were situated on householders' premises. Damaged walking surface conditions were reported by accident-involved employees to have been in place for over 12 months in most cases, and the majority of hazards were reported to be common hazards on their walks.

Lighting at the site of the accident was described by the accident-involved employee as 'poor' in 20% (n=8) of cases, and the employee believed the absence of adequate lighting contributed to their accident in 15% (n=6) of cases. Where poor lighting was involved in accident causation, falls occurred on householders' property in 75% of cases (n=4). Combining avoidable hazards and absence of adequate lighting (arguably another avoidable source
of accidents), a total of 38 % (n=15) of cases involved hazards which might have easily been repaired or removed.

5.3.3 Footwear and equipment

Table 5.3 shows details of footwear used at time of the accident, the mean time footwear had been used for delivery work, and the mean rated condition. The condition was rated on a five point scale, based on the amount of tread remaining on the soling and heel of the shoe. Ratings were obtained from an examination of the footwear by the researcher.

Table 5.3 Footwear used at time of STFA: footwear type, age and condition

<table>
<thead>
<tr>
<th>Footwear type</th>
<th>Proportion of accidents where footwear worn (%)</th>
<th>Mean age of footwear (time from approx. date of issue) months</th>
<th>Mean rated condition of tread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royal Mail trainers</td>
<td>38 (n=15)</td>
<td>4.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Royal Mail Air sole (Dr Martin shoe)</td>
<td>25 (n=10)</td>
<td>4.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Royal Mail walking (Clarks shoe)</td>
<td>20 (n=8)</td>
<td>3.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Royal Mail Wellingtons</td>
<td>5 (n=2) (occasional use)</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Non Royal Mail footwear</td>
<td>12 (n=5)</td>
<td>4.5</td>
<td>3</td>
</tr>
</tbody>
</table>

Tread rating scale: very good (tread unworn) = 5; good (most tread remaining) = 4; moderate = 3; poor (little tread remaining) = 2; very poor (worn smooth, no tread) = 1

Royal Mail supplied trainers were the most frequently used footwear (38 %), despite the winter conditions. Five accident-involved employees (12 %) were wearing their own footwear, suggesting preference for alternative footwear to that supplied by the Royal Mail for delivery work during the winter. Mean tread ratings were 'poor' to 'very poor' for all shoes supplied as part of uniform, despite the fact mean time in use ranged from only 3.3 to 4.7 months (footwear is supplied to delivery staff on the basis of 1 pair per year). Where the PDO had slipped, footwear was rated as having tread in 'very poor' condition in 75 % of cases. These findings support those from the accident-independent investigations where all respondents noted footwear supplied to PDO was unsuitable for use in winter conditions.
Snow chains are provided to employees as personal protective equipment for working in winter conditions. In none of the cases where slips occurred on snow (n=16) were snow chains being worn at the time of the fall. All respondents stated they had access to snow chains if they wanted them. Reasons given for non-use of snow chains included discomfort when walking on cleared ground, skidding on ice, and time-costs associated with putting chains on and taking them off as underfoot conditions changed. Confusion was also expressed by some employees as to when snow chains should be worn. These findings were in line with those obtained from PDO in focus groups and from interviews with safety personnel, and confirm snow chains are ineffective in some conditions and an unpopular form of footwear attachment.

The most common method of delivery being used at the time of the fall was manual mail pouch carriage (75% / n=30). A trolley or bike was being used by the employee to transport mail at the time of the accident in 10% of cases. Where the mail pouch was carried manually, the pouch was at least three-quarters full in 40% (n=16) of cases (the employee was usually able to gauge the fullness of their pouch from where they were on their delivery round at the time of the incident). There was some evidence the pouch weight contributed to the fall in 8% (n=3) of cases. In two of these cases the weight appeared to have caused the employee to over-balance following a slip, and in one case the employee tripped and was unable to maintain balance due to the weight of their load.

Accident-involved employees reported carrying over-weight (over 16 kg) pouches at the time of the STFA in 10% (n=4) of cases, while 58% (n=23) of employees stated they did so at some point during a typical working day (77% of all accident-involved employees who carried their pouches manually). This finding reflects those from accident-independent investigations where safety personnel, managers and PDO suggested PDO commonly carried over-weight mail pouches.

5.3.4 Unsafe behaviour and work practices
Table 5.4 provides a breakdown of unsafe behaviours and working practices identified as being in common use in accident-independent investigations. The proportion of accident-involved employees who were using each unsafe
practice at the time of the accident are shown, together with the proportion of PDO who reported using these practices during normal working.

Table 5.4. Use of unsafe behaviours and working practices at time of accident and during normal working

<table>
<thead>
<tr>
<th>Unsafe behaviour or practice</th>
<th>Proportion of PDO using practice at time of fall</th>
<th>Proportion of PDO who use practice during normal working</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rushing (running, jogging, walking very quickly) in slippery conditions</td>
<td>n=13 (33 %)</td>
<td>n=28 (70 %)</td>
</tr>
<tr>
<td>Taking short-cut across/entering hazardous area (over wall/across lawn, etc.)</td>
<td>n=0 (0 %)</td>
<td>n=26 (65 %)</td>
</tr>
<tr>
<td>Reading or sorting mail while walking</td>
<td>n=16 (40 %)</td>
<td>n=34 (85 %)</td>
</tr>
<tr>
<td>Jumping down steps/skipping steps</td>
<td>n=0 (0 %)</td>
<td>n=10 (25 %)</td>
</tr>
<tr>
<td>Jumping off platform/from vehicle</td>
<td>n=0 (0 %)</td>
<td>n=4 (10 %)</td>
</tr>
<tr>
<td>Cycle scooting (one foot on pedal, one on ground)</td>
<td>n=0 (0 %)</td>
<td>n=1 (3 %)</td>
</tr>
<tr>
<td>Carrying more than one pouch</td>
<td>n=1 (2 %)</td>
<td>n=8 (20 %)</td>
</tr>
<tr>
<td>Total accident-involved employees using some unsafe practice at time of STFA</td>
<td>n=24 (60 %)</td>
<td></td>
</tr>
</tbody>
</table>

At the time of the STFA, 33 % (n=13) of employees reported they were rushing (walking very fast or running) in slippery conditions, and 40 % (n=16) said they were reading letter addresses or sorting mail from a bundle or pouch while walking. All but one of the employees who had been reading addresses while walking believed this activity had caused them not to have seen the hazard involved in their fall. Some form of unsafe practice was reported as being used at the time of the accident in 60 % (n=24) of cases. These findings support those from accident-independent investigations, and
suggest the practice of reading letter addresses while walking is particularly important in delivery STFA.

Accident-involved employees' responses concerning the use of unsafe practices during normal working suggest the practices of rushing, reading while walking, and taking short-cuts are in common use. Large proportions of PDO (25%) also reported jumping down or skipping steps. More than one pouch was carried at the same time at some point of a typical working day by 20% of PDO. This was most frequently done whilst transporting pouches from the delivery office to vehicles, and during the first delivery round. The majority of accident-involved employees (75% / n=30) believed using these unsafe practices increased their risk of having accidents on delivery.

PDO who were using some form of unsafe practice at the time of the STFA were asked to give the main reason why they were doing so. Time-saving was the most common response. Reasons PDO were trying to save time included making time for themselves so they could get back to the office or go home early (50% / n=12), time pressure (difficulty delivering mail within the time target) (42% / n=10), and to catch a bus or lift back to the office following delivery of first round (8% / n=2).

5.3.5 Task and route familiarity
Accident-involved employees' experience of job and delivery route were considered. Mean time spent working on the delivery route on which the STFA occurred was nearly two years, and employees had spent more than six months working on the delivery route where the accident occurred in 55% of cases. Employees reported being 'very familiar' with the route in 78% of cases. It appears inexperience of the task and under-familiarity with the delivery route were unlikely to be risk factors for this sample of delivery STFA.

5.3.6 Overtime working
Nine or more hours overtime had been worked by the accident-involved employee in the two days preceding the STFA in 25% (n=10) of cases. Four employees had worked 13 or more hours overtime, suggesting the possibility of tiredness and fatigue contributing to accident incidence. The issue of whether overtime and shift working, and the effects of tiredness and fatigue, contribute to delivery STFA incidence requires further research.
5.3.7 Training received by accident-involved employees

Accident-involved employees were asked to state whether they had received classroom-based new-entrant training when commencing work for Royal Mail Midlands. PDO recalled receiving such training in 38% (n=15) of cases, and all respondents reported having received on-the-job training with an experienced PDO for a period of between three and five days. It is noted, however, these responses are subject to individuals' ability to recall events and possible ambiguity concerning what is meant by 'classroom training'. These findings do, however, support those of previous project research. ‘On-the-job’ training may be problematic in that there is little control over what is taught in relation to safe delivery practice (see 4.3.5).

Some form of safety training was reported being received during the past two years by 55% (n=22) of respondents. Thus, 45% did not recall having received safety training, despite this being an expectation of management. Again these findings are subject to the individual's ability to recall these events and ambiguity over what is meant by 'safety training'. These findings also reflect those of previous project research. Where some form of safety training had been received during the past two years it had been provided by the employee's office manager in most cases in the form of a team brief. Length of team brief sessions where safety issues were included were reported to be 10 minutes or less in most cases.

5.3.8 Management safety practice

Accident-involved employees were asked to comment on specific elements of their DOM's safety activities. Table 5.5 shows a breakdown of office managers' safety practices as reported by accident-involved employees. Findings again supported those from accident-independent investigations. A majority of accident-involved employees said their office managers regularly gave warnings concerning working in slippery conditions. This advice was usually offered on winter mornings prior to PDO leaving to commence their delivery rounds. Advice on use of safe working practices was also provided to a majority of respondents, but respondents noted this advice was generally related to safe use of office equipment (bulk containers etc.) and lifting and handling, rather than delivery working practices involved in delivery STFA. Few managers were reported by PDO to take action related to hazards outside the delivery office, or to reduce exposure of PDO to hazardous weather conditions.
Table 5.5 Management safety practice, as reported by accident-involved delivery officers

<table>
<thead>
<tr>
<th>Management safety practice</th>
<th>Specific safety activities</th>
<th>DOM undertaking practice (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervision of delivery staff</td>
<td>Action to ensure correct equipment use</td>
<td>75 (n=30)</td>
</tr>
<tr>
<td></td>
<td>Action to ensure safe working practices</td>
<td>20 (n=8)</td>
</tr>
<tr>
<td></td>
<td>Safety inspection outside office (i.e. of delivery staff undertaking deliveries)</td>
<td>0</td>
</tr>
<tr>
<td>Footwear and equipment management</td>
<td>Check delivery staff in possession of correct equipment for winter working (e.g. footwear in good condition, snow chains)</td>
<td>35 (n=14)</td>
</tr>
<tr>
<td>Hazard management</td>
<td>Encourage delivery staff to report hazards on walks</td>
<td>5 (n=2)</td>
</tr>
<tr>
<td></td>
<td>Action to remove hazards on walks when reported</td>
<td>8 (n=3)</td>
</tr>
<tr>
<td>Safety communications</td>
<td>Regular safety content in team briefs</td>
<td>38 (n=14)</td>
</tr>
<tr>
<td></td>
<td>Regular advice on safe working practice</td>
<td>70 (n=28)</td>
</tr>
<tr>
<td></td>
<td>Warnings associated with severe weather</td>
<td>85 (n=34)</td>
</tr>
<tr>
<td>Adverse weather practice</td>
<td>Action to protect delivery staff during severe weather (general)</td>
<td>20 (n=8)</td>
</tr>
<tr>
<td></td>
<td>Action to protect delivery staff on day of accident - if slip was weather related</td>
<td>10 (n=4)</td>
</tr>
</tbody>
</table>

Where the accident-involved employee's accident had involved slippery underfoot conditions, none reported their manager had taken action to reduce PDO exposure to hazardous conditions. Accident-involved employees reported their managers checked PDO were in possession of equipment required for working in winter conditions in 35% of cases.
5.4 Discussion

5.4.1 Key findings: common contributory factors
Detailed accident follow-up interviews confirmed a range of contributory risk factors identified in previous research (chapters three and four). These factors appear to interact with the primary risk factor: slippery underfoot conditions. Notable amongst these factors are the use of footwear unsuitable for heavy wear and winter working, and the use of unsafe, time-saving behaviour or working practices, particularly rushing in slippery conditions and reading addresses while walking.

From the findings of this research it is possible to identify risk factor interactions commonly involved in delivery STFA. For example, for 50% of STFA cases considered in the study, each of the following risk factors were involved:

a) Presence of slippery underfoot conditions (e.g. snow/ice)
b) Use of footwear with worn tread (rated 'worn smooth' by researcher)
c) Rushing (running or walking very quickly) or reading mail addresses while walking

It is noted this combination of risk factors would be involved in a smaller proportion of delivery STFA when measured over an entire year, as slippery underfoot conditions are involved in approximately 50% of STFA per year (see 3.3.2) compared to the 83% of cases in this sample of winter STFA. However, it is argued this combination of factors represents the major risk for delivery STFA, perhaps contributing to between 35% and 40% of annual delivery STFA.

A second important risk factor combination appears to include the presence of tripping hazards (including 'avoidable' temporary hazards and permanent environmental features, such as kerbs), and use of the unsafe practice of reading addresses or sorting mail for the next delivery point while walking. As suggested in chapter four, accidents such as tripping or bumping into objects may occur when the dual tasks of monitoring the walking environment and undertaking a productive task conflict (Saari, 1984). Of the 10% (n=4) of accidents where the employee tripped and fell, all accident-
involved employees did not see the hazard due to the fact they were looking at their mail to prepare letters for the next delivery point.

Other factors found to be important in this sample of accidents include the involvement of 'avoidable' environmental hazards and the absence of adequate lighting (together involved in a total of 38% of cases). These findings support those of Fothergill et al (1995), who found uneven underfoot surfaces or inadequate street lighting to be involved in over half of falls occurring in public places reported by accident and emergency department patients.

Footwear and equipment factors implicated in this sample of STFA accidents include the non-use of footwear attachments for working in snow, and use of footwear unsuitable for winter conditions. These findings suggest PDO have little protection from slippery underfoot conditions. It is possible the carriage of a heavy asymmetric load (the delivery pouch) may further reduce PDOs' ability to maintain balance in slippery conditions. Previous research on the effect of load carrying has shown it to induce an abnormal gait pattern (short-stride length) for better stance in slippery conditions (e.g. Myung and Smith, 1997), and the relative stability of the load carrier to be reduced roughly linearly with the magnitude and height of the weight (Davis, 1983). Further laboratory-based research is required, however, before more confident assertions can be made regarding the effect of load carrying on the slipping likelihood of PDO walking in slippery underfoot conditions.

This study has supported previous investigations (chapter four), which found organisational policies and practices to underlie the use of unsafe behaviour and work practices. Rushing in slippery conditions and other forms of unsafe behaviour appear to be influenced by organisational-based motivation, such as the 'job and finish' practice and quality of service targets. Local management safety practices also appear to be implicated in STFA risk: this study found DOM to do little to protect PDO on days where severe weather increased the risk of injury due to slipping accidents. Other local management safety practices which appear to be undertaken by only a small proportion of DOM include hazard management and supervision of PDO outside the office (i.e. safety tours of staff on delivery). Project research reported in chapter six considers the role of these management safety practices in delivery office safety performance.
5.4.2 Considerations in the interpretation of results

A number of issues should be considered when interpreting the findings of this study. The small sample size suggests possible problems of representativeness. The sample included in the study was representative of the PDO population, however, and the findings of the study support those derived from the analysis of a large database of accidents (chapter three). An increased sample size of accident cases would have been at the expense of depth of analysis, the major strength of this study. Occupational accidents are complex events, and the aims of this research were to consider a sample of delivery STFA in depth. The use of interviews permitted the collection of detailed information on a wide range of factors, as well as allowing the researcher to observe where and how each STFA took place.

Problems associated with the subjective and memory-dependent nature of accident accounts (Williamson and Feyer, 1990) were countered to some extent by undertaking interviews with accident-involved employees at the site of the accident. As well as providing the employee with cues to memory for accident events (e.g. contextual cues), the ability of the employee to demonstrate accident events and hazards within their actual context helped the researcher understand employees' accounts of accident circumstances. The use of a chart of accident events assisted this process, as accident-involved employees were able to verify the model accurately represented accident events.

5.5 Summary and conclusions

This chapter has presented findings from interviews with 40 STFA accident-involved PDO. The detailed interview schedule allowed a large quantity of information concerning delivery STFA risk factors to be collected. The findings supported those from accident-independent investigations (chapter four), and suggested a number of contributory factors commonly interact with the primary environmental risk factors: slippery underfoot conditions and tripping hazards. In this study, 50% of accidents involved a combination of three key factors: slippery underfoot conditions, use of footwear with worn tread, and use of time-saving, unsafe behaviours and work practices. The practice of reading letter addresses while walking was found to be an important factor in delivery STFA, producing disturbances in the flow of
information between PDO and their working environment. Local management safety practices, such as failure to take action to reduce PDO exposure to hazardous walking conditions during adverse weather, and organisational-based motivation to rush and take risks during delivery, were identified as important underlying factors for a large proportion of delivery STFA.
SAFETY PRACTICES OF MANAGERS OF HIGH AND LOW ACCIDENT-INCIDENCE RATE POSTAL DELIVERY OFFICES

6.1 Introduction

6.1.1 Rationale for the study of management safety practice
The study presented in this chapter focused on management safety practices as previous project research (chapters four and five) suggested local delivery office managers (DOM) have an important influence on PDO safety performance. The published literature also recognises the supervisor or first-line manager as a key-person in accident prevention, having daily contact with staff and the opportunity to control unsafe conditions and acts likely to cause accidents at work (Heinrich, 1980). A number of studies have considered the effectiveness of management and supervisor safety practices in occupational safety performance. Many of these studies analysed safety practices common to companies with outstanding safety performance, or compared practices of companies with high injury rates with those having low rates (e.g. Cohen, 1977; Simonds and Shafai-Sahrai, 1977; Smith et al, 1978; Cohen and Cleveland, 1983; Chew, 1988). Smith et al (1978) note the following factors were found to be important to successful safety program performance in more than one such study: strong management concern for safety; full-time safety director who reports to top management; frequent use of safety promotions; frequent use of accident investigations; formal training of employees and supervisors; frequent positive contacts between employees and supervisors. These and other more recent studies (e.g. Simard and Marchand, 1994) highlight the importance of manager and supervisor safety practice in occupational safety.

Turning to the specific safety responsibilities of DOM, Royal Mail local office managers are required to undertake a variety of safety-related activities as part of their supervisory function. DOM are responsible for ensuring all accidents to staff under their supervision are investigated fully. The HSE (1985) suggest STFA should be investigated to determine accident events and contributory factors. In addition, results of such investigations should be followed up by rectifying hazards, modifying systems of work and
publicising lessons learned to employees. The present study focused attention on the standard of accident investigation undertaken at high and low accident-incidence rate delivery offices.

Previous research has also suggested hazard identification and management are important in accident prevention, including STFA (e.g. Buck and Coleman, 1985; Smith and Beringer, 1987; Leamon, 1992). The involvement of employees in hazard recognition has been highlighted as an important safety measure (Smith and Beringer, 1987). The present study considered DOMs' hazard management activities, particularly their propensity to encourage hazard reporting and efforts to remove reported hazards from the work environment.

Safety communications and positive contacts between first-line management and staff have been found to be important to the achievement of good safety performance (Smith et al, 1978; Smith and Beringer, 1987). The present study attempted to determine the frequency and quality of safety-related communications between DOM and PDO.

The safety practices used by DOM can influence the level of exposure to slippery underfoot conditions faced by PDO. In focus groups (chapter four), PDO suggested DOM use of adverse weather practices and replacement of worn footwear to be important in PDO safety performance. These views were reflected in interviews with safety personnel. The present study considered measures taken by DOM to reduce the risk of STFA among their delivery staff during severe weather conditions, and footwear and equipment management at high and low accident-incidence delivery offices.

A related reason for studying the role of management safety practice in PDO safety performance was the belief that safety efforts might have greatest impact, and be most cost effective, where interventions are introduced at the local management level.

6.1.2 Outline of research presented in this chapter
Data from previous project research (chapters four and five) were considered to determine DOM safety practices which might affect PDO safety performance. Interviews with senior delivery managers and DOM were undertaken to identify management safety practices used by DOM, and
barriers and incentives which influence the use of safety practices. A focus group session with senior safety managers considered the areas of safety in which the DOM might most effectively play a role in improving safety performance. Using data produced from these methods, and information from published safety literature, a list of 'desirable' management safety practices and activities was drawn up. DOM from a sample of 20 'matched' high and low accident-incidence rate postal delivery offices (based on two year accident figures for all accident types) were interviewed by telephone on two occasions to determine their use of 'desirable' safety practices, and to identify differences between safety practices used by DOM of high and low accident-incidence rate offices. Safety practices considered in the study included accident investigation and prevention activities, adverse weather practice, hazard management, safety communications, and supervision and equipment management.

6.1.3 Aims
i) To identify management safety practices used by DOM.

ii) To determine 'desirable' management safety practices.

iii) To identify factors which affect the use of 'desirable' management safety practices by DOM.

iv) To determine whether the use of 'desirable' management safety practices differs between high and low accident-incidence rate postal delivery offices.

v) To develop suggestions for improving safety performance within postal delivery offices through intervention at the level of the DOM.

6.2 Methods

6.2.1 Overview of study methodology
The study had two phases. Phase one was designed to identify safety-related practices used by Royal Mail Midlands DOM, and to determine 'desirable' management safety practice and factors which affected DOMs' use of 'desirable' practice. Phase two was designed to determine the extent and
quality of use of 'desirable' safety practices by a sample of DOM from 'matched' high and low accident-incidence rate postal delivery offices, and to identify whether DOM from these offices differed in their use of these practices.

6.2.2  **Phase one methodology**
Table 6.1 outlines methods used in phase one of the study, together with study aims.*

Table 6.1 Methods used in phase one of the study

<table>
<thead>
<tr>
<th>Aim</th>
<th>Method</th>
<th>Information sought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify safety-related practices used by DOM</td>
<td>Reference to data from previous project research (i.e. accident-independent investigations and accident interviews)</td>
<td>DOMs' actions which were thought to reduce/increase the risk of accidents to PDO</td>
</tr>
<tr>
<td></td>
<td>Semi-structured interviews with senior managers and DOM (n= 6)</td>
<td>DOM's actions identified as accident contributory factors</td>
</tr>
<tr>
<td>Produce a list of 'desirable' management safety practice for DOM</td>
<td>Focus discussion group meeting with senior safety managers (n=12 participants)</td>
<td>Activities DOM undertake which reduce or increase the risk of accidents to PDO</td>
</tr>
<tr>
<td>Identify factors which determine DOMs' use of 'desirable' management safety practices</td>
<td>Semi-structured interviews with senior managers and DOM (n= 6)</td>
<td>Most effective DOM safety practices/role of DOM in improving safety performance</td>
</tr>
<tr>
<td></td>
<td>Focus discussion meeting with senior safety managers</td>
<td>Factors which influence DOMs' use of 'desirable' safety practices (i.e. incentives and barriers to use)</td>
</tr>
</tbody>
</table>

* The main findings from phase one of this study were presented at the Annual Conference of the Ergonomics Society, Lincoln, 1997 (Bentley and Haslam, 1997b).
An initial list of safety practices used by DOM was produced. Methods used to identify these practices included an analysis of previous project research data (reported in chapters four and five) related to the role of management practice in STFA risk, and semi-structured interviews with senior delivery managers (n=3) and DOM (n=3). Interviews lasted approximately 60 minutes, and were held at the workplace of the respondent. Interview respondents were asked to describe safety practices used by DOM, noting the frequency with which they were used and the circumstances under which they were used. In addition, respondents were asked to describe factors which affected DOMs' use of management safety practices.

A focus group session was held with senior safety managers (n=12) from throughout Royal Mail UK. The focus group session lasted approximately 80 minutes, and was held as part of a regular conference of senior safety personnel from the Royal Mail. Participants were asked to comment on the use and effectiveness of the management safety practices identified from the research reported above, and to consider the areas of safety in which the DOM might most effectively play a role in improving delivery office safety performance. From data produced from the above methods, and reference to published safety literature, a list of 'desirable' management safety practices for DOM was produced.

6.2.3 Phase two methodology
Table 6.2 presents the methods used in phase two of the study, together with study aims. A sample of DOM from 10 low accident-incidence rate postal delivery offices (LAO) and 10 high accident-incidence rate postal delivery offices (HAO) were interviewed over the telephone on two occasions. Interviews were prearranged so the DOM set aside the necessary period of time during which they would not be disturbed. Two pilot interviews identified problems with the interview schedule (minor changes to terminology were necessary), and confirmed the suitability of telephone interviews for this study.

The researcher assured all DOM of anonymity, and encouraged them to be as open and honest with their responses as possible. DOM were told the study was to look at safety practices currently employed at delivery offices, but were not informed about the inclusion of very high and low accident-incidence rate delivery offices in the study.
Table 6.2. Methods used in phase two of the study

<table>
<thead>
<tr>
<th>Aim</th>
<th>Method</th>
<th>Information sought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the extent and quality of use of 'desirable' safety-related practices by a sample of DOM (n=20)</td>
<td>Semi-structured telephone interviews with DOM: 1st interview = 40 mins. 2nd interview = 10 mins Analysis of a sample of accident report forms completed by DOM</td>
<td>DOMs' reported use of safety-related practices/ specific examples of use</td>
</tr>
<tr>
<td>Determine whether use of 'desirable' safety practices differed between DOM from high and low accident rate offices</td>
<td>Telephone interviews Analysis of accident reports</td>
<td>DOMs' reported use of safety-related practices/ specific examples of use</td>
</tr>
<tr>
<td>Identify DOMs' opinions of the most effective safety-related practices they used</td>
<td>Telephone interviews</td>
<td>Practices which DOM used which they believed to be most effective in reducing the risk of accidents</td>
</tr>
<tr>
<td>Identify factors which effect DOMs' use of 'desirable' safety practices</td>
<td>Telephone interviews</td>
<td>Incentives and barriers to use of 'desirable' safety-related practices</td>
</tr>
</tbody>
</table>

The first interview lasted approximately 40 minutes. The researcher asked the DOM a series of questions from a detailed interview schedule related to their use of management safety practices. For some safety practices (e.g. accident investigation and prevention, hazard management) the DOM was asked to provide specific detailed examples of recent use. This was done to help validate DOMs' claims regarding the undertaking of certain safety-related activities, and to provide additional information about safety practices.
used by DOM. DOM were also asked to describe practices they used which they believed were most effective in promoting a good safety performance amongst their PDO, and factors which affected their use of 'desirable' safety practices.

The second interview lasted approximately 10 minutes, and was designed to allow the researcher to ask follow-up questions where more information was required, or points of clarification concerning DOMs' responses needed to be addressed. The second interview also allowed the researcher to re-present a number of questions regarding safety activity as a check for reliability in DOMs' responses.

Accident report forms completed by DOM from the 20 offices were analysed to determine the quality of accident investigating, reporting and prevention by DOM. Report forms completed during different periods of the year (March 1996-February 1997) and pertaining to four different accident types (non-vehicle) were examined. All reports related to non-serious, lost-time accidents (see section 6.4.1.3 for criteria used to assess DOMs' accident report forms).

From the above measures it was possible to determine the extent and quality of use of 'desirable' management safety practices, and whether there were differences in the practices employed by DOM of LAO and HAO.

6.2.3.1 DOM sample
The sample of 20 postal delivery offices to be included in the study was selected from all Midlands postal delivery offices which met the following criteria:

1. The DOM must have been in post at least 18 months
2. Offices must serve a predominantly urban area
3. Offices must have between 35 and 150 PDO in post (i.e. medium-sized office)

From Midlands delivery offices meeting this criteria, 20 offices having notably high or low accident-incidence rates (for both non-lost time and lost-time
accidents - based on aggregated accident figures for the previous two years for all accident types) were selected for inclusion in the study. Accident incidence rates were calculated by aggregating the total reported accidents for the previous two years, dividing by the number of PDO in post at the office and multiplying by 1000. The 10 HAO had incidence rates at least twice as great as the 10 LAO.

Table 6.3 shows accident-incidence categories, staff profile categories (actual figures cannot be given because of the need for anonymity) and the proportion of walks affected by adverse weather for the 20 offices included in the study.

The main observations from these data are:

1. DOM of low accident rate offices (LAO) had, on average, been in post longer than DOM from high rate offices (HAO). However, most of this difference was due to one LAO where the DOM had been in post for over 10 years.

2. No differences were observed for the proportion of female PDO in post.

3. No notable differences were observed for the proportion of PDO over the age of 45 years or under 26 years.

4. No differences were observed between HAO and LAO for the proportion of delivery walks affected by adverse weather conditions.

5. A notable difference (n.s.) was observed between the proportion of PDO estimated by DOM and their support managers to carry their mail pouch around walks.

The extent to which observations four and five above were accurate is uncertain, as these figures were based solely on estimations from DOM and their assistants. The above measures were taken in order to match offices on as many criteria as possible to increase confidence that large differences in accident-incidence rates would be influenced by DOMs' use of management safety practices.
Table 6.3 Accident-incidence rates, staff profiles and walks affected by adverse weather for study delivery offices

<table>
<thead>
<tr>
<th>Office (case no.)</th>
<th>Accident incidence category (accidents per 1000 PDO)</th>
<th>DOM time in post category (years)</th>
<th>No. of PDO in post category (%)</th>
<th>Female PDO (%)</th>
<th>PDO under 26 (%)</th>
<th>PDO over 45 (%)</th>
<th>Delivery walks weather affected (%)</th>
<th>PDO who carry pouch (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>low 1</td>
<td>0 - 300</td>
<td>0-2</td>
<td>0-50</td>
<td>13</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>low 2</td>
<td>0 - 300</td>
<td>0-2</td>
<td>0-50</td>
<td>0</td>
<td>20</td>
<td>10</td>
<td>40</td>
<td>95</td>
</tr>
<tr>
<td>low 3</td>
<td>0 - 400</td>
<td>10+</td>
<td>0-50</td>
<td>18</td>
<td>20</td>
<td>30</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>low 4</td>
<td>0 - 400</td>
<td>3-5</td>
<td>0-50</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>low 5</td>
<td>0 - 400</td>
<td>3-5</td>
<td>51-100</td>
<td>8</td>
<td>4</td>
<td>24</td>
<td>10</td>
<td>70</td>
</tr>
<tr>
<td>low 6</td>
<td>0 - 400</td>
<td>6-10</td>
<td>0-50</td>
<td>17</td>
<td>17</td>
<td>21</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>low 7</td>
<td>0 - 400</td>
<td>3-5</td>
<td>51-100</td>
<td>33</td>
<td>8</td>
<td>20</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>low 8</td>
<td>0 - 500</td>
<td>0-2</td>
<td>101-150</td>
<td>10</td>
<td>30</td>
<td>50</td>
<td>20</td>
<td>90</td>
</tr>
<tr>
<td>low 9</td>
<td>0 - 500</td>
<td>0-2</td>
<td>101-150</td>
<td>13</td>
<td>12</td>
<td>20</td>
<td>15</td>
<td>70</td>
</tr>
<tr>
<td>low 10</td>
<td>0 - 500</td>
<td>3-5</td>
<td>0-50</td>
<td>6</td>
<td>4</td>
<td>30</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td>Mean</td>
<td>376</td>
<td>4.2</td>
<td>65.5</td>
<td>14.3</td>
<td>14.0</td>
<td>23.0</td>
<td>19</td>
<td>56</td>
</tr>
<tr>
<td>s.d.</td>
<td>91.0</td>
<td>4.0</td>
<td>42.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high 1</td>
<td>900 +</td>
<td>3-5</td>
<td>51-100</td>
<td>3</td>
<td>10</td>
<td>25</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td>high 2</td>
<td>900 +</td>
<td>0-2</td>
<td>0-50</td>
<td>29</td>
<td>35</td>
<td>28</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>high 3</td>
<td>900 +</td>
<td>3-5</td>
<td>101-150</td>
<td>20</td>
<td>16</td>
<td>28</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>high 4</td>
<td>900 +</td>
<td>0-2</td>
<td>51-100</td>
<td>40</td>
<td>20</td>
<td>15</td>
<td>15</td>
<td>80</td>
</tr>
<tr>
<td>high 5</td>
<td>900 +</td>
<td>3-5</td>
<td>0-50</td>
<td>5</td>
<td>10</td>
<td>12</td>
<td>20</td>
<td>95</td>
</tr>
<tr>
<td>high 6</td>
<td>1000 +</td>
<td>0-2</td>
<td>51-100</td>
<td>2</td>
<td>40</td>
<td>30</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td>high 7</td>
<td>1000 +</td>
<td>0-2</td>
<td>0-50</td>
<td>2</td>
<td>5</td>
<td>15</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>high 8</td>
<td>1000 +</td>
<td>3-5</td>
<td>51-100</td>
<td>6</td>
<td>20</td>
<td>18</td>
<td>15</td>
<td>95</td>
</tr>
<tr>
<td>high 9</td>
<td>1200 +</td>
<td>0-2</td>
<td>0-50</td>
<td>25</td>
<td>5</td>
<td>5</td>
<td>35</td>
<td>85</td>
</tr>
<tr>
<td>high 10</td>
<td>1200 +</td>
<td>3-5</td>
<td>101-150</td>
<td>10</td>
<td>17</td>
<td>40</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Mean</td>
<td>1030</td>
<td>2.6</td>
<td>70.1</td>
<td>14.2</td>
<td>17.8</td>
<td>21.6</td>
<td>18</td>
<td>70.5</td>
</tr>
<tr>
<td>s.d.</td>
<td>146.1</td>
<td>1.05</td>
<td>38.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.3 Phase one results: 'Desirable' DOM safety-related practices

6.3.1 'Desirable’ DOM safety-related practices

From the methods outlined in section 6.2.2 a list of 'desirable' DOM safety-related practices was produced and is presented in table 6.4. Management safety practices are presented under five headings: accident investigation and prevention, adverse weather practice, safety communications and supervision, hazard management, and equipment and uniform management. The list of 'desirable' safety practices was used to produce the interview schedule for measuring the use of 'desirable' safety practices by DOM of LAO and HAO in phase two of the study.

Table 6.4 'Desirable' DOM safety-related activities

<table>
<thead>
<tr>
<th>DOM safety-related practice</th>
<th>Specific examples of 'desirable' practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accident investigation and follow-up prevention activity</td>
<td>DOM personally investigates all reported accidents</td>
</tr>
<tr>
<td></td>
<td>Accident investigation is thorough:</td>
</tr>
<tr>
<td></td>
<td>* accident-involved employee and witness are interviewed</td>
</tr>
<tr>
<td></td>
<td>* DOM visits site of accident</td>
</tr>
<tr>
<td></td>
<td>* DOM identifies all contributory factors</td>
</tr>
<tr>
<td></td>
<td>DOM takes necessary follow-up preventive action (e.g. contacts persons responsible for hazard, provides necessary equipment, etc.)</td>
</tr>
<tr>
<td></td>
<td>DOM shares outcome of investigation and follow-up prevention with PDO in team briefings</td>
</tr>
<tr>
<td>Adverse weather practice</td>
<td>DOM takes action to protect PDO from increased risk of injury during periods of adverse weather:</td>
</tr>
<tr>
<td></td>
<td>* reduce PDO exposure to adverse conditions (e.g. withhold staff until conditions improve/cancel 2nd deliveries)</td>
</tr>
<tr>
<td></td>
<td>* provide transport assistance to start of delivery walk where required (e.g. where delivery walk is a long distance from office)</td>
</tr>
<tr>
<td></td>
<td>* heavy mail items by van/not by foot</td>
</tr>
<tr>
<td></td>
<td>* safety equipment/clothing supplied for winter working</td>
</tr>
<tr>
<td></td>
<td>* special briefings</td>
</tr>
<tr>
<td><strong>Safety communications and supervision</strong></td>
<td><em>table 6.4 continued</em></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Daily contact between DOM and PDO on safety and other job-related matters</td>
<td></td>
</tr>
<tr>
<td>Regular safety-focused team-briefings</td>
<td></td>
</tr>
<tr>
<td>Display of safety campaign materials</td>
<td></td>
</tr>
<tr>
<td>Informal safety advice</td>
<td></td>
</tr>
<tr>
<td>DOM operates an open door policy</td>
<td></td>
</tr>
<tr>
<td>Involvement of senior management (e.g. safety tours), and high priority of safety in meetings between management</td>
<td></td>
</tr>
<tr>
<td>DOM alerts PDO to instances of unsafe practice/behaviour</td>
<td></td>
</tr>
<tr>
<td>DOM undertakes off-site safety inspections</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Hazard management</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DOM encourages reporting of hazards by delivery staff</td>
<td></td>
</tr>
<tr>
<td>Hazards are recorded appropriately (i.e. hazard cards, 'walk logs')</td>
<td></td>
</tr>
<tr>
<td>DOM takes action to remove 'avoidable' environmental hazards</td>
<td></td>
</tr>
<tr>
<td>DOM undertakes regular office safety tours</td>
<td></td>
</tr>
<tr>
<td>DOM shares the outcome of hazard reporting and removal efforts with staff</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Equipment and uniform management</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DOM replaces footwear as required (e.g. due to damage or wear)</td>
<td></td>
</tr>
<tr>
<td>Snow chains and other protective equipment available to PDO/DOM explains need for use, etc.</td>
<td></td>
</tr>
<tr>
<td>DOM undertakes pouch weighing exercises</td>
<td></td>
</tr>
<tr>
<td>DOM arranges additional pouch 'drop points' en route where necessary to reduce pouch weight</td>
<td></td>
</tr>
<tr>
<td>DOM encourages PDO to use alternative delivery methods to manual pouch carriage where possible (i.e. trolleys/cycles)</td>
<td></td>
</tr>
<tr>
<td>DOM demonstrates correct use of delivery office equipment (e.g. lifting and handling)</td>
<td></td>
</tr>
</tbody>
</table>
6.3.2 Factors affecting use of safety practices by DOM

Senior managers, DOM and senior safety personnel were asked to suggest factors which they believed affected DOMs' use of the 'desirable' safety practices listed in table 6.4. Factors respondents believed affected use of safety practices by DOM included:

* DOM's knowledge of 'desirable' management safety practices
* DOM's training in areas of safety management
* time constraints/workload
* budget constraints
* non-compatibility with quality considerations
* non-compatibility with business policy
* non-availability and slow supply of safety equipment and footwear

The role of these factors in DOMs' use of 'desirable' safety practices was considered in the interviews with DOM from LAO and HAO in phase two of the study.

6.4 Phase two results: use of 'desirable' safety practices by managers of high and low accident-incidence rate postal delivery offices

The findings for phase two of the study are presented under headings related to the 'desirable' management safety practices identified in phase one of the study: accident investigation and reporting, adverse weather practice, safety communications and supervision, hazard management, safety equipment and uniform management. Outlines of interview questions and key findings are followed by short discussions.

6.4.1 Accident investigation and reporting

6.4.1.1 Interview questions

DOM were asked a number of questions related to accident investigations undertaken at their delivery office:

i) Under what circumstances do you interview the accident-involved employee (e.g. only in cases where absence from work is required, all reported accidents, etc.)?
ii) Under what circumstances do you inspect the accident site as part of your investigation (e.g. accidents within delivery office only, all accidents, injury producing accidents only, etc.)?

iii) Under what circumstances do you take action to reduce the risk of a similar accident happening in the future?

iiiia) Under what circumstances do you take action to reduce the risk of a similar accident happening in the future?

iiiib) What remedial action do you take (e.g. visit householder, write to council, provide necessary equipment, etc.)?

iv) Do you use examples of accidents you have investigated in team briefs?

In addition, DOM were asked to describe the process of accident investigation undertaken by themselves or their operations managers, using examples from recent accidents investigated. This was done to help validate DOMs' responses to the above questions (i-iv). Finally, DOM were asked whether they had attended an accident reporting training course or workshop, and whether they believed their training in accident reporting to be adequate.

6.4.1.2 Key findings from interviews

i) All 20 DOM reported interviewing the accident-involved employee prior to completing the manager's report form. No DOM reported copying the statement of events from the employee's report rather than interviewing the employee.

ii) More DOM from LAO reported always inspecting the accident site as part of their investigation. This was true both for accidents occurring within the delivery office and yard (LAO = 9/10; HAO = 6/10) and outside the delivery office (LAO = 5/10; HAO = 1/10). The main circumstances under which DOM did not inspect the accident site were where the hazard involved was weather related, where no specific hazard had been reported by the accident-involved employee, and where time did not allow such an activity (e.g. where the accident took place away from the delivery office).

iii) More DOM from LAO reported always taking action to reduce the risk of a similar accident occurring (telling staff to 'take more care in
further' was not alone considered a preventive action (LAO = 8/10; HAO = 5/10). Preventive action typically taken included visiting the householder or a telephone call or letter to the local council, removing or guarding a hazard situated within the delivery office or yard, or providing training or a demonstration of correct working methods to staff.

iv) DOM from LAO more often reported using examples from accidents at their offices in team briefs (LAO = 8/10; HAO = 4/10).

v) Few DOM reported having attended an accident reporting training course or workshop (LAO = 3/10; HAO = 4/10).

vi) DOM from low accident rate offices more often reported their training in accident investigation and reporting to be adequate (LAO = 7/10; HAO = 4/10) (note, training in this context was understood as written instructions for undertaking accident investigations and reporting accidents).

6.4.1.3 Criteria for the analysis of accident reports
Employee and manager accident report forms were examined for each delivery office in the survey. Report forms completed during different periods of the year (1996/7) and pertaining to four different accident types (non-vehicle) were examined. All reports related to non-serious, lost-time accidents. The following criteria were used to assess the quality of managers' report forms:

i) number of words in 'describe the accident and causes' box

ii) contributory risk factors identified (whether primary hazard only or hazard plus additional factors such as behaviour or environmental conditions)

iii) additional information on manager's report form to that provided on employee's form about accident circumstances

iv) inspection of accident site (determined by whether manager ticked box asking if site inspected, or mentioned visiting the site elsewhere in the report)
v) action to prevent similar accident (any information given in the relevant box other than 'advised employee to take more care')

vi) overall evidence of investigation (based on manager's overall completion of form - e.g. completing all relevant boxes, and each of the above categories, i-v).

Table 6.5 provides a summary of findings from the analysis of accident report forms completed by DOM from the 10 LAO and 10 HAO. Four accident report forms were examined for each office. The table entries show the number of words used in the accident description box, the number of reports for each DOM (out of 4) in which risk factors other than primary hazard were identified, information additional to that provided in the employee's report, preventive action reported, accident site inspected and overall evidence of an investigation.

6.4.1.4 Key findings from the analysis of accident reports

i) DOM from LAO used more words (n.s.) to complete their account of accident circumstances and causes.

ii) DOM from LAO more often identified contributory risk factors (other than the primary hazard) in their account of accident circumstances (n.s.). These typically included the accident-involved employee's behaviour (e.g. lifting method or rushing), and environmental conditions (e.g. lighting or conditions underfoot).

iii) DOM from LAO more often provided additional information on their report form than was given by the employee. However, the overall performance of DOM was poor in this respect, with additional information about accident events and causes being provided by the DOM in just 14 of the 80 reports examined. A major reason for DOM failing to provide additional information as a result of their interviews with accident-involved staff was their propensity to simply copy the employee's account of the accident from the employee's report. It is noted this finding is at odds with DOMs' responses in the telephone interviews (see 6.4.1.2-i).
<table>
<thead>
<tr>
<th>LAO</th>
<th>No of words in accident description</th>
<th>Non-hazard risk factors identified</th>
<th>Additiona-</th>
<th>Preventive action reported</th>
<th>Inspected accident site</th>
<th>Overall evidence of investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>l info in DOM form</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>29</td>
<td>4/4</td>
<td>2/4</td>
<td>4/4</td>
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<td>29</td>
<td>2/4</td>
<td>1/4</td>
<td>1/4</td>
<td>2/4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Totals</td>
<td>mean = 27.6</td>
<td>21/40</td>
<td>10/40</td>
<td>22/40</td>
<td>17/40</td>
</tr>
<tr>
<td></td>
<td>s.d. = 11.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>HAO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>38</td>
<td>2/4</td>
<td>1/4</td>
<td>4/4</td>
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<td>31</td>
<td>2/4</td>
<td>0/4</td>
<td>2/4</td>
<td>0/4</td>
<td>0/4</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>1/4</td>
<td>1/4</td>
<td>4/4</td>
<td>0/4</td>
<td>1/4</td>
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<td>18</td>
<td>1/4</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>2/4</td>
<td>1/4</td>
<td>3/4</td>
<td>1/4</td>
<td>2/4</td>
</tr>
<tr>
<td>9</td>
<td>23</td>
<td>1/4</td>
<td>0/4</td>
<td>2/4</td>
<td>0/4</td>
<td>1/4</td>
</tr>
<tr>
<td>10</td>
<td>19</td>
<td>1/4</td>
<td>0/4</td>
<td>1/4</td>
<td>0/4</td>
<td>0/4</td>
</tr>
<tr>
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<td>Totals</td>
<td>mean = 23.7</td>
<td>13/40</td>
<td>4/40</td>
<td>20/40</td>
<td>3/40</td>
</tr>
<tr>
<td></td>
<td>s.d. = 7.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8/40</td>
</tr>
</tbody>
</table>

iv) DOM from LAO more often inspected the accident site (for each office accident reports pertaining to an equal amount of indoor/ outdoor accidents - 1 indoor/3 outdoor - were included to control for convenience of inspection). A small number of DOM
reported taking photographs of unsafe conditions such as raised or broken paving for Royal Mail records and for evidence to present to the local council or householders, businesses, etc.

v) DOM from LAO were more often rated as providing evidence of a thorough accident investigation, as measured by the overall report, including whether all relevant boxes were completed and whether accident contributory factors were identified, etc.

vi) There was little difference in the propensity for DOM to take action to prevent a similar accident occurring. However managers from HAO more often restricted their action to providing specific advice on work practices and safety, and less often took steps to remove hazards such as contacting householders or the council.

6.4.1.5 Discussion of DOMs' accident investigation and reporting

i) The overall quality of investigation appears to be poor, particularly failure to inspect the accident site, to provide a detailed account of accident circumstances and to report preventive measures. These findings suggest Royal Mail managers fall well below the standards recommended by the Health and Safety Executive (see 6.1.1).

ii) DOM from LAO were found to undertake more thorough investigations and more often take action to remove hazards. This may help promote a better safety climate within offices, and discourage the false reporting of accidents on delivery (particularly where the accident site is inspected and other efforts made to verify the employee's account).

iii) The practice of using examples from local accidents in team briefs to illustrate risks is used more often by DOM in LAO. A number of DOM reported this method of safety communication to be the most effective way of promoting safety awareness amongst their delivery staff.

iv) Additional information regarding accident circumstances was provided in only 14 from a total of 80 of DOM accident report forms. This finding did not support the interview responses of DOM, all of
whom argued they interviewed the accident-involved employee, rather than copied the employee's accident report, prior to completing the manager's report.

v) Other findings from the analysis of accident report forms do appear to support interview findings, suggesting DOM from LAO more often undertake thorough accident investigations, and take necessary remedial measures.

6.4.2 Adverse weather practice

6.4.2.1 Interview questions: changes to normal working practices during adverse winter weather

In the absence of any well defined or widely adopted business policy for practice during adverse weather, the study attempted to identify local practices used by DOM to provide protection to employees. The interview survey was undertaken approximately 2 weeks after severe winter weather conditions were experienced in most areas of the Midlands division. DOM were asked to describe the conditions, how long unsafe conditions affected their area, and any changes made to normal working practice during this period to help reduce the risk to PDO.

6.4.2.2 Key findings

Table 6.6 shows changes to normal working practice by DOM from LAO and HAO during periods of severe weather in January 1997 (reported range of period of severe conditions affecting survey offices = 2-21 days).

i) The condition noted by managers to be most problematic for their delivery employees was ice which followed the initial snow fall. It was noted that snow chains were useless in these conditions, and PDO complained of slipping regularly. Cycle deliveries were particularly dangerous in these conditions, whether cycling or pushing a cycle. DOMs reported that some walks were much more affected by adverse conditions than others. These walks included those to rural areas using vans or cycles, and walks with untreated side roads or steep hills.
Table 6.6. Changes to normal working practices

<table>
<thead>
<tr>
<th>Change to normal practice</th>
<th>DOMs from LAO who made changes (n)</th>
<th>DOMs from HAO who made changes (n)</th>
<th>Total DOMs who made change (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay deliveries until conditions improve</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>'Once over ground' (cancelled 2nd delivery + no return to office)</td>
<td>7</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>Additional time allowed for deliveries</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Transport of cycle and foot PDO to first delivery point (OMV or postbus)</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Heavy mail items by OMV instead of by foot</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Cycles not used in hazardous areas</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>PDO told not to approach any 'risky' delivery points - return mail to office</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>PDO told to break up pouches and extra drops provided</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>No vehicles on affected routes (rural, untreated roads)</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>PDO 'doubled-up' on each affected walk</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DOM personally checked PDO had correct equipment (torches, chains, jackets etc.)</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Consult PDO arriving for work to determine conditions</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Special team briefs (to explain conditions and working changes)</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>

ii) Most common practices during the period of severe weather were:

a) once over the ground - one delivery, usually with PDO not returning to the delivery office
b) special team briefs - explaining the need for care and reason for changes to working practices

c) additional time given to PDO to complete their first delivery (this was made explicit to staff)

d) transport for foot and cycle PDO to start of delivery walks by Post Bus or van.

iii) Only one office delayed deliveries until conditions improved.

iv) There were no notable differences between use of adverse weather practices between DOM of LAO and HAO.

6.4.2.3 DOMs’ ideas for reducing the risk to PDO during severe weather

DOMs were asked to provide ideas for reducing the risk of accidents during severe weather conditions. Suggestions (not listed in table 6.6) included:

i) Improved footwear - walking boots (perhaps kept at office to stop use outside of work and to ensure availability when required)

ii) Alternative to snow chains which can be used on ice (e.g. rubber studs or an overshoe with good grip)

iii) Lightening loads: extra vehicles for transporting loads, more drop points, no heavy loads by foot or cycle

iv) One-off postmark on mail to ask customers to provide safe premises

v) List of ‘casuals’ available to managers for emergency periods

vi) Borrowing PDO from unaffected offices - perhaps to double up rounds

vii) Various training and awareness suggestions.
6.4.2.4 Discussion of findings from analysis of adverse weather practice

i) DOM pointed out some delivery walks were affected to a much greater extent by adverse weather conditions than others. This suggests measures intended to reduce the risk of accidents on days where weather conditions are particularly severe should be focused on those walks known to be most affected by such conditions (e.g. walks with steep hills, rural lanes, cycle deliveries, etc.).

ii) Despite the particularly severe conditions during the period considered by the study, only one DOM delayed deliveries until conditions improved. When asked why PDO were allowed to work in such conditions, the majority of DOM noted they were aware of the additional risk presented by the conditions, but argued the mail must go out at all costs. The practice of cancelling second deliveries, and allowing PDO to travel straight home after the first delivery was used by a majority of DOM. This had the effect of reducing the amount PDO were exposed to hazardous conditions, but meant PDO were working during potentially the most hazardous period of the day, during early morning. In addition, this practice may add to PDO motivation to rush and take risks in order to return home at an early time. A number of DOM took action to reduce exposure of PDO to adverse conditions by transporting PDO to the start of their walks.

6.4.3 Safety communication and supervision

The survey investigated the various methods of safety communication and supervision used by DOM of LAO and HAO.

6.4.3.1 Interview questions

DOM were asked a number of questions related to 'desirable' practice for safety communications and supervision:

i) What level of contact do you have with your PDO?
   - how much time do you spend on the sorting room floor?

ii) How often do you speak to PDO informally about safety matters?
   - what form does this communication take?
iii) How often do you hold safety-focused team briefs?
   - how often is safety material included in briefs?
   - what type of safety material do you use in briefs?
   - do you produce any of your own safety material for briefs?

iv) What other methods are used to present safety information to PDO at your office?

v) Under what circumstances do you bring to the attention of your PDO instances of unsafe behaviour or working practice/discipline PDO regarding use of unsafe behaviour or working practice?

vi) How often do you undertake off-site safety inspections (observation of PDO on delivery)?

6.4.3.2 Key findings
A variety of methods are used at all delivery offices to communicate safety information to PDO. These are discussed below:

i) All DOM reported that either they or their operations managers were on the sorting room floor for the majority of time PDO were within the delivery office.

ii) All DOM reported that they spoke informally to PDO about safety matters in response to observing a task being carried out incorrectly or dangerously, staff obstructing walkways and horseplay, etc. All DOM also reported speaking to PDO informally about weather conditions. This informal communication usually took place as the manager walked the sorting office floor.

iii) DOM from the four best performing offices stressed the importance of continual reminders about safe working, rather than relying solely on team briefs where much information is ignored.

iv) All DOM included safety material in team briefs at least once every two months, while five DOM of LAO and two DOM of HAO included their own safety information in most weekly briefs.
v) Other methods of safety communication employed included:

* letters to PDO from area safety advisors
* poster campaigns
* meetings between safety reps and DOM to discuss staff problems, etc.
* special notice boards for information on hazards
* tours of inspection
* discussion/demonstration of correct handling practices

vi) No DOMs reported undertaking off-site safety observations of PDO (although this had been undertaken by support managers on occasion for non-safety related purposes).

6.4.3.3 Discussion of findings concerning DOMs’ safety communications and supervision practices

i) The most apparent difference in safety management style observed from the interviews was LAO DOMs’ reported propensity to continuously discuss safety matters with their PDO, particularly on the sorting room floor and before PDO left for deliveries. This is in line with published safety literature (e.g. Smith et al, 1978; Smith and Beringer, 1987) which suggests positive contacts and informal communications between supervisors and staff are important in safety performance. For example, Smith and Beringer (1987) note the important role the supervisor has in informal training, reinforcing safety knowledge and skills learned during formal training.

ii) DOM who reported constantly briefing PDO formally and informally about safety matters more often reported staff attitudes to be sensible and safety oriented on the whole. DOM of LAO also reported less frequent use of unsafe behaviour and working practices by their PDO (the two measures were pouch misuse and rushing on delivery), suggesting good safety communication may promote a good safety climate.
6.4.4 Hazard management

6.4.4.1 Interview questions
DOM were questioned about their activities to reduce the risk of accidents to their PDO due to hazards and unsafe conditions. As well as asking specific questions about the DOM's hazard management activities, DOM were asked to provide two examples of where PDO had reported a hazard or unsafe condition (other than dogs) to them and they had taken action to reduce the risk presented by the hazard.

Questions included:

i) Do you encourage PDO to report hazards and unsafe conditions to you?
- how is such reporting encouraged?

ii) Where are hazards documented once reported?

iii) Under what circumstances have you taken action to reduce the risk of a hazard or unsafe condition (other than dogs)?

iv) Describe actions you have taken to reduce the risk presented by hazards or unsafe conditions

v) Describe any other measures you undertake to control hazards or unsafe conditions

vi) Is any feedback provided to PDO following your action to remove hazards?

6.4.4.2 Key findings
i) The majority of DOM (16/20) said outdoor hazards (with the exception of dogs) were rarely or never reported to them by their PDO. The most frequently reported hazards were obstructions and problems gaining access to delivery points due to cars, building works, etc.
ii) Most DOM (15/20) said they encouraged PDO to report hazards to them, while no DOM did this regularly.

iii) Hazards were recorded on hazard cards and in walk logs. Walk logs were completed and up to date in just eight out of 20 offices. Hazard cards were used in 18 of the 20 offices, but DOM believed they were rarely filled out by PDO for hazards other than dogs, and that staff new to a delivery route rarely referred to hazard cards or walk logs to determine hazards on the walk.

iv) Other methods for recording hazards included a special hazard notice board and a 'safety hazard/near-miss reporting book'. Only using these measures was any feedback provided to PDO concerning the DOM's efforts to remove hazards.

v) Eight DOM of LAO and three DOM of HAO argued they always took action to contact the party concerned once hazards were brought to their attention. This action was usually to visit the party concerned, or write or telephone the local council where repair to pavements or roads were required, where repair work in progress was causing PDO problems, and where lighting was in need of repair or was permanently absent. Ten DOM reported taking photographic evidence of damaged pavements or other hazards at some time. A number of DOM had recently been issued with cameras for this purpose.

6.4.4.3 Discussion of findings

i) A major problem appears to be related to PDOs' failure to report hazards encountered on their walks. It is possible this process is considered too time-consuming, or requires too great an effort. In addition, employees may believe DOM are uninterested in hearing about such hazards, and are unlikely to take action to remove 'avoidable' environmental hazards (findings from employee focus groups support this suggestion - see section 4.3.6.5). Action to reduce the risk to PDO from hazards and unsafe conditions is the most visible way in which DOM can demonstrate their concern for PDO safety. In addition, the published literature (e.g. Smith and Beringer, 1987) suggests employee involvement in hazard identification has a positive impact on safety awareness and safe work practices. Based on these
assumptions, it is possible a simple hazard reporting system, requiring DOM to act on reported hazards, might increase reporting rates and improve office safety climate.

6.4.5 Equipment and uniform management

6.4.5.1 Interview questions
i) What footwear is available to your PDO?

ii) On what basis is this footwear supplied/replaced?

iii) Do you encourage PDO to check the condition of their footwear regularly?
   - how and when do you do this?

iv) Did all PDO have snow chains and torches in their possession prior to the winter period (were sufficient quantities held at the office by the DOM)?

v) Is use of safety equipment discussed with PDO in team briefs?

vi) Do you encourage PDO to use alternative methods to manual carriage when delivering mail?
   - what alternative methods?
   - why are alternative methods currently not used?

vii) Are alternative methods of delivery available?

6.4.5.2 Key findings
i) All Royal Mail footwear types were available to PDO at each office in the survey, with the exception of Dr. Martin boots which most DOM believed were not available to PDO. One DOM tried to order boots but was told by stores the employee must provide a special reason why they needed boots, while a second DOM was told boots could be purchased by the employee but not supplied as part of uniform issue. Two DOM of LAO discouraged the use of trainers, while another encouraged PDO to wear alternative footwear to trainers.
ii) Footwear is supplied freely as part of uniform on the basis of one pair per year. All DOM in the survey reported PDO requesting new footwear due to wear prior to the time a new pair were due. Two DOM reported providing free replacement footwear, and a further two DOM reported replacing trainers when worn, but only with shoes (a local agreement). Sixteen of the 20 DOM reported stores refusal to replace worn footwear unless it was faulty or damaged in the first few weeks. Two DOM argued their area safety advisor insisted PDO were entitled to free replacement footwear as required, but stores refused to make replacements.

iii) Two DOM of LAO reported advising PDO to check the condition of their footwear prior to the winter period. This request was made in team briefs.

iv) Thirteen DOM reported they had checked all PDO had snow chains, torches and other relevant equipment in their possession prior to the winter period. Three DOM said this equipment was held in stock and was available when required. Four DOM had not ordered snow chains from stores because their staff refused to wear them.

v) Nine DOM of LAO and six DOM of HAO reported discussing the use of safety equipment in team briefs. Equipment discussed included safety fluorescent jackets, containers, cycles, torches and trolleys.

vi) No DOM attempted to encourage PDO to use alternative methods of delivery to manual pouch carrying. The main reasons for this were the unsuitability of other methods (e.g. trolleys) for the walks where PDO presently carry pouches manually, the extra time other methods might take, and PDO preference for the manual carrying method of delivery. Trolleys and cycles were generally unavailable to PDO who wished to change their method of delivery, but could be provided in the case of pregnancy or back problems.

6.4.5.3 Discussion of findings related to footwear and equipment management

i) The confusion that appears to exist in relation to footwear replacement may contribute to the numbers of PDO working in winter conditions with little or no tread remaining on shoe soling. In addition
to providing superior quality footwear, employees, managers and stores staff need to be aware of the policy for replacement for damaged and worn footwear.

ii) As the quantity of heavy business and advertising mail increases, it may be necessary to introduce alternative delivery methods for foot PDO. No DOM reported making efforts to increase the numbers of PDO using alternative methods of delivery to manual pouch carriage. DOM were reluctant to interfere with the way walks had been designed, and some noted delivery staff preferred to carry pouches as this method was quicker than using trolleys. Managers were aware, however, of the increased risk of back injury and accidents incurred while carrying heavy loads. A number of DOM also noted a large proportion of PDO carried more than one pouch at some point of the day, and many more carried over-weight pouches (see chapters four and five).

6.4.6 *Activities DOM believed to be most effective in promoting good safety performance*

DOMs were asked to describe the activities they undertook which they believed were the most effective in promoting good safety performance. Key activities highlighted by DOM of LAO included:

i) Safety content in each weekly team brief

ii) Discussion of safety issues with individual PDO or small groups to consolidate issues covered in briefs

iii) Providing examples of accidents to PDO in team briefings

iv) Walking the floor and speaking to PDO during sorting or as they leave for deliveries (particularly during adverse weather)

v) Reminding PDO about weight limits - undertaking pouch weighing

vi) 'Open' style of management - employees encouraged to come to manager with any problem
vii) Showing videos with 'high impact'.

Each of these activities relate to forms of safety communication. No DOM mentioned accident investigations, use of adverse weather practices or methods of hazard control, suggesting they may have limited awareness of the importance of these activities. These findings might suggest, however, that safety communications are of primary importance in promoting good safety performance amongst PDO. DOM of HAO also tended to report safety communications activities (usually team briefs) as being most effective in promoting good safety performance.

6.4.7 Factors which DOM believed limited their ability to undertake safety practices

DOM were asked to describe any factors which limited their ability to undertake the various safety related activities they had earlier been questioned about. DOM were presented with a list of possible 'limiting factors' (as identified in phase one of the study) and asked whether each factor affected their ability to undertake safety related practices and, in addition, to provide an example or explanation for their response. DOMs' responses are shown in table 6.7.

Table 6.7. Factors limiting DOMs' ability to undertake 'desirable' safety practice

<table>
<thead>
<tr>
<th>Factor limiting use of 'desirable' safety practice</th>
<th>DOMs reporting factor (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training in/knowledge of health and safety management</td>
<td>9</td>
</tr>
<tr>
<td>Time/workload factors (competing demands)</td>
<td>15</td>
</tr>
<tr>
<td>Cost/budget factors</td>
<td>6</td>
</tr>
<tr>
<td>Non-compatibility with quality considerations</td>
<td>6</td>
</tr>
<tr>
<td>Non-availability of good safety equipment/footwear</td>
<td>14</td>
</tr>
<tr>
<td>PDO indifference towards safety instructions/rushing by PDO</td>
<td>12</td>
</tr>
</tbody>
</table>
Time and workload considerations, poor equipment and PDO non-compliance (due largely to employees' desire to finish work as quickly as possible) were the major limiting factors reported by DOM to effect their use of 'desirable' safety related practices. DOM of LAO and HAO did not differ notably in their reporting of factors affecting their use of 'desirable' safety practices.

6.5 A model of management and organisational factors which may influence delivery office safety performance

Figure 6.1 outlines the role of management and organisational factors which appear to influence delivery office safety performance. Previous chapters (see chapters four and five) have discussed how organisational factors such as business policy may influence PDO attitudes, and their propensity to take risks and adopt unsafe working practices (top half of the model). The findings presented in this chapter suggest the safety attitudes and activities of DOM may also affect delivery office accident performance, both directly, through removal of unsafe conditions (e.g. adverse weather practice, hazard control), and indirectly, through their influence on PDO safety-related attitudes and behaviour (e.g. safety communications and supervision, safety priority of DOM) (bottom half of the model).

6.6 Study limitations

A number of issues should be considered when interpreting the findings of this study. Specifically, the study used a small sample of participants, and relied to a large extent on DOMs' self-reported accounts of behaviour. Moreover, a number of factors, other than DOM safety practice, should be considered as possible explanatory variables when considering differences in delivery office safety performance.

6.6.1 Sample size
The sample of 20 offices was the maximum number available while meeting the requirements outlined in 6.2.3.1. While limiting the opportunity for quantitative analysis, the use of a small sample allowed for an in-depth study of each DOM's safety activities, thereby increasing the validity of the findings.
6.6.2 Managers' self-reported safety practices

It is possible the responses of DOM to questions about their safety practices may have been affected by their desire to appear 'safety conscious' or active to the researcher who was undertaking the interview. In an attempt to ensure DOMs' responses were as honest as possible, the researcher emphasised the
fact that the interview was fully confidential, and the identities of those taking part in the study would not be made known to the management of the Royal Mail. DOM were not informed of their high or low accident rate status, nor were they aware the relative safety performance of participating offices was a consideration of the study. Further efforts to increase the validity of the findings included requiring DOM to provide actual examples of use of safety practices, in addition to answering questions related to their safety activities. The use of follow-up interviews, where additional questions could be asked, allowed the researcher to go back over any statements made concerning DOMs' use of safety practice, and to clear up ambiguities and misunderstandings. The analysis of accident reports allowed the researcher to validate DOMs' accounts of their accident investigations through a secondary source, although this was not possible for the remaining safety practices considered in the study.

6.6.3 Factors other than DOM safety practice which might explain differences in office accident rates

The study attempted to match delivery offices on as many criteria as possible to increase the confidence by which the differences in accident rates between offices could be attributed to DOMs' influence (table 6.3). However, it is possible these differences may, in part, be explained by other factors. The greater use of manual pouch carrying by PDO from HAO is perhaps the most likely variable to impact on delivery office accident rates (although the proportions of PDO carrying pouches manually at each office noted in table 6.3 were based solely on DOMs' estimations). Previous project research (chapters four and five) suggested carrying of heavy mail pouches can increase the risk of STFA as well as chronic back injuries.

DOM and PDO training were also considered by the study. No marked differences in the proportions of DOM of LAO and HAO who had attended training sessions was found (table 6.8), nor had notably larger proportions of PDO from LAO received new-entrant training.

Another factor which might influence delivery office accident rates is whether DOMs' safety performance is assessed by senior management. This was considered in the study. Sixteen of the 20 DOM (8 HAO and 8 LAO) said they were assessed in some way in terms of their safety performance. This assessment took several forms including feedback of monthly or yearly
Table 6.8. Training courses and workshops attended by DOM

<table>
<thead>
<tr>
<th>Course/workshop title</th>
<th>LAO DOM attending training</th>
<th>HAO DOM attending training</th>
<th>Total DOM attending training</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOM induction</td>
<td>5/10</td>
<td>5/10</td>
<td>10/20</td>
</tr>
<tr>
<td>Risk assessment</td>
<td>9/10</td>
<td>8/10</td>
<td>17/20</td>
</tr>
<tr>
<td>Accident reporting</td>
<td>4/10</td>
<td>4/10</td>
<td>8/20</td>
</tr>
<tr>
<td>Safe systems/safety management at work</td>
<td>2/10</td>
<td>5/10</td>
<td>7/20</td>
</tr>
<tr>
<td>Lifting and handling</td>
<td>3/10</td>
<td>9/10</td>
<td>12/20</td>
</tr>
<tr>
<td>Health and safety module</td>
<td>7/10</td>
<td>6/10</td>
<td>13/20</td>
</tr>
</tbody>
</table>

accident figures. DOM were also questioned about the priority their line manager placed on safety compared to other considerations such as quality targets, budgets etc., and the amount of emphasis their line manager put on safety matters (e.g. time spent discussing safety issues in meetings with DOM). No marked differences were found between the responses of DOM of LAO and HAO, suggesting these differences may not contribute to differences in delivery office accident rates for this sample of offices.

6.7 Summary and conclusions

The research presented in this chapter has considered the use of safety practices by local delivery office managers, and the role of DOMs' use of safety practices in delivery office safety performance. A list of 'desirable' management safety practices was produced using a number of methods in phase one of the study. These safety practices were organised under a number of headings: accident investigation and prevention, adverse weather practice, safety communications and supervision, hazard management and equipment and uniform management. In the second phase of the study 20
DOM were questioned about their use of these 'desirable' safety practices, for the purpose of determining the extent of their use, and whether differences existed in their use by DOM of LAO and HAO.

A number of DOM safety practices appear to be particularly important in promoting a good safety performance among PDO. DOM from the best performing delivery offices emphasised the amount of time they spent communicating safety advice and warnings to their PDO, using a variety of methods of communication. The same DOMs reported good safety attitudes and behaviour among their PDO, reinforcing the suggestion that their safety communications are effective. DOM of LAO also undertook more thorough accident investigations, more often identifying accident contributory factors and taking actions to reduce the risk of further accidents. The overall quality of accident investigation and reporting by DOM was poor, however, as were DOMs' hazard management efforts. Protection of PDO during periods of adverse weather was confined to actions which limited the level of disruption to services (first deliveries), and DOM noted delivery walks and areas are unequally affected by adverse conditions. This suggests adverse weather practice should be targeted at those PDO most affected by weather conditions. No DOM encouraged the use of alternative methods of delivery to manual pouch carrying, despite the fact this method was known to increase the risk of injury through accidents and chronic back problems. Factors affecting DOM use of 'desirable' safety practice were also identified. Prominent amongst these were time and workload factors and the availability of suitable footwear and equipment to support PDO.

These findings suggest how delivery office safety performance might be improved through intervention at the role of the local office manager. A number of possible interventions at the level of the DOM are suggested.

These are discussed in detail in chapter seven, and are presented in outline below:

1) Improved accident reporting form which requires managers to document all contributory factors (under various headings), and remedial measures taken.
2) Introduction of an adverse weather policy which involves the use of risk assessment by DOM to determine walks most affected by severe weather conditions and production of an action plan detailing measures to reduce exposure to hazardous conditions of affected PDO.

3) Improved safety communication strategies, particularly informal discussion of safety issues to PDO in the workplace, and staff safety awareness training.

4) A simple hazard control system, providing PDO an easy method by which to report hazards on their walks, and feedback from DOM on action taken in relation to the hazard.

5) Assessment/appraisal of DOM safety performance and safety practice by senior management. DOM incentive to improve delivery office safety performance.
Chapter Seven

INTERVENTION SELECTION, DESIGN AND IMPLEMENTATION

7.1 Introduction

7.1.1 Summary of findings from previous project research and implications for a programme of intervention

Previous chapters have presented findings from studies designed to identify risk factors for STFA occurring during the delivery of mail. Key risk factors are summarised in figure 4.2, and include: slippery underfoot conditions (the primary risk factor), non weather-related hazardous environmental conditions (e.g. tripping hazards, absence of lighting), footwear and equipment, unsafe behaviour and working practices, job and safety training and underlying management and organisational factors. Findings from interviews with STFA-involved postal delivery officers (chapter five) suggested a number of risk factors commonly act together to produce the accident/injury outcome. Typically, behavioural (e.g. unsafe behaviour) and/or footwear or equipment factors interact with the presence of either slippery underfoot conditions or a tripping hazard. Underlying these risks are management and organisational factors. For example, action, or failure to take action, on the part of the local office manager can affect PDO exposure to hazardous working conditions. Organisational-based motivations for PDO to rush and take risks may influence behaviour in the presence of such hazards (see figure 6.1). The large number of diverse risk factors which appear to be implicated in delivery STFA risk suggest no single solution will be likely to markedly impact on accident incidence rates. Rather, a range of safety measures should be targeted both at the level of the individual employee and management.

7.1.2 Outline of research presented in this chapter

This chapter presents an account of how intervention measures designed to impact on delivery STFA were selected and designed, and recommendations made for their implementation. The approach taken in this research was based on the principles that interventions should be research led, designed to impact directly on key STFA risk factors, and the process of selection and
design of a programme of intervention should be participative. The need to involve workers and management at the various stages of any ergonomics study is well recognised (e.g. Haines and McAtamney, 1995; Wilson, 1995). Advantages of such a participative approach include provision of a broad base of experience from which assessment and intervention can be developed, and facilitation of a smooth transition of modified work practices and equipment (Haines and McAtamney, 1995). Ideas produced by PDO during earlier stages of the project (chapter four) contributed to the production of an initial set of intervention ideas. Senior management and safety personnel participated in the selection and design of intervention programmes through focus groups, comment questionnaires and interviews. The main purpose for management involvement in this process was to draw on their knowledge and experience, and to ensure suggested interventions would be suitable for introduction within the specific organisational context of the Royal Mail. It was also recognised organisational investment in any programme of intervention would be dependent on senior management's understanding of the potential benefits of suggested countermeasures (in terms of safety and productivity), and in particular, the economic justification for such measures (see Stubbs, 1992).

The process of intervention selection and design involved a number of stages. Preliminary intervention ideas were based on previous project research and the published literature. The viability of these initial ideas, in terms of the business' experience, current systems and resources, etc., was determined in discussions with senior management and safety personnel. A questionnaire survey of senior safety managers and DOM (the personnel most likely to be responsible for implementing interventions) was undertaken to determine likely impact, management and union resistance and design considerations for suggested interventions. In addition, a focus group of senior safety management considered the feasibility of each intervention, discussing possible impact, compatibility with existing systems, etc. Selection of interventions to be recommended to the Royal Mail was based on this research. Design of selected interventions was based on previous project research, on published literature and consultation with Royal Mail safety and training personnel. Implementation recommendations were made following interviews with senior safety personnel, and were based on the business' resources and readiness for each intervention, and the need to assess the impact of a number of the safety measures.
7.1.3 Aims

i) To determine a range of intervention measures targeted at key delivery STFA risk factors identified in earlier research.

ii) To use a participative methodology for the selection and design of a programme of intervention suitable for introduction within the Royal Mail.

7.2 Methods and results

7.2.1 Preliminary intervention suggestions: matching solutions to key risk factors

Table 7.1 presents the key risk factors identified in chapters three to six, and possible measures to reduce their impact. These possible solutions were derived from a number of sources: the published safety literature, ideas suggested by PDO and managers in earlier project research, through a process of consultation with ergonomics professionals, and through initial consultation with Royal Mail safety personnel.

7.2.2 Discussion of preliminary intervention suggestions with senior management and safety personnel

The intervention suggestions (table 7.1) were presented to a group of Royal Mail senior management and safety personnel (the project committee, see section 1.4.2). The group consisted of seven members, including two directors, senior management and safety managers. Following presentation of the preliminary intervention suggestions, group members were asked to provide their views on the viability of each measure in terms of compatibility with existing management and work systems, previous business' experience of similar measures, resources, union resistance, etc. From these discussions it was possible to determine measures which were likely to lack the support of management and safety personnel, and those which were expected to be successful in the light of previous business experience and existing systems. On the basis of these discussions, a revised set of suggested interventions was produced and presented in a number of forms to management and safety personnel for comment (see 7.2.3 and 7.2.4).
Table 7.1. Key risk factors and possible intervention measures

<table>
<thead>
<tr>
<th>Key risk factors</th>
<th>Intervention suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slippery underfoot conditions: snow, ice, mud</strong></td>
<td>Adverse weather policy (reduce exposure of PDO to adverse conditions)</td>
</tr>
<tr>
<td></td>
<td>Communicate with council, domestic and business customers, re-provision of safe walking areas (e.g. postmark, media campaign)</td>
</tr>
<tr>
<td></td>
<td>Footwear/footwear attachments (e.g. crampons/overshoes)</td>
</tr>
<tr>
<td></td>
<td>Training: skills for working in slippery conditions</td>
</tr>
<tr>
<td><strong>Non-weather related environmental hazards: uneven paving, obstacles, holes in paving, absence of adequate lighting, etc.</strong></td>
<td>Communicate with council, domestic and business customers re-provision of safe walking areas</td>
</tr>
<tr>
<td></td>
<td>Working group with other local services and council - to identify and correct hazards</td>
</tr>
<tr>
<td></td>
<td>Hazard reporting and removal system</td>
</tr>
<tr>
<td></td>
<td>Training: skills for hazard spotting, etc.</td>
</tr>
<tr>
<td><strong>Use of non-slip-resistant footwear</strong></td>
<td>Improved occupational footwear (superior slip-resistance, durability, comfort, etc.)</td>
</tr>
<tr>
<td></td>
<td>Replacement of footwear as required policy</td>
</tr>
</tbody>
</table>
| Ineffective footwear attachments for working in slippery conditions | table 7.1 continued
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Footwear attachments suitable for use on snow and ice (e.g. crampons, studded overshoes)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heavy asymmetric load</th>
<th>Increased use of trolleys to transport mail (redesign trolley so suitable for all terrain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervision/pouch-weighing</td>
<td></td>
</tr>
<tr>
<td>Additional drop points (pouch boxes/cages)</td>
<td></td>
</tr>
<tr>
<td>Heavy mail items not delivered by foot</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unsafe working practice: rushing/short-cuts/entering hazardous areas</th>
<th>Training: safe working practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour modification programme (incentive/feedback related to working safely)</td>
<td></td>
</tr>
<tr>
<td>Improve PDO awareness regarding entry to hazardous delivery points</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reading addresses/sorting mail while walking</th>
<th>Training and behaviour modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trolley/pouch in which mail is organised and presented so PDO does not need to find and separate mail for delivery point - reduce time PDO distracted from environment</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carrying over-weight/ more than one pouch</th>
<th>Training and behaviour modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative delivery methods</td>
<td></td>
</tr>
<tr>
<td>Random pouch weighing/enforce health and safety standard</td>
<td></td>
</tr>
<tr>
<td><strong>On-the-job training (perpetuating use of unsafe working practices)</strong></td>
<td><strong>table 7.1 continued</strong></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Training mentors: experienced PDO as dedicated trainers for new-recruits - to include safe working practices and other job-related instruction</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Absence of safety skills training for delivery work</strong></th>
<th><strong>Training workshops: working in slippery conditions, hazard spotting, safe working practices - participative learning</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Poor accident investigation and prevention by local office managers</strong></th>
<th><strong>Redesigned accident form and reporting system (requires DOM to identify risk factors and remedial measures)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Training workshops (accident investigation and prevention)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Accident investigation included in management safety objectives/appraisal</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Absence of effective hazard control programme</strong></th>
<th><strong>Simple system for reporting hazards and feedback to staff on DOM action</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Absence of procedures to protect PDO in adverse conditions</strong></th>
<th><strong>Adverse weather policy: reduce exposure of PDO to adverse conditions</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Organisational-based motivations to rush and take risks</strong></th>
<th><strong>Behaviour management programme (incentive/feedback related to working safely)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Remove incentive to rush and take risks (i.e. stop 'job and finish' practice, etc.)</strong></td>
</tr>
</tbody>
</table>
7.2.3 Senior safety management intervention comment questionnaire
survey and focus group session

All Divisional Safety Managers from throughout the UK (n=9) were posted an intervention comment questionnaire (appendix E) outlining the revised set of intervention suggestions (see appendix E for outlines of suggested interventions). Nine suggested interventions were included in the questionnaire:

i) Adverse weather practice
ii) Underfoot accidents training workshops
iii) On-the-job training mentors
iv) Goal-setting and feedback for safe working practices
v) Goal-setting and feedback for lost-time accidents
vi) Delivery office manager safety objectives
vii) DOM's accident report form
viii) Delivery staff safety improvement discussion groups
ix) Hazard reporting and feedback form

Footwear-related recommendations were not included in the questionnaire as these had already been accepted by management.

Safety managers were asked to rate each suggested intervention in terms of its likely impact, cost and resistance from management and union (CWU). Ratings were on a scale of 'high', 'medium' and 'low', and respondents were asked to write a sentence in support of each rating response.

A focus group session was held with the safety managers (n=9) who had completed the questionnaire. The meeting lasted approximately 90 minutes, and was scheduled as part of a monthly Divisional Safety Managers' meeting. Each suggested intervention was introduced in turn by the researcher (group moderator), and participants were asked to discuss the interventions in the light of their experience as Royal Mail safety managers. Respondents were able to refer to their completed intervention comment questionnaire during the discussion.

Table 7.2 provides impact, cost and resistance ratings for each suggested intervention, together with a sample of comments made in questionnaires or in the focus group by safety managers. Ratings presented in table 7.2 are overall ratings, based on the combined responses of the nine safety managers.
<table>
<thead>
<tr>
<th>Suggested intervention</th>
<th>Impact rating</th>
<th>Comments: impact</th>
<th>Cost rating</th>
<th>Comments: cost</th>
<th>Resistance rating</th>
<th>Comments: resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverse weather practice</td>
<td>High</td>
<td>The most effective means of reducing slipping risks</td>
<td>Moderate</td>
<td>Overtime costs</td>
<td>Moderate</td>
<td>Management: The fundamental need to deliver mail will override safety risks identified Extra work for managers Possibility for abuse Union: Will be in favour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Will raise safety awareness of staff and managers</td>
<td></td>
<td>Delayed deliveries</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Staff will be aware a viable plan is in place</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Will tie in with current business program of change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underfoot accidents training workshops for PDO</td>
<td>Moderate to high</td>
<td>The course would address a current gap in training</td>
<td>Moderate</td>
<td>The availability of group learning time should keep down costs</td>
<td>Low</td>
<td>Management: Pressure from other sources for group learning sessions (30 minute training slots) Overriding problem of staff attitudes-PDO won't want to know because of the 'job and finish' practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training PDO to work safely in hazardous conditions will be effective only if combined with other measures (e.g. footwear)</td>
<td></td>
<td>Could be prohibitively expensive if taken in very small groups (re-trainer time)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Will raise staff awareness on the issue of safe working</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'On-the-job' training mentors</td>
<td>Moderate</td>
<td>An effective way of increasing the rate of safety training; Ensures all new-recruits get training from the start-its hard to change established behav. Use of an 'office trainer' for manual handling training has worked well in past</td>
<td>Moderate</td>
<td>Would need more than one trainer at large offices - very expensive Training would also need to address non-safety areas to make cost-effective</td>
<td>Moderate</td>
<td>Management: Office coaxes could be difficult to recruit and get released Management/union: Postman doing DOM's work</td>
</tr>
<tr>
<td>Suggested intervention</td>
<td>Impact rating</td>
<td>Comments: impact</td>
<td>Cost rating</td>
<td>Comments: cost</td>
<td>Resistance rating</td>
<td>Comments: resistance</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>----------------</td>
<td>------------------</td>
<td>---------------------</td>
</tr>
</tbody>
</table>
| Goal-setting and feedback/safe work practice | Low | Would link effectively with planned Safety Observation Feedback Tours (SOFT)  
Staff will not take notice of feedback  
Business not ready culturally  
Accidents not necessarily a result of non-compliance with safety rules | Low | Cost of incentives could be a problem - feedback a better option  
Manpower required for measurement | Moderate to high | Management:  
Too much measuring already  
Additional work for DOM  
Union:  
Accidents are not always the result of non-compliance with safe work practices  
Suggests a 'spying' attitude |
| Goal-setting and feedback for lost-time accidents | Low to moderate | Staff will not take notice of feedback  
Business not ready culturally | Low to moderate | Should be self-funding, but money for incentives needs to be budgeted for-cost of incentives (if used) would prove prohibitive  
Feedback only is best -no incentives | High | Management:  
Should not reward staff for avoiding accidents/not reporting accidents  
Union:  
Incentive not to report accidents |
| Delivery Office Manager (DOM) safety objectives | Moderate | Encapsulates the approach the business is currently embarking on  
Should benefit office safety performance if tied to good DOM training  
Will be effective only if objectives are specific and achievable | Low to moderate | DOM time - safety activities will interfere with productivity-related work | Moderate | Management:  
Other demands on DOM re-objectives for budget, quality, etc.  
Incentives will encourage DOM to only cover activities on their objectives  
Big increase in workload for DOM |
<table>
<thead>
<tr>
<th>Suggested intervention</th>
<th>Impact rating</th>
<th>Comments: impact</th>
<th>Cost rating</th>
<th>Comments: cost</th>
<th>Resistance rating</th>
<th>Comments: resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager's accident reporting form</td>
<td>Moderate to high</td>
<td>Will improve the quality of investigations: establish the causes of accidents</td>
<td>Low to moderate</td>
<td>Report form production, piloting, etc.</td>
<td>Low to moderate</td>
<td>Management: Pressures of other work will be cited as reasons for not undertaking investigations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Will raise DOM awareness</td>
<td></td>
<td>Analysis</td>
<td></td>
<td>Managers not adequately trained to conduct investigations and some will resist change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effective remedial measures will be identified</td>
<td></td>
<td>DOM time</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Will help deter 'dubious' reporting</td>
<td></td>
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</tr>
<tr>
<td>Safety improvement focus groups</td>
<td>Moderate</td>
<td>More safety awareness will result from staff involvement</td>
<td>Low</td>
<td>Possible staff over-time(if held outside normal hours)</td>
<td>Low to moderate</td>
<td>Management: Possibly add to DOM's workload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Will demonstrate business' commitment to safety</td>
<td></td>
<td></td>
<td></td>
<td>Problem if no management ownership</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May only be attended by safety-aware staff</td>
<td></td>
<td></td>
<td></td>
<td>Union: PDO may not want to stay after work</td>
</tr>
<tr>
<td>Hazard reporting and feedback form</td>
<td>Moderate to high</td>
<td>Will increase safety awareness</td>
<td>Low</td>
<td>Cost of form development low as already suitable prototype to trial</td>
<td>Low</td>
<td>Management: More work for DOM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Will encourage proactive prevention</td>
<td></td>
<td>Manager's time</td>
<td></td>
<td>Union: Will be in favour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Will provide a direct sign of management's safety concern</td>
<td></td>
<td>Possibly the most economical method of reducing risks</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>System may be under-used</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Local council and householders can't always afford to repair hazard/may not co-operate</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
A brief discussion regarding each of the suggested intervention measures is provided below. Specifically, discussions consider the responses of safety managers to the suggested interventions, and implications for intervention selection, design and implementation.

7.2.3.1 *Adverse weather practice*

Adverse weather practice was the intervention safety managers considered likely to have the highest impact on safety performance for delivery STFA. Respondents believed a national policy for adverse weather was long overdue, and agreed a risk assessment with a well defined action plan was required. The main problem foreseen by respondents was possible management resistance to the practice due to the overriding need to keep the quality of mail delivery as high as possible. Respondents argued suggestions put forward for adverse weather practice should be incorporated into the business' 'adverse weather policy' document which had been produced as a response to earlier findings from this project (chapters 3, 4 and 5).

7.2.3.2 *Underfoot accidents training workshops for postal delivery staff*

The training workshops were rated by most safety managers to have a moderate likely impact on delivery STFA incidence. Respondents believed the training workshops were required to fill a gap in existing training, and felt skills training for working in hazardous conditions could impact on accident rates. Respondents were especially eager to employ the active involvement of PDO in training workshops, as similar approaches were found to be successful in raising safety awareness in the past. Respondents noted workshops should take place away from the working environment and be undertaken by trainers, not office managers. It was suggested the course materials be put into Royal Mail format prior to trialing the training workshop program.

7.2.3.3 *On-the-job training mentors*

Safety managers rated the likely impact of on-the-job training mentors as being moderate. Their comments regarding this measure were generally positive and supportive, however. Respondents agreed it was vital to get training right from the outset of an employee's career, as bad habits developed early on were difficult to extinguish later on. Respondents noted this approach to 'on-the-job' training had been used in a similar form elsewhere and had appeared to be successful. Safety managers' main concern
was the high costs which might be incurred where more than one trainer was required at large offices. Respondents believed this training should cover all areas, not just health and safety (this was the intention of the role), and suggested union workplace safety representatives might have a role in undertaking this training. Finally, it was noted trainers/mentors should themselves receive necessary training for the role.

7.2.3.4 Goal-setting and feedback for safe working practices
Safety managers rated goal-setting and feedback for safe working practices as having the least likely impact, with five respondents rating the measure as having a low likely impact. The main reasons for this rating were based on the belief the organisation was not ready for this approach, although respondents saw behavioural management approaches being more readily accepted following the cultural change expected within the business over the coming two years (as a result of other management initiatives). Safety managers also noted this intervention would fit with planned safety observation initiatives (SOFT). Respondents believed union resistance to such an approach would be high. It was decided this intervention would not be included in the initial set of recommendations, but should be considered for later introduction.

7.2.3.5 Goal-setting and feedback for lost-time accidents
Safety managers rated goal-setting and feedback for lost-time accidents as having a low to moderate likely impact. The same reasons were provided for these ratings as for the behaviour modification programme. Union and management resistance was likely to be high as incentives may be seen as rewarding the non-reporting of accidents. It was decided this intervention would not be included in the initial set of recommendations, and not considered for later introduction.

7.2.3.6 Delivery Office Manager (DOM) safety objectives
Safety managers' opinions on the likely impact of DOM safety objectives were split equally between high, moderate and low. Respondents noted this approach fitted well with other management and safety initiatives. Some safety managers were concerned that objectives for other performance measures were not effective, and this type of initiative might be resisted by DOM as it would add significantly to their workload. Measurement of accident performance could be difficult, according to safety managers, as
DOM move between delivery offices regularly. It was noted this initiative should be supported by the provision of necessary training for DOM.

7.2.3.7 Manager's accident report form
The accident investigation and reporting programme received a moderate to high rating from safety managers. Respondents agreed the present quality of investigations (and remedial efforts) was poor, and part of the reason for this was the accident report form, the design of which did not encourage a full investigation. Respondents agreed a revised form should require the manager to identify all contributory factors (under relevant headings) and remedial actions. Respondents were concerned DOM would not find sufficient time to undertake thorough investigations. It was decided consideration should be given to whether all (or lost time only) accidents should be investigated in this manner.

7.2.3.8 Delivery staff safety improvement discussion groups
Safety managers rated the likely impact of safety improvement groups as moderate. Respondents noted greater staff involvement was a positive and required step in improving safety awareness, however. It was suggested this initiative might be included as one of a 'basket of measures' at the manager's disposal. A number of respondents argued the groups might be best employed considering recent accidents rather than general safety issues. All respondents agreed the initiative would quickly tire without efforts to keep the groups 'alive'.

7.2.3.9 Hazard control program: hazard / near-miss reporting and feedback
Safety managers' ratings for impact were split between high and moderate. Respondents all believed this initiative would be a good way of showing management concern for employee safety. However, safety managers warned this approach would only have the right impact on safety awareness and attitude if managers promptly took action and provided quick feedback to PDO. Where a similar form had recently been used in one division there had been problems with underuse due to poor communication between PDO and managers. It was decided the introduction of these forms should be accompanied by publicity encouraging their use and explaining their benefit.
7.2.4 Delivery office manager intervention comment questionnaire

DOMs' views were sought in order research might benefit from their knowledge, and because the majority of intervention measures were designed to be targeted at local office management level. Data described in section 7.2.3 were used to develop a revised set of suggested interventions. A second intervention comment questionnaire was produced to obtain the views of DOM on the revised suggested interventions (appendix F). Two of the interventions included in the safety managers' questionnaire were not included in the DOM questionnaire (goal-setting and feedback programs), in light of the problems expressed with this approach by safety managers.

A sample of DOM (n=30) was selected from a list containing all Royal Mail Midlands office managers, with a similar number of managers selected from each local delivery area within the Midlands division. Managers from various sized delivery offices (in terms of staff in post numbers) were included among respondents. The response rate for the DOM questionnaire was 50% (n=15). This poor response rate was achieved despite follow-up telephone requests to DOM to return completed forms. Respondents' length of service (as an office manager) ranged from 20 months to 14 years (mean=4.3 years). Respondents' ages ranged from 28 to 59 (mean=41.6). One respondent was female.

Respondents were asked to rate each suggested intervention in terms of its likely impact and resistance from management and union. Ratings were on a scale of 'high', 'medium' and 'low', and respondents were asked to write a sentence in support of each rating response. Respondents were asked to comment on their overall opinion of each intervention, and how each measure might be improved.

Table 7.3 provides impact, union resistance and management resistance ratings for each suggested intervention, together with a sample of comments made in questionnaires by DOM. Ratings presented in table 7.3 are overall ratings, based on the combined responses of the 15 DOM.
<table>
<thead>
<tr>
<th>Suggested intervention</th>
<th>Impact rating</th>
<th>Comments: impact</th>
<th>Union resistance rating</th>
<th>Comments: union resistance</th>
<th>Management resistance rating</th>
<th>Comments: management resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverse weather practice</td>
<td>High</td>
<td>A clearly defined policy is urgently needed and will reduce slipping accidents</td>
<td>Low</td>
<td>Union would be in favour</td>
<td>Moderate</td>
<td>Open to abuse, DOM workload</td>
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<tr>
<td></td>
<td></td>
<td>Risk assessment will help managers make the decisions and select appropriate actions</td>
<td></td>
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<td></td>
<td></td>
<td>May not work effectively because need to achieve quality targets</td>
<td></td>
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<tr>
<td>Underfoot accidents training workshops for delivery staff</td>
<td>High</td>
<td>Will raise PDO safety awareness/improve PDO skills</td>
<td>Low</td>
<td>Union would be in favour</td>
<td>Low</td>
<td>OK as long as training managers undertake training-not DOM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The involvement of group discussions should increase the impact</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>It would only reach some staff</td>
<td></td>
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<tr>
<td>'On-the-job' training mentors</td>
<td>High</td>
<td>It is important to train for safety from the start</td>
<td>Moderate</td>
<td>This would only improve on the existing practice (using trained, not untrained mentors)</td>
<td>Low to moderate</td>
<td>Could be expensive to have trainer/s on-site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Employees respond to instruction from experienced colleagues</td>
<td></td>
<td>Unlikely to be union resistance</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>It will be difficult to find volunteers and enthusiasm</td>
<td></td>
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</tr>
<tr>
<td>Suggested intervention</td>
<td>Impact rating</td>
<td>Comments: impact</td>
<td>Union resistance rating</td>
<td>Comments: union resistance rating</td>
<td>Management resistance rating</td>
<td>Comments: management resistance</td>
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<tr>
<td>Delivery Office Manager (DOM) safety objectives</td>
<td>Moderate</td>
<td>The goal (incentive) will be something to go for - it will motivate managers</td>
<td>Low</td>
<td>Unlikely to be union resistance</td>
<td>Moderate</td>
<td>DOMs' workload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitory incentives won't buy safety</td>
<td></td>
<td></td>
<td></td>
<td>Increased pressure on DOM</td>
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<tr>
<td></td>
<td></td>
<td>Managers cannot control the elements (weather accidents)</td>
<td></td>
<td></td>
<td></td>
<td>Already too much measurement</td>
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<tr>
<td></td>
<td></td>
<td>Most accidents happen outside the office - so managers' efforts will not have an impact</td>
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<tr>
<td>Manager's accident reporting form</td>
<td>Moderate to high</td>
<td>It is vital to set a higher standard of accident reporting if accidents are going to be reduced</td>
<td>Low</td>
<td>Unlikely to be union resistance</td>
<td>Moderate</td>
<td>DOMs' workload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training DOM in accident investigation will improve reporting and prevention</td>
<td></td>
<td></td>
<td></td>
<td>Won't have time to visit accident site/take follow-up remedial action</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intervention prior to accidents occurring will be more effective - e.g. near-miss analysis/hazard management</td>
<td></td>
<td></td>
<td></td>
<td>Singleton DOM will have particular problems making time for this</td>
</tr>
<tr>
<td>Suggested intervention</td>
<td>Impact rating</td>
<td>Comments: impact</td>
<td>Union resistance rating</td>
<td>Comments: union resistance rating</td>
<td>Management resistance rating</td>
<td>Comments: management resistance</td>
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<tr>
<td>Safety improvement focus groups</td>
<td>Moderate</td>
<td>More safety awareness will result</td>
<td>Low to moderate</td>
<td>Unions would welcome this, but might be sceptical about management action resulting from group reports</td>
<td>Low</td>
<td>May increase DOM’s workload</td>
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<tr>
<td></td>
<td></td>
<td>Staff involvement in safety is important</td>
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<td></td>
<td></td>
<td>The groups would only get interest from a small fraction of staff (who are already safety conscious)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Keeping staff commitment to this initiative would be a major problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazard reporting and feedback form</td>
<td>Moderate</td>
<td>This intervention would attack accidents prior to incidents occurring - as with near-miss reporting</td>
<td>Low</td>
<td>Unlikely to be union resistance</td>
<td>Low to moderate</td>
<td>Will increase DOM’s workload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Staff can see something being done and will respond to that</td>
<td></td>
<td></td>
<td></td>
<td>Problem if viewed as another 'paper exercise'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DOM’s workload means they may not be able to follow-up reports as quickly as suggested</td>
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</tr>
</tbody>
</table>
A brief discussion regarding each of the suggested interventions is provided below. The discussion considers responses of DOM to suggested interventions, and implications for intervention selection, design and implementation.

7.2.4.1 Adverse weather practice
Like safety managers, DOM believed this intervention would have the greatest impact on safety performance of all suggested interventions. DOM also agreed there was a clear need for this approach, believing it would successfully reduce accidents as long as risk assessments were undertaken correctly, and correct action plans put in place. Respondents were concerned quality of service measures (e.g. 'clear-office') should be suspended on weather affected days, as normal productivity targets could not be met. DOM noted the union would favour this initiative, but care would be necessary to ensure the system was not abused. No changes were made to the design of this intervention as a result of DOMs' responses.

7.2.4.2 Underfoot accidents training workshops for delivery staff
The training workshops were rated to have a high likely impact. DOM agreed with safety managers that this initiative was needed to address a gap in current training. DOM also agreed the sessions should be taken away from the work environment, and be undertaken by trainers rather than DOM. Likely resistance was rated as low for both union and management. No changes were made to the design of this intervention as a result of DOMs' responses.

7.2.4.3 On-the-job training mentors
DOM rated the likely impact of 'on-the-job' training mentors as being moderate to high. Like safety managers, DOM noted it was important to train staff in correct safety practices from the start of their employment. DOMs' main concerns were the potential costs where more than one trainer was required in larger offices. DOM noted periodic visits by mentor to trainee must be maintained and logged. Likely union resistance was rated as moderate. Sources of union resistance were suggested to include: 'CWU will oppose this as with all aspects of 'new way of working', 'selecting staff will be a sticking point', 'postmen doing managers' work'. This measure appears to be thought of as potentially effective and workable by DOM and safety managers.
7.2.4.4 Delivery Office Manager safety objectives
As with safety managers, DOMs' ratings for likely impact were equally split between high, moderate and low, producing a moderate overall score. DOMs' comments supported the view of safety managers that this initiative would be a problem due to the increase in workload for DOM. Resistance from DOM is likely to be high due to additional workload and pressure to achieve other performance targets. As a result of this survey, changes related to the incentive element of this intervention were made.

7.2.4.5 Manager's accident report form
As with safety managers, DOM rated the accident reporting form as having a moderate to high likely impact rating. DOM believed an improved reporting form would encourage thorough investigations, and were in favour of provision of checklists to assist in identifying contributory factors and remedial actions. DOM supported the view of safety managers that this initiative would depend on provision of sufficient time to undertake investigations. Resistance from union was rated as likely to be low (only one DOM did not rate it as low). Likely management resistance was rated as moderate. Reasons for DOMs' ratings for management resistance were all associated with workload and time constraints. No changes were made to the design of this intervention as a result of DOMs' responses.

7.2.4.6 Delivery staff safety improvement discussion groups
DOM rated the likely impact of safety improvement groups as moderate, although there was a diversity of opinion between DOM. DOM agreed with safety managers that greater staff involvement in safety would be effective, but warned about the difficulties of getting staff involved in such initiatives. DOM noted this intervention would only be effective where the DOM had the necessary resources to take action in response to the group's suggestions. From these surveys it was concluded safety improvement groups might be introduced as an optional tool for DOM, rather than a suggested intervention for all delivery offices.

7.2.4.7 Hazard reporting and feedback form
DOM rated the likely impact of this measure as moderate. DOM supported the ideas of a proactive tool to assist in accident prevention, and agreed with safety managers that this measure would raise PDO safety awareness and demonstrate management's concern for safety. The main concern of DOM
was again the increased workload which would result from this intervention. No changes were made to the design of this intervention as a result of DOMs’ responses.

7.2.5 Considerations in the interpretation of findings reported in this study
Findings from the survey presented above have provided important insights into the views of Royal Mail safety and operations management. Caution is needed, however, when interpreting these findings. It is acknowledged the persons surveyed are not fully equipped to judge the extent to which suggested interventions might be successful in reducing delivery STFA incidence. Rather, the purpose of the study was to ensure suggested intervention measures would be successfully introduced within the specific organisational context of the Royal Mail, and that intervention design benefited from the knowledge and experience of Royal Mail personnel.

The extent to which respondents’ ratings reliably measured their actual opinions regarding the suggested interventions is uncertain. However, respondents’ comments in questionnaires and focus groups assisted the researcher in identifying specific issues and problems regarding each proposed intervention. Interviews with senior safety and management personnel allowed further investigation of these issues.

7.3 Recommended intervention programme
Data described in section 7.2 (above) were used in the process of selecting and designing a programme of intervention for the reduction in incidence of STFA during the delivery of mail. The selected interventions were designed to target STFA risks at three levels: slip resistance, exposure to hazardous conditions, and employee behaviour in the face of hazardous conditions. Table 7.4 lists recommended intervention measures and the risks they target.

Considerations in the selection and design of interventions are presented below, along with an outline of intervention content.

7.3.1 Superior occupational footwear
HSE (1995) suggest selection of footwear and soling materials maybe the main means for reducing the slip hazard where employees work in the 'unpredictable' outdoor environment. The provision of slip-resistant
occupational footwear and footwear attachments for use on ice and snow could be interpreted as necessary in meeting the business' responsibilities under Personal Protective Equipment (PPE) Regulations (1992). HSE (1995) argue employees have a duty to provide, free of charge, all necessary PPE, including footwear. They add, 'footwear should be appropriate for the task and floor surface, fit properly and be maintained and renewed as necessary'. The HSE further note the British Standard relating to safety footwear contains no test specification for slip resistance. The employer is advised to 'select footwear with sole material and pattern most suited to the prevailing underfoot conditions'. The organisation must also consider their footwear policy, ensuring it 'clearly establishes responsibilities for provision and wearing of adequate footwear by employees' (HSE, 1985).

<table>
<thead>
<tr>
<th>Key factors</th>
<th>Intervention programme components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip-resistance</td>
<td>1. Superior occupational footwear, suitable for winter use</td>
</tr>
<tr>
<td></td>
<td>2. Improved footwear attachments (specification to be determined-e.g. crampons/overshoes)</td>
</tr>
<tr>
<td>Exposure to hazardous conditions</td>
<td>1. Adverse weather policy</td>
</tr>
<tr>
<td></td>
<td>2. Hazard reporting and feedback form</td>
</tr>
<tr>
<td></td>
<td>3. Improved accident reporting form ('on-line' version ?)</td>
</tr>
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<td></td>
<td>4. DOM safety objectives</td>
</tr>
<tr>
<td>Employee behaviour in the face of</td>
<td>1. Underfoot accidents training workshops</td>
</tr>
<tr>
<td>the face of hazardous conditions</td>
<td>2. 'On-the-job' training mentors</td>
</tr>
<tr>
<td></td>
<td>3. Behaviour modification programme</td>
</tr>
</tbody>
</table>
Some advice regarding choice of soling compound for occupational footwear is provided in the literature. For example, Manning et al (1991) and Manning and Jones (1994) found microcellular polyurethane soling compound to be the most slip-resistant soling material for oily and wet floors. Bruce et al (1986) also found microcellular polyurethane soling to be best suited for walking on icy surfaces.

The need for superior occupational footwear for PDO was recognised following initial findings from project studies reported in chapters three, four and five, and work has been undertaken by the Royal Mail ergonomics consultants to determine specifications for an improved shoe/boot for use during winter working. Suggestions regarding footwear as an output from this project include provision of a walking boot for the winter period, providing superior slip-resistance for icy and wet conditions, and ankle support, and lower cost comfortable shoes or trainers for summer working. The provision of walking boots or slip-resistant shoes for the winter period would be costed on the basis of the new footwear lasting two years, with regular lower-cost footwear used during non-weather affected months.

7.3.2 Footwear attachment for working on snow and ice
A replacement for the snow chain is required to improve slip-resistance when walking on snow and ice. The attachment should be effective on both snow and ice (the snow chains currently provided are effective only in moderately deep snow), and should be comfortable and simple to put on and take off. The published literature offers relatively little in terms of the effectiveness of footwear attachments, although Bruce et al (1986) found crampons (steel studs in a rubber strip) to provide very good slip-resistance on an icy surface. It is anticipated Royal Mail ergonomics consultants will consider the specification and design of this equipment.

7.3.3 Adverse weather policy
The Royal Mail has a duty of care to reduce risks to employees to as low as reasonably practicable (Management of Health and Safety at Work Regulations 1992). However, project research (chapters five and six) suggests DOM do little to reduce PDO exposure to hazardous underfoot conditions during periods of severe weather. It is clear the increased risk of injury to PDO during these periods needs to be addressed by organisational policy.
DOM and PDO have noted some delivery walks are affected to a much greater extent by adverse weather conditions than others. This suggests measures intended to reduce the risk of accidents on days where weather conditions are particularly severe should be focused on those walks known to be most affected by such conditions (e.g. walks with steep hills, rural lanes, cycle routes, etc.). Walks most affected during periods of adverse weather should be identified prior to the winter period, and action plans developed to determine how the DOM will limit risks to PDO who work on these routes.

The following measures were suggested. These were incorporated into the Royal Mail's policy document for adverse weather practice:

- The manager undertakes risk assessment of all walks in co-operation with PDO to determine the extent individual walks are affected by severe weather conditions.

- Risk assessment should provide advice on how the manager should respond to different conditions, and include a well defined action plan detailing lower risk measures for delivering mail on most affected walks.

- These action plans should be drawn up and approved prior to winter period.

- On weather-affected mornings DOM should undertake to determine delivery areas/walks most affected by severe conditions. This may be achieved in a number of ways, including: consultation with incoming PDO (arriving at work) regarding condition of delivery areas, radio reports, telephone information services, etc.

- General changes to working practices for affected offices might include:
  - Postpone deliveries until conditions are acceptable once over the ground (cancel second deliveries)
  - Provisions of transport to start of walk for foot and cycle PDO
  - Heavy items (e.g. magazines) by van
  - PDO not to approach any 'risky' delivery/collection points
  - Additional time for deliveries.
7.3.4 Hazard reporting and feedback form

Published safety literature has highlighted the importance of hazard identification and control in STFA prevention (Buck and Coleman, 1985; HSE, 1985; Marletta, 1991; Leamon, 1992; Woodall and Cox, 1993). Smith and Beringer (1987) point out the involvement of employees in hazard recognition serves to sensitise them to the working environment and motivates safe work practice. Previous project research indicated reporting of hazards encountered on delivery walks by PDO is very limited. Reasons for this reluctance to report hazards on the part of PDO include low expectations of action being taken by management regarding the reported hazard, and absence of a simple system for the reporting and control of hazards. A two-part hazard form (appendix G) was recommended, providing feedback to PDO concerning actions taken by their local office manager in relation to the hazard. Feedback should be provided promptly by managers, who should take the necessary action to remove, guard or otherwise control the hazard (where hazard is within the office environment), or contact the council or customer regarding the hazard (where hazard situated outside office). To support this initiative, PDO should receive special training briefs on hazard spotting and reporting (including unsafe conditions and acts), and managers provided with checklists to assist selection of remedial actions.

7.3.5 DOM accident reporting form

The analysis of accident events and contributory factors is recognised in the published literature as a necessary first step in STFA prevention. Buck and Coleman (1985) stress the importance of gaining sufficient knowledge about STFA within an industry (through accident analysis) to generate an action plan for accident prevention.

The HSE (1985) suggest the following advice on STFA accident investigation:

i) Accidents should be investigated and the information analysed to determine the initiating event and relevant contributory factors

ii) There should be a company procedure for following up the results of such accident investigations with regard to:
   a) rectifying hazards
   b) modifying or amending systems of work
   c) publicising to employees lessons learned
Previous project research (chapter six) found accident investigation, reporting and prevention efforts by DOM to be of a poor standard. Specifically, managers often fail to adequately identify accident contributory factors and take necessary remedial measures. The present accident reporting form requires the manager to write the causes of the accident in a single box. A new accident reporting form is recommended, requiring the manager to document contributory factors under a number of headings (e.g. unsafe conditions, weather, contributory actions, etc.), and note remedial actions taken in relation to each factor identified. It is suggested this approach might be incorporated into any future computer-based 'on-line' system for accident reporting. The following might also be incorporated into any new form/system for accident reporting:

- a checklist of possible contributory factors and remedial actions to guide manager
- manager to visit accident site, provide photo, etc.
- training for managers through workshops
- assessment and feedback of manager's reporting (part of managers' safety objectives?).
- provision of feedback of outcomes of accident investigations to PDO in team briefings.

7.3.6 Delivery office manager safety objectives
Published safety research has demonstrated the importance of the role of supervisor, or supervisory management, in accident prevention. Heinrich (1980) notes industrial management are dependent on supervision for the direct control of worker performance and maintenance of environmental conditions. The supervisor can, from this view, be considered a key-person in accident prevention, having daily contact with workers and the opportunity to control unsafe conditions and acts. Studies which have considered the effectiveness of supervisor safety practices in occupational safety (e.g. Cohen, 1977; Simonds and Shafai-Sahrai, 1977; Smith et al, 1978; Cohen and Cleveland, 1983; Chew, 1988) have found factors such as thorough and frequent accident investigations and frequent positive contacts between
employees and supervisors to be important in a company's safety performance. Smith and Beringer (1987) point out the important role the supervisor has in employee safety training, in the form of 'informal training' to reinforce and maintain skills and knowledge gained during 'formal training'.

Previous project research suggested DOMs' safety-related activity is often limited and of a poor standard (chapter 6). Delivery offices which have very good safety performance figures have DOM who undertake superior safety activity to DOM of offices with poor safety performance.

A major reason for poor safety efforts by DOM appears to be the high perceived priority of other performance-related concerns (quality targets, budgets, etc.). It was suggested the safety performance of DOM should be subject to the same appraisal measures as other productivity-related concerns. For example, a series of safety objectives should be achieved before the DOM can be rewarded (bonuses) for non-safety-related performance achievements (i.e. safety performance as a gateway to other performance-related rewards). These safety-related objectives should be assessed as frequently as feasible by the DOM's manager or safety advisor, and might include:

- safety inspection tours (office and on delivery routes)
- hazard control
- safety communication/safety improvement focus groups
- risk assessments
- accident reporting
- target safety performance (accident-incidence rates)

7.3.7 Underfoot accidents training workshops
Training in skills for safe working in the 'unpredictable' outdoor environment was recommended as part of an overall programme of behavioural and attitudinal change. While a number of papers and publications (e.g. HSE, 1985) suggest training of workers as one of a number of measures for fall
prevention, little published literature is available on the subject. Pater (1985) suggests workers should be educated to prevent falls and to take action to reduce injuries from unpreventable falls. Worker education should involve motivating employees to prevent falls by helping them understand falls can happen to them and the potential costs of falls to the individual and the organisation. Pater further suggests employees are taught visualisation techniques (mental run-through) for 'walking around alert and well-balanced, catching themselves just as they start to slip, using safe falling principles in an unavoidable fall'. Employees should learn to use the head to maintain good balance, use hands to prevent falls (e.g. gripping handrails, balance) and feet for improving balance ('front-wheel walking'). Employees should also learn how to minimise the risk of injury in the event of an unpreventable fall. Safe falling principles include protection of vital areas (head, spine, back, joints), and dispersion of the force of impact (contact ground with large soft tissue areas, controlled physical relaxation) (Pater, 1985).

Project research (chapter five) has suggested unsafe, time-saving, working practices contribute to a majority of delivery STFA. In addition, PDO often fail to hazard-spot (an important requirement for pedestrians) because attention is diverted to the delivery task (i.e. reading letter addresses, sorting through mail, etc.). Research has also shown PDO are not equipped with knowledge or skills necessary to reduce their risk of falls when working in slippery conditions, or to avoid injury following a fall. It was decided each of these key factors should be covered in a series of short training workshop sessions (to fit in with planned 'group learning' time). A plan outlining training needs, objectives, implementation and evaluation was produced in conjunction with Royal Mail safety and training personnel. The training content was based on the training requirements identified in previous research, the suggestions of Pater (1985) described above, and learning principles regularly incorporated into effective training programmes, as described by Glendon and Mc Kenna (1995). These were: motivation and feedback (feedback on performance, quizzes, practice of skills); positive reinforcement (verbal encouragement, quiz performance, etc.); over learning (practising skill until automatic - mental rehearsal of skills); trainee active involvement (discussion sessions, rehearsed actions - mental run-throughs); and learning appropriately from experience (discussion of trainee accidents/near-misses and accident case studies).
Course details and materials were produced by the researcher, with advice from Royal Mail training and safety personnel regarding consistency with existing training formats, etc. Piloting and assessment of training was planned with senior safety management. The impact of the training programme on the knowledge, behaviour and safety performance of a large number of delivery employees is to be assessed. The evaluation is to use before versus after and control versus experimental group comparisons.

7.3.8 'On the job' training mentors
Previous project research (chapter four) suggests many new-recruits rely on 'on-the-job' training, usually with experienced but untrained PDO, for induction to the postal delivery job. There is some evidence this form of training may perpetuate the use of unsafe working practices, as PDO may be taught from the start of their employment to complete their deliveries in as short a time as possible. Specially trained new-recruit training mentors were recommended, to ensure safe practice is taught from the start. As well as instructing new-recruits on safety issues, the mentor would cover other job-related training. Training mentors would be drawn from existing PDO personnel, and would be responsible for mentoring new-recruits assigned to their delivery office. Records of training/mentoring provided to new-recruits should be logged, and the mentor should pay follow-up visits to new-recruits on delivery following initial training.

7.3.9 Behaviour modification programme
Project research has found unsafe working practices to be a key risk factor for delivery STFA. It is also likely unsafe practices and acts are important contributors to other accident types in the Royal Mail. A number of researchers have argued the need to support training and other information and awareness initiatives with motivational programmes (e.g. Saari, 1990; Glendon, 1991). A programme of behaviour modification is suggested in support of the training programme described in 7.3.2.7. The use of incentives and/or feedback have been found to be successful in improving safety conditions and reducing accidents (see McAfee and Winn, 1989 for a critique of the literature). The use of goal-setting and feedback to successfully increase the use of safe behaviour has also been reported in a number of more recent studies (e.g. Cooper et al, 1994; Duff et al, 1994; Laitinen and Ruohomäki, 1996). A suggested programme for behavioural change in respect of unsafe practices and acts involved in both STFA and other accident
types is outlined below. Measures based on observation and recording of safe/unsafe behaviour are recommended, rather than lost-time injuries, as they are considered to be more sensitive and reliable indicators of safety performance (Cooper et al, 1994).

Goal-setting and feedback for safe working practices:

- identification of critical safety behaviours using accident records and in-depth interviews, focus groups, etc.

- measurement of baseline use of safe/unsafe working practices (within and outside office)

- target for improved % safe practice - agreed in meetings with PDO and management/safety management

- sample monitoring of PDO, using checklist of safe practices

- regular feedback to PDO using charts comparing target with actual performance

- DOM discusses performance in relation to target in briefs/letter from safety manager

- achievement of targets could be linked to a group-based money or prize incentive

- self-assessment (monitoring of personal behaviours by PDO) could be used as an alternative to the undertaking of monitoring and feedback by managers/safety personnel (difficult due to remote working location of PDO).

A methodology for assessment of effectiveness of a programme of behaviour modification, similar to that for training workshops, was outlined in conjunction with senior safety management.
7.4 Implementation of the intervention programme

A phased implementation of the various components of the intervention programme was recommended (table 7.5) following further consultation with senior safety managers.

Table 7.5. Phased implementation of intervention programme

<table>
<thead>
<tr>
<th>Phase</th>
<th>Intervention programme components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Short-term</td>
<td>Footwear</td>
</tr>
<tr>
<td>(work commenced)</td>
<td>Adverse weather policy/practice</td>
</tr>
<tr>
<td></td>
<td>Hazard report form</td>
</tr>
<tr>
<td>Medium-term</td>
<td>Footwear attachments for working on snow/ice</td>
</tr>
<tr>
<td>(within 2 years)</td>
<td>Training workshops</td>
</tr>
<tr>
<td></td>
<td>'On-the-job' new-recruit training mentors</td>
</tr>
<tr>
<td></td>
<td>Accident reporting form ('on-line' version ?)</td>
</tr>
<tr>
<td>3 Longer-term</td>
<td>Behaviour modification programme</td>
</tr>
<tr>
<td>(beyond 2 years)</td>
<td>DOM safety objectives</td>
</tr>
</tbody>
</table>

Phase one recommendations required pilot work, but not evaluation studies to assess their impact. Phase one interventions were also considered the most vital in terms of reducing STFA risk. These interventions were therefore recommended for short-term introduction. Assessment of training workshops was planned for the 12 month period following the study, and it was anticipated this intervention would be implemented in the medium-term. The accident reporting form required design, piloting and associated training, and was therefore recommended for medium-term introduction. Behaviour
modification and DOM safety objectives were recommended for longer-term introduction due to the business' current resistance to these measures, and the need for evaluation studies to assess their impact on behaviour and accident performance. Senior safety and management personnel believed these programmes would be more readily accepted by management, unions and staff, following cultural changes expected within the business over the two years following the project.

7.5 Summary and conclusions

A number of countermeasures have been recommended to target the numerous and diverse range of STFA risk factors identified in previous project research. Interventions were research-led, and selected and designed on the basis of published research and ideas and input from all levels of Royal Mail personnel. The involvement of senior management and safety personnel ensured safety measures were suitable for introduction within the organisational context of the Royal Mail.

PDO slipping risk is to be reduced through the supply of footwear providing good slip-resistance, and footwear attachments effective for working on ice and snow. Problems associated with PDO exposure to hazardous conditions are to be addressed using a number of safety measures, including introduction of an adverse weather policy, hazard reporting and feedback cards and an improved system of accident reporting. Finally, training and behaviour modification programmes have been suggested to improve PDO safety practice and work behaviour in the face of hazardous conditions.

Safety measures are to be implemented through a phased introduction, with short-term measures being those designed to have an immediate impact on winter accidents, and interventions requiring evaluation studies to assess their impact being introduced last.

The requirement to adequately evaluate intervention impact on safety performance, and provide economic justification for the proposed measures, was recognised (Purswell and Rumar, 1984; Glendon, 1991; Stubbs, 1992). Intervention trials for training and behaviour modification programmes were planned in outline with senior safety personnel. Methods for piloting and
evaluation of accident reporting forms and hazard forms were also suggested. The potential benefit of other initiatives (in terms of reduced accident-related costs and improvements in quality of service, etc.) were also assessed and presented to the project committee.
8.1 Chapter summary

This chapter provides a summary of project research. Key findings are reviewed in relation to the research aims outlined in chapter one. Next, contributions to knowledge provided by the research are suggested, and possible directions for future research outlined. Lastly, final conclusions are offered.

8.2 A review of key findings in relation to research aims

The general aims of the project were to identify key risk factors for STFA during the delivery of mail, and measures to reduce the incidence and severity of these accidents. These aims were agreed with the project committee at the outset of the project. Within these broad aims, a number of specific research objectives were formulated (section 1.4.1). The following section reviews project findings in relation to these specific objectives, before turning to a brief discussion of project research as it addresses the general research aims.

8.2.1 Employee population groups at greatest risk

The first research objective was to identify employee population groups at greatest risk of incurring STFA and injuries from falls during the delivery of mail. This research was undertaken to provide insights into possible causes of falls among PDO and highlight training needs, rather than to inform future personnel selection strategies (see Brown, 1995).

8.2.1.1 Male and female delivery STFA risk

Previous published STFA research has found males to have an increased risk of occupational STFA (Malmivaara et al, 1993; Leamon and Murphy, 1995). However, men are more likely to work in high STFA risk occupations (e.g. postal services, forestry and transport). Other research suggests females may be more vulnerable to falling in home and leisure situations. Non-
occupational statistics for three Nordic countries, for example, show females to incur higher proportions of STFA than males (Lund, 1984).

From the analysis of in-house accident data (chapter three), female PDO were found to incur significantly higher incidence rates for delivery STFA than their male colleagues. Moreover, female PDO more often required over 3 day and over 21 day absence from work following a fall on delivery, suggesting a greater severity of injury. Largest differences in incidence rates were observed for tripping accidents, with females incurring rates almost 100% greater than male PDO. These findings are useful as they provide evidence of sex differences in STFA risk for male and female employees performing the same task. It is not clear why females should incur such a high incidence of delivery STFA. Possible explanations include: women being more likely to report occupational accidents (although male and female PDO reported the same proportion of non-lost time delivery STFA); lesser strength among female workers due to their smaller stature (Zwerling, 1993) (the postal delivery task is extremely physically demanding); and use of fashion shoes with high heels (most staff wear Royal Mail issued footwear, however).

8.2.1.2 Delivery STFA across employee age groups
It is well known STFA are most prevalent amongst the elderly population (Fothergill, 1995; Leamon and Murphy, 1995). Over 3 day STFA incidence rates have also been found to rise almost linearly against age in UK industry (Buck and Coleman, 1985). A number of studies have found older workers to be more likely to suffer STFA than other accident types (Buck and Coleman, 1985; Cloutier, 1994; Leamon and Murphy, 1995). Incidence rates for injurious falls outside the work setting also appear to rise with age (Malmivaara et al, 1993), while experimental studies have found younger subjects to have superior stability (ability to retain an upright posture against accelerative forces) to older persons (Negata, 1993).

Delivery STFA incidence was found to increase with age for all reported accidents, while the reverse was true for over 3 day injuries alone. This trend is not in line with that of the general working population (Buck and Coleman, 1985). Further analysis in the present study revealed older employees have highest incidence rates for falls on the level (slips and trips on the level), but lowest rates for falls on steps. It is suggested greater experience or reduced
mobility may encourage older PDO to work more slowly and carefully on steps.

In conclusion, delivery STFA risk appears to be related to age and sex, with largest differences observed between male and female PDO. Reasons for these differences in STFA incidence are unclear, although the significant physical demand of the delivery task suggests one possible explanation.

8.2.2 Unsafe behaviour and working practices

The second research objective was to determine the extent to which unsafe behaviour and working practices were involved in STFA during the delivery of mail. Unsafe behaviour may be defined as 'an error or violation committed in the presence of a potential hazard' (Reason, 1992), while unsafe practices refer to potentially hazardous task-related procedures accepted by management and/or workers. The present project employed a variety of accident-independent methods (chapter four) to obtain information about unsafe behaviour and working practices. Having identified a number of possible unsafe behaviours and practices increasing delivery STFA risk, a series of accident follow-up interviews (chapter five) confirmed their involvement in actual STFA and their level of use in everyday working. Two important unsafe behaviours or practices were found to be rushing in slippery conditions and reading letter addresses while walking between delivery points.

8.2.2.1 Rushing in slippery conditions

Rushing, particularly in slippery conditions, was identified from accident independent investigations and accident follow-up interviews as being one of the key factors in delivery STFA risk. The various forms of rushing increasing STFA risk included running, jogging or walking very quickly, skipping or jumping down steps, and taking hazardous short-cuts. The published STFA literature suggests slipping accidents are more likely where the pedestrian is walking quickly (Marletta, 1991). Taking short-cuts across lawns, over walls, down stairways, etc., and entering dangerous walking areas, increases PDOs' exposure to STFA hazards, and subsequent STFA potential. PDO appear to be motivated to rush and take hazardous short-cuts by the incentive of early finish times ('job and finish'), over-time opportunities and the need to complete deliveries within a target time. These, and other
organisational influences on behaviour may be described as psychological precursors to unsafe acts (Reason, 1992).

8.2.2.2 Reading letter addresses while walking
Looking at mail while walking greatly increases the risk of slipping and tripping accidents. PDO also report often walking into objects such as lamp posts and walls while they were preparing mail for the next delivery point. The requirement to check addresses and to visually locate delivery points (see task analysis, figure 1.3) appears to interfere with the task of monitoring the walking surface for potential hazards. In situations where many hazards are present in the environment, and the working environment is uncontrolled and unpredictable, additional demands on information processing may increase the risk of accidents (Saari, 1984; Pheasant, 1992). It is suggested this practice may, to some extent, account for the poor STFA performance of PDO compared to other employees who undertake much of their work walking in public places (e.g. police officers, traffic wardens). Reasons for the use of this practice include time-saving, habit, guarding against missed deliveries (letters posted to wrong address and undelivered mail), and following unfamiliar routes (e.g. when covering for an absent colleague).

8.2.3 Physical and ambient environment
The third research objective was to identify important environmental risk factors. PDO work in an uncontrolled, highly unpredictable and variable environment. Consequently they are exposed to a large number of potentially injurious hazards and unsafe conditions each day. Hazards and underfoot conditions commonly involved in delivery STFA were identified from the accident analysis (chapter three), accident-independent investigations (chapter four) and accident follow-up interviews (chapter five). Slipping was the most common initiating event for delivery STFA. Hazards frequently involved in slipping accidents included ice, snow and wet underfoot conditions. Proportions of STFA involving these hazards were similar to those reported in previous published research (e.g. Andersson and Lagerlöf, 1983; Lund 1984; Manning et al, 1988), and accidents involving snow and ice were found to cluster during short time periods. Snow and ice were particularly hazardous on sloped driveways and steps, and caused PDO to work at slower than normal pace.
Common non-weather related environmental factors include uneven ground, obstacles, kerbs and other abrupt vertical transitions from the walking surface. Many of these hazards could be described as 'avoidable', suggesting efforts to produce safer walking surfaces on householders' property and in public areas might significantly reduce the incidence of delivery STFA. Large numbers of STFA were also found to occur on steps and stairways. Injuries incurred on steps more often required over 3 day absence, suggesting PDO are more likely to fall and to sustain injury on steps than while walking on the level. These findings are in line with those of previous research which has highlighted the particularly high risk of falls on steps and stairways (e.g. Manning et al, 1988; Negata, 1993). Absence of adequate lighting was found to be a factor in a number of accidents investigated using follow-up interviews. PDO also highlighted the risks associated with working in dark environments (e.g. unlit flats, inadequately illuminated steps, etc.) during early winter mornings. These findings are in line with those of Fothergill et al (1995), who found inadequate street lighting may have been a factor in 42 % of falls in public places during darkness.

8.2.4 Footwear and equipment
The forth research objective was to consider the suitability of footwear and equipment for the delivery task, with respect to the risk of delivery STFA. Key factors considered under this heading included PDO footwear, footwear attachments, the mail pouch and methods of delivery.

8.2.4.1 Footwear
PDO are issued with a free pair of shoes each year as part of their uniform entitlement. They are currently offered a choice of trainers, walking shoes and Dr. Martin shoes. Project research found each of these footwear items quickly became worn, offering poor slip-resistance, and being perceived as ineffective protection against slipping by both employees and safety personnel (section 4.3.3.1 and 5.3.3). Confusion over the Royal Mail's footwear replacement policy further increased the number of PDO at risk of slipping due to use of footwear with worn tread in slippery conditions. Footwear supplied to PDO does not appear to comply with the employer's duty to provide all necessary PPE (HSE, 1996).
8.2.4.2 Footwear attachments (snow chains)
PDO are supplied with snow chains for winter working. Research found snow chains to be unpopular with PDO, to be perceived to be useful only in deepish snow (section 4.3.3.2), and to not have been in use by any accident-involved employees at the time of a slip in snow (section 5.3.3). Previous published research has suggested snow chains are particularly hazardous in icy underfoot conditions (Bruce et al, 1982), with crampons providing best traction for walking on ice. Again, Royal Mail may not be in compliance with the rights of employees to necessary PPE.

8.2.4.3 Delivery pouches and delivery methods
The majority of PDO carry their mail manually; mail is contained in a bag (pouch) which is worn on or over one shoulder. Pouches weigh up to 16 kg when full, although research (sections 4.3.3.3 and 5.3.3) found PDO often carry over-weight pouches and more than one pouch at a time. It is unclear what role the carriage of a heavy asymmetric load plays in loss of balance accidents, although PDO in focus groups strongly suggested this practice increased their slipping potential. There is also some evidence in the published literature that load carrying may increase the risk of slipping and loss of balance accidents (Davis, 1983; Myung and Smith, 1997). Further research is required to determine the importance of side load carrying in delivery STFA.

A smaller proportion of PDO use bicycles and trolleys to transport their mail to and about their delivery route. While PDO believed these delivery methods reduce the risk of incurring delivery STFA and back problems, most preferred manual pouch carrying as it is perceived as the quickest delivery method. Moreover, many delivery walks are not suitable for trolley use (e.g. they contain many steps or are situated some distance from the delivery office). Managers appear not to actively encourage use of alternative delivery methods to pouch carrying, and most PDO use the method which has traditionally been assigned to their walk (exceptions are PDO who are pregnant or have back problems).

8.2.5 Management and organisational factors
The fifth research objective was to identify the role of management and organisational factors in delivery STFA risk. Organisational factors were identified from accident-independent investigations (section 4.3.7) and
interviews with accident-involved PDO (section 5.3.4). Management safety practice influencing STFA risk was identified from accident-independent investigations (4.3.6), interviews with accident-involved PDO (5.3.8) and the survey of managers of high and low accident rate delivery officers (chapter six). Management and organisational factors influencing delivery office safety performance are summarised in figure 6.1. It is suggested these factors represent latent failures (Reason, 1992), producing the preconditions for unsafe acts and working practices, and influencing PDO exposure to unsafe working conditions.

8.2.5.1 Organisational factors
Quality of service targets (e.g. 'clear-office policy' and delivery time targets), unequal distribution of workload across the day and week, and the 'job and finish' policy appear to underlie PDO propensity to rush and take risks on delivery. Productivity incentives to office managers (suggesting a low priority of safety in respect of other performance-related concerns), may further underlie the risk to PDO. The supply of inadequate footwear, ambiguous footwear policy, personal protective equipment and training for working in hazardous conditions are the most 'visible' organisational factors influencing delivery STFA risk.

8.2.5.2 Management safety practice
DOM are responsible for a number of safety-related activities which are relevant to delivery STFA prevention. Adverse weather practice (actions to reduce PDO exposure to severe weather conditions) and hazard management are activities which directly influence PDO exposure to hazardous working conditions. Other management safety practice which may influence PDO safety performance include accident investigation and prevention, safety communication and supervision (chapter six).

8.2.6 General project aims

8.2.6.1 Identification of key risk factors for STFA during the delivery of mail
Risk factors for delivery STFA, discussed above, are presented in the ergonomics systems model proposed in figure 8.1. Delivery STFA occur as a result of some mismatch between individual, task and environment system components. The dark line represents the organisational boundary, and organisational influences are shown to underlie other risk factors.
**Extra-organisational influences**
public and council maintenance of walking areas, business and customer requirements, etc.

**Organisational influences**
policies, quality of service targets, safety culture, work-load management, management safety practice, training provision, etc.

**Individual factors**
biographical (sex, age)
behavioural (unsafe acts)
training/safety awareness
information processing
(e.g. hazard perception, attitude, risk-taking, motivation), etc.

**Task and equipment factors**
walking/work pace
carrying loads
task-related
distractions
(e.g. reading letter addresses)
footwear, etc.

**Environmental factors**
slippery underfoot surfaces
uneven/damaged paving
other abrupt vertical transitions
steep hills/sloped drives
steps
lighting, etc.

**Extra-organisational influences**
economic, competition, legislated standards of service, etc.

Figure 8.1. A model for STFA during the delivery of mail
Extra-organisational influences underlie organisational factors, as well as impinging on individual, task and environment factors directly.

8.2.6.2 Identification of interventions to reduce the incidence and severity of delivery STFA

The second general research aim was to identify interventions to reduce the incidence and severity of STFA during the delivery of mail. Recommendations made to the business as an output from this project were selected on the basis of their potential to impact on key risk factors identified above (figures 4.2 and 8.1). Intervention measures were design to target these factors at three levels: slip-resistance, exposure to hazardous conditions, and behaviour in the face of hazardous conditions. A participative approach was taken to intervention selection and design, drawing on the knowledge and experience of managers and employees ('subject matter experts'), and helping to position safety measures successfully within the organisational context of the Royal Mail.

8.3 Contributions to knowledge

The small quantity of articles considering STFA published in the ergonomics and safety literature does not reflect the scale of the STFA problem within industry. This deficit of knowledge regarding the causes of occupational STFA suggests considerable academic research is needed if causes of falls at work and effective countermeasures are to be identified. While much work over the past 15 years has been concerned with the problem of slip resistance and its measurement, relatively few published articles have considered other important STFA factors. Moreover, very few studies were found to be reported in the literature which addressed the problem of STFA within specific high STFA risk industries (e.g. Hoyos and Zimolong, 1988; Nicholson and David, 1985).

The major contribution to knowledge provided by this thesis, therefore, is the provision of data regarding STFA and their causes within a high STFA risk industry. That this data extends beyond the conventional analysis of accident statistics, considering all aspects of the worker-task-environment system (including management and organisational influences), adds further to knowledge. Specific information produced by this thesis on which little or no
other research was found includes: comparison of the relative STFA risk for male and female workers employed in the same industry, and undertaking the same task; an understanding of the role of task-related behaviour in STFA; and the influence of management and organisational factors in ‘everyday’ accidents.

The project also offers a methodological contribution. The use of a variety of accident-centred and accident-independent methods of investigation to determine the role of individual, task-related and environmental factors in delivery STFA, suggests a potentially profitable approach for future research into occupational falls and other ‘everyday’ accidents.

8.4 Directions for future research

This project has raised many questions, and many factors identified as having a possible role in delivery STFA risk have not been fully addressed by project research. This section briefly outlines possible directions for future research.

Firstly, as argued above, there is a need for research looking at causes and countermeasures for STFA occurring in high risk industries. Particular issues worthy of interest from researchers include the role of task-related risks (e.g. load carrying, manual exertion, working practices, etc.) and management and organisational factors.

A large proportion of falls incurred during leisure and work activities occur in public places such as on pavements and roads. The cost of these accidents to society is considerable. Future research might investigate falls among pedestrians (and employees who work in outdoor public areas) to determine the involvement of ‘avoidable’ environmental factors such as inadequate lighting, uneven walking surfaces, obstacles and damaged steps and stairways. This work might build on that undertaken by Fothergill et al (1995), and consider possible measures to reduce the impact of these hazards.

Research undertaken in chapters four and five suggested carriage of a heavy asymmetric load may increase the risk of STFA among PDO. This research relied on PDO reporting their subjective experiences of load carrying, and the role of the load in STFA. Laboratory-based research, considering slipping
during loaded and unloaded conditions, would be a useful accompaniment to research already undertaken. Pilot experimental work considering this and other issues for slipping is currently being undertaken by the Health and Safety Ergonomics Unit at Loughborough University.

A large proportion of delivery STFA occur on snow and ice. PDO are currently issued with snow chains for use in winter conditions, but these footwear attachments are ineffective on ice, and unpopular with delivery staff. Bruce et al (1982) found crampons (rubber with steel studs) to perform very well on icy surfaces. No recent research was found which considered the effectiveness of a range of footwear attachments on ice and snow, however. Research in this area would benefit the Royal Mail, as they look for a suitable alternative to the snow chain.

Finally, a behaviour modification programme has been suggested to impact on the use of unsafe behaviour and work practices by PDO. Previous programmes of this kind have attempted to increase the use of safe behaviour and work practices using goal-setting and feedback strategies (e.g. Cooper et al, 1994; Duff et al, 1994; Laitinen and Ruohomäki, 1996). Employees involved in these programmes worked on construction sites, in mines, and other situations where the monitoring and recording of safety-related behaviour was unproblematic due to worksite location. Little research was found which considered behaviour modification programmes with employees who work in remote and variable locations. One exception was a study by Haines et al (1982), which measured the effectiveness of a behaviour modification intervention for urban transit operators (bus drivers). However, this study included the use of competition and incentives, considered their effect on accident rates rather than behavioural outcomes alone. Further research might look at the effect of training, goal-setting and feedback on the safety performance of employees who work in remote, variable and unsupervised environments, and the use of self-monitoring strategies in conjunction with limited observation for measuring safety-related behaviours.

8.5 Final conclusions

From research undertaken in this project it is concluded risk factors for falls during the delivery of mail are large in number and diverse in nature.
Slippery underfoot conditions, use of footwear with inadequate slip resistance, and unsafe behaviour such as rushing and reading addresses while walking, contribute to a large proportion of delivery STFA. Underlying these risk factors are management and organisational influences. Management safety practices have a direct impact on PDO exposure to hazardous conditions, while organisational-based motivations to rush and take risks (psychological precursors to unsafe acts) stem from the business' policies, practices and quality of service targets. It is clear no single solution will markedly impact on delivery STFA rates. Rather, a range of interventions have been suggested, targeted at increasing slip resistance (footwear and attachments), reducing PDO exposure to hazardous conditions (e.g. severe weather practice), and improving PDO knowledge, awareness and skills for working in hazardous conditions (e.g. training workshops).
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## Appendix A: Coding form for in-house accident data

<table>
<thead>
<tr>
<th>Activity</th>
<th>Code</th>
<th>Fall initiating event</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking on the level</td>
<td>1</td>
<td>Foot slipped</td>
<td>1</td>
</tr>
<tr>
<td>Ascending/descending steps</td>
<td>2</td>
<td>Foot tripped</td>
<td>2</td>
</tr>
<tr>
<td>Climbing in/out of vehicle</td>
<td>3</td>
<td>Missed step</td>
<td>3</td>
</tr>
<tr>
<td>Climbing on/off bike</td>
<td>4</td>
<td>Trod in</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>Stepped on</td>
<td>5</td>
</tr>
<tr>
<td>Unclassified</td>
<td>6</td>
<td>Other</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface condition/hazard</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice</td>
<td>1</td>
</tr>
<tr>
<td>Wet surface (concrete/Tarmac)</td>
<td>2</td>
</tr>
<tr>
<td>Snow</td>
<td>3</td>
</tr>
<tr>
<td>Mud/grass</td>
<td>4</td>
</tr>
<tr>
<td>Loose surface</td>
<td>5</td>
</tr>
<tr>
<td>Uneven ground</td>
<td>6</td>
</tr>
<tr>
<td>Obstacle</td>
<td>7</td>
</tr>
<tr>
<td>Kerb</td>
<td>8</td>
</tr>
<tr>
<td>Wall/fence/gate</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
</tr>
</tbody>
</table>
Appendix B: Coding form for in-house accident reports

Coding form

<table>
<thead>
<tr>
<th>Accident location (general)</th>
<th>Code</th>
<th>Specific location</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private premises (domestic)</td>
<td>1</td>
<td>Road</td>
<td>1</td>
</tr>
<tr>
<td>Public area</td>
<td>2</td>
<td>Pavement</td>
<td>2</td>
</tr>
<tr>
<td>Business premises</td>
<td>3</td>
<td>Driveway</td>
<td>3</td>
</tr>
<tr>
<td>Flats</td>
<td>4</td>
<td>Steps</td>
<td>4</td>
</tr>
<tr>
<td>Royal Mail premises (e.g. yard)</td>
<td>5</td>
<td>Garden</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>Other grassed area</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Code</th>
<th>Hazard</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice</td>
<td>1</td>
<td>Hole in walking surface</td>
<td>7</td>
</tr>
<tr>
<td>Snow</td>
<td>2</td>
<td>Obstacle (temporary)</td>
<td>8</td>
</tr>
<tr>
<td>Mud</td>
<td>3</td>
<td>Steps (where hazard on steps not specified)</td>
<td>9</td>
</tr>
<tr>
<td>Oil</td>
<td>4</td>
<td>Kerb</td>
<td>10</td>
</tr>
<tr>
<td>Uneven ground / paving</td>
<td>5</td>
<td>Other</td>
<td>11</td>
</tr>
<tr>
<td>Wall / fence / gate</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Case information recording form

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Acc. location (general area)</th>
<th>Acc. location (specific area)</th>
<th>Main hazard involved</th>
<th>Other environmental factors</th>
<th>Activity preceding fall</th>
<th>Unsafe behav./ work practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

Short questionnaire (Delivery Office Managers)
Delivery Office Manager Questionnaire

This survey is being carried out by the Health and Safety Ergonomics Unit at Loughborough University.

Your responses will be treated confidentially and are for research purposes only. Please answer all the questions.

When you have completed the questionnaire please return it to Loughborough University in the envelope provided.

Thank you for your help with this research.
Delivery Office Manager Questionnaire

1 Do you feel falling accidents during deliveries are an inevitable consequence of the type of work carried out by postal delivery officers?

YES [ ] NO [ ]

Briefly say why you have answered either YES or NO

________________________________________________________________________

________________________________________________________________________

2 Based on your experience as a Delivery Office Manager, please tell us why you think falling accidents occur during the delivery of mail.

(list up to five reasons)

1 ____________________________________________________________

________________________________________________________________________

________________________________________________________________________

2 ____________________________________________________________

________________________________________________________________________

________________________________________________________________________

3 ____________________________________________________________

________________________________________________________________________

________________________________________________________________________

4 ____________________________________________________________

________________________________________________________________________

________________________________________________________________________

5 ____________________________________________________________

________________________________________________________________________
Describe any actions you have taken in order to reduce the risk of falling accidents among your delivery staff. If none, write 'none'.

(list up to five actions)

1


2


3


4


5
4 Describe any factors which you believe restrict your ability to take action to reduce the risk of falling accidents to your delivery staff.

(list up to five factors)

1. 

2. 

3. 

4. 

5. 
Please list below any ideas you have as to how the Royal Mail could best reduce the incidence of falling accidents occurring during the delivery of mail.

(list up to 6 ideas)

1


2


3


4


5


6
6 Finally, please provide the following information about yourself and your work

a) Your name ____________________________

b) Your delivery office ____________________________

c) Number of postal delivery officers under your supervision ______

d) Length of time as a DOM _____years _____months

e) Your age _____ f) Your sex ______

Thank you for your help with this research. Please return your questionnaire to Loughborough University as soon as you are able, using the envelope provided.
Appendix D

Short questionnaire (Postal Delivery Officers)
Postal Delivery Officer Questionnaire

This survey is being carried out by the Health and Safety Ergonomics Unit at Loughborough University.

Your responses will be treated confidentially and are for research purposes only. Please try and answer all the questions.

When you have completed the questionnaire please seal it in the envelope provided and return it to your manager.

Thank you for your help with this research.
Based on your experience as a postal delivery officer, please tell us why you think falling accidents occur during the delivery of mail.

(list up to five reasons)

1

2

3

4

5
2 Please tell us about anything postmen and women do while on delivery which in your opinion might increase their chances of having a falling accident.

(list up to four actions which might cause falls on delivery)

1

2

3

4

3 Please tell us why you think postmen and women do the things you listed in the last question

(list up to four reasons the above actions are taken)

1

2

3

4
Describe any actions your manager has taken which you believe might reduce the risk of falling accidents occurring during the delivery of mail.

(list up to five actions)

1. 

2. 

3. 

4. 

5. 

Please list any ideas you have as to how the Royal Mail could best reduce the number of falling accidents occurring to postal delivery officers.

(list up to five ideas)

1. 

2. 

3. 

4. 

5. 
6 Have you attended any *talks, team briefs or training* where falling accidents occurring during the delivery of mail were part of the content during the past 12 months?

YES ☐ NO ☐

*(if you answered NO go straight to question 10)*

7 Who gave you this talk or training?

*(tick one box only)*

- Your office manager ☐
- A training manager ☐
- Other ☐ Who? _______________________

8 Approximately how long did this talk or training last? _____ minutes

9 Where did this talk or training take place?

*(tick one box only)*

- At your delivery office ☐
- At a training centre ☐
- Other ☐ Where? _______________________

D5
Finally, please provide us with some information about yourself and your work

a) About how long have you been a postal delivery officer?
   _____ years _____ months

b) How long have you worked on your current walk?
   _____ years _____ months

c) Your sex?  MALE ☐  FEMALE ☐

d) Describe the main area you deliver to
   *(tick one box only)*
   RURAL ☐
   RESIDENTIAL ☐
   TOWN/CITY CENTRE ☐
   OTHER ☐ Describe ____________________

e) Describe your main method of delivery
   *(tick one box only)*
   WALKING (CARRYING POUCH) ☐
   WALKING (USING TROLLEY) ☐
   BICYCLE ☐
   VAN ☐
   OTHER ☐ Describe ____________________

Thank you for your help with this research. Please seal the completed questionnaire in the envelope provided and hand it to your manager as soon as you are able.
Appendix E

Intervention comment questionnaire (Divisional Safety Managers)
DIVISIONAL SAFETY MANAGER QUESTIONNAIRE

Interventions to reduce falls and other accidents occurring during the delivery of mail

Once you have completed this questionnaire, please return it promptly in the envelope provided
Instructions for completion of the questionnaire

1 Read the bullet-point intervention outline at the top of the first page.

2 Give your rating for the likely impact of the intervention described in the outline, in terms of its likely ability to play a role in reducing falls and other delivery accidents. Do this by placing a tick in either the high, moderate or low box (i.e. a tick in the 'high' box indicates you believe the intervention will have a high likely impact on delivery accidents). Please provide a reason for your rating in the space provided below.

3 Provide ratings for likely cost and resistance from management and CWU in the same way.

4 Provide a brief comment on your overall opinion of the intervention in the space provided.

5 Tell us how you feel the intervention might be improved in the space provided.

6 Do the above for the remaining interventions.

Thank you for your help with this research.
SEVERE WEATHER PRACTICE: WALK RISK ASSESSMENT AND ACTION PLAN

- Manager undertakes risk assessment of all walks in co-operation with staff to determine the extent individual walks are affected by severe weather.
- Risk assessment should include a well defined action plan detailing lower risk measures for delivering mail on most affected walks.
- These action plans should be drawn up and approved prior to winter period.
- General changes to working practices for affected offices might include:
  - Once over the ground
  - Transport to start of walk for foot and cycle staff
  - Heavy items (e.g., magazines) by OMV

YOUR VIEWS

Likely impact: High [ ] Medium [ ] Low [ ]
Reason for rating of impact

Likely cost: High [ ] Medium [ ] Low [ ]
Reason for rating of cost

Likely resistance: Management High [ ] Medium [ ] Low [ ]
CWU High [ ] Medium [ ] Low [ ]
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
ON-THE-JOB' TRAINING MENTORS

- experienced, safety aware staff selected and trained locally to be 'on-the-job' trainers
- trainers given management status and pay during training of new recruits
- trainer meets and trains new recruits 'on-the-job' during first few days
- training includes emphasis on using safe working practices, working in adverse conditions and being aware of hazards
- trainer follows up initial training with periodic visits to the trainee on their walk to discuss any problems and check safe practice is being used

YOUR VIEWS

Likely impact: High ☐ Medium ☐ Low ☐
Reason for rating of impact

Likely cost: High ☐ Medium ☐ Low ☐
Reason for rating of cost

Likely resistance: Management High ☐ Medium ☐ Low ☐
CWU High ☐ Medium ☐ Low ☐
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
ACCIDENT INVESTIGATION AND REPORTING: MANAGER’S REPORT FORM

- form requires manager to document contributory factors under several headings (e.g. unsafe conditions, weather, contributory actions, etc.). Participative approach - involvement of as many staff as possible
- form requires manager to document remedial action for each contributory factor
- form includes a checklist of possible contributory factors and remedial actions to guide the manager
- the manager may be required to visit the accident site, provide photos, etc.
- training through workshops

YOUR VIEWS

Likely impact: High □  Medium □  Low □

Reason for rating of impact

Likely cost    High □  Medium □  Low □

Reason for rating of cost

Likely resistance: Management High □  Medium □  Low □

Reason for rating of resistance

Likely resistance: CWU High □  Medium □  Low □

Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
GOAL SETTING AND FEEDBACK FOR SAFE WORKING PRACTICES

- measure baseline use of safe working practices
- target for improved % safe practice-agreed in meetings between staff representatives and safety management
- sample monitoring of staff, using checklist of safe practices
- regular feedback to staff using charts comparing target with actual performance
- DOM discusses performance in relation to targets in briefs
- achievements of targets could be linked to a group-based reward

YOUR VIEWS

Likely impact: High ☐ Medium ☐ Low ☐
Reason for rating of impact

Likely cost High ☐ Medium ☐ Low ☐
Reason for rating of cost

Likely resistance: Management High ☐ Medium ☐ Low ☐
CWU High ☐ Medium ☐ Low ☐
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
GOAL SETTING AND FEEDBACK FOR LOST TIME ACCIDENTS

- target for improved % in local accident rates in meetings between staff representatives and safety management
- chart displayed within the office shows targets along a 12 month time-line
- regular feedback to staff using charts comparing target with actual performance
- DOM discusses performance in relation to targets in briefs
- achievements of targets could be linked to a group-based reward

YOUR VIEWS

Likely impact: High ☐  Medium ☐  Low ☐
Reason for rating of impact

Likely cost High ☐  Medium ☐  Low ☐
Reason for rating of cost

Likely resistance: Management High ☐  Medium ☐  Low ☐
CWU High ☐  Medium ☐  Low ☐
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
DELIVERY OFFICE MANAGER SAFETY OBJECTIVES

- A series of safety-related objectives by which managers are assessed as part of yearly appraisal by DAM.

- Objectives might include:
  - Safety inspection tours (office and on walks)
  - Risk assessments
  - Accident reporting
  - Improved office safety performance

- A money incentive could be provided for successfully meeting objectives.

YOUR VIEWS

Likely impact: High □ Medium □ Low □
Reason for rating of impact

Likely cost: High □ Medium □ Low □
Reason for rating of cost

Likely resistance: Management High □ Medium □ Low □
CWU High □ Medium □ Low □
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
DELIVERY STAFF SAFETY IMPROVEMENT DISCUSSION GROUPS

◆ small groups of staff volunteers meet monthly or bi-monthly to discuss safety-related issues - aims are to produce office safety improvement

◆ the group moderator (perhaps the DOM or Ops manager) produces a report of the group’s output - the DOM acts on local issues and the ASA or DAM feeds back a response promptly to the group detailing actions to be taken by them (if appropriate)

◆ participative approach - involvement of as many staff as possible

YOUR VIEWS

Likely impact:  High □  Medium □  Low □

Reason for rating of impact

Likely cost  High □  Medium □  Low □

Reason for rating of cost

Likely resistance: Management High □  Medium □  Low □  CWU High □  Medium □  Low □

Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
UNDERFOOT ACCIDENTS TRAINING WORKSHOPS FOR DELIVERY STAFF

- a draft course has been prepared already as part of the 'outdoor falls' project
- four half hour training sessions (during group learning time)
- content includes: working in slippery conditions, hazard awareness and safe working practices
- training focuses on awareness and skills training
- sessions end with group discussion of trainees' experiences in relation to the material learned
- refresher briefs, including quizzes to consolidate learning

YOUR VIEWS

Likely impact: High [ ] Medium [ ] Low [ ]
Reason for rating of impact

Likely cost: High [ ] Medium [ ] Low [ ]
Reason for rating of cost

Likely resistance: Management High [ ] Medium [ ] Low [ ]
CWU High [ ] Medium [ ] Low [ ]
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
HAZARD CONTROL PROGRAM: HAZARD REPORTING AND FEEDBACK FORM

- delivery staff receive special training briefs on hazard spotting and reporting (including unsafe conditions and acts)

- employees are encouraged to report hazards to DOM using a two section form; one half completed by employee detailing hazard, one half used to feed back promptly to employee action taken by manager or relevant party (see appendices for example of safety hazard report form)

YOUR VIEWS

Likely impact: High □  Medium □  Low □
Reason for rating of impact

Likely cost: High □  Medium □  Low □
Reason for rating of cost

Likely resistance: Management High □  Medium □  Low □  CWU High □  Medium □  Low □
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
Appendix F

Intervention comment questionnaire (Delivery Office Managers)
DELIVERY OFFICE MANAGER QUESTIONNAIRE

Interventions to reduce falls and other accidents occurring during the delivery of mail

Once you have completed this questionnaire, please return it promptly in the envelope provided
Instructions for completion of the questionnaire

1. Read the bullet-point intervention outline at the top of the first page.

2. Give your rating for the likely impact of the intervention described in the outline, in terms of its likely ability to play a role in reducing falls and other delivery accidents. Do this by placing a tick in either the high, moderate or low box (i.e. a tick in the 'high' box indicates you believe the intervention will have a high likely impact on delivery accidents). Please provide a reason for your rating in the space provided below.

3. Provide ratings for likely resistance from management and CWU in the same way.

4. Provide a brief comment on your overall opinion of the intervention in the space provided.

5. Tell us how you feel the intervention might be improved in the space provided.

6. Do the above for the remaining interventions.

Thank you for your help with this research.
SEVERE WEATHER PRACTICE: WALK RISK ASSESSMENT AND ACTION PLAN

- Manager undertakes risk assessment of all walks in co-operation with staff to determine the extent individual walks are affected by severe weather.

- Risk assessment should include a well defined action plan detailing lower risk measures for delivering mail on most affected walks.

- These action plans should be drawn up and approved prior to the winter period.

- General changes to working practices for affected offices might include:
  - Transport to start of walk for foot and cycle staff
  - Heavy items (e.g., magazines) by OMV

- A well defined, widely adopted business policy for severe weather days should be produced - including suspension of quality targets.

YOUR VIEWS

Likely impact: High □ Medium □ Low □
Reason for rating of impact

Likely resistance (CWU) High □ Medium □ Low □
Reason for rating of resistance

Likely resistance (management) High □ Medium □ Low □
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
UNDERFOOT ACCIDENTS TRAINING WORKSHOPS FOR DELIVERY STAFF

- a draft course has been prepared already as part of the ‘outdoor falls’ project
- four half hour training sessions (during group learning time)
- content includes: working in slippery conditions, hazard awareness and safe working practices
- training focuses on awareness and skills training
- sessions end with group discussion of trainees’ experiences in relation to the material learned
- refresher briefs, including quizzes to consolidate learning

YOUR VIEWS

Likely impact: High ☐ Medium ☐ Low ☐
Reason for rating of impact

Likely resistance (CWU, management) High ☐ Medium ☐ Low ☐
Reason for rating of resistance

Likely resistance (CWU, management) High ☐ Medium ☐ Low ☐
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
‘ON-THE-JOB’ TRAINING MENTORS

- experienced, safety aware staff selected and trained locally to be ‘on-the-job’ trainers
- trainers given management status and pay during training of new recruits
- trainer meets and trains new recruits ‘on-the-job’ during first few days
- training includes emphasis on using safe working practices, working in adverse conditions and being aware of hazards
- trainer follows up initial training with periodic visits to the trainee on their walk to discuss any problems and check safe practice is being used

YOUR VIEWS

Likely impact: High □ Medium □ Low □

Reason for rating of impact

Likely resistance (CWU) High □ Medium □ Low □

Reason for rating of resistance

Likely resistance (management) High □ Medium □ Low □

Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
ACCIDENT INVESTIGATION AND REPORTING: MANAGER'S REPORT FORM

- form requires manager to document contributory factors under several headings (e.g. unsafe conditions, weather, contributory actions, etc.).
  - participative approach - involvement of as many staff as possible
- form requires manager to document remedial action for each contributory factor
- form includes a checklist of possible contributory factors and remedial actions to guide the manager
- the manager may be required to visit the accident site, provide photos, etc.
- training through workshops

YOUR VIEWS

Likely impact: High □ Medium □ Low □

Reason for rating of impact

------------------------------------------------------

Likely resistance (CWU) High □ Medium □ Low □

Reason for rating of resistance

------------------------------------------------------

Likely resistance (Management) High □ Medium □ Low □

Reason for rating of resistance

------------------------------------------------------

Your overall opinion of the intervention measure

------------------------------------------------------

Your ideas about how this intervention might be improved

------------------------------------------------------
DELIVERY OFFICE MANAGER SAFETY OBJECTIVES

- a series of safety-related objectives by which managers are assessed as part of yearly appraisal by DAM

- objectives might include:
  - safety inspection tours (office and on walks)
  - risk assessments
  - accident reporting
  - improved office safety performance

- a money incentive could be provided for successfully meeting objectives

YOUR VIEWS

Likely impact: High□ Medium□ Low□
Reason for rating of impact

Likely resistance (CWU) High□ Medium□ Low□
Reason for rating of resistance

Likely resistance (management) High□ Medium□ Low□
Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
DELIVERY STAFF SAFETY IMPROVEMENT DISCUSSION GROUPS

- small groups of staff volunteers meet monthly or bi-monthly to discuss safety-related issues - aims are to produce office safety improvement
- the group moderator (perhaps the DOM or Ops manager) produces a report of the group’s output - the DOM acts on local issues and the ASA or DAM feeds back a response promptly to the group detailing actions to be taken by them (if appropriate)
- participative approach - involvement of as many staff as possible

YOUR VIEWS

Likely impact: High [ ] Medium [ ] Low [ ]

Reason for rating of impact

Likely resistance (CWU) High [ ] Medium [ ] Low [ ]

Reason for rating of resistance

Likely resistance (Management) High [ ] Medium [ ] Low [ ]

Reason for rating of resistance

Your overall opinion of the intervention measure

Your ideas about how this intervention might be improved
HAZARD CONTROL PROGRAM: HAZARD REPORTING AND FEEDBACK FORM

- Delivery staff receive special training briefs on hazard spotting and reporting (including unsafe conditions and acts).
- Employees are encouraged to report hazards to DOM using a two-section form; one half completed by employee detailing hazard, one half used to feed back promptly to employee action taken by manager or relevant party (see appendices for example of safety hazard report form).

YOUR VIEWS

Likely impact: High □  Medium □  Low □
Reason for rating of impact

------------------------------------------------------

------------------------------------------------------

------------------------------------------------------

Likely resistance (CWU) High □  Medium □  Low □
Reason for rating of resistance

------------------------------------------------------

------------------------------------------------------

------------------------------------------------------

Likely resistance (management)  High □  Medium □  Low □
Reason for rating of resistance

------------------------------------------------------

------------------------------------------------------

------------------------------------------------------

Your overall opinion of the intervention measure

------------------------------------------------------

------------------------------------------------------

------------------------------------------------------

Your ideas about how this intervention might be improved

------------------------------------------------------

------------------------------------------------------
Appendix G

Hazard reporting form
SAFETY HAZARD REPORT
This form should be handed to the relevant Dept/Section or Shift Manager OR, if in doubt, your immediate Manager.

Part A

To: ..........................................................
    (Department/Section/Shift Manager)

From: ..................................................
    (Name) ...........................................
    (section)

I wish to report the following safety hazard:

................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................

Location of hazard:

................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................
................................................................................................................................................................................

Date: ..........................................................
Appendix H

Published papers related to work reported in this thesis
Outdoor falls are the largest cause of accidents and lost time within the delivery function of the Royal Mail. Accident-independent methods of investigation were used to provide data on contributory risk factors for outdoor falls to postal delivery employees. Possible factors identified include the use of unsafe working practices, which appear to be reinforced by rewards associated with reduced task time; use of footwear inappropriate for heavy use and slippery conditions; and the condition of public and private premises.

Introduction

Slips, trips and falls on the level represent an huge cost to industry in terms of lost production, medical and compensation costs, and human suffering. The Health and Safety Executive (HSE) figures for 1992/3 show that slips, trips and falls on the level represent 33% of all major injuries, and 20% of all over three day injuries to employees (HSE 1994). For those industries where a significant number of over three day injuries caused by a slip, trip or fall on the same level were reported to the HSE, the highest incidence rate occurred in postal services and telecommunications. Although the grouping of these two industries in HSE figures makes the picture unclear, it appears that postal services compare badly to other organisations for this type of accident. Postal delivery employees work for up to four hours per day, six days per week, exposed to the variable and unpredictable conditions of weather and waking surfaces. Fovergill (1995), in interviews with fall accident victims who had attended an accident and emergency department, found that potentially avoidable environmental factors such as uneven surfaces and inadequate lighting contributed to more than half of all falls occurring in public places. When the effect of adverse weather conditions is added to these environmental risk factors, it is perhaps unsurprising that outdoor falls represent the largest cause of accident and lost time within the delivery function of the Royal Mail, with outdoor falls representing nearly 30% of all reported accidents and over 36% of all days lost (Bentley and Haslam, 1996).
The aims of this study are to identify possible contributory risk factors for outdoor falls to postal delivery employees, and make recommendations for their removal or reduction.

Methods

Table 1 provides a breakdown of accident-independent methods used in the study and the information collected. The techniques draw on the experience and knowledge of postal delivery employees and managers, who are considered 'subject matter experts'. The information collected was used to produce a description of possible contributory factors for outdoor falls to delivery employees, and to supplement findings of accident-centred methods of investigation such as statistical analysis of accident data and a detailed accident follow-up survey (Bentley and Haslam, 1996).

<table>
<thead>
<tr>
<th>Method</th>
<th>Information collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews with personnel responsible for safety</td>
<td>Training of new recruits; Safety training; Type and quality of equipment and footwear provided; Management safety activities.</td>
</tr>
<tr>
<td>(N=17)</td>
<td></td>
</tr>
<tr>
<td>Discussion groups with postal delivery employees</td>
<td>Experience of fall accidents and near misses; Behavioural factors related to falls on delivery; Task factors; Situational influences on behaviour; Experience of use of footwear and equipment; Safety attitudes and activities of management, supervisors and employees; Perception of risks of fall accidents.</td>
</tr>
<tr>
<td>(3 groups of 8-10 employees)</td>
<td></td>
</tr>
<tr>
<td>Questionnaire survey of postal delivery employees and delivery office managers</td>
<td>Physical environmental factors related to fall accidents; Behavioural factors which increase the risk of fall accidents; Reason unsafe behaviours used on delivery; Organisational factors which employees believe relate to fall accidents; Employees' ideas for reducing the incidence of outdoor fall accidents to delivery employees</td>
</tr>
<tr>
<td>Response rates:</td>
<td></td>
</tr>
<tr>
<td>Managers 48 % (25 respondents)</td>
<td></td>
</tr>
<tr>
<td>Employees 39 % (110 respondents)</td>
<td></td>
</tr>
</tbody>
</table>

Results: contributory factors identified

A summary of possible contributory risk factors for outdoor fall accidents in postal delivery employees, as identified by employees and managers, is presented in figure 1. Factors are grouped into three main sections: 1. Individual characteristics and behaviour; 2. Footwear and equipment; 3. Physical environment.
Figure 1. Summary of possible contributory risk factors for outdoor falls in postal delivery employees
Individual Behaviour: Unsafe Practices and Time-Saving Behaviours

Figure 2 provides a breakdown of unsafe practices identified most frequently by employees and managers as increasing the risk of a fall accident whilst on delivery. A majority of employee discussion group members and questionnaire respondents argued that the use of these practices was necessary to meet Royal Mail's targets for delivery of first post on the busiest days of the week, and because of the increasing quantity of mail they must deliver within the time allocated for each delivery route. The mail load is unevenly distributed across days of the week and across the two delivery rounds. Later days of the week tend to be much heavier than Mondays and Tuesdays, and up to 90% of mail is taken out on the first of the two deliveries. In addition, employees noted that they prefer to deliver mail at a regular time each day as they are aware that customers often rely on their good time-keeping. This sometimes leads to rushing, particularly when adverse weather or heavy work loads cause them to lose time.

Managers, on the other hand, tended to explain the use of unsafe practices in terms of the business' 'job and finish' policy which allows employees to go home once they have delivered the last letter of their second delivery. Official timings of walks assume safe practice (e.g. walk up and down every drive), therefore any time the employee is able to save by taking short-cuts, rushing or carrying over-weight pouches, contributes to an earlier finish time.

Reading whilst walking was considered by both employees and managers to greatly increase the risk of fall accidents. Employees argued that to check the address for the next delivery point whilst stationary would incur unacceptable time costs which outweighed safety considerations. In addition, employees noted that this practice was used to help avoid 'miss-deliveries' (delivery of mail items to an incorrect address), and to follow the route on an unfamiliar round.

Reasons given by employees for carrying overweight pouches included the unequal distribution of mail between days and rounds, and the bulk and weight of heavy mail items (e.g. magazines, advertising and business mail).

Further organisational factors associated with the use of unsafe practices include the passing on of unsafe habits and time-saving behaviours through 'on-the-job' training methods, and difficulties related to supervisory monitoring of delivery employees, due to their remote location.

In summary, unsafe, time-saving practices appear to be habitually used by a large proportion of delivery employees. It appears the use of unsafe working practices is reinforced by the rewards of reduced task time, and is perceived by a large number of employees as necessary during the busiest periods of work. Any attempt to encourage employees to adopt alternative safe practices may be unsuccessful in the long term while these types of situational influences on behaviour exist.

Footwear and Equipment

Employees, managers and safety personnel noted that the choice of footwear offered by Royal Mail to its delivery employees does not offer a high level of protection from either slipping (the first fall event in over 50% of all outdoor falls to delivery employees, (Bentley and Haslam, 1996)) or ankle injury (the most commonly injured body part in all outdoor fall accidents to delivery employees). Grip is worn away, particularly at the vital
heel area, after only a few months' wear (verified in a series of inspections of employee's shoes, N=38), but footwear is often replaced just once a year.

**Unsure practices used by delivery employees**

- **Rushing**
  - Time pressure
  - Quantity of mail to deliver

- **Taking short-cuts**
  - Habitual work practice
  - Time pressure
  - Ensure letters go to correct houses
  - Following addresses on unfamiliar route

- **Reading and sorting whilst walking**
  - Habitual work practice
  - Quantity of mail to deliver

- **Carrying over-weight mail pouches**
  - Weight of new mail items
  - Time pressure

**Reasons given by employees for use of unsafe practices**

- **Time pressure**
- **Delivery time target**
- **Timing of walks**
- **Unequal distribution of delivery load across day and week**

**Possible organisational influences on behaviour**

- **Job and finish policy**
- **As for rushing and short-cuts**
- **Reprimand for miss-deliveries**
- **Training**
- **Unequal distribution of delivery load across day and week**
- **Use of pouch to carry heavy business mail**
- **As for rushing and short-cuts**

**Figure 2.** Unsafe practices: reasons for their use and possible organisational influences on behaviour
Trolleys are designed as an alternative to carrying mail pouches manually, but appear to be under used. In discussion groups, employees argued that trolleys slowed them down, could not be used for remote walks or on walks with many steps, and produced a security problem when left unattended. Snow chains are issued to delivery employees as protective equipment for working in snow, but were described by employees in discussion groups as being effective only in fairly deep snow, and subsequently under used. Accident statistics for outdoor falls to delivery employees suggest the incidence of falls increases markedly during extended periods of snow fall (Bentley and Haslam, 1996). For this reason it is important that employees are made aware of the conditions under which they should wear snow chains.

Physical Environment

Unsurprisingly, the weather and walking conditions underfoot were mentioned most often as contributory factors in outdoor falls to delivery employees. Of the measures to reduce the risk of falls in adverse weather conditions, the most promising include the provision of superior occupational footwear, lighter pouch loads (mail broken up into smaller individual pouch loads), and the allowance of additional time to complete deliveries in adverse weather conditions.

Obstacles and contaminants left on home owners’ drives represent a major hazard, and are particularly problematic when there is insufficient lighting of the area. Likewise, the unpredictable condition of public pavements and roads was described as a major risk factor.

Conclusion

Possible contributory factors for outdoor falls to postal delivery employees have been identified through the use of accident-independent techniques. Many outdoor falls are avoidable events. Measures to reduce the incidence of these accidents might include: rewarding and reinforcing safe rather than unsafe practices; provision of safe and unobstructed walkways on private premises; and the supply of appropriate equipment and training to employees to help them undertake their work in greater safety.

Acknowledgements

The authors wish to acknowledge the support of the Royal Mail, and particularly wish to thank John Leaviss, Mike Dixon and Ian Cooper for their close interest with this work.

References

Health and Safety Executive 1994, Key fact sheet on slipping and tripping injuries to employees between 1986/87 and 1992/3., Statistical Services Unit, Room 512, Daniel House, Bootle, Merseyside.
OUTDOOR FALLS IN POSTAL DELIVERY EMPLOYEES: A SYSTEMATIC ANALYSIS OF IN-HOUSE ACCIDENT DATA

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outdoor falls; slips, trips and falls; delivery employees; accident analysis

An analysis of accident data for 1734 outdoor fall accidents to postal delivery employees occurring over a two year period has been undertaken. The analysis examined the activity of the employee at the time of the accident, and the fall initiating event (FIE). In 63% of cases the employee was walking on the level, and in 19% on steps. The most common FIE was a foot slip, with 46% of all slips on the level being ice slips. The most common trip falls were uneven ground, obstacle and kerb trips. Analysis was also undertaken for month, time, sex, age and body part injured. A number of possible measures for reducing the incidence of outdoor falls are suggested.

INTRODUCTION

Slip, trip and fall accidents are not a trivial problem. They represent a huge cost to industry in terms of lost production, medical and compensation costs, as well as the human suffering from the resulting injuries. The Health and Safety Executive (HSE) figures for 1992/93 show that slips, trips and falls on the level represent 33% of all major injuries, and 20% of all over three day injuries to employees (HSE, 1994). Buck and Coleman (1985) found from their analysis of accidents notified to HSE that 17% of slip, trip and fall accidents on the level resulted in bone fracture injuries, suggesting that the human cost of such accidents can be considerable. Postal delivery employees undertake much of their work in an unpredictable outdoor environment (Bentley and Haslam, 1996), and the majority of mail is delivered to each door by foot, regardless of weather conditions. Outdoor falls are the largest cause of accident and lost time within the delivery function of the Royal Mail. The present study was undertaken to identify accident hazards associated with outdoor fall accidents to postal delivery employees.

ACCIDENT ANALYSIS

1734 outdoor fall accidents to postal delivery employees, occurring over the two year period April 1993 to March 1995, were considered in the analysis. Of these, a total of 26% resulted in more than 3 days absence from work, and 9% in more than 3 weeks absence, suggesting that relatively serious injuries are not uncommon.
Analysis by activity of employee and Fall Initiating Event (FIE)

Figure 1 shows the activity of the employee at the time of the fall, together with FIE and breakdown of slip and trip types (these data were coded from 'one-line' descriptions of accident circumstances provided on the data output).

<table>
<thead>
<tr>
<th>Activity of employee</th>
<th>Fall initiating event (FIE)</th>
<th>Slip or trip type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking on the level (63 %)</td>
<td>Slips (49.2 %)</td>
<td>Ice slip (46.3 %)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Snow slip (17.1 %)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wet slip (12.1 %)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grass slip (12.1 %)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaves slip (6.2 %)</td>
</tr>
<tr>
<td></td>
<td>Trod in/stepped on (4.7 %)</td>
<td>Loose-surface (6.2 %)</td>
</tr>
<tr>
<td></td>
<td>Unclassified (19.3 %)</td>
<td></td>
</tr>
<tr>
<td>Walking on steps (19 %)</td>
<td>Trips (26.8 %)</td>
<td>Uneven ground (35 %)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Obstacle trip (28 %)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kerb trip (27.8 %)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wall trip (8.8 %)</td>
</tr>
<tr>
<td>Climbing in/out of vehicle (3 %)</td>
<td>Slips (61 %)</td>
<td></td>
</tr>
<tr>
<td>Climbing on/off bike (1 %)</td>
<td>Trips/missed step/stumble (14.8 %)</td>
<td></td>
</tr>
<tr>
<td>Unclassified (14 %)</td>
<td>Unclassified/other (24.4 %)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Activity of the employee at the time of the fall and Fall Initiating Event (FIE).
Nearly one-fifth of all reported falls occurred while the employee was walking on steps. Taking into account the level of exposure, delivery employees are much more likely to suffer a fall whilst walking on steps than when on the level. In addition, the employee is more likely to incur a lost-time injury following a fall on steps (35% of falls on steps resulted in over 3 days absence compared to 22% of falls on the level). The FIE for 49% of falls on the level and 61% of falls on steps was a slip of the foot. Of slips on the level, 46% were ice slips, 17% snow slips, and 24% wet or grass slips. The major types of trips were uneven ground (35%), obstacle trips (28%) and kerb trips (28%).

**Analysis by month of year and time of day**

The 'U' shaped distribution of accidents across the year (figure 2) reflects the seasonal nature of outdoor fall accidents, with 50% of falls occurring during the four month period November to February. 58% of all outdoor falls during this four month period were ice or snow slips. Trip falls and falls on steps were unaffected by seasonal conditions, and were distributed evenly across the months of the year.

Only 10% of all reported outdoor falls occurred during the month of December, despite the increased workload associated with Christmas post. Possible explanations for the relatively low fall accident rate during this period include the opportunity for over-time working and customer tips during December, and the relaxation of time targets for delivery of first post during the busy Christmas period.

Cross-tabular analysis of month by FIE showed 80% of a total of 113 snow falls occurred in just one month (February 1994) of the 24 months analysed. This suggests any extended period of snow would greatly increase the incidence of outdoor falls.

Nearly 60% of outdoor falls occurred before 9 am. Possible explanations for this finding include: darkness; adverse weather conditions; and a greater workload in the early part of the day (Bentley and Haslam, 1996).
Analysis by sex and age of employee

Incidence rates were more than 50% greater for female employees than males for both years of the analysis. It is unclear why females should have a greater propensity to suffer fall accidents, possible explanations include: physical strength differences; greater willingness to report accidents; and the use of inappropriate footwear. Younger employees (under 30) were found to have higher incidence rates than their older colleagues, while older employees and females more often required absence from work following a fall accident.

Analysis by body part injured

The ankle was the most commonly injured body part (23% of all injuries were to the ankle), and required over three days absence from work more frequently than other body part injuries (35% of ankle injuries). Knee and back injuries were the next most commonly injured body parts. Ankle injuries most frequently followed a step or trip accident, while back injuries more commonly resulted from slips.

CONCLUSIONS

The analysis has identified a number of accident hazards, in particular walking on steps, ice or snow, grass, uneven ground and obstacles. The risks associated with these hazards should be highlighted in safety awareness and training programmes. Outdoor fall accidents are most common during the winter months, but the 50% of falls which occurred outside of this period should not be ignored by safety awareness programmes. Measures which may contribute to a reduction in incidence of these accidents include: occupation footwear with superior grip and protection; increased use of snow chains; additional time to complete deliveries in adverse weather conditions; and training in the use of safe work practices (Bentley and Haslam, 1996). Further work is assessing the effectiveness of a number of these intervention measures.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support of the Royal Mail, and particularly wish to thank John Leaviss, Mike Dixon and Ian Cooper for their assistance with this work.

REFERENCES


Interviews with slip, trip and fall accident-involved postal delivery employees

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Abstract
Detailed follow-up interviews were undertaken with 40 slip, trip and fall accident-involved postal delivery employees. Interviews took place during the English winter months October through February. Falls followed a foot slip in 83% of cases. Snow, ice and raised paving were the most common hazards associated with falls. 'Avoidable' environmental hazards were involved in 23% of cases, and inadequate lighting was a factor in 20% of cases. Employee's footwear tread was rated as being in poor condition (worn smooth) in 75% of cases where the employee had slipped. Some form of unsafe, time-saving behaviour was being used at the time of the fall in 60% of cases, and 38% of employees failed to notice or avoid the hazard involved due to reading letter addresses whilst walking. 'Behaviour shaping factors' which appear to underlie use of time-saving behaviours include business policy and quality targets.

1. Introduction
Slips, trips and falls (STF) make up a considerable proportion of all accidents at work. Health and Safety Commission figures for 1995/6 show STF on the same level are the largest cause of injury to employees, representing 35% of all major injuries and 20% of over three day injuries (HSC, 1996). The present authors have attempted to identify contributory risk factors for falls occurring during the delivery of mail (Bentley and Haslam, 1996a; 1996b). Two years' accident data (1734 cases) were analysed to determine accident circumstances, employee groups most at risk, and when delivery falls occurred with greatest frequency. Over 50% of falls followed foot slips, and falls usually occurred whilst the employee was walking on the level (63%) or on steps (19%). Ice and snow were the major type of underfoot surface where the employee had slipped, while trips most frequently involved uneven paving, obstacles and kerbs. Female employees had incidence rates over 50% greater than male colleagues. Falls most frequently occurred during the first delivery round (7-10am) and between November and February.

A focus group, interview and questionnaire survey was undertaken with delivery staff and management to collect information on factors not identifiable through analysis of accident data and reports. Delivery staff and safety personnel suggested unsafe working practices such as rushing on slippery ground and taking short-cuts were in common use, influenced by the business' 'job and finish' policy, and sometimes necessary to complete deliveries on time. Management safety practices and organisational issues such as training and policy were also highlighted as important underlying risk factors for delivery falls.

The present study was undertaken to expand the results of the above research by providing in-depth data on delivery fall accidents through the use of detailed follow-up interviews. The survey was undertaken during the English autumn and winter months (October through March).

2. Method

Participants
A sample of accident-involved employees was drawn from accident reports received by Royal Mail Midlands Personnel Department. Interviews were arranged with the employees involved in every tenth report for the earliest possible date (mean time between accident and
interview = 9.5 days). Interviews took place at the site of the accident, with each interview lasting approximately 30 minutes. Interviews were undertaken during the employee's normal working hours.

**Data collection**

Accident-involved employees were asked to describe and demonstrate the sequence of events leading to their injury. The researcher completed an accident 'sequence of events chart', and the employee was asked to verify whether the chart accurately represented accident events. Having described the accident events, the employee was asked a number of questions concerning the hazard, their work behaviour, use of footwear and equipment, work methods and training.

**Data analysis**

Casual factors and possible underlying organisational influences were added to the 'sequence of events charts', allowing a full description of each accident to be modelled on a single diagram. Quantitative analysis was also undertaken from employees' responses to the questions contained in the interview schedule.

3. Results

**Participants**

Employees' ages ranged from 19 to 56 years, and their length of service from 1 week to 27 years, with a mean length of service of 9 years, 3 months. Full-time employees made up 85% of those interviewed. Female employees comprised 22% of the sample.

**Analysis of employee's activity and Fall Initiating Event (FIE)**

The most common activity immediately preceding a fall was walking on the level (50% / n=20), followed by walking down a sloped driveway (30% / n=12). Falls occurred on steps in 10% of cases (n=4), and during entry or egress from a van in 8% of cases (n=3). 'Foot slip' was the FIE in 83% of cases (n=33), and 'foot tripped' in 10% of cases (n=4). The remaining FIE were 'trod in hole' (5% / n=2) and 'missed step' (2% / n=1). All falls on a slope and 70% of falls on the level followed a foot slip.

**The physical environment**

The most frequent underfoot conditions were snow (40% / n=16), ice or frost (20% / n=8) and raised or damaged paving (8% / n=3). 'Avoidable' environmental hazards were associated with 23% (n=9) of falls. These included any hazard which, in the opinion of the accident-involved employee and the researcher, could be easily removed or repaired and was not a normal feature of a well maintained premises or a public area. Avoidable hazards included uneven or broken paving slabs and holes in paving. The employee believed the absence of adequate lighting contributed to their accident in 15% of cases (n=6).

**Footwear and equipment**

The condition of accident-involved employees' footwear tread was examined and rated by the researcher. The tread was rated as poor (worn smooth) in 75% of cases where the employee had slipped. The mean time this footwear had been used for delivery work was 4.4 months (footwear is replaced on a yearly basis). Snow chains are provided as PPE for working in snow, but were not being used by any of the 16 employees who fell as a result of a slip on snow. The most common delivery method being used at the time of the fall was manual mail pouch carriage (75% / n=30). The mail pouch was full or nearly full in 40% of cases, and there was evidence the weight of the pouch had contributed to loss of balance and the subsequent fall in 8% of cases (n=3).

**Unsafe working practices**

At the time of the fall, 33% of employees (n=13) were rushing (walking very quickly or running on the level or on steps) in slippery conditions, and 40% (n=16) said they were reading letter addresses whilst walking. All but one employee who had been reading addresses believed this activity had caused them not to have seen the hazard and/or not to
have taken action to avoid slipping (ie adjust their stride or avoid the area). One employee was carrying two loaded mail pouches at the time of the accident. Some form of unsafe practice was being used at the time of the accident in 60% of cases (n=24), and employees suggested the practices of rushing, reading letter addresses whilst walking and taking shortcuts are in common use during normal working. Reasons given for using these 'time-saving' behaviours were to make time to ensure an early finish (50%), workload (difficulty delivering mail within the time target) (42%), and to catch a bus or lift back to the delivery office (8%). 'Behaviour shaping factors' (ie those which appear to underlie the use of unsafe, time-saving behaviours) appear to include the business' quality measures (such as target finish times for deliveries) and the 'job and finish' policy. Safety attitudes and activities of local office managers may also influence employee attitudes and behaviour.

**Overtime working**
The possibility of tiredness or fatigue (due to working long shifts) as a factor in delivery falls was considered. Accident-involved employees had worked 9 or more hours overtime in the two days preceding the fall in 25% of cases (n=10), and 10% of employees (n=4) had worked 13 or more hours overtime.

**Training**
Accident-involved employees recalled receiving new-entrant training in 38% of cases (n=15), while all employees reported receiving 'on-the-job' training with an experienced member of delivery staff. Some form of safety training had been received by 55% of employees (n=22) during the past 2 years, most commonly undertaken by local managers.

4. Conclusion
The detailed follow-up interviews confirmed a range of contributory risk factors identified in previous research. These factors appear to interact with the primary risk factor: slippery weather conditions. Notable amongst these are the supply of footwear unsuitable for heavy use and winter working, the use of unsafe, time-saving working practices, and 'avoidable' environmental hazards, particularly on householders' premises. Because of the diversity of risk factors for delivery falls, no single control measure is likely to have a marked impact on delivery fall incidence. Rather, a number of interventions are required to target the physical, behavioural and organisational risks outlined above. Further research by the present authors is considering the role of a number of factors, including management safety activities, method of delivery, task behaviour, and overtime working, in delivery office accident performance (Bentley and Haslam, 1997).

**Acknowledgements**
The authors wish to acknowledge the support of the Royal Mail, and in particular wish to thank Mike Dixon, Ian Cooper, Cynthia Yeates and Howard Kilroy for their assistance.

**References**


This paper presents results from a preliminary investigation into the role of supervisor safety practices in postal delivery office safety performance. Supervisor safety practices which may promote improved safety performance were determined from an analysis of contributory supervisor factors for delivery falls, and a survey of management and safety personnel. 'Desirable' safety practices identified included thorough accident investigation, hazard control activities, and use of special practices during severe weather. Further research is considering the use of these practices by supervisors of high and low accident rate postal delivery offices.

Introduction

Accident incidence rates for postal delivery staff working at different delivery offices vary considerably, despite most delivery staff undertaking similar tasks. These differences in safety performance are still observed when the effects of geographical region (effect of weather conditions), delivery area (eg rural/urban), size of delivery office workforce (staff in post), and time supervisor is in post, are taken into account. One explanation for differences in safety performance may be supervisor safety practice.

A number of studies have considered the effectiveness of safety programs and management and supervisor safety practices in occupational safety performance. Many of these studies analysed safety practices common to companies with outstanding safety performance, or compared practices of companies with high injury rates with those having low rates (eg Cohen, 1977; Simonds and Shafai-Sahrai, 1977; Smith et al, 1978; Cohen and Cleveland, 1983; Chew, 1988). Smith et al (1978) notes the following factors were found to be important to successful safety program performance in more than one such study: strong management concern for safety; full-time safety director who reports to top management; frequent use of safety promotions; frequent use of accident investigations; formal training of employees and supervisors; frequent positive contacts between employees and supervisors; stable workforce (older and more experienced employees/ married employees). These and other more recent studies (eg Simard and Marchand, 1994) highlight the importance of manager and supervisor safety practice in occupational safety. The objective of the present study was to identify supervisor...
safety practices which are effective in promoting good safety performance among postal delivery staff. Two methods were used to determine 'desirable' supervisor safety practices: an analysis of supervisor factors identified as contributory to delivery falls, and a survey of management and safety personnel.

![Figure 1. Summary diagram of risk factors for delivery fall accidents](image-url)
Previous research considering the role of supervisor factors in delivery fall accidents

Delivery falls are the largest cause of accident and lost time for Royal Mail delivery staff. Previous research (Bentley and Haslam, 1996a and 1996b), involving analysis of accident data and reports, and delivery fall follow-up interviews, has found supervisor factors underlie a notable proportion of these accidents. For example, many accidents occurred because employees were attempting to work normally in adverse weather conditions. In addition, an analysis of accident reports suggested accident investigations by office supervisors were often too brief for identification of contributory factors and suitable preventive measures.

A survey of delivery staff, using focus groups and questionnaires, supported these findings, suggesting safety practices employed by office supervisors can affect delivery staff safety performance. Examples of supervisor factors associated with delivery fall accidents include failure to adopt measures to protect delivery staff during periods of adverse weather, failure to respond to employees' reports of hazards on delivery walks, and overlooking employee use of unsafe practice such as carrying more than one delivery pouch. Figure 1 summarises the major risk factors for delivery falls as identified from this research.

Delivery staff argued supervisor safety practices which were most effective in promoting good safety performance among delivery staff included additional time for deliveries during adverse weather, efforts to remove hazards and unsafe conditions from their walks (e.g., dangerous dogs; holes in pavements; etc.), replacement of worn footwear, and lightening delivery loads by providing more 'drop points' where additional mail pouches can be picked up by delivery staff en route.

This research provided an index of 'desirable' supervisor safety practices designed to affect delivery staff safety performance through the control of unsafe conditions and acts connected with delivery accidents. In addition, these practices can be expected to have a positive affect on delivery office safety climate, as employees perceive safety activities of management as reflecting the business' commitment to safety.

Survey of management and safety personnel to identify supervisor safety-related practices which may be effective in improving delivery office safety performance

A survey of Royal Mail management and safety personnel was undertaken to determine safety practices currently used by office supervisors, practices considered to be most effective in promoting improved safety performance, and factors affecting supervisors' use of 'desirable' safety practices. Interviews with senior delivery managers and office supervisors were undertaken to identify practices currently employed, and barriers and incentives which influence the use of safety practices. A discussion session with senior safety personnel considered the areas of safety in which the office supervisor might most effectively play a role in improving office safety performance.

Using data produced from this survey and from the research described above, a list of 'desirable' supervisor safety practices and activities was drawn up (table 1). Some specific examples of 'desirable' supervisor safety practices are listed under the headings accident investigation and follow-up prevention, severe weather practice; safety communications, hazard control and equipment management.
<table>
<thead>
<tr>
<th>Supervisor safety practice</th>
<th>Specific examples of 'desirable' practice</th>
</tr>
</thead>
</table>
| Accident investigation and follow-up prevention activity | Supervisor personally investigates all reported accidents  
Accident investigation is thorough:  
* accident-involved employee is interviewed along with witnesses;  
* supervisor visits site of accident  
* supervisor identifies all contributing factors;  
Supervisor takes necessary follow-up preventive action (eg letters to Council or householder to have a hazard removed)  
Supervisor shares outcome of investigation and follow-up prevention with staff |
| Severe weather practice | Supervisor takes action to protect delivery staff from increased risk of injury during periods of severe weather (eg withhold staff until conditions improve; allow more time for deliveries; provide transport assistance; heavy mail items not taken out by foot; equipment for adverse weather supplied; special briefings) |
| Safety communications | Daily contact between supervisors and staff on safety and other job matters.  
Regular safety-focused team-briefings  
Display of safety campaign materials  
Informal safety advice  
Supervisor operates an open door policy  
Involvement of senior management (eg safety tours), and high priority of safety in meetings between senior management and office supervisors |
| Hazard control | Supervisor encourages reporting of hazards  
Hazards are recorded appropriately (ie hazard cards, 'walklogs')  
Supervisor takes action to remove 'avoidable' environmental hazards (eg writes to/visits Council or householder), or makes alternative delivery arrangements  
Supervisor undertakes regular office safety tours  
Supervisor shares the outcome of hazard reporting and removal efforts with staff |

(continued)
Factors affecting current use of safety practices by office supervisors

Factors which affect the use of the above safety practices were considered in the survey and are listed below:

- supervisor’s knowledge of ‘best safety practice’
- supervisor’s training in areas of safety management
- time constraints
- budget constraints
- non-compatibility with quality considerations
- non-compatibility with business policies

Supervisor safety practices in 'high' and 'low' accident rate delivery offices

These preliminary findings are being used in the design of a more detailed study which is to consider the role of activities presented in table 1 and other management related factors in delivery office safety performance. A sample of 'high' and 'low' accident rate postal delivery offices are being surveyed, using questionnaires and interviews with office supervisors.

The questions are:

- Do supervisor safety practices used in 'low' accident rate offices differ from those in 'high' accident rate offices?
- Safety practices do supervisors perceive as effective in accident reduction, and how do they understand their role in office safety performance?
- The following factors related to delivery office safety performance?
  - Working practices used (e.g., walk and carry pouch, pouch trolley, pedal cycle)
The results of this and previous research will be used to determine possible safety intervention measures to reduce the incidence of accidents occurring during the delivery of mail. As part of this process, 'safety intervention' focus groups will be held with employees, management and safety personnel. Within these groups risk factors and possible solutions will be discussed, along with ideas for intervention design and implementation.

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References


