A technical guide to the selection and use of fall prevention and arrest equipment

Prepared by **Glasgow Caledonian University**
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RESEARCH REPORT 302

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A technical guide to the selection and use of fall prevention and arrest equipment

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The following report was prepared by Glasgow Caledonian University, School of the Built and Natural Environment for the Health and Safety Executive (HSE) and describes a study on fall prevention and arrest equipment available to the construction industry. The objectives of the research are to critically appraise:

- Purlin Trolley Systems
- Safety Decking
- Fall Arrest Mats
- Safety Netting
- Cable and Track-Based fall arrest systems
- NASC's SG4:00: The Use of Fall Arrest Equipment when Erecting, Altering and Dismantling Scaffold

There is a large, and increasing, availability and diversity of such equipment and this research has collected data on each of the systems, currently available. The principles of the 'hierarchy of risk control' are important when selecting appropriate safety equipment for working at height; the order of preference being:

- Prevention – guardrails / barriers / purlin trolleys / safety decking
- Passive arrest – safety nets / fall arrest mats
- Active arrest – cable and track-based systems / SG4:00
- Mitigation of any consequences of an accident

The risk of a fall must, wherever possible, be designed out. If this is not possible, the above hierarchy must be followed in equipment selection. The outcome of this research illustrates good practice, which was derived from interviews with system users, experts in selection and planning of accident protection methods, and observations of live case study sites.

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TERMS AND DEFINITIONS

For the purposes of this report, the following terms and definitions will apply (adapted from definitions contained within prBS 8437: *Selection, use and maintenance of fall protection systems and equipment for use in the workplace*)**.**

Fall protection	Prevention of an operative from going into a free fall by way of rigid barrier or similar protection medium
Fall prevention	Prevention of the user of fall protection equipment from going into a free fall
Fall arrest	Prevention of the user of a fall arrest system from colliding with the ground or structure in a free fall ***Note:*** *a fall arrest system will not prevent a fall but should minimise the risk of injury in the event of a fall*
Fall mitigation	Reduction in the severity of the hazards and risks associated with fall protection
Fall/Work restraint	Personal fall protection system that restricts the travel of the user away from potentially hazardous areas
Work positioning	Fall protection system that enables the user to work supported in tension or suspension in such a way that the fall is prevented[1]

Fall arrest safety systems:

Global/Passive	An encompassing system that protects large areas and provides fall arrest for more than one individual at one time. In normal circumstances the beneficiaries of these systems are not the installers
Personal/Active	An assembly of components to arrest the fall of an individual user/wearer against a fall from a height at work

[1] *Work positioning (sometimes referred to as 'person support') is not classed as either fall arrest or work restraint.*

EXECUTIVE SUMMARY

INTRODUCTION

This report was prepared by Glasgow Caledonian University, School of the Built and Natural Environment for the Health and Safety Executive (HSE) and describes a study on fall prevention and arrest equipment available to the construction industry. The information provided is a culmination of two separate research reports, the second being an addendum report on safety decking sanctioned by HSE due to demand from industry representatives.

Working at height is the highest risk area within the United Kingdom (UK) construction industry. Each year, approximately 100 workers are fatally injured whilst carrying out a task at height, of which approximately 50% of these occur in the construction industry.

AIMS AND OBJECTIVES

This research covers issues in the selection and application of a variety of safety systems. The objectives of the research are to critically appraise current industry practices when working at heights, and to evaluate the safety benefits and limitations of:

- Purlin Trolley Systems
- Safety Decking
- Fall Arrest Mats
- Safety Netting
- Cable and Track-Based fall arrest systems
- NASC's SG4:00: The Use of Fall Arrest Equipment when Erecting, Altering and Dismantling Scaffold

There is a large, and increasing, availability and diversity of such equipment and this research has collected data on each of the systems, currently available.

This report should serve as authoritative guidance on the accommodation, selection, installation, use and supervision of the various types of available fall protection for construction designers, planners, production managers, trainers and supervisors.

DATA COLLECTION AND ANALYSIS

The research programme was carried out in five phases:

Steering Group – A steering group of senior industry stakeholders was formed to advise on the strategic direction of the research.

Interviews – Interviews were held with industry specialists, recommended by the Steering Group, to assist in directing the research focus.

Collection of technical data – The initial phase of the research programme involved collecting comprehensive data on each of the systems within the research focus.

Focus Groups – A series of focus groups, each covering a different system, was held to investigate both generic and system specific issues in the selection and use of the equipment.

Site observations and interviews – Visits to system manufacturers and suppliers offices, contractors' offices and sites was made to observe each system in operation and to discuss issues in the selection and use of the equipment.

Each focus group meeting was audio-recorded and the recordings verbatim transcribed for evidence purposes. The transcriptions were analysed in two stages, to identify issues of substance and then classify the data, using a content structure based on a standard set of key words applicable to generic issues and each of the systems.

Notes from site meetings were prepared and circulated to the interviewees, and were analysed in similar fashion to the focus group transcriptions.

MAIN FINDINGS

The main findings of this report are detailed in the following Chapters. Findings on the specific safety systems are summarised below.

Purlin trolley systems

Purlin trolleys are fall prevention equipment and are used as an alternative to safety nets. HSG33 '*Health and Safety in Roof Work*' negatively describes the early forms of purlin trolleys, and is now considered out-of-date. The systems included within the research have undergone re-evaluation and modification to become the systems available today, and appear to have significant benefits under appropriate circumstances.

The purlin trolley is a system that has been innovated by the roof industry, for the roof industry, and is suitable for many industrial roofing situations.

Purlin trolley systems are essentially ***passive*** systems and users do not experience problems associated with ***active*** systems, such as forgetting to clip on. The exposed leading edge is protected at all times, prior-to and following roof sheet installation, as the double guardrail is always in front of the roofing operations. The systems provide a safety deck for the users to walk on, and to store their hand tools. No access is required to the area below the roof for the installation and use of purlin trolley systems.

The advantages of these systems appear to be underestimated, especially if consideration is given to using these in tandem with nets, i.e. providing prevention and arrest.

Safety Decking

Lightweight safety decking systems have emerged as capable means of fall prevention, and as such, safety decking sits higher in the hierarchy of risk control.

Safety decking is classified as 'work equipment' under PUWER. There are two types of safety decking covered by this research; decking panels supported by props (PSD systems), and extendable aluminium trellis decking (EAT). All safety decking systems are lightweight working platforms positioned just below the working area and capable of supporting a person and their light tools. Care must be taken, through a regular and competent supervision regime, that platforms are not overloaded; with either operatives, or materials.

With all safety decking systems, there is an element of control required on the area below the system. PSD systems props will render the area below unusable, whilst when using EAT systems the area below should be made an exclusion zone until works overhead have been completed.

EAT systems do not require props to support the working platform, thus the system can successfully be used over the most adverse of ground conditions. EAT systems are manufactured completely from aluminium. Modified EAT systems are manufactured with a non-conductive plastic coating to assist in reducing the risk of electric shocks for the users.

The popularity of safety decking systems is growing. The systems included within the research go through frequent re-evaluations and modifications, and this research suggests that use of these systems will continue and grow.

Fall arrest mats

There are two types of fall arrest mat used in the UK: the air-mat, and the soft-filled mat. Both are laid on the ground or suspended floor, beneath the working area, and protect operatives from relatively low falls of up to 2.5 metres. The mats are designed to decelerate (or cushion) the operatives' fall, and hence minimize the worst effects of a fall from height.

Collective fall arrest systems are specifically mentioned in the forthcoming Work at Height Regulations 2004, and this is recognition of their increasing popularity within industry.

The air-mat system comprises a series of interlinked modular inflated mattresses. They rely on a continuous air feed. This is achieved by mechanical pumps or fans. In order that air-mats are inflated correctly, the air fans need to operate within a certain pressure range.

The soft-filled mat system comprises interconnected cushioning mats filled with a packaging medium designed to dissipate the kinetic energy of a falling person.

The simplicity of fall arrest mats is a major factor in their use. The systems will only be effective if they are positioned correctly, which relies on careful site control to ensure that modules are always below where work at height is taking place. There is a need for effective supervision to ensure the correct use of the systems.

The markets for fall arrest mats would appear to be domesticated housing, and industrial works during the installation of flooring materials above. It would appear a crude distinction is emerging; the low-rise housing market appearing to favour soft-filled mats, and higher-rise flatted structures appearing to favour air mats. To date, it is felt that the maintenance and facilities management sectors have not taken advantage of fall arrest mats as a means of passive fall protection.

Safety nets

Although widespread use of netting has been relatively recent, they have been recognised in UK Regulations for almost 40-years.

Netting used in the UK construction industry is manufactured and using techniques adopted from the fishing industry.

With the introduction of FASET relatively early in the usage of netting on construction sites, the industry has taken positive steps to regulate themselves. This positive step has provided a backbone for the industry from which to build training standards, regulatory influence, guidance, advice, etc.

The markets for safety nets would appear to be during industrial works on framed structures. Industry has recently questioned the validity of using netting in domesticated housing, and there would appear to be a shift toward fall arrest mats in this area.

Training standards for the safety netting industry are controlled by FASET. In order that anyone is qualified to install, alter, dismantle, or inspect safety nets they must have attended a FASET-registered training course, and passed an appropriate test.

The general consensus was that although the system was not considered as the panacea for all working at height issues, the introduction of this collective passive system has been of benefit to industry.

Cable and track-based safety systems

Cable and track-based safety systems can offer a practical solution, particularly to maintenance and other short duration or infrequent access problems, for many building users. This research uncovered little evidence of these systems being used during actual construction works. The systems consist of a number of components that together provide continuous attachment and ‘hands-free’ working to the users. They can either restrain the user from accessing the area of risk or arrest them in the event of a fall.

Cable and track systems are ‘personal fall arrest systems’ and, as such, are at the lower end of the fall protection hierarchy. Their governance by guidance and European Standards is extensive, due mainly to the number of different components.

Cable and track-based safety systems differ from most other systems in this report as they are installed primarily to assist in maintenance functions during the building’s life.

The system complexity will determine the amount, and level, of training required. Installation and dismantling of the system involves time and co-ordinated effort by trained personnel.

As the systems are active and rely on the user to carry out positive actions, there is a constant risk that such actions may be forgotten or overlooked, which could lead to the user being exposed to a fall risk whilst unprotected.

The popularity of these systems appears to be growing, in part due to designer's analysis of maintenance access requirements [Construction (Design and Management) Regulations 1994, Regulation 13]. The systems included within the research go through frequent re-evaluations and modifications. Manufacturers and installers appear to be willing partners in the whole safe access management process.

SG4:00 The Use of Fall Arrest Equipment when Erecting, Altering and Dismantling Scaffold

SG4:00 is a significant step forward for safety in the scaffolding industry; however it does not address all safety hazards present during scaffolding operations. The guide covers façade, independent scaffolds, formed of steel tubes and fittings, and does not yet cover other forms of scaffold, such as proprietary scaffolds, birdcage, grandstands, etc. However, SG4:00 is subject to a full review at this time, with future SG4:00 guidance intended to serve as a complete guide to the management of risk whilst carrying out scaffolding operations.

In order that SG4:00 is properly implemented, there is a requirement to use fall arrest equipment. Various new technologies and techniques have been adopted by organisations within the scaffolding industry to attempt to prevent falls, or to reduce fall distances, for example:

- Above-head fixing clamps
- Portable clamps incorporated into a lanyard
- Inertia reels/blocks
- Advanced guardrails
- Pole systems (based mainly on technique rather than equipment)

The National Access and Scaffolding Confederation (NASC) is the national representative employers organisation for the access and scaffolding industry, and proponent of SG4:00.

Training must be provided for scaffolders. Adequate training in SG4:00 is crucial in the development of a safer and more competent workplace.

NASC SG4:00 is a positive start on the regulation of basic scaffolding procedures, and has been received encouragingly by the majority of the scaffolding industry. With continued support from key industry stakeholders, the system will become industry normal good practice and be accepted by all scaffolders as the safe way to work, and hopefully the only way to work, provided that advanced guardrail systems are also considered.

ADDITIONAL FINDINGS

The treatment by HSE of 'falls from height' as a priority area and the introduction the new Work at Height Regulations 2004 is likely to further accelerate the technological development of access methods (for example, podium towers as ladder substitutes), in addition to the fall protection equipment reported here.

RECOMMENDATIONS FOR INDUSTRY

The principles of the 'hierarchy of risk control' are important when selecting appropriate safety equipment for working at height; the order of preference being:

- Prevention – guardrails / barriers / purlin trolleys / safety decking
- Passive arrest – safety nets / fall arrest mats
- Active arrest – cable and track-based systems / SG4:00
- Mitigation of any consequences of an accident

The risk of a fall must, wherever possible, be designed out. If this is not possible, the above hierarchy must be followed in equipment selection. Dialogue with clients and designers is important to ensure that the system chosen will integrate with the structure and construction process.

Planning of fall protection must always consider the rescue of a faller from the equipment, in the event of an accident. Important issues to cover in a rescue plan includes:

- Speed of rescue; Rescue method; Additional equipment; Cooperation with emergency services; First-aid; Training

Cost is always a consideration. It is recommended that the true cost of selected equipment is known. The costs to be considered should include:

- Provision of equipment:
    - Purchase, Hire, Subcontract
- Additional costs:
    - Installation, Storage, Transportation, Inspection, Maintenance, Impact on productivity, Training, Supervision, Dismantling and removal

An honest consideration of whole life costs, and opportunity costs, associated with safety systems is recommended. It is not enough only to consider capital costs.

A maintenance programme is essential to ensure that safety systems remain in good, safe functional order.

Awareness must be shown of the different languages and cultures that may be present on site. The intelligibility of information communicated to non-English-speaking personnel must be considered to ensure safety is not compromised.

FINAL REMARK

The outcome of this research illustrates good practice, which was derived from interviews with system users, experts in selection and planning of accident protection methods, and observations of live case study sites.

There are many issues to be addressed in the selection of fall prevention and protection equipment. The primary consideration should always be safety of construction site personnel and, where relevant, the general pubic.

In this climate of rapid change, it is important that information and advice to industry is kept up-to-date. This report, and any publication of industry guidance resulting from it, should be reviewed and updated regularly to retain its currency.

1.0 INTRODUCTION

1.1 INTRODUCTION

Construction work involves an active working environment where hazards often create unexpected and direct risk of injury or death to the workforce, and other people affected by the works. All hazards must be controlled, as far as reasonably practicable, in order to eliminate or mitigate these risks. Working at height is the highest risk area within the United Kingdom (UK) construction industry. Each year, approximately 100 workers are fatally injured whilst carrying out a task at height. Almost half of these fatalities are in the Construction Industry, where around 50% of all fatalities are due to '*falls from height*' or '*falls through fragile [roofing] materials*'. Table 1 shows all-industry fatality statistics, related to working at height, from the past 12-year period:

Year	No. of Fatalities	Year	No. of Fatalities
1991/92	106	1997/98	92
1992/93	90	1998/99	80
1993/94	81	1999/00	68
1994/95	79	2000/01	74
1995/96	64	2001/02	69
1996/97	88	2002/03	49

Table 1 Workplace fatalities per year due to falling from height
(Information obtained from the Health and Safety Executive's (HSE) web page: http://www.hse.gov.uk/statistics, 07 January 2003, 10:00am)

The statistics also suggest that new build (e.g. profiled aluminium roofing) is just as dangerous as refurbishment (e.g. asbestos cement roofing). Further, falls from heights also account for a notable number of accidents in other industries where employees or building owners have fallen from height during routine building repair or maintenance operations.

1.2 BACKGROUND

The research described in this report was carried out under two separate research contracts awarded to Glasgow Caledonian University, School of the Built and Natural Environment through the 'Competition of Ideas' promoted in the HSE Mainstream Research Market, 2001/2002. The start date for the initial research contract was April 2002, with the addendum contract, into safety decking, starting in October 2003.

Tackling health and safety issues is important for all industries, so much so that these matters are of frequent concern at Parliamentary level. This concern resulted in the development of

government-backed initiatives aimed at promotion of health and safety. HSE have targeted prevention of falls from height through major campaigns, such as:

- Key Priority Programmes (KPP), which help to achieve health and safety improvement targets outlined in *'Revitalising Health and Safety'*, The Construction Summit (*'Turning Concern in to Action'*), and Revitalising Health and Safety in Construction
- Numerous 'Blitzes' by HSE Inspectors during 2002 and 2003, and a constant topic during HSE's Safety and Health Awareness Days (SHADs), and Designer Awareness Days (DADs); and
- One of 5 target areas in the recent initiative known as '*The High 5*', championed by HSE through the Working Well Together campaign (www.wwt.uk.com)

Through these national initiatives, the dangers of working at height have been highlighted and this may have contributed to the recent decline in work at height fatalities over the past 2-years (see Table 1). However, the prevention of accidents involving falls from height remains a high priority for HSE and for industry.

Falls from height are a major problem. As a large proportion of these accidents result in fatalities and major injuries, the causes are investigated by the HSE Inspectorate. As a result of the analysis of information derived from these accident investigations, the Construction (Health, Safety & Welfare) Regulations 1996, has been used to promote a 'hierarchical system' of risk control. This hierarchy ranks risk control measures that place prevention before protection; that place total workforce protection before individual protection; and that place passive control, requiring no action by the operative, before active control, requiring action such as clipping on lanyards, as the preferred options. The specifics of the hierarchy will be described in Chapter 3.

1.3 OBJECTIVES

There are many systems available to prevent or arrest falls from height during construction, operation and maintenance of buildings or engineering structures. The research reported here covers issues in the selection and application of a variety of such systems and the advantages and disadvantages of the five most frequently encountered, together with issues specifically related to their application in building maintenance and refurbishment.

The objectives of the research covered by this report are to critically appraise current industry-wide practices and procedures when working at heights, and to evaluate the safety benefits and limitations of:

- Purlin trolley systems during industrial roof work
- Safety decking during construction works
- Fall arrest mats when working at heights or near leading edges
- Safety nets during roof work
- Cable and track-based fall arrest systems as a means of protection when working at heights or near a leading edge
- The National Access And Scaffolding Confederation (NASC) SG4:00 – The Use of Fall Arrest Equipment when Erecting, Altering and Dismantling Scaffold

Further objectives are:

- To provide additional advice on the operational, time and cost advantages and disadvantages associated with each system listed and, ultimately,

- To provide a comprehensive report for industry practitioners, in design, planning and production, covering general selection issues in the introduction and operation of height protection equipment and the benefits and limitations of each type of available equipment.

The immediate beneficiaries of this research will be designers, who should be aware of modern fall prevention and arrest equipment, in order to accommodate it in their designs, and those responsible for selection, installation and application of such equipment. The ultimate beneficiaries will be those who would otherwise suffer the personal and economic consequences of such accidents.

1.4 SCOPE

In total, six safety systems were investigated:

- Purlin Trolley Systems
- Safety decking
- Fall Arrest Mats
- Safety Netting
- Cable and Track-Based fall arrest systems
- NASC's SG4:00

There is a large, and increasing, availability and diversity of such equipment and this research has collected data on each of the systems, currently available. In order to maintain the currency and completeness of the information, it will be essential to periodically review and update the content.

This report does not attempt to deal with the management of safe working at height, per se – only insofar as it relates to the selection and use of fall prevention and protection equipment. However, it should serve as authoritative guidance on the accommodation, selection, installation, use and supervision of the various types of available fall protection for construction designers, planners, production managers, trainers and supervisors. Neither has it attempted to distinguish between safety systems of the same generic type; its purpose is to provide 'real-world' experience of available system types, to identify appropriate situations for their use and to improve industry practice in their selection and use.

DISCLAIMER: Throughout the individual chapters on generic system types, various sources of equipment data provided by manufacturers and suppliers will be credited and the authors are extremely grateful for the time and effort that these companies provided in support of the research. However, the authors cannot and do not endorse the product or service of any particular system supplier or manufacturer.

1.5 SUMMARY OF REPORT CONTENTS

The outcome of this research illustrates best practice, which was derived from interviews with system users, experts in selection and planning of accident protection methods, and observations of live case study sites. Chapter 2 discusses the methodology adopted for data collection during the research.

Chapter 3 discusses generic selection issues that pertain to the systems within the research focus. Areas included in the generic Chapter include: the hierarchy of risk control; a proposed 'traffic light' system selection method; impact of system selection on site operations; and, cost factors.

Chapters 4 to 9 on the individual safety systems have a structure that follows the data collection and analysis framework created for the main data collection phases: technical literature searches; expert focus groups; and, site observation and interviews. The content of each Chapter is aimed, primarily, at informing industry choice, planning and use of the particular type of equipment. The topics covered for these Chapters include:

System history; Legislative history; European Normative (EN) & Conformity European (CE) Standards; The Work At Height Regulations 2004[2]; System types available; Materials used; System manufacture; Trade and Industry Organisations; Industry recommendations for use; Advantages and disadvantages; Training standards; Rescue; Installation and dismantling; Manual handling; Inspection and maintenance; Monitoring and policing; Equipment maintenance; Storage and transportation; Equipment life span; and, Disposal of damaged materials.

Chapter 10 is a synthesis of the major issues uncovered in the research and a summary of the most important information and instances of good practice relating to the application of the individual systems.

[2] *The Work at Height Regulations 2004 incorporates the Temporary Work at Height Directive 2001/45/EC as outlined in Consultative Document 192.*

2.0 METHODOLOGY

2.1 INTRODUCTION

The research programme was carried out in five phases:

Steering Group – A steering group of senior industry stakeholders was formed to advise on the strategic direction of the research, review progress and outcomes and assist in obtaining access to construction sites and personnel during the site visit phase.

Interviews – Interviews were held with industry specialists, recommended by the Steering Group, to assist in directing the research focus on each of the fall protection systems to be studied.

Collection of technical data – To fully understand the functioning of the systems and relevant legislation, codes of practice and operating environments, the initial phase of the research programme involved collecting comprehensive data on each of the systems within the research focus.

Focus Groups – A series of focus groups, each covering a different system, was held to investigate both generic and system specific issues in the selection and use of the equipment. These provided information on industry practice, system data and guidance for the collection of site data in phase three.

Site observations and interviews – A series of visits to system manufacturers and suppliers offices, contractors' offices and sites was made to observe each system in operation and to discuss, with suppliers, site planners, supervisors and operatives, issues in the selection and use of the equipment.

2.2 RESEARCH GOVERNANCE

A Steering Group was formed to oversee the research programme. The remit of the group was to:

- Provide strategic direction to the research
- Give specialist advice on behalf of industry
- Facilitate access to suitable construction sites to view the systems in operation and interview appropriate personnel, and
- Suggest further contacts within the industry who could contribute to the research

The group met on dates throughout the research that allowed feedback to be delivered on progress:

13th June 2002
25th September 2002
14th January 2003
30th April 2003

Table 2 details the members of the Steering Group.

Table 2 – Steering Group Members		
Name	**Organisation**	**Occupation**
Chris White, MBE	Ogilvie Construction	Health and Safety Manager
Malcolm McIntyre	Bovis Lend Lease	Chief Health and Safety Manager
Peter Conway	Kier Scotland	Health and Safety Manager
Jim Purdie	Scottish Water Solutions	Health and Safety Manager
Rev Malcolm James	MJ Consultancy	Private consultant in health and safety
John Carpenter	Health and Safety Consultant	Private consultant in health and safety
John Bissett / Denis Hands	CITB National Construction College	Senior Training Advisor
Hash Maitra	Health & Safety Executive	HM Principal Specialist Inspector, and Research Lead Interest
Hedley Horsler	Health & Safety Executive	HM Principal Inspector
Linda Cowen	Health & Safety Executive	Administrative Support

The research flowchart on page 10 shows the synergy between the steering group and focus groups.

2.2 COLLECTION OF TECHNICAL DATA

Initial exploratory research of all systems was carried out, in which literature covering:

- The manufacture and application of each system
- Legislation relevant to its selection, testing, maintenance and use
- Codes of practice on relevant generic health and safety issues and those specific to the equipment
- Any other information on issues likely to influence the selection and use of such fall protection equipment

The Research Assistant also attended training courses provided to industry on working at heights and on the application of specific equipment, to improve understanding of equipment use, training issues, and the environment in which operatives would apply it.

2.3 FOCUS GROUPS

Early in the research, it was decided to form Focus Groups of industry specialists and deep topic experts. One Focus Group was held for each of the five systems, with a final Group covering the implications of the systems in Maintenance and Refurbishment. The purpose of the focus groups was to discuss and advise on:

- Generic issues surrounding the selection and use of fall protection equipment
- Issues specific to the particular system
- Issues requiring further investigation through collection of data from industry offices and sites
- The content and dissemination of industry guidance arising from the results of the research

Each focus group meeting was audio-recorded and the recordings verbatim transcribed for evidence purposes, and typically ran to 30+ pages. These transcriptions are held privately by the research team and are not publicly available in order to comply with the essence of Data Protection, good research etiquette, and assurances given by the research team. The transcriptions were analysed in two stages, to identify issues of substance and then classify the data, using a content structure based on a standard set of key words applicable to generic issues and each of the systems. The resulting analyses were sent to the participants to ensure that the information collated had been correctly interpreted and to permit the inclusion of any further thoughts that they might have had.

Page 9 provides a research flow chart that maps the work, timing, and sequence, of the Steering and Focus Groups. This chart also includes other aspects of the research in sequential order, such as; industry interviews, training, site visits etc.

Participants in each of the focus groups included representatives from manufacturers, training providers, testing bodies, and general contractors. The following Sections provide information on the Focus Group participants, demonstrating the areas of expertise that were represented.

Appendix 1 includes details on all focus groups dates and attendees.

Appendix 2 details the analysis of information from the focus groups as fed back to the attendees.

2.4 SITE DATA COLLECTION

In order to supplement information collected in the focus groups, numerous visits were made to construction sites and other industrial locations to interview people with experience of the selection and use of each system. From these visits, a total of 31 recorded site interviews were carried out either face-to-face, or via telephone. The objectives were to resolve any unresolved issues remaining from the focus groups, to confirm opinions expressed in the focus groups and to observe the systems in use.

After observation of the system in operation, including where possible erection and dismantling, semi-structured interviews were held to establish the benefits, limitations and optimum conditions for use of the systems. Notes from these meetings were prepared and circulated to the interviewees to confirm that the information recorded was accurate and to allow any further thoughts to be added by the interviewee. Due to brevity and ethical considerations, the transcripts of these meetings are held by the research team and are referenced throughout the system Chapters. Not including these transcribed interviews as an appendix neither adds nor detracts from the validity of this report, as all transcripts have been reviewed and the appropriate information extracted. The interviews were held with representatives from the following groups:

- Manufacturers (26)
- Clients (8)
- Designers of construction methods (3)
- Project Managers (10)
- Contractors (21)
- Trainers (6)
- Supervisors (7)
- Operatives [end-users] (6)

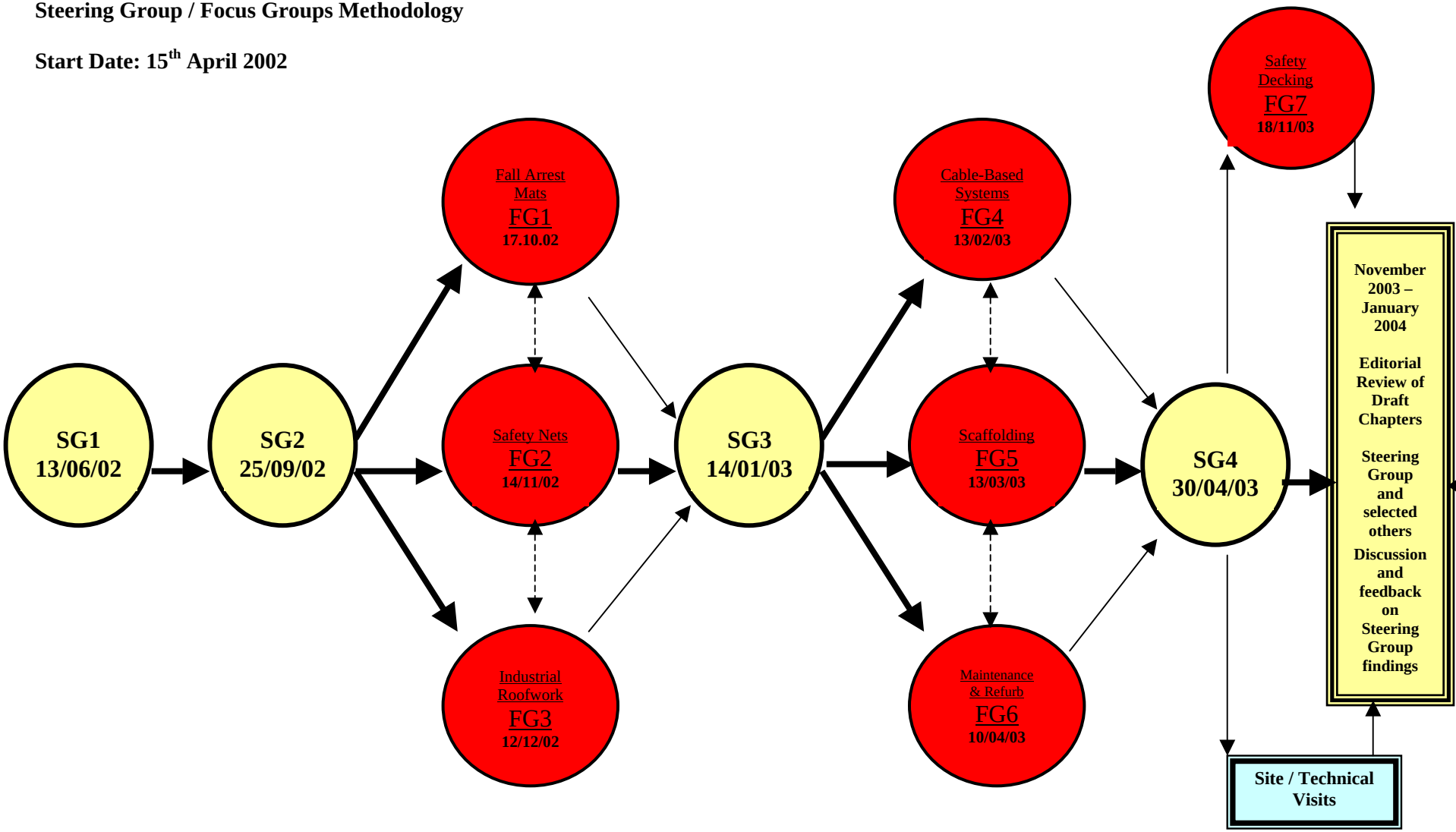
Appendix 3 includes a breakdown of manufacturers interviewed for each system, and the interview questions put to interviewees during the site data collection phase.

2.5 DATA SYNTHESIS

The key word analytical framework, established from the focus groups for the site data collection, was used to synthesise the data collected from all three phases of the research, technical data, focus groups and site data, and the results can be found in the following chapters of this report. Frequent use of appropriate quotations from the interviews has been used to support the data synthesis, and the discussion of results, for each system. Anonymity has been respected but the position of the quoted interviewee identified, as far as this would allow.

Steering Group / Focus Groups Methodology

Start Date: 15th April 2002



3.0 GENERAL SELECTION ISSUES

3.1 INTRODUCTION

There are many issues to be addressed in the selection of fall prevention and protection equipment. The primary consideration should always be safety of construction site personnel and, where relevant, the general pubic. However, those attributes of the equipment covered in this research that impact on time, cost and quality, of the work that the system is installed to enable, will also be considered by contractors. It is essential that they operate in a safe manner, whilst remaining efficient, commercially competitive, and satisfying their client's requirements.

The information contained within this Chapter is based on general evidence borne from 7 focus Groups, and over 30 on-site interviews. The specific attributes and the benefits and limitations of each system, in relation to their impact on all these issues, will be dealt with in following chapters; but there are general issues to be addressed in the selection process that apply to all systems. These are dealt with in this chapter.

3.2 EQUIPMENT SELECTION

The selection of fall protection equipment should be carefully considered prior to opting for a particular system. Guidance on selection of suitable equipment should be sought from system specialists and manufacturers. For all work equipment, Regulation 4, *Suitability of work equipment*, of The Provision and Use of Work Equipment Regulations 1998 (PUWER), states:

> *(1) Every employer shall ensure that work equipment is so constructed or adapted as to be suitable for the purpose for which it is used or provided.*
>
> *(2) In selecting work equipment, every employer shall have regard to the working conditions and to the risks to the health and safety of persons which exist in the premises or undertaking in which that work equipment is to be used…*

As all equipment and system components within this report are classified as work equipment under PUWER, this Regulation should be considered prior to selecting any form of equipment.

3.3 SAFETY

Safety hierarchy

The Health and Safety Executive promotes a clearly structured approach to risk control, referred to as a 'hierarchical system'. This is explained in the Construction (Health, Safety and Welfare) Regulations 1996 and will be expanded in the forthcoming Work at Height Regulations 2004. It is based on clear principles:

- Prevention is better than protection

- Passive protection (protecting all personnel at risk and not requiring actions by the individual, e.g. safety nets) is better than active protection (requiring individual action in order to protect him/herself, e.g. clipping on lanyards)
- As a last resort, care must be taken to mitigate any consequences of an accident

In relation to fall protection, these principles lead to clear conclusions. The first is that the risk of a fall must, wherever possible, be designed out. The first point at which this can be achieved is in the design of the structure. In design risk assessment the designer is, under The Construction (Design & Management) Regulations 1994 (CDM), legally required to try to anticipate the activities in the construction process that might expose operatives to risk of fall from height; and, wherever reasonably practicable, to produce designs that do not expose them to such risks, or to minimise these risks. This issue was raised frequently in the focus groups and interviews:

> "*In my opinion, designers haven't recognised their responsibilities under the CDM Regulations"*
> (Director, July 2003) and,
>
> *"They don't design buildings to do away with the need for access. Most designs are too intricate"*
> (Safety, Health, Environment and Quality Manager, July 2003)

The first way that the above might be achieved is to design such that construction does not require work at height. This will not be explored further, as it falls outside the remit of this research.

The second way that this objective can be achieved is to design such that fall prevention and protection equipment can most easily be installed and operated. Clearly, knowledge of construction processes is an important element in this area and a competent contractor can assist if the procurement and project management processes permit early involvement. Whilst designers should anticipate foreseeable risks and try to design such that they are minimised, they clearly cannot be expected to know the exact construction processes that the contractor will adopt. The contractor, therefore, with this detailed knowledge, should discuss the construction methods, and their associated risks, with the designer as soon as possible. In this way any practicable modifications to the design, to reduce these risks, may be considered. There are specific examples of such modifications, such as designing anchorages for safety lines or safety nets into steelwork fabrication that are relatively easily achieved. These issues will be dealt with at more length in the chapters on the specific equipment to which they relate.

In the selection of fall prevention and protection methods, the HSE hierarchy is an important guide. The Management of Health and Safety at Work Regulations 1999 (MHSWR), Regulation 4, *Principles of prevention to be applied* directs the reader to Schedule 1 *General principles of prevention*. This Schedule highlights the following the following hierarchy of risk control elements:

(a) avoid risks
(b) evaluate the risks which cannot be avoided
(c) combat the risks at source
(d) adapt the work to the individual

(e) adapt to technological progress
(f) replace the dangerous by the non or less dangerous
(g) develop a coherent overall prevention policy
(h) give collective protective measures priority over individual protective measures
(i) give appropriate instructions to employees

The above list highlights the essence of the preferred solutions within the hierarchy and should be considered prior to selecting any fall protection equipment.

Of the *fall arrest* options considered in this research, safety nets and fall arrest mats will be the first choice, circumstances permitting, because they provide protection to all workers at height and do not require them to take any protective action themselves. The choice between these two fall protection methods will then depend, mainly, upon their ability to mitigate the injurious effects of a fall. This is a qualitative decision, in relation to safety, and will depend on the exact circumstances of their deployment:

- height of possible fall
- ease of installation of the safety system
- coverage of potential fall area by the protective equipment
- risk of, and degree of protection from, injury during fall
- possible injury on impact with the protective equipment
- possible injury from falling debris, materials or tools
- ease of rescue and possible injury during rescue.

There are also many, properly regarded as 'secondary', issues, related to the impact of the equipment installation on production, such as interference with production process or materials storage, and therefore on progress and cost, that will be dealt with later.

Other methods of protection covered in this research, cable-based systems, purlin trolley systems and some of the special equipment provided in scaffold erection, can require action by the operative to take advantage of the protection offered. This will involve the wearing of personal protective equipment, harnesses and lanyards, and may include the following examples:

- clipping the line to an anchor point on the structure
- clipping the line to a rail on the trolley system, when necessary to leave the protection of the guard rails
- clipping on, in the case of scaffold erection, before moving to a lift unprotected by handrail.

The only circumstance in which a scaffolder erecting the next lift may be said to have passive protection is if he/she is using one of the latest methods of erecting the advanced guardrail, from the lift below, before climbing to the new lift. The advantages and disadvantages of each of these methods will be addressed fully in the respective chapters.

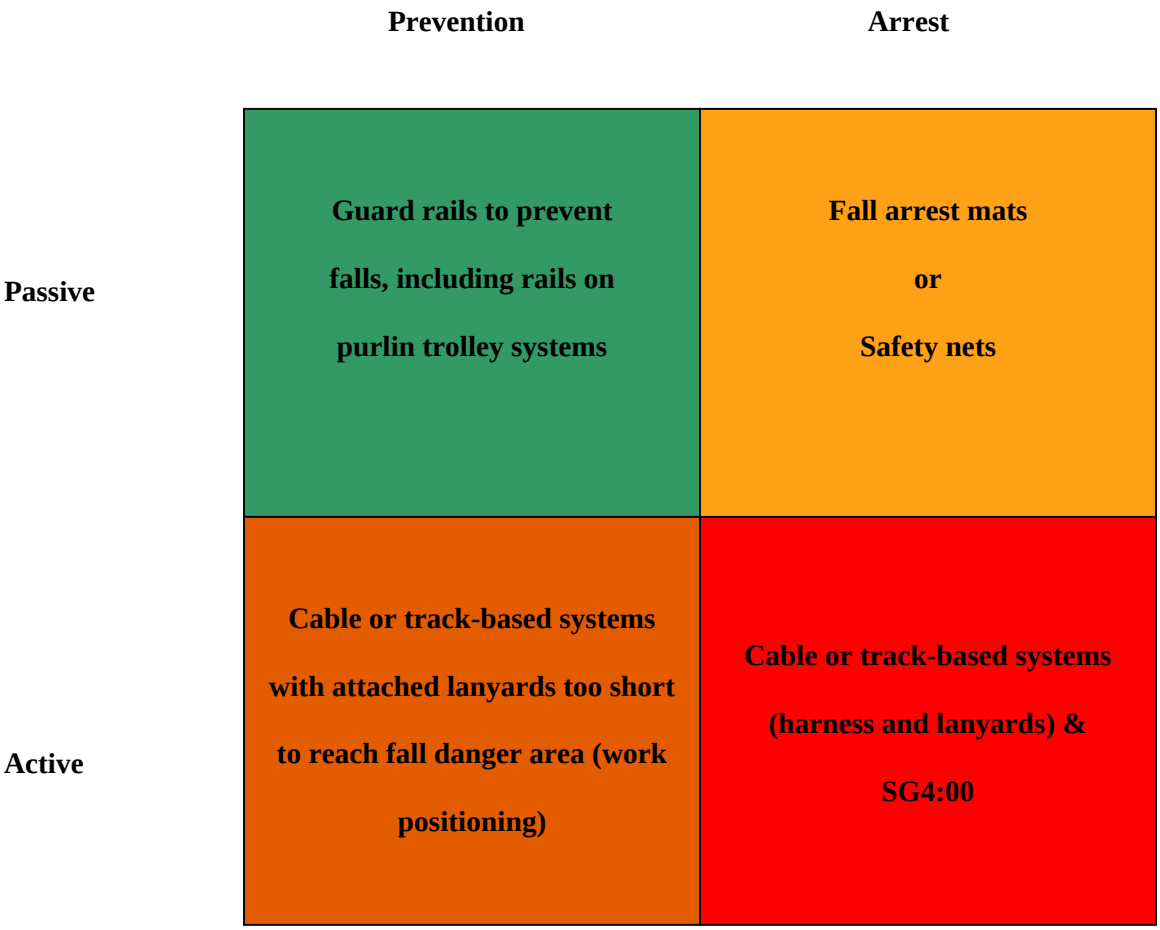


Figure 1 – Traffic light selection ranking

Figure 1 shows the hierarchy of fall prevention and protection methods using a 'traffic-light' based sequence of green, light-orange, dark-orange, red, indicating a safety rank order for selection. Similar to the colours of the traffic light, the colours are interpreted as follows:

- Red – *last resort* – look for an alternative safe system of work
- Dark orange – attempt to *find an alternative arrangement*, consult risk assessment and rescue method statement, and proceed with caution
- Orange – *seek advice* from risk assessment, and proceed with due diligence
- Green – *proceed with due care*

Generic Legislative Guidance and Standards

Throughout the systems Chapters is a continuous emphasis on legislation relating to the safety equipment. To avoid repetition, the following legislation can be seen as being relevant to the use of ***all*** systems in this report, during construction works:

The Health and Safety at Work Act 1974
The Electricity at Work Regulations 1989
The Manual Handling Operations Regulations 1992
The Workplace (Health, Safety and Welfare) Regulations 1992
The Personal Protective Equipment at Work Regulations 1992
The Construction (Design & Management) Regulations 1994
The Supply of Machinery for Safety Regulations 1994
The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995
The Construction (Health, Safety & Welfare) Regulations 1996
The Provision and Use of Work Equipment Regulations 1998
The Lifting Operations and Lifting Equipment Regulations 1998
The Management of Health and Safety at Work Regulations 1999
The Personal Protective Equipment Regulations 2002
The Work at Height Regulations 2004 (pending)

The following Health and Safety Executive (HSE) Guidance Notes are also applicable:

HS (G) 33	Health and Safety in Roofwork
HS (G) 141	Electrical Safety on Construction Sites
HS (G) 149	Backs for the Future – Safe Manual Handling in Construction
HS (G) 150	Health and Safety in Construction

Appendix 4 provides information on the various British Standards (BS) and European Normities (EN) that pertain to each individual safety system. The most relevant BS EN's will be mentioned throughout the subsequent Chapters.

Appendix 5 provides information on the appropriate Regulations and Schedules from the pending Work at Height Regulations that affect each safety system. The numbers and headings are included in each system Chapter. It is important to note that these references may be subject to change as the regulations evolve through consultation and subsequent amendment; however they are accurate at the time of submission of this report.

Interaction with structure

All of the methods of fall protection considered in this research interact with either temporary structures, such as scaffold, or the permanent structure under construction. This interaction will, in many cases, apply potentially damaging loads to the structure in two ways:

- forces arising from the equipment itself, such as the pressure applied by air-mats or nets to adjacent walls
- forces arising from shock loading from arrest of a falling body, such as the forces of deceleration on a cable or lanyard anchorage.

The most important aspect of this effect is a likely increase in the safety risk to personnel, arising from a number of possible causes:

- collapse, or serious distortion, of the temporary or permanent structure to which the equipment is attached, resulting in failure of the equipment (e.g. failure of scaffold to support the shock load of the attached line or lanyard, when a fall takes place)
- damage or failure of the means of attachment of the equipment (e.g. the anchors of nets or safety cables)
- immediate collapse of a part of the structure onto construction personnel
- damage to the structure leaving it in an unstable condition, resulting in subsequent collapse either during later construction activity or during occupation

Aesthetics

The selection of fall prevention and protection equipment should always be made on the basis of safety of personnel. However, some of the equipment covered in the research, particularly that intended to protect maintenance personnel after the commissioning of the building, has a significant impact on its aesthetics. Items such as permanent guardrails and running lines for anchoring lanyards will often be obvious to even casual inspection and can detract from the aesthetic look of the building.

This is principally an issue for the designer but early discussion with both the construction contractor, in the case of fall prevention equipment with application during construction, and with maintenance contractors (such as roof maintenance or external cleaning contractors) will often lead to a satisfactory compromise to satisfy both aesthetic and safety requirements.

The Chapters on cable and track-based systems, and maintenance include more extensive material on this issue and contain specific recommendations.

3.4 IMPACT ON SITE OPERATIONS

The selection, design and installation of any fall prevention and protection equipment must always take full account of its interaction with all site activity. The equipment will interact in two ways:

- The effectiveness of the protection given by the equipment will be affected by adjacent site activity, for example, storage of materials stocks may hamper the ability to safely arrest a fall for fall arrest mats or nets.
- The equipment will affect the activities and productivity of operatives using it, sometimes negatively (e.g. interference from harness and line) and sometimes positively (e.g. confidence and freedom of movement, deriving from the equipment).

Consideration should be given to all the following factors in equipment selection and application:

- Operations of all trades, whether
    - using it (e.g. the constraint provided by harness and lines)
    - operating in its vicinity (e.g. resulting trip hazards)
- Impact on freedom of movement at the work-place
- Access to the work-place, of
    - operatives, or

    - supervision and management
- Operative confidence, deriving from loss of fear of falling, particularly in the case of safety nets or fall arrest mats.
- Materials supply to the work-place
- Materials storage
    - at the work-place
    - below or adjacent to the work area

These factors will impact on production progress and time, productivity and cost; and, sometimes, quality of work produced. They should form a checklist of issues to be addressed during selection, in relation to both planning, and cost estimating and control.

Planning

Following the HSE advice contained in the 'hierarchy', the starting point in planning height safety should be to, as far as possible, design (or plan) out operations at height from the master programme. Following this, the residual risks of the remaining operations at height must be identified. Then, the first stage of planning safety equipment is to identify the equipment options, in relation to the strategic construction method statement. Because of the potentially significant effect on construction operations, the selection process will often be iterative, in that choice of equipment will affect operations, and vice versa, with choices to be made in both, as a result of the effect of the other.

There will be many issues to consider in this planning and equipment selection process:

- Sequencing of operations to avoid congested working at height putting pressure on safety equipment
- Duration of operations at risk (the shorter, the better)
- Avoidance of overlap of ground-based operations and operations at height, particularly directly above
- Storage of materials in positions where they could interfere with satisfactory performance of fall protection equipment (e.g. encroaching on space for nets to deform under a faller)
- Transport of materials to height and danger from falling materials
- Temporary, safe storage of materials at height, to avoid materials falling with an operative
- Risk of activity overrun, in relation to the provision of fall protection equipment – could it be required for longer than the programme suggests?
- Sensitivity of the installed equipment (e.g. the space required for fall arrest mats) to possible changes in the programme

As part of an appropriate planning regime, there should be consideration for procedures to be followed in the event of an emergency. In this regard, Regulation 9 of MHSWR, *Contacts with external services*, states the following:

> *Every employer shall ensure that any necessary contacts with external services are arranged, particularly as regards first-aid, emergency medical care and rescue work.*

The information collated under Regulation 9 should be incorporated in the rescue method statement of the health and safety file.

Additional resource requirements

When planning the installation of fall protection equipment, it is necessary also to plan for adequate additional resources to cover:

- Installation and removal:
  Much fall protection equipment requires specially trained and competent installers to ensure correct installation, alteration and removal. Consideration should be given, during the selection and planning process, to the availability of competent people in the contractor's organisation and, if not, then to the selection of suitable subcontractors.
- Training:
  Most fall protection equipment also requires competent operatives to ensure its safe operation, either in position or during removal and installation in new locations. Appropriate training needs to be planned, for inclusion in site induction programmes or toolbox talks.
- Maintenance:
  Equipment may require maintenance during its period on site and this will necessitate:
  - Careful investigation of the manufacturer's or suppliers recommendations
  - Setting up recording and auditing procedures, to ensure compliance
  - Further training of management and supervision in these procedures

Method statements, risk assessments and safety plans

Site specific height safety outcomes of the strategic and resource planning activities should be recorded, with other health and safety issues, in the form of method statements and risk assessments and included in the construction phase Health and Safety Plan for the project (HSE (2001), Managing Health and Safety in Construction, Approved Code of Practice).

Care should also be taken to ensure that these plans and their documentation are always re-visited in the event of any updating of the project construction programme, to ensure that the initial assumptions about risk and safety are still valid.

Rescue

Planning of fall protection must always consider the rescue of a faller from the equipment, in the event of an accident. There are a number of vitally important issues to cover in any rescue plans:

- Speed of rescue:
  It is essential that plans ensure rescue within an acceptable time, to prevent:
  - suspension trauma developing in the fallen person (see Section 8.7.1), or
  - exacerbating any injury caused during the fall
- Rescue method:
  The method of rescue to be adopted, whether (and how) to lift, lower or otherwise transport the (possibly) injured person from the equipment (e.g. hanging from a lanyard and harness, or suspended in a safety net) will require definition. Consideration should be given to the possible need for assistance from other personnel and, particularly, whether they will be required to climb or be hoisted/lowered onto the safety equipment. The ability of the equipment to support this additional load must be investigated, as part of the selection process.

- Additional equipment:
  Equipment, such as a mobile elevated working platform, may be required to lift rescuers into position and several issues will have to be investigated, in order to ensure a robust plan for rescue:
    - Availability – the project programme and construction method statement should be interrogated to ensure that the required equipment will be available.
    - Location – it must always be accessible to the rescue team and within a travelling distance that ensures appropriate speed of rescue.
    - Access – adequate access for the rescue equipment must be available and kept clear of any obstruction that may take too long to clear.
- Cooperation with emergency services:
  If there is any possibility that the emergency services (normally the Fire Service) may be required to assist the rescue, then they should be approached during the rescue planning, to confirm that they have the capability and proximity of equipment that might be required. Advice on rescue methods, from the Fire Service, can be a valuable contribution in the planning process.
- First-aid:
  First-aid may be required, to treat injuries or suspension trauma and adequately trained personnel should be include in the requirements of rescue planning.
- Training:
  Special training in the methods of rescue that are planned will be required for any potential members of a rescue team and the content and timing of this must be considered, as part of the site safety training programme.

3.5 MAINTENANCE AND REFURBISHMENT

The systems within this report are considered in both new-build and maintenance and refurbishment situations. There are more small contractors working in maintenance and refurbishment, than new-build contractors in the construction industry. Many of these contractors have less knowledge and experience in health and safety. There is a significant difference between new-build construction, which tends to be well controlled, and maintenance and refurbishment on existing buildings. New-build construction projects are, generally, more rigid in what is allowable and more closely supervised.

Planning and Design

Under the CDM Regulations 1994, the designer has a duty to provide a building which is safe to maintain and refurbish over its' lifetime. Therefore, all foreseeable maintenance and refurbishment problems should be solved before a building is constructed. The lifetime maintenance of the building components requires consideration in the early stages, so that it is not reactive, but planned refurbishment. Maintenance of all materials must be considered over their lifetime.

During the design of refurbishment projects refurbishment, particularly those built pre-CDM, designers should avoid replacing materials like-for-like. For example, if fragile roof lights are being replaced, safe (i.e. non-fragile) roof-lights should be installed.

Supervision

During all maintenance and refurbishment works to existing buildings, the workforce must be appropriately supervised. A commitment to appropriate levels of on-site supervision is required from the top level of the organisation in order for it to be successful.

Supervisors are the most important people in refurbishment and maintenance; if supervisors are prepared to walk by, or ignore, a specific safety problem, this will send a message to the workers that this hazard is being accepted by the management.

Choice

On many occasions, the maintenance manager does not have an abundance of choice when it comes to the safety equipment available that can be used to keep the workforce safe whilst carrying out their maintenance and refurbishment work. The choices are dependant on system suitability and availability, and the competence of the workers to use the equipment safely. The following subsections explain the two main factors that the manager must account for when selecting the most appropriate safety equipment for the works.

Training / Competence

There is believed to be less evidence of appropriate operative training during maintenance and refurbishment of existing buildings; it is not stringent and there is not the supervision present that there is on new-build construction sites. For example, if a couple of roof tiles are being replaced, the building owner is unlikely to insist on the operatives completing a half-day induction to carry out these works. However, there must be a balance between the level of training required relative to the tasks that are to be undertaken. Again, the responsibility is with the supervisor to ensure that the workforce has received the required training to be considered sufficiently competent to carry out the works.

Training requirements are discussed throughout a breadth of current Regulations. For example, Regulation 17, *Information and training*, of The Construction (Design and Management) Regulations 1994 (CDM), state the following:

> *(2) The principal contractor shall ensure, so far as is reasonably practicable, that every contractor who is an employer provides any of his employees at work carrying out the construction work with –*
>
> > *(b) any health and safety training which the employer is required to provide to those employees in respect of that work by virtue of regulation 13 (2)(b) of the Management of Health and Safety at Work Regulations 1999*

Regulation 13, *Capabilities and training*, described in paragraph (2)(b) above, states:

(2) Every employer shall ensure that his employees are provided with adequate health and safety training –

> *(b) on their being exposed to new or increased risks because of –*
>
> > *(ii) the introduction of new work equipment into…the employer's undertaking*
> >
> > *(iii) the introduction of new technology into the employer's undertaking, or*

(iv) the introduction of a new system of work…within the employer's undertaking

(3) The training referred to in paragraph (2) shall –
(a) be repeated periodically where appropriate
(b) be adopted to take account of any new or changed risks to the health and safety of the employees concerned…

Training specific to work equipment is discussed in PUWER, Regulation 9, *Training*. This Regulations stipulates the following in regard to training:

(1) Every employer shall ensure that all persons who use work equipment have received adequate training for purposes of health and safety, including training in the methods which may be adopted when using the work equipment, any risks which such use may entail and precautions to be taken.

(2) Every employer shall ensure that any of his employees who supervises or manages the use of work equipment has received adequate training for purposes of health and safety, including training in the methods which may be adopted when using the work equipment, any risks which such use may entail and precautions to be taken.

As discussed, training is given a lot of exposure throughout current Regulations. It is important to consider the requirements of both generic and specific training for the workforce. Further, this training must be supplemented by periodic refresher training as deemed appropriate by industry guidance and manufacturers recommendations.

Job duration and Risk exposure

Prior to selecting any safety system for use during maintenance, refurbishment or construction works, the risk assessment, as described above, will determine the workers exposure to risk. The results of this risk assessment will determine the most appropriate system for that particular building. Many issues during the selection must be addressed, including:

- How far is the potential fall?
- Is it a completely fragile roof or only fragile roof lights?
- If the roof is not fragile at all, and the protection is required at the eaves or gables only, how are these protected?
- What part of the roof is being used to gain access to the roof structure?

If a dangerous area requires regular maintenance, for example, daily or weekly access, use of guardrails and toe boards around the exposed areas is the preferred safety system. Should the exposure be very low, for example access required every 5-years to clean out guttering, harnesses and cable or track-based systems would be acceptable. Learned judgments must be made through appropriate risk assessment and safety expertise.

Each individual system chapter within this report has a section covering the use of the system in maintenance and refurbishment.

3.6 COST

Comments from practitioners, during the research, when asked if cost is considered during the selection of fall arrest equipment, ranged from:

> "*Yes. Netting is the cheapest way of arresting falls in the marketplace today*"
> (Site Manager, April 2003) and,
>
> "*Yes. You could make anything you do safer, and to achieve that you'd undoubtedly have more costs.*"
> (Director, July 2003) to,
>
> "*Cost does get considered and* [what is] *'reasonably practicable' does get asked, but generally equipment selection is not cost–driven.*"
> (Project Manager, May 2003)

It is clear that cost is always, and must be, a consideration, even if it is not the first one. It is important that the true costs of any equipment selected are known. The costs to be considered should, therefore include, where appropriate:

- Provision of equipment:
  This will depend on the procurement option selected:
  - Purchase – if fall protection equipment for the construction programme is bought specifically for the particular project, then the cost will be simply the purchase cost; if not, then the purchase cost will be written off over a period and included in an internal hire rate that should also include estimated costs of routine maintenance, storage, testing, repair, plant department overheads etc., much of which will depend on company internal accounting policy.

    In the case of permanent fall protection equipment, for building maintenance, full life-cycle costing should be adopted and particular consideration given to the cost effects of the way it supports, or hinders, the tasks for which it is installed. The cost implications of these effects, over the life of the building, can be far greater than the initial purchase and installation costs.
  - Hire – if the equipment is hired, care should be taken to calculate the full duration of the requirement from the project construction programme, including any contingency for programme flexibility (see Planning); it is regrettable if a manager is placed under pressure to release fall protection equipment before risks are fully eliminated.
  - Subcontract – in many instances much of the management of costs is passed on to subcontractors, under agreements covering supply, installation and removal of equipment; in which case, though, care must still be taken to estimate and manage the duration of requirement rigorously – the above remarks about hire will apply equally here.

- Additional costs:

  There are many additional costs of providing fall protection equipment, all of which should be considered if fair comparison is to be made between alternatives. The following is a check-list for consideration:

  - Installation
  - Moving from location to location on site
  - Dismantling and removal
  - Storage
  - Transport
  - Inspection
  - Impact on production and productivity
  - Training
  - Supervision and control
  - Maintenance and repair

Cost significant issues will be treated more fully, if appropriate, in the individual chapters on the types of equipment in the research.

3.7 LANGUAGE

Due to the relaxing of borders and restrictions on working within the European Community, awareness must be shown of the different languages and cultures that may be present on site in the UK construction industry. Intelligibility of information communicated to non-UK personnel must be carefully considered to ensure that their safety is not compromised in any way. This may sometimes necessitate using visual aids during training and toolbox talks, or by hiring-in the services of interpreters. Whatever means is used, it must be intelligible to ***all*** site operatives, and not restricted to English-speaking personnel.

3.8 SUMMARY

Information included within this chapter is applicable to all the safety systems covered in this report. It is included in this chapter so as to avoid unnecessary repetition.

There are many issues to be addressed in the selection of fall prevention and protection equipment. The primary consideration should always be safety of construction site personnel and, where relevant, the general pubic.

The principles of the hierarchy of risk control are important when selecting appropriate safety equipment for working at height; the order of preference being:

- Prevention – guardrails / barriers
- Passive arrest – safety nets / fall arrest mats
- Active arrest – cable and track-based systems / SG4:00
- Mitigation of any consequences of an accident

The risk of a fall must, wherever possible, be designed out. If this is not possible, the above hierarchy must be followed in equipment selection.

A 'traffic light'-based sequence of selection has been suggested to clearly distinguish the preferred choices amongst the equipment studied.

Both the effect that a safety system in operation will have on the structure on which it is used, and the aesthetics of the installed system must be given consideration prior to selection. Dialogue with clients and designers is important to ensure that the system chosen will integrate with the structure and construction process, and will be unobtrusive physically and visually if remaining as part of the finished structure.

Fall prevention and protection equipment must always take full account of its interaction with all site activity. Consideration should be given to the following:

- Operations of all trades
- Impact on freedom of movement
- Access to the work-place
- Operative confidence
- Materials supply to the work-place
- Materials storage

These factors will impact on production progress and time, productivity and cost; and, sometimes, quality of work produced. They should form a checklist of issues to be addressed during selection.

Planning of fall protection must always consider the rescue of a faller from the equipment, in the event of an accident. Important issues to cover in a rescue plan include:

- Speed of rescue
- Rescue method
- Additional equipment
    - Availability
    - Location
    - Access
- Cooperation with emergency services
- First-aid
- Training

The systems within this report are considered in both new-build and maintenance and refurbishment situations. The areas of consideration for each system within the latter industry include:

- Planning and Design
- Supervision
- Choice
- Training / Competence
- Job duration and Risk exposure

Training in correct equipment use is important. In situations of exposure to risks of falling from height, training is an area that should be adequately resourced for appropriate personnel.

Cost is always, and must be, a consideration. It is important that the true cost of selected equipment is known. The costs to be considered should include:

- Provision of equipment:
    - Purchase
    - Hire
    - Subcontract
- Additional costs:
    - Installation, Storage, Transportation, Inspection, Maintenance, Impact on productivity, Training, Supervision, Dismantling and removal

Awareness must be shown of the different languages and cultures that may be present on site. Intelligibility of information communicated to non-English-speaking personnel must be considered to ensure safety is not compromised. Visual aids during training and toolbox talks, or hiring-in the services of interpreters should be considered. Information must be intelligible to all site operatives.

4.0 PURLIN TROLLEY SYSTEMS

4.1 INTRODUCTION

Roof work is one of the highest risk construction processes. Roof workers are exposed to hazards and risks through almost all of their working practices; therefore, steps must be taken to ensure their safety. During industrial roofing works, many accidents are caused by a lack of proper fall prevention or arrest equipment. There are many hazards and risks present during all roofing works, for example: accidents at the leading edge on new build; falls from the gutter position when leaving the completed roof area; gaps between leading edge protection and the solid roof covering; movement of materials across to leading edges; work activity around the leading edges; movement between leading edges and other areas of the roof; falls from the permanent edge; loading out; retrieving materials from where they are loaded out, etc. To reduce the risks faced by roofing workers, safe systems of work must be adopted.

A roofing system should eliminate or reduce the risk before site work, through careful design and planning. When constructing a roof, operatives are often not visually aware of the dangers, due to the roofing components obscuring the ground from the roof level. The operatives can be operating under a false perception of risk. Whilst fixed edge protection can be attached to the structure at the perimeter, the working area requires some form of protection. In industrial roof construction, one such solution is to use purlin trolleys, which can be installed on the roof purlins, to protect roof workers during installation. The principal of the purlin trolley is to provide a working platform with protection at the leading edge and the working edge (i.e. the side where the sheets will be installed).

Purlin trolley systems are used as an alternative to nets. There are occasions that both systems might be used concurrently, which would allow other trades to access the roof at the same time. This will be discussed in Section 4.6.

This Chapter will describe the principles of purlin trolley safety systems and their benefits and limitations.

4.2 HISTORY OF PURLIN TROLLEYS

HSE Publication, HSG33 '*Health and Safety in Roof Work*' (pg 43, para's 136-138) explains the ***early forms*** of the purlin trolley as:

… a working platform, they often in practice provide little protection while laying and fixing sheets, as once the sheets are fixed, trolleys have to be moved, creating another gap in which to lay the next sheet.

In most situations, additional measures [i.e. running lines and lanyards]…are required to protect those using trolley systems from fall through the gap…or through fragile material such as partially fixed liner sheets.

Trolley systems rely on the alignment of the supporting steelwork and the quality of the joints between purlins for trolleys to run freely. Attempting to free trolleys which have jammed can be dangerous.

In relation to the systems that are now available, HSG33 is inaccurate in some of the assertions that it makes on the practicalities of the systems. Conventional precautions of wearing safety harnesses connected to a cable-based system, were deemed (by HSG33) ineffective in controlling the risk, and could no longer be considered as an adequate precaution at the time HSG33 was written. Early forms of the purlin trolley incorporated a working platform, a handrail on the leading edge, and an open working edge. With no protection at the working edge, the user required some form of additional equipment to prevent falls. Early use required supplementary PPE, i.e. cable systems, harness and lanyard, for fall arrest protection. The use of PPE was found to be difficult to manage, because it restricted mobility, introduced a trip hazard, and there was a difficulty in obtaining suitable anchorage points for the cables.

Early thinking was that these systems were suitable for simple roof designs that do not feature curved surfaces or intricate plan shapes. However, our research findings indicate that this is not the case, and in many situations this is where the purlin trolley excels (see Plate 1).

Plate 1: Purlin trolley system used on a curved roof (*courtesy of Jayeff Ltd*)

A number of technical advances have been made to purlin trolleys. For example, patented systems now manage to protect the working edge, by means of a trolley, which limits the open area by the provision of a horizontal barrier (attached to the trolley) that rests just below where the roof sheet will be fixed. Thus, if someone accidentally stands on the unfixed sheet, the sheet and worker will be caught by the barrier. The system eliminates the need for harnesses and lanyards and provides an alternative to the use of nets or PPE systems (www.rosswaydowd.co.uk - 0121 377 6612).

One trolley system operates a roller-bearing mounted trolley to ensure ease of movement of the platform as the roof progresses, if the purlin steel is ‘in tolerance’, i.e. is within the allowable tolerance for deviation from the specification (0141 952 6184).

Current purlin trolley systems have been innovated and field-tested over a number of years and are much improved on the original concept, having been designed by contractors, for carrying out their own industrial roofing works.

4.3 LEGISLATIVE HISTORY

Further to information contained in Section 3.2 (Generic Legislative Guidance), the following Regulations and guidance are appropriate to purlin trolley systems due to the system being classified as 'work equipment':

The Provision and Use of Work Equipment Regulations (PUWER) 1998

Appendix 4 contains a list of the most relevant British and EN Standards relating to the manufacture and use of purlin trolleys, of which the construction manager must pay particular attention to. The following British Standards are highlighted as the most appropriate to the application of purlin trolley systems:

BS 5427:1996	Code of practice for the use of profiled sheet for roof and wall cladding on buildings. Design
BS 6229:2003	Flat roofs with continuously supported coverings. Code of practice

4.3.1 The Work at Height Regulations 2004

The following Regulations and Schedule sections of the forthcoming Work at Heights Regulations 2004, apply to the use of purlin trolley systems:

Regulation 7 – *General principles for selection of work equipment for work at height*
Regulation 8 – *Requirements for particular work equipment*
Regulation 10 – *Fragile surfaces.*
Regulation 12 – *Inspection of work equipment*

SCHEDULE 1: REQUIREMENTS FOR GUARD-RAILS ETC

Parts 2-6

SCHEDULE 2: REQUIREMENTS FOR WORKING PLATFORMS

Part 2. *Condition of surfaces*
Part 3. *Stability of supporting structure*
Part 4. *Stability of working platforms*
Part 5. *Safety on working platforms*
Part 6. *Loading*

Appendix 5 details the contents of the above sections of the Regulations. It is important to note that the above references may be subject to change as the regulations evolve through consultation and subsequent amendment; however they are accurate at the time of submission of this report.

4.4 TYPES AVAILABLE

This research has identified only two systems available to the construction industry, and information contained within this Chapter is based on these systems.

The systems are prefabricated trolleys that are attached to a safety deck, which is adjustable to various purlin spacings, and are positioned just below the purlin surface. The safety deck ensures fall prevention between the trolley and the open edge of the roofing sheets being fitted. A fixed double guardrail is attached to the decking on the leading edge, (i.e. the opposite side to that being worked on). The working edge is protected by a support framework, positioned between the roof purlins, which prevent the operative falling into the gap when the trolley is moved along as the installation progresses. The decking unit is attached to purpose designed trolleys, which are moved along the purlins at roof level. Plate 2 shows the main component parts of the purlin trolley system (supplied by Jayeff).

Plate 2: Main Components of purlin trolley system (*Jayeff's Leadguard*)

When selecting a safety system for use during industrial roof work, there are various choices by the designer or constructor, which affect the situation facing the roofers on site:

> material specification; surface finish; durability of materials; installation of the roof; access to the roof (during installation and post-construct); loading of the roof (during construction and post-construct); accessories for fixing the roofing materials during construction; position of anti-sag bars and trimmer steel (if applicable); pitch and curvature of the roof (profile); thermal insulation and/or roof linings; composite panels (weight, fragility, length, shape); roof lights; pipe and flue flashings; ridges and ridge ventilators; roof edge protection (during construction and post-construct); gutter configuration.

Any one, or a combination of these, will have an effect on the selection and use of the safety system.

Purlin trolleys are suitable for both pitched and curved roofs with a range of accessories, including a double safety deck, which protects the operatives on both sides of the working platform when re-roofing existing buildings. The purlin trolleys are available to suit all lengths of roof slopes.

4.4.1 Materials Used

Typical component parts of the purlin trolley include:

- Decking/staging (preferably non-slip)
- Integral handrails
- Toe board protection (net or equivalent)
- Protection staging/framing, which is adjustable to suit differing purlin centres
- Bracketry appropriate to the individual system, which assists in the installation and moving of the system when in-situ
- Connection devices to hold the system in place, and affords ease of movement during use

Both trolley systems are technically similar and include comparable materials in their design:

Fragility

When discussing safety systems for industrial roof work, concerns about roofing material fragility were frequently mentioned. It is important to ensure that, as much as possible, roof sheeting is not fragile. The current test, accepted by HSE, to classify non-fragile materials is contained in the Advisory Committee for Roofwork (ACR) document, '*Test for Fragility of Roofing Assemblies' (Second Edition)*, ACR[M]001:2000. Further information on the content of this new HSE-approved document is contained within Appendix 6, including details on the testing and fragility requirements under this guidance[3].

4.4.2 Manufacture

Both organisations identified are roofing contractors who manufacture their own purlin trolleys. Both systems perform the same function but, due to the differing materials used, are manufactured using slightly different techniques.

In general, specific components are bought in from various external sources and the manufacturers will assemble these at their premises to form the purlin trolley system. Some components are fabricated by the system manufacturers, however the majority are sourced externally. The main components are aluminium or steel. Aluminium is used to keep the system's weight to a minimum; however, steel is used where more strength is required.

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[3] *Further research into fragility, and other roofing issues, is included in the forthcoming DTI (Department of Trade and Industry) PII (Partners In Innovation) 2002 publication entitled; BRE34 'A radical approach to designing out health and safety risks in roofing'. The project is BRE led via a committee of roofwork experts and looks at: unguarded edges, fragility, untrained roofers, etc. A questionnaire for organisations with an interest in these areas can be found at: www.projects.bre.co.uk/saferoof*

4.5 TRADE AND INDUSTRY ORGANISATION

Purlin trolley systems are not governed by any regulatory authority, such as fall arrest nets are by FASET (see Chapter 5). However, both trolley manufacturers are primarily roofing manufacturers and installers, therefore this Section provides information on industry-recognised regulatory bodies.

The National Federation of Roofing Contractors (NFRC) is the UK's largest trade association for the roofing industry. The NFRC covers over 45% of the UK and Irish roof contracting market and embraces approximately 800 contracting company branches and franchises, and 120 manufacturers and service providers. Further information on NFRC can be found in Appendix 7. Other organisations representing 'roof work' include:

- British Cladding Council (BCC) – (Tel: 0161 748 1527)
- Confederation of Roofing Contractors (CRC) (www.corc.co.uk)
- Fibre Cement Manufacturers Association (FCMA) (Tel: 01434 601393)
- Flat Roofing Alliance (FRA) (www.fra.org.uk)
- Independent Nationwide Federation of Rooflight Manufacturers (INFORM) (www.rooflights.org.uk)
- Institute of Roofing (IoR) (www.instituteofroofing.org.uk)
- Metal Cladding and Roofing Manufacturers Association (MCRMA) (www.mcrma.co.uk)
- National Association of Rooflight Manufacturers (NARM) (www.rooflights.org)
- Roofing Industry Alliance (RIA) (www.riahallmarked.org.uk)

4.6 INDUSTRY PERCEPTION AND EXPERIENCE

This Section draws on experiences of industry practitioners, supervisors, and users of purlin trolley systems. During data collection, the research team experienced difficulties in tracing and interviewing users of the systems, because many users were contracted-in (i.e. self-employed or labour only) roof workers, thus were transient and unavailable.

HSG33 Health and Safety in Roofwork (paragraphs 139-140), states that where purlin trolleys are used:

- There should be a safe system for installing and/or assembling them on the roof specified in the method statement
- The trolley attachment/locking system should be appropriate to the purlin design
- A safe system for moving the trolleys should be established
- The joints between the purlins must allow the trolley to slide freely. Even minor misalignment can cause the trolley to jam and lead to unsafe systems of work
- There should be a safe means of access to the trolley
- When used as edge protection, the trolley must always be locked in position so that it can resist the turning moment of a person falling onto the guardrail
- If there is a risk of falling from the end of the trolley, e.g. at an unprotected ridge, a suitable barrier should be provided

Industry requires information from manufacturers on the construction tasks that are most suited for the use of purlin trolleys. This will assist in the planning process and should be communicated clearly in the method statement. This will be discussed in Section 4.6.1.

Work sequence

Tight construction programmes dictate construction methods, and the roofing contractor inherits residual risk, if not involved and thus able to eliminate it at design stage.

The traditional method of constructing an industrial roof is a liner sheet, 2 layers of mineral fibre, and a top sheet. Composite roof panels (i.e. a single panel that incorporates the liner, mineral fibre, and top sheet) are also used. These panels represent a shift from traditional industrial roofing components to comply with the current Building Regulations (Part J in England, Part L in Scotland) on environmental performance. This research provided anecdotal evidence that insurers are sceptical of the benefits of composite panels due to an increased risk of potential combustibility. The composite system is believed to save installation time. However, with supplementary fixings required, such as spacers, and increased weight in the panels, these are not always the most appropriate system.

If using the traditional installation method, the most common work sequence is to 'tray out' the whole roof space with liner sheets, then move back and install the remaining system components. This provides water-tightness at an early stage. However, there is a problem with fragility with this method, as discussed in Appendix 6.

Transfer of roofing materials

The transfer of roofing materials should be carefully planned to ensure that all operatives are not subject to increased risk. It is important to ensure that the loading of materials on to the roof structure is always on the working edge, and not the leading edge of the trolley system. Loading materials from ground to roof level is an important activity and consideration must be given to:

- The location of material loaded onto the framework – will this affect the manner in which work can be undertaken safely
- The methods that will be used to load these materials at roof level – safe access will be required at roof level for operatives to guide and temporarily store materials
- When located at roof level, safe access will be required from material location to final fixing location

If the materials are incorrectly loaded, the trolley system will need to be dismantled or the materials moved at roof level incurring unnecessary risk. Roof workers should not be required to climb over the guardrail protection into an exposed area to retrieve materials (see Plate 3). Planned movement of materials should follow the principles listed:

- Materials are delivered, as required, to a loading bay at the gable end
- Materials should be fed in from behind the leading edge by way of an appropriate lifting device, e.g. crane or tele-handler
- Work is co-ordinated so that open edges are minimised

- Where work on adjoining slopes is out of phase (often the case at ridges and valleys), suitable barriers must be provided at open edges
- The roof sheet length should match the trolley length

Plate 3: Loading roofing materials to safe zone on roof (*supplied by Rossway Dowd*)

Environmental factors

Roofing works are carried out at height. Thus, some weather conditions increase the operative's exposure to risk. When using purlin trolley systems, industry should adopt work practices preventing exposure of roof workers to weather conditions that make their task more dangerous:

> "*If it was deemed too wet to use the system, it would be too wet to go onto the roof, in any case – we work it with general roofing rules*"
> (Operations Director, October 2003)

Due to changes in the UK climate, work at height is subject to increased wind conditions. Carrying roofing panels in wind can prove a dangerous task (sometimes referred to as 'sail effect'), therefore, the security of having a handrail close to the working edge to use for stability can provide greater security than, for example, fall arrest nets.

Alternative systems

The main alternative to purlin trolleys is safety netting. The purlin trolley industry feels that on many occasions nets are selected as the preferred safety system due to HSE's stance (in HSG33) that netting is the preferred method of fall arrest:

> "*Industry is biased toward nets, then when a job comes up that can't accommodate nets, the main contractor goes away scratching his head – the trolley might be the only way to do it safely*"
> (Manufacturing Director, August 2003)

In a few construction projects fall arrest nets are the only option, due to roof shape and/or configuration. However, circumstances can exist where purlin trolleys are the only system that can be used; for example, in warehouse re-roofing projects where there is insufficient space above stored materials for the nets to deflect under a faller (such as in whiskey bonds).

Contrast of systems

The hierarchy of risk control, described in Chapter 3, should be considered prior to selecting a safety system and the interaction of trolleys with harness and lanyard use is important in respect of the hierarchy preference for general rather than personal protective equipment.

Each system needs to be considered for the job it is expected to support:

> "*Dependant on the size of job; the trolley is better used on bigger jobs*"
> (Manufacturing Director, August 2003)

It has been suggested during the research that the safest method would be to use two safety systems (e.g. netting and trolleys), however, this was considered, by practitioners, to be too costly. The alternative to two systems is to scaffold the whole working area and install a crash deck; again, this rarely happens due to cost constraints. The research team believes that further consideration of purlin trolley use in conjunction with safety nets is required. Netting is normally allowed for within the CDM construction phase health and safety plan and the safety cost of the trolley is marginal being, typically, absorbed by the roofing contractor as his own preferred production and safety system. The cost argument should be re-visited to ensure that the grounds for rejecting dual systems are objective.

4.6.1 Advantages and Disadvantages

This Section deals with the advantages and disadvantages of purlin trolley systems. Purlin trolleys are included within HSE's HSG33 document as a recognised safety system. Some criticisms contained within HSG33 do not support the use of purlin trolleys; however, manufacturers have further developed the systems so that the factors criticised within the publication have been addressed.

Manufacturers of the systems are confident that their product is safe, if used properly:

> "*The only problems that have ever arisen with the trolley have been caused by human error*"
> (Specialist Roofer, October 2003)

Advantages

If used correctly, purlin trolley systems can provide fall ***prevention*** and are therefore higher up the hierarchy of risk control than, fall arrest nets or most line and harness systems. At worst, the user would experience a fall on the level

When in position, and operatives remain within the guard-rail throughout their activities, it is a passive system and users do not experience problems associated with active systems, such as

forgetting to clip on. However, it must be noted that supplementary PPE is required for set-up and dismantling of the system

The exposed leading edge is protected at all times, prior-to and following roof sheet installation, as the double guardrail is always in front of the roofing operations

The systems are not restricted by roof size or shape, and has the flexibility to cope with non-standard roof shapes, for example, barrel vault roofs. However, in such scenarios a line, harness and lanyard is required when climbing to the apex of the roof, as the edge protection may not be of sufficient height to protect the worker. When installed, it provides a mobile safety platform with required flexibility for roofing work

The systems provide a safety deck for the users to walk on, and to store their hand tools on. If properly controlled, there is little risk of any tools or materials dropping through the system

Due to the nature of the system, manufacturers report that the users have more confidence during the roof works. However, this increased confidence must be guarded against to ensure it does not develop into decreased awareness levels, leading to risk-taking tendencies

The system provides protection at the leading and working edge, thus the need for a fall arrest system below the roof is eliminated for the roofing operations. However, precautions may be required to guard against falling materials or tools

No access is required to the area below the roof for the installation and use of purlin trolley systems. Therefore, it is suitable during, for example, swimming pool construction, or refurbishment works where services are attached or close to the roof that will make it difficult to install other systems, for example, nets by abseiling

Purlin trolleys are suited to works where the ground conditions have yet to be brought up to a standard that could support plant or machinery required to assist in the erection of alternative systems. Therefore, it is not necessary to prepare expensive ground conditions to suit MEWPs, and other access equipment, which may be required to install other safety systems. This could assist the construction programme by ensuring the building is watertight at the earliest opportunity

When compared to safety netting, purlin trolleys are reported to be less costly to hire and they improve roofing productivity due to the definite interaction with the roof installation. The risks associated with net installation are also eliminated. Installation time used to be extensive; however, the speed of modern systems is much improved on earlier designs

If installing liner sheets that are classed as ‘fragile’ under ACR guidelines (see Appendix 6), the system provides fall prevention during the process of bringing the roof surface up to a ‘non-fragile’ condition

When using the system, the roofer can monitor the components and performance of the platform, whereas this is not the case with fall arrest nets as someone other than the roofers installs this safety system

Safe access is created for inspection and supervisory staff, who may wish to inspect the roof during construction

Disadvantages

The roof design will affect ability of the system to perform its function. For example, if there were anti-sag bars fitted to the roof structure, it is likely that the trolley would be obstructed; unless the design has taken prior account of this. The span size of the roof will determine how much of a problem this is

When used on barrel-shaped and half-barrel shaped roofs, problems arise with the permanent edge protection where the operative is raised so that the guardrail is no longer at waist height. This is a common roofing problem normally solved by using treble perimeter guardrails, however, these systems are known for their lack of rigidity in such circumstances

Purlin trolley systems can be bulky and awkward for the users, especially those who are unfamiliar with the workings of the system. Like all safety systems, experience of use is crucial for this system

The systems may be used infrequently, which can lead to the components not being regularly maintained. If a system is not used for a long period, then is used on site, there can be lubrication problems of the moving parts that make up the system. The principles of the Provision and Use of Work Equipment Regulations 1998 should be adhered to at all times, as described in Section 4.3

Problems can exist in the control of loading out the roofing materials, unless this operation is planned. If packs of materials are loaded out in the conventional way, they can be ahead of the leading edge, (common in the early stages of the roof construction). This could entail operatives scaling the leading edge and venturing into unprotected areas

Personnel walking around areas of the roof leads to difficulties of control. Multi-disciplined personnel are difficult to supervise and control due to the nature of construction systems and complexities of the construction process. However, close supervisory control and personal discipline is essential and is a management responsibility that must be addressed to avoid potential risks of personnel moving outside the protection of the trolley system without adequate PPE

Opinion recorded in this research has suggested that trolley systems are not recommended for use on smaller jobs, as they are considered to have too much preparatory set-up work involved to justify consideration

4.6.2 System Use During Maintenance and Refurbishment

Purlin trolley systems are designed primarily for use during the construction of industrial roofs during new build. During data collection, one particular industry challenge appears to have been addressed by using (modified) purlin trolley systems; that of re-roofing existing whiskey bond roofs. In this situation, the frames supporting the casks reach from the floor to just below the ceiling, making fall arrest nets unacceptable due to lack of the required clearance for accommodation of safety nets, or their deformation under a faller:

"*The problem is, in some cases, it's difficult physically to use nets. The good example I can think of are whiskey bonds, which are nearly all covered in asbestos, and the whiskey is stacked right up to within 6-inches of the roof, you just physically can't get a net in. The re-covering, particularly of whiskey bond roofs, is a serious problem*"
(HSE Principal Inspector, April 2003)

However, if the existing roof were due for over-cladding with a new roofing skin, purlin trolleys cannot be considered as they must be situated between the purlins and this cannot be achieved if the existing roof system remains in place.

If purlin trolley systems are considered for refurbishment works, attention must be paid to the load-bearing capabilities of the existing structure. The existing purlins must be capable of sustaining the loading of the purlin trolley. Further, the success of the system is dependant on the purlin centres being within tolerance for the trolley wheels, in order that the trolley can travel the length of the roof without the risk of jamming:

"*These are old buildings where the purlins may not be very good at taking trolleys because they may well be all over the place*"
(HSE Principal Specialist Inspector, April 2003)

The purlin trolley could be the most appropriate system in the replacing of existing whiskey bond roofing, however it appears that the systems are not being used extensively in this situation:

"*[Some contractors are]…still using crawling boards on some industrial roofs but not doing it very well, and acres and acres need replacing over next 20 or 30 years*"
(HSE Principal Specialist Inspector, April 2003)

Plate 4: Modified purlin trolley in a roofing refurbishment situation. Note the old and new roofing covering. Edge protection should be provided under such circumstances.

4.7 TRAINING STANDARDS

The Federation of Master Builders states that there are approximately 45,000 people employed in the roofing industry with approximately 2,000 joining annually and, of these new entrants, only 300-400 are formally trained in trade skills (www.fmb.org.uk). These figures show that there is a major shortage of training of roofers in industry. If this figure is accurate, training roofing operatives in the safe use of an individual safety system may prove difficult if they have received no other formal training for their trade. The Major Contractors Group's (MCG) initiative, the Construction Skills Certification Scheme (CSCS), has a trade area for 'Roof Sheeter and Cladder', which all trades-people in this industry must conform to if they are to seek employment on MCG construction sites in the UK[4]. This Section will discuss the training requirements for the safe and efficient use of purlin trolleys.

- Leading edge protection systems require a trained and competent workforce; not only training on the system components, but training about the risks involved in carrying the trade tasks and in using the system. Today's purlin trolley systems are highly engineered equipment; therefore, users require technical training in the operation of the system.

To ensure that operatives are appropriately trained in the installation, use and dismantling of purlin trolleys, the following list provides guidance:

- Every project is unique, therefore training is specific to each individual job
- Training should be given prior to using the safety system, for those who will be using the system, i.e. supervisor training, and understanding information within the risk assessment and method statement
- This training is provided when the system is delivered to site. In this way, training is provided immediately prior to, and during first use of the system. Communicating information to the workforce is via tool box awareness talks and demonstrations, based on from information contained within the method statement
- An instructor will take the operatives through all workings of the system
- If the system is on continuous hire, it must be checked that it is the same squad and supervisor using the system, and induction training provided to all new squads
- Feedback to trainers is important; if the equipment is consistently being misused or abused, this might highlight a training issue, and should be addressed

The trolley systems are normally available on a hire-only basis. Depending on the hirer, subcontractors may install and dismantle the system by themselves, or rely on the expertise of the manufacturer. In either situation, the subcontractor's operatives will require training in the appropriate use of the system. Therefore, time has to be made available for the operatives to be trained properly.

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[4] *CSCS aims to register every competent construction operative within the UK not currently on a skills registration scheme. Operatives will get an individual registration card (similar to a credit card), which lasts for three or five years. The CSCS card also provides evidence that the holder has undergone health and safety awareness training or testing. (www.cscs.uk.com)*

4.7.1 Rescue

The system is fall prevention and not arrest, therefore, rescue is not as much of a concern as with other systems within this report. However, that is not to suggest that using a purlin trolley system negates the need to provide adequate rescue information and training. Trolley systems are designed for use at height, thus consideration must be given to the practicalities of retrieving people from height if they have received injuries from an accident, or have suffered some other form of disabling medical emergency. This subject should be covered in the risk assessment and method statement.

4.8 INSTALLING AND DISMANTLING

The systems can be assembled on the ground and hoisted into position, or assembled on the roof surface. The assembly method will be guided by the risk assessment. The trolleys can be assembled using conventional roofing tools that the roofer will be carrying, thus eliminating the requirement for further equipment to be carried.

The method employed for installing and using the purlin trolley will depend on the building being constructed. Risk assessments will be required to ensure that ancillary safety equipment and procedures are provided and communicated to the roofing personnel. Installation and dismantling of the system involves time and co-ordinated effort by trained personnel:

> "*There is work involved setting the system up, and it is ultimately dependant on the profile of the roof – this determines how long installation will take (usually 1-2 days)*"
> (Specialist Roofer, October 2003).

There are risks involved when installing and dismantling. However, as the system is normally erected and dismantled once per roof slope the operative's exposure to risk is limited to these activities.

Once installed, the trolley runs along the length of the roof purlins. The decking and working edge protection features can be altered/adjusted to suit the purlin spacing. Modern systems can be used without having to readjust and reposition once they are set up, and can be used for the full duration of the roofing activity; this depends on the roof profile:

> "*…by selecting a purlin system compatible with the trolley system, e.g. no sag bars, no plant support steelwork penetrating the roof etc.*"
> (Manufacturing Director, August 2003)

If two slopes of a roof are being constructed simultaneously, this must be controlled to ensure that both pitches progress at the same speed (see Plate 5). Should one pitch progress at a different speed, barriers must be installed at the ridge:

> "*…problems can occur when doing two slopes of a roof at the one time – if this is not managed correctly, and progressed simultaneously problems of exposed edges could arise*"
> (Specialist Roofer, October 2003)

Equipment required

Supplementary plant, for installation and dismantling of purlin trolley systems, is expensive to hire. However, it is only required for these short periods and can be programmed to keep the costs at a minimum. The costs of equipment hire are dependant on duration required and location of the site. The required plant, for example, a crane, telehandler or scissor lift, may be available on site, for other works, and obtainable at short notice. The hire duration and cost of this plant are reportedly not as large as for other safety systems, for example, mobile elevated working platforms used to install safety nets.

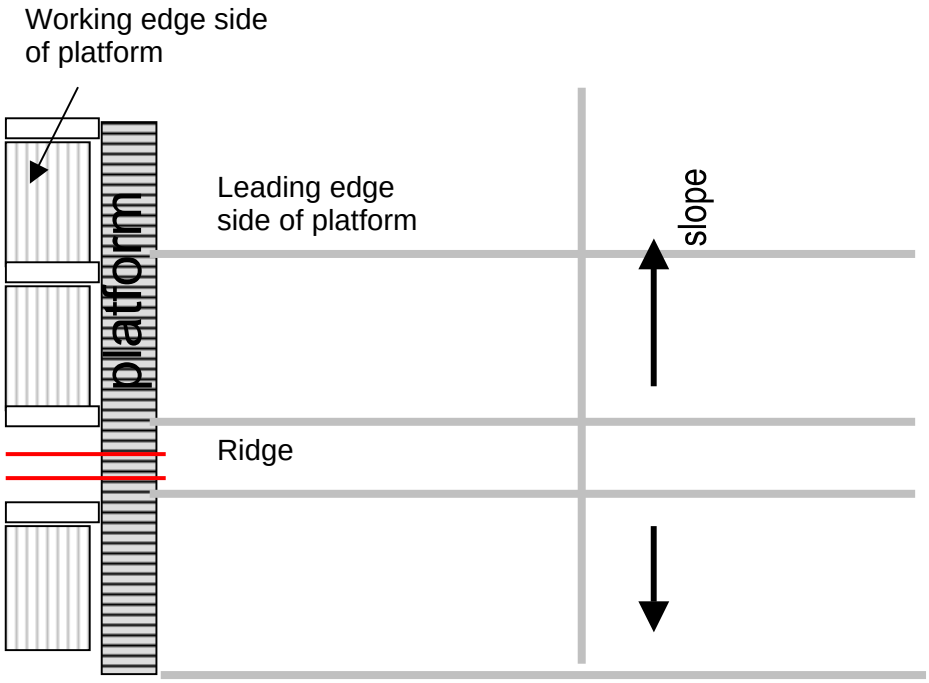

Plate 5: Sequence of two roof slopes progressing in tandem (*adapted from Rossway Dowd information*)

4.8.1 Loading on the Structure

Industry members expressed concerns about the loading that is placed on the structure when using purlin trolley systems, and the effect that this loading would have on the structure's integrity. These loadings have been addressed through system development, with newer systems being lighter than earlier versions:

> "*It is as lightweight as it can be, taking into account what it is there for; to take a man's weight during working and in the event of a fall*"
> (Specialist Roofer, October 2003)

A further concern was that of material storage both on and in the vicinity of the system, which impose further loading on the structure.

The systems available weigh 90-120Kg per linear metre, thus the user must seek assurances from the structural engineer that the portal frame and purlins are strong enough to take this weight during roof construction. Again, this highlights the importance of early contractor involvement in the design process to ensure that provisions are made for the safety system.

4.8.2 Method of Installation

Typically, the purlin trolley system is hoisted into position at the roof edge. Supplementary PPE will be required for the operatives on the roof who are connected (via harness and lanyard) to the perimeter guardrail during the installation procedure. The trolley rests on the roof purlins, and is held in position by the weight of the system. The purlin trolley system rolls over the purlins and is locked in position via a braking mechanism when the desired position has been reached.

4.8.3 Sequence of Dismantling

Dismantling the purlin trolley is simply the reverse of the installation. This procedure is slightly easier as the roofers now have a place on which to stand, as the roof is complete (or non-fragile) up to this point.

During roof construction, the roof panels are installed from eaves to ridge to full slope length; subsequent panels are installed from eaves to ridge until end of the roof is reached. At this point, the trolley is craned off or partially dismantled and left on the newly laid roof, pending removal; the operative is then harnessed to the structure to provide active protection for laying the final sheets.

4.9 MANUAL HANDLING

Manual handling during roof work should be considered when selecting an appropriate safety system. The heavy tasks associated with installation and dismantling of the system are reliant on ancillary plant, therefore much of the physical strain should normally be removed from the operatives.

Manual handling is not such an issue of concern for purlin trolleys because it is too heavy too lift, thus all lifting is done by mechanical means. Once in position, the trolley is pushed along the purlins to the length of the safety deck, thus force is required to be applied to the trolley from the operatives. The trolley length will determine the number of operatives that will be required to move the system, as it is required to move laterally. The system is moved once the new area of roofing is considered non-fragile. Depending on the roof size and profile, the trolley could be in position for extended periods of time, thus it does not require frequent manual handling:

> "*When we're using the system, we are not constantly moving it – it is only moved every so often on completion of a phase of sheeting…it has no serious effects on us*"
> (Specialist Roofer, October 2003)

4.10 INSPECTION AND MAINTENANCE

All parts of the system should be regularly inspected by a competent person, with the findings suitably recorded. Trolleys should be inspected prior to use, during use and before storage on completion of use, as per PUWER 1998.

Due to the robust nature of the system, little maintenance is required during its use; thus, most maintenance is carried out in the factory. The systems are inspected prior to going out on hire, and on return from hire. The systems are designed for exposed use on site, and both manufacturers believe the systems are over-designed to provide safer working conditions.

4.10.1 Monitoring and Supervision

Appropriate monitoring and supervision of purlin trolley systems should include:

- Checking operatives' training, competency and understanding of the work method
- Supervising the use of the safety equipment, ensuring that:
    - the purlin clips are installed correctly
    - the safety decks are fixed correctly
    - the handrails and toe boards are in position, etc
    - the system is being moved properly
    - the brakes are being used
    - the system is not being overloaded with tools or materials
- Coordination of all trades on the roof, and of the roofing progress (to ensure roof pitches progress simultaneously)
- Control of people, e.g. ensuring no stepping out-with protected areas, or over fragile materials
- Control measures, such as signs are properly displayed and understood

Purlin trolleys are available to industry on a hire only basis, and are not for sale. This assists quality control over the product. Each trolley is recalled after every job, inspected and tested prior to being released back out to site.

With numerous components making up a roof structure, the risk of falling materials increases. Fixings, tools and equipment must all be kept under close supervision to ensure that nothing is in danger of falling. Reliance on debris nets is inappropriate.

Monitoring correct use of the equipment is simplified as the trolleys are specially designed for their intended purpose:

> "*Once the system is in position, it is very difficult to do anything else with the system other than what it is designed for*"
> (Manufacturing Director, August 2003)

4.10.2 Maintenance of Equipment

Only ***minimal*** repairs, for example lubrication of moving parts, should be carried out by personnel other than the manufacturer. In all other cases, the manufacturer will carry out necessary repairs, as reported through the inspection regime adopted by the hiring organisation.

The system components will require inspection and maintenance. There are numerous components, probably spread over a sizeable area. Examples of maintenance requirements are: all moving parts are lubricated; bolts or rivets are checked and tightened; handrails and safety deck are checked for rigidity and re-secured (bolted or welded); the working platform is cleared of debris and free from damage. Manufacturers recommendations must be followed and, if appropriate, their assistance obtained.

Information on all maintenance carried out should be recorded and be available for audit purposes. Quality control of the systems, between uses, is important:

> "*When it's brought back to the yard…the system will not be released back into industry until it has been inspected and brought up to scratch*"
> (Specialist Roofer, October 2003)

4.10.3 Storage and Transportation

The systems are made up of a series of components, which can be dismantled into smaller units for ease of transit and storage. They are transported to, and from site by articulated lorry suitable for transportation of scaffolding materials. When not in use, the components are stored either in purpose-made crates or in areas appropriate to storage of scaffold materials, i.e. clean, dry, elevated, free from direct sunlight, chemical attack, etc.

4.10.4 Typical Life Span

There is no set lifespan for purlin trolley systems. Each platform is manufactured for a particular application, thus is normally used only for that job. The components are re-used in a new application, with an inspection and maintenance regime ensuring that each new system is safe prior to leaving the factory. The system lifespan is dependant on site use and exposure to the elements. The non-metal parts of the systems, for example, the nylon rollers, may require changing during the lifetime of the system, however at this time a suggested lifespan for the whole system is 10-years.

4.10.5 Disposal of Damaged Materials

The disposal of damaged or irreparable system components is treated similar to scaffold components, in that they would be placed in a designated quarantine area, then taken to a scrap yard for recycling if appropriate (steel and aluminium). The remaining materials that cannot be recycled would be disposed of in the normal manner for construction waste. The component parts are specific only to purlin trolley system, thus the potential for re-use or misuse of individual components is greatly reduced compared with, for example, safety nets that are beyond their serviceable life.

4.11 SUMMARY

To reduce the risks faced by roofing workers, safe systems of work must be adopted. Purlin trolleys are fall prevention equipment. Purlin trolley systems are used as an alternative to safety nets. Nets are often selected as the preferred safety system because of HSE's stance, in HSG33, that netting is the preferred method of fall arrest. This view requires to be reconsidered in HSG33.

HSG33 '*Health and Safety in Roof Work*' negatively describes the early forms of purlin trolleys, and is now considered out-of-date. These systems have also proved suitable for numerous roof designs, for example, barrel vault roofs.

Although not governed by specific guidance or trade authority, the purlin trolley is a system that has been innovated by the roof industry, for the roof industry, and is suitable for many industrial roofing situations.

- The transfer of roofing materials should be carefully planned to ensure that all operatives are not subject to increased risk. Roof workers should not be required to transfer over the guardrail protection into an exposed area to retrieve materials.

- When using purlin trolley systems, good work-at-height practices should be adopted, and roof workers should not be exposed to weather conditions that make their task more dangerous.

Purlin trolley systems are essentially ***passive*** systems and users do not experience problems associated with ***active*** systems, such as forgetting to clip on. The exposed leading edge is protected at all times, prior-to and following roof sheet installation, as the double guardrail is always in front of the roofing operations. The systems provide a safety deck for the users to walk on, and to store their hand tools. No access is required to the area below the roof for the installation and use of purlin trolley systems.

The systems are sometimes used infrequently, which can lead to the components not being regularly maintained, unless a robust maintenance regime can be quality assessed, as per Regulation 5 (1) of PUWER 1998.

Leading edge protection systems require a trained and competent workforce. Safe and appropriate use depends on competent and correct behaviour by the installer and users. The roofing contractor's operatives will require training in the appropriate use of the system, therefore, time has to be made available for the operatives to be trained.

The systems can be assembled on the ground and hoisted into position, or assembled on the roof surface. The assembly method will be affected by the risk assessment. Once installed, the trolley runs along the length of the roof purlins.

Supplementary plant is required for installation and dismantling. Therefore, much of the physical burden is removed from the operatives. The hire costs of this plant are not as large as the costs associated with other safety systems, for example, fall arrest nets.

The user must seek assurances from the structural engineer that the portal frame and purlins are robust enough to take this weight during roof construction.

Purlin trolleys are available to industry on a hire only basis, and are not for sale. This helps to ensure adequate quality control. Monitoring correct use of the equipment is simplified as the trolleys are difficult to use for any other than their intended purpose.

Storage relies on supplementary plant to aide this process. The systems are made up of a series of components, which are transported to, and from site by articulated lorry. When not in use, the components are stored either in purpose-made crates or in areas appropriate to storage of scaffold materials.

In conclusion, the advantages of these systems appear to be underestimated. The systems included within the research have undergone re-evaluation and modification to become the systems available today, and appear to have significant benefits under appropriate circumstances.

5.0 SAFETY DECKING

5.1 INTRODUCTION

The protection of people whilst working at heights continues to grow in importance. In relation to working at heights on tasks such as the installation of block and beam floors etc, lightweight safety decking systems have emerged. These systems act as a means of ***preventing*** falls and thus they are a more fundamental risk control solution than systems that aim to mitigate the consequences of a fall, for example, fall arrest mats. Thus, safety decking sits higher in the hierarchy of risk control criteria set out by The Construction (Health, Safety and Welfare) Regulations 1996 (CHSWR), The Management of Health and Safety at Work Regulations 1999 (MHSWR), and the forthcoming Work at Height Regulations 2004 (WAHR), see Section 5.3.1.

There are numerous manufacturers of decking systems available to industry, all using different names for their products. For the purposes of this report, all will be globally referred to as safety decking. There are two types of safety decking covered by this research; decking panels supported by props (hereafter referred to as '*Propped Safety Decking*' [PSD]), and extendable aluminium trellis decking (hereafter referred to as '*Extendable Aluminium Trellis*' [EAT]) – both will be further described in Section 5.4.

For the purposes of this report, safety decking is classified as 'work equipment' under the Provision and Use of Work Equipment Regulations 1998 (PUWER). Regulation 2, *Interpretation*, of PUWER states the following:

> *"work equipment" means any machinery, appliance, apparatus, tool or installation for use at work (whether exclusively or not)*

The emphasis on PUWER for safety decking is that such safety systems conform to the definition of work equipment and the general principles of: installed for stability, inspected and maintained by a competent person. The following Sections will explain the most relevant regulations relating to safety decking.

Safety decking will only prevent the fall if installed in the correct manner. If the equipment is installed so as to still provide some form of trip hazard, the risks could be greatly increased (especially if the decking is installed in high structures). Many reported falls in construction are from a slip or trip on the level leading to the fall from height (often high fall) at an unprotected or poorly protected edge, therefore, the importance of correct installation cannot be understated.

5.2 HISTORY OF SAFETY DECKING

PSD and EAT are recent systems, most systems covered by this research being less than 3-years old. The PSD system was first widely promoted to industry when the earliest of the systems studied in this research was evaluated in the Construction Industry Training Board (CITB) video '*If you should fall*' in 2001 (© CITB, 2001); though it had been available to industry for a number of years prior to this time (www.safetydeck.net). Since publication of this video, other manufacturers have developed products to prevent falls in a similar manner.

PSD can be construed as an innovation evolved from scaffold crash decks. Their advantage is that they are simpler, quicker, and cheaper to erect than scaffold protection structures. These systems were originally intended to provide just fall arrest, with the deck elevated to a position just below the working surface. This original concept has been further developed, in more recent systems to provide a more rigid and stable working platform formed from relatively light components, which are simple to erect.

EAT systems were developed to combat problems faced by operatives installing roof trusses: there is nowhere for them to stand when fixing and bracing the trusses; and satisfactory anchorage points for personal fall arrest equipment are often difficult to find. The trellis innovation protects these operatives by providing a temporary work platform.

With the influence of the hierarchy of risk control, industry's standpoint on safety systems selected has evolved; from a heavy lean towards PPE, to consideration of systems that satisfy the upper levels of the hierarchy. Safety decking satisfies the hierarchical requirements by acting as a preventative fall work platform, and also as passive, collective fall prevention for all operatives working on the systems.

5.3 LEGISLATIVE HISTORY

Further to information contained in Section 3.2 (Generic Legislative Guidance) of Research Report 4372/R33.105, the following Regulations are appropriate to safety decking, being classified as work equipment:

The Provision and Use of Work Equipment Regulations 1998

Appendix 4 contains a list of the most relevant British and EN Standards relating to the manufacture and use of safety decking. The following British Standards are particularly appropriate to the application of safety decking:

BS 5973:1993 Code of practice for access and working scaffolds and special scaffold structures in steel

BS 5975:1996 Code of practice for falsework.

These Standards will be referenced as appropriate throughout this Chapter.

5.3.1 The Work at Height Regulations 2004

Safety decking is subject to the requirements of the forthcoming WAHR, which set a hierarchy, in accordance with the principle of collective protection, for the selection and use of safety equipment for all work at height.

The following Regulations and Schedule sections of the forthcoming WAHR, apply to the selection and use of safety decking:

Regulation 2 – *Interpretation*
Regulation 6 – *Avoidance of risks from work at height*
Regulation 7 – *General principles for selection of work equipment for work at height*
Regulation 8 – *Requirements for particular work equipment*
Regulation 12 – *Inspection of work equipment*

SCHEDULE 2: REQUIREMENTS FOR WORKING PLATFORMS

SCHEDULE 3: REQUIREMENTS FOR COLLECTIVE SAFEGUARDS FOR ARRESTING FALLS

Parts 1, 2, 3 (B) & 4

Appendix 5 details the contents of the above sections of the Regulations. It is important to note that the above references may be subject to change as the regulations evolve through consultation and subsequent amendment; however they are accurate at the time of submission of this report.

5.4 TYPES AVAILABLE

There are two main categories of safety decking considered in this research. The first category is made up of plastic decking panels supported in position by props (PSD). The second is an extendable aluminium trellis arrangement, which is positioned on the joists or trusses of the roof being constructed (EAT)[5].

All safety decking systems can be described as lightweight working platforms positioned just below the working surface area and capable of supporting a person and their light tools. A fundamental principle of their use is that they are ***not*** designed to be loaded or stored with materials, for example, bricks. This is strictly countenanced.

Plate 6: EAT system used in a domestic housing setting (*courtesy of Oxford Safety Components*)

[5] *EAT systems can also be configured to be used under propped conditions by using a proprietary scaffold framework. This would be the case for the installation of attic trusses due to the number of spans between the truss support cords.*

Plate 7: Typical PDS used in a domestic housing construction setting (*courtesy of Tarmac*)[6]

Main components – PSD systems

Decking panels

Decking panels provide the platform on which operatives can stand, walk and work whilst carrying out their tasks. Various types of panel are available: panels that have numerous square voids over the surface area (see Plate 7); slatted panels (Plate 8); and solid panels (Plate 9).

[6] *Plate 7 shows PSD in more of an arrest situation than prevention and this is not the ideal situation. In essence, this installation is fall arrest (**crash deck**) and not prevention (**work platform**) [i.e. there is an unprotected edge where one could fall circa 1m]. Bearing in mind that fall height is even less of an issue under the forthcoming Work at Height Regulations 2004*

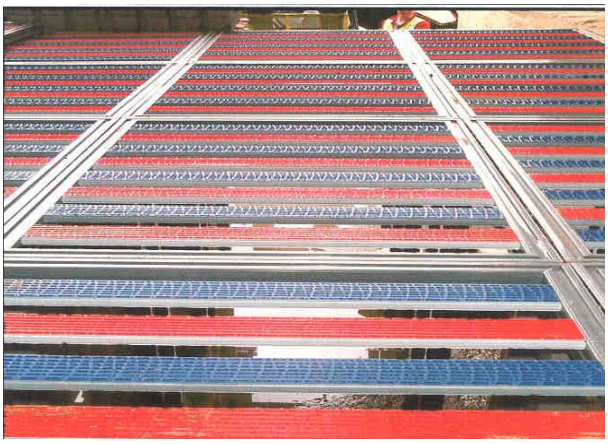

Plate 8: Slatted panel PSD system (*courtesy of HL Plastics*)
Note: Gap between 20-55mm

The size of decking panels is non-adjustable, therefore they can't be used in spaces smaller than the panel.

Plate 9: Solid panel PSD system (*courtesy of Austin Reynolds Signs*)

Props

The system support props rest on the flooring below and the system is laterally supported by the external walls. At present the props used are not extendable in any way other than by adding a collar at the bottom of the prop to raise the height. Should adjustable-height props be considered in the future, BS 5975:1996, section 3.9.6, *Adjustable steel props*, could provide guidance on loading, plumbness and general erection tolerances.

"*There should be longer legs available for different applications – the system is restricting itself by having one standard leg length…when one deck was overlapped, the leg proved to be too short to reach the floor for the appropriate support, and was sometimes propped up by a brick – we are not comfortable with this at all and feel that this should be addressed*"
(Contracts Manager, January 2004)

The development of adjustable props, similar in principle to scaffold jacks, would help overcome the potential problem of uneven, or pre-screeded, floors.

Collars

At the top of each prop on one researched system, a collar arrangement (sometimes referred to as a flange), used to connect the prop to the panel, also acts as a connector of the panels at the corners. Each panel has 5 props, one at each corner shared with adjacent panels, and one in the centre. All fittings are push fittings. The props are secured via a variety of methods, such as; tying from the top of the panels and connecting onto the poles below, or using a pin to connect the prop to the panel (see below)

Some manufacturers are currently developing prop 'feet' to fit to the base of the prop to add height to combat undulating surfaces. This component is not yet available to industry, but when available could assist with the problems faced with undulating surfaces described above. With various sizes expected to be developed, this provides partial adjustability for the system height.

Pins

On one researched system, pins are used to connect the top of the prop to the underside of the decking panel (www.hlplastics.co.uk/suredeck). The prop is pushed into the leg-top connector mouldings, and the locking pin is passed through both the retainer clip and the frame to secure the props in position (see Plate 10). There are other systems that do not use pins.

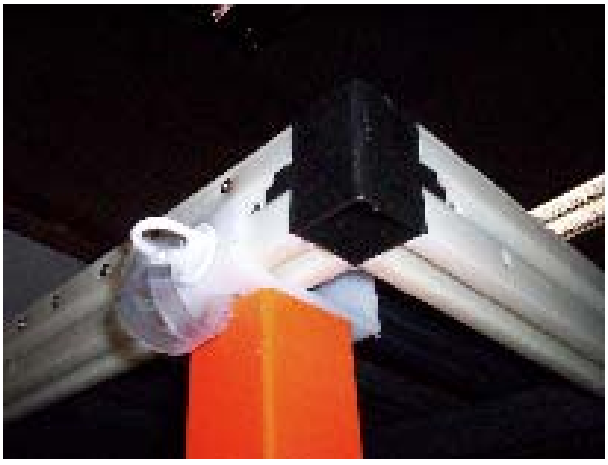

Plate 10: Pin arrangement connecting prop to decking panel (*courtesy of HL Plastics*)

Edge pieces – PSD system

To obtain a sturdy structure, PSD systems must ensure that they fit between all surrounding walls. A tight-fit at all lateral stability surfaces provides:

- Sturdiness of the decking structure
- A complete walking and working platform
- A reduction in the risks of falling persons or materials through any gaps
- A reduction in sway of the completed system

To achieve a complete fit, decking panels may have to be cut to an appropriate size (either on site or by way of utilising standard sized edge panels), or the panels will have to be overlapped (see Section 5.8).

Main components – EAT system

During data collection, the research team sought co-operation from only one manufacturer of this system (in the understanding that there was only one). Therefore, the findings (and, in particular, any technical information) are from one source.

The system works on the trellis concept of opening and closing, and the longer the trellis extends, the stronger the system becomes. The trellis is flexible so that it deflects slightly to form to the profile of the trusses on which it rests, which are not always 100% true. The trellises interlock with each other, and can provide a level trip-free platform. However, if overlapped they will provide a tripping hazard of approx 13mm. They are fitted with fabric straps to attach to the joists at each end, to restrain movement and eliminate the risk of tipping. Trellis panels are painted red at the edges to warn users of the edge of the platform. EAT systems are not reliant on props, therefore are not reliant on supporting floor conditions. Further, the system is not influenced by verticality of supports; all the system requires is that the roofing trusses or joists are in a position on which the trellis can rest. (oxfordsafety@aol.com).

A plastic-coated, insulated version is also available for use close to electrical conductors. See Section 5.6.3 for further information.

5.4.1 Materials Used

PSD systems use plastic materials, rather than metal, to take advantage of their lightweight properties. The components are manufactured from recycled PVC extrusions, with a UV-inhibitor added to combat UV rays, which cause degradation in the plastic material.

All component parts of EAT systems are manufactured from aluminium; both the trellis arrangement, and the connecting rivets. The strength of the system comes from the trellis arrangement.

5.4.2 Manufacture

As with all safety equipment, different manufacturing organisations adopt varying techniques during the development of their products. As there are various systems available in industry, this report will not describe all methods of manufacture – this would add substantial volume to the report – but will describe the principles behind safety decking manufacture.

PVC components of safety decking are manufactured by specialist plastics organisations that possess the technology to provide the moulding configurations for the various component shapes. The moulding manufacturing technique provides advantages over other forms of manufacture when the system components are formed complete with no requirement for additional cutting of the plastic, which has the potential to weaken the component at the cut area.

The trellis arrangement is manufactured aluminium square tubular sections, cut to the required size, and riveted together to form the extendable trellis. It is at this time that the manufacturer's logo and further paintwork as required would be applied.

Testing of safety decking components is out-with the scope of this research. However, the following information provides an outline of testing procedures. During system development, practical simulation tests are carried out to predict considerations that are important in ensuring that the decking remains stable and does not damage surrounding structures, whatever the climatic conditions. Testing issues include the following areas:

- Point loading
- Universally distributed loading
- Axial compression of plumb props
- Shear (out of plumb)
- Eccentric loading
- Extremes of temperature
- Degradation and deformation of materials

Testing of these systems is in line with principles laid down BS5973:1993 Code of Practice on access and working scaffolds in steel.[7]

5.5 TRADE AND INDUSTRY ORGANISATION

The safety decking industry do not yet have a regulatory body governing membership, training, quality standards, etc., such as FASET provides for the safety netting industry (see Section 7.5). The fact that a regulatory body is not in place could be viewed as detrimental, when considering the selection of a fall protection system.

> "*One of the questions that has been asked on many occasions is 'what recognised training course is there to erect [the] system?' The answer is that there isn't one, as it has no recognition or no official body overseeing it.*"

[7] *BS 5973:1993 will be superseded on 1st June 2004 with BS EN 12811-1 Temporary works equipment - Part 1: Scaffolds - Performance requirements and general design*

(Managing Director, November 2003)

Forming a new regulatory organisation has been suggested in many research consultations. Suggestions were made to approach FASET for membership (under a new safety decking branch), but anecdotal evidence suggests that FASET have yet to seriously consider embracing safety decking. With more manufacturers and distributors of these systems entering the marketplace, the advent of a regulatory authority is recommended to support and control their continued emergence as an effective and reliable piece of safety equipment.

5.6 INDUSTRY RECOMMENDATIONS FOR USE

This Section deals with recommendations for use based on legislation, guidance and direct experiences of industry personnel: from management to the users of safety decking as a safety system, collected and derived from a series of meetings, interviews and observations.

Recommendations from industry representatives confirmed that the site works and on-site conditions largely determine the most appropriate safety system to select.

> "*The works being done should be considered before deciding on an appropriate safety system – it may be that materials or tools required in the vicinity of the system could cause problems if accidents happen*"
> (Site Manager, January 2004)

For example, conditions can exist that prevent the use of PSD systems, such as where there are no walls for lateral support or the floor required for support is too far below, or is too varied in level.

Information and views collected highlight the simple format of safety decking systems as one of their most attractive features. In comparison, for example, to safety systems that rely on supplementary PPE, such as cable and track-based systems, or require additional mechanical equipment, such as air-filled mats, decking systems have a minimal number of components, are easy to erect, and provide convenient and effective access to the work face.

> "*The beauty of the system is its simplicity, and it is a brilliant step forward from the systems we used in the past*"
> (Contracts Manager, January 2004)

One of the few disadvantages is that, if overlapping is required, trip hazards are created, which can increase the likelihood of falls on the level. Manufacturers have developed various additional components to alleviate these risks, or to clearly highlight the danger that is present. For example, a removable ramp (bright yellow), warning labels on the edge of the decking panels saying '*mind the step*' or similar, or different coloured (e.g. luminous yellow) decking panels to warn of a trip hazard.

There is an emerging body of opinion that believe in using EAT systems in conjunction with soft-filled mats to provide fall prevention (trellis), and arrest (mats), in the one installation.

> "*…considered a hybrid of decking and soft-filled mats to combat the problem of the system being too low in some applications, but this then complicates what is intended to be a simple system. Although this would discourage walking on the system, it involves two suppliers and installers and leads to further administration work to control this*"
> (Contracts Manager, January 2004)

This hybrid system has cost and logistical difficulties, but there is no doubt that this is best practice.

EAT manufacturers have developed a quality control procedure in the form of a database of history for all trellis manufactured, including: when they are manufactured (date, time); where they have been or are being used; by whom, for what purpose; what maintenance and repairs have been carried out; etc. A recommendation of this research is that PSD systems also incorporate this quality control procedure.

One main recommendation for PSD was that it would not be classed as fall prevention unless it was installed as close to the floor above as possible. This requires procuring the correctly modular height at the planning stage.

The following information provides the main advantages and disadvantages of both types of safety decking.

5.6.1 Advantages and Disadvantages

The information below is derived from observations on safety decking by people in construction.

Generic advantages

Safety decking provides passive, global (or collective) protection, i.e. the user does not have to carry out an additional task, such as clipping on a lanyard, to ensure that he/she will be protected.

System components are manufactured from recyclable materials, giving an environmental benefit

The systems are quick and simple to erect and dismantle, due to the minimal number of components and simple jointing methods

The systems are classified as lightweight working platforms and, as such, provide a walking and working platform for better operative manoeuvrability in the work area[8]

> "*Decking is a good system for what we require – it provides adequate protection for the workers and assists in the construction process due to the fact that it can be walked on*"
> (Site Manager, January 2004)

The various system configurations all lend themselves to flat packing for low transportation costs

[8] *Safety decking systems have evolved from the early systems that were available. Some decking systems, particularly PSD systems, were originally for fall arrest only, and not to be walked/worked on. All PSD systems within this research focus have evolved to be classified as lightweight working platforms.*

They are strong and durable but lightweight enough to be easily handled on site

Safety decking is simple to use and cannot break down (i.e. it includes no mechanical components and requires no power source to perform its function), thus they are simple to use and cannot break down

It is obvious when the system is in place and correctly erected; and, therefore, easy to monitor

Safety decking does not need to be moved once it has been installed. The system will remain in place until the workspace above is otherwise protected

Anecdotal evidence suggests that concentration levels of operatives working above (or on), the decking increases, as they are able to concentrate solely on their job, and productivity and quality of work should benefit

Contractor's site staff will also benefit, once decking is installed and handed-over, from reduced supervision requirements, as they do not have to monitor workers to check that they are clipping-on, etc., as is the case with active systems. However, this does not remove the need to inspect the installation at periodic intervals (see Section 5.10.1)

PSD advantages

These systems are lightweight plastic and can offer cost and time savings over the traditional tube and fitting scaffold 'crash deck' solution

EAT advantages

EAT systems are not reliant on props; therefore, are not reliant on flooring conditions or verticality of supports. All the system requires is that the supporting roofing trusses or joists are in position and stable

Generic disadvantages

As the systems are relatively new to industry, there is concern that information is unavailable about what the decking components have been subjected to, during their time on site. Even after inspection, it is still difficult to gauge the damage that could have been caused to the components of the system

PSD disadvantages

Defects are not easily identified on the underside of PSD systems, as the user working above may not be aware, for example, of any defective or missing props below

If PSD systems are considered for non-standard building storey heights, the props may not be long enough to enable the decking platforms to be raised to an appropriate level. This factor was mentioned on numerous occasions

> "*The manufacturers don't provide adjustable legs for non-standard building heights – this is a hindrance*"
> (Site Manager, January 2004)

Trades altering or moving decking props to suit their own needs is a potential problem. The interfaces between trades working on and adjacent to the decking must be planned and closely monitored. Unauthorised adjustment of system components should be closely monitored

Transportation and storage requires large vehicles and space on site. This could be problematic for confined sites with tight access

Some early forms of PSD were made up of solid panels, with no provision for drainage of water. This led to the panels becoming heavy when being moved, transferred more weight to the props, spilled onto the operatives moving the decks, and increased potential for freezing in colder conditions:

> "*Improvement: there are no forms of drainage on the decks and water gathers in the profile – when it is being dismantled this can lead to the deck being heavier and can drench the worker*"
> (Site Manager, January 2004)

> "*All systems must have an appropriate means of drainage of water, should it be used in wet conditions – puddling can cause problems, which could get worse if the puddles were to freeze during colder weather…it is imperative that any surface water is afforded a means of appropriately draining away…*"
> (Site Manager, January 2004)

PSD systems rely on the verticality of the support props, which can be affected by the floor level and the competence and care of the installers

EAT disadvantages

During installation of roof joists or trusses, the operatives still have no fall prevention system. The set-up mat used to remove the crane attachment and to space the trusses can only be used when these components have been positioned, thus other safety protection must be provided at this time

The above information highlights the main benefits and drawbacks of safety decking, as seen by managers, supervisors and people working with the system.

5.6.2 Comparison of EAT with PSD systems

The following information compares EAT systems with PSD systems. The main difference is that EAT systems do not require props to support the working platform; thus, the system can be used over the most adverse of ground conditions:

> "*Most systems require flooring below them in order for them to be considered [not trellis systems though]*"
> (Site Manager, January 2004)

The main drawback of using a EAT system as opposed to PSD systems is that the operatives have little protection during the actual installation phase of the roof trusses or joists. When the trusses are in position, the installation of the trellis is straightforward and can be carried out from the

safety of a protected area (usually the perimeter scaffold). However, during the initial installation of the trusses the operatives must have an alternative safety system (normally either fall arrest mats, safety netting or PPE), to ensure safe working:

> *When using the trellis system, the workers are not protected during the truss installation; with a crash deck they are protected all of the time. The trellis requires definite action by the users*
> (Contracts Manager, January 2004)

EAT systems are a quick and less expensive solution to fall prevention, and are better than no protection at all. PSD systems are more expensive than EAT systems, but are considered as more complete.

EAT systems have more limited applications than PSD systems; being mainly used during truss erection and access over open joists and truss cords. EAT systems are not used in block and beam flooring installations, like PSD systems.

Situations exist on-site that favour EAT systems over PSD systems, as described above. It is the responsibility of the competent site management team to select the most appropriate safety system for the specific site and conditions faced at any particular time.

5.6.3 System Use During Maintenance and Refurbishment

Both systems are designed primarily for use during new construction works. Situations also exist during maintenance and refurbishment that favour the use of safety decking.

EAT systems

In attic spaces, resting on existing ceiling joists, EAT systems will provide a working platform, or just access. This system is especially suited to these works as the trellis folds down to sizes small enough to pass through attic hatches (fold-down size: 1.0m x 0.7m). Further, there is an EAT system manufactured with a non-conductive plastic coating, which reduces the risk of electric shocks to users in circumstances where this risk might be present.

PSD systems

On many occasions, PSD cannot be considered for refurbishment works, due to a lack of restraining walls on all four sides of the system, to provide lateral support. In existing buildings, the specifier of the safety system must be satisfied that the following requirements are met prior to the decision of safety decking as the preferred system:

- The layout of the building provides adequate lateral support
- The environment is not detrimental to the decking construction, i.e. not in the vicinity of corrosive chemicals that could affect the performance of the system components
- The decking can be dismantled in a safe manner on completion of the works

On refurbishment works, the stability of the building structure is under scrutiny. Systems should be carefully selected and considered, with the aide of a structural engineer's report if appropriate.

Maintenance and refurbishment sites tend to be, in the main, congested sites, with restricted space available. This should also be taken into account prior to selecting any safety system.

5.7 TRAINING STANDARDS

Safety decking systems require knowledge of how fittings and units are put together to erect a technically sound, safe and effective platform for people to work from. Adequate training must be provided for those installing and using safety decking.

For most safety decking systems, suppliers provide training to all users on how to install and dismantle the system – the trainer will then view the operatives carrying out these functions to assess their competency prior to leaving the site. How training is given is organisation-specific. The standard of installation to be achieved is taken from PUWER:

- Installed correctly
- Stable
- Strong
- Inspected and maintained
- Fit for purpose

Industry management and supervisors, etc., should be trained in the use of safety decking. This enables site management to have as much responsibility for the monitoring the system, as those who are actually using the equipment.

There should be a requirement for 'refresher' training on safety decking principles. Again, this would be organisation-specific, and should be included within appropriate toolbox talks, safety newsletter, or other internal information medium. EAT manufacturer's recommend that this training is refreshed at every maintenance visit (see Section 5.10.2).

As discussed in Section 5.5, accreditation by a training body, such as CITB or FASET, was suggested by one system manufacturer as the only way to endorse appropriate training programmes for installation and use of safety decking. This research concludes that due to the increasing popularity of decking systems in industry today, training regulation is critical for system development in industry. Consideration should be given to establishing a simulation-type course (half-day or full-day) at a CITB centre for accredited training.

As safety decking systems are new to industry, MHSWR, Regulation 13 *Capabilities and training*, apply to the systems. This Regulation states the following:

> *(2) Every employer shall ensure that his employees are provided with adequate health and safety training –*
>
> *(b) on their being exposed to new or increased risks because of –*
>
> *(ii) the introduction of new work equipment into…the employer's undertaking*

Further, PUWER, Regulation 9, *Training*, stipulates the following in regard to training in the use of work equipment:

(1) Every employer shall ensure that all persons who use work equipment have received adequate training for purposes of health and safety, including training in the methods which may be adopted when using the work equipment

In general, training in the use of safety decking is delivered on site via demonstrations and participation. On successful completion of the training, the trainer will certify that the individual is competent to use the system, and will issue documentation to support this (usually in the form of a competence card).

5.7.1 Rescue

Safety decking is primarily fall prevention, thus the implications of rescue are similar to that of purlin trolley systems (see Chapter 4), albeit the systems would not be used at the same height as that of the purlin trolleys. In theory, as the system is a lightweight working platform the operatives will be standing on the decking surface and would normally receive injuries typical of a fall on the level.

Rescue requirements must be incorporated into the method statement for the works, in the form of a rescue method statement, and must adopt the principles set down in MHSWR, Regulation 9, *Contacts with external services*, as described in Chapter 3 of the main report.

As previously discussed, some early forms of PSD systems were not designed or used as walking or working platforms and this gave reason for concerns over problems of rescue, that must be addressed if these early systems are encountered.

> "*From a novice's point of view (which we were when we used the systems), the suppliers were shy in providing information of the system characteristics, particularly on rescue*"
> (Site Manager, January 2004)

> "*They state that the system can't be walked on, but provide no guidance on how to effect a rescue from the decking, where people will require to walk across the system – this should all be accounted for in the method statement*"
> (Site Manager, January 2004)

However, as all currently produced safety decking systems encountered during this research are now classified as lightweight working platforms and can be walked on, rescue can be effected relatively easily. Nonetheless, care must be taken, through training and supervision, to ensure that the systems are not overloaded with people or materials, as this could lead to collapse of the system, particularly in emergency situations. Further, it is important to take account, in any rescue plans, of the different circumstances should the decking be erected below the working level, as a fall arrest platform.

5.8 INSTALLATION AND DISMANTLING

The importance of appropriate installation of safety decking equipment has been discussed earlier in this Chapter. If safety decking systems are in good condition and correctly erected, they

provide reliable fall protection. Therefore, it is essential that installation, altering and dismantling tasks are carried out only by trained and qualified personnel, as described in Section 5.7.

> "*The system is only as good as the workers using it, and how they install and dismantle it*"
> (Site Manager, January 2004)

As with any safety system, installation and dismantling should be carried out in a safe manner and not expose the installer to unnecessary risks. Further, all operatives (and the general public if appropriate), above and below the area that is receiving the safety system must be protected. A methodical approach to installation and dismantling, developed through thorough training, must be adopted. The safety system selected should be planned for the particular site and not detrimental to the building fabric or interfere unnecessarily with the works programme. Development of the project method statements and risk assessments must take account of fall protection equipment which, particularly in the case of safety decking, should be an integral part of the planned production process. The method statement must incorporate a plan of the erection and dismantling sequence.

> "*The area below cannot be used when the decking is in place due to the props, thus this area cannot be occupied at this time – this must be accounted for in the programme and afforded the appropriate time*"
> (Site Manager, January 2004)

Time needs to be spent on installation of safety decking systems. However, the benefit on programme time of having a combined working platform and fall prevention measure is an attractive feature of safety decking. This research recommends that the installation and dismantling of decking systems should be identifiable master programme items.

> "*The time lost by its installation was made up by the increased productivity of roof installation when the system was in place*"
> (Contracts Manager, January 2004)

The following sections cover the main items for consideration when installing, using and dismantling safety decking systems.

Lateral support (PSD systems only)

The issue of lateral support by the building walls was frequently addressed and concerns were raised about the forces on the brick/blockwork if they were not afforded the appropriate curing time. On many occasions the system is used in the installation of pre-cast flooring panels and the walls also require sufficient curing time in order to receive the loading from the panels. In these circumstances, there is not a problem but pressure to progress must not be permitted to lead to a situation where the decking is inadequately supported.

As the system relies on lateral support for its stability, the whole working area is normally decked-out at one time, to provide the support on all sides. If the area is very large, the installation could be progressive, however this raises issues about how support would be obtained at the leading edge, and how the area would be controlled and the exposed edge protected.

As discussed in Section 5.6.1, if the flooring below the PSD system is undulated or sloped, the decking will follow this profile as currently available support poles are the same length and non-adjustable. This could affect safe occupation of the decking.

Overlapping

In non-rectangular room shapes, for example, at bay windows, the decking panels are overlapped to provide continuous protection. However, this provides the user with a tripping hazard of the thickness of the decking (approx. 50mm). Innovative suggestions provided through data collection were to use different coloured decking panels at any area where an overlap had occurred; this would highlight the danger to the users. Also, adapting the flange arrangement for use at the bottom of the props as and when required to provide a level supporting surface. One manufacturer has innovated a brightly coloured, removable ramp for overlapped situations. Another manufacturer has injected a warning label on the edge of all decking panels saying '*mind the step*'. Innovations such as these examples provide further evidence that the safety decking industry is in dialogue with industry.

Installation of all work equipment must conform to PUWER, Regulation 20, *Stability*. This Regulation states the following in relation to work equipment's stability:

> *Every employer shall ensure that work equipment or any part of work equipment is stabilised by clamping or otherwise where necessary for purposes of health or safety.*

Most system manufacturers and distributors offer a complete installation, maintenance, transport, inspection and system audit control package to the contractor, which removes the burden of ensuring that the systems are used appropriately, and allows the contractor to concentrate on management and supervision of his core operations. This provides tighter quality control and peace of mind that competent personnel are providing the safety system, without the need to train site personnel.

Installing the safety decking system on site at the right time takes good communication between the site management team, and the installing organisation. Like any programmed operation, the logistics of delivery to site and transportation to the appropriate site area should be carefully considered and catered for prior to the system being delivered and installed.

5.8.1 Securing Methods

Most safety decking systems are not secured to the built structure to perform their function. However, in some systems a degree of securing is required. For example, EAT systems come with an attached strap and clip that is wrapped and clipped round the joists on which they rest. One version of the PSD system relies on securing the props to the decking panel via elasticated straps that go over the panel and connect to the top of the prop. These straps can also be utilised in areas where overlapping the panels is required, or where supplementary support is necessary:

> "*When the decking panels were overlapped in non-standard shaped areas, they used straps to hold the panels down*"
> (Contracts Manager, January 2004)

Securing the system during installation on one system is discussed in Section 5.4, where pins are used to connect the top of the prop to the underside of the decking panel.

5.8.2 Methods of Installation

Due to the differing physical characteristics of both system types, installation requires separate procedures to ensure that each system is afforded the optimum installation solution. The installation procedures for both the PSD and the EAT are described below.

With all safety decking systems, control is required of the area below the system. PSD systems make the area below congested and unusable, whilst when using EAT systems the area below should be an exclusion zone until works overhead have been completed:

> "*It does hold up any works that are required to be carried out below, which influences the programme, but in today's climate there should be no working below, therefore that shouldn't be a problem*"
> (Contracts Manager, January 2004)

PSD systems

- All propped decking should be erected on a firm and level surface
- Ensure the room area where the platform is to be erected is clear from debris, and any voids on the walls and floors have been appropriately covered
- All walls should be sufficiently cured before installation of the decking can commence, affording ***at least*** 24-hours curing time
- Decking components should be stacked neatly to one area within the room being decked
- Set out room with decking panels to compare which way is the best fit, by initially positioning them along the wall (the best installation method, with minimal overlaps may entail using decking panels in opposite directions)
- Start off the system from the required corner and continue to the opposite wall until one side of the room is complete, or a gap of less than one deck width remains
- The first panel is set out tight into the corner as a starting point, this will normally require 2 people, one to hold the panel above their head, and the other to place the collars and standards for it to sit on. At this point, the standards should to lean into the corner to keep the panel and legs from falling over (see Plate 11)
- Complete the remaining area
- Once the first panel is stable, fix other safety decks and props into position starting from the first panel and working away towards the opposite walls

- The system needs to be wedged between the surrounding walls to provide maximum stability. Depending upon the size of the gap at the perimeter, an in-fill deck it may be required to close the gap. If none are available, the decking must be overlapped on top of the last panel fitted

- The technique for overlapping differs for the individual PSD systems. The main criteria to address when overlapping is that there is a trip hazard on the walking surface that must be accounted for during use of the system, and that the props will not reach the floor level when the deck is overlapped. These challenges are approached in different ways dependant of the system used, as described elsewhere in this Chapter

- Once the system is considered to be stable, all props should be adjusted so that they are vertical, utilising a spirit level. Verticality is referred to in BS5975:1996, Section 7.3.2.4 *Purposely fabricated steelwork*, and Section 8.4.2.1 *Adjustable steel props, and forkheads*. The latter of these sections states that *the props should be plumb within 1.5^0 of vertical…i.e. not exceeding 25mm out-of-vertical over a height of 1m*

- Some systems utilise a fifth prop in the centre of the decking panel for optimum support. If this is the case, the installation of this should be approached during the progressive installation as described above

- The system is now ready for use

Plate 11: Standards leaning into corner to keep the first panel from falling over

Installation principles

- Props are plumb / vertical, and in contact with the ground
- There is a level platform on which to walk and work
- Allowable live loads are restricted to singular pedestrian travel, i.e. a maximum of one person per supported decking panel
- No material loads allowable
- No shock loads allowable
- The decking system should be in positive connection with walls to ensure lateral stability. This will ensure sway avoidance, and no shear in the propped support
- Brick or block cement bonds need to have adequately cured; a rule of thumb is ***at least*** 24-hours must pass before installation of PSD
- Receipt of handover certificate

Pre-use inspection

Ensure that the installation fills the area to which it is fitted, and that there is no sway in the system

Check that all decking panels accommodate the associated collars or pins correctly, and all collars are appropriately connected to the standards

Inspect the installation visually to ensure everything is level and that there are no tripping hazards (or that these are accounted for by way of supplementary equipment). This inspection should be carried out from both the perimeter scaffold, and the floor below the installation

EAT systems

- Once transported to the area of use, the trellis deck is to be used on top of the rafters of the first trusses that are hoisted into position

- Using a specially designed set-up deck (i.e. a trellis deck that is shorter and wider than the standard trellis decking), the first trusses are spread and fixed in position (see Plate 12)

Plate 12: EAT set-up deck for use to first-fix trusses

- The operative transfers from the perimeter scaffold to the set-up deck (to remove crane hooks used for positioning the trusses, and to secure temporary braces to space the joists)
- The standard trellis deck is moved along to safeguard the operatives when positioning the next trusses
- The extendable trellis is spread across the rafters of the trusses that are now in position (from the safety of the perimeter scaffold – see Plate 13), and fixed by the securing straps at each end (Plate 14). Ensure that the trellis is not extended too far – each trellis is recommended to extend no further than 7-joists, at 600mm centres
- Additional trellis decks are installed until the whole exposed area is decked in the manner described above
- Receipt of handover certificate
- The system is now ready for use

Plate 13: EAT installation from perimeter scaffold (*Site visit, November 2003*)

Plate 14: EAT deck fixed by the securing straps at each end

Pre-use inspection

Ensure that the whole area is covered with trellis decking, and that no gaps exist

Ensure the attachment straps are securely wrapped around the joists and clipped together

Ensure the trellis is not extended out too far, and does not excessively overlap

All pre-use inspections can be carried out from either below the installation, or from the perimeter scaffold

5.8.3 Dismantling Techniques

The dismantling of safety decking is as important a task as the installation. In certain situations the operatives using the system could be exposed to further risks. The decking equipment must be visually checked, prior to dismantling, for debris on the decking panels and arrangements made for its safe removal. ***All*** components of the system must be visually checked. During this inspection, note should be taken of any obvious damage that the equipment has incurred during its installation and period of use, and this should be reported to the person accountable for the examination of the components preceding their next employment. The decking should be dismantled in stages, in reverse of that of the installation technique described above.

Again, guidance on dismantling can be utilised from BS 5975:1996, which states:

> ***2.9 Dismantling***
> *As at the loading stage, a permit to dismantle or unload the falsework may be appropriate, particularly where this takes place in stages. It may be appropriate to issue it in conjunction with the designer of the permanent structure.*

Installation and dismantling guidance can also be found in BS 5973, Section 3, *Work on Site*. Information on this can be found in Appendix 6.

It is during the dismantling phase that water on the deck surface could become a nuisance or even a cause of injury. Careful planning and control of the installation and dismantling processes is required to ensure that all equipment is appropriately used. Numerous systems are now manufactured with 'weep-holes' for water drainage.

5.9 MANUAL HANDLING

Section 7 of the Health and Safety at Work Act 1974 says, '*It shall be the duty of every employee while at work to take reasonable care of himself and of other persons who may be affected by his actions or omissions*'. Manual handling of any safety system is important when considering the impact that the safety system will have on those installing and using the equipment. This is particularly the case when considering PSD due to the emphasis on repetitive transfer of materials above operative head height, however this is not thought to be any different to activities involved in scaffold installation[9]. Manufacturer's guidance and training on manual handling in relation to safety decking aims to reduce work-related upper limb disorders, thus the following information should be considered prior to selecting an appropriate safety system.

> "*Because it is built at over 2m in height, the installers are always stretching above their head height – it can be strenuous at times*"
> (Site Manager, January 2004)

Typical weights and sizes of the main system components are:

PSD systems

The weight of props used is between 1.2kg–2kg dependent on the manufacturer, with most props being between 1.8m-2.1m in length.

Decking panels range from 7kg–10kg, again dependent on the manufacturer, with the panel sizes varying from 1.0 m^2 – 1.2m^2

EAT systems

The trellis system, when folded down to its storage shape weighs approximately 11kg, and measures 0.7m^2.

It is not only at the installation and dismantling stage that the shape and weight of the system components have an effect; when transporting the equipment around the site, this will have a

[9] *The Manual Handling Operations Regulations 1992 suggests that as a rule of thumb for singular lifts for males, 5-10kg is the maximum weight that should be lifted* ***above shoulder height****; for females it is 3-7kg. These figure guides may reduce further due to twisting and repetitive lifting.*

manual handling effect if there is carrying involved. There are two scenarios for site transportation:

> "*If the site uses its cranes and loading bay properly, then it [manual handling] is not a problem*"
> (Site Manager, January 2004)

> "*Access to the area that the decking will be installed in will have an effect on the workforce, particularly if the operatives themselves have to transfer the materials themselves with no mechanical aide*"
> (Site Manager, January 2004)

The first of these is the preferred method of transportation of decking components; however, the practicalities of site layout determine that, on many occasions, a crane is not always available to the operatives. Attention to these issues during the planning phase could lead to decreased exposure to detrimental manual handling situations.

Most interviewees indicated that manual handling of safety decking system components was not a problem, however, it is possible that these opinions represent a 'macho' view common in construction:

> "*There are generally no problems with the weight of the components and repetitive movements when installing or dismantling the system*"
> (Site Manager, January 2004)

Exposure to adverse environmental conditions on site is a hazard for the safety of the operatives installing, altering or dismantling the decking due to its shape and dimensions, and its susceptibility to be caught by wind gusts. Therefore, appropriate planning and investigation of potential inclement weather conditions must be considered, prior to selection, and, particularly, immediately prior to erection and dismantling of safety decking.

5.10 INSPECTION AND MAINTENANCE

The importance of regular inspection cannot be overstated. Safety decking constitutes an item of work equipment, thus there is a duty to inspect under PUWER, Regulation 6, *Inspection*. This regulation states:

> *(1) Every employer shall ensure that, where the safety of work equipment depends on the installation conditions, it is inspected –*
>
> *(a) after installation and before being put into service for the first time, or*
> *(b) after assembly at a new site or in a new location,*
>
> *to ensure that it has been installed correctly and is safe to operate.*

Environmental Conditions

Due to the plastic material of the components in PSD, ultraviolet (UV) rays have a detrimental effect. Due to the relative newness of the systems, little is yet known about the effects on structural performance of prolonged UV or extreme heat and cold that is likely to be experienced on site. The incorporation of an UV-inhibitor during manufacture lessens the effects of UV rays. Periodic and thorough testing must be carried out on the decking to ensure that the UV rays have not damaged the decking components beyond their required minimum strength.

Trellis decking is made entirely of aluminium, which is not susceptible to damage from UV rays as plastic is, and is generally considered as a durable material to use in exposed situations as would likely to be faced on site.

Regulation 6 of PUWER requires the following inspection regime:

> *(2) Every employer shall ensure that work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is inspected –*
>
> *(a) at suitable intervals; and*
>
> *(b) each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred,*
>
> *to ensure that health and safety conditions are maintained and that any deterioration can be detected and remedied in good time.*

Stability

If safety decking is not stable, it will seriously increase risks for operatives working on the equipment. Regulation 20 of PUWER, *Stability*, states:

> *Every employer shall ensure that work equipment…is stabilised…where necessary for purposes of health or safety*

Therefore, inspection and verification of the stability of the installation must be part of the inspection process.

Handover Certificate

Prior to inspection, the inspector should ensure that an appropriate *handover certificate* has been issued by the installer, similar to that described in Section 5.8.2 (BS 5975, Section 2.8), which should have evidence that the company and product comply with good industry practice. Failure to produce the handover certificate should deem the installation unfit for use, and no work should be carried out from, or above, the decking until the certificate has been received:

> "*When we receive it and it is installed, we inspect it and obtain a handover certificate from the supplier*"
> (Site Manager, January 2004)

Appendix 7 shows the typical components that would be expected on a competent handover certificate.

Frequency of Inspection

Like all other safety systems, safety decking must, while installed, be visually checked, regularly, to ensure that it is fit for purpose.

> "*We carried out inspections on a weekly basis ourselves to ensure that panels hadn't been removed and that legs were not accidentally knocked-off of the vertical – we would adjust minor parts of the system if required, but were instructed not to interfere with the system by the sub-contractor*"
> (Contracts Manager, January 2004)

This raises an issue as to where the division of responsibility lies between the construction contractor and the decking installer, in the respect of disturbance to the installation during use. It must be made clear in the contractual and organisational arrangements, as it is in scaffolding installation, who is responsible for remedying such damage.

It was also recommended during focus group discussions and interviews that inspection is done, based on scaffold inspection principles, i.e. on a daily basis, prior to entering the workspace above, and following periods of inclement weather, with a more rigorous, recorded inspection carried out on a weekly basis. This principle is derived from The Construction (Health, Safety & Welfare) Regulations 1996 (CHSWR), Regulation 29, *Inspection*, which states:

> *Before work at height make sure the place of work is inspected, (and at subsequent specified periods), by a competent person*

'*Specified periods*' can be taken as:

- Before first use
- At the start of every work shift
- Following events likely to affect stability, and,
- In writing at least every 7-days

Appendix 8 provides information that is likely to be contained within the 7-day inspection. The inspection must be recorded to provide a detailed account of appropriate supervision of the system. Regulation 30, *Reports*, of CHSWR reads:

> *Following inspection, ensure written reports are made by the competent person*

Schedule 2, *Requirements for Working Platforms*, provides information on the requirements for working platforms and should be considered a guide when implementing an inspection regime for safety decking. This schedule covers: *Condition of surfaces; Stability of supporting structure; Stability of working platform; Safety on working platforms; and, Loading*. Appendix 9 provides the information that is contained within this schedule.

Stock-rotation

Stock-rotation is suggested, to contribute to maintaining the safety decking components in good condition. This involves ensuring that all components in a batch are rotated when in the workshop to ensure a more uniform usage of the equipment, and that the whole batch will age at approximately the same time. This relies on all equipment being returned to the factory, inspected, repaired and recorded, prior to being put back into service. This will assist the control of obsolescence and replacement.

5.10.1 Monitoring and Supervision

Acceptable standards of on-site practice can only be achieved through thorough monitoring and supervision of the safety system by competent persons.

As previously mentioned, early forms of PSD were not intended as working platforms; however, site operatives often treated them as such:

> "*The system we used was not considered a working platform, but the workers still walked on it*"
> (Contracts Manager, January 2004)

Care must be taken, through a regular and competent supervision regime, that platforms are not overloaded; with either operatives, or materials. The control measures in place to ensure safe systems of work, and that platforms are not used as material storage areas should be rigorous and enforced through competent training and regular toolbox talks:

> "*The system can be walked across, which is a good help, but care has to be taken to ensure this is not abused as workers can get complacent if not supervised properly*"
> (Site Manager, January 2004)

The Health and Safety at Work etc Act 1974, *Section 2, Employers Duties to Employees*, deals with provision of plant and furthermore, safe systems of work for the appropriate usage of all plant and equipment provided. When monitoring and supervising safety systems, this is the statute that should be referred to. This section states the following:

> *…provision and maintenance of plant and systems of work that are, so far as reasonably practicable, safe and without risk to health*

BS5795:1996, Section 2.5, *Co-ordination and Supervision*, provides information on these areas when dealing with falsework. These principles are a useful guide when initiating monitoring and supervision procedures for safety decking, as there are many parallels between safety decking and falsework. For example:

> ***2.5.1 General***
> *Work on site should be the subject of careful direction, supervision and inspection to ensure that the falsework structure is constructed safely…a methodical approach should be adopted and it is recommended that comprehensive job notes are maintained.*

2.5.2 Falsework coordinator

2.5.2.1 *When a construction organisation decides to appoint a falsework co-ordinator…It is important that his appointment gives him adequate authority to carry out his tasks…to provide adequate authority to stop work if it has not been carried out satisfactorily…Once the falsework has been checked and passed, it should not be altered until that loading stage has been completed, and the design allows for it to be dismantled or altered.*

Further information on the falsework co-ordinator can be found in Appendix 10.

Prior to the system being installed, a design of the system could be requested from, or provided by, the installer. If this is the case, BS5795:1996, Section 6, *Design of Falsework* should be adhered to[10]. However, as most installations are of standard design, it is suggested that there is little requirement for independent checking, unless the decking were to be used in extraordinary conditions; for example, as a support structure in maintenance and refurbishment settings.

For monitoring and supervising the system when in position, Section 7.4 of BS 5975, *Checking Falsework*, should be used as guidance. The main points of this section are listed below. ***Note:*** this information mainly deals with PSD; however, the principles could also be adopted for EAT systems.

The following text has been adopted from BS 5975 and describes when systems should be checked:

7.4.1 When to check

There are a number of clearly defined stages in the construction of certain types of falsework when formal checks are desirable…It is recommended that the need for a formal check should be considered:

a) when the proposed founding level for the falsework is in preparation…
c) when the falsework reaches its support level
d) at intermediate stages, when the strength or stability of the falsework may have been adversely affected by environmental or other loading conditions or unauthorized interference
e) where equipment is being continually reused and periodic checks are appropriate

Section 7.4.2 of this Standard, *Items to be Checked*, details the main items that should be inspected. An abbreviated list, specific to safety decking, is provided in Appendix 11.

If all of the following functions are adequately controlled and supervised, the safety decking will perform the tasks for which it is intended:

- Installation

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[10] *BS 5975:1996,* ***6.1.3 Checking the design***
Prior to the commencement of any construction work, the proposed falsework design should be subject to a check for concept, adequacy and correctness…by a person or persons independent from those directly responsible for the design.

- Equipment used
- Works overhead
- Number of persons above the system
- Not using the installation as a materials store
- Props below the decking (PSD), and,
- Control of the sub-contractors

Quality Control

In order that decking systems are used only when the installation process is complete, both Regulation 20, *Stability*, of PUWER and Section 2, *Procedures*, of BS 5975:1996 should be followed. The latter of these publications states the following:

> ***2.8 Loading the falsework***
> *As a means of exercising a degree of control over the rate of progression once the stage has been reached that the falsework may be loaded, it may be advisable to have a formal procedure for giving permission to load…perhaps in the form of a `Permit to load'. In simple cases, a single permit, made out as soon as the falsework has been satisfactorily checked, may be appropriate.*

The permit to load can be taken as the handover certificate described in Section 5.10.

As the systems are designed for lightweight working, the general rule of thumb is that the decking will support one operative and his/her hand tools (between 0.75-2.0kN/m^2), rigorous supervision must be in place to ensure that only people that need to be on the system are there, and that there are no materials stored on the platforms.

5.10.2 Maintenance of the Equipment

Maintenance inspections should be carried out as described in Section 5.10.1. The repairs required will depend on the results of the inspection. All maintenance operations should be carried out ***after*** the decking is dismantled and ***before*** the components are re-used. Maintenance of the equipment is crucial to ensure its fitness for purpose the next time it is required on site. In support, PUWER, Regulation 5, *Maintenance*, states:

> *(1) Every employer shall ensure that work equipment is maintained in an efficient state, in efficient working order and in good repair.*

If the maintenance function is carried out by persons inadequately trained or qualified, site personnel are put at risk. Dependent on their use, the components will also require thorough washing with clean water (preferably by hosing), and allowed to dry naturally.

Further, Regulation 22, *Maintenance operations*, states the following:

> *Every employer shall take appropriate measures to ensure that work equipment is so constructed or adapted that…maintenance operations which involve a risk to health or safety can be carried out…*

> *(a)…without exposing the person carrying them out to a risk to his health or safety; or*
> *(b) appropriate measures can be taken for the protection of any person…which involve a risk to his health or safety.*

Safety decking components must only be repaired by the manufacturer. As discussed in Section 5.10, manufacturers and suppliers offer an inspection and repair service:

> "*…the onus would be back on the supplier to come back in to repair or replace any defective components – if this occurs in an area that we are working directly above, this can have significant cost and programme implications*"
> (Site Manager, January 2004)

In addition, the manufacturer would also provide spare system components that can be used in the event that any equipment is damaged, rendering the system unusable:

> *Spare decks and props are left [on site] in case any piece of the system gets damaged*
> (Site Manager, January 2004)

To this end, the users would require some form of basic training in system installation to ensure that the spare components are installed properly.

EAT systems are annually removed from side, tested, reconditioned and put back into service by the manufacturer. Further, the system manufacturer carries out maintenance visits to sites where their equipment is being used every 4-6 weeks. This recorded visit takes care of the lubrication of the trellis, and ensures that all rivets are in place.

It is important to note that when either plastic or aluminium are damaged or split in any way, that these are difficult to repair or maintain. Thus, there is little actual maintenance of system components per se, apart from appropriate cleaning of the equipment.

5.10.3 Storage and Transportation

When not in use, safety decking components should be stored under the following conditions at all times:

- Away from heat, chemicals and solar radiation (UV)
- Not close to thermal sources
- In dry conditions
- In well ventilated conditions, elevated from the floor or ground

Transportation of safety decking will be dependent on the amount of equipment required for a specific job/site. Care must be taken to ensure that the materials are transported in conditions similar to those for storage. With the various component parts required to make up PSD, such as props, collars and decking panels, small vehicles are not able to carry enough equipment to satisfy the requirements a full site installation. Due to the physical nature of PSD (i.e. with little or no flexibility for minimising the volume), storage and transportation is a more laborious task than that of EAT systems. PSD systems can be flat-packed for easy storage and transportation

(see Plate 15). There is no collapsing of the decking panels themselves – they are simply taken down and stacked on top of each other. Transportation of PSD systems is normally by lorry (normally 7.5 tonne vehicles). Similarities exist between the transportation and storage issues for PSD systems and soft-filled mats in terms of the bulkiness of system components.

Plate 15: Storage of PSD system components

A single trellis deck folds up to approximately 0.7m^2 (see Plate 16), and many decks can be transported in normal site vehicles, (as per Section 6.12.3 of main report).

Plate 16: Folded EAT decking

Storage of decking equipment also presents similar problems, when the decking is not required for periods of time on-site. The recommended procedure is that they are in place until no longer required, then either moved to another work area to be used again, or taken off-hire by the manufacturer or supplier:

> "*…it is either kept in position until it is ready to be moved to another area, or it is taken off-hire until we need it again*"
> (Site Manager, January 2004)

When this is not possible, a suitable space on site is required for storage. This could present problems on confined sites, and this is where site management would need to manage the programme accordingly to ensure that this storage issue does not become a major problem for the site:

> "*Storage can be a problem if the site had restricted access both to the site and to the position that the decking is to be delivered (if its out-with the crane's area)*"
> (Site Manager, January 2004)

The system components can be stored outside, as long as they are not exposed to harmful elements as listed above.

5.10.4 Typical Life Span

As all types of safety decking have only recently been used in the construction industry, their long-term endurance capabilities remain unclear. Coupled with industry's reliance on specialist suppliers of decking as and when the equipment is required, decking systems life span capabilities continue to be indefinite:

> "*Long-term, we don't know how reliable the system is as it is all sub-contracted in – it is the sub-contractors responsibility to ensure reliability*"
> (Contracts Manager, January 2004)

At present, contractors do not have access to information about the history of the individual components, upon which to base any control procedures. Therefore, component life span is, and must remain, the supplier's responsibility.

Individual component durability plays a significant part in the system's life span. If the equipment is not robust enough for the conditions it is likely to face on site, it will fail. Consensus between manufacturers and users was that safety decking systems are designed and manufactured to be robust enough for most site conditions:

> *"I have been using the system [PSD] for over 2-years and have never came across a part of the equipment that required any repairs*"
> (Site Manager, January 2004)

In theory, the components of PSD systems are estimated to have a useful life of 40 years, due to the advanced plastic used, however, this timescale does not take account of the physical wear and tear the system will endure on site, and through regular site use. Therefore, a more conservative

estimate, from manufacturers interviewed, is that these systems should be recommended to have a lifespan of around 5-years. Without data to support this timescale, it is suggested that all equipment is thoroughly tested, regularly, and care taken to remove it from service at the first sign of unacceptable degradation.

EAT components have a lifespan of 2-years. After this, the manufacturer will remove them from circulation and will recycle the material.

Only by closely monitoring decking systems over the coming years will an accurate estimate of their typical life span be established.

5.10.5 Disposal of Damaged Materials

Both safety decking types are manufactured from recyclable products, thus recycling of these components is the means of disposal already selected by the manufacturers encountered during this research. In addition to information collated from the research data collection, the following actions are recommended for disposal of defective decking:

- Remove from area incorporating other system components and quarantine in a secure area
- Mark all quarantined components to ensure easy recognition that they are for recycling
- Consider breaking-up components if possible to ensure that they will not be brought back into service

Following the above procedure will ensure that there is no opportunity for others to retrieve the decking components and re-use on another job. Incineration is also an option for disposal of plastic decking materials; however, recycling is the most environmentally-friendly means of disposal.

5.11 SUMMARY

Lightweight safety decking systems have emerged as capable means of fall prevention, and as such, safety decking sits higher in the hierarchy of risk control.

Safety decking is classified as 'work equipment' under PUWER. There are two types of safety decking covered by this research; decking panels supported by props, and extendable aluminium trellis decking. The systems are similar, in concept, to scaffold-based crash decking. PSD systems rely on lateral stability from the building structure.

All safety decking systems can be described as lightweight working platforms positioned just below the working area and capable of supporting a person and their light tools.

With all safety decking systems, there is an element of control required on the area below the system. PSD systems props will render the area below unusable, whilst when using EAT systems the area below should be made an exclusion zone until works overhead have been completed.

EAT systems do not require props to support the working platform, thus the system can successfully be used over the most adverse of ground conditions. The main drawback of using a

trellis system is that the operatives have little protection during the actual installation phase of the roof trusses or joists.

EAT systems are manufactured completely from aluminium. Modified EAT systems are manufactured with a non-conductive plastic coating to assist in reducing the risk of electric shocks for the users.

PSD systems use plastic materials (recycled PVC). The main reasoning for this is the lightweight properties of plastics.

The safety decking industry does not yet have a regulatory body governing membership, training, standards, etc. A regulatory authority needs to be established soon to fulfil consumer expectations.

Safety decking provides the users with passive, global (or collective) protection. The systems are quick and simple to erect and dismantle due to the minimal number of components involved in each system. Safety decking has no mechanical components and requires no power source to perform its function.

Adequate training must be provided for those installing and using safety decking. Site management and supervisors, etc., should also be trained in the use of safety decking. In general, training is delivered on site via demonstrations and participation. Consideration should be given to establishing a simulation-type course (half-day or full-day) at a CITB centre for accredited training.

Some system manufacturers and distributors offer a complete safety package to the contractor, which removes the burden of ensuring that the systems are used appropriately. The training requirements, mentioned above, are required for the installers and site management only, if these packages are hired-in. The packages include installation, maintenance, transportation, inspection and system audit control.

Due to the plastic material used in PSD, UV rays have a detrimental effect on these components. Little is yet known about the effects on the material of prolonged exposure to UV light and extreme heat or cold, however the introduction of an UV-inhibitor during manufacture reduces the detrimental effects.

Acceptable standards of on-site practice can only be achieved through thorough monitoring and supervision of the safety system by competent persons. Care must be taken, through a regular and competent supervision regime, that platforms are not overloaded; with either operatives, or materials.

If all of the following site functions are adequately controlled and supervised, the safety decking will perform the tasks for which it is intended:

- Installation; Equipment used; Works overhead; Number of persons above the system; Not using the installation as a materials store; Props below the decking, and, Control of the sub-contractors

Transportation of safety decking will be dependent on the amount of equipment required for a specific job/site. Due to the larger and heavier nature of PSD, storage and transportation is a more laborious task than with EAT systems. PSD systems can be flat-packed for easy storage and transportation.

In conclusion, the popularity of safety decking systems is growing:

> "*Many workers are now insisting on the system being in place before carrying out any works above*"
> (Site Manager, January 2004)

The systems included within the research go through frequent re-evaluations and modifications, and this research suggests that use of these systems will continue and grow.

6.0 FALL ARREST MATS

6.1 INTRODUCTION

There are situations in construction, for example the installation of elevated pre-cast slabs with unprotected edges, where safety nets are impractical. The normal alternative is a harness and line attached either to the scaffold structure, structural steel or the previously laid slab. However, use of another alternative, fall arrest mats or bags, is growing within the industry. Some such systems have already been tested and certified by organisations such as the Building Research Establishment (BRE), and the National Engineering Laboratories (NEL). Systems already available in the marketplace have been adopted as a preferred method of fall arrest by industry organisations, and bodies such as the Precast Flooring Federation (PFF) have determined that passive systems is their preferred method of fall arrest for all of their members.

There are two types of fall arrest mat on the market in the United Kingdom (UK): the air-mat, and the soft-filled mat. Air-mats are balloon-type structures of woven fabric coated with polyvinyl chloride, maintained at a constant internal pressure by a small air pump. Whereas soft-filled mats are cushion-like structures of tear-resistant man-made fabric, containing a resilient but compressible material such as polystyrene. Both are laid on the ground or suspended floor, beneath the working area, and protect operatives from relatively low falls of up to 2.5 metres. Various trade and slang terminology are attributed to both systems, for example the 'bouncy castle' or the 'bean bag', however for the purposes of this report both will be referred to as stated above.

The fall arrest mat provides passive fall protection for operatives working overhead, and closes the area and openings it occupies from 'intruders', such as debris, stored materials and unwanted human traffic. The mats are designed to decelerate (or cushion) the operatives' fall, and hence minimize the worst effects of a fall from height. Provided the system is installed as per the guidelines in Section 6.10, the fall arrest mats reduce the risk to the person falling of 'secondary strike injuries', (i.e. striking the permanent or temporary structure, debris or stacked material) whilst falling or being arrested by some other fall arrest device – this is common when a fall is arrested on, for example, scaffolding or existing buildings.

These systems are gaining popularity in industry and are already making significant advances into the domestic housing sector. This sector has experienced problems with safety nets, due to their limitations in low-level construction (discussed in Chapter 7), and harnesses, because it is difficult to find robust attachment points (see Chapter 8).

In interviews with leaders in the playground equipment industry, two fundamental flaws with current mats were highlighted:

- The shape of the mats and
- The weight of the mats.

Both issues will be addressed throughout this chapter.

Interviews with representatives of industry who use fall arrest mats, supervise their use, and manage their selection, described in Chapter 2 led to conclusions on practical issues in the selection and use of fall-arrest mats, provided throughout this Chapter.

This chapter will provide details of the specific legislation related to fall arrest mats; furnish the reader with an appreciation of the technical benefits and limitations of the systems; and provide guidance on appropriate circumstances for use of the systems.

6.2 HISTORY OF FALL ARREST MATS

Air-mats

It is generally accepted in construction that the air-mat idea and its technology is derived from the leisure industry, with its fairground-type inflatable play equipment (hence the common on-site reference to this equipment as 'bouncy castles'). Similar versions of the standard flat mat have also been used for a long time by stunt personnel in the entertainment industry, whilst shooting films, TV shows, etc. Adaptation (of the principle at least) from both industries could be said to be the case, however it is pertinent to point out that the principle has been greatly developed to cope with the more robust set of operational scenarios that the typical contractor is likely to face during day-to-day operations on a construction site.

1973 saw the very first 'bouncy castle', with the typical castle shape, in use by the playground equipment industry. Prior to this there were various mats (mostly simple flat bags) in circulation. However, it was not until around the end of the 1990's that these principles were applied to fall arrest in the construction industry. At this time members of the playground equipment industry began to work with members of the construction community with a view to apply their expert knowledge and experience to the safety problems of the construction industry. The result of these collaborations is the air-mat that is used on many construction sites today.

Soft-filled mats

Again, comparisons can be made with the playground equipment industry in that the concept of a filled mat to protect a falling person or object is not new, but rather a modification to an already tried and tested solution.

The soft-filled mat concept was initially considered by members of the Precast Flooring Federation (PFF), when the concept of passive fall arrest (initially in the form of the air-mat) became a serious consideration.

The soft-filled mat concept was developed as a result of the Precast Flooring Federation (in April 2001) deciding that passive fall arrest (initially in the form of the air-mat and safety netting) was their preferred method of fall arrest for members of this industry. As an alternative to the inflated mat, industry members began to develop the soft-filled mat as a solution to the dangers from falls from heights, of up to 2.5 metres, principally for the domestic housing market.

6.3 LEGISLATIVE HISTORY

As fall arrest mats have only been in widespread existence for 4-5 years, their governance by legislation is limited in its scope. This has an impact on all aspects of the fall arrest mat industry in that there would appear to be minimal legal control over items such as manufacture, testing, transportation, certification, etc. However, under closer scrutiny it can be demonstrated that in the absence of dedicated legislation relating to fall arrest mats, other legislation has a level of jurisdiction over the industry. This will be borne out in this section.

6.3.1 Relevant Legislation

Further to information contained in Section 3.2 (Generic Legislative Guidance), the following regulations and guidance are appropriate to fall arrest mats due to the system being classified as 'work equipment':

The Provision and Use of Work Equipment Regulations (PUWER) 1998

The two recent Publicly Available Specifications (PAS) published by the British Standards Institute (BSI) can also be used for direct reference to fall arrest mats:

PAS 2004	Inflatable Collective Fall Arrest Systems
PAS 59	Filled Collective Fall Arrest Systems (pending)

6.3.2 Definitive Legislation

As explained, there is, as yet, a lack of definitive legislation related directly to fall arrest mats. Whilst this in itself should not cause great inconvenience to either manufacturer or user, from evidence gathered during the research it appears that certain sections of industry have doubts about specifying any product that is unregulated. In industry direct comparisons are regularly made between fall arrest mats and safety netting, with safety netting suggested as having a greater reliability due to its control by British Standard, BS EN 1263:2002 Safety Nets, and the formation of a nationally recognised industry trade organisation, FASET (Fall Arrest Safety Equipment and Training) [see Chapter 7]. These factors will be discussed in greater depth in Section 6.4.

At present, there are no legally recognised standards or codes of practice for the testing and certification of fall arrest mat equipment. For example: should a person fall into a mat, there is no requirement to remove the mat from site for appropriate testing of the mat's integrity (as there is with safety nets); and there is also no requirement for the removal of a mat for testing once any repair has been carried out.

Current practice is that each company applying such a system must develop its own procedures for managing the supply, testing, monitoring and use of the equipment in line with current good health and safety practices.

However, the situation is beginning to change with the publication of the two BSI Publicly Available Specifications (PAS), listed above.

6.3.3 Publicly Available Specification (PAS)

BSI's PAS publications listed in Section 6.3.1 are the closest to legislation that the fall arrest mat industry has to date. They are sponsored by industry members and developed through BSI. Once the initial sponsorship and development phase is complete, the consultation document was distributed to appropriate and interested industry members for comment before finalising the document. It is quite clearly stated that the 'PAS documents are not to be regarded as a British Standard, and that it would be withdrawn upon publication of its content in, or as, a British Standard' (BSI, 2003).

The PAS document describes in detail, the testing requirements of the equipment, the management systems that should be in place to support the system, and various technicalities associated with each of the two types of arrest mat. They do not describe the workings of the system, how it should be installed, handled, transported, etc., and thus could be looked upon as limited in scope, however they are at the very least a start and provide users of the systems with a definite source of reference for the systems. Appendix 8 provides contents lists from each PAS document to illustrate the information contained in both documents.

6.3.4 Related Legislation

Following ongoing consultation with HSE and industry, and in the absence of recognized testing certification, soft-filled mat manufacturers have opted to test their equipment, through National Engineering Laboratories (NEL), to BS EN 1263-1: 1997 Safety Nets Part 1, Safety Requirements, Test Methods. Within this Standard the 'T' Type or horizontal nets are the most closely comparable with the soft-filled mats, which provided an adequate testing regime for the product.

Members of the air-mat industry have adopted a similar approach through testing with Building Research Establishment (BRE), by using weights described in the HSE Document: ACR[M] 001:2000 Test for Fragility of Roofing Assemblies, which specifies test methods to imitate people falling or stumbling on roofs.

Following the research team's discussions with representatives of the playground equipment industry, a suggestion was made to test all systems to the European Standards BS EN 1176:1998 Playground Equipment, and BS EN 1177:1998 Impact Absorbing Playground Surfacing, which harmonised existing national standards (principally BS 5696:1986 Play equipment intended for permanent installation outdoors, BS 7188:1989 Methods of test for impact absorbing playground surfaces and DIN 7926 ISO 7926:1991-12 Dehydrated tarragon). As the principles of both air and soft-fill systems were historically derived from this industry, this would appear to be an appropriate legislative framework within which to operate in the absence of dedicated regulations. To date, the research team have not put forward this legislation to the fall-arrest mat industry, and as such cannot comment on the acceptance, or otherwise, of it.

6.3.5 The Work at Height Regulations 2004

The following regulations and Schedule sections of the forthcoming Work at Heights Regulations 2004, apply to the use of fall arrest mats:

Regulation 2 – *Interpretation*
Regulation 7 – *General principles for selection of work equipment for work at height*
Regulation 8 – *Requirements for particular work equipment*

SCHEDULE 3: REQUIREMENTS FOR COLLECTIVE SAFEGUARDS FOR ARRESTING FALLS

Parts 1, 2, 3 (b) & 4

Appendix 5 details the contents of the above sections of the regulations. It is important to note that the above references may be subject to change as the regulations progress through the consultation and subsequent amendment phases, however they are accurate at the time of submission of this report.

The significance of collective fall protection systems being specifically mentioned in the forthcoming regulations is testimony to, and recognition of, their increasing popularity within industry.

6.4 TRADE AND INDUSTRY ORGANISATION

As mentioned in Section 6.3.2, the fall arrest mat industry does not as yet have a regulatory body governing membership, training, standards, etc., and this is viewed by some areas of industry as being inferior to the provision of FASET for the safety netting industry. The fact that a body such as this is not in place has no direct bearing on the suitability and performance of fall arrest mats per se, however with the construction industry making significant strides in organisation and self-regulation, mats could be viewed as an inferior product due to this fact. This is all the more significant because providers of fall arrest mats are in direct competition with safety netting contractors for many contracts today.

Forming a new regulatory organisation has been suggested in the many of the research consultations. Examples of what the recognized regulatory authority would be responsible for are:

- Promoting best practice throughout the fall arrest mat industry
- Providing industry regulation for product quality
- Providing and promoting training standards in conjunction with legal requirements
- Ensuring thorough vetting of all members of the authority, and making this available to industry, i.e. production of a register of member organisations who have successfully proved, through vetting, that they are competent to carry out works involving fall arrest mats
- Ensuring that all new developments in fall arrest mats for construction are monitored and regulated

The absence of a regulatory body does not mean that fall arrest mats are therefore used in an unsafe manner on sites. This was explained thus:

"*…however, compliance with both the law and safe working practice is paramount*"
(Project Manager, May 2003)

This principle appears to be accepted through all organisations interviewed during the site visits.

6.5 AIR-INFLATED AND SOFT-FILLED MATS – SYSTEM PERCEPTIONS PRIOR TO STUDY

The inclusion of fall arrest mats within this report was primarily aimed at raising awareness of the advantages and disadvantages of these systems, and making industry aware of a relatively new and innovative piece of equipment that could solve potential problems faced when working at height. With industry increasingly looking to passive safety systems for fall arrest, all aspects of the fall arrest mat system required appraisal in order to inform industry of exactly what the system could do to assist in health and safety practices.

The initial system included within this research was the air-mat system. This was due to the fact that the soft-filled mat system had not entered the marketplace at this time. The obvious comparisons in the overall purposes of each system made the inclusion of the soft-filled mats a simple modification to the research objectives.

Initial issues that were raised as concerns from industry were that of perception of the fall arrest mat (particularly the air-mat) being viewed, or used, as an amusement, i.e. persons jumping into the mats as an act of horseplay, or for convenience when attempting to descend the structure. This area was borne out as the research progressed and is discussed in Section 6.8. The technical aspects of the mechanical fans was also an area that required research as little was known of the requirements of the fans, the expected pressures and outputs, etc.

Other areas of concern (of the soft-filled mats) were that of their flame retardant properties; the possibility of emitting toxic gases because of the man-made fibres included in the manufacturing process; vandalism of the bags and the scattering of the internal polystyrene; and the effects on the human body of a fall due to the shallow depths of the mats – it was thought that people were still hurting themselves when they fall. Legislation, or the lack of it, governing fall arrest mats was also an area of consideration for the focus of the research.

All of the above perceptions, and more, were researched and conclusions were drawn. This will be borne out in subsequent Sections.

6.6 AIR-INFLATED MATS

During data collection, the research team sought advice and information from all manufacturers of air-mats, via articles in national trade press and approaches to industry representatives. Co-operation was offered from only one manufacturing organisation: Airtek (formerly Airmat Safety Ltd). Although people interviewed have led the research team to suspect that there may be more manufacturers of air-mat systems in the UK, no further information on these organisations was found, despite a thorough search. Therefore, the findings (and in particular the technical information) are mainly from one source.

The characteristics of the air-mat differ from that of the soft-filled mat in structure, construction, shape, appearance, etc. The following information provides an overview of the characteristics of the air-mat; its manufacture, and the mechanical technology required to ensure that the air-mats function adequately.

The Airtek product has been selected as a typical example of an air-mat system. The air-mat system comprises a series on interlinked modular inflated mattresses. The modules are manufactured in a range of sizes allowing coverage of almost any size and shape of construction area. Bag dimensions come in standard sizes ranging from small to large, and are either 0.75m or 1.5m in height (un-inflated). On the recently designed parapet bags, (to protect the operative falling over the edges of the mats) the parapet provides an additional 1.2m in height (see Section 6.8.3, and Plate 8). The 1.5m-deep mats have been tested to arrest falls of up to 7m, but do not promote their use to heights of this kind. There are also 0.75m-deep mats that can arrest lower falls, and are more suitable for one-storey domestic dwellings.

The largest standard air-mats produced are 2.4 x 2.4 x1.5m – this size of mat enables manual handling for transporting and carrying, as it weighs approximately 23 kilograms.

Typical sizes are as follows (inflated[11]):

2.4 x 2.7 x 1.64m;	1.8 x 1.5 x 1.64m;
2.4 x 2.1 x 1.64m;	1.8 x 0.9 x 1.64m;
2.4 x 1.5 x 1.64m;	1.2 x 1.5 x 1.64m;
2.4 x 0.9 x 1.64m;	1.2 x 0.9 x 1.64m.

Plate 17: Configuration of air mats in domesticated housing sector (© Bison)

The mat is vented, to provide a constant airflow at all times; this reduces the 'bounce' factor when persons fall into the mat, and combats over-inflation and stresses on adjacent structures/surfaces. Design of the mats produces a certain amount of air loss through the stitching, which aids this ventilation requirement. The air-mat system is designed in this way to

[11] *Air mats can expect an increase in size, when inflated, of approx 10% of their overall un-inflated dimensions*

allow air dispersion from the mat and requires constant functioning of the inflation pump. This avoids over pressurisation and excessive pressure on the surrounding structure (a particular problem with newly formed masonry and brickwork).

Current innovations to the safety mat systems (since their earliest format) are:

- the use of safety sheeting (of the same material specification as the mats themselves), which is placed over the cross-sectional joints of mats to prevent any operative slipping between the mats in the event of a fall;
- 'parapet' walls, which provide an overall height of 2.6m, and help to prevent 'horizontal roll-off' for the faller (these additions also close any openings in a building, such as doors and windows, which otherwise could permit fallers to be ejected from the mat area);
- wedge-shaped parapets that can be added to the standard flat mat system to provide horizontal roll-off protection;
- different shaped mats, such as corner mats, useful for maintenance and refurbishment;
- air-mat modification of shape by opening/closing air feed inlets, thus re-distributing the air flow, to suit changing circumstances.

The air-mat industry is constantly modifying its products to suit the particular needs of the industry that it serves.

6.6.1 Manufacture

A typical example of the material of manufacture for the air-mat modules is described in the following specification (derived from BRE Client Report 206-981, 2002 – www.airtek.com):

- Fabric: 940 decitex woven polyamide, approx 154 gsm
- Coating: Coating of polyvinyl chloride on both sides

Testing is in accordance with BS 3424:1982 Methods for Test of Coated Fabrics:

- Tensile strength: Warp – 2250N/50mm
Weft – 1850N/50mm
- Tear strength: Across Warp – 400N
Across Weft – 380N
- Coating adhesive: 100N/50mm
- Fusion: No cracking or disintegration of coating for a minimum of 15 minutes

Flame resistance tested to BS 5438:1989, Methods of test for flammability of textile fabrics when subjected to a small igniting flame applied to the face or bottom edge of vertically oriented specimens, Test 2A:

- Flame resistance: 10 seconds flame application (surface ignition) – no flame or hole to burn to any edge

In comparison with a typical testing regime for play equipment, it is noted that the specific properties of the construction-based air-mat material is of a lower specification to that of the playground equipment industry materials. It is also noted that the above material example does

not appear to have been tested for both light-fastness (BS 1006:1990 Methods of test of colour fastness of textiles and leather) or toxicity (BS EN 71-2: 1994, BS 5665-2:1994 Safety of toys, flammability), due to the particular usage of playground equipment, the covering material is generally tested for both of these elements, as well as all elements listed above. This difference in specification is mainly due to the nature of usage for both pieces of equipment – the construction industry air-mat is designed only to arrest falls in the event of an accident, whereas the playground equipment industry's equipment is designed for long periods of usage by numerous persons at any given time; hence the higher specification.

During manufacture of the air-mat, circular holes are machine-cut to accommodate the air inlet and outlet holes. The patches are then retained and form part of the fitter's puncture repair kit, which is carried with the fitter at all times (see Section 6.12).

6.6.2 Air Flow Technologies

As previously discussed, air-mats rely on a continuous air feed. This is achieved via mechanical pumps or fans. Industry uses four different pump types for the inflation of air-mats: petrol, gas, diesel and electricity. It is estimated that 80% of the fans supplied to the air-mat industry are petrol driven. The fans have features such as:

- Speed control
- Audible alarms to alert the user should the fuel run low
- Safety cut-out feature in the event of overheating
- Damp conditions operational capability
- Filters to suit fans/blowers working in dusty or sandy conditions
- Motors to suit global voltages/frequencies

The essence of inflation of air-mats is that a pre-determined fixed amount of air is transferred into varying sizes and shapes of mats. The control of this air is important when considering the pressure difference that will occur when transferring through numerous mats in sequence, and/or mats of varying shape (www.gibbonsfans.com).

Speed controllers for electric fans are expensive and are not widely used. This is likely to remain the case without appropriate legislation.

In order that air-mats are inflated correctly, the air fans require to operate within certain pressure levels. Further, the pressure requires to be maintained throughout the configuration of the mat system.

The pressure to the mats must be fed at:

a) more than 0.0374 kilo-Pascals [kPa] (equivalent to 38.1mm of pressure), to inflate the mat sufficient to prevent a faller hitting the ground on impact; and
b) less than 0.137kPa (equivalent to 139.7mm of pressure), to prevent a faller bouncing on the mat on impact.

To provide an appropriate working mean pressure, the recommended optimum running pressure for the fans is 0.0872kPa (equivalent to 88.9mm of pressure). If operated at this level, the

operative will not actually bounce, but will be absorbed by the air-mat creating a comfortable landing.

The internal pressure of the air-mats is controlled by a combination of the following:

- fan speed
- the number of fans running for the air-mat configuration
- via controlled air loss through the stitching of the mats, and
- through opened inlet/outlet holes opened by the users (if mat is a tight fit to the space, or lower pressure is required)

A leading supplier of fans to the air-mat industry stated that it is bad practice to use the same type of fan for every type of mat – the pressure and surface tension must be uniform throughout the whole safe landing surface. In technical terms, the pressure must be 'equalised'. The potential for injury is much greater if the pressure is not equalised. This equalisation of pressure is achieved by flow of air through the interlocking mats via plastic couplers, and utilising multiple fans to supply enough airflow through to all modules within the series. Fans with variable speed control should be used if using air-mats of differing sizes and/or shapes. This could become extremely important when using parapet bags in conjunction with normal flat mats. The difficulty is ensuring that this practice is adopted by industry comes through the lack of adequate regulation in this area – at present, all air-mat manufacturers and users are utilising 'rule-of-thumb' methods when considering the provision of fan technology.

At present, there is no legislation on the running of pumps/fans when used in conjunction with air-mats. Apart from the emissions, moving parts and resonance, fans remain relatively unregulated. However, there is other relevant legislation that should be consulted when considering using mechanical fans on site. These are: The Electricity at Work Regulations 1989; The Supply of Machinery for Safety Regulations 1994; The Provision and Use of Work Equipment Regulations 1998.

Technical assistance should be sought when considering the provision of fan technology for air-mats on site. Output pressure and volume capacity are the two main factors to be considered when calculating fan requirements. The more air that is required, the less pressure will be achieved, by the same fan. Industry interviews have suggested that information on fans is not readily available, and this must be obtained when considering the use of air-mats. On discussing fan technology, the following was stated:

> "*this [apparent disregard on the importance of the air fans] is not considered as best practice when considering the pumps that inflate the mats. [there is] Very little emphasis on, and information about, the pumps is available for checking and appropriate certification*"
> (Project Manager, May 2003)

Industry must be aware of their duties to have adequate knowledge on all components of a system – if little or no information is available for managers in industry, there may be reluctance to use such equipment.

The final important consideration for fan technology is its connection to the air-mats – the hoses. Friction within the mat causes air pressure dissipation. This is also the case in the hoses that supply the mats with the air from the fans. A recommended rule of thumb when considering hose type and length is that the pipe should be 200mm, with a ***maximum*** length of 3-4m. Corrugated flexible piping will cause internal turbulence and dissipate the pressure prior to the air even reaching the mat; this is also the case should the hoses be bent, kinked, or out of shape. This may be overlooked on site, but should be given careful attention as failure to provide an adequate hose configuration could lead to an inadequate air-mat installation.

6.7 SOFT-FILLED MATS

The soft-filled mat system comprises interconnected cushioning mats filled with a packaging medium designed to dissipate the kinetic energy of a falling person (BSI, 2003). The system is filled with polystyrene packaging enclosed in perforated cells. On the outer bag are strategically positioned plastic snap clips; these clips are used to join together the mats to form the fall arrest system. The system was initially conceived solely for the domesticated housing market where there are fall heights of between two and five metres – in this sector of the market, the soft-filled mat system has recently been accepted, with several major organisations within the industry opting for the system as a preferred method of fall arrest. The cushioning element of the system is polystyrene fill, and the fixed amount of material used to fill each mat is carried out in the manufacturers' plant and sealed in predetermined sized bags. These bags are delivered to the distributors premises and are inserted complete into their own outer casings to ensure a consistent product, and to assist with quality control of the product.

Typical dimensions of the soft-filled mats are as follows:

2.55m x 0.55m x 0.55m – standard size mat
1.25m x 0.55m x 0.55m – half size mat
2.5m x 0.75m x 0.4m – timber frame mat
1.25m x 0.75m x 0.4m – half size timber frame mat

Plate 18: Soft-filled mats installation in domesticated housing (*Site visit, June 2003*)

Soft-filled mats are rectangular in shape and cover approximately 1.0 – 1.5m^2. Each standard full size mat takes up 0.84m^3 (half size mats 0.36m^3). The mats are compatible with each other only and are not recommended for use in conjunction with any other soft-filled mat systems.

6.7.1 Manufacture

A typical example of the material of manufacture for the air-mat modules is described in the following specification:

The following Standards are adhered to for the following durability tests:

Corrosion:	BS 7479:1991 Method for salt spray corrosion tests in artificial atmospheres
Weather resistance:	BS EN ISO 4892-3:2000 Plastics – Methods of exposure to laboratory light sources – Fluorescent UV lamps
Ignitability:	BS 5852:1990 Methods of test for assessment of the ignitability of upholstered seating by smouldering and flaming ignition sources

This energy-absorbing mat consists of a polypropylene-woven outer mat, and a polyethylene inner bag filled with recyclable energy-absorbing polystyrene. This free-flowing cushioning material is made from expanded polystyrene and exhibits high compressive creep and recovery properties.

- Polystyrene infill: Expanded into a 'figure-of-eight' shape. Polystyrene auto-ignition temperature is circa 463^oC. Depolymerises and ignites in the presence of a suitable source circa 283^oC[12].
- Fabric outer bags: Constructed from 1650/1800 Denier tear-resistant, man-made fabric of low weight (0.1Kgm^{-2}), and of low tensile strength (1.7MNm^{-3}). Panels and ends are cut using a heat cutter to avert any fraying.
- Sewing: Sewn together using an over-locking machine and a heavy gauge (5000-denier) thread – use of a polyester 5/12 reverse twist blue thread for final assembly
- Buckles: Tested at a rate of 4:1000 (0.4%) – 50Kg buckle and strap test
- Final Assembly: Bags stencilled and marked, as a necessary part of batch-trace-ability and correct installation procedure.

[12] *There are 3 standard shapes in polystyrene fill dependant on the manufacturer. As well as the figure-of-eight shape described above, there is 'E' and 'S' shaped configurations available. It is believed that the shape used currently does not have physical properties that are better than other shapes – it is simply the shape that has been chosen for the current mats.*

- UV Degradation: Materials subjected to a 300% overload during dynamic testing.
- Weight: Lightweight bags (<7Kg)

In comparison with a typical testing regime for play equipment, as described in Section 6.5.1, it is noted that the specific properties of the construction-based soft-filled mat materials are of a different, and possibly lower, specification from that of the playground equipment industry materials. It is also noted that the above material example, like the air-mat, does not appear to have been tested for both light-fastness (BS 1006:1990 Methods of test of colour fastness of textiles and leather) or toxicity (BS EN 71-2: 1994, BS 5665-2:1994 Safety of toys, flammability). This difference in specification is mainly due to the nature of usage for the contrasting pieces of equipment, for contrasting industries, as described in Section 6.6.1.

6.8 INDUSTRY RECOMMENDATIONS FOR USE

Fall arrest mats are becoming more popular within industry due to the focus, in the hierarchy (see Section 3.2), on passive fall protection as the preferred method of fall arrest. Changes in legislation, in particular the forthcoming Work at Height Regulations 2004, are moving industry towards passive protection and industry is recognising the benefits of fall arrest mats in circumstances such as domestic housing during prefabricated system erection, or during installation of precast concrete slabs in domestic or industrial construction – in any situation where passive fall protection is decided to be more appropriate than active systems. The purpose of this Section is to provide industrial examples of the benefits and limitations of fall arrest mats. Operational examples of the generic advantages and disadvantages of both systems will be provided.

It was stated during the focus groups research that fall arrest mats provide operatives with psychological comfort that they are exposed to less risk of injury should a fall occur. This was confirmed during site interviews when operatives declared that they had full confidence in the system, and their confidence level had increased knowing that the system was in place below them:

> "*If we were unfortunate enough to fall, we would be happy to fall into the bags – we'd be more worried about tools injuring us in the fall*"
> (Joiners and soft-filled mat installers, June 2003)

This was also supported by the same operatives through insistence that the systems are totally practical, reliable and reduce the risk of injury significantly.

The recommended maximum distance a person should be allowed to fall into an air-mat is two metres, however the air-mats are tested successfully to arrest a fall of up to six metres. As was stated at the fall arrest mats Focus Group meeting:

"*We are out there and we are happy…with them working in storey heights of 6 metres. At the moment we don't plan in exceeding that. But it is tested and it's tested thoroughly above that.*"
(Director [Airtek], October 2002)

The openings for the door and windows in room are unprotected as standard fall arrest mats do not tend to cover the full size of the opening. To this end, some form of edge-protecting mat, i.e. the parapet mats as discussed in Section 6.6 (see Plate 8), or specialist technique should be considered if fall arrest mats are to be viewed as the ideal method of fall arrest for all building types. This will be discussed further in Section 6.10.

Plate 19: Parapet air-mat configuration in an industrial situation, providing cushioned edge protection and passive fall arrest (© Bison)

6.8.1 Advantages and Disadvantages

This Section deals with the advantages and disadvantages of fall arrest mats. There are generic advantages and disadvantages of using fall arrest mats in particular work situations. Further, there are benefits and limitations of both systems, which are described below.

Generic advantages

The mats reduce the incidence of injuries caused by pendulum effect[13] associated with other systems, for example, cable or track-based systems (see Section 8.6.1)

Users of fall arrest mats reported that the soft landing and the 'carpet' effect of the systems provide a positive psychological reaction by those relying on the system, leading to greater confidence at the work place, greater freedom of movement and faster working

[13] *Pendulum effect is; falling at an angle from the anchorage point and swinging like a pendulum; this increases the risk of secondary strike injuries for the faller.*

System manufacturers offer a complete safety package to the contractor, which removes the burden of ensuring that the systems are used appropriately, and allows the contractor to concentrate on management and supervision of his core operations. The packages include installation, maintenance, transport, inspection and system audit control. Advantages of this include tighter quality control and peace of mind that professionally competent personnel are providing the fall protection, without the need to train site personnel

Air-mat advantages

The air-mat system is a one-day operation – installed on the day that it is required only. This differs slightly from safety nets and safety decking where these systems would normally be erected at least one day before the works are to take place. This can be viewed more as a requirement than an advantage, with installers required to arrive at precisely the right time, affording little flexibility, however, it does ensure that the system will not be on site for any longer than is necessary, thus reducing hiring costs, and the potential for damage

There are individual mat shapes that can be manipulated to fit different locations, for example, the following shaped modules are now available:

- Parapet modules
- Shaped bay window modules
- Shaped stairwell modules
- Modules dimensioned for corridors
- Parapet top modules designed to fit onto standard flat modules
- Modules with adapted top and additional bottom clips for use in high wind environments at high level

Cover sheets can prevent a faller from falling in between the mat modules, minimising the possibility of post-fall injuries from the mat itself

Soft-filled mat advantages

The expected use for this system is domestic housing construction. There has, so far, been a lack of suitable fall arrest protection in the housing industry. To date, the system has been marketed purely for domestic housing and has not been used out-with this sector. However, there is potential for the soft-filled mat to be used in other areas of industry, for example the building maintenance industry, although any use in such areas should only be recommended following stringent assessment of the appropriateness of the system in such circumstances

The simplicity of installation, use and removal of fall arrest mats is a major factor in their selection and could make them appropriate for other areas of construction, in the future

This system's main advantage is that it is non-mechanical, is flexible, and is a very easy to install and use. It is a very lightweight system (<7Kg per mat, even for the larger mats). Manual handling of the system is not likely to cause strain injury; and the system is easily moved from location to location

In confined spaces it is flexible as the shape of a mat can be manipulated, rather like a 'bean-bag', to suit the available space

A complete installation also provides a protective platform that can be walked on if absolutely necessary. Further, they are simple for an uninjured faller to walk out, obviating the need for rescue facilities

Due to the robust nature of the outer casings, the systems are very resistant to tearing

Generic disadvantages

The systems tend to be viewed as amusement equipment for intruders to the site and provide another attraction for potential trespassers

The set-up time for both systems can be long, including transporting materials from the vehicles or their storage points, to their position, and the subsequent positioning and set-up of the equipment

The systems will only be effective if they are positioned correctly, which relies on appropriate site control, to ensure that modules are always positioned below where the work at height is taking place

Air-mat disadvantages

The loading on surrounding structures is not as much of an issue with mats as with safety decking[14] and nets, which always rely upon edge support from the surrounding walling. However, there are situations in which fall arrest mats, particularly air-filled mats, can apply lateral loads to surrounding walls and this possibility must be taken into account in planning their use, for example, in areas adjacent to 'green' brick or block work, i.e. the mortar bonding the brick/block work is not adequately set (a rule of thumb method is to allow 48 hours from laying the brick/block before carrying out adjacent works)

If the mat modules are not sized correctly; in particular using mats too large for the void, they can (during inflation) apply excessive loads to the surrounding walls, thus increasing the likelihood of damaging adjacent works

It is estimated that 80% of the fans supplied to the air-mat industry are petrol driven. These fans do not have pressure adjustment controls. This means that 80% of the fans in use for this purpose have limited pressure adjustment facilities and it is possible that air-mats can be used at inappropriate pressures

Some people have suggested an environmental issue when considering pollution and noise factors, however this is out-with the scope of this report

There is potential for deflation of the mats without the workers above being aware. Perception of height from above is distorted and could lead personnel to believe that the mats are fully inflated, when they are not. The air-mats deflate quickly if the airflow is halted to the unit. The airflow could cease due to a number of reasons, for example, the fan running out of fuel[15]; the hoses to the inlets becoming dislodged, the mats being punctured, etc.

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[14] *Information on Safety Decking is included in the report of Research Contract*

[15] *Audible alarms (see Section 6.6.2) were recommended by some interviewees during data collection*

Soft-filled mat disadvantages

Due to the bulky, non-collapsible nature of soft-filled mats, consideration must be given to storage and transportation. If large areas are being 'matted-out', there is a requirement for considerable storage and transport capacity

Soft-filled mats do not utilise a cover sheet to avoid a faller falling in between the mats, increasing the possibility of the faller striking the ground

Anecdotal evidence suggested that the attachment clips that connect the mats together can be brittle and easily broken, which could increase the likelihood of a faller falling between the mats and striking the surface below

The mats are vulnerable to vandalism. Occasions have been reported of the mats being sliced open and the polystyrene fill strewn over sites. The fill also provides a potential fire hazard, if used under hot work, such as welding

Inadequate records of the history of the modules can be a concern. The users may not be aware of how often the bags have been used prior to arriving on site

There is potential for the mats to fill with water if the outer casing is punctured in any way. This would make the mats heavier and more difficult to move around the site. The following quotation supports this:

> "*Water also gets into the bags and makes them heavier and more difficult to handle – not sure if this is through a tear or the water penetrating the surface material*"
> (Joiners and soft-filled mat installers, June 2003)

This suggests that, during inclement weather, the soft-filled mats are more difficult to handle and also casts doubt on the waterproof integrity of the outer casing of the mats. However, as this issue was raised by only a small number of interviewees, it remains an unresolved question at this stage due to unsubstantiated evidence that the frequency of the problem is considered a factor

6.8.3 System Use During Maintenance and Refurbishment

Fall arrest mats were not originally designed for use during maintenance and refurbishment works but advances in system design of air-mats, i.e. the parapet bags, has provided potential for use under certain conditions in this industry.

At present, the soft-filled mat manufacturer is not marketing the product for maintenance and refurbishment.

6.9 TRAINING STANDARDS

Due to the lack of appropriate legislation and a regulatory authority, there is inadequate guidance on, and provision of, training. To date, both the air-mat and the soft-filled mat manufacturers / distributors provide the training necessary for successful usage of their respective systems. As

discussed in Section 6.3.4, due to the lack of necessary testing regimes the industry has to 'adopt' testing and training guidance from other legislation.

Training in the use of both systems is very hands-on, and provides the users with the expertise to install, inspect, transport, etc. the system on site. This avoids the need to bring in expert help, as is normally the case with, for example, safety nets (i.e. the contractor would have to request that FASET-trained operatives come onto site to carry out any alterations to the netting system). This training should cover the mechanics of each system, the appropriate transportation, usage, installation, storage, maintenance, repair, etc. Currently, the site manager is supplied with the relevant guidelines, risk assessments and documentation appropriate to the systems. This was explained thus:

> *"The manufacturer's rep came out and showed everyone how the system works, how it was operated, how to move it, connect it, etc.*"
> (Site Manager, May 2003)

This research suggests that there should be more stringent training and flow of information from the trainers to both the workforce and site management.

6.9.1 Rescue

Rescue considerations must be addressed when considering any safety system. For fall arrest mats, rescue does not create significant problems. Should a person fall into a fall arrest mat, the average time of rescue from the mat is estimated to be around 2-3 minutes due to the quick deflation time (for air-mats), and the fact that a rescuer can walk over the mats (for soft-filled mats) to get to the faller and action the appropriate rescue procedure.

There are other considerations that must be addressed in rescue situations, for example, should medical treatment be required for the faller, provision for the appropriate level of first-aid or procedure for emergency services should be afforded. This information should be contained in the Rescue Method Statement for each individual area of work to be carried out. Specific provision for rescue considerations are covered in the following legislation:

The Construction (Health, Safety & Welfare) Regulations 1996 (Regulations 20), and,
The Management of Health and Safety at Work Regulations 1999 (Regulation 8).

6.10 INSTALLATION

Site circumstances constrain the safety equipment that can be used, and the installation techniques that must be employed. Often, circumstances afford the site manager little, or no, choice as to what systems can be used. For example:

> "*On timber roofs nets couldn't be used as the height was not high enough (2.8m). It was felt that the only system that could be used was air-mats – it was the most practical and the cheapest*"
> (Site Manager, April 2003)

The installation regime must be fully understood by site management and those installing the system.

It has been suggested that installation of fall arrest mats (in domestic housing in particular) is significantly less dangerous than safety netting. This is due mainly to the avoidance of injuries from netting hooks during rigging or de-rigging of nets. The installation of nets will be discussed in Chapter 7.

Due to the differing mechanics of both systems, installation requires separate procedures to ensure that each system is afforded the optimum installation solution. The installation procedures for both the air-mat and the soft-filled mat are described below.

6.10.1 Air-Inflated Mats

The manufacturer's recommendation for installation of this type of fall arrest mat should include the following sequence of operations:

- The area is checked for cleanliness and safety prior to any units being installed; any debris or protruding object that could cause damage to the units are to be removed / made safe.

- The units are visually inspected for any obvious damage prior to installation, and the appropriate action taken should any defects be found.

- The units are installed in the area requiring the protection, and laid out and connected by a means of flexible air couplings, with push connections.

- All connectors, clips and ties are fixed securely and checked (to ensure the units fit together closely, and there are no gaps).

- The cover sheet is laid over the top of the units, ensuring that it does not coincide with the joints between the units (not within 600mm of a module joint)

- The pump is connected and switched on to inflate the unit (see Section 6.5.2); during inflation the units should be inspected to ensure that they are filling uniformly

- When fully inflated, the safety zone should be checked to ensure that all components are operating correctly and that the area is completely protected with an integrated surface with no gaps or voids.

- De-installation and removal is simply the reverse of the above sequence.

Site management control is important when considering the installation of safety equipment. The following points were highlighted during the site visit interviews:

> "*We found that the mats weren't moved by the operatives; some were not inflated at all; if the pumps had run out of petrol and the mats deflated, they were just being left; the set-up time of the mats caused the men to simply ignore the system; the air-mats were abused*

and damaged due to a lack of respect because the men didn't want to use the system; there was a real laziness factor with the air-mat system."
(Project Manager, April 2003)

6.10.2 Soft-Filled Mats

The manufacturer's recommendations for installation of this type of fall arrest mat should include the following sequence of operations:

- The area is checked for cleanliness and safety prior to any units being installed; any debris or protruding object that could cause damage to the units are to be removed / made safe.

- All units are visually inspected for damage.

- In domestic timber kit construction, if the joists are not boarded, scaffold planks (or other access equipment) would be positioned to form a safe working platform on which to stand whilst fixing / installing the units.

- As with competent construction practice, all stairwells should be covered with appropriate boarding and clearly marked with an adequate barrier to provide fall protection.

- Working from one corner, the units are laid in opposite direction to the joists (if used in timber kit domestic dwelling properties) with the manufacturer's logo facing upwards.

- As the units are laid, they are clipped together to form a complete unit; all clips are used (except those along the perimeter).

- The system is flexible to fit into confined/awkward spaces. A process known as 'double bagging' is adopted if window/door openings present a risk, or if the fall height is over the desired two metres. Double bagging is simply laying an extra layer of mats over the bottom layer, thus providing double the protection to the users. At window and door openings, this procedure will protect the users from potentially rolling off the mats out of the room should a fall occur. The decision to double-bag should be taken by site supervisory staff with appropriate experience in this system to determine that this process will improve safety for the system users.

- De-installation and removal is simply the reverse of the above sequence.

Due to the lightweight nature of the product, and its speed and ease of installation, this has little time constraint on any of the trades working overhead. For example, a user of soft-filled mats, stated:

"*[the installation was]…twice as quick as a safety net*"
(Site Manager, June 2003).

6.11 MANUAL HANDLING

As with any piece of equipment used in the workplace today, manual handling issues must be adequately considered and appropriate action taken to ensure the persons using/installing the equipment aren't at risk of injury through handling the equipment; this is governed by the Manual Handling Operations Regulations 1992.

The advantages of both air-mats and soft-filled mats is that each of their heaviest units (when not subjected to environmental conditions such as rain, wind, etc.) are under the 25Kg single-person lifting limits (at waist height conditions), set by the above regulations; the heaviest air-mat being approximately 23Kg, and the typical weight of a soft-filled mat being around 6Kg. However, there are other manual handling issues to consider when using this equipment, for example, the repetitive movements required in installing numerous soft-filled mats within a short period of time; or the effects on the body of moving inflated mats to other positions. As fall arrest mats have not been used on construction sites for a long period of time, and in lieu of a proper ergonomic assessment, the aforementioned hazards are only suggestions of the manual handling issues that could arise. Therefore, both systems will require suitable and sufficient risk assessments to be carried out to ensure no person using/installing the equipment will be exposed to any unnecessary risks.

With regard to handling soft-filled mats, the following quotation was taken directly from site personnel during the site interviews phase:

> "*There are no…manual handling issues with the system*"
> (Site Manager, June 2003)

6.12 INSPECTION AND MAINTENANCE

As with any piece of equipment, inspection and maintenance of the fall arrest mats should be carried out on a regular basis, and, in particular, immediately prior to using the equipment. The following list can be considered an appropriate guide for inspection and maintenance of fall arrest mats:

- ***All*** component parts of the system are visually inspected for damage, degradation and wear and tear prior to every installation, and again upon de-installation.

- Any component parts found to be damaged or degraded in any way should be taken out of service immediately and reported to the appropriate line manager. The exception to this would be a minor hole in an air-mat, which could be repaired on site using the site repair kit (similar to a bicycle puncture repair kit), or a minor tear in the external covering of a soft-filled mat. If in any doubt, the recommended procedure would be return the equipment to the manufacturer to be inspected and repaired.

- When in use, regular, full inspections of the system should be carried out, including all component parts and the integrity of whole the system. Appropriate written records of such inspections should be kept and regularly audited.

There are many obstacles and objects on construction sites that can damage the integrity of the mat material. One main area of concern for industry is the effect that sparks from above has on the mat surface. However, a suitable and sufficient risk assessment would ensure that any such works are progressed out-with the potential danger area of the mats.

6.12.1 Monitoring and Supervision

In conjunction with ensuring inspection of the systems prior-to and during installation (as discussed in Sections 6.10.1 & 6.10.2), there is a need for constant supervision to ensure the correct use of the systems. Although manufacturers provide the complete safety package, industry does still hire the equipment (of both systems) on a regular basis, thus the need for careful supervision under these conditions. The mechanics of both types of fall arrest mat are different, and this determines that there are differing monitoring and supervision requirements for each. The following generic elements should be inspected for all fall arrest mats:

- That the system is installed correctly
- Is positioned correctly (below the workers)
- Is filling the space below and there are no spaces available to fall through
- All sections are correctly clipped together
- No debris is on top of the mats
- The system has not been damaged or vandalised
- Access and egress is not restricted by the mats, etc.

As there is more sophisticated equipment involved in air-mats, the monitoring is more involved. This has caused problems on site for those responsible for supervision the proper use of this system:

> "*…there is a bit of a wooliness in information on what parts and components of the system need to be checked*"
> (Project Manager, May 2003);

> "*A heavier presence of monitoring is required with this system…There is…a lot of policing involved with this system, particularly on bigger jobs. This is extremely time consuming*"
> (Site Manger, April 2003)

Due to both the technology used and the amount of component parts used in air-mat systems, the monitoring function on site involves a significant amount of time and effort. This must be accounted for when selecting such a safety system. This factor must also be carefully considered if employing sub-contractors to install and use fall arrest mats:

> "*Sub-contractors don't put as much emphasis on safety as main contractors do, therefore there is a constant requirement to monitor and police them*"
> (Site Manger, April 2003).

The whole function of monitoring and supervising fall arrest mats as a safety system requires detailed planning prior to commencing any works on site.

6.12.2 Maintenance of the Equipment

As both systems are relatively new to industry, little information was available on long-term durability, maintenance and repair. However, with the systems involving differing components and differing levels of technology, there will be diverse maintenance considerations for each. Further to the general information contained in Section 6.12, the durability of both systems will become evident through time and usage on sites over a prolonged period.

With specific reference to soft-filled mats, the maintenance function appears to be of little concern to one particular user:

> "*In the long-term, maintenance is bound to be required, however we haven't come across any requirements yet (in over 18-months of using them)… They are recommended for a power-wash from time-to-time, but generally little maintenance is required…We've never had any need for maintenance…we've never had to send a bag back yet*"
> (Site Manager, June 2003)

Due to its low technology and materials used in manufacture, the soft-filled mat appears to be a durable piece of equipment.

Maintenance of equipment with air-mats is not normally carried out on site. Minor puncture repairs can be carried out on site, and are made by fixing patches of the base material of the module using a chemical bonding agent specified by the manufacturer. For larger-scale damage, the damaged mats would be set aside, returned to the manufacturer's base and repaired. All air-mats should be inspected following a major repair. To date, the only suggested fault with the (Airtek) air-mat system was that of inferior attachment clips (breaking, snapping, etc), and it is believed that this has since been rectified with the introduction of heavier duty clips.

6.12.3 Storage and Transportation

If air-mats are left on-site overnight or at weekends etc., they are normally deflated and left to sit in position. Alternatively, they can be put in safe storage if this is deemed appropriate by site staff. Safe storage could be either an on-site container used for the purpose of securely storing equipment when not in use, or in the installers vans. As the mats deflate to a flat section of material, they are easily folded up and stored in their individual bags, which makes storage simple and convenient.

Transportation of the air-mat system requires vehicles to accommodate the equipment. With the various component parts required to make up a system, e.g. mat units, cover sheets, hoses, fans, fuel, etc., small vans, e.g. 7.94m^3 (www.ford.co.uk), are not able to carry enough equipment to satisfy the requirement for most sites. It is estimated that larger, and more suitable, vehicles can transport between 200-240m^2 of mats.

The size of vehicle used will depend on the size of the job and the equipment required.

Due to the physical nature of the soft-filled mats (i.e. ready-filled with little flexibility for minimising the volume), storage and transportation is a more laborious task than that of the air-mat. Transportation of the system is by articulated lorry. Space required for the system varies

from job to job. The manufacturers of the system estimate that approximately 100 standard mats will fit into a standard 'curtain-sided' articulated vehicle (approx 140m^2), and 60-80 mats in a rigid vehicle (85-110m^2). Storage of the equipment presents similar problems when the mats are not required for periods of time on-site. The recommended procedure is that they are in place until no longer required, then either moved to another safety area to be used again, or taken off-hire by the manufacturer or supplier. When this is not possible, a suitable space on site is required for storage. The mats would be clipped together and left in an appropriate place, ideally protected from the elements. This could present problems on confined sites, and this is where site management would require to manage the programme accordingly to ensure that this storage issue does not become a major problem for the site.

6.12.4 Typical Life Span

As discussed earlier, fall arrest mats have been in existence in industry for a relatively short time, and therefore the effects that 'wear and tear' and degradation over time have on the integrity of the system cannot be assessed accurately. At this time, the manufacturers estimate that, with appropriate inspection and maintenance, both the air-mats and soft-filled mats should have a useful life of approximately ten years.

6.12.5 Disposal of Damaged Materials

In the event of component parts of the equipment being rendered unsafe for use on-site, the manufacturer should be contacted for advice on inspection, repair or disposal of the materials. This both assists the manufacturer with quality control of the product, by allowing testing to be carried out on equipment that has 'failed'; and ensures that the equipment is not used in an unsafe state. Manufacturers accepting returned and damaged equipment is considered as standard practice with all contacts involved in this Chapter.

Advice on disposal should always be sought from the equipment manufacturer.

6.13 SUMMARY

The use of fall arrest mats is growing within the construction industry. There are two types of fall arrest mat used in the UK: the air-mat, and the soft-filled mat. Both are laid on the ground or suspended floor, beneath the working area, and protect operatives from relatively low falls of up to 2.5 metres. The mats are designed to decelerate (or cushion) the operatives' fall, and hence minimize the worst effects of a fall from height.

Fall arrest mats have only been widely available for 4-5 years, therefore, their governance by legislation is limited. Thus, there is minimal legal control over items such as manufacture, testing, transportation, certification, etc. However, other legislation has a level of jurisdiction over the industry. This situation is beginning to change with the publication of two BSI PAS documents:

- PAS 2004 – Inflatable Collective Fall Arrest Systems
- PAS 59 – Filled Collective Fall Arrest Systems

Collective fall arrest systems are specifically mentioned in the forthcoming Work at Height Regulations 2004, and this is recognition of their increasing popularity within industry.

The air-mat system comprises a series of interlinked modular inflated mattresses. The modules are manufactured in a range of sizes allowing coverage of almost any size and shape of construction area.

Air-mats rely on a continuous air feed. This is achieved by mechanical pumps or fans. In order that air-mats are inflated correctly, the air fans need to operate within a certain pressure range. Further, the pressure has to be maintained throughout the configuration of the mat system. Technical assistance should be sought when considering the provision of fan technology for air-mats on site.

The soft-filled mat system comprises interconnected cushioning mats filled with a packaging medium designed to dissipate the kinetic energy of a falling person. The system was initially conceived for the domesticated housing market where there are fall heights of between two and five metres.

The simplicity of fall arrest mats is a major factor in their installation, use, removal, etc., and could make it appropriate for other areas of construction, in the future. The systems will only be effective if they are positioned correctly, which relies on careful site control to ensure that modules are always below where work at height is taking place.

Both fall-arrest mat manufacturers provide the training necessary for successful use of their respective systems. Training in the use of the systems is hands-on.

Inspection and maintenance of the fall arrest mats should be carried out on a regular basis, and, in particular, immediately prior to using the equipment. There is a need for effective supervision to ensure the correct use of the systems. The mechanics of both types of fall arrest mat are different, and this determines that there are differing monitoring and supervision requirements for each.

At this time, the manufacturers estimate that, with appropriate inspection and maintenance, both the air-mats and soft-filled mats should have a useful life of approximately ten years.

During the site visits and industry interviews, very few negative comments were received about fall arrest mats, and again this is viewed as testimony that it is a system that appears to have been embraced by industry.

The markets for fall arrest mats would appear to be domesticated housing, and industrial works during the installation of flooring materials above. It would appear a crude distinction is emerging; the low-rise housing market appearing to favour soft-filled mats, and higher-rise flatted structures appearing to favour air mats. Further take-up by other sections of the industry may come in time, as suggested previously there is scope for fall arrest mats to be used within the maintenance and refurbishment industries. To date, it is felt that the maintenance and facilities management sectors have not taken advantage of fall arrest mats as a means of passive fall protection. In both of these, there remains a bias towards active fall arrest.

Safety netting originated the concept of using passive fall arrest as a successful (and accepted) method of fall protection, and the fall arrest mat industry has taken this concept a stage further and developed a system specific to the needs of specialist problem areas in the construction industry. At this time there would appear to be few other systems in the marketplace to rival the fall arrest mat in what it does, and how it does it.

7.0 FALL ARREST NETTING (SAFETY NETS)

7.1 INTRODUCTION

Many organisations in the UK construction industry use safety netting as the preferred form of passive fall protection and many industrial, commercial, domestic new build and refurbishment building projects are carried out with nets in place for much of the construction programme. The system has been championed by HSE, which has stated, in HSG33: Health & Safety In Roof Work, that "*safety nets are the preferred solution for fall arrest*" (HSE, 1998). The use of safety nets during industrial roof work was published as an 'HSE Enforcement Priority', in 2001.

Safety nets are increasingly used to provide accident protection on building and construction sites. They are designed to provide ***passive fall protection*** without any active or cognisant effort on the part of the user. Safety nets are designed with mesh strong enough to withstand the force of people falling into the net, and of an appropriate size to avoid any faller suffering undue physical harm from contact with the net. However, some problems do exist that prevent their use in some circumstances. These limitations will be mentioned where appropriate, and discussed in more depth in Section 7.6.1.

The amount of physical effort required to use a fall-arrest system will also have a major bearing on selection and industry tends to favour passive systems. With many users of netting not actually being involved in the rigging and dismantling of nets, industry has embraced this concept. This issue will also be addressed in this Chapter.

High-tensile net platforms, both rigid and flexible, have recently been introduced, providing a temporary working platform and fall prevention in one system. In this report only polypropylene personnel safety nets are considered.

Interviews with representatives of industry who use safety netting, supervise their use, and manage their selection, described in Chapter 2 led to conclusions on practical issues in the selection and use of the system, provided throughout this Chapter. Also, this Chapter will provide details of specific legislation related to safety netting, highlight the technical benefits and limitations of the system, and provide guidance on appropriate circumstances for use of the system.

7.2 HISTORY OF SAFETY NETS

Safety netting used in the construction industry today is based on manufacturing techniques developed, over more than 100 years, for nets for the fishing industry. The manufacturing techniques and materials used will be further explained in Section 7.4.2.

Some have expressed concern that nets have not been in use for long enough to know their true long-term advantages and effectiveness; however, as Section 7.3 will show, safety netting has been used and legislatively governed for longer than is often believed. In the past, usage of safety nets was very low, due, in part, to cost. However, pressure from the HSE Inspectorate increased their usage on site. Manufacturing of nets in the UK ended a number of years ago, and users then

turned to Europe purchase nets (Portugal and Germany in particular). European manufacturers' systems have established bases in the UK to distribute the netting throughout their industry networks.

7.3 LEGISLATIVE HISTORY

Further to information contained in Section 3.2 (Generic Legislative Guidance), the following Regulations and guidance are appropriate to safety nets. Safety netting has been recognised as a method of fall arrest for a number of years. The first Regulations to specifically mention safety nets were The Construction (Working Places) Regulations 1966, Regulation 38: *Prevention of falls and provision of safety nets and belts*. In this Regulation, the following is stated:

> **38.** – (1) …*there shall…be provided and so erected and kept in such positions as to be effective to protect persons carrying on that part of the work or using…suitable safety nets…of such design and so constructed and installed as to prevent…injury to persons falling on to them*

The first actual guidance on nets in construction was published in 1972. This short Approved Code of Practice (ACoP) was based only on knotted nets and debris nets. Netting has been used regularly in construction works for approximately 10-years, but has enjoyed more recent widespread use as a direct result of Regulation 6 of the Construction (Health, Safety & Welfare) Regulations 1996 and the publication of HSG33, Health & Safety in Roofwork. With the publication of HSG33, the HSE promoted safety nets as a major contributor to height safety within the industry, by giving their use its explicit support.

Safety nets control by codes of practice and British Standards is extensive. The chronological history of British Standards and Codes of Practice is included in Appendix 4, which provides the evolution of control over the system.

7.3.1 European Normative (EN) Standard & Conformity European (CE) Quality Mark

European Normative (EN) is the prefix for all European-wide legislative standards, and is intended to both work in conjunction with, and eventually incorporate, all British Standards (BS). The EN most referred to for nets is (BS) EN 1263: Parts 1 & 2. This recent European standard also incorporates provisions from the following publications:

EN 919:1995	Fibre ropes for general service – Determination of certain physical and mechanical properties.
EN ISO 7500-1:1999	Metallic materials – Verification of static uniaxial testing machines – Part 1: Tension/compression testing machines.
ISO 1806: 2002	Fishing nets – Determination of mesh breaking load of netting.
BS EN ISO 4892-1:2001	Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance.

prEN 13374: (Draft for Public Comment) Temporary edge protection systems – Product specification, test methods[16].

7.3.2 The Work at Height Regulations 2004

In relation to safety nets, the Regulations and Schedules referred to are the same as those consulted for fall arrest mats (see Section 6.3.5). The following regulations and Schedule sections of the forthcoming Work at Heights Regulations 2004, apply to the use of safety nets:

Regulation 2 – *Interpretation*
Regulation 7 – *General principles for selection of work equipment for work at height*
Regulation 8 – *Requirements for particular work equipment*

SCHEDULE 3: REQUIREMENTS FOR COLLECTIVE SAFEGUARDS FOR ARRESTING FALLS

Parts 1, 2, 3 (b) & 4

Appendix 5 details the contents of the above sections of the regulations. It is important to note that the above references may be subject to change as the regulations progress through the consultation and subsequent amendment phases, however they are accurate at the time of submission of this report.

7.4 TYPES AVAILABLE

Under clause 4.2 of BS EN 1263-1, the four different types of safety netting available are:

System S: Safety netting with a border rope
System T: Safety netting attached on brackets for horizontal use
System U: Safety netting attached to supporting framework for vertical use
System V: Safety netting with a border rope attached to a gallow type support

Safety net type 'S' is generally used for fall protection throughout the UK, and is the main type covered in this Chapter.

Within BS EN 1236-1, Clause 3.2, the following definitions are given:

Mesh – *a series of ropes arranged in a basic geometric pattern (either in squares or diamonds) forming a net* (see Plate 10)

Net – *connection of meshes*

[16] *Temporary edge protection systems also includes nets in the vertical position. However these systems are out-with the scope of this report.*

Safety net – *net supported by a border rope, other supporting elements or a combination of these designed to catch persons falling from a height*

Border rope – *rope which passes through each mesh at the perimeter of a net and determines the perimetric dimensions of the safety net*

Tie rope – *rope used for securing the border rope to a suitable support*

Coupling rope – *rope that joins two or more safety nets together*

Test mesh – *mesh which is worked into the safety net and which can be removed to determine any deterioration due to ageing without impairing the performance of the net*

Safety nets come in various sizes and shapes dependant on the requirements of the site. Examples of typical sizes are:

Industrial Roofing:
5x5m; 7.5x5m; 2.5x15m; 5x10m; 7.5x7.5m; 5x15m; 7.5x10m; 10x10m; 7.5x15m; 10x12.5m

Domestic Housing:
7x8.5m; 8x10.5m; 11x11m; 11x13.5m

Plate 20: Safety nets in low-rise industrial construction setting. Netting positioned as close as is possible to the underside of the roof structure

As discussed in Section 7.2, safety netting is no longer manufactured in the UK, but has numerous distributing bodies for the alteration, repair, and distribution of the safety system. Rolls (or bales) of the netting are distributed direct from European manufacturers to the UK, where they will be modified to suit the sizes mentioned above. Excess bales are generally kept by the distributing agents to accommodate the requirement for producing non-standard sized nets on an ad-hoc basis.

7.4.1 Materials Used

Many sizes of nets are available. They are generally made from high-strength multifilament polypropylene (PPM), reinforced around the edges, and have an integral border cord of minimum breaking strength 30kN.

The forces applied to the structure via the attachment points of the net are determined by the position of impact of faller. Impact, from a fall, on different areas of a net (particularly on larger spans) will cause the net to react in different ways. This is an important factor that should always be considered when planning and using nets. When considering such situations, the designer must liase with the structural engineer to ensure that the structure will suffer no structural damage from the forces generated from both the fall, and the subsequent suspension of the faller. It is the planning supervisor's responsibility, under Regulation 14 of CDM, to ensure that all parties liase with each other to make certain of interaction between the temporary and permanent structure.

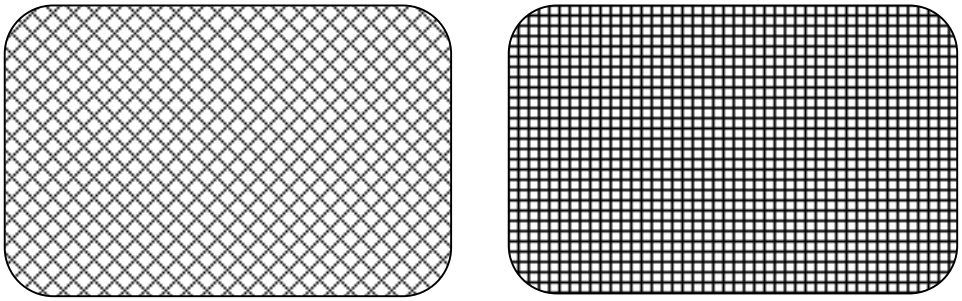
When considering the testing regime, there exists an issue with the 100kg standard test load and the 6kN design loadings. British Telecom raised the issue that around 50% of their 25,000-strong workforce actually weigh over 100kg[17].

7.4.2 Manufacture

Two types of net are available, knotted and knotless nets. The following descriptions are adopted from Fall Arrest Safety Equipment Training (FASET) training literature (see Section 7.7). The earliest manufactured nets were knotted, formed by knotting cords at junctions, to produce the net area. They have a set knot tension and, when they experience an impact the knots local to the impact permanently tighten and absorb the energy, which implies a deterioration of the system and possible rejection for further use. This type of netting is heavier than knotless nets and the construction industry has all but ceased to use this type. However, it should be noted that the FASET training syllabus covers both.

Knotless nets are knitted into a pattern of voids and crossover points to form the net. The performance of these nets is dictated by specifying the proportion of the longitudinal threads to the proportion of the external threads, and by changing the pitch. In this way, very specific energy absorption characteristics can be set. It is believed that the newer knotless nets reduce the risk of facial injury, compared with knotted nets. Both types can be formed into either diamond or square mesh, with the square mesh being the most popular form used in the UK construction industry. There exists no definitive reason for this, with typical explanations being that most spaces that the safety nets will 'fill' are square or rectangle in shape; also, manufacturing the square-meshed nets is more simplistic when attaching the border ropes to the perimeter (see Plate 10).

[17] *Current research at Loughborough University is investigating whether current harnesses are too weak for the average construction worker, as it is believed that industry personnel are heavier than the testing limit (100Kg). Presently, it is recommended that anyone over 100Kg should check the suitability of their fall arrest equipment.*



Diamond Mesh **Square Mesh**

Plate 21: Diamond and square net configuration. The UK industry favours square net construction on most occasions.

Safety nets have a ultra-violet (UV) inhibitor added to the netting fibres during manufacture to guard against UV degradation during use of the system. Also during manufacture, each net will have affixed an identity label. This label assists in monitoring and policing the age and testing requirements of the net, as described in Section 7.10.1. Lead seals are also applied by the testing agency, and carry the same identity number on both the label and the test mesh samples. This provides evidence that the safety net and the test mesh samples belong together, in order to prove that the safety net still possesses the necessary strength and energy-absorption qualities. In accordance with BS EN 1263-1, Clause 8, and for quality and safety control, the following information should be included on all labelling on safety nets:

- The name or mark of the manufacturer or importer
- The designation in accordance with, Clause 5.2, which dictates that '*the designation of a net shall include it's denomination, reference to this European Standard, the system of the safety net, and the details of the mesh size, mesh configuration and net size and production inspection level*'.
- The identity in accordance with Clause 6.1.5, which describes the test mesh requirements, and the need '*to ensure that the test mesh can be properly identified with the mesh rope, seals with the same identity number shall be fixed to the test mesh and to the related net*'.
- The year and month of manufacture of the net
- The minimum energy absorption capacity of the test mesh
- The manufacturer's article code
- The official number issued by the testing agency who certified the net

The marking on the net should be permanent, e.g. labels or plastic discs sewn or riveted onto the net so that they cannot be removed without damaging it.

7.5 TRADE AND INDUSTRY ORGANISATION

The training organisation for the safety netting industry is called Fall Arrest Safety Equipment Training (FASET). FASET was launched in the autumn of 2000 and is backed by the Construction Industry Training Board (CITB), which works in conjunction and runs a competency based training card scheme to certify net riggers, and inspectors. FASET was formed by members of the netting industry and modelled on a scheme run by the Industrial Rope Access Trade Association (IRATA), (see below). The aim of FASET is to produce high standards and high levels of reliability, and to ensure proper use of the net safety system through improved training. FASET includes 90% of Britain's net manufacturers, training organisations and the largest rigging companies. It has standardised the training previously offered by many safety net suppliers.

Working with the CITB, FASET also has a certification record scheme for members registered with them. The scheme operates in a similar way to other construction industry skills certification card systems, e.g. Construction Industry Scaffolders Record Scheme (CISRS), etc (see Chapter 9).

From information collected during site interviews, it became clear that the presence of an organisation such as FASET was of great comfort to industry, particularly management of organisations who were content with the fact that the safety system being used was appropriately regulated. FASET recently changed status from a Limited organisation (with shareholders), to a trade organisation.

7.5.1 Industrial Rope Access Trade Association (IRATA)

There are various ways to install and dismantle safety nets (see Section 7.8), with roped access techniques being one such method. The roped access industry is governed by an organisation called the Industrial Rope Access Trade Association (IRATA), which was formed in the late 1980's by a number of organisations in the rope access industry, to provide a safe working environment for members of the industry. As discussed above, FASET viewed the practices of IRATA as a good model for the safety net industry. From information obtained from IRATA's website (www.irata.org), their main activities are to:

- Promote and maintain a high standard of industrial rope access activities in terms of safety and work quality
- Provide guidance on training and certification of personnel involved in industrial rope access
- Produce publications and guidance on good working practice, training and other related topics
- Prepare submission and provide informed opinion and advice to government departments and others concerning health, safety and training
- Assist working parties charged with commenting on and discussing existing and draft legislation and directives
- Assist in the provision of appropriate educational training and certification opportunities for personnel employed in industrial rope access
- Provide a forum for the free and informal exchange of experience and opinion

FASET and IRATA maintain strong links with each other, and exchange safety and other relevant industrial information as is appropriate.

7.6 INDUSTRY RECOMMENDATIONS FOR USE

This Section deals with recommendations for use based on legislation and direct experiences of industry personnel: from management to the users of nets as a safety system.

When considering using safety nets, as with most safety equipment, the manufacturer will provide an instruction manual for the use and application of the system. This manual should be consulted and followed at all times when planning/using safety nets as a fall arrest system. BS EN 1263-2 covers requirements for the minimum content of such instruction manuals. Clause 4/1 states that, *the instruction manual shall be available in the language of the user, and shall contain at least the following information:*

- Required anchorage forces
- Maximum fall height
- Minimum catching width
- Safety net linkage
- Minimum distance below the safety net
- Storage
- Examination
- Replacement

In addition to the above, special installation instructions shall be followed according to the specific application of the net (see Section 7.8).

Safety nets are to protect workers from injury in the event of a fall. They might catch small materials, however all materials handled above a safety net, should have, as far as is reasonably practicable, an independent means of restraint against falling. This subject was described thus:

> "*Safety nets are a good system. They act as a good secondary safety feature in the event that materials are blown/knocked off the roof. The net will catch the material and stop it hitting anyone below. The nets are not relied on for this, but it is comforting to know they would be there to perform this task if required.*"
> (Specialist Roofer, May 2003).

Some situations do not provide viable alternative choices between fall arrest systems such as mats, safety decking and safety nets. Safety nets are currently a viable solution to fall arrest in industrial roofing, where the working height will preclude the use of mats or crash decking. Further examples will be provided in Section 7.6.2.

Safety nets can be used in many different situations to provide passive fall protection to those working above them. The main areas of use in today's industry are; industrial roof works, domesticated housing, and maintenance and refurbishment (for working above roof level). Nets can be used on some refurbishment work, for example, to protect falls through fragile roof lights

in circumstances where the primary protection[18] is removed (carelessly or otherwise). Further information on the uses of safety nets is included in Section 7.8.

When considering any form of safety system, close attention must be paid to what work is to be carried out overhead, for example, any hot works (e.g. welding and grinding) above nets can have an adverse effect on the net's integrity through spark travel. Therefore, the works overhead must be accounted for in the risk assessment specific for each individual site.

Safety nets provide increased confidence for the users of the system. If a netting system has been installed properly (ensuring production of a handover certificate, see Section 7.10) it provides the user with an increased sense of security. The reasoning for this is different for each individual, however consensual reasons have been given as the following:

- The netting is a very visual system, on which defects can be easily detected for the users.
- There is a perception that if a person were unfortunate enough to fall, the net itself is a reliable means of arresting the fall.
- Further, should a person's fall be arrested by a net, it is believed that the fall will be 'soft'.

Management and supervisory personnel have a duty to ensure that a risk of overconfidence does not develop amongst users of safety nets.

Time

Information collated through industry interviews suggests that using nets could save time and/or resources during the construction process. As the users of the system are generally not the installers, there is an obvious benefit in relation to their freedom of movement over a larger area than they would have if bound by, for example, a harness and lanyard. Therefore, the lack of need to clip onto a suitable anchor point determines that the users are not as restricted by this safety system. This has a bearing on the costs of the project. This was highlighted in the following statement:

> "*…and also [nets] are responsible for hugely increased productivity of those workers*"
> (Specialist Roofer, May 2003).

Safety nets provide the users with passive, global (or collective) protection, i.e. the user (or users) does not have to physically carry out a task to ensure that he/she will be protected. This is emphasised in the following assertion:

> "*Safety nets help enormously – they do not hinder at all*"
> (Contracts Manager, May 2003)

Subsequently, management resources are not required to monitor and police the system to the same extent, as is the case for other systems (see Section 7.10.1). Once installed, will perform its task without further safety related activities by the users.

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[18] *Primary protection for fragile roof coverings can be taken to include the following; a) exclusion zones from the hazard area on the roof surface, b) barrier protection, c) the non-fragile roof light cover, d) crawling boards, etc.*

The acceptance of safety nets within the roofing industry was exemplified when it was said:

> "*I have experienced every system available, and I can state that this is the best system by far*"
> (Specialist Roofer, May 2003).

7.6.1 Advantages and Disadvantages

Every safety system has advantages and disadvantages, with no single system being regarded as the universal remedy for all dangers when working at height. Safety netting is no different. Below is a list of comments and observations on safety nets direct from industry:

Advantages

As the system is low-tech (i.e. it includes no mechanical components), it is simple to use and nothing can mechanically break down that could render the system inoperable

The system is so obviously in place when erected; it is very visual, and defects are easily identified due to the simplistic nature of the system

It is believed that safety netting has a positive effect on the culture of construction sites, when site personnel seeing the efforts that management are making to ensure increased safety provisions for workers. This is then hoped to spread to the individuals themselves

The netting is not easily damaged when it is used in the correct manner, either through installation, use, or de-rigging – it is robust enough for the site conditions that it will face

The nets are designed to catch a standard man's weight (100Kg) from a fall of up to 7m. The system is somewhat over-designed in this sense to ensure that it is more than capable to carry out the tasks for which it designed

As standard practice, the nets are installed ***as close as possible*** to the working surface (or up to 2m below). Therefore, they cause few problems with any plant/materials catching or snagging them from below

Before safety nets were introduced to the construction industry, the systems most widely used were active systems, which involved clipping/tying to the structure. These systems somewhat hindered operations for those who had to use them. Netting alleviates the requirement to do this, and thus provides more freedom for the workers to carry out their tasks

As opposed to clipping-on systems, or other systems (e.g. purlin trolleys), netting does not require to be moved once it has been installed. The system will remain in place until the workspace above is completely non-fragile, and only then will it be removed

By opting for any other safety system that requires physical action to move it during overhead operations, there exists potential to increase the dangers of an accident from moving/altering these systems as works progress

By having safety nets installed, the speed of the operatives working above them may increase due to their not being as restricted as they can be with other systems. This could have a positive effect on work activities. This factor could provide potential savings on time and costs

Concentration levels of operatives working above the nets increases, as they are able to concentrate solely on their job as opposed to always being conscious of physically interacting with the safety system used

When the safety nets are installed, the operatives have no further obstructions in their way and can carry on with their work without undue interruptions and difficulties

The main contractor's site staff will also benefit if netting is installed through reduced supervision requirements, as they do not have to constantly monitor the workers to check that they are clipping-on, etc.

The users of the system are not required to physically do any task in order for the netting to be in position. Installation is only carried out by trained personnel. This significantly reduces the likelihood of untrained/unqualified person installing or altering the system, thus reduces the possibility of faulty installations being in place

Should any individual be unfortunate enough to experience a fall into a safety net, their landing will be soft and in all likelihood they will remain relatively unharmed (dependant on many factors, e.g. the quality of the installation, any materials that could fall with the person, etc.)

Disadvantages

Nets are manufactured from lightweight polypropylene, and are not designed for vigorous use. The netting will be damaged if it were to come into contact with moving plant and/or falling materials; sparks from hot works; falling tools, etc. Care of plant movement must be taken when using nets for first-floor installations

Their remains ignorance in industry towards the calculating of clearance distances below safety nets (particularly at lower levels). Specialist help is not sought early enough in the design process to tackle this on-site problem. Even then, clearance distances remain underestimated by industry management, which could lead to potential injury situations

If the clearance distances are not satisfactorily accounted for, there is an increased risk of 'secondary strike injuries' (either hitting something on the way into a net, being hit by materials when arrested by the net, hitting materials/plant below the net, or hitting the ground). The importance of this area cannot be understated

If netting has been used to arrest a fall (regardless of height/severity of fall), this equipment must be taken off-hire and returned to the manufacturer for inspection, maintenance (if required), and re-certification. This could have significant programming implications, particularly if working on a remote site where there is little scope for receiving new nets onto site in early course

Other trades altering netting to suit their own individual needs is a significant problem on site today. The interface with other trades must be considered and closely monitored to ensure that it does not increase hazardous situations for workers coming behind these trades

Attaching to wall heads or scaffolding in domestic house building is now being met with industry uncertainty. This uncertainty could lead to lack of trust in the system within this arm of industry

As the manufacture of the nets relies on mesh, there is always a potential that materials and tools can fall through the nets. This is a problem. There also appears to be misapprehension by those planning and organising the work below the nets that nothing will get through them – this is not the case. However, in many instances overlaid debris nets are used in conjunction with the safety nets to catch any falling debris/materials, etc.

Although industry as a whole is confident in the safety nets system, there remains concern that information is unavailable about what every net has been through in their time on site. Even after thorough inspection, it is still difficult to gauge the potential damage that could have been caused to the integrity of the net (inside material). In this respect, there remains minor distrust in the system

The above information highlights the main benefits and drawbacks of using safety netting from those actually working with the system on a regular basis. Therefore, the examples given cannot be considered as industry's collective standpoint in relation to nets – rather a typical example of 'real-life' issues from those at the 'sharp end'

7.6.2 System Use During Maintenance and Refurbishment

Safety nets are designed primarily for use during the construction of industrial roofs during new build. Situations exist during maintenance and refurbishment that favour the use of safety nets as a fall arrest system; for example, below roof level during re-roofing works. It is impractical to consider netting for small maintenance works, due to installation time, cost, etc. In existing buildings, the specifier of the safety system must be satisfied that the following requirements are met prior to the decision to use netting as the preferred system:

- The geography of the building lends itself to safe installation of the netting
- The environment is not detrimental to the netting construction, i.e. not in the vicinity of corrosive chemicals that could affect the performance of the nets
- The works are not of a nature that is damaging to the net fabric, for example, involving hot works with heavy spark flow
- The required clearance distance below the net exists, including allowance for its deformation under a faller
- There are appropriate anchorage points for securing the nets
- The anchorage is of sufficient structural strength and stability to take the loadings of the net and any impact loading and suspension loading of a faller
- The nets can be struck (i.e. dismantled) in a safe manner on completion of the works

Only when the above criteria are satisfied can safety nets be selected for works during maintenance and refurbishment.

7.7 TRAINING STANDARDS

Training provisions for the safety netting industry was one of the main issues that brought about the formation of FASET. Through FASET (or FASET-approved training centres), various courses are available that are essential for effective use of the system. From the industry interviews, a consensus was evident, that both FASET and IRATA are highly competent in the training of net installers. One such comment to support this is:

> "T*he guys who erect the nets are specialists, and no-one else is trained to use them and shouldn't be using them*"
> (Site Manager, April 2003)

FASET provides three primary training courses:

- Housebuild rigging
- General rigging (industrial new build/refurbishment)
- Inspectors course (for those who certify and/or sign off the suitability of a rigged system prior to use)

In addition, FASET offer advanced modules to cover more complicated rigging techniques.

Many users of safety netting are not involved in the installation or maintenance of the system, therefore there is no requirement for more general training in the installation and use of the equipment. One organisation interviewed confirmed this fact when it was said:

> "*…our operatives do not install the system – it is not part of their operational experience*"
> (Contracts Manager, May 2003), and,

> "*…employees do not touch the nets at all – they are not qualified to touch/move/alter them, and they have a company rule not to do so*"
> (Specialist Roofer, May 2003)

In order that construction sites are afforded optimum safety protection, all site staff should be appropriately trained. In relation to safety nets, it is recommended that the users of the system have some recognised training in the basics of netting systems. This was exemplified when it was identified:

> "*One man from every squad within our company is a FASET-qualified net inspector, and can view nets and assess them before anyone goes up onto the roof*"
> (Specialist Roofer, July 2003)

Further, some managers interviewed during the site visits suggested that FASET should consider some form of training course that would suit construction managers, supervisors, and those working above the nets (i.e. the users). The suggestion was that a less technical and detailed course than the one for inspectors would suffice:

"*We would possibly consider sending our operatives on a net appreciation course (lesser than an inspector's course), as this would help in their understanding of the netting system that they are relying on*"
(Contracts Manager, May 2003)

It is felt that the more site personnel know about nets, the more the projects will run rapidly and safely. Operative training needs were highlighted thus:

"*The operatives knowledge is only as good as what we impart to them; it's down to their experience, knowledge and our toolbox talks to keep them aware*"
(Contracts Manager, May 2003)

FASET-approved training is currently the only valid CITB-recognised training certificate available in the UK for safety netting. Major industry players are also following the example set by the introduction of FASET by insistence by the Major Contractors Group (MCG) that, from 2003, anyone installing, altering or dismantling safety nets must be FASET-trained. This will ensure that on most major construction projects, the safety netting personnel will be adequately trained and qualified.

Installation organisations are specialists in their field and are mostly sub-contracted in as and when required on a construction project. To this end main contractors are not, or are minimally, involved in the training of operatives in these organisations. This requires both trust (of the individuals and the training regimes), and thorough vetting and quality control procedures. Each individual brought onto site requires suitable induction by the main contractor to ensure that they are given all necessary information to perform their task in a safe manner. This induction is required to be recorded to confirm it has taken place. The onus is on the inducting person to ensure that the operatives understand what they have been told. One method of recording inductions was given during site interviews:

"*The operatives would sign the method statement, the toolbox talk sheet, the induction form and the health and safety information booklet*"
(Contracts Manager, May 2003)

In reality, it would appear that there exists trust between the main contractors and the netting organisations:

"*All of the installers that we use are specialists, which makes our job a little easier*"
(Site Manager, April 2003)

When interviewing management and operatives about the issue of who should be trained (in general, not solely on safety nets) on site, many answers were given, most which stated; everyone who has responsibilities for management and supervision of the system, or who's job comes into contact with the system will require specific training in that safety system. This was highlighted in the following statement:

"*Every man who is working on site will be required to be trained regardless of where they will be working*"
(Contracts Manager, May 2003)

7.7.1 Rescue

Rescue from safety nets can sometimes be a complex operation due to the height at which the system is installed. Netting in domestic housing would require a more straightforward rescue procedure than in industrial roofing with heights of 15m, or more. Simply relying on the premise that a Mobile Elevated Working Platform (MEWP) will be available on site is not sufficient; neither is a reliance on the emergency services as a method of rescue. However, the emergency services can be part of rescue planning (dependent on their location and call-out time – the risk assessment would identify this), and, in that case, must be consulted, prior to commencing works on site, during development of the safety plans.

> "*For most jobs we get in touch with the local fire station and invite them to give input into all of our rescue practicalities at this time*"
> (Contracts Manager, May 2003)

It must be ensured that rescue provisions are made for ***all*** phases of site operations; for example:

> "*Rescue provisions are also necessary at handover stage for steelwork, netting and edge protection phases*"
> (Contracts Manager, May 2003)

Therefore, the site management must be vigilant and experienced in their reviewing of the method statement and supporting documentation to ensure that this is in fact the case.

One experience of a rescue situation, was described as follows:

> "*On one occasion I know of an operative who fell into a net; another operative went into the net to rescue him, and both got out unharmed*"
> (Specialist Roofer, May 2003)

However, it is not recommended that operatives climb into a net to affect a rescue unless this procedure was contained within the method statement and was proved to be a suitable and safe way of rescue. A faller who requires rescue from a net can be recovered from either above or below the catching area, dependant on the particular scenario. FASET training information provides the following recommendations for both:

Rescue from above

…a maximum of two other persons can enter the net…They should approach the "casualty" slowly, and if possible from opposite sides, as there will be significant movement within the net and this could be detrimental to the injury…If the casualty can be readily moved, they can assist him out of the net using purlins (in industrial roofing scenarios) for additional support

Rescue from below

In the event that the injury is severe, and movement of the casualty will be detrimental and require assistance, a "stretcher/board" should be brought up to the casualty from below the net (using a MEWP or similar), and positioned underneath the casualty…a hole should then be cut in the net…releasing both.

7.8 INSTALLATION AND DE-RIGGING

When safety nets are correctly installed, altered, dismantled and maintained they provide reliable passive fall protection. Therefore, it is essential that such tasks are carried out only by trained and qualified personnel. Also, the operatives erecting the nets should be protected from falling during this installation process, by MEWPs or harness and line, etc. Incorrect installation could lead to an increased likelihood of accidents and injuries to both the installers and users of the safety system. BS EN 1263-2 does not provide any guidelines on techniques to be adopted during installation or de-rigging of safety nets, but FASET training material suggests the procedures described in Sections 7.8.1 – 7.8.4. Various methods of installation of safety nets are in operation, with supplementary equipment/access systems always being required. Examples of this are: ladders for low-level or short-term work; MEWPs e.g. scissor lifts, cherry pickers or booms – generally considered to be the most appropriate method; rope access techniques; or hand-held poles for the installation from floor-level, which make it possible to rig and remove netting without having to access height (www.rombull.co.uk). The suitability of towers, stepladders, and forklift trucks for installation is not recommended. Each individual site installation should be considered on its own specific merits, and the most appropriate supplementary equipment chosen to assist in the process. Importantly, it must be ensured that the operatives using the supplementary equipment must be appropriately trained and certified that they are competent to use it.

As discussed in Section 7.4, Type 'S' safety nets are the preferred system used for collective fall protection in the UK construction industry. BS EN 1263-2, Clause 5, Positioning of system S safety nets describes the size of the nets; the positioning of the system with tie ropes; linkage and overlapping of the nets; and maximum permissible deformation of the safety nets. This Clause should be consulted prior to installation of safety netting to ensure conformity with the European Standard, and good working practices.

The potential fall height is a factor that requires consideration when planning to use safety nets. The fall height must be kept to a minimum, therefore the netting should be installed ***as close as possible*** to the working level. This was emphasised thus:

> "*All netting is [should be] completely local to the works that are going on*"
> (Contracts Manager, May 2003)

Safety netting deflects considerably under a faller. The deflection height should always be determined, in order to calculate the required minimum clearance, to ensure that fallers do not injure themselves on any part of the structure or material below.

Any passive fall arrest system must take into account the maximum number of people who will be working above the system. FASET and HSE continue to look at this area and, in the meantime, interim guidance has been set at **two** persons over an individual net. However, this will have implications for the rescue procedure.

Proper installation of safety nets breeds confidence in those using the system. However, this is always dependant on the quality of the installation. The following comments made during interview, emphasises this:

> "*If the nets are installed properly, there should be no interference with the works overhead at all*", and "*Nets are only as good as the guys who install them*"
> (Contracts Manager, May 2003)

The amount of care and attention that is paid to the installation of the safety nets should be paid to the dismantling (or de-rigging) of the nets. This area is as crucial as the installation for the safety of the person/s doing the de-rigging. It is also at this time that inspection, storage, and maintenance issues become important for the equipment's fitness for subsequent use and its life expectancy.

Safety nets will give effective protection where they are spread completely below those working at height, with a suitable extension around the edges of the working area that is beyond any possible point that could be reached by a falling person (James, M., 1999). The specifics of catching widths of netting are explained through the following diagram:

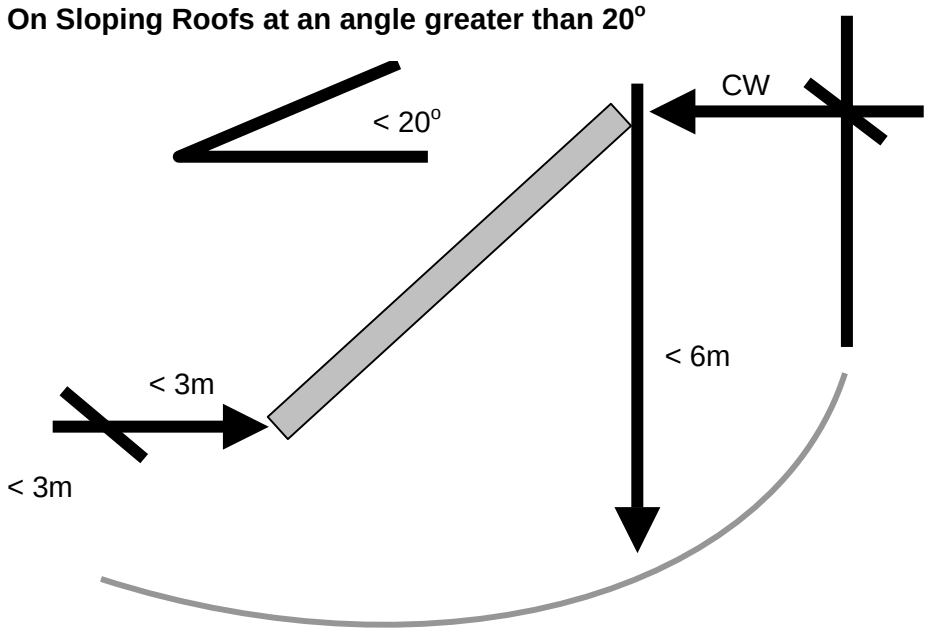

Plate 22: Fall height and catching width diagram taken from FASET literature.
NB: CW – catching width

The following sections cover the main items for consideration when installing, using and de-rigging safety nets.

7.8.1 Anchor Points

Careful design of the anchorage points is one of the most crucial parts of system planning and installation. Advice must be sought from people competent to evaluate the effects of loading, under fall arrest conditions, on both the anchor points and the supporting structure.

With Type S netting, the supporting anchorage points are not expected to deflect along with the system, therefore assurances must be sought that these points have the capabilities to withstand the maximum forces that could be applied by the nets in an arrest situation. FASET training information proposes that the anchorage points must be able to withstand a maximum point load of 6 kilo-Newton's (kN), applied at an angle of 45^{o} downwards from the horizontal. When supported continuously along a structural member, adjacent support loads of 4kN, 6kN, and 4kN should be applied at the appropriate support centres (see Plate 12).

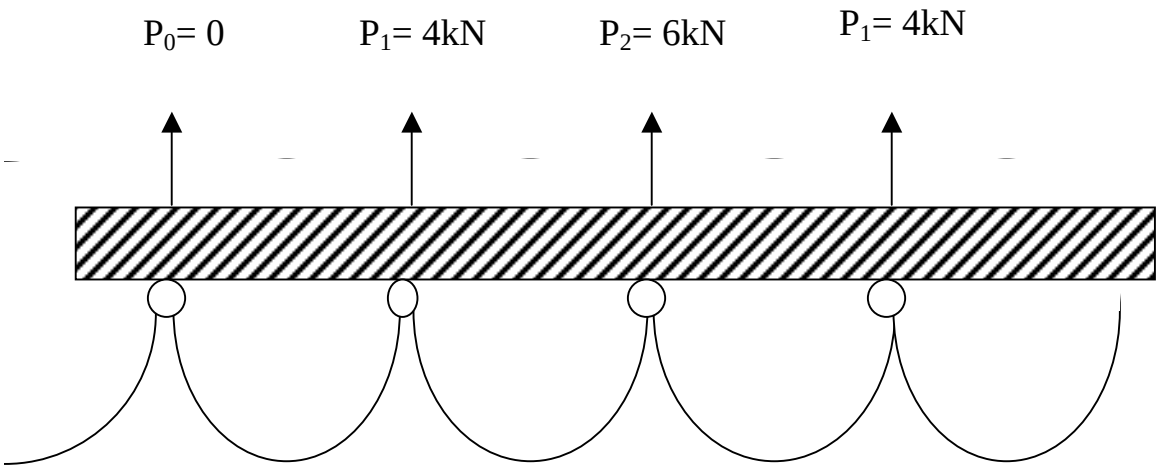

Plate 23: Continuous support loads along length of net installation

These loadings account for the maximum load for a fall of 7m and, consequently, are greater than would be experienced in many situations. On nets installed at less than 2m from the working surface, this loading is very much reduced. Therefore, if designers work to the above installation loadings (i.e. the worst-case scenario), they could be construed to have over-designed the anchorage support under normal installation situations. Close collaboration between the designer and the net installers is required to ensure that the installation parameters are determined at an early stage. This will provide information for both parties to ensure that the specific anchorage required will be provided on each installation, thus reducing the likelihood of over/under designing of anchorage.

Safety nets are to be supported at ***maximum*** centres of 2.5m along each side of the span. FASET recommend that due to the fact that this maximum distance can form gaps between the tie points, the recommended centres should be between 1.5-2.0m. The procedure for attaching the nets to their anchorage points is discussed in Section 7.8.2.

When considering anchorage loadings, for new, existing or temporary structures, the appropriate designer of the structure should be consulted. The following summarised statements have been made throughout the research data collection phases on industry's perception of the responsibilities that the planning and design teams should have in relation to anchorage for safety nets:

- Many believe that designers do not understand, or even look at, anchorage loads when designing structures.
- Industry feels that the designers should be informing the net erectors on suitable anchorage points and safe loads for each individual structure.
- Anchorage points could and ***should*** be provided at the design stage. This would bring many benefits for the installers.
- Industry requires a decision to be made at the design stage on what the protection system is going to be during construction and/or maintenance. It is widely believed that the design community assume no responsibility for these specifics, which would appear to contravene their responsibilities under the Construction (Design and Management) Regulations 1994 (CDM).
- Some form of information on the position and direction for use of the anchorage points is required by industry, e.g. in the form of a handover certificate to confirm their use.

The above sample of comments made on the design function in relation to anchorage loadings, point towards many practitioners in industry believing that the design function does not assist in the planning for safety. The most common solution suggested was for there to be increased cohesion between the designers of buildings, the contractors constructing the buildings, and the end-users (i.e. the 'tenants' of the building). This cohesion could initially come in the form of contact between industry regulatory authorities, such as RIBA and FASET, with a view to establishing a partnership to take this suggestion forward. To date, it is reported that steel manufacturers have been collaborating with net installers with a view to manufacturing cleats/hooks in the steelwork to provide anchorage points for the nets. This is a welcome move and it is recommended that other members in the construction supply chain can follow this example. This highlights the essence of integrated supply chains in the spirit of Accelerating Change (Strategic Forum for Construction, 2002).

In relation to anchor points, the following information was adapted from the FASET website; Safety nets Type S, to EN 1263-1, ***should not*** be supported upon a handrail unless it is specifically designed for that purpose. This could be reviewed once a handrail performance specification is available.

Research into the means of anchorage and loading of net anchorage is currently being investigated by Martin Holden of HSE with a view to including this information in a revision of BS EN 1263.

7.8.2 Securing Methods

There are numerous methods and systems to attach safety nets to the anchorage points. The following describes the most widely used methods in today's industry.

The most popular method of securing safety nets to their anchor point is by way of tying the net using nylon tie cords. A series of knots can be utilised. The method of tying should ensure that the border ropes are incorporated, together with excess (salvage) netting. This ensures that an adequate connection is gained, and also reduces the risk of damage to the netting mesh (if tied incorrectly). The following diagrams provide the most commonly used knots in the safety netting industry:

Plate 24: Rigger knot 1 (*courtesy of FASET*)

Plate 25: Rigger knot 2 (*courtesy of FASET*)

Plate 26: Bow line knot (*courtesy of FASET*)

As discussed in Section 7.8.1, manufactured, pre-fixed cleats/hooks to steelwork are a positive step for safety during net installation if the steel manufacturer is brought on board at the early stages of design. Having the hooks in-situ could mean that installation of the nets is carried out from the floor below by hoisting up the netting on the end of an extension pole and hooking it over. This would satisfy the uppermost point in the hierarchy of control by mitigating the need to work at height. By utilising the hooks, and tensioning the netting internally, there is no need to go out-with the perimeter of the building, which may prove invaluable in confined sites with restricted footprints. Further, the hooks will be in place for the lifetime of the steelwork, thus can be used for future maintenance works.

A system exists to assist installers in situations where precast concrete floor slabs or metal decking is to be installed (or is already installed) on the steelwork. This causes problems for the installer when trying to tie the net support ropes round the steel beams, as feeding the ropes around the steel conflicts with the floor deck. If the ropes are around the steel, prior to placing the floor deck, the ropes have to be cut to de-rig the nets. The system uses clips to secure the nets to the bottom of the flange on I-beams, with two metal 'grips' connected with an adjustable webbing strap. The grips incorporate steel hooks from which the nets are suspended. The following diagram (number) shows the system in use. Many personnel interviewed during data collection confirmed that this system is used regularly within industry in the UK, as it is designed specifically for Type S safety netting (for further information, see www.thegrippa.com).

Other innovations in safety nets are hooks specifically designed for installation in domestic housing construction. These have been met with widespread concern about the effects of loading on either 'green' brick and blockwork, or timber 'kit' partitions. Therefore, modifications have been made to these hooks that sit on the wall plate and have a strap carrying the load directly to the scaffolding (until such times as the roof trusses are installed and stability is provided to the walls). Once stability is established, the strapping is be removed, leaving the hook in place to support the netting. This has implications likened to that discussed in Section 7.8.1, where the scaffold would have to be certified as being able to support the loading potentially applied to it from an arrested fall.

Any one, or a combination of the methods above could be employed on any given contract, dependant on the site-specific circumstances.

7.8.3 Methods of Installation

In order to understand the methods employed during installation of safety nets, it is important to comprehend the terminology used in this process. The following list provides brief summaries of the terminology commonly used in the safety netting industry.

Flying – nets 'tacked' into position at corners and/or spans, but not fully fixed; useful technique to gauge amount of nets required for a job.

Eaves bagging – tying border cord tightly across the span to produce a straight edge, then gathering salvage of side length into the same tie point to form along the supported edge of the net. This produces a bag in the net, which flattens out across the span, preventing the rest of the net 'waisting' into the building.

Tying out – nets tend to 'waist in' across the span at the eaves of the building (and on overlaps). This gap should be tied out to maintain coverage of the protected area.

Gathering – the process of collecting excess netting (usually employed during eaves bagging and de-rigging).

Salvage – excess netting requiring gathered and bagged as described above

Tiling – technique used in sloped roof situations when overlapping to prevent materials falling through the joint in the nets (people will not fall through as the border rope would form a stiff edge if the net was in an arrest situation, thus ensuring no potential 'roll out' of the individual). The net above lies on top of the one below.

Barrels – as the roof slope gets progressively steeper on barrelled roofs, the netting must be bagged progressively more to prevent sliding down the roof in the event of a fall.

Gaps – the space between the safety net and the building edge/anchor point. No gaps larger than the mesh size of that particular type of net should be evident (100mm for Type S). In certain circumstances, e.g. around service drops, or abnormal shaped objects, a ***maximum*** allowable gap of 225mm can be accepted.

Lacing – joining nets together mid-span using lacing cord (minimum 8mm diameter). The lacing includes both border ropes and edges and ensures no gaps as described above. The cord is securely tied off at each end. This technique must be used if the lap is less than 2m.

Overlap – if overlapping of nets is necessary, the minimum lap should be 2m wide – lacing of the laps is always recommended.

The following information presents typical installation methods taught by FASET. Other techniques and sequences are used, depending on site-specific circumstances, e.g. net sizes, geometry of space to be filled, etc. However, the following examples provide a grasp of the

systematic methods that should be employed for ease of installation. The information contained in the FASET training manuals for rigging should be consulted prior to attempting any installations.

Corners first: the four corners of the net are tied into position first and the net is flown into its approximate position on a temporary basis. Once this first phase is complete, the installer can then visually assess which sides, if any, require gathering and bagging. Once this assessment is made, the installer progressively goes round the net tying, gathering and ensuring all gaps are closed. Under normal circumstances, the installer may fly numerous nets prior to making the assessment and passing round carrying out the final fix. This technique sometimes means the installer visiting tying points twice, which can be laborious, however this technique is preferred during roped access installations as it reduces the lifting load on the installers.

Progressive: packing the 'flaked' nets (see Section 7.8.4), so that a single corner is at the top. The first corner is tied, and the installer rigs the netting progressively along the short side (eaves). When the end of the span is reached (next supporting portal), the net would be gathered to the corner and secured (possibly eaves bagged). The installer is then able to rig along the portal side. Once the next span is reached, the installer will then cross the span and tension-up the final corner. ***Note:*** this technique, although quicker than corners first, requires an oversized MEWP with a large basket due to the netting being stored in the basket as it is being installed.

The progressive technique can cover larger areas in a shorter time, however, industry appears to favour the corners first technique (or modifications of it).

The benefits of correctly installed safety nets was described when the following statements were made during the site visits phase:

> "*The installation of the netting is strictly controlled*", and,
>
> "*If nets are installed intact and dismantled and taken away in the correct and safe manner, there will be no problems with the system*"
> (Contracts Manager, May 2003)

Selection of plant and equipment for temporary access, to assist installation, will depend on the particular circumstances of the installation. The MEWP is very useful, if available and access is feasible. Evidence of this was provided when one person stated:

> "*The nets are not too easy to install, but are much easier from a cherry-picker*"
> (Contracts Manager, May 2003)

As FASET provide the training for approximately 99% of the installers in the UK's netting industry, one of the two techniques described will be used on most construction sites today. By having this information, site management are better equipped to identify any variances of the practices and manage the situations accordingly.

7.8.4 De-rigging Techniques

The de-rigging (or striking) of safety nets is as important a task as the installation. The netting must be visually checked, prior to de-rigging, for debris in the net and, where practicable, arrangements made for its safe removal. The accessibility of ***all*** components of the system must be checked, as must be the configuration of the netting, e.g. is it laced, overlapped, etc. During this visual inspection, note should be taken of any obvious damage that the net has incurred during it's installation period, and this should be reported to the person accountable for the examination of the nets preceding their next employment. The netting should be de-rigged in stages, similar to that of the installation technique described above.

Once full de-rigging is complete, including appropriate inspection and maintenance as described in Section 7.10, the netting should be folded prior to storage and transportation (discussed in Section 7.10.3), to minimise the volume of the material. The method of folding is:

- Pulling the net out from opposite corners to collapse the natural lay of the mesh cord joints. The netting can then be folded in one of two ways; it can be 'flaked' down in a concertina fold, which ensures that a corner is left visible at the top for ease of installation for subsequent uses; or, folded in from both ends into a 'parcel' shape

- Once folded, the netting should be tied using temporary ties around the netting to ensure that it retains its folded shape for ease of transportation and storage. Also, the nets must have the identification labels showing for ease of batch checking.

7.9 MANUAL HANDLING

Manual handling of any safety system is important when considering the impact that the safety system will have on those installing and using the equipment. BS EN 1263-1, Clause 9 dictates that with every safety net distributed to industry, the manufacturers have a duty to provide information on their handling instructions. These instructions shall include information on:

- Installation, use and dismantling
- Storage, care and inspection
- Dates for the test of the test meshes
- Conditions for withdrawal from service of the nets
- Any hazards warning (e.g. extreme temperature, chemical influence)
- Declaration of conformity (that the product conforms to the European Standard)

The handling instructions should also state that if any safety net has arrested the fall of a person or object, the net may only be used again after inspection by a competent person.

There are two main handling issues facing the installers of nets:

1. The environmental elements faced on construction sites, and
2. The weight of the nets that they are installing

Exposure to severe environmental conditions on site is not only a hazard for the integrity of the safety net material, but also for the safety of the operatives installing, altering or dismantling the nets. Section 7.10 discusses the detrimental effects that excessive exposure to ultraviolet rays has on the integrity of the net material. Conditions such as excessive wind, rain, sleet, and snow all have an effect on the operative's ***comfort*** and ***ability*** to carry out their tasks on site. This factor is highlighted when it was said:

> "*All exposure to the elements presents problems of some form for both the net erectors, and the netting itself. A wet net is a heavy net; cold conditions bring handling problems for the operatives; wind is an extremely significant factor in both erection and dismantling."*
> (Contract Manager, May 2003)

Therefore, appropriate planning and investigation of potential inclement weather conditions must be carefully considered prior to safety netting being selected as a preferred method of fall arrest on site.

Section 7.8.3 describes the installation techniques adopted by the safety netting industry. The principle of handling any safety net is similar regardless of the size and type of net used, and the techniques developed by industry to ensure that the optimum weights of the nets have been accounted for. The average weight of safety nets is normally below the allowable single-person lifting limits imposed by the code of practice for the Manual Handling Operations Regulations 1992 (<25Kg). Standard bales of netting (without border ropes) weigh around 205 grams (g) per m^2. Further, it is common practice on many construction sites to lace the netting together, which would take the weight over this limit. Care must be taken to ensure that if this is the case, all operations must be designated with the appropriate number of personnel to ensure that the Regulations are not compromised in any way. Also, cognisance must be taken of the supplementary tools and equipment that the installer requires for installation of the netting within the site-specific risk assessment, e.g. tying rope, lacings, etc. Therefore, site management/supervisors must ensure that the effects of the system weight and the environmental influence over the system are fully recognised and accounted for in the method statements and risk assessments.

As with all safety equipment, the manufacturer's instructions and industry guidance must be followed at all times.

7.10 INSPECTION AND MAINTENANCE

All safety nets used on UK construction sites should be in accordance with BS EN 1263. Through suitable training and experience, the persons responsible for the installation, inspection and maintenance of the systems will ensure that all aspects of the system conform to this Standard.

Ultraviolet (UV) rays have a detrimental effect on the safety netting material. Periodic and thorough testing must be carried out on the netting to ensure that the UV rays have not damaged the net beyond its useful limit. As discussed in Section 7.4.2, during manufacture, all safety nets are fitted with 'test meshes/cords' to assist in the monitoring of UV degradation of the netting

structure. These test cords are removed on ***at least*** an annual basis and taken to an approved testing centre, which will carry out a series of dynamic tests to measure the maximum tensile strength of the yarn. The annual inspection date is shown on the label attached to each net. Each new net is fitted with 3 test cords (The cords appear as additional strands of netting material); one will be removed annually and tested, thus under normal atmospheric conditions, the net is expected to last for up to 4-years, i.e. one cord tested after the first 12 months, the next after 24 months, and the final cord after 36 months. This gives the net an initial lifespan of 4-years. Thereafter, a section of the netting should be cut out and tested to ensure its integrity (see Section 7.10.4). Therefore, any inspector of netting need not necessarily be alarmed if the netting has no visible test cord in place, as long as the site management can produce certification that the netting has been tested within the previous 12-monthly period. The testing criteria should be as follows:

- Any net whose cord that breaks at a force below 1900 Newton's (N) should be removed from service and destroyed.

- Any net that breaks at a force between 1901-2390N has at least one year left of use, but should be closely monitored during this time.

- Any net that breaks at a force of 2391+N is fit for purpose, without any special precautions.

Confusion occasionally surrounds the net cord testing limitations, where some believe the testing is carried out to gauge the strength of the net following a fall, or after prolonged periods of use. This is not the case; the test cords are purely to assess the effects of UV degradation on the netting structure.

Manufacturers and licensed distributors of safety nets provide the hirers with controlled audit procedures/trails for their nets. Technology has been introduced in the form of bar-coding systems to track the history of all aspects of the nets 'life', e.g. date of manufacture, where it has been used, maintenance carried out, etc. The control of the nets in this way should be a recommended safety precaution. This control was described when the following statement was made:

> "*All inspections and maintenance is appropriately logged through the organisation to provide a track record*"
> (Contracts Manager, May 2003)

Stock-rotation is another important contribution of these organisations to improving the condition of safety nets – this involves ensuring that all netting in a batch is rotated when in the workshop to ensure a more uniform usage of the equipment, and that the whole batch will age at approximately the same time. This system assists the control of obsolescence and replacement.

The use of obsolete or defective safety nets is prohibited, and only competent maintenance and inspection techniques will ensure that this does not happen. By following this example, site management can rest assured that they are acting in the best interests of safety:

> "*Each net is inspected every time prior to it being erected, and every time it is dismantled*"
> (Contracts Manager, May 2003)

The following quotations, from net users, suggest that net degradation and damage on site is rare:

> "*There have been one or two examples of nets being caught/snagged, but this is very rare*"
> (Specialist Roofer, May 2003), and,

> "*I've seen a few repaired nets being used, but haven't seen any damaged ones*"
> (Specialist Roofer, July 2003)

Prior to inspection, the inspector should ensure that an appropriate *handover certificate* has been issued by the installer, which should have evidence that the company and product comply with FASET guidelines. Failure to produce the handover certificate should deem the nets unfit for purpose, and no work should be carried out above the nets until the certificate has been received. Further, should any maintenance be carried out on the net (either on site or in the manufacturer's workshop), a second handover certificate should be issued to the site manager to confirm that the net remains fit for purpose. This was emphasised in the following statement:

> "*If any alteration were required on the existing nets, a secondary safety certificate would be required*"
> (Contracts Manager, May 2003)

Safety nets usually form part of a safety system, for example, alongside double guardrail edge protection, therefore good practice is to ensure that no operatives are allowed to enter an area protected by a net until the handover certificate has been issued, and additional required protection has been proved to be provided. Evidence collated during site interviews would suggest that this practice is enforced on site. This paper trail is crucial if the industry wishes safety netting to remain tightly controlled and, therefore, safe.

From information collated during site visits, it became clear that the vast majority of users do not have a member of staff in-house qualified to inspect the competency of net installations. It was also felt that there is not enough dissemination of information from the regulatory bodies to encourage site management teams to ensure that the inspection staff are appropriately trained. This area should be addressed to ensure that more widespread training is carried out to enhance the competence of the site team to inspect netting installations.

Like many other safety systems, safety netting must be visually checked on a regular basis to ensure that it is fit for purpose. It was recommended during focus group discussions and interviews that this inspection is done on a daily basis, prior to entering the workspace above, with a more rigorous inspection carried out on a weekly basis. Under normal construction conditions, it is unlikely that a series of nets would be in position for long periods of time, however the recording procedure for the inspections should be approached in a similar manner to, for example, scaffolding. By utilising the expertise of the trained personnel who are using the equipment on a regular basis, management can be confident that, with appropriate monitoring and policing (see 7.10.1), the systems are being correctly inspected. This was reinforced when it was stated:

"*The operatives are handling the nets all the time, so they know how good a shape the nets are in…Every time they are dismantled, they are inspected*"
(Contracts Manager, May 2003)

The importance of regular inspection cannot be understated. If safety netting is deemed to constitute an item of work equipment, there exists a duty to inspect under the Provision and Use of Work Equipment Regulations 1998, Regulation 6.

7.10.1 Monitoring and Supervision

The insistence of training to FASET standards ***does not*** necessarily guarantee satisfactory installation and use of safety nets in good condition. Acceptable standards of on-site practice can only be achieved through thorough monitoring and policing of the safety system by competent management and supervision.

Management should ensure that the following checks are made to ensure the continued reliability of the netting:

- The equipment is complaint with BS EN 1263
- The installers are adequately trained
- Systems are in place to ensure daily inspection of the net
- Test cords are sent for testing annually
- The nets are not used as a storage area or debris protection
- Adequate storage and maintenance procedures are available

The following list provides examples of the defects that should be looked for during inspections:

- Incorrect installation (practices contrary to installation techniques described in Section 7.8.3)
- Defects in knots (if applicable)
- Abrasion of cords
- Cuts and nicks
- Damage to stitching
- Heat/friction damage
- Damaged/deformed fittings
- Contamination (dirt, debris, etc)
- UV degradation (very rarely visible to the naked eye)

It has been stated during site interviews that safety nets are the right choice where there is not a heavy supervision culture on site. Ensuring that the netting conforms to the information described above should bring peace of mind that an adequate safety system is in place. This eases the time burden slightly on the site management, where they do not need to constantly monitor workers to ensure in the case of harness and line, for example, that they are clipped on.

Control of the installation; the equipment being used; the works overhead; the amount of persons above the net; the materials to prevent dropping into nets; the space below the netting (zone of deflection is free at all times), and control of the sub-contractors. If all of the areas mentioned are controlled, the safety netting function will satisfactorily perform the tasks for which it is intended.

7.10.2 Maintenance of the Equipment

Maintenance inspections should be carried out as described in Section 7.10.1. The repairs required will depend on the results of the inspections. All maintenance should be carried out ***after*** the nets are dried and ***before*** they are folded. Dependant on their use, the nets may also require thorough washing with clean water (preferably by hosing), and allowed to dry naturally.

Safety nets must only be repaired by the manufacturer. As discussed in Section 7.10, manufacturers and suppliers offer an inspection and repair service. A typical maintenance regime is as follows: nets ***must*** come back from site (nets going from site to site is ***prohibited***); they are registered, booked in and inspected; they are then tested and repaired by someone who is qualified. Theoretically, the bar code system will not allow the net to leave the warehouse unless it has gone through all these procedures, however there exists room for human error when scanning the nets both in and out of the warehouse.

Repairs will generally be required wherever a safety net has been: used to arrest a fall (either by a person or materials/tools, etc.; or damaged from works/plant below. This relies on adequate monitoring and policing, and reporting of any damage by persons on site. Typical examples of general maintenance requirements are: sewing in new material to replace broken cords; patching larger areas of damaged net by sewing in a new area; replacing damaged border ropes, etc.

The following statement was made during the site interviews phase, and grasps the essence that industry is aware of the maintenance requirements of using netting:

> "*If the nets were damaged to a degree that they had to be replaced, the maintenance would be carried out at the sub-contractors workshop; Low-level maintenance is carried out on-site; any high-level maintenance would be carried out back at the sub-contractors workshop*"
> (Contracts Manager, May 2003)

Maintenance of the equipment is crucial to ensure its fitness for purpose the next time it is required on site. If this function is carried out by persons inadequately trained or qualified, site personnel's lives are at risk.

7.10.3 Storage and Transportation

When not in use, safety nets must be stored under the following conditions at all times:

- Away from heat, chemicals and solar radiation
- Not close to thermal sources
- Not in any areas where vermin could potentially get to the nets
- In dry conditions (they should also be dried naturally)
- In well ventilated conditions, elevated from the floor or ground
- Nets should be turned periodically to allow adequate air circulation

Site practices sometimes do not reflect proper procedures when dealing with safety systems. The following quotes suggest that good practice in relation to safety nets has yet to be embraced by all members of industry:

"*There are storage issues; stripped nets sometimes are left lying on the ground for 3 / 4 days – this can't be good for the nets*"
(Specialist Roofer, July 2003)

"*A criticism is that a lot of nets are dismantled, taken down and left too long on the ground before being removed from site – they should be removed a lot quicker*", and,

"*The nets should be taken off-site as soon as they're not required – sites evolve and there is usually little space for storing nets; they could get easily damaged if left*", and,

"*The nets should be brought on-site, used, and removed from site immediately if there of no use anywhere else on the site*"
(Contracts Manager, May 2003)

Transportation of safety nets will be dependant on the amount of netting required for a specific job/site. As the nets fold up easily, and all supplementary equipment is small in size, netting can usually be transported in vehicles as described in Section 6.12.3. However, care must be taken to ensure that the materials are transported in conditions similar to those for storage, i.e. dry, free from contaminants, etc. To this end, some organisations have purpose-made trailers for transport of netting equipment; this helps to ensure that the nets are transported consistently in a satisfactory way.

7.10.4 Typical Life Span

As safety nets have only been used extensively in the construction industry for a relatively short time, their long-term endurance capabilities remain unclear. The nets are manufactured with 3-test cords, indicating that the net is expected to be fit for purpose for 4-years (i.e. one cord tested annually after 12-months of manufacture). This research attempted to gain industry opinion on the suitability of nets that are coming toward the end of this period, to collect opinion as to how the nets have performed in this time, and gauge what (if any) action was necessary after this period. Industry organisations interviewed remained positive about the nets in use, and reported no major problems with the older nets.

Through time, use, and exposure to environmental conditions (principally UV rays), safety nets lose their strength. Only by closely monitoring nets over the coming years will an accurate estimate of their typical life span be established.

7.10.5 Disposal of Damaged Materials

The question was asked during the research team's interviews with manufacturers: what happens to nets beyond their natural usage, what processes are in place to permanently remove these from the workplace? Further to information collated from the data collection phase of the research, the following list can be taken to be a recommended procedure for disposal of defective netting:

- Remove all the labels from the net
- Cut all border ropes
- Cut the netting up as much as is possible

- Dispose of in appropriate manner (bin, skip)

Following the above procedure will ensure that there is no opportunity for others to retrieve the netting and re-use on another job. Incineration is also an option for the net material.

7.11 SUMMARY

Due to changes in legislation and HSE's stance on safety netting being a preferred system of fall arrest, the popularity of the system is vast within the UK construction industry. Although widespread use of netting has been relatively recent, they have been recognised in UK Regulations for almost 40-years.

The introduction of appropriate EN & CE certification ensures that industry's clients have definite benchmarks from which to scrutinise the integrity of the equipment used. This, coupled with the guidance contained within the forthcoming Work at Height Regulations 2004, is ensuring that this safety system is more than adequately controlled at this time.

Netting used in the UK construction industry is manufactured and distributed from mainland Europe, using techniques adopted from the fishing industry. The techniques of manufacture and the materials used have developed through time, and will continue to develop, which should make for a safer area of industry in the future.

With the introduction of FASET relatively early in the 'boom' of usage of netting on construction sites, the industry has taken positive steps to regulate themselves in conjunction with advices from HSE. This positive step has provided a backbone for the industry from which to build training standards, regulatory influence, guidance, advice, etc. The introduction of FASET has enhanced the construction industry's perception of the safety system.

The benefits and limitations of the system were spelled out in section 7.6.1, and came directly from industry members. It is important to note this point, as in essence this Chapter has been written by the industry, for the industry. The markets for safety nets would appear to be during industrial works on framed structures. Industry has recently questioned the validity of using netting in domesticated housing, and there would appear to be a shift toward fall arrest mats in this area. This is not to suggest that nets cannot be successful in this field, however as time passes industry will 'iron out' any problems and will eventually find 'niches' for all safety systems.

Training standards for the safety netting industry are controlled by FASET. In order that anyone is qualified to install, alter, dismantle, or inspect safety nets they must have attended a FASET-registered training course, and passed an appropriate test. The attendee will then be issued with the appropriate FASET registration card, which site management should insist on viewing and recording prior to any works being carried out on site. The training courses are designed specifically for industry and include:

- netting manufacture
- applications for use
- inspection

- storage
- rescue
- installation and de-rigging
- anchor points
- securing methods
- inspection and maintenance
- storage and transportation of equipment

Manual handling issues for safety netting purport to be of little issue when considering the implications of the Manual Handling Operations Regulations 1992, however cognisance must be taken of the weight effects when lacing the nets together, and the effects that the elements (particularly wind and rain) have on the netting during use. This is an area that site management must pay particular attention to.

Few bad comments were received on the task that safety netting performs. Consensus was that although the system was not considered as the panacea for all working at height issues, the introduction of this collective passive system has been of benefit to industry. At this time there would appear to be few other systems in the marketplace to rival the safety net in what it does, and how it does it.

8.0 CABLE & TRACK-BASED SYSTEMS

8.1 INTRODUCTION

When people are working at height near to, or at, an exposed edge or other fall hazard, suitable protection is required to prevent them from falling. In the absence of a suitable barrier fall prevention system, other systems must be considered. Cable or track-based safety systems are one of the options. They consist of a number of components that together provide continuous attachment and 'hands-free' working to the users. These systems can either restrain the user from accessing the area of risk or arrest them in the event of a fall. They are designed to achieve minimum damage to the user, the system, and the structure that the system is attached to. Generally, these systems are called 'Horizontal Anchor Lines', with cable systems referred to as 'flexible', and track-based systems as 'rigid'. Here, they will be referred to as cable or track-based systems.

Cable systems utilise a tensioned cable attached at either end to a structure and supported at regular intervals by intermediate brackets. Users attach to the cable via a mechanism, known as the traveller, which will allow them to move along the system and across the brackets, preferably without the need for detaching.

Track-based systems, sometimes referred to as rail-based systems, are similar to cable systems without the requirement for fixed post-style supports along the length of the track/rail. Instead, the track, of profiled metal incorporating a number of individual sections bolted together, is fixed along its length to the structure, providing the necessary stability and strength. A traveller, (sometimes referred to as a 'trolley') is either permanently attached to the track, or is supplied to the user and fitted to the track via pre-determined entry/exit points (Section 8.4).

Currently available systems are very similar. These systems can be installed as either temporary fall protection, during construction work, or as permanent maintenance access systems. The latter may be installed during new build or as a retrofit fall arrest measure to facilitate routine maintenance of older properties. Both systems appear to be extremely simple; however the technicalities of each system can be complex and, if misused, can present risk to the user. Both systems can vary in the way they are used *and* the number of people that can use them at the same time. The use of the systems will be determined by the type of rail fixing used which, itself, will be determined by the type of roof covering. Correct installation and use of cable and track systems depends on these and other factors that will be further explained throughout this Chapter.

Cable and track-based safety systems provide fall arrest or restraint where guardrails are impractical or present aesthetic problems. These systems may be specified as part of a building's maintenance system because they are visually unobtrusive and thus sympathetic to the architectural needs of historic buildings (Section 8.6). It is believed by many that cable-based systems prove to be of only limited value during construction works, however, there are occasions during refurbishment and/or maintenance work where cable and track-based systems are preferred over other systems.

The research proposal (April 2001) included only the cable-based system, as little was then known of the track-based system in construction. The obvious similarities in the two systems made the inclusion of track safety systems a necessary extension of the research objectives.

Twelve manufacturers and/or systems installers were involved in the research, which demonstrates the wide range of products and services available to industry in this area, and further research and development is developing the technology very quickly, making it difficult for architects and designers[19] to keep up to date with different products, and methods of application.

Cable and track safety systems are used in a variety of roles in numerous industries; telecommunications, entertainment, oil and gas, transportation, utilities, bridges, defence, sailing, heritage, etc. Unlike other Chapters within this report, this Chapter deals with safety systems of which there are numerous forms available. This Chapter will not describe every available system – this would add substantial volume to the report – but will describe the principles behind cable and track safety systems, and highlight the benefits and limitations of each.

8.2 HISTORY OF CABLE & TRACK-BASED SAFETY SYSTEMS

Cable-based safety systems have been used in the construction industry for approximately 30-years, with track-based systems appearing sometime around the early 1980's. The concept for both systems originated from, and remains significantly influenced by, products from the sailing industry. The technology for both systems is similar to what is available in the marine market; however components are manufactured to suit different uses and environments. There have been significant changes since the earliest systems appeared, resulting mainly from market requirements and legislation.

Traditionally, for cable-based systems, the anchorage posts were of heavy rigid steel. The weight and size of these presented loading problems themselves, before even considering the loading issues of falling persons. Typically, they had to be attached to rigid parts of the building structure. Since these early systems, manufacturers have carried out research and development into the early problems, and have produced lightweight and flexible systems to suit most needs and most building structure types. The progress made in establishing these systems as recognised methods of fall arrest in industry was highlighted thus:

> "*In times gone by we used to have to scaffold everything for high works – nowadays we have other systems in place that negates the need for scaffolding, e.g. cable systems*"
> (District Works Manager, September 2003).

Cable and track systems are 'personal fall arrest systems' and, as such, are at the lower end of the fall protection hierarchy (Section 3.2 – Safety hierarchy). Thus, the above statement can be considered as a conflict to the hierarchy defined within the Work at Height Regulations 2004 (pending).

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[19] *Under Regulation 13 of The Construction (Design and Management) Regulations 1994, the designer is classified as someone who produces drawings, prepares specifications and dictates construction methods. The Designer must also give the Client 'robust' advice.*

8.3 LEGISLATIVE HISTORY

Due to the number of component parts used in cable and track systems, their governance by guidance, and Standards is extensive. The European Union have recognised Standards, which govern the manufacture and installation of horizontal and vertical safety systems. This Chapter will cover only horizontal safety systems, however references will be made to the similarities of both horizontal and vertical systems as and when appropriate.

Further to information contained in Section 3.2 (Generic Legislative Guidance), the following regulations and guidance are appropriate to cable and track-based safety systems due to their relevance to the main criteria of the physical requirements related to the system, and the equipment used:

The Personal Protective Equipment at Work (PPEAW) Regulations 1992
The Manual Handling Operations (MHO) Regulations 1992
The Personal Protective Equipment (PPE) Regulations 2002

The following Health and Safety Executive (HSE) Guidance Notes are also applicable:

INDG367 Inspecting Fall Arrest Equipment made from Webbing (HSE publication)

Appendix 4 contains a list of the most relevant British and EN Standards relating to the manufacture and use of cable and track systems. The following British Standards are highlighted as the most appropriate to consult, prior to using cable and track systems:

BS EN 364:1993:	Personal protective equipment against falls from a height. Test methods
BS EN 365:1993:	Personal protective equipment against falls from a height. General requirements for instructions for use and for marking
BS EN 813:1997	Personal protective equipment for prevention of falls from a height. Sit harnesses
BS EN 795:1997	Protection against falls from a height – Anchor devices – Requirements and testing (N.B. - currently under review)
BS EN 363:2002	Personal protective equipment against falls from a height. Fall arrest systems

BS EN 363 is the main publication covering protecting against falls from height, to which all other EN's must conform.

During data collection, various concerns were raised in relation to BS EN 795:1997:

- It is not recognised under the PPE Regulations, which is a contentious issue in industry at present. This area is currently under review by BS EN organisations.

- The Standard is not broad enough – there should be a minimum installation standard for all systems for quality of the installer, materials used for the handover, etc. This would also provide a basis for the HSE control the industry.
- It is, in many situations, obsolete; testing requirements need to be a lot clearer, and appropriate for different installations.

Under legislation, 'workplaces' and 'construction sites' have two defined meanings when considering work at heights. Brief interpretations are:

- Workplace – a static and regular place of work
- Construction – an irregular site with potential for temporary works

8.3.1 European Normative (EN) Standard & Conformity European (CE) Quality Mark

Cable and track-based systems are governed by many Regulations, due mainly to the number of different components. With regard to the supplementary PPE used in conjunction with the systems, European Directive 89/656/EEC for personal protective equipment at work set the standards for the PPE Regulations in force today. The directive makes CE marking compulsory for all items of PPE that are subject to a European Standard.

It should be emphasised that the CE standard is the ***minimum*** European requirement. To obtain the CE marking, equipment must be shown to achieve the requirements of the appropriate EN classification and, in use, the equipment must exhibit an EN number relative to the application. It is not satisfactory to simply have an EN number evident on the equipment – it must be assured that the appropriate criteria are met and, to do this, a thorough knowledge of the *relevant* EN's is required.

8.3.2 The Work at Height Regulations 2004

The following Regulations and Schedule sections of the forthcoming Work at Heights Regulations 2004, apply to the use of cable and track-based safety systems:

Requirements for particular work equipment

Regulation 8 – *Requirements for particular work equipment*
Regulation 10 – *Fragile surfaces.*
Regulation 13 – *Inspection of places of work at height*

SCHEDULE 2: REQUIREMENTS FOR PERSONAL FALL PROTECTION SYSTEMS

Parts 1-3

Appendix 5 details the contents of the above sections of the Regulations. It is important to note that the above references may be subject to change as the regulations evolve through consultation and subsequent amendment; however they are accurate at the time of submission of this report.

8.4 SYSTEMS AVAILABLE

There are numerous track and cable-based systems available that perform similar functions, but are of varying style, quality and manufacture. The objective of all of the systems is to provide continual "hands-free" protection. This is achieved by attaching line and harness to a traveller that runs smoothly from end to end of the cable or rail, without intervention by the user or need to detach it from the system.

Ideally, these systems will be positioned directly above the working area, to ensure that any potential fall is minimised. However, this is not always possible and systems must be carefully selected and designed to suit the needs of each installation. Many features exist and it would not be appropriate to describe them all. The following features are a sample of the most important:

Anchorage posts:
- That clamp to the standing seam roof, negating the need for penetrative fixings.
- That require penetrative fixings with appropriate configuration to avoid water ingress.
- That collapse under the loading of a fall, thus absorbing energy
- That bend out of and back into shape under the loading of a fall

Cables:
- That dissipate the energy of fall loading
- Single and twin cable systems
- Steel and synthetic cables
- Cables that can span from anything up to in excess of 50m between intermediate supports
- Corner configurations in cables

Tracks:
- Forming part of a roof's ridge to provide track-based protection, and to maintain the integrity of the roofing structure's ability to withstand the elements
- Continuous protection through the horizontal and vertical plane without the need for detachment

Plate 27: Typical cable system in-situ for arrest protection to operatives during roof maintenance, showing cable running through anchorage posts (*Taken during site visit to BNFL, May 2003*)

Plate 28: Typical track safety system attached to roof covering for arrest protection during roof maintenance works, showing the track and traveller (*courtesy of Saferidge*)

In order to select an appropriate system, the specifier must be aware of the systems that are available. The main components that make up a cable or track safety system are briefly described below.

General

Annex II of the PPE Regulations 2002, Section 3.1.2.2, *Prevention of falls from a height*, states that all PPE should be; *designed to prevent falls…or their effects and must incorporate a body harness and an attachment system which can be connected to a reliable anchorage point. It must be designed so that…the vertical drop of the user is minimised…and the breaking force does not…attain the threshold value at which physical injury or the tearing or rupture of any PPE component which might cause the user to fall can…occur.*

Anchor

An anchor as part of a safety system is a fixture (or place) for the secure attachment of anchor lines or persons. They can be either permanent or temporary, and as such are governed by BS EN 795:1997 or BS 7883:1997, respectively. In Europe all anchorage points within horizontal safety systems should be designed, manufactured and installed in accordance with BS EN 795, Section 4.2, which states: *The anchor device (s), anchor points (s)…shall be so designed as to accept the personal protective equipment and ensure that it is not possible for correctly connected personal protective equipment to become detached unintentionally.*

There are various forms of anchorage used for the cable and track systems described in BS EN 795:1997:

Class A1 – structural anchors designed to be secured to vertical, horizontal and inclined surfaces

Class A2 – structural anchors designed to be secured to inclined roofs

Class B – transportable temporary anchor devices

Class C – anchor devices for use with horizontal flexible anchor lines (i.e. cable-based systems)

Class D – anchor devices for use with horizontal rigid lines (i.e. track-based systems)

Class E – deadweight anchors for use on horizontal surfaces

The requirement and testing regime for anchors used in cable safety systems is Class C, and in track-based systems is Class D. Careful attention should be paid to the testing requirements within the specification for both systems. The positioning of anchor points is crucial to minimise a fall as much as is reasonably practicable. Under Section 6, Marking, the Standard states: *For Class C…anchor devices, the manufacturer or installer shall clearly mark on or near the anchor device the following parameters:*

a) the maximum number of attached workers
b) the need for energy absorbers
c) the ground clearance requirements

Under Section 7, Information supplied by the manufacturer, the Standard states: *A statement shall be included by the manufacturer that the anchor devices have been tested to this standard…and that, unless otherwise stated, they are appropriate for single person use with an energy absorber to EN 355. In addition:*

a) For class C anchor devices (anchor devices employing horizontal flexible anchor lines) the instructions for use shall include the maximum force that can be permitted at the extremity and intermediate structural anchors.

Cable systems will be connected through a series of anchorage points, located according to the configuration of the system, i.e. single span or multi-span, straight or following the plan shape of the building. Track systems are similar to this in that they will be anchored (i.e. secured to the structure) at several points. However, they are designed to act as beams, under bending moments and shear forces, whereas the cable operates under tension. The size and direction of the loads on the anchor points will, therefore, be different.

Traveller

The traveller is a piece of equipment that is designed to connect to, and slide over anchor points or along tracks. The travellers are usually tailor-made to suit the particular cable or track system, with a connection for attachment of supplementary PPE, e.g. connector, lanyard, and full-body harness. Most travellers are designed not to operate correctly, i.e. travel along the system, if they are not fitted correctly. Stops are fitted to the systems to ensure that there is no accidental removal of the traveller from the system. Track travellers can be enclosed to eliminate excessive build up of debris on the main running track. Dependant on the particular system, the travellers sometimes remain permanently on the cable/track (preferably at the access point to the system) to ensure that they are always fitted correctly, and to avoid the opportunity of tampering with the mechanics, or use on an incompatible system. There is a need for the travellers that remain in-situ not to be subject to movement through wind or gravity, normally through some form of

braking mechanism. Many manufacturers now try to minimise the number of moving parts within their systems, to avoid wear of the moving parts. Static travellers, i.e. rigid travellers that simply glide over the cable or track with no moving components, are now the most commonly used form of traveller used in industry.

Connecting device

The connecting device is an openable device used to connect components of the safety system. There are various types of connector used for the cable and track systems, with the most common being described in BS EN 362:1993:

Class M – multi-use; a connector for general use

Class T – termination; a connector with a captive eye

Class A – anchor; a connector intended to be linked directly to a specific type of anchor

Class Q – screwlink; a connector that is closed by a screw-motion gate, which is a load-bearing part of the connector

Connection to the safety system should ***always*** be made in an area where there is no risk of falling. If the connector is not used in the appropriate position, i.e. vertically, approximately one third of the overall strength will be lost. This is known as 'cross loading'. Standard connectors are designed and manufactured with a safe working load of 15kN

Within the hierarchy of risk control, PPE should only be used once design and engineering controls, alone or in combination, have been unable to eliminate or control a particular hazard. To connect to any cable or track system an operative must use the following PPE, as protection from the system will be ineffective without this supplementary equipment that attaches the user to the system:

Lanyard

The lanyard is the connecting element of a personal fall protection system of a fixed length with at least two terminations for the attachment of connectors. There are two types available for use with cable and track systems; fall arrest (sometimes referred to as passive), and fall restraint (sometimes referred to as active) lanyards. The lanyard may be manufactured of fibre rope, wire rope, webbing or chain, with the most commonly used in construction being webbing or fibre rope. Fall arresting lanyards incorporate a shock-absorbing element; this provides the lanyard with the capability to arrest a fall in a 'softer' manner. The shock-absorbing lanyard (sometimes referred to as 'energy-absorbing') is manufactured so that a portion of lanyard material (usually housed in a plastic or rubber casing and positioned near to the connector at the harness) will tear and absorb the energy caused by the falling operative. The fall is finally terminated by the forces applied to the shock absorber being reduced, thus no longer tearing the device. The purpose of the energy absorption is to minimise the impact force generated in a fall, for both the anchor point, and the faller. Section 3.1 of BS EN 355:2002 describes an energy absorber as; *element or component of a fall arrest system, which is designed to dissipate kinetic energy developed during a fall from a height*

When calculating fall distances during the design of a cable/track system, the length of the fully extended lanyard is important. With various lengths available in industry, this must be carefully considered, to ensure that an appropriate length is used.

When selecting a lanyard, the following items must be considered:

- Type of lanyard to use (restraint / shock-absorbing)
- Length
- Connector (at both the anchor and user ends)

Lanyards are designed to withstand dynamic loads of up to 15kN.

Inertia reel

Sometimes referred to as fall arrest blocks, these systems operate a braking mechanism similar to that of a car seat belt. Therefore, in the event of a fall, the clutch mechanism will activate the brake and so reduce the fall distance. These systems can be steel wire or webbing, and are designed to extend and retract as the user moves during working operations. The benefit of the inertia reel is that by reducing the fall distance, the user will not receive as high impact forces as could be expected with a shock-absorbing lanyard. These devices are particularly useful in areas with low clearance heights, beneath the working area.

Due to their weight, they are sometimes deemed unsuitable for cable-based systems, although lightweight versions are available. This weight can exert a downward force on the cabling. Further, it has been reported that inertia reel blocks do not move along the cable as easily as the normal lanyard. However, they do have great benefits in the right circumstances; for example, many systems are attached overhead and can reduce the fall to almost zero in these circumstances. Neverthless, industry tends to take the view that retractable lifelines, self-retracting lifelines, blocks or reels, are generally not compatible with cable-based systems.

Full body harness

A full body harness is required by law. BS EN 361:2002 describes the full body harness to be; *a body support primarily for fall arrest purposes, i.e. a component of a fall arrest system. The full body harness may comprise straps, fittings, buckles or other elements, suitably arranged and assembled to support the whole body of a person and to restrain the wearer during a fall and after the arrest of a fall.*

Harnesses are normally worn for extended periods (sometimes all of the working day, depending on the trade and activities being carried out). If harness selection is not approached in an informed manner, and by a competent person, the likelihood is that the wrong equipment will be chosen, which may not be compatible with other equipment within the system, thus will not provide the factor of safety that it is designed to provide. Equipment selection is an important area. This was explained thus:

"*Providing the specific PPE for particular installations is just as important as the system being connected to*"
(Contracts Manager, September 2003)

The following areas must be considered prior to selecting PPE:

- The wearer's comfort and mobility
- Duration of use
- What it is to be used for
- The exposure to chemical/environmental conditions

8.4.1 Materials Used for Cable and Track Systems

The materials used in the manufacture of track and cable systems include: aluminium, stainless steel, metal alloys, polyester fibre, neoprene, rope, polyamide, and rubber. They vary in the different systems. It is the specifier's responsibility to ensure that account is taken of the materials used in their manufacture, as there may be specific properties required or danger of deterioration of a particular material. Examples of the properties that may be required are:

- dielectric properties for non-conductivity
- resistance to water/chemical attack/UV rays/corrosion
- resistance to high temperature (melting points)
- compatibility with surrounding materials
- galvanised/zinc-coated/epoxy resin coated (tracks)
- colour coding requirements

Therefore, the decision process for system selection is more complicated than is generally considered.

There are three rope types used for lanyards in the height access industry: webbing, polyamide, and kermantle (Section 8.4.2). Expert guidance should be sought prior to specifying any rope to be used. Webbing should not be used if the lanyard is likely to be in contact with straight edges, due to their limited tear and shear properties.

8.4.2 Manufacture

The assembly of cable and track systems differs for each manufacturer. The process of manufacture is dictated by the particular component parts that the system comprises. Manufacturing guidelines also relate to the PPE that is used in conjunction with the systems. Most systems supplied to industry are bespoke for individual circumstances, and manufacturing processes embrace this individuality and incorporate the variety of directions and configurations that will be encountered on site.

The Personal Safety Manufacturers Association (PSMA) – see Section 8.5 – has published a document entitled, *Height Safety Best Practice*, which sets out guidelines for, amongst others, manufacturers of personal safety systems. The guidelines state that *a competent manufacturer/distributor should promote best practices by implementing the following*:

- PSMA membership
- Provide general support and advice to customers
- Clear information and literature about product range
- Provide prompt technical support
- Display a clear understanding of product applications
- List product strengths and limitations (fit for purpose)
- Compliance with all relevant regulations and standards, for example, CE markings
- Provide clear and comprehensive instructions and guidance for use
- Advise on storage, inspections and maintenance of equipment
- Training support and guidance on competencies
- Advice on the compatibility of equipment
- Operate an accredited quality assurance system
- Research new developments
- Supply equipment in appropriate packaging and properly labelled
- Issue certificates of conformity where relevant
- Carry adequate product and third party liability insurance

Interviewees were generally of the opinion that this list provides an acceptable benchmark for manufacturer and supplier performance. If the specifier of safety systems took the necessary steps to ensure that the manufacturer/distributor of the equipment complied with the above requirements, then they would be obtaining the services of a competent organisation.

8.5 TRADE AND INDUSTRY ORGANISATION

The national representative organisation for the personal protective equipment industry is the Personal Safety Manufacturers Association (PSMA). The PSMA represents the majority of companies manufacturing and/or supplying PPE to the UK market and is federated to the British Safety Industry Federation (BSIF). The PSMA also works in conjunction with HSE to produce standards for competencies of people installing, assessing, instructing on personal safety systems. At present, PSMA has a membership of over 50 organisations.

This organisation was originally founded as the Industrial Safety (Protective Equipment) Manufacturers Association (ISPEMA) in 1959, and has a track record of promoting the views of responsible manufacturers to BSI, the public and others during this time.

Technical Product Groups within PSMA write, review and influence Technical Standards via British Standards Institute (BSI) Committees for UK, CEN (within the European Directive on PPE) and ISO Standards. These Technical Product Groups cover areas other than work at height equipment, i.e. eye protection, gloves & clothing, head, hearing, and respiration protection. The Health and Safety Committee of PSMA place appropriate importance on training within this field. The Working at Heights Safety Committee is made up of industry members with a vested interest in height safety. The participants of this committee strive to be the driving force in the UK height safety industry. This committee recently formulated the Height and Access Safety Group (HASG), who are working in consultation with the Health and Safety executive to reduce the cost to society caused by fall accidents, through improved safety management practices, proper selection, use and care of fall protection equipment. The members of the HASG are made up from 16-manufacturers and/or suppliers of fall protection equipment.

It was stated on many occasions during the research data collection that legislation and best practice are very close and compatible. Therefore, the inference is that the individual trade association and manufacturer recommendations can be looked upon as complying with law, however, this is a significant generalisation and certainly should not be taken as a guarantee. Trade authorities in industry play the important part of bringing industry together to produce one collective voice for lobbying government for improving EN Standards, installer competence, and certification scheme, etc.

8.6 INDUSTRY RECOMMENDATIONS FOR USE

This section of the Chapter draws on experiences of industry practitioners, specifiers, supervisors, and users of the systems. During data collection, the research team experienced difficulties in tracing and interviewing the users of the installed systems, due to the fact that more often than not, the manufacturer and the installer is not the end user. This highlighted a problem faced by the cable and track industry in that the end user is sometimes very difficult to determine on existing buildings where access may be required by many users at various times of the day, under various environmental conditions. Careful consideration must be given to who the eventual end users of the system are likely to be, and for ensuring that these personnel are appropriately trained in the specifics of the systems. For this, close liaison must be promoted between the manufacturers and the building owners and/or clients. It must be established early who the building occupier is likely to be, in order to establish the specific requirements of the systems, and the provision for appropriate training.

During data collection on other systems within the research focus, i.e. purlin trolley systems and erection and dismantling of scaffold (SG4:00), it emerged that cable based systems have their role to play in the safe use of both systems. For example, should a purlin trolley system be used on a curved roof, when the operative reaches the peak, his waist will be higher than the guardrail due to the profile. Thus, supplementary PPE systems are required to ensure that the operatives are not exposed to further risks (see Chapter 4). Similar situations were described for scaffold operations, where cable systems would be used on occasions where the scaffolder is exposed to greater risks during erection and dismantling the scaffold structure (see Chapter 9).

There exist many factors that must be taken into account during the design phase of system selection. Factors such as aesthetics, lightning protection, other environmental conditions, access to and egress from the system, maintenance, rescue, etc. This brief list distinguishes the requirement for specialist input into the selection process for all decision makers to ensure the correct evaluations are made on the most suitable equipment.

General issues

A consensus from industry personnel interviewed during the data collection process was that the simpler a safety system is, the more likely that it will; a) be used, and b) be used correctly. This issue was raised principally because cable and track-based safety systems are active systems, thus rely wholly on the user's actions and attitudes for safe use of the equipment. Lessons can be learned from a cultural approach to system selection in that the user should always be considered.

Frequency of use is an area that must be given forethought in systems selection, and will include input from the design team. Guidance for designers is needed to decide what is 'frequent', e.g. access to a height for maintenance once a day is frequent, therefore a permanent system with guardrails is recommended. Access to a height on a less frequent basis could be viewed differently and specifying cable or track-based safety systems is more appropriate. Again, specialist input from manufacturers and/or distributors is recommended at the earliest possible stage in the design process.

When attaching cable or track systems that require penetrative fixings, consideration must be given to the effect that this will have on the thermal and structural capabilities of the structure to which the system is fixed. Guidance from an experienced engineer must be sought and followed in these instances. Industry has developed a system that uses non-penetrative fixings compatible with standing seam roof sheeting. Products such as these should be considered if penetrating the structure is not a favourable solution.

Structure

Cable and track-based safety systems must be connected to a suitably robust structure in order to perform their task. This structure will be either a wall, ceiling or, more commonly, some area of the roofing structure. The loadings applied to any structure that the systems are to connect to are important. If the loadings are misinterpreted, or misunderstood, the consequences could be severe for both the building owner and the users of the system. A sound knowledge of the systems available, the structure it will be attached to, and the environmental considerations for that structure is a minimum requirement. Regulation 3.9 of the provisional BS 8437 *Selection, use and maintenance of fall protection systems and equipment for use in the workplace* describes the following loads that must be considered when considering cable and track safety systems:

Safe working load (SWL) –	designated maximum working load of an item of equipment under specified conditions by the user or competent person
Maximum rated load –	maximum mass in kilograms of personnel, including tools and equipment carried, as specified by the manufacturer
Minimum rated load –	minimum mass in kilograms of personnel, including tools and equipment carried, as specified by the manufacturer
Breaking load –	minimum load at which an item of equipment breaks when it is tested new, under specific conditions
Proof load –	test load applied to verify that an item of equipment does not exhibit permanent deformation under that load, at that particular time

Cable systems

The essence of the reaction of cable-based safety systems in a fall-arrest situation is that they allow the load of the falling person to be distributed over a wide area, and the load is transmitted along the cable to the anchorage points. Loads are transmitted and shared throughout the safety

system in a complex manner. The forces generated from a fall are transferred from the cable through the intermediate posts, to the end posts, whilst applying force to the structure through force transfer. Whether the system is based around steel or synthetic cables, the following incorporate the fall loading:

- The cable through stretching
- The anchorage posts local to the position of the fall
- The structure the posts are attached to
- The shock-absorbing lanyard (when deployed)

The layout and detailed design of the system will determine how much load is applied to each component during fall arrest. Examples of system characteristics are; low stretch cabling, low dynamic sag, excellent shock absorbing capabilities, little elasticity ('bounce' factor), less load transferred to the structure resulting in lower end loads, etc. The factors surrounding the connecting structure and use of the system will determine the requirements of the safety system.

Shock-absorbency in the cable depends on the cable length between intermediate anchorage posts, which also affects the deployment of the lanyard. If the cable is short, there will be less absorbency in the cable, therefore, the shock-absorbent part of the lanyard deploys further, and vice-versa. It is reported that the impact forces end up being similar and deflection is much the same with most systems, whether they have shorter or longer cables.

Track systems

These systems are similar in many ways to the use of cable systems, with the main difference being that there are no individual anchorage posts. These systems are installed to allow safe access for inspection and maintenance purposes without the necessity to unclip when negotiating corners and/or different levels (i.e. can transfer to the vertical plane without the need to unclip). Different levels of elevated works is where problems can arise and is where vertical systems are strongly favoured – the attraction of a system where ***absolutely no*** unclipping was required by the operative following the initial attachment to the system is what industry want.

Number of users

The number of personnel that can be attached to a cable/track system at one time varies from system to system, and from installation to installation. Systems generally are designed to accommodate from one to six users at the same time. However many manufacturers will declare that systems that support in excess of six users can be designed and installed if required. When considering the amount of people that are likely to require protection by cable/track systems at any one time, the issue of rescue must also be considered. For example, if a system were designed for one user, a separate system for rescue must be considered, as the rescuer could not use the same system as the faller was suspended from.

If systems require multiple users on a regular basis, then cable/track-based systems should be a last resort, as the safety hierarchy would suggest a barrier system. Where this is not possible, the number of users on a system should be kept to the minimum.

Fall Dynamics

Industry is of the opinion that designers, specifiers, installers and users do not realise the forces involved in a fall of any kind from any system. A problem with fall dynamics is how to model what happens when a person falls on a safety system. This is normally calculated by using specialist computer software, which determines:

- That there is sufficient space to be arrested safely (i.e. the total fall distance that will occur)
- The maximum deceleration force on the person falling
- The loading on the anchor points due to the above
- The potential loadings applied during rescue
- That the software is appropriate to the system involved

The specifics of fall dynamics are out-with the scope of this report, however the following brief description provides an overview of the main issues; when a person is falling it takes approximately 3m for their falling speed to reach *terminal velocity*, which is estimated to be around 122mph. The effect of striking the ground at this speed is the equivalent to over 20-times the body's natural weight, which is equal to approximately 2-2.5 tonnes (20-25kN) for the average 100kg (or 1kN) person. Thus, it can be seen that even low falls can have physical consequences for humans. The maximum impact force allowable for the human body under BS EN 355:2002 is 6kN (600kg). Section 4.4 of this standard confirms this load when it states; *the braking force F shall not exceed 6kN*.

Specialist packages

Many manufacturers and distributors provide a full technical package of advice and support on initial design, installation, training, and maintenance. Some contractors insist that this form of technical package is provided from their suppliers as a point of best practice.

It now appears that manufacturers accept a responsibility that goes beyond the simple manufacture of a safety system.

Factors in installation on Historical buildings

Inconspicuous appearance on a wide range of roof profiles is often required. In new build, these systems have a minimum impact on aesthetics. This is particularly the case during the renovation of historic buildings with dome roofs and other unusual features. For example, these buildings may make safety nets difficult and dangerous to install and may mean that the net is well over 2m below the apex of the roof. Cable and track based systems have recently become widely used by agencies maintaining historical buildings. This is mainly due to their near invisibility when installed, which maintains architectural integrity, and ensures that any persons requiring access to carry out works at height will be protected. There is a conflict between aesthetics and safety requirements. This is a situation where a less than ideal position in the hierarchy is accepted because an alternative is unacceptable.

The difficulties faced with maintaining historic buildings were described during site interviews with one historical agency, when the following was said:

"*We have systems in place that aren't ideal, and could be safer, but we can't come up with anything better under the circumstances in which we work*", and "*It is very building-specific as to what is required*"
(District Works Manager, September/October 2003).

Fall protection

The PSMA provides guidelines for fall protection, (*Height Safety Best Practice, 2003*). The guidelines list the following factors to consider in the planning of systems:

- Determine and evaluate the fall risks
- Define the correct system for the works
- Provide a rescue plan
- Provide the user with the necessary training for inspecting, handling, using, maintaining and storing the equipment
- Ensure that all elements of the equipment are compatible, e.g. BE, EN, ISO, CE
- Ensure that the equipment complies with the law and the CE standards
- Select reliable anchorage points as close as possible to the user (ideally above the user). The anchorage must comply with BS EN795:1997 or have a minimum strength at failure of at least twice the maximum rated fall arrest load
- Avoid any member of the workforce working alone
- Provide proper storage conditions for all equipment
- Do not allow any modifications to systems components without the manufacturers agreement
- Report any defect, abnormality, wear, or fall that might affect the integrity of the system

It is important to implement a competent inspection regime to ensure the above guidelines are followed. This will be further discussed in Section 8.10.

8.6.1 Advantages and Disadvantages

This Section deals with the advantages and disadvantages of cable and track safety systems, identified by industry. When discussing the specifics of these systems industry recognises that they are lower down the hierarchy of risk control due to their reliance on PPE; they are active systems, in comparison to passive systems, such as rigid rails. However, this should not detract from the positive aspects of the system, as industry is not always afforded optimum installation conditions on every occasion.

Generic Advantages

These systems provide continuous protection along the length of the system, which should be the length of the working area. If used in a safe and appropriate manner, both systems are reliable

Both systems are extremely useful during maintenance and/or refurbishment works, particularly when the work is of short duration at infrequent intervals

The systems are less visible than other, more obvious safety systems, e.g. perimeter guardrails

There are security advantages with these systems, when compared to ground-to-roof scaffolding. There are no easy accesses for the public or intruders

For roof installations, some systems can be accessed and used without the need for entry to the building. This has two main advantages; 1) the works can be carried out at any time of the day, whether the building is open or closed, 2) without the need to enter the premises there will be no disruption to any internal activities

All systems are based on technologies from the sailing industry. Therefore, the materials used are resistant to harsh environmental conditions. This is important when considering systems that may be used infrequently and remain for long periods of time unused

The systems are usually designed to last as long as the roofing structure, as long as they are properly maintained in line with the manufacturers recommendations

In most work situations, the systems will provide hands-free protection. However, some systems can provide problems and can require an action from the user, which requires putting down tools or equipment carried

Cable System Advantages

Some cable system manufacturers design the cables to provide as low as possibly elasticity, i.e. as rigid as possible, which results in less loading on the faller, and the structure, i.e. the user will not bounce around following a fall and risk further trauma. There must be a compromise between 'bounce' and a sudden arrest for the user, as low elasticity gives high shock loads, and vice versa

Some cable systems can span large distances (i.e. >50m) between the anchor points, which means fewer penetrations of the roof surface, thus less maintenance for the building owner for both the fabric of the building, and the number of anchorage posts

When comparing cable systems directly with track systems, the following list can be seen as the major advantages:

- The spans that can be provided negate the need for frequent fixings (larger number of fixings for the track)
- The components used are generally lighter weight than the track traveller
- The systems can be less visible than many track systems

Some cable system anchorage posts are designed to 'fail' under fall loading, much in the same way as cable-based motorway safety barriers, on impact. This energy absorption dissipates the shock loading on the user

Track System Advantages

The operative must be protected from ground level onto the system. If this is not addressed through the design of a system, the operatives could be exposed to greater risks than using the system itself. In this area, track systems have an advantage as they can integrate vertical, horizontal, and inclined elements (without the need for unclipping), for ease of travel to and from the work area. Careful design and planning of access and egress arrangements is important with these systems

As track-based systems act as an anchorage point along their entire length, they are thought to be more effective than cable systems. The rigidity of these systems contrasts with the more flexible cables, and there is no opportunity for travelling or falling further than the lanyard allows

The psychological advantage of a non-flexing rigid rail results in reduced concern for the user. Free from the hindrance of constant reattachment to different sections or levels, operatives can often work faster and still be secure in the knowledge that they cannot fall off of a structure

Early cable systems were deemed ineffective at manoeuvring round bends or obstacles, which prompted the introduction of the track-based systems into industry. However, the cable industry has developed corner adaptors for such situations. Track systems are currently superior at going round such obstacles

Track systems minimise the pendulum effect, which can result in impact injuries to fallers. This is due mainly to their travellers gliding on the track in tandem with the system user, thus reducing the potential angle of the lanyard when a fall occurs

The following are additional advantages of track systems:

- There are no problems with cable sag
- The whole system acts as an anchorage point
- There is no need for pre-tension indicators for the cables
- There are no requirements for in-line shock absorbers
- No intermediate brackets are required
- The system requires little maintenance

Generic Disadvantages

Cable and track-based systems are principally considered to be fall arrest, not fall prevention. Further, the systems are personal protection (classed as 'active'), which is further down the hierarchy of risk control (Chapter 3), i.e. action is required by the user to ensure it performs its function. This introduces other practical problems that need to be considered during the design stages; for example, mounting a rescue immediately and other foreseeable risks (suspension trauma, secondary strike injuries, and pendulum effect)

If the systems are to be retrofitted to a structure, the installation operatives are exposed to increased risk (of working at height) during these works

The performance of each component of cable and track systems interacts with that of the other equipment in the system. For example, the lanyard and the cable operate together, and the lanyard 'tear' extension may not work properly because of the spring in the cable

The systems are susceptible to pendulum effect. Therefore, care must be taken to ensure that the traveller is always, as much as is practicable, level with the user to reduce the risks of a pendulum fall

There have been suggestions that the PPE used (i.e. the full-body harness) is uncomfortable. With developments in materials used and manufacturing techniques it has been suggested that

this is no longer a valid excuse. Industry must supervise the wearing and use of all equipment to ensure that a culture of acceptance develops

Many users of the systems (particularly cable systems) feel that there is inadequate technical information from suppliers on the limitations of the system, leading to systems being incorrectly used. With the manufacturers and distributors now often providing training, it is hoped that this concern will not have a significant bearing on the safety of the users in the future

There is an issue of compatibility of components within cable and track systems. The most common criticism is that the travellers for each system are incompatible. This becomes problematic if a site has several cable/track systems installed, and an irregular workforce being exposed to these systems. If the incorrect traveller is used a faller may not be arrested as intended, or will be arrested with a substantially higher force

There appears to be little, if any, synergy between manufacturing organisations to develop compatible systems. A challenge exists for manufacturers to work together to standardise the equipment used in the industry

On occasions, operatives modify and adapt systems to suit their particular needs, mixing parts of different systems. Not only is this bad practice, manufacturer's warranties would be invalid if the system is altered

Both systems are made up of numerous components. This research found that purchasers and users are becoming increasingly attracted to systems with less parts; easier to use and less to lose or damage. Systems with many components could also be visually distasteful on a historic building

Dependent on the positioning of the system, the ropes/lanyards can become a trip hazard. This is especially the case if the systems are positioned close to the work area, and if they are situated near floor level

Although advertised as hands-free systems, the reality is that both systems are not completely without the need for operative intervention when moving position. This can have implications if, for example, carrying hazardous materials. In such situations, it is best to specify a barrier system, e.g. guardrail

An ongoing maintenance programme will be required to ensure that systems remain in good functional order. With numerous components to be maintained, the time and cost implications could be significant

Cable System Disadvantages

The configuration of the system, for example, single or multi-span, will have an effect on the distances involved in a fall. The span between intermediate anchor posts should be as short as possible, to reduce cable deflection and, therefore, fall distance and bounce. Therefore, the maintenance benefits of fewer anchorage posts and increased span lengths must be weighed against the increased risk of strike injury during falls

A cable system can be situated above the users. Inertia reels cannot be used in this situation because the weight will deflect the cable; or it will not go through the intermediate anchorage brackets. Also, the user may experience a pendulum effect during a fall

Some cable-based systems can span large gaps, but, as well as resulting in a longer fall distance, there are larger forces applied to the anchorage posts in a fall

Some systems may require anchorage support from as little as every 5m. If penetrative fixings are used, this could mean an increased likelihood of potential maintenance problems. More anchorage posts could also mean increased costs and time on the installation; further, this will have financial implications for future maintenance requirements

Some cable systems (particularly wire systems) can be surprisingly elastic, which can bring an element of elastic 'bounce' when a faller reaches the point of maximum deflection during a fall. This increases the likelihood of the faller experiencing secondary strike injuries against the structure

Some cable systems require user disconnection and reconnection at either side of anchorage brackets; and, in others, travellers are reported not to glide easily over the anchorage supports, again encouraging disconnection. The travellers must be suitable to pass through or over the intermediate support brackets without obstruction

8.6.2 System Use During Maintenance and Refurbishment

Cable and track-based safety systems differ from most other systems in this report as they are installed primarily to assist in maintenance functions during the building's life. Under the CDM Regulations 1994, the designer must ensure safe access for maintenance activities over the lifetime of the building, thus all new build works should have appropriate measures in place. Existing buildings with no fall protection systems installed is an area that requires attention to ensure that all maintenance functions are carried out in a safe manner[20]. Retrofit installations are discussed in Section 8.8.2.

The nature of maintenance works will determine whether cable or track-based systems are suitable for these tasks. For complete refurbishment works, for example, re-roofing a building, cable and track systems are not appropriate. For infrequent access, for example, once per month (or less) to carry out lightweight duties, cable and track systems would be recommended. Should the frequency of access be more, or the duties carried out are of a heavyweight nature, a fall prevention system, i.e. rigid guardrail, would be recommended.

Further, both systems can be limited by the number of personnel that can be attached at any one time, which could hamper both working operations and any possible rescue activity.

[20] *CDM Regulation 13 dictates that during the design phase, the designer makes every attempt to adhere to the following principles: avoid the risk altogether; reduce the risks present; and, inform the client of the residual risks.*

8.7 TRAINING STANDARDS

There is a demand for training on the installation and use of cable and track safety systems.

The PPEAW Regulations 1992, Regulation 9 (1) states;

(1) Where an employer is required to ensure that personal protective equipment is provided to an employee, the employer shall also ensure that the employee is provided with such information, instruction and training as is adequate and appropriate to enable the employee to know –

> *(a) the risk or risks which the personal protective equipment is to be used;*
> *(b) the purpose for this and the manner in which personal protective equipment is to be used; and*
> *(c) any action to be taken by the employee to ensure that the personal protective equipment remains in an efficient state, in efficient working order and in good repair…*

Servicing and simple maintenance of the equipment is sometimes be included in training courses; this way, each operative has an understanding of the basics of these issues, which could be a potential safety benefit in the future. This also alleviates the possibility of unqualified personnel tampering with equipment that they have not been trained to handle.

Training in proper equipment use will be required for anyone who is likely to use it. This can be difficult for building owners who have only intermittent access requirements.

The cost to train people in system use is expensive, particularly in construction, with its transient labour force and high employee turnover. Also, in the case of permanently installed, maintenance systems there are often long periods between uses. Training is forgotten and trained personnel leave. Regular training and retraining in the installation, use and maintenance of the equipment is essential.

Installers and users of cable and track systems are trained through a network of manufacturers and distributors local to their place of work. Installers will be specifically trained in the system use, fitting the system, and signing-off equipment to the end–user. Industry normally receives training direct from the manufacturers of the systems (or their representatives);

> *"This now forms part of our selection process, as we'd only select manufacturers/installers that could provide this training service"*
> (District Works Manager, September/October 2003).

Organisations must ensure the competence of the training organisation, as many distributors do not manufacture the devices; they only retail them.

The training committee of the HASG sets standards in the delivery of practical training and classroom education for work at height, and are in the process of completing a Code of Practice for this area. This document is the first in its field and sets out requirements for training providers in the following areas:

- Training safety management system
- Documentation and record keeping requirements
- Management responsibility, authority and communication
- Suitability of training provided
- Training design and development
- Management of training resources
- Training staff
- Training environment
- Use of sub-contractors
- Assessment and certification (validation)

This document intends to ensure that work at height training is delivered in a safe and reliable manner (http://www.hasg.org.uk). The HASG have approached areas of their training standards to include generic issues of industry-recommended practices, to ensure that they are consistent with general industry principles on height safety training; not only related to cable and track-based safety systems.

The system complexity will determine the amount, and level, of training required. Industry reports a lack of understanding and training on issues such as cable stretch, fall distances, and shock loads. In many circumstances the end-user will only require training in the use of the system and appropriate use and care of the supplementary equipment. Industry must ensure that the training provided is relevant to the users and the tasks that they perform.

There is a danger with active safety systems that operatives will not use the system provided, or that it will be used incorrectly. Management supervision and training must emphasise the importance of correct system use.

Training is expensive but cost can be minimised by keeping to a minimum of the people who use the system, and need training.

The handover process is when most training is carried out. Presence of the safety file is not enough to ensure site safety throughout the lifetime of the structure as this may never be read. On many occasions the client cannot assemble all those who may use the system at one time. If this is missed at the handover stage, video training can be employed to ensure that everyone with a responsibility for the safety system gets access to training material. This can be especially useful for ad-hoc subcontractors brought onto site, however, the instructional video should not be considered an appropriate training solution under normal circumstances. Instructional videos should only be used as support tools to the training programme provided[21].

8.7.1 Rescue

Rescue from either cable or track safety systems can be a complex procedure and requires careful planning, prior to any works taking place.

[21] *Video training can be considered as 'instructional' under training guidelines, i.e. they do not prepare the individual for the high-risk environment that they will work in. Further, under CDM the installer can be the designer, who has a duty to inform the client on all safety-critical information – it is suggested that video instruction could not competently perform this task.*

Research has been carried out to investigate the effect of prolonged suspension in fall protection harnesses. It is widely accepted that rescue should be affected within 20-30 minutes. Phenomena's known as; 1. Suspension trauma, and, 2. Rescue death are recognised as genuine risks to a person held in suspension for any significant length of time. The specifics of this condition are out-with the scope of this report, however, further information on this can be found in Appendix 9, and the following publications:

- CRR 451/2002: Harness Suspension: review and evaluation of existing information (http://www.hse.gov.uk/research/crr_htm/2002/crr02451.htm)
- CRR 411/2002: Analysis and evaluation of different types of test surrogate employed in the dynamic performance testing of fall-arrest equipment (http://www.hse.gov.uk/research/crr_htm/2002/crr02411.htm)
- HSL/2003/09: Survivable Impact Forces on Human Body Constrained by a Full Body Harness (http://www.hse.gov.uk/research/hsl_pdf/2003/hsl03-09.pdf).

Rescue comes under '*Procedures for serious and imminent danger and for danger areas'* as described in Regulation 8 of the Management of Health and Safety at Works Regulations 1999. Rescue should be affected as soon as is possible, particularly if the faller is injured or distressed in any way. Therefore, rescue methods and techniques must be given high priority when selecting a safety system. This will come in the form of the rescue method statement (RMS), normally included within the general method statement. When considering the RMS, the specifier must take account of all factors surrounding the safety system, then make an appropriate decision on whether or not rescue can be carried out easily, for example, different decisions will be required if the faller has been injured. The following factors should be considered:

- PPE should be selected that reduces shock loadings on the body (maximum allowable 6kN – BS EN 355:2002)
- Fall distances must be of such a distance that self-rescue of the faller is a possibility (e.g. self-retracting inertia reels as opposed to shock-absorbing lanyards where appropriate)
- The likelihood (and preferable avoidance) of lone working when using the system
- Considering mechanical aides to assist in the rescue process; for example, manual or automatic descending devices, which allow a third party to lower the faller either from the same system using abseiling techniques, or independently from the system
- The availability of specialist rescue teams in areas where it would appear that rescue could be problematic

On occasion, a faller can carry out a rescue operation alone, with the aide of rescue equipment. However, this requires particular conditions and equipment and makes the assumption the faller has not been injured during the fall; this is known as 'assisted self-rescue'. Equipment is available in industry to support rescue procedures, for example, retractable inertia blocks. The construction manager must make the decision as to what is the most appropriate under the circumstances of the works at hand. Another rescue procedure is known as 'fully assisted self-rescue', where tools and equipment are available on site to affect the rescue. In this case, rescue products are brought onto site during the works, or are already on site as a matter of course, e.g. MEWPs, towers etc. Emergency services rescue teams may also be resident on the site on larger projects e.g. chemical works, football stadia etc.

The main issue to consider is the required equipment, for example, is the rescue equipment the same as the equipment that the faller has used, or is supplementary equipment required? On some roof safety systems, individual anchors for cable-based systems can be used for a fixing point for the rescuer.

During a rescue situation, the rescuer should be looking to perform one of the following techniques:

- Engage the faller who is suspended by their lanyard
- Raise the faller in order to release their current attachment point; and
- Raise or lower the faller to an appropriate point of safety

There is no safe system of work, with track and cable-based fall arrest systems, without a means of rescue. The duty holder should ensure that designers or installers to comply with provided guidance. Rescue systems can be complex, and need to be considered and purchased with the fall arrest system and included in the training. Further, rescue systems should be regularly tested and practiced to ensure that they work, and are efficient.

Systems are often unique in their rescue requirements. Issues can exist of the effects that that faller would have on the rescuer, i.e. could the rescuer be pulled off, or how do you get a third party onto the line to help with the rescue? These issues highlight the complicated nature of rescue requirements, which must be appropriately catered for early in the planning process through expert help and assistance from the manufacturer, designer, and installer.

8.8 INSTALLATION AND DE-RIGGING

The method employed for installing, using and de-rigging the equipment used for cable and track-based safety systems will depend on the building being constructed, or the physical profile of the existing building. Risk assessments will be required to ensure that ancillary safety equipment and procedures are provided and communicated to the installation personnel. Installation and dismantling of the system involves time and co-ordinated effort by trained personnel.

With any safety system, considerations must be given to ensure that the equipment is correct for the task, and that the surrounding environment accommodates the system. These considerations should be given at the earliest possible opportunity prior to physically carrying out any works on site.

8.8.1 Anchor Points

There are many forms of anchorage points for the numerous systems available. The anchorage adopted for each system should be carefully considered to ensure that it meets the required criteria for that installation. The anchorage is a feature of each system and, therefore, must be considered in the selection of an appropriate system. Again, the duty holder must seek specialist assistance from industry organisations to ensure that necessary provisions are being met. Specification of anchorage is one of the most fundamental parts of cable and track-based safety systems. BS EN 795:1997, Annex A *Installation recommendations*, discusses anchorage, with

sections A.5 and A.6 covering *anchor devices employing flexible anchor lines*, and *anchor devices employing rigid anchor lines* respectively. These sections are summarised below:

For fixings in steelwork or timber, the design and installation should be verified by calculation by a qualified engineer to be capable of sustaining the type test force.

For fixings in other materials the installer should verify the suitability by carrying out a test in a sample of the material. Thereafter each structural anchor…should be submitted to an axial pull-out force of 5kN to confirm the soundness of the fixing. The structural anchor should sustain the force for a minimum of 15 seconds.

The installer should ensure that the distance required or necessary to arrest the fall of a falling worker does not exceed the distance available on site.

If anchorage requirements are misunderstood or miscalculated, the system could be rendered as of no safety benefit to the user.

8.8.2 Method of Installation

Installation of cable and track safety systems is very much system-specific and depends on the on-site practicalities with which the installer is faced. Standard procedure is to fix the anchorage points first, with the cable/track being almost the last process. The specific process involved with each system is out-with the scope of this report.

Permanent cable and track-based safety systems can be installed during initial construction, or fitted retrospectively to existing buildings. Temporary systems will be portable but are installed and dismantled in a similar fashion to permanent systems. Cable and track systems are often retrofitted to existing buildings or structures to ensure that the buildings are compliant with current legislation. There are variable risks to be encountered during this task. Contributors to potentially dangerous situations for the installer are:

- Exposure to the height
- Unreliable technical information in the form of unknown substrates (e.g. granite, asbestos infill, etc.)
- A lack of understanding of the dangers in retrofitting (see Section 8.6.2)

Careful planning, including a detailed on-site survey, must be carried out prior to exposing an installer to risk[22]. Specialist knowledge of the operation of the system and the optimum installation procedures is required to ensure a safe installation.

> "*It is very important to know the systems you are going to work on; the installation of the equipment is just as important as the final layout of the system*", and,
>
> "*The specialism is in knowing where to put the system*"
> (Contracts Manager, September 2003)

[22] *CDM Regulation 11: Every client shall ensue that the planning supervisor is provided with all the information about the state or condition of any premises at which construction work is intended to be carried out.*

8.8.3 Sequence of Attachment to and Disengaging from Systems

The procedure for attaching to and disengaging from cable and track safety systems is system-specific, depending on the circumstances of each site. However, the following list should be considered as a minimum requirement to ensure that operatives are protected at all times:

- The user must always be protected during ***all*** works, including access to and from the safety system.
- All personnel must be prohibited from entering an unprotected area
- It must be ensured that the PPE is appropriate for the system to be engaged
- Appropriate PPE should be put on prior to being exposed to the height
- The system user must be conversant with the system components, and the practicalities of the system
- The lanyard connector should be engaged to the traveller on the system as soon as is possible
- All safety systems should be used in the way in which it they are intended
- In all situations, some form of permit to work system should be in operation to monitor who is using the equipment

8.9 MANUAL HANDLING

The system selected will determine the manual handling. The systems are designed to be as unobtrusive to the user as possible, therefore manual handling associated with the system is normally not an issue for the users of either system. Supplementary PPE that is used is lightweight and should have no adverse effect on the wearer/user during the use of the system.

The main manual handling issues with cable and track-based safety systems are related to the original installation of the systems. Handling of larger components of the systems, for example, anchorage posts or lengths of cable/track, during installation must be considered, and the requirements of the Manual Handling Operations Regulations 1992 followed. All installation works should be carried out by appropriately trained, competent, and experienced personnel who are familiar with the handling issues relating to each system.

8.10 INSPECTION AND MAINTENANCE

Cable and track safety systems are made up of a series of components that provide active fall protection for the user. If any of these parts fail, are used incorrectly, are incompatible, or damaged, the whole system may fail to operate effectively. Duty holders and users must ensure that management control systems are in place to inspect, record and maintain ***all*** equipment used in these systems[23]. This obligation can be incorporated in a larger inspection regime for the building itself. In accordance with recommendations in BS EN 795:1997, an installation should be inspected annually by trained personnel to ensure suitability for continued use. In many installations, the most frequent user of the equipment could be the system inspector.

[23] *The combined components used as part of a cable and track-based safety systems could be classified as 'work equipment'. In this regard a strong parallel exists with the requirements of The Provision and Use of Work Equipment Regulations 1998, in that the equipment is subject to an examination regime by a competent person.*

All PPE associated with fall arrest systems needs regular inspections and re-certification in accordance with BS EN 365:1993 Personal Protective Equipment against falls from height – General requirements for instruction for use and marking. PPE must undergo regular formal and informal inspection to monitor its' capabilities to perform the task for which it is intended. The following should be considered standard for PPE used in conjunction with a cable and track-based safety system:

Prior-to-use inspection: carried out by the person using the equipment (assuming they are competent to do so). Tactile and visual checks, undertaken in well-lit conditions, suffice at this stage.

Intervening inspection: a recorded detailed inspection, used on an ad-hoc basis as and when deemed appropriate by the duty holder; usually following exposure to extreme conditions.

Comprehensive inspection: more formal and in-depth than the prior-to-use inspection. Carried out at periodic intervals specified by the duty holder borne from the equipment manufacturer's recommendations. These inspections will be held either 3 or 6-monthly (dependant on use and exposure) and will be formally recorded and filed as part of the safe system of work.

Equipment should be withdrawn from use and passed for comprehensive inspection if:

- There is no recorded evidence of periodic inspection
- Identification labelling is not evident or is undeterminable
- Any identification marking bears superseded legislation (i.e. pre-CE marking)
- If, after any form of inspection, the equipment has raised doubts about material integrity

No operative should use any third party's safety equipment unless satisfied that it has received appropriate maintenance and inspection. It is imperative to have accurate records, in the form of the health and safety file, for the history of equipment used in order that it can be determined that the equipment is fit for purpose.

During inspection, various standard procedures are carried out depending on what component part of the safety system is being inspected. When dealing with the softer parts of the systems, for example, cables and/or harness and lanyard, the two most common defects are abrasion and cuts on the material. For clarity, abrasion is described as 'natural degradation', and cuts are described as 'physical incision of the material'.

8.10.1 Monitoring and Supervision

Supervision of system use is dependant on various factors, for example, system use, and tasks undertaken during use. Compliance with manufacturer's recommendations is essential and these recommendations must be communicated to the end-user. During data collection, numerous interviewees commented that guidance rarely reached the end-user, and would probably not be consulted even if it were available. This area must be addressed by the supervisory organisation to improve the user's awareness of the safety systems. Warning and safety notices should always be positioned at the equipment storage areas and all access points.

Ensuring that this information is readily available does not constitute adequate monitoring and supervision. On-site and desktop supervision must be constant to ensure that everyone is aware of the dangers, and are taking every reasonable step to ensure that all works are undertaken safely.

> "*How far do you go to supervise? You can have all the necessary paperwork in place, but ultimately accidents are caused by human error*"
> (District Works Manager, September/October 2003)

The reliance on human action for the correct use of cable and track systems determines the need for a significant site presence from the supervisory organisation.

Monitoring and supervising the safety system is dependent on an appropriately detailed handover process after installation. This involves the manufacturer passing all relevant information to the building owners, who have a responsibility to pass this information to those who will be supervising the users. The supervisors have the responsibility to pass this information to the end user. The handover package will form the basis of the supervision procedures. This information will include: user instructions, equipment logs, and the operation and maintenance manual. Regular communication with supervisors and system users is required to ensure that everyone is aware of the dangers that exist if safety equipment is improperly used.

> "*We discuss every aspect of the works with everyone prior to them coming to site, and definitely before they are given a key to access the area. Granting access to these areas is dependant on whether the appropriate method statement and risk assessments have been received, and ultimately will depend on the weather at that time*"
> (District Works Manager, September/October 2003).

As PPE is a crucial part of cable and track safety systems, the following information provides examples of the potential dangers that the systems face when left in-situ. Regulation 10 (1) of The PPEAW Regulations 1992 state; '*Every employer shall take all reasonable steps to ensure that any personal protective equipment provided to his employees…is properly used*'. There is a wide range of causes of loss of physical strength, leading to degradation of the synthetic fibres used in webbing and rope lanyards, for example:

- Abuse/misuse of the equipment
- UV-degradation
- Natural ageing
- Dirt and/or grit
- Abrasion at edges
- Cuts in web, rope or stitching
- Unintentional knots in the equipment (tying knots in any equipment will reduce its strength and will also generate heat inside the knot that will ultimately result in degradation of the material)
- Surface abrasion (an industry rule of thumb is that there is an allowable tolerance of 10% degradation for abrasion)
- Chemical attack (sometimes difficult to see with the naked eye)
- Heat and/or friction damage, i.e. burns
- Deployed shock absorber

- Damaged or deformed fittings

This list can be taken to be hazards that affect ***all*** equipment used in cable and track-based safety systems, and inspection procedures must be developed to recognise these potential hazards.

A safety system should have a means to indicate if it has been used to arrest a fall. This will assist supervisors in their assessment of whether the system remains fit for purpose, and should be appropriately recorded in the file for that piece of equipment. Good practice is to dispose of PPE that has been used in arresting a fall.

8.10.2 Maintenance of the Equipment

When considering the maintenance of the equipment used in cable and track-based safety systems, account must be taken of the various materials that make up a system, for example, metals, synthetic cable, fabric (for PPE). Manufacturers information provided at handover will provide this information, together with information on recommended maintenance procedures for all component parts. Apart from general housekeeping duties, like washing the system components, any maintenance on the system should be carried out by a suitably trained and qualified person. Manufacturer's instructions should be consulted prior to cleaning any equipment, and it is recommended that clean water should be used.

> Regulation 7 (1) of The PPEAW Regulations 1992: '*Every employer should ensure that any PPE is maintained in an efficient state, in efficient working order and in good repair. For maintenance of complex PPE – a high standard of training will be required*'

General maintenance of the systems will depend on what system has been installed, how exposed it is to the elements, and, what is recommended by the manufacturer. Again, a parallel exists between this area and the requirements under PUWER 1998. A list of maintenance requirements for these safety systems is provided below:

- Visual checking
- Tensioning tests (for cable systems)
- Load testing (in accordance with BS EN 795:1997)
- Lubrication (of any moving parts)
- Cleaning

It has been suggested that, frequently, little maintenance is carried out on systems once they have been installed. The main reason for this is due to the systems being perceived as basic with few component parts. This perception should not prevent having a suitable maintenance programme in place.

8.10.3 Storage and Transportation

Storage of equipment is extremely important. If storage does not conform to the manufacturer's recommendations, equipment is likely to become damaged or degraded.

On some systems, the only removable component is the traveller. The traveller and the supplementary PPE are the main parts requiring storage. Recommended storage of the PPE is described below:

- Equipment will be removed by the operative and visually inspected for any defects
- If the equipment is dirty, it will be cleaned (in line with the manufacturers recommendations)
- Safety harnesses and lanyards will be hung on a hook in a dry and ventilated room
- Equipment should not be left out in the rain and never dried over a heater
- Equipment should be visually inspected for defects prior to re-use

If the above procedure is followed, the likelihood of using defective equipment is reduced. The PPE is small and lightweight, and can easily be carried from job to job in the worker's bag with some attendant likelihood of damage during this uncontrolled transit.

8.10.4 Typical Life Span

Some equipment provided by manufacturers is given a recommended maximum life span under normal usage. Good quality control is to ensure that equipment that has reached this age is removed from site and destroyed. For the PPE used with cable and track systems, common life spans for the equipment are: 10 years from the date of manufacture; or 5 years from the date of first use. When purchased as a kit, all equipment should be kept together in that kit for its lifetime. This will ensure that all parts of the system are completely compatible, will age at the same rate and, thus, can be replaced at the same time.

Cable and track systems are expected to last up to as long as the building fabric itself. This will depend on exposure to the elements. At all times, the manufacturers recommendations should be sought and followed.

8.10.5 Disposal of Damaged Materials

When a piece of equipment has been used to arrest a fall, has been damaged beyond repair, or has come to the end of its' natural life, it is recommended that all parts of the equipment are destroyed.

Manufacturer's recommend that organisations operate some form of 'quarantine' arrangement for disposal of equipment that is no longer fit for purpose. This arrangement would involve a management system that guarantees that there is no possibility that the equipment can be retrieved and used again. Instant cutting up of all cables, PPE, etc., is a recommended practice when equipment is deemed to be no longer fit for purpose.

If the safety system components themselves are being taken out of service, this would be carried out by suitably trained personnel who would dispose of the equipment on behalf of the client.

8.11 SUMMARY

Cable and track-based safety systems can offer a practical solution, particularly to maintenance and other short duration or infrequent access problems, for many building users. This research

uncovered little evidence of these systems being used during actual construction works. The systems consist of a number of components that together provide continuous attachment and 'hands-free' working to the users. They can either restrain the user from accessing the area of risk or arrest them in the event of a fall. The concept for both systems originated from products from the sailing industry.

These systems can be installed as either temporary fall protection, during construction work, or as permanent maintenance access systems.

Cable and track systems are 'personal fall arrest systems' and, as such, are at the lower end of the fall protection hierarchy. Their governance by guidance and European Standards is extensive, due mainly to the number of different components.

The systems comprise many components. The following are a sample of the most important:

Anchorage posts; Cables; Tracks; Traveller; Connector; Lanyard; Inertia Reel; Full body harness.

The national representative organisation for the personal protective equipment industry is the Personal Safety Manufacturers Association (PSMA). The PSMA represents the majority of companies manufacturing and/or supplying PPE to the UK.

Inconspicuous appearance on a wide range of roof profiles is often required. This is particularly the case during the renovation of historic buildings with dome roofs and other unusual features. Cable and track systems satisfy this need.

When comparing cable systems directly with track systems, the following can be seen as the major advantages:

- The spans that can be provided avoid the need for frequent fixings
- The components used are generally lighter weight than the track traveller
- The systems can be less visible than many track systems

The following are the main advantages of track systems when compared to cable systems:

- There are no problems with cable sag
- The whole system acts as an anchorage point to the lanyard and harness
- No intermediate brackets are required

An ongoing maintenance programme is essential to ensure that systems remain in good, safe functional order.

Cable and track-based safety systems differ from most other systems in this report as they are installed primarily to assist in maintenance functions during the building's life. For complete refurbishment works, cable and track systems are not appropriate.

There is a demand for training on the installation and use of cable and track safety systems. The system complexity will determine the amount, and level, of training required.

Rescue from either cable or track safety systems can be complex and requires careful planning, prior to any works taking place. Rescue must be affected as soon as is possible.

Installation and dismantling of the system involves time and co-ordinated effort by trained personnel. Installation is very much system-specific and depends on the on-site practicalities with which the installer is faced.

Use of the system should be closely supervised. As the systems are active and rely on the user to carry out positive actions, there is a constant risk that such actions may be forgotten or overlooked, which could lead to the user being exposed to a fall risk whilst unprotected.

Maintenance of the systems will depend on what system has been installed, how exposed it is to the elements, and, what is recommended by the manufacturer.

Good equipment maintenance control is required to ensure that equipment that has reached its recommended life is removed from site and destroyed. A quarantine arrangement should be in place for disposal of damaged or old equipment, to ensure that it does not find its way back into use.

In conclusion, the popularity of these systems appears to be growing, in part due to designer's analysis of maintenance access requirements [CDM Regulations 1994, Regulation 13]. The systems included within the research go through frequent re-evaluations and modifications. Manufacturers and installers are aware of the requirements for their systems, and appear to be willing partners in the whole safe access management process. This is as a positive help for industry.

9.0 SAFETY DURING SCAFFOLDING WORKS (SG4:00)

9.1 INTRODUCTION

When erecting, altering or dismantling scaffolds, the scaffolders responsible for this work continuously face a risk of falling. It is necessary that operations are controlled in this high-risk industry, and that the industry has legislation and guidance to, as far as is reasonably practicable, guarantee the safety of all personnel carrying out the scaffolding task.

The National Access and Scaffolding Confederation (NASC) [see Section 9.5] published Safety Guidance Note, SG4:00 – *'The Use of Fall Arrest Equipment when Erecting, Altering and Dismantling Scaffold'* in 2000, in direct response to Regulation 6, *Prevention of Falls*, of the Construction (Health, Safety & Welfare) Regulations 1996. The guide is endorsed by the Construction Confederation, HSE, several major contractors, and NASC member companies.

SG4:00 is a significant step forward for safety in the scaffolding industry; however it does not satisfactorily address all safety hazards present during scaffolding operations, and has, in fact, created ancillary hazards, such as clipping on at the foot level, trip hazards, etc. The guide covers façade, independent scaffolds, formed of steel tubes and fittings, and does not yet cover other forms of scaffold, such as proprietary scaffolds, birdcage, grandstands, etc. However, this guide is being reviewed at the time of print (March, 2004) to account for other scaffold types. This will be further discussed during this Chapter.

Section 9.8 describes the techniques involved in SG4:00.

Within the scaffolding industry, there are two main types of scaffolders identified through this research; 'town' scaffolders, and 'refinery' scaffolders. It is not clear as to whether these universally known terms throughout the UK. For clarity, 'town' scaffolders are the type generally found on construction sites, and normally operate on price work; 'refinery' scaffolders work mainly on plants/premises of large industrial clients. The refinery scaffolders are thought to be the safer scaffolders of the two, mainly due to the limited and controlled environment in which they operate. For example, petrochemical plant industry clients often insist on a higher level of safety than that of SG4:00.

The hazards and risks arising from misuse of the scaffold by other trades are often greater and more frequent than during erection or dismantling. This 'misuse' can include; undermining foundations, taking out key components, removing ties, overloading of structure, etc., but is out-with the scope of this report, and will not be discussed.

The techniques of SG4:00 along with the equipment used, the legislative requirements, and industry's perception of the safety system will be discussed in this Chapter.

9.2 HISTORY OF SG4:00

The Construction (Health, Safety & Welfare) Regulations 1996, Regulation 6 (Prevention of Falls) states: *Where any person is to carry out work at a place from which he is liable to fall a*

distance of 2-metres or more…be provided suitable and sufficient means of protection to prevent, so far as is reasonably practicable, the fall of any person from that place. Appendix 10 lists the information contained within Schedules 1, 2, and 4 of these Regulations, which detail additional requirements of component parts of the equipment utilised during the SG4:00 function.

In direct response to the above Regulations the NASC produced a guidance note in 1998, recommending when and under what circumstances safety harnesses should be used. This guidance was seen as a first step, however there was confusion in its application, and concern was expressed that the guidance lacked clarity and did not strictly comply with the law. Following this feedback from industry, NASC formed a working party to produce an industry guide for the use of fall arrest equipment during scaffolding operations. The Working Party is a sub-group of the NASC Safety Committee, which deals with other issues in height safety, e.g. harnesses, selection, degradation, inspection, etc. Following discussions with the HSE, SG4:00 was published in 2000. SG4:00 was endorsed by HSE, subject to an agreement that NASC would continue to review and develop the guidance to accommodate innovations in scaffold products. This resulted, for example, in a review SG4:00 and an addendum to cover the erection and dismantling of birdcage scaffolds (SG23:03).

In the scaffolding industry operatives are averse to wearing harnesses, lanyards etc. Although this contravenes health and safety law, the main arguments for this are that such PPE restricts operatives movement and can provide a distraction hazard; and that, anyway, the scaffolding industry's accident record is good when compared to other high-risk industries (see Section 9.5). This was highlighted during the industry interviews thus:

> "*SG4:00 takes a bit of getting used to, however it was a requirement but not a lot of change has occurred to the scaffold accident statistics, which tells it's own story*"
> (Scaffolders, June 2003).

Appendix 11 lists other NASC Guidance notes, and shows where SG4:00 fits into their guidance for their members.

SG4:00 is subject to a full review at this time, with future SG4:00 guidance intended to serve as a complete guide to the management of risk whilst carrying out scaffolding operations. This review will also follow the hierarchy of risk control to prevent falls, contained in Regulation 6 of the Construction (Health, Safety & Welfare) Regulations 1996.

9.3 LEGISLATIVE HISTORY

Further to information contained in Section 3.2 (Generic Legislative Guidance), the following Regulations and guidance are appropriate to SG4:00 due to the guidance being practiced in conjunction with 'work equipment':

The Provision and Use of Work Equipment Regulations (PUWER) 1998

The following Health and Safety Executive (HSE) Guidance Notes are also applicable:

INDG367 Inspecting Fall Arrest Equipment made from Webbing (HSE publication)

DIN E2041 Factors of Safety in Scaffolds

Appendix 4 contains a list of the most relevant British and EN Standards relating to the equipment used during the implementation of SG4:00, of which the construction manager must pay particular attention to. The following British Standards are highlighted as the most appropriate to the application of SG4:00:

BS 5973:1993 Code of practice for access and working scaffolds and special scaffold structures in steel[24]

BS 5975:1996 Code of practice for falsework

9.3.1 European Normity (EN) Standard & CE Quality Mark

Testing to appropriate EN Standards (as listed in Section 9.3), and the CE marking is particularly relevant when considering the equipment that will be used during the SG4:00 function. This equipment will be explained in Section 9.4.1. Chapter 8 discussed the main pieces of fall-arrest equipment (PPE) that are used during SG4:00. Specifiers of equipment have a duty to ensure that all components of a safety system conform to the minimum EN Standards, and bear the CE marking.

9.3.2 The Work at Height Regulations 2004

The following Regulations and Schedule sections of the forthcoming Work at Heights Regulations 2004, apply to the implementation of SG4:00:

Regulation 2 – *Interpretation*
Regulation 6 – *Avoidance of risks from work at height*
Regulation 7 – *General principles for selection of work equipment for work at height*
Regulation 8 – *Requirements for particular work equipment*

SCHEDULE 2: REQUIREMENTS FOR WORKING PLATFORMS

Parts 1 & 2

Appendix 5 details the contents of the above sections of the Regulations. It is important to note that the above references may be subject to change as the regulations evolve through consultation and subsequent amendment; however they are accurate at the time of submission of this report.

9.4 SYSTEMS AVAILABLE

In order that SG4:00 is properly implemented, there is a requirement to use fall arrest equipment. Standard equipment under the guidelines is: full body harness, shock-absorbing lanyard, and a

[24] *In view of the forthcoming introduction of EN 12811 (anticipated 2004), an NASC working party has been re-writing BS 5973 in such a way that it does not conflict with the new European document. The rewrite end date was contracted as 13th February 2004. For further information see www.nasc.org.uk*

'connector', i.e. a means of connecting the lanyard to the scaffold structure. Harnesses are considered to be one of the most complicated items of PPE to use. Correct wearing and use of this equipment requires suitable training. Training specific to SG4:00 will be discussed further in Section 9.7.

During early implementation of SG4:00, appropriate PPE was not available to support the guidance given. This prompted manufacturers and designers to re-design existing equipment to cope with the risks brought about by introduction of the guidelines, such as clipping on at the feet. These are further described below.

Employers are legally obliged to provide the operatives with the right equipment to carry out their work in a safe manner. The responsible employer will be aware of the equipment and systems at his/her disposal, and should also be aware of innovations in specification that could improve safety. Since the introduction of SG4:00, industry members have attempted to pioneer equipment that will assist in the processes involved in this safety system. Various new technologies and techniques have been adopted by organisations within the scaffolding industry to attempt to prevent falls, or to reduce fall distances. The most prevalent systems are described below.

Above-head fixing clamps

These allow the scaffolder to secure lanyard hooks (above head height) at all levels without having to unclip the lanyard during operations in that area. The clamp is designed for attachment to scaffold standards (uprights), therefore is independent of the ledgers and transoms. The clamp is tightened to its attachment point in the same manner as standard scaffold fittings. These clamps can also be fitted to the scaffold uprights before they are brought onto site for ease of installation. (www.jordanclamps.co.uk)

Portable clamps incorporated into a lanyard

Similar to the clamps described above, this equipment is designed to attach to scaffold standards and horizontal tubes. It takes the clamp arrangement a stage further by incorporating the clamp within a shock-absorbing lanyard. Various forms of lanyard are available with this system; for example, an elasticated lanyard to reduce tripping and snagging hazards. The anchorage clamp is opened and closed around its attachment point and 'grips' the vertical tube as the scaffolder pulls down on it.

The problem with both of the above products is that SG4:00 states that the scaffolder should ***never*** clip to standards of a scaffold (see Section 9.8.1). Therefore, neither system complies strictly with the safety guidance that they were invented to facilitate. NASC recently carried out anchor point (dynamic load) testing on the clamp fitting whilst connected to a standard, which produced acceptable results. It is anticipated a future revision of SG4:00 could address the issue of clipping to uprights/standards, as a result of these tests. A full report of the findings of these tests will be issued by NASC in the near future.

Inertia reels/blocks

Early thinking in the methods described within SG4:00 was that a safer system would be to introduce a fast-response inertia reel as part of the installation. These reels are lightweight,

compact and are similar in construction, operation, and looks to a car seat belt. If used as part of the fall prevention installation, they could reduce the free fall distance of the scaffolder from the distance of a standard lanyard (typically 1.7m), to virtually zero (as the inertia reel is normally connected directly to the D-ring on the back of the harness, and not a lanyard). However, self-retracting lifelines, of which inertia reels are an example, should only be used up to a ***maximum*** of 40^{o} from the vertical position; any further than this will result in the faller swinging like a pendulum (pendulum effect) and increases, unacceptably, the likelihood of secondary strike injuries. Further, manufacturers' instructions usually require an overhead anchor and this is not always possible under the current SG4:00 guidance. Concerns expressed by industry during data collection were that dirt/foreign objects were liable to get into the clutch mechanism, which would lead to jamming and poor operation of the equipment.

All these pieces of equipment act as ***fall arrest*** and not ***fall prevention***, and are, therefore, further down the hierarchy of risk control. In an attempt to comply with the hierarchy, various forms of guardrails, that are installed on a scaffold 'lift' prior to personnel entering this workspace, have been developed. Commonly referred to as 'advanced guardrails', these systems provide the required fall prevention control for the scaffolders. The main benefits of these systems is that operatives are prevented from falling and, therefore, avoid the need to clip on whilst erecting or dismantling the scaffold. This, which could have a positive effect not only on the safety of the personnel carrying out the scaffold works, but also on the productivity of the operations. Advanced guardrails are still in their infancy within the industry, therefore not enough experience has been gained to reflect on the benefits and limitations. Industry experience is described in Section 9.6.

9.4.1 Selection of Equipment to Comply with SG4:00

Further to the generic selection factors described in Chapter 3, this Section describes what information the scaffolding industry requires when selecting appropriate equipment.

From views expressed during the focus group and interviews, awareness of innovation seems to be high and the scaffolding industry is quick to assess new equipment. It is clear that the scaffold industry is assisted by NASC (Section 9.5) who offer advice if it is available on new equipment. NASC also consult HSE on any matters on compliance with legislation.

With specific regard to PPE to comply with SG4:00, the scaffold industry has great experience of the various types of equipment available. Manufacturers and suppliers of the equipment have a responsibility to design and provide suitably usable equipment and should communicate and investigate industry needs. Scaffolders require as much freedom, as is reasonably practicable, to carry out their work. The use of PPE in many circumstances restricts the operative's movements, which can increase the likelihood of exposure to other risks, *or* increase the probability of cutting corners in safety matters. Within SG4:00 some equipment provides this freedom more than others, for example, above-head fixing clamps, and it is the responsibility of the employer to ensure that the most appropriate system has been specified to allow for the factors mentioned. By communicating with the manufacturers, the trade association, the suppliers, and most importantly those who are/will be using the equipment, the employers will be in a position to select the most appropriate equipment.

9.4.2 Manufacture

This Chapter does not describe a specific piece of safety equipment. SG4:00 is a safety procedure, and is relatively vague about what equipment should be used in order to satisfy its requirements. The main emphasis of the guidance is on personal protective equipment, with the following equipment prescribed as the ***minimum*** apparatus required for successful implementation of the guide:

- Safety helmet
- Safety footwear
- Full body harness, complete with rear dorsal ring
- Shock-absorbing lanyard (normally a fixed length of 1.75m)
- Opening scaffold hook (connector) for one-handed operation

Most of the PPE used in scaffold erection has more general usage and has already been fully described in Chapter 8.

This equipment, if manufactured to the Standards referred to in Section 9.3, and subject to appropriate inspection (Section 9.10) will satisfactorily perform the required tasks.

9.5 TRADE AND INDUSTRY ORGANISATION

The National Access & Scaffolding Confederation (NASC) is the national representative employers organisation for the access and scaffolding industry. NASC membership accounts for approximately 80% of the UK's total scaffold industry workload and is increasingly broadening operations within the European Community. One of the first significant achievements of the NASC was the original British Standard for Scaffolding, BS1139, issued in the early 1950s. Today, the NASC has over 130 members.

The NASC operates a strict policy of full compliance to all new legislation and its own code of conduct. Through an annual membership audit, NASC ensure that members uphold best industry practice[25]. Appendix 12 details the information sought by NASC during the annual audit of all member organisations. Persons interviewed during data collection believe that if clients are not specifying NASC members for access and scaffolding requirements, the chances of endangering the public, colleagues and the individual organisation is greatly increased. Assurances are provided by NASC as a regulatory body, that by using NASC members, clients can have the acquired the services of well-trained experts working to the highest standards.

NASC publish regular technical and safety guidance notes to ensure members always have access to the latest information. They also produce a variety of other vital information including an annual NASC Safety Report, regular general newsletters, and health and safety newsletters. Appendix 13 details the NASC's regional committee's.

Further information can be obtained from the NASC website: www.nasc.org.uk

[25] *NASC are currently modifying their audit paperwork and will present it to the NASC Officers for approval early in 2004.*

9.5.1 Prefabricated Access Suppliers' and Manufacturers Association (PASMA)

As the access and scaffolding industry is so diverse, with numerous forms of equipment available to the workplace, PASMA was formed independently from NASC to regulate the alloy access towers industry. This equipment is out-with the scope of this report.

9.6 INDUSTRY RECOMMENDATIONS FOR USE

From discussions with industry representatives during data collection, it emerged that the major point of contention with SG4:00 is the issue of clipping on. Recent research reports suggest that the worst-case circumstance for clipping on is at foot level, yet this would appear to be what SG4:00 is asking the operatives to do. The reports consulted for this information were:

- CRR 451/2002: Harness Suspension: review and evaluation of existing information (http://www.hse.gov.uk/research/crr_htm/2002/crr02451.htm)
- CRR 411/2002: Analysis and evaluation of different types of test surrogate employed in the dynamic performance testing of fall-arrest equipment (http://www.hse.gov.uk/research/crr_htm/2002/crr02411.htm)
- HSL/2002/16: Assessment of factors that influence the tensile strength of safety harness and lanyard webbings (http://www.hse.gov.uk/research/hsl_pdf/2002/hsl02-16a.pdf)
- HSL/2003/09: Survivable Impact Forces on Human Body Constrained by a Full Body Harness (http://www.hse.gov.uk/research/hsl_pdf/2003/hsl03-09.pdf).

As with most guidance, there is an issue of how the user of the guidance interprets the information provided. On closer inspection of the guidance laid down in SG4:00, and through industry-led experiences highlighted during site interviews, if the safe system of work within SG4:00 is properly put into effect it would require a minimal amount of clipping on (Section 9.8.2). For example, concerns were raised that personnel were required to enter a new scaffold 'lift' (i.e. a new scaffold level) unprotected by a guardrail, then bend down to clip their lanyard at foot level (thus increasing exposure to risk). However, progressing to the next platform and *then* clipping on at feet is not working to the guidelines set out in SG4:00 – the operative should clip on at the ledger above then climb up; *then* the connection is at foot level. Further examples of misinterpretation of the guidance were provided during site interviews, which would lead one to believe that problems stem from lack of/or inadequate training, rather than improper practice (Section 9.7). This issue was highlighted during site interviews when numerous members of the scaffold industry were asked, '*Where/when does SG4:00 have an influence on your work?*' The answers were many and varied, for example:

> "*2-metres and above; when the handrails are not in position; from the second lift upward; 4-metres and above*."
> (Various interviewees, 2003)

Again, this can be related directly to the training provided to the industry. This ambiguity of interpretation of the guidance is cause for concern and must be addressed by each organisation prior to carrying out any works involving the SG4:00 guidance.

The necessity for SG4:00 is a source of much debate within the access and scaffolding industry. However, regulation of this high-risk industry is necessary, a fact accepted by many:

> "*SG4:00 is definitely necessary; when you think back to what might've been in the past when we weren't using it, it is definitely necessary*"
> (Scaffolder, June 2003), and,

> "*I have experienced a fall and the system worked perfectly*"
> (Scaffolder, July 2003)

Statements like these were common during the site interview phase of data collection.

Various suggestions for improvements of SG4:00 were provided by industry practitioners during the site interview phase. The suggestions ranged from adopting wholly new safety procedures, to modifying the existing guidance, for example, by attaching to ***rear edge*** of the platform instead of the leading edge reduces a fall by approximately 1.5m. Some of these suggestions, from experienced practitioners, will be further developed in Section 9.6.1.

Section 9.8.2 describes the process involved in implementing the guidance. A crucial part of this process is the installation of a single guardrail to ***all*** non-working lifts of the scaffold – this protects the scaffolder at all times, i.e. during erection and dismantling. Many industry practitioners believe that the introduction of supplementary equipment, such as the advanced guardrail and the above head clamps could lead to a 'relaxation' in attitude to this crucial safety feature. This was highlighted during a site interview:

> "*Human nature dictates that dismantling a scaffold erected using the advanced guardrail system will not see scaffolders temporarily put in guardrails on non-working lifts. Advanced guardrails are not the panacea that…industry…seems to think they are; their use is very limited and the numbers of components required and their management/control is no small problem either. Further, the use of the above-head fixing clamp should not be encouraged by saying that it negates the need to put a single guardrail on non-working lifts, as it is maintained that this is a major safety feature of SG4:00*"
> (Safety Advisor, September 2003)

It is to be expected that all safety systems will have advocators and adversaries, based on individual or organisational experiences. The positive statements referenced above can be counterbalanced by equally negative statements, with just as much reasoned argument. These are discussed below.

9.6.1 Advantages and Disadvantages

Arguments for and against SG4:00 have been wide and varied from many areas of the access and scaffolding industry. This Section will provide the main advantages and disadvantages, expressed by experienced safety managers, site managers and operatives, from the industry data collection.

As previously discussed, SG4:00 in its current form is a good step forward for the access and scaffolding industry, but only covers façade scaffolds at this time. The guide also promotes the

use of harnesses, which do not protect the individual until a certain height (Section 9.8.2). However, as this guide is the industry standard, scaffolding organisations must incorporate a method of work using the principles of SG4:00.

Advantages

Having the system in place provides the users with more confidence when carrying out the scaffolding function. This is mainly due to being clipped on at times of exposure to the risk of falling (at unprotected edges). To this end, many operatives interviewed stated that they would rather have the system in place than not have it

The guidance hinders on-site operations, but is ultimately a safer system of work, therefore it helps because it is making the job safer

It provides a further safeguard for scaffolders and reduces risks to the operatives

Environmental issues do not affect implementation of the system. As the system is technique-based, with support from PPE, adverse environmental conditions, i.e. weather conditions, do not hinder employment of the guidance any more than they would hamper on-site operations in general

As SG4:00 has been in place for over 3-years, the system is viewed as the industry standard, and as such is becoming more accepted and less difficult to enforce on today's construction sites

Newer recruits to the scaffolding industry are positive about the guidance as they have not known any different procedure, which could have a knock-on effect to those within the industry who are reluctant to adopt the guidelines laid down in SG4:00

Disadvantages

In the organisations that apply SG4:00, it is difficult to get their scaffolders to comply with the guidance when others in industry sometimes ignore their legal obligations. However, the compliant organisations are still expected to compete on price

A problem with SG4:00 is the lack of take-up by smaller companies in the industry. This is further compromised by a lack of enforcement by local authorities, and the lack of resource of the HSE to take enforcement action against the numerous scaffold companies not making any attempt to work to the guidelines

If the operative were to clip on at foot level on the second lift (4m), the operative would still hit the ground in the event of a fall. This is because they will fall 2m, plus shock-absorber extension, plus height of the person

Scaffolders are constantly moving when carrying out scaffolding operations – they are rarely in the same place for any length of time. The industry has had to change their whole way of working to accommodate the guidelines. When the system is implemented correctly, it is estimated from numerous sources that it slows scaffolding production down between 20-50%.

Users view the system as an overly-repetitive series of clipping and unclipping

It affects not only the physical scaffolding, but also affects the administration side of operations in that organisations have more responsibility to record training, equipment used, etc. All of this has a knock-on effect on costs

Sometimes the harness gets in the users or passing operative's way and restricts their movement to a stage where they could be unsafe, i.e. lanyards are a trip hazard when clipped at foot level; they sometimes make a safer situation more dangerous because of this

The guidance gives inflexibility in the scaffolders workplace and restricts operative movement, which can be viewed as both detrimental (e.g. by restricting the worker's movements to within the confines of a lanyard length), and helpful (e.g. by arresting the fall of the worker) to safety considerations

Scaffolders have used one method their whole working life, and then are told to change it – this has proved difficult particularly for the older, and more experienced personnel

SG4:00 interferes with materials passage between lifts in that the harness pulls at the operatives when they are trying to move equipment and materials

Scaffolders not used to wearing PPE complain that they always know that they are wearing the equipment. Factors mentioned were; the harness is uncomfortable at the legs and the shoulders, but in order for the system to work properly, it must be a tight fitting. This could point to a training issue for wearing of PPE, or to the quality of equipment used by an organisation

The guidelines present further hazards, in the event of a fall, from secondary strike injuries, i.e. hitting the scaffold, or being pulled back into the scaffold structure in the event of a fall

The above information highlights the main benefits and drawbacks of implementing SG4:00 from those actually working with the system on a regular basis. Therefore, the examples given should be considered as typical examples of 'real-life' issues from those at the 'sharp end' of the industry.

9.6.2 System Use During Maintenance and Refurbishment

SG4:00 is intended for use during erection, alteration and dismantling of any façade scaffolding, thus is not confined to any one particular sector of the construction or engineering industries. Information collected during this research suggests that the principles of SG4:00 are as commonly used in maintenance and refurbishment as they are in new-build construction. The principles and techniques in the SG4 guidance do not change when used in different industry sectors and appropriate levels of monitoring and supervision (covered more fully in Section 9.10.1) are equally as important during scaffolding works in maintenance and refurbishment as they are in new-build.

9.7 TRAINING STANDARDS

Complex construction requires complex scaffolds. A less qualified workforce makes scaffolding operations more difficult. Access and scaffolding systems require comprehensive knowledge of

how specialised fittings and units are put together to erect a technically sound, safe and effective platform for people to work and construct from. The industry is mainly an outdoor occupation and is carried out in most weather conditions. Adequate training must be provided for scaffolding, and should include tasks where any risk to health and safety of operatives, or other persons affected by their actions. Scaffold work is physically demanding, therefore operatives require to be fit, have good hand-eye co-ordination, good organisation skills and have the ability to plan ahead.

Under NASC and CITB training courses, successful candidates of the CISRS are also awarded a National Vocational Qualification (NVQ). These offer registration to the Construction Skills Certification Scheme (CSCS) – the industry's largest skills register and benchmark for skills quality. This training involves periods of on-site experience, courses in training centres and an outward-bound course.

It is always important to consider who in the organisation will be carrying out a safe system of work, as the system selected may not always suit this type of individual. By looking internally to the employees when considering every safety operation, an organisation can identify the strengths and weaknesses it possesses, and tailor the training accordingly.

Training has become one of the most important aspects within the scaffold industry for all organisations. In order to become competent in the guidelines set out in SG4:00, the individual must first satisfy general scaffolding training. An overview of this training is provided below. Two courses are provided for general scaffolding skills taking the individual to NVQ Level 2 or 3, dependant on the course selected. Appendix 14 provides information on the training routes available for scaffolding training.

Training specific to SG4:00 would be carried out during this initial training, or on completion of the general scaffolders course. Specific training on the guidance should include the following requirements:

- How to inspect all PPE
- How to identify signs of wear and tear on the equipment
- How to appropriately wear the equipment
- When it will be required to clip to a secure anchor point
- What and where the secure anchor points are
- How to ascertain a protected platform to reduce the need for clipping-on the PPE

Adequate training in SG4:00 to supplement the general and/or advanced training previously provided to operatives is crucial in the development of a safer and more competent workplace. As the guidance is mainly diagram-based, this assists understanding of the concepts involved in adequate implementation of SG4:00. Plate 19 provides a typical example of the information contained within the guidance. The fact that the system of work involves PPE and is lower in the hierarchy of risk control, therefore increasing the risk of injury, should ensure that closer attention is paid to training provisions. How this training is given is organisation-specific. Due to the differing working practices to be adopted within SG4:00, industry must have some degree of flexibility when monitoring the effectiveness of the system. If operatives break rules on a regular basis, this indicates a need for further training or retraining. Habitual offenders should be

managed in this manner, with only an absolute refusal to adopt the safety system being reason for disciplinary action against an individual.

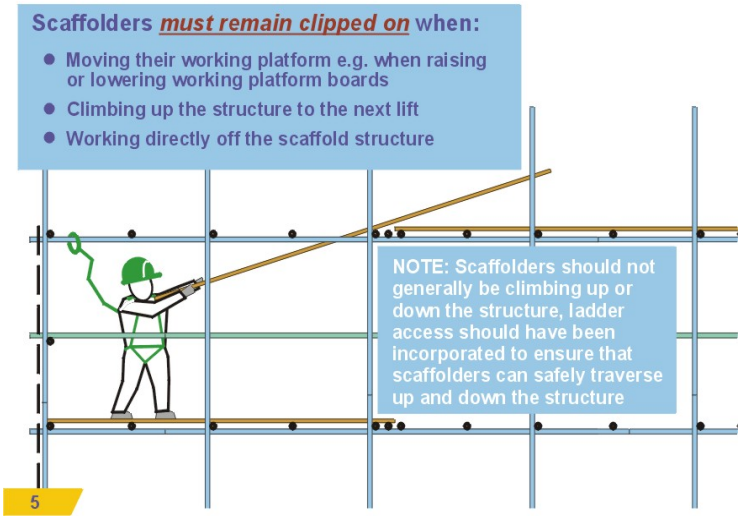

Plate 29: SG4:00 in pictorial format to increase understanding during training. All major tasks under the guidance are presented in this way

Proprietary scaffolding is being used more in industry and operatives are getting less experience of tube and fitting scaffold (particularly in Scotland). Training courses have all scaffolding systems included within their syllabus in order to qualify the trainee as a 'general scaffolder'. However, questions were raised during site interviews about whether this was the best use of the trainee's time, when they may only ever use one form of scaffolding out in industry. Suggestions on how to approach this problem were given, with the most common proposal being to train the trainees in the system most appropriate to their geographical area, i.e. Scotland has an approximate ratio of 80% system scaffolding to 20% tube and fitting, whereas England is almost the opposite of this.

Concerns were raised throughout the data collection phase on the level of training that can be achieved by relatively inexperience personnel in the scaffolding industry. Under current CITB training schemes, operatives can be trained from ages 18-21 to an advanced level, and be certificated (following assessment) as 'advanced' scaffolders. This concerns industry because these trainees have yet to gain the necessary on-site experience and practice. Competence of an individual can be said to equal Training + Experience. Employers should *not* submit inexperienced scaffolders for advanced assessments until they are completely satisfied that the operative has the necessary on-site experience to qualify.

The overwhelming consensus from all industry interviews was that everyone that SG4:00 involves, management, supervisors, etc., should be trained in the use of SG4:00. This enables all of site management to have as much responsibility for the monitoring of the system, as those who are actually using the guidance.

The amount of people and the amount of training that is required in the scaffolding industry on the guidelines of SG4:00 has been problematic for industry. The industry employs in excess of 12,000 employees, and struggled to cope with ensuring that all appropriate operatives were trained. Today, it is alleged that many scaffolders remain untrained in the sequence of the guidance. This brought further discussion from major construction contracting members of the Steering Group, when it was intimated that they had heard little, if anything, about the introduction of SG4:00 until it was published and 'landed on the desk'. This lack of industry awareness could account for industry's slowness in embracing the guidance.

Under current SG4:00 guidance there is no reference to, or requirement for, 'refresher' training in its principles. Again, this would be organisation-specific, and should be included within appropriate toolbox talks, safety newsletter, or other internal information medium to ensure that the training given is not undermined or forgotten.

Monitoring and supervision of the application of training will be covered in more detail in Section 9.10.1.

9.7.1 Access and Scaffold Industry Training Organisation (ASITO)

ASITO is made up of representatives of the NASC, the CITB, CISRS, employee representatives from the Transport and General Workers Union (TGWU), the Union of Construction, Allied Trades and Technicians (UCATT), and the Construction Industry Joint Council (CIJC). The aim of the group is to develop training to meet the needs of the industry.

9.7.2 Rescue

With any safety system or equipment, when someone falls there is the problem of rescue. During all site works, the practicality of rescue should be considered. As the essence of SG4:00 is PPE, the safety security lies firmly with the operatives carrying out the scaffolding works, and their actions during this time. SG4:00 explains that the requirements for emergency procedures should consider the main elements discussed in Section 3.3 of this report, and the following specific scaffold elements when making provisions for rescue during scaffolding operations:

- Number and experience of scaffolding teams
- The type of scaffolding structure

During the site visit phase, a series of questions on perception of rescue within SG4:00 were asked. The responses were varied, for example, there was almost a 50/50 split in the amount of people saying that rescue ***was*** an issue, with the amount saying rescue ***wasn't*** an issue. Supplementary to rescue information included in Section 3.3, the following responses were provided:

Rescue provisions very much depend on the type of job, and its location. No two scaffolding jobs are ever the same, and each must be treated individually to ensure they are afforded the conditions for rescue that is appropriate to that individual situation.

Training on the rescue for each specific site would be provided during site induction, and this training is a supplement to rescue training provided to the scaffolders during their basic training as described in Section 9.7.

Industry operatives have little experience of rescue using SG4:00, therefore little is known about the practicalities of this process. This could be viewed in two ways: one, SG4:00 is such a safe system that no-one falls when implementing the procedures in the correct manner; or two, the guidance has not been in widespread application long enough for the majority of industry to have experience of the feasibility of rescue. One interviewee asked, "*How many rescues have been carried out under SG4:00? Is it a real concern?*" Whichever reason is true, there remains a consensus that further thought must be given to rescue when using SG4:00.

There are various manufacturers of PPE rescue systems in the marketplace. It is the responsibility of the industry, with the aid of the regulatory authorities, to test and specify appropriate systems dependant on the specific site conditions. For example, Scotland has an approximate ratio of 80% system scaffolding to 20% tube and fitting, whereas England is almost the opposite of this.

9.8 INSTALLATION AND DE-RIGGING

The main contents of SG4:00 are the procedures for installation, alteration, and dismantling scaffold. Brief descriptions of these are provided in the next Sections.

Unlike other systems within the research focus, there is little choice other than to comply when considering SG4:00. There are few alternatives to what is considered to be the industry standard. Thus, the main issues contained within the guide will be described below.

9.8.1 Anchor Points

Section 9.1 states that the current version of SG4:00 covers independent tube and fitting scaffolding. One main difference between system scaffolding and tube and fitting scaffolding is that in system scaffold there are one-use components, e.g. a ledger is a ledger. In tube and fitting, tubes become ledgers, transoms, standards etc. With 3 or 4 different load-bearing couplings on a tube and fitting scaffold, a scaffolder could use the wrong one as an anchor point, for example using a swivel fixing instead of a double fixing. Therefore, attention must be paid to the various scaffold systems, and the allowable anchor points for each type when considering the safe system of work to be adopted.

From information contained within SG4:00, the following guidance is provided and should be followed at all times:

Always clip to (in preferential sequence):

- Ledgers supported with load-bearing couplers
- Guardrails supported with load-bearing couplers
- Transoms supported by the ledgers in the lift above fixed at both ends by single couplers

Never clip to:

- Standards (mention testing that was done recently)
- Ledgers supported with putlog or half couplers
- Ledgers or guardrails within a bay where it has a joint
- Guardrails supported with putlog or half couplers
- Transoms below the foot level
- Transoms when under slung below ledgers

When selecting an anchor point, case must be taken to ensure that the operation of the lanyard and shock absorber is not impeded.

9.8.2 Method of Installation

The following information is taken from SG4:00: scaffolding should be completed progressively with scaffolders installing a single guardrail on all lifts to provide protection whilst traversing and at work. Scaffolders *must* be clipped on when installing components outside of the guardrail. Traversing along scaffold elevations outside of at least a single guardrail must be limited to the maximum length of the material used, thus the maximum distance a scaffolder can traverse is 6.4m / 21ft.

9.8.3 Alteration Techniques

It is recommended that the single guardrail remains to ensure that scaffolders are protected when carrying out alteration works. Scaffolders should be working off a minimum 3-board platform (3 x 225mm boards) or more for wider structures when carrying out these operations

9.8.4 Sequence of Dismantling

All dismantling activities should be carried out progressively, reversing the erection process. Therefore scaffolders should work along the elevation removing the single guardrail and then lowering the boards from that section of guardrail to the lift below. Scaffolders ***must not*** remove the single guardrail from the whole elevation before lowering the boards.

Readers are also encouraged to consult NASC for further details.

9.9 MANUAL HANDLING

When considering safe systems of works that centre around physical activity, as is the case with SG4:00, manual handling is an important consideration. With any manual handling operation it is important to ensure strict compliance with the Manual Handling Operations Regulations 1992. The further down the hierarchy the system is, the more likely that manual handling will increase in importance. Further to the generic duties contained within Chapter 3, under these Regulations the following principles should be addressed by relevant parties who have responsibilities under SG4:00:

- Avoidance (of the hazards and risks)

- Reduce (exposure to the hazards and risks)
- Inform (the users of the hazards and risks present in order that they can plan for safety accordingly)

From information obtained during data collection, it becomes clear that SG4:00 does bring with it additional physical activity when compared to systems previously adopted by the access and scaffolding industry. It is, possibly, too early to tell whether this additional activity exposes the user to a greater risk of musculoskeletal disorders (MSD's) or other physical injuries.

The following comments were received directly from users (i.e. scaffolders) of the safety system during numerous site interviews:

> "*SG4:00 brings additional carrying of materials/equipment…there is increased bending below the handrail to receive materials*"
> (Scaffolders, June 2003)

> "*There is a definite effect on using SG4:00 in the form of increased back problems with bending down a lot more…The harnesses pull you when you're trying to move equipment and materials*"
> (Scaffolder, July 2003)

It is clear to see that the users are subject to increased bending below the single guardrail during transfer of materials. Quite whether this is purely inconvenience, or is having a detrimental effect on the physical well being of the users remains to be seen.

The reported problems associated with the safety system in relation to manual handling were not expressed by all interviewees. One user stated:

> "*There is no extra effort involved in using the SG4:00 practices*"
> (Scaffolder, May 2003).

Again, this could be a perception issue of one person/group experience of a system compared to another, and could relate directly back to training and competence. The answer to this question would require further and more detailed study and is out-with the scope of this report.

9.10 INSPECTION AND MAINTENANCE

The inspection and maintenance of appropriate PPE is discussed in general terms within Chapter 8. The specific procedures in this section, relating to equipment when being used under SG4:00, should be read in conjunction with those in Chapter 8.

There is not a large amount of equipment used during the function of SG4:00, regardless of which method of employing the guidelines is adopted. However, the importance of competent inspection and maintenance of what is used remains paramount. Thorough and regular inspection of each individual piece of equipment will highlight any defects, which must be corrected, or the equipment withdrawn.

Organisations operate in different ways. Some organisations issue the operative with the equipment, and deem this equipment to be their responsibility for inspection and highlighting of any defects out-with any audited inspection procedure (following appropriate training on how to inspect and identify defects with the equipment). Other organisations retain all safety equipment and issue it to the employees as and when it is required on site. This second approach may not be suitable for a busy construction site, with employees spread over various locations, or using sub-contractors.

Appropriate recording of the date that an operative is issued with PPE is required by every employer. This should form part of the individual's safety file that will be updated on a regular basis.

From information collated during site interviews, the following could be adopted as a typical inspection and maintenance regime:

- Every part of all of the equipment must be checked during inspections
- Equipment should be thoroughly inspected prior to issuing to operatives
- The equipment is inspected after every use (every evening if returning the equipment to storage)
- Daily inspections are carried out by the users
- 3 or 6-monthly inspections are carried out by supervisors (this will be recorded), and will be dependent on the manufacturers recommendations

In order that supervisors have the competence to thoroughly inspect equipment and record the findings (including recommendations for repair/replacement), they should have attended a training course suitable to the equipment. Again, this should be recorded in their personal training file.

All users of the equipment will have some responsibility for inspecting the equipment. The users must also be aware how to go about this, either by way of attendance at a suitable training course or by information passed through internal toolbox talks, etc. Equipment ***should not*** be used if there exists some ambiguity of its integrity.

It is generally believed that the basic equipment used in SG4:00 functions is robust and strong enough for the tasks in which it is employed *if* the equipment is stored, inspected and maintained in an appropriate manner.

PPE is the main equipment used in the guidance. Industry representatives have expressed a reluctance to consider repairing any damaged PPE, with the majority declaring that the equipment would simply be taken out of service and destroyed (Section 9.10.5).

For inspection and maintenance of supplementary systems within SG4:00 (above-head clamps, advanced guardrails, etc), procedures must be obtained and followed from the manufacturers. These procedures should then be incorporated into the maintenance schedule described above.

9.10.1 Monitoring and Supervision

The monitoring and supervision of SG4:00 is principally carried out on site. Industry must ensure that operatives are properly supervised, and are complying with the guidelines laid out in this safe system of work. It is recognised that many organisations in industry do have adequate safety monitoring systems. However, it is the implementation of these systems that would appear to be deficient. This point was constantly emphasised. For example, one interviewee said:

> "*The system is there; the implementation may be left wanting…We may have procedures in place, but the key is ensuring that they are carried out adequately at each stage*"
> (SHEQ Manager, July 2003)

The equipment used and safety system selected to execute SG4:00 is very visual, i.e. it is obvious when the guidelines are being properly implemented through inspection of the personnel's equipment, and their method of working. For example, most scaffolders in today's construction industry will be seen wearing a full-body safety harness at all times, thus it becomes simple to spot those who are not wearing one.

Monitoring of the guidance does not commence when construction commences on site. It is the responsibility of the site management team to ensure that the workforce employed on each site has undertaken training in SG4:00 prior to allowing works to commence. By ensuring that the training has been carried out, site management have the knowledge to assess the competence of the scaffolding workforce. When the works are being undertaken, the responsibility lies with the site and trade supervisors to ensure that the operatives are working to the guidelines. There should be a periodic audit to ensure that any new members to the site team are appropriately trained.

Through interviews with scaffold management personnel, who have been directly involved with accident investigation, it has become apparent that none of the accidents have ever involved an operative who was complying with correct practice. This is a training issue, but more importantly is an enforcement issue – if the workers know that non-compliance is not tolerated in the strictest possible terms, the likelihood is that short cuts will not be taken. Therefore, close supervision is required.

9.10.2 Maintenance of the Equipment

Further to the maintenance issues of PPE discussed in Chapter 8, it is clear that different safety systems require different equipment inspection and maintenance procedures. The user (i.e. the wearer) of the PPE has a responsibility to ensure that the equipment has at least undergone a visual inspection prior to every use. From this inspection, and the inspection regime laid down in Section 9.10, any defects in the equipment should be highlighted at the earliest opportunity.

Section 9.10 states that industry rarely would consider maintaining the equipment used in SG4:00 – instead opting for complete replacement. Evidence of this was presented in the following statement:

> "*if any major maintenance is required the equipment would simply be put in the bin; it's not cost-effective to maintain the equipment*"

(Scaffolders, June 2003)

The industry has to balance the safety requirement with the cost implications, but never to the detriment of safety issues. The fact that all interviewees indicated the instant disposal of damaged PPE would suggest that it is not cost effective to embark upon maintenance of the equipment.

9.10.3 Storage and Transportation

The procedure adopted for both storage of the equipment when not in use, and the method of transportation of the equipment from job to job will have a major impact on the condition and life of the product.

The nature of the site and the works will determine the provisions required for storage. If the scaffolders are employed within a refinery environment, or on large construction sites, with storage for equipment, the likelihood is that there will be adequate conditions for storage, and little requirement for transport of the equipment. With a more mobile workforce, the equipment is generally stored in the scaffolders workbag and transported from site-to-site. Some organisation's vehicles are purposely fitted with hooks in the rear of the vehicle for the equipment to be hung up. Secure and protected storage must be planned for and provided.

The following list is a typical example of procedures to be followed for storage of the equipment covered by SG4:00:

- The equipment will be removed by the operative and visually inspected for any defects
- If the equipment is dirty, it will be cleaned, in line with the manufacturers recommendations
- The safety harnesses and lanyards will be hung on a hook in a dry and ventilated room
- The equipment should not be left out in the rain and never dried over a heater
- The equipment will be visually inspected for defects prior to re-use

If the scaffolding works are carried out in potentially damaging conditions, for example, in petro-chemical plants, the equipment should be stored in 'separation' areas, to keep it apart from the general usage equipment, and will require special procedures to account for these circumstances.

9.10.4 Typical Life Span

Differing manufacturers of PPE suggest different lifespans on their equipment. The lifespan of the equipment will depend on the following factors:

- Frequency of usage
- Exposure to environmental elements
- Exposure to chemicals
- Nature/industry of use
- Conditions of storage
- Periods of inspection and maintenance

A recommended maximum life for a full-body harness and lanyard is 10-years from the date of manufacture, or 5-years from the date of first use.

When purchased as a 'kit', all equipment should be kept together for the lifetime that it is used. This will ensure that all parts of the system are compatible and will age at a similar rate.

9.10.5 Disposal of Damaged Materials

Disposal of materials deemed to be beyond repair should be given careful attention, as there is the possibility that this PPE could be picked up and re-used by inexperienced personnel. All fabric equipment, should be cut into small sections. Disposal of metallic components, e.g. the karabiners, D-rings, etc., should be detached from the equipment and disposed of safely.

All members of the workforce should be trained never to use any equipment that has either been discarded, or has an uncertain origin.

9.11 SUMMARY

SG4:00 is a significant step forward for safety in the scaffolding industry; however it does not address all safety hazards present during scaffolding operations. The guide covers façade, independent scaffolds, formed of steel tubes and fittings, and does not yet cover other forms of scaffold, such as proprietary scaffolds, birdcage, grandstands, etc. However, SG4:00 is subject to a full review at this time, with future SG4:00 guidance intended to serve as a complete guide to the management of risk whilst carrying out scaffolding operations[26].

SG4:00 is a safety procedure, and is relatively vague about what equipment should be used in order to satisfy its requirements. In order that SG4:00 is properly implemented, there is a requirement to use fall arrest equipment. Employers are legally obliged to provide their operatives with the right equipment to carry out their work in a safe manner. Various new technologies and techniques have been adopted by organisations within the scaffolding industry to attempt to prevent falls, or to reduce fall distances, for example:

- Above-head fixing clamps
- Portable clamps incorporated into a lanyard
- Inertia reels/blocks
- Advanced guardrails
- Pole systems (based mainly on technique rather than equipment)

Scaffolders require as much freedom, as is reasonably practicable, to carry out their work. The use of PPE in many circumstances restricts the operative's movements, which can increase the likelihood of exposure to other risks.

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[26] *NASC has begun a review of SG4:00 with the intention of publishing a new series of guidance. The revised document will give guidance to management and users. The new document will be a series of guidance notes based on the hierarchy outlined in Regulation 6 of CHSW Regulations 1996. This new guidance is anticipated to be published during 2004.*

The NASC is the national representative employers organisation for the access and scaffolding industry. Assurances are provided by NASC that by using NASC members, clients will be employing the services of well-trained experts working to the highest standards.

The industry has had to change its whole way of working to accommodate the guidelines. The necessity for SG4:00 is a source of much debate within the access and scaffolding industry. SG4:00 has been in force for over 3-years, the system is viewed as the industry standard, and as such is becoming more accepted on construction sites. Unlike other systems within the research focus, there is little choice other than to comply with SG4:00. There are few alternatives to what is considered to be the industry standard.

The principles of SG4:00 are as commonly used in maintenance and refurbishment as they are in new-build construction. The principles and techniques of the guidance do not change when used in different industry sectors.

Training must be provided for scaffolders. Adequate training in SG4:00 is crucial in the development of a safer and more competent workplace. The fact that the system of work involves PPE and is lower in the hierarchy of risk control, therefore increasing the risk of injury, should ensure that close attention is paid to training provisions.

Rescue provision should be considered in the planning of scaffolding works.

As a major focus of SG4:00 is PPE, a major element of safety lies firmly with the operatives carrying out the scaffolding works, and their actions during this time.

The support of this guidance from NASC has gone a long way to ensuring that the guidance is promoted within the industry, and its involvement with the current review of this guidance is further evidence that this industry body is pro-active in its role of governing the industry. This review is likely to be published sometime in 2004, and will include many of the systems that the original guidance did not, e.g. systems scaffolds, etc.

In conclusion, NASC SG4:00 is a positive start on the regulation of basic scaffolding procedures, and has been received encouragingly by many members of the industry. With continued support from key industry stakeholders, e.g. HSE, CITB, industry contractors, etc., the system will, it is hoped and expected, become industry normal good practice and be accepted by all scaffolders as the safe way to work. However, this will take time.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 INTRODUCTION

This final Chapter of the report will review the main, general outcomes of the research. It does not include the specific outcomes relating to individual types of fall protection equipment as these have been developed in detail in the appropriate system Chapters. It will include recommendations for industry and individual practitioners, for practice in the selection and use of fall protection equipment, and also, where appropriate, make recommendations for future research and development.

10.2 PROTECTION AND SELECTION HIERARCHY

Consideration of the hierarchy of risk control, recommended in the Construction (Health, Safety and Welfare) Regulations 1996 and to be expanded in the forthcoming Work at Height Regulations 2004, provides a clear route to be followed in the selection of fall prevention and arrest equipment. This proposes prevention in preference to arrest, and passive measures in preference to active ones. These principles suggest a definite ranking order in the selection of equipment, and this is represented in the diagram (Figure 1) reproduced below:

	Prevention	**Arrest**
Passive	**Guard rails to prevent falls, including rails on purlin trolley systems**	**Safety nets or Fall arrest mats**
Active	**Cable or track-based systems with attached lanyards too short to reach fall danger area (work positioning)**	**Cable or track-based systems (harness and lanyards) & SG4:00**

Figure 1 (reproduced from Chapter 3) – Traffic light selection ranking

The principles of the forthcoming Work at Height Regulations 2004 are:

Avoidance – avoid the need to work at height through designing out the work at height activity

Protection – through installation of guardrails or parapet wall construction to ***prevent*** the worker falling in the first instance

Arrest – if the above cannot be achieved, the fall must be arrested. All reasonable steps must be taken to ensure the potential fall distance is as short as is practicable, and the impact and suspension force on the faller is as low as is feasible. This area is broken down into the following distinct categories:

a) collective, global protection (e.g. safety nets / fall arrest mats) is favoured over;
b) active, individual arrest (e.g. harness and lanyard)

N.B. It should be noted that safety decking also removes the risk of fall, without action by the operatives; though this equipment is not yet included in the report.

According to the hierarchy, methods of fall protection are methods of prevention, requiring action by the operative, or methods by arrest, requiring no action. This seems to suggest that these types of methods are of equivalent value. However, in most circumstances, logic and experience suggest that methods requiring positive action from the operative are more likely to lead to injury, resulting from lack of training or supervision, than methods providing fall arrest. Thus, where other considerations, such as interface with the activities to be carried out, do not suggest otherwise, fall arrest mats or nets are preferred to harnesses with restraining lanyards and cable or track.

The hierarchy suggests that, potentially, the most 'dangerous' methods covered in this report are those relying on arrest by personal protective equipment, i.e. harnesses and lanyards. The dangers inherent in the possibilities of inadequate or inadequately maintained equipment, inadequate training and inadequate supervision, and deliberate or forgetful failure to wear the equipment, are too high to ensure this equipment is considered only as a last resort.

10.3 OTHER CONSIDERATIONS IN EQUIPMENT SELECTION

The conclusions above must be qualified by reference to the many other considerations in the selection of equipment. There will always be circumstances in which choice of the safer equipment type will be prevented by:

- the nature or duration of the tasks to be carried out;
- potential impact on the permanent, or temporary, structure, including the fragility of the working surface;
- the nature of the immediate work environment; or, even

- availability of the preferred equipment.

Cost, if the cost effects of equipment choice are significant in relation to the value of the activity requiring fall protection, will also be a factor in selection.

There are situations, exemplified in the previous chapters, in which the tasks demand that operatives work in locations in which there is significant risk of a fall, or are not protected by the most desirable equipment (under hierarchy guidelines). Like all safety management decisions, selection of fall prevention and arrest equipment is subject to the qualification of what is 'reasonably practicable'. However, this condition must not be seen to exonerate the manager, in the event of an accident, and selection of a less safe option should increase the pressure to ensure that all other aspects of fall protection are fully explored in the planning and operation of the equipment[27]. In these situations it is vitally important that the selection of fall protection equipment is seen as a part of an integrated process of fall protection, including:

- adequate method statements, risk assessments and safety plans; including
- plans for rescue of fallers
- dissemination of appropriate technical information about the equipment, particularly concerning its care, installation, use and limitations
- planned operative and supervisor training
- presentation of all information and training in a readily assimilated form, taking account of the intellectual and linguistic capabilities of the audience
- planned and audited equipment inspection and control; and
- other appropriate supervisory and management actions before, during and after the use of the equipment

Additional issues in equipment selection, that have been treated at some length in this report, include:

- interaction with the structure, permanent or temporary
- interaction with the work operations (influence on ,or influence by)
- interference with, or by, material storage
- installation and removal procedures and problems
- knowledge and experience needs in personnel
- storage and maintenance requirements
- aesthetics, in the case of permanent maintenance equipment; and, importantly to client and contractor
- direct and indirect costs

10.4 SELECTION PROCESS AND SAFETY PLAN

The process of selection should consider all the factors above. In many instances, some of the factors unrelated to safety can be dealt with relatively superficially because it is clear that they will have little bearing on the eventual choice. However, a structured process of selection, using

[27] *The Work at Height Regulations 2004 determine that systems lower in the hierarchy, for example PPE, require to be justified as the most practicable safety system for the works at hand.*

the factors as a checklist of issues to be considered will ensure that nothing important is neglected. A simple option evaluation chart, in the form of a table, matrix or spreadsheet of collected information or experience, with options along the 'x-axis' and a checklist of issues down the 'y-axis' (Figure 2) can assist this process. It will also provide additional, project specific evidence to add to the construction health and safety plan.

Factors (sample)	**Safety Nets**	**Fall Arrest Mats**	**Cable & Track Systems**
Safety hierarchy	*Table completed with information on each option from technical data, work programme, method statements, past experience, etc.*		
Interaction with work			
Erection and removal			
Cost			
Final decision			

Figure 2 – Option Evaluation Chart

10.5 MAINTENANCE

The selection and use of fall protection equipment for maintenance should be seen in two parts:

- selection of access equipment, or provision for equipment, during design; and,
- selection and use of temporary equipment in short-term maintenance planning and operation

Consideration of all foreseeable maintenance activity should be a fundamental part of the design process and embrace, as far as possible, contributions from the client, building occupier and maintenance contractors. Risk of falls is high in maintenance activity due to the temporary, short duration and often precarious nature of access arrangements for the task to be undertaken. Intuitive, as well as formal risk assessment is a function of severity and duration and there is always a great temptation to run unacceptably severe risk, if the duration is short. Many of these risks can be designed out or considerably mitigated, if the tasks are foreseen and facilities for appropriate fall protection equipment designed into the building[28].

All parties to the design process can contribute, through design risk assessment, to this objective and designs should not be signed off until a complete evaluation of maintenance activities has been achieved. As well as contributing to height safety, it is a vital part of all health and safety operational planning; and has a considerable economic benefit to building life cycle costing, if maintenance activity is anticipated and resources properly planned[29].

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[28] *The following information can be used to aide the design process:*
Construction Industry Council's 'Safety in Design' guides: www.safetyindesign.org
CDM: Designers can do more: www.hse.gov.uk/construction/designers
HSE designer self-help group: www.cdmdesigner-manager@webcommunities.hse.gov.uk
CDM Work sector guidance for designers C604: www.ciria.org
Iddon, J. & Carpenter, J., CIRIA C611: Safe Access for Maintenance and Repair, ISBN: 0860176118
See footnote 2: DTI PII 2002 publication; BRE34 'A radical approach to designing out health and safety risks in roofing'
Designing out risk was also incorporated in the recent Designer Awareness Days (DAD)

[29] *CDM planning and designer issues are explained in detail in forthcoming HSE Research Project 4375 R68.075*

A further, important dimension of building maintenance pre-planning is the communication of adequate information on the specification, maintenance and operation of any permanent fall protection equipment for building maintenance access, such as cable or track systems. Further, provision for the installation of temporary fall protection equipment provided in the building design and construction must be properly communicated to all appropriate parties. This is an essential part of the health and safety file, which must be kept in an accessible form and location; and disseminated wherever and to whomever is appropriate. This provides a difficult and continuing training task as the personnel requiring protection may change frequently over the life of the building.

Short-term maintenance planning and operation, by its very nature, often attracts inadequate attention. It also frequently involves the use of equipment, such as ladders and MEWPs, which are not subjects of this research (see footnote 21; CIRIA C611: Safe Access for Maintenance and Repair). Selection and use of any of the systems studied in this research should be undertaken with consideration of all the issues addressed in the chapters on the specific equipment.

10.6 FURTHER RESEARCH

Variety of types of equipment and new features in existing equipment are changing rapidly. Improvements to existing equipment, such as advanced guard rails in scaffolding, and new approaches to fall protection, such as safety decking, are likely to render some conclusions of this report out of date.

The treatment by HSE of 'falls from height' as a priority area and the introduction the new Work at Height Regulations 2004 is likely to further accelerate the technological development of access methods, for example podium towers as ladder substitutes, and fall protection equipment.

In this climate of rapid change, it is important that information and advice to industry is kept up-to-date. This report, and any publication of industry guidance resulting from it, should be reviewed and updated regularly.

The choice between active fall prevention, restraining line and harness, and passive fall arrest mats or nets, seems logical, on the bases outlined previously. However, further study of real experience, particularly the consequences of fall accidents involving safety nets and fall arrest mats, could alter this conclusion in some circumstances, for example where rescue is problematic or where falls into the arrest medium are at the higher end of the acceptable range.

There are other areas where real experience should be the subject of further collection of information. Air mats, soft-filled mats and safety decking are relatively new innovations and frequently options for the same situation[30]. Longer experience of these systems will add to the facility to choose the best available option, providing this experience is collected and made available in a comprehensive and balanced way. Some form of incident reporting and analysis of

[30] *Hybrid systems, i.e. using 2 safety systems in conjunction to provide optimum protection, were suggested as a recommended practice in some work situations. Anecdotal evidence of using safety nets and purlin trolley systems, or safety decking and soft-filled mats were provided during the research. However, it is acknowledged that this is not custom in practice on sites at this time. This research suggests that further research be carried out in this area.*

falls, both injurious and non-injurious, involving these systems – and indeed any others not yet being marketed – would be very useful for this purpose.

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Fall Arrest Safety Equipment Training (FASET) – www.faset.org.uk

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Institute of Maintenance and Building Management (IMBM) – www.imbm.org.uk

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National Access and Scaffolding Confederation (NASC) – www.nasc.org.uk

National Federation of Roofing Contractors (NFRC) – www.nfrc.co.uk

Personal Safety Manufacturers Association (PSMA) – www.hasg.org.uk

Precast Flooring Federation (PFF) – www.pff.org.uk

Working Well Together (WWT) – www.wwt.uk.com

APPENDICES

APPENDIX 1

FOCUS GROUP DATES AND ATTENDEE'S

APPENDIX 1

Focus Group 1 – Fall Arrest Mats

The group met on 17th October 2002 at Glasgow Caledonian University. Representatives from industry who attended the meeting are listed in Table 3. Members of the air fan industry were invited to this meeting but were unfortunately unable to attend due to other commitments. However, the research team met with these industry stakeholders during the series of industry interviews. The focus group analysis was distributed to them with the opportunity to provide feedback on the issues raised.

Table 3 Participants in Focus Group 1 – Fall Arrest Mats

Name	**Organisation**	**Occupation**
David Burgess	Precast Flooring Federation (PFF)	Chairman of Health and Safety Committee
Colin Hutchinson	Airtek Safety Ltd (formerly Airmat Safety Ltd)	Managing Director
John Duggan	Airtek Safety Ltd/National Federation of Builders (NFB)	Chairman of NFB
Chris Price	Forest Safety Products	Sales Director
Sue Price	Forest Safety Products	Company Secretary
Murray Padkin	Bison	Airmat Manager
Graeme Middleton	Kier Scotland	Site Manager
Harry Crawford	National Engineering Laboratories	Formerly of NEL, Harry now works as an Engineering and Design Consultant

Focus Group 2 – Fall Arrest Nets

The group met on 12th November 2002 at Glasgow Caledonian University. Representatives from industry who attended the meeting are listed in Table 4.

Table 4 Participants in Focus Group 2 – Safety Nets

Name	**Organisation**	***Occupation***
Chris White, MBE	Ogilvie Construction	Health and Safety Manager
Malcolm McIntyre	***Bovis Lend Lease***	Chief Health and Safety Manager
Peter Conway	Kier Scotland	Health and Safety Manager
Martin Holden	Health & Safety Executive	HM Principal Specialist Inspector
Malcolm James	MJ Consultancy	Private consultant in health and safety
Dave Collins	Huck Nets	Sales Manager
Gary Price	Higher Safety	Contracts Manager
Mark Stephen	Rigblast Group	Access Safety Supervisor
Neil Harrison	Track International	Project Manager
Scott Gartshore	Laing / O'Rourke	Safety Adviser
John Bissett	CITB National Construction College	Senior Training Advisor

Focus Group 3 – Purlin Trolley Systems

The group met on 12th December 2002 at Glasgow Caledonian University. Representatives from industry who attended the meeting are listed in Table 5. Manufacturers of both purlin trolley systems included within this report were in attendance.

Table 5 Participants in Focus Group 3 – Purlin Trolley Systems

Name	Organisation	Occupation
Ian Whittingham MBE	H&S Consultant	Specialist speaker height safety and accident (high fall) victim
Malcolm McIntyre	Bovis Lend Lease	Health and Safety Manager
Peter Conway	Kier Scotland	Health and Safety Manager
John Shelton	Health & Safety Executive	HM Inspector of Health & Safety
Bill Price	WF Price Roofing	Managing Director
Robbie Price	Jayeff Ltd	Manufacturing Director
Paul Bridges	CA Group	Divisional Director
Brendan Dowd	Rossway Dowd Ltd Roofing Contractor	Operations Director
Jerry Dowd	Rossway Dowd Ltd Roofing Contractor	Business and Development Manager
Mike Baldwin	Sala Group	Commercial Director
Kenny Fraser	Glasgow City Council	Senior Health and Safety Officer
Alex Owens	Grainger Building Services Ltd	Director
Duncan McNicol	Bonnington Contracts	Safety Officer

Focus Group 4 – Cable & Track-Based Safety Systems

The group met on 13th February 2003 at Glasgow Caledonian University. Representatives from industry who attended the meeting are listed in Table 6.

Table 6 Participants in Focus Group 4 – Cable & Track-Based Safety Systems

Name	Organisation	Occupation
Malcolm McIntyre	Bovis Lend Lease	Chief Health and Safety Manager
Peter Conway	Kier Scotland	Health and Safety Manager
Mike Baldwin	Sala Group	Commercial Director
Bob Murdoch	Troll / Bacou Dalloz	Technical Sales Manager
Pete Ward	Spanset	Height Safety Manager
Nick Hayes	The Access Group	Director
Phil Boyce	Prime Fabrications	Contracts Manager
Stuart Linnitt	Tractel Training Solutions	Training Manager
Alex McLatchie	Anchorman	Contracts Manager
Simon McLuckie	Scorpio Safety Systems	Sales & Marketing Executive
David Grub	Scorpio Safety Systems	Director
Dan Lavery	Adrain Safety Management	Health & Safety Consultant
David Riches	Safety Squared	Consulting Safety Engineer
David Gleave	Saferidge	Director
John Reid	Jarvis Workspace FM Ltd	Health and Safety Manager

Focus Group 5 – Safety During Scaffolding Works – SG4:00

The group met on 13th March 2003 at Glasgow Caledonian University. Representatives from industry who attended the meeting are listed in Table 7. Analysis of the transcription was distributed to NASC's Health and Safety Committee for review and comment.

Table 7 Attendees at Focus Group 5 – Safety During Scaffold Works – SG4:00

Name	Organisation	Occupation
Peter Conway	Kier Scotland	Health and Safety Manager
Chris White	Ogilvie Construction	Health and Safety Manager
Colin Wilkie	CITB National Construction College	Training Manager
Linda Cowen	Health and Safety Executive	Administrative Support
Dr Barbara Marino Duffy	ARUP Project Management	Planning Supervisor
Gavin Watson	SGB	Safety Adviser
Mike Spain	Bacou Dalloz	Area Sales Manager
Mark Clarke	Bluestone plc	Senior Health and Safety Manager
Adam Campbell	Jordan Safety Services	Director
Tracey Campbell	Jordan Safety Services	Director
Phil Hinch	Lyndon Scaffolding plc	SHEQ Manager
Ronnie Cheetham	Safe Access Scaffold Inspection Ltd	Director
Gary Gallagher	Turner Access	Director
Jim Hooker	Interserve Industrial Services Ltd	Regional Safety Advisor
John Dick	JD Scaffold Ltd	Director
Kenny Fraser	Glasgow City Council	Senior Health and Safety Officer

Focus Group 6 – Safety During Maintenance & Refurbishment

The group met on 10th April 2003 at Glasgow Caledonian University. Representatives from industry who attended the meeting are listed in Table 8.

Table 8 Participants in Focus Group 6 – Safety During Maintenance & Refurbishment

Name	Organisation	Occupation
Hedley Horsler	Health and Safety Executive	HM Principal Inspector
Alistair Stewart	Institute of Maintenance & Building Management	Member of IMBM and maintenance & refurbishment contractor
Jamie Stewart	Institute of Maintenance & Building Management	Member of IMBM and maintenance & refurbishment contractor
Kenny Fraser	Glasgow City Council	Senior Health and Safety Officer
Simon McLuckie	Scorpio Safety Systems	Sales & Marketing Executive
Dr Barbara Marino Duffy	ARUP Project Management	Planning Supervisor
Bob Curwen	British Nuclear Fuels Ltd	Project Manager
Ian Cruden	British Nuclear Fuels Ltd	Resident Engineer's Safety Officer
Alistair Aitken	Paterson Safety Anchors Ltd	Director
Ross Dover	Bonnington Contracts	Senior Quantity Surveyor
John Bissett	CITB National Construction College	Senior Training Advisor

Focus Group 7 – Safety Decking

The group met on 18th November 2003 at Glasgow Caledonian University. Representatives from industry who attended the meeting are listed in Table 8.

Table 9 Participants in Focus Group 7 – Safety Decking

Name	Organisation	Occupation
Hedley Horsler	Health and Safety Executive	HM Principal Inspector
Jim Purdie	Ramoyle plc	Health and Safety Manager
Mark Sims	HL Plastics Ltd	Health and Safety Manager
Roger Hicks	Tarmac Safety Deck	Health and Safety Manager
John Black	Oxford Safety Components	Director
David Black	Oxford Safety Components	Director
Jackie Horsewood	Wenlock Health and Safety Ltd	Health and Safety Consultant

APPENDIX 2

FOCUS GROUP ANALYSIS

APPENDIX 2

The following information details feedback to the focus group attendees taken directly from the verbatim transcriptions.

FOCUS GROUP 1 ANALYSIS – FALL ARREST MATS

CLASSIFICATION OF ISSUES

GENERIC ISSUES

Cost

Cost is a significant factor in the equipment selection process
Cost is the major barrier – too many organizations operate by the 'bottom line'
Smaller organisations will be more problematic in relation to costs (cutting corners)
Culture is changing in relation to costs
Passive systems are more cost-effective than is generally thought

Client's Role

Clients should assume a greater role – there exists little client support for safety systems
Client specification is influencing industry culture and should be embraced
Clients should be taking greater steps to promote and police health and safety

Culture

Safety culture is still not fully accepted in industry
A reactive culture exists to accidents and proposed safety systems
It's about developing the culture in industry
Industry culture is changing for the better
All connected industries have a role to play in the required culture change
Progression and acceptance of the passive system is the way forward

Planning

Quality of planning and workmanship leads to accidents (if it is not of sufficient quality)
The Planning Supervisor function is not effective in its' current form
Proper planning is the key – safety issues should be tackled at the development phase
The system can be utilised in many industries if it is embraced at the planning phase
Proper planning of the integration of the passive system can lead to increased productivity

Design Influence

Designer influence should be throughout the whole process

Supply Chain Issues

Cohesion between integral members of the supply chain is essential

The system is being constantly modified following ongoing testing and end-user feedback

Governmental Responsibility
Government and Parliament have crucial roles to play in this industry with regards to legislative influence on organisations to take cognisance of safety systems

GENERAL & SPECIFIC ISSUES

Incidents / Accidents
Reportable incidents are on the increase due to the measures put in place in the method statement
How many unreported incidents are there in industry today?

Monitoring and Policing
Policing is crucial – policing of safety systems is the key
Policing is a hidden cost that is rarely considered
Installation and training control by the suppliers and manufacturers is a key policing tool
Policing and training on an ongoing basis will only improve industry
Policing must be thorough and hands-on
Reason for the contractors selecting the complete specialist packages – the policing aspect
Proper use of the system stems from proper policing
FASET-approved installers do not guarantee quality installations – policing remains crucial

Training
There exists an industry skills shortage
Training of personnel and policing is of paramount importance
Lack of training in use of the equipment will ultimately lead to accidents
Industry needs education on an ongoing basis
Trained installers are the only individuals allowed to install these systems
Consistency of training and policing is essential
Communication of information to end-users is required

SPECIFIC ISSUES

Versatility of System
Positioning of the system when in use is simplistic
It is a very flexible and versatile system
Simplicity is a major factor with the fall arrest mat systems
There exists potential advances in technology – the introduction of the computer chip
Passive systems are becoming popular and are more simple than active system
The system is flexible and versatile enough to cope with on-site intricacies

Injuries
Reduces incidence of ‘secondary strike injuries’

Complete Safety Package
Package by registered installer – install, maintain, inspect and control

Tighter quality control is a benefit
Professionally competent personnel using this equipment will increase safety
Full installation service is preferred form a contractor's view
Appropriate quality management systems will assist the process

Psychological Factors
The soft landing and the 'carpet' effect provides a positive psychological reaction by those relying on the system

Forming a new Regulatory Organisation
Establishment of a recognized regulatory authority – a body to promote best practice
Industry regulation for product quality
Industry is moving quicker than the legislation – a regulatory authority would embrace this
Any authority would require to be holistic in its approach

Personal experience of falls
User perception and acceptance of passive systems

Lessons learned – factors affecting falls
Accepted risks of industry
Negativity to working at height
HSE are aware of these problems, yet still appear to favour active systems as opposed to passive
Different hazards exist for various phases of works on site

Issues in selection of equipment
Ease of use of the system – simplicity
The reliance on an individual to do something is mitigated with passive protection
Suppliers and installers influence industry
Health and safety is looked upon as a last resort in most circumstances
Insurance companies have a responsibility

Consistency – any instances of vetting contractors through the Planning Supervisor and insisting on using passive technologies
CDM's deficiencies are becoming more apparent
Health and safety plan – purely a paper exercise?
Increased vetting of the method statement is required within the whole industry

Exploring cost issues further
First costs are the most relevant – having to spend money at all
Industry believes in: the smaller the outlay, the better
There is a lack of knowledge on whole cost benefits
Equipment testing is important
Harness failures during testing prompted PFF to switch to 100% passive fall protection

Knowledge required on whole life costs for equipment by way of a cost model
Planning and cost estimation are at the forefront of most profit-making organizations
Passive protection package – hire, install, maintain and remove
Cost control

Cost analysis should be looked at in terms of long-term expenditure
The crucial cost issue is the life cycle cost
Product quality control over the whole lifetime
Industry-recognised insurance schemes are available for trained organizations
Recognized industry body is the way forward (e.g. FASET)
Client confidence in registered organisations

Barriers prevention correct use of fall arrest equipment
Greater control of product development
Human factors – short cuts are inevitably taken
Increased quality of service delivery
Installation – a system is only as good as its installation
Certification for quality control

Ongoing inspection in terms of testing
Lack of regulatory guidance in passive fall arrest
General health and safety legislation is used at present
The onus is put onto the installers to ensure their method statement and safety management systems conform to relevant legislation

When are fall arrest mats an obvious choice
Their compatibility with other systems is an advantage
Tested to, and used at, 6m fall distances
Mats breed confidence – positive psychological factors
Space management of the area below
Positive effects on site conditions
Rescue times and procedures are favourable

How do mats impact on the general culture of risk taking
It's a question of attitude
There are limits to the level of misuse
End-user appreciation is evident – increased morale and culture improvement in attitude

Examples of over-confidence and 'tom-foolery'
No examples of any significant laxness in attitude
Mats promote a more cautious attitude
Workers are more confident with the system in place
The matting system is diverse and can be adapted to most situations
Mats aren't always the answer
Not recommended for heavily compartmented structures

With a heavily modularised building are wall heights an issue
If the supplier/installer is involved early enough in the design and construct phase, problems can be negotiated before on-site works commence

Can proper planning and forethought be dealt with?

There appears to be a move towards mats in industry

It is important that safety systems are considered at project management level
The mat system is adaptable to be used in 'site-specific' conditions
New innovations in the mat technology – from end-user feedback
Minimal installation time

Can we direct the above topics to the soft-filled mats system
Designed principally for domestic housing sector

Air-filled vs. soft-filled

Building design issues
The buildings should be designed to be built

Applications for mat systems to be used in maintenance and refurbishment industries
There is scope for usage in these industries
The is a requirement for a system of this nature in many other industries
Potential usage of mats in the demolition industry
Global protection should be considered before individual protection

Is manual handling an issue in relation to mats?
There is constant development of the system components
Soft-filled mats are extremely light and are fitted with handles for ease of movement

Productivity – does this system slow down operations?
It speeds things up as the operatives are not physically attached to a fixed point
Integration of all members of the construction-phase will assist

Height barriers
Tested and accepted by HSE for a 4.4m fall distance

Perception of height and risk
An apprehension exists with an open-net system when the ground can be seen
The serviceability of the mats and their robustness are main advantages

Fan technology for air-filled systems

Regulation of air
Regulation of air is not relevant!
The system is designed with impact in mind

Is over/under inflation a problem?
No major problems experiences – the industry is learning from other industries

Suggestions for the final guidance

Inspection regimes
Extract information from industry to input into guide
Specific details on each safety system should be included

Must contain workable and usable information
Guidance for repair of used/damaged mats

Formulation of a Fall Arrest Mat Regulatory authority
Self-regulation already exists
Promotion of industry's opinion/perception of mats is essential
There is an ongoing review of current regulations in relation to passive fall arrest
HSE must be involved
Mat certification to European quality criteria is the next step
Progression is the key

Final thoughts

How to keep the information updated
Reliability of information is essential
Accreditation of products and their users is also necessary
A national database is a logical way forward
A recognized standard for testing and specification is a recommended step
The position of a falling person is not universal – safety systems must account for this

FOCUS GROUP 2 ANALYSIS – SAFETY NETTING

CLASSIFICATION OF ISSUES

GENERIC ISSUES

Cost

Cost considerations prevented nets being used in the past

Cost: is the bottom line for most organisations
is the first consideration - unless there is an organisational policy decision – e.g. to always use passive fall protection
is very important - but if the client doesn't support our safety policy, walk away from the work
of nets through misuse - e.g. dropping large elements into the net
comparisons with all other systems – not just other nets

Potential saving of 10% of roofing cost by using safety nets - in the actual speed of the people working above

Can companies (particularly small) afford to walk away from work?

Set out rules at tender stage - price for nets or equivalent (safe) methods

Sometimes QS's try and procure work without specifying whole package

Cheapest installation will undoubtedly get a second-rate installation

Safety method statements and risk assessments should consider that nothing should fall

Client's Role

Document has got to have a section in it somewhere that talks about the client's responsibilities

Educate the clients that if we do the system properly they are going to save money

Tell the client that we want to save lives – give them the right approach; it can make a big difference.

Culture/Behaviour/Attitude

Particular problem in Scotland 'The Braveheart Syndrome'

Behaviour – 75-80% of our accidents have got a behavioural issue of the individual involved

Behaviour – in IRATA we had to get mental conditioning of rope access people to do the right thing – three-year reviews were built in, from the very beginning

Behaviour/attitude – we all take short cuts, unless the mental attitude is to always do the right thing

Attitude/culture – "we have never done it like that, we don't need to do that; this the way that I have always done it"

Culture/control - it's the company at the top that gets the flack, when these sub-contractors shouldn't be on there doing the job in the first place (vetting)

Safety is down to attitude as well as training

Planning

RA – compare risks from every system – e.g. number injured erecting and dismantling scaffold are probably higher than those using nets

Planning/RA – what they are actually doing at the time of the potential fall, e.g. using cutting equipment
Co-ordination – the problem is bringing all the disciplines together early enough
Knowledge management: same project team, same sub-contractors making the same mistakes
re-invent the wheel – many organisations don't keep MSs and RAs – must learn for the next job

Design Influence

Research into means of anchorage and loading of net anchorage (Martin Holden – HSE)
Anchorage loads: can be significant, if you take what's written in the Standard.
research is being done to try to identify accurately what the loads are
Design: designers don't understand, or even look at, anchorage loads when nets are selected
designers should be informing the net erector on anchorage points and safe loads
standards for netting has a set of loads on the basis of the greatest that could occur
over-design – maximum load for 7m fall – on nets less than 2m high this is very much reduced – industry now in the process of determining anchorage loads for 2m fall
anchorage points are provided at the design stage – many benefits – requires decision at the design stage what the protection system is going to be
major design implications – if temporary works people and design team know nets are going to be used so they design temporary bracing that is not going to affect it
Design/planning – steelwork punched to attach the nets – back to CDM – built in at design stage

Supply Chain Issues

Planning/supply chain management – different ends of the supply chain need to talk to each other

Governmental Responsibility

(See 'Forming a new Regulatory Organisation' – later)

Other

Working conditions/housekeeping - a trip or a stumble into a safety net

GENERAL & SPECIFIC ISSUES

Policy

Policy for any working at height as the first priority - nets
Policy for sub-contractors – nets as a first priority

Monitoring and Policing

Safe number over nets – FASET have come up with 3 over any individual net (M Holden)

Training

Training: users, (must be made to) realise the limitations of nets
danger of untrained rescue person handling somebody with serious injury with safety nets it looks so simple
intelligent net installers required
clients/customers who know what they are looking for – if end-user doesn't know what that net is there for, invariably it gets abused

Inspection/training: the vast majority of users haven't got anybody in house that can inspect
courses on nets inspection and use for managers – difficulties in obtaining information and access
Training/communication – FASET document (planned) – what can and can't be solved with safety nets
Supervision/training – lot of companies see the nets as a storage area or a debris protection netting – need to train people what nets are for
Education and training for construction managers and those actually working above the nets
Education – the more site management teams know about nets, the more the project will run rapidly and safely – training

Control

Control: of materials to prevent dropping into nets
of equipment – many nets now three years old – old, tired and limp
of equipment – Higher Safety run a bar code system - to scan the nets in and out of the warehouse
of the space under net – keeping the zone of deflection free at all times
of SCs – procure a good SC and they sometimes sub-contract the work out
of SC – (MCG) as of 2003, anyone installing safety nets must be FASET trained
of nets – FASET training does not guarantee use of satisfactory quality nets
there needs to be policing – FASET should withdraw certificates for failures
third party auditing
Handover Certificate – should have evidence that the company and product comply

Under-reporting of incidents is prevalent in industry
Maintenance regime – nets must come back from site, be registered, booked in, inspected, tested and repaired by someone who is qualified
Test cords attached to each net, used to identify UV degradation – system highlights when test cord should be removed from the net – bar code system won't allow the net to leave the warehouse unless it has gone through all these procedures
Net should be in accordance with the British Standards
Inspection – not enough dissemination of information or qualified people on site
Inspection – checking off nets against maintenance records, as they arrive on site
Training – FASET is the only valid, CITB recognised training certificate

SPECIFIC ISSUES

Versatility of System

Safe number of people who can operate over nets

Planning

Planning: must get nets as close to the working platform as possible
need drawings – for steel work, drawings and programmes
'Down south' the use of nets is in the construction plan
of the actual construction phase and the pre-construction phase
deflection of net in the event of a fall
impossible, in some cases, to put nets where there is no steel
net contractors to attend every site meeting – programming and installation problems

can't get nets up - a roll on effect to the roofing programme
RA of operations (materials and tools used) above nets
RA – fall into a net with some of your equipment is going to injure you more than the net
Need a Rescue Statement plan
Time – using nets as well as other systems could save time and/or resources
Need to consider the equipment as a whole - installation for dismantling - rescue procedures - the risks associated with erecting nets
Design/planning – direction on safe anchorage points – a handover certificate to confirm their use
Nets – the most obvious solution for a standard portal frame
Nets are the right choice where there isn't policing – where policing is difficult you know protection is there
Refurbishment works – for working above roof level
Interaction with work – phasing and sequencing of works
House-building on wall heads is a particular dangerous area, a place not to put a net.
Anywhere that the net is not going to be allowed it to deflect properly
Always consider is the task that is taking place above the nets
Positioning – Do you put the net above the planned bracing or below?
Positioning - below the bracing to allow the netting to deflect properly

Injuries
Failures of nets – material falling into a net can cause failure in advance of the individual falling
What injuries can be sustained from the net itself when falling into a net?
Injury from net – older style knotless nets tend to cause facial injuries landing in the net

Psychological Factors
Attitude to fall into nets – laughed it off
Attitude to nets – 'oh, I can do anything'
Quality improvement – guys concentrating more on the job, not worried about if they fall
Attitude – with nets for rope-access use, guys become complacent

Forming a new Regulatory Organisation Regulation
Self-regulation doesn't work
Regulation - looking for statutory, periodic, thorough examination

GUIDE CONTENTS

- Current HSE guides simple to read, plain English but they're usually quite thick.
- A do's and don'ts handout sheet that you can photocopy and give to the person doing the job – user friendly
- Current to Standard, the BSEN for safety nets
- Client advice – CDM client's role, need to put emphasis on client's responsibilities
- Document has got to have a section in it somewhere that talks about the client's responsibilities
- Cost – tell the clients if we do the system properly they are going to save money
- Tell the client that we want to save lives – give them the right approach, it can make a big difference.

- Have some guidance for planning – what the Planning Supervisors and Design Teams should be doing
- Show peripheral issues involved in nets measured against those in other methods e.g. scaffolding
- Three key items – competent rigging, comprehensive maintenance and a compliant product
- A toolbox talk with all the salient points in the guide – guidance that we have isn't in that sort of format
- Keep it simple, without reinventing the wheel

FOCUS GROUP 3 ANALYSIS – SAFETY DURING INDUSTRIAL ROOFWORK

CLASSIFICATION OF ISSUES

Most of the issues from the consolidated list have been classified under appropriate headings. Some issues not related to the selection, and use, of equipment have been deleted.

GENERIC ISSUES

Cost
Some specific cost issues later

Culture/Behaviour/Attitude
psychological and behavioural issues
acceptance of fall prevention/protection system
user friendly systems

Communication
communication to operatives
consultation with operative and supervisor levels
communication between contractors
failure in communication of risks to operatives
systematic process of communication to supervisors and operatives
information from manufacturers – can this equipment be used in this environment
communicating manufacturers information to the workforce
managers need more information on provision and use of work equipment

Planning
organisational learning to benefit new projects/situations
problem solving by teamwork
planning and co–ordination
CDM Regulations bring people on board early
co–coordinated work method/risk assessment under CDM
PUWER, the Provision and Use of Work Equipment Regulations
fit for purpose
tight current programmes – dictate construction methods
management systems – safety through design of systems

Design Influence
risk avoidance – by alternative design or methods of construction
understanding of construction among designers
what designers and construction planners can do to make construction easier/safer
eliminate the risk in design
designers not addressing (temporary) factors of safety during construction

GENERAL & SPECIFIC ISSUES

Costs

extra costs using both systems together – issues of cranes and telehandlers – telehandlers and cranes, you have to pay for them by the hour
installation plant not large cost of a netting or a deck system – a crane is about £300 per day, and a telehandler is around £300 per week
costs with erection of nets – mobile work platforms, cherry pickers – time to allow the men to work safely to erect the nets
possible cost model guide – portal steel frame buildings – two different systems, what are the time and the costs involved
clear specification at tender stage what we expect subcontractors to provide
inexperienced building surveyors negotiating subcontractors prices, without knowledge of building or roofing – surveyors are the wrong people to be sending this information out to the tendering contractors. NB – not just a cost issue

Site Conditions

wind/weather conditions

- global warming, subject to far higher wind conditions

carrying liner panels in winds – nets not enough – need handrails as well

Training

- achievement of understanding and awareness at all levels of industry
- leading edge protection systems require trained and competent workforce
- systems more complex than ever before
- workforce selection and training

induction training of all new gangs and they sign to say that they have been inducted. Nobody goes on a roof unless they've been inducted
no apprenticeships for sheet layers, roofers or cladders
need more trained advisors or train the trainer type of guy
not just training on the system, training about the risk
time to train properly
apprentices put through CITB building college at Birmingham
trolley relies on the individual behaviour – full of different components and we (??) will be coming out, probably by May next year, with uniform training methods –as an organisation, not one manufacturer

Control

control measures, signs, etc
communication and policing of use of the safety equipment
supervision
some systems need inspections prior to use
checks of competency, training and understanding of the work method
competent persons
proactive equipment, materials, supervision planning and control
can have the best system in the world but unless the person is competent
accreditation or affiliation to CSCS or SCORE
CSCS for roofers to say that they have used these types of systems and they have used nets etc.

the problem with CSCS with roofers is demonstrating that they have trade qualifications

SPECIFIC ISSUES

Alternative Systems

safety nets are seen to be HSE preferred method
problems with safety nets as well
safety nets – operatives protected at all times – trolleys depend on competent behaviour
more comfortable with the whole area of the roof netted
safety system is there in case operative makes a mistake
more comfortable with the safety system that accommodates anything that operative does
possibly an argument for using both systems
both systems together (nets and trolleys) – in the real world it is too expensive
prevent accident happening, rather than catch somebody who has had an accident
netting will not stop a falling spacer bar killing somebody on the ground
nets with debris netting attached being developed in the United States – too expensive yet
roof nets specified in the contract documents and it was allowed for in the prelims
situation when can't get nets up without installation risk
not necessarily one versus the other – how they both operate in tandem – hierarchy of control
possible false sense of security of nets
possible puncture of net by material falling with operative
nets becoming a cowboy trade
each system needs to be considered on merit, in context
buildings without external access – with nets, where do the materials come up?
purlin trolley system requires correct behaviour – safety nets and other passive systems are a higher degree of controls – passive systems should be considered first
proper documentation; all nets checked and inspected before they come to site, and before use it has handover certificate, further inspections by ourselves
with nets steel designers can design fixings into the steel for the nets
nets need a netting specialist, knowing what they are looking for, to go up and check.
can get untrained cowboys
if nets only available on a hire–only basis, can take it out of service when needed
could scaffold it all out, put a crash deck in – cost?
purlin trolleys or nets – very few projects where you are restricted to only one option
there are situations where nets simply aren't useable.
where there is no internal access – e.g. swimming pool area
there are situations where you can't net – e.g. out of the reach of access equipment – out of 100 projects only one would fall into that category.
ask the question, what is the risk involved in the installation of the nets?
recognised training scheme, competence card and a way to install the nets
in very large buildings – not enough nets – have to leapfrog the nets as the roof progresses
needs coordination – roofing contractor can get ahead into an unprotected area
taking the leading edge with you (trolleys) makes it potentially simpler for very large buildings
trolley systems for smaller jobs, used to be expensive (set–up time) – but speed of modern systems is much better
netting on small jobs is probably safer than setting up dedicated trolley systems
there are cases when nets won't work due to design of the temporary bracing

if the steelwork is not completely fixed, and needs roof to give lateral stability a loaded net, from a fall, this can move the steelwork
Other systems for steep pitches – e.g. access platforms on ladder beams spanning up the roof and on tracks top and bottom

Planning
communication/understanding of risk management hierarchy
desired work sequence – get the building water tight then fall back to rest of the fixings
tray a whole roof out and then come back and put the top sheet on
fixing liner panel, then a z–bar, then a top sheet is too slow
problem of gutter face, area – loading out, installation of gutters, retrieving materials from where they are loaded out
problem of planning the job – materials movement gutter installation
hierarchy of control – first thing have to stop a fall – then fall arrest
movement of roof sheets from stacks on roof to workplace – with trolleys
management of materials and management and control of the system – both systems
planning of the job should be communicated clearly in great detail in work method statement method statement for the trolley system
can get good telehandlers up to 17 mts high – material management
nets or trolley systems – risk of falling materials in both cases
work method and planning of the job, try to design it out
ensure that people and other trades are not working below
other trades can get ahead of the roofing contractor above
roofing materials, should be fed in from behind the leading edge
packs of materials loaded out in the conventional way can be ahead of the leading edge, in the early stages
HSG33 (revised) does not mention feeding materials into the roof areas – edge protection may not be guardrail, mid–rail, and toe board/gutter – may be a work platform at the eaves of the building behind the leading edge
sometimes (e.g. on a valley slope), nets can interfere with lifting materials from underneath sometimes the safety system can create risk
issue of ground conditions for cherry pickers and mobile platforms
responsibility of the client for the system (main contractor) to design safety system
planning supervisors/planning office could deal with this at the first stage.
need practical experience to specify safety system
risks involved when putting the trolley systems in place.
there are risks in putting them in, but you only erect and dismantle once
roof loaded–out first, materials being moved over the trolley system
repair and maintenance of fragile roofs – areas are high risk
precautions need to be commensurate with level of risk

Design
design, particularly the gutter area, need to design out problems
overall roof construction system (design and planning) – eliminate risk before site work
roof structure itself designed for fixing device – e.g. inertia reels and Turfer lines

Design – Planning
roofing contractor brought on board early – many main contractors leave too late

does any one communicate problems to designers
roofing contractor inherits the risk, should be involved at the design stage
contractors brought in at the design stage to advise on compatibility of safety systems and build method

Control of subcontractors
communication and direction by main contractors of specialist roofing contractors
problems of control with roofers on piecework
nets becoming a cowboy trade.

Psychological Factors
men prefer to work from the (trolley system) platform – something to walk on, anti-slip in bad weather – somewhere to put tools – nothing dropping through netting onto people – earn more money due to better working conditions
roofer prefers nets place, feels safer, works better, improves quality of the job

Technical Issues
rolling platform leading edge protection
permanent integral handrail/gutter system
accidents at the leading edge on new build
falls from the gutter position when leaving the completed roof area
effectiveness of leading edge protection system as it's moved forwards
gap between leading edge protection and the solid roof covering
movement of materials across to leading edge
people stepping across purlin top, over flimsy liner material
work activity around the leading edge
movement between leading edge and other areas of the roof
falls from the permanent edge
new leading edge protection systems, improved and quite sophisticated
0.4mm liner trays – safety dependent on correct fixing
0.4/0.7mm liners/composite panels – all fragile until they are properly and fully fixed
trolley system helped reduce risk of damage to 0.4mm liners
appropriateness of the trolley system to a built up or a composite system
industry change (fashion?) from the composite panel type of roof installation back to two skins with spacer bars and all kinds of ironmongery
problems with the trolley system are loading out – gutter installation – unfixed panel at edge of the roof – fragile area
HSE testing of fall arrest part of trolley systems – catchment trays – robustness
purlin trolley system has horizontal and vertical ball-bearing rollers – easy movement if steel is something like in tolerance
the only thing that interferes with platform system is if there is a purlin anti-sag bar system that comes within 40mm of the purlin top
some trolley systems work with sag bars, but need to look at this on day one
modern systems can be used without having to readjust and reposition – once they are properly set up they can be used for the full duration of the roofing activity
trolley systems on a hire-only basis – you have got to erect them – need training, competency and experience– nets subcontract out to a reputable company that supply, install and dismantle

modern trolley systems are excellent, but they really rely on a high degree of skill if your own workers have to use them
hire-only is done to control maintenance and checking of equipment
the more components there are in equipment (trolleys) the more chance of it going wrong
barrel-shaped and half-barrel shaped roofs – problems with permanent edge protection – where operative is raised so that his edge protection (guard rail) is no longer at the waist height – need to prevent the spill off e.g. by 'bagging' the nets so that you to fall into them – similar consideration at the lower eave where working on a curved platform of the leading edge protection system
have put treads on these so they can walk up like a ladder – or cradles with wheels.
use of trolley systems in refurbishment and on excessively curved roofs

PPE
sometimes nets, trolleys and harnesses
not harnessed to lay sheeting unless a particularly awkward bit
sometimes clip on the trolley system rail, which they shouldn't do – handrails may not be strong enough

GUIDE CONTENTS
- each step: systematic method statement, risk assessment, planning – user-friendly customising of that documentation – competency in risk assessment – designer involvement – designer/roofing contractor communication – planning supervisor liaison with designers
- emphasis on required competency and training programmes
- understandable, clear and very lucid (for all levels)
- training requirements of the people installing the systems.
- suitable and unsuitable situations for equipment
- strengths and weaknesses of each system – interface with/inclusion in method statements
- emphasis on the management/supervisors to explain methods statements to operatives – suitable for operatives that can't read – pictures and careful, simple explanation – don't forget the individual
- current method statements far too long – start looking at developing simple task sheets – some don't read and write – getting more non-English speakers
- e.g. NFRC excellent brochure – A4 size and pictorial – or new asbestos manual
- need something visual.
- Must consider overall roof construction process, not just safety system – no two jobs are the same
- draw some portal frames – cover different scenarios – perhaps edge protection in particularly difficult areas to get to – e.g. use real building with impeded access – more practical stuff
- driven from start of the job, before the job gets on site – the design stage – risk assessment, detailed and specific not generic – e.g. excavations, where ACOP and method statement on site before excavation can begin
- supervisors training on the method statement – consultation with operatives, supervisors, trade reps – tool box/awareness talks – administration of control procedures to ensure dissemination and understanding of information (risk assessment and method statement)

FOCUS GROUP 4 ANALYSIS – CABLE & TRACK–BASED SYSTEMS

CLASSIFICATION OF ISSUES

GENERIC ISSUES

Most of the issues from the consolidated list have been classified under appropriate headings. Some issues not related to the selection and use of equipment have been deleted.

Cost
See section on Costs in 'General and Specific Issues'

Culture/Behaviour/Attitude
Risk perception – low height of fall (<5 metres) leading to death – no PPE and no nets
Attitude to risk – failure to 'learn' – guy had fallen twice – no 'profit' from experience
Fall off (pylons) twice – the mentality and culture – still no harnesses used

Planning
When working at height, the whole system needs to be risk assessed because of the interface with the operation, equipment and other operations

Design Influence
See section Design in 'Specific Issues'

GENERAL & SPECIFIC ISSUES

Costs
Architects work to a budget, hence horizontal lifeline systems are often selected
The systems currently in the marketplace are very similar, and first who gets in there with right price decides what system will be used
Cost is a big concern as there is so many people in the market just now
Close after cost concerns is certification, but equipment selection is primarily very price sensitive
On retrofits, cost is again a major influence – many organisations '*didn't anticipate that they'd have to spend any money*'

Site Conditions
Roof finishes – rain and damp environmental conditions make roof finishes slippy

Training
Manufacturer's / installers must get information to the end–user and train how the harnesses work, i.e. the properties of the harness and how to wear it correctly
Retraining is required as there are often long periods before and in between uses

Hand–over process – trainers can't get all the users together for training at the one time; this is critical – it often cascades down an organisation. Video training is sometimes used for subcontractors brought onto site
There requires to be a focus on 'minimum standard' of training
Cost to train people to rescue is expensive – with employee turnover in industry, this creates a problem
Specific training is required to install a cable system
Installers are trained through a network of instruction in use, fitting and signing off equipment to the end–user
In the more complex systems, the clarity of the instruction information provided can be poor
There are problems where trainers have inadequate knowledge of PPE to issue the right kit
There exists a lot of confusion on how retractable devices work (inertia reels)
End–user training is very important; there should be clear guidance for the end–user on training and competence of the people using systems
There should be more guidance for designers on 'hierarchy' of safety
There should also be more information given to architects – the RIBA make them aware of their responsibilities

Control

PPE – examples of operatives falling from a basket of scissor lift wearing no harness
Handover/communication process: manufacturer to contractor/sub–contractor, building owner and maintenance staff – there must be user instructions, equipment logs (lost, damaged etc.)
Marking on the systems isn't clear
Permit to work system; manuals, correct PPE necessary, etc.
O&M manual part of huge handover package – manual for fall equipment never gets to the user
Management and supervision – the problem is expecting operatives to clip on – there must also be control of what he/she is hooking on to
It is never recommended to 'loop back' to a roof light or something to compensate for slack
A regulatory authority should be formed like FASET; manufacturers need to lobby for improving EN Standards, installer competence, and certification scheme, etc.
HSE require greater emphasis on competence regulation, e.g. more specific about rescue requirements
The owners of buildings must insist on proof of competence of the training of the system users
EN795 isn't broad enough – there should be a minimum installation standard for all systems for quality of the installer, materials used for the handover, etc. This would give power for the HSE to govern the industry

SPECIFIC ISSUES

Planning

Rescue: Rescue is a major concern: designers and installers don't offer guidance. There is no safe system of work without a means of rescue
If a person were held in suspension by harness and lanyard for up to 45 minutes before rescue, the person could certainly be dead (suspension trauma)
Rescue methods should be tested
Rescue systems are complex and need to be considered and purchased with training
Organisations can't rely on Fire Service to be part of the safety system

Consult the fire brigades to see if they can provide rescue, i.e. get into that location, but do not rely on them – using the fire service is not a sensible answer.

HSE do not permit reliance on emergency services as part of a safe system of work

There are only one or two specialist line rescue teams per county, and they may not be close to your place of work

Problems of rescue: high structures; problem of going horizontal into the structure sometimes greater than vertical height

Risk assessments require to be specific. Also, talk to rescue service personnel

There is sometimes a reliance on the use of cherry picker for rescue – it can't be guaranteed it's always going to be there

There is inadequate technical back–up from suppliers on the limitations of the system

Manufacturers are ok, but distributors don't talk to manufacturers – they give advice based on inadequate information – training is required for users and installers

The big barrier to the use of this equipment is that they are personal protective, and only protect the individual

Audits should check out potential fall distances and system flexibility; systems are installed where fall distances are unknown/unchecked – this points (again) to a lack of training.

Fall distances and the criteria for fixing systems – people are installing systems without this information

For temporary systems Sala have produced a graph showing: one, two or three men on the system v. the gap between anchor points – it then provides the fall distance (other organisations have similar information about to be published)

Design

Architects: don't consider the hierarchy of risk control; permanent edge protection best, then a restraint system

Fall-arrest is last line of defence, but in design risk assessment architects select fall arrest system, as it is an easy solution for them

Architects should look at other solutions – engineering the danger out is the best way

Architects may cut back to individual anchor points – these are not user-friendly and are less likely to get used

90% of architects do not understand their CDM responsibilities and will use cheapest system

Architects need to adhere to CDM responsibility, and collaborate with the installers

Architects can ignore recommendations for fall restraint systems – this only serves to make difficulty for the end-user

Architects are not yet very knowledgeable of different manufacturer's products, and solutions

RIBA/CPD focuses on what architects are interested in – not what is required by industry

For temporary support systems, architects abdicate their responsibilities – they leave it up to the main contractor to design, or to engage the appropriate specialists

For permanent systems, the majority of architects go for roof anchors – they are cheap and do not interfere with aesthetics. This, however, leaves problems for building owner

Aesthetics: barrier systems make some buildings look like they have still got the scaffolding up

Architects are concerned about aesthetics – cable–based system is a lot less unsightly than a walkway

Early-stage design risk assessments are inadequate

Hierarchy of control: PPE is the last line of defence – designing-out the risk is the first principle

In design for the hierarchy of safety, first consider: a parapet wall, then handrail all round – without a handrail round, the options for collective safety are reduced; fall-restraint and finally fall-arrest should then be considered

Permanent handrail systems don't rely on the individual – there are high initial costs, but low running costs for the lifetime of that building

With PPE there has to be training and re-training of individuals in the inspection and maintaining of the equipment

Track systems have to penetrate the roof – could potentially lead to leakage problems

Some cable systems can span large distances between the anchor points, which means less penetration of the roof surface

The most expensive thing is time – compared with a track system with many fittings, the cable system would be more advantageous on many occasions

Roofing material manufacturers, in their warranties, require the whole roof structure to be inspected at least once annually. Therefore, the whole roof area must be designed to be accessible for personnel at least once annually

The biggest risk with fitting these systems is in retro–fit because there are very variable circumstances: cascillated, granite, crumbly buildings, asbestos infill, etc.

Design – Planning

People don't realise the forces involved in a fall – guardrails are not able to take the weight

Lack of understanding and training about issues like line stretching

Consideration must be given to environmental conditions, for example, corrosive atmosphere

Cable-based systems don't prevent falling; they just stop worse injuries – a restraint system prevents falling

Designers should always for fall-restraint systems, so that people can only just get to the edge; no free fall possibility

The temporary situation gives the biggest danger of fitting system components at incorrect heights through inadequate instruction

The simpler a safety system, the more likely it is to be used correctly

Manufacturers / users need the opportunity to influence design so that the system is carefully designed to be simple to use; safest point of entry, no additional components to reach the main system, etc. Consultation with the end-user is recommended, where possible

Guidance for designers is needed to decide what is 'frequent', e.g. maintenance once a month is frequent, therefore a permanent system with guardrails is necessary. Once a year access could get away with a lanyard system

An architect may not allow what is being recommended as it 'doesn't look good', e.g. a wire can be seen

Access must be considered early in the design process; not at the end

Rigid systems (track) are more effective at restraining than a cable system

Rigid systems are better at going round circles and obstacles than a cable system

Many PPE distributors don't manufacture the devices – they only sell them. This brings us back to standards of competency

The problem is how to model what happens when a person falls on a cable-based system. This would need computer programme: first, to make sure there is sufficient space to be arrested safely

(it's a dynamic problem); second, to limit the amount of force or acceleration on the person falling; third, the strength of the anchor points has to have a high enough safety factor to sustain the fall and to support fall rescue operations.
If manufacturers prices included the cost of doing this analysis properly, then they will be less competitive as a solution
The systems are very complex; each one is different: it goes round different points; round corners; round half–corners; up and down, perhaps over ridges
The problem with risk assessment by the Project Manager is that it is not done until works commence on site. This is 'too late to upset the programme'
Every installation should be taken on it's own merits – depends on frequency task
This report is an opportunity to help designers in some form of cost–benefit analysis, eliminating risk through design v. cost of living with the risk for lifetime of the building
We need more emphasis on the guidance from HSE and from standards
The design of cable-based systems needs to ensure that every part of the structure can be accessed, as necessary; assess the whole solution for risks, including installation and maintenance risks; consider different types of roof: standing seam, the profile roof, composite sheeting, and different types of anchor fixings
BS EN 795 is obsolete; testing requirements need to be a lot clearer, for different installations

Control of subcontractors
There requires to be adequate policing of installers
There is a real policing issue: who is responsible for what?
Policing would help to deter the cowboys, as would a regulatory body to affiliate or accredit – this would assist in industry control
The main contractors should take more control of installation and certification, and should recognise their continuing responsibility over a 5-year period

Technical Issues
Most systems are not limited to two men
On systems limited to two persons: if one fell and the other goes with him, how do you get a third man onto that line to help with the rescue?
Some temporary lines are rated as one-man systems, because of the problem of one man pulling the other off. In this situation better installing two systems in parallel – then you can walk past without the problems of passing and unclipping from the system
Increased line lengths give many problems: strength and the integrity of the bracketry; this leads back to the competency of the systems designers
Harness with lanyard problems: these operate as two independent systems – the lanyard extension won't work properly because of the spring in the running line. What's the tension, how far is it going to sag, what about the pendulum effect?
Shock–absorbency in the line depends on the line length, which affects the deployment of the lanyard. If you shorten the line, you get less absorbency of the line, the lanyard deploys further, and vice-versa – the impact forces end up being similar and deflection is much the same
There are obvious safety concerns for installers accessing areas to install anchor points
PSMA, Personal Safety Manufacturers Association, is working in conjunction with HSE to produce a standard for competencies of people installing, assessing, instructing on systems
IRATA standards such as BS7985, show safe working can be achieved with temporary systems, given competency, even with high–risk applications
The industry needs to develop a standard, and are hoping to get a standard out by the end of 2003

Few people now participate in developing European Standards: Standards are only as good as the input into them – this leads to inadequate Standards
Complexity – most permanent systems consist of only three elements: harness, shock-absorbing lanyard, where necessary, and the wire system on which can be fixed to a traveller
Some systems fuse the traveller into the system so that it can't be removed
Subcontracting companies (e.g. maintenance) have problems with incompatible travellers on both similar and different systems
It is not recommended to use retractable lanyards (inertia reels), as they often won't go through the brackets, and there is a pendulum effect
The big problem with any wire system is that it could be up in the ceiling, rather than foot level – can't use arresters on that, because the weight of it will pull the cable down, or it won't go through the brackets – you will get a pendulum effect if you fall
Some organisations advocate the use of self–retracting lifelines, EN360 devices, for horizontal use in specific circumstances
Twin-line systems sag a lot less and this has disadvantages as well as advantages – overhead it means it can travel past the intermediate anchorage point, whereas single might not
You can't have any kind of specific guidance that says 'you cannot use a wire system in these circumstances with a reel', because if you do it becomes a technological barrier because it becomes a standard or a work practice
If installers know those parameters, and precise engineering principles –there's not a problem
There is an issues of compatibility of components within a fall-arrest system – bits that connect the wire to the user are very important – if they don't work correctly with the horizontal wire then the person won't be arrested (or will be arrested with a substantially higher force than was intended)
There's no compatibility testing officially recognised by the standard system – there was such a system in place before we had the European Standards, and the British Standards
Retractable lifelines, self-retracting lifelines, blocks or reels, are generally not compatible with horizontal wires
Some designers have come up with anti–ratcheting devices for these products – such retractable devices are perhaps more compatible with rigid systems (track), as opposed to flexible systems (cable)
Horizontal, rigid rail systems successful in circular installations – problem with cable–based systems is the travelling device has difficulty getting through intermediate brackets
Another problem to consider is that we have to protect the person from ground level onto the system – for this the rail system is better as it can integrate the vertical element with horizontal element and inclined element
Different systems have different connections – problems can be experienced when attempting to get from one to the other – this is more difficult with a wire system
Steep-sided roofs are of particular concern – even with full scaffold in place, the HSE are concerned about the '2m rule', so as soon as an operative is 2 mts up the slope, he/she will need protection
Moving machinery negates use of restraint systems such as rails – only logical way is a wire
cable–based systems can span large gaps – but penalty is that a fall is very long distance, and large forces applied to the ends
Safety issues are more complicated due to there being at least ten safety cables on the market now
Industry needs greater standardisation, particularly of travellers
Installers should provide handover package for users

Maintenance

Systems are supposed to be checked on an annual basis

There are poor standards for lifelines – the requirement for marking of lines contains huge variations, for example, the annual maintenance requirements is not certified on the plate

The vast majority of the systems are never inspected

Regular inspection is a must

More guidance on maintenance of the systems is required for the end–user

Maintenance of all equipment is extremely important

PPE

Inadequate harness – only shoulder straps and a waistband, no leg straps, no thigh straps

The question must be asked, 'is correct PPE on site for this task?'

FOCUS GROUP 5 ANALYSIS – SAFETY DURING SCAFFOLD WORKS

CLASSIFICATION OF ISSUES

GENERIC ISSUES

Most of the issues from the consolidated list have been classified under appropriate headings. *Some issues not related to the selection and use of equipment have been deleted.*

Cost
See 'Specific and General'

Culture/Behaviour/Attitude
Complacency is an issue – 'I thought I was experienced, but there were not enough boards on, I forgot to tighten a fitting, etc.' *Issues like this lead to falls*
Culture change: it takes a long time to change culture, but safety needs policing first

Planning
See 'Specific and General'

GENERAL & SPECIFIC ISSUES

Costs
Pricing gives many problems in our industry
A lot of crucial elements are missed out on erecting the scaffolding for the benefit of price
Big firms will go for the cheapest subcontractor: a contractor could be half the price one of the reputable companies, and that's what would be accepted, and then they'll complain that scaffolders are not working to SG4
There is no safety incentive when it's all driven by price
How much is it costing, what should client to pay for? This information should be itemised in the bill of quantities
Principal contractors, clients, and the scaffold industry need to collaborate about the cost implications, including impact on progress – they get what they pay for a lot of the time

Site Conditions
In Italy most accidents were happening while dismantling, because they are more in a hurry when dismantling
There could also be a language barrier problem – non-English speakers receiving inadequate instruction
The lack of qualified workers is greater than we admit – particularly in smaller companies

Training
One of the biggest problems is the amount of young people coming into the industry: 21-year old boys coming out as advanced scaffolders

Unsafe acts out-with the parameters of good practice: a lot of it is down to lack of experience and commitment to safety
CITB scheme: operatives trained from 18-21 to advanced level, but they've still got to get experience, then it's up to employers to apply for cards for them
There exists a possible conflict of interest when a company can say, 'that I think that my boy's fit to be an advanced scaffolder' – but they've got to have verifiable evidence before they can obtain NVQ qualification
CITB give tube and fitting, cuplock and yellow jelly training – but the majority will never see tube and fitting or yellow jelly – should need experience in all scaffolding systems in order to qualify for a certificate
Tube and fittings scaffolders are completely different from system scaffolders
CISRS scheme now incorporates system scaffolds
Systems training is now nationally recognised training: it differentiates between different types of systems that have been accepted for the scheme, and tube and fittings
Until now it's been manufacturers providing training, now it's independent approved training bodies
Industry is aiming too low with the quality of people being employed
Industry needs far more training than we're currently providing
Experienced people are leaving the industry – systems scaffolding being used more and guys not getting experience of tube and fitting
The training is predominantly tube and fitting, not systems scaffolding
In the past, trainees were sent out to an aluminium firms for a year, tube and fitting firm for a year and a cuplock system scaffold for a year – that's what's needed
Scaffolders can't just use every type of scaffold – they've got to be trained
Many scaffolders were never trained in SG4 – nobody explained procedures
Older operatives are saying 'that takes too long' – changing their ideas is back to supervision
Training and supervision. – problem getting harness worn properly and providing comfortable harness – it is a snag hazard, a hazard in a fall, and gives inflexibility in work
Competency with scheme run by the NASC – training, experience, and then formally assessed against standard – VQ Level 2 for the basic scaffolder, and Level 3 for the advanced scaffolder
An advanced scaffolder would be in charge of and design jobs – basic scaffolder is qualified to do the majority of jobs, but not qualified to read designed drawings
Small firms are not going to pay for CITB instruction – as soon the scaffolder is trained, he/she will leave for another firm – that's the problem
Training needs to be far more intense than it is: 6-month experience, 2-weeks training, 6-months experience, 2-weeks training, 6-months experience and a one day assessment, then a certificate is nowhere near enough
People abuse scaffolds: industry should consider training bricklayers etc. to appreciate the type of scaffold they're working on

Behaviour, attitude, culture

There are different types of scaffolders: town scaffolders, who work on price, and 'refinery' scaffolders – when guys from refineries work on the town, have the safest scaffolders
The industry needs a registration card that can be withdrawn for poor practice, like CORGI
Operatives on oil rigs walk about with a harness 24–hours a day – we need to bring the scaffold industry up to this standard
Culture is problem, but it is changing slowly
Employers need to provide the operatives with the right equipment

Operative can be provided with harness and guidelines, but if they think it's not safe, they're not going to use it
Harness is one of the most complicated PPE, and requires appropriate training

Control and supervision

Better policing, monitoring systems, and client interfaces are required in industrial scaffolding than in subcontracting
In 1996 the double guardrail was introduced – some scaffolders put the double guardrail in, but miss alternate fittings – always excuses to cut corners
The biggest problem is the lack of supervision
In experience of 5 or 6 serious accidents with scaffolders, we have never found one fully complying with correct practice
The 7-day inspection regulation isn't enough – in North America, they inspect before every work shift
Industry require to ensure the operatives are properly supervised, and work to SG4
Supervision is one of the main criteria in new Temp. Work at Height Regs
Appropriate recording and registering of the date that an operative is issued with a harness is required by every employer, also, weekly visual inspections and every 6–month checked by a competent person
People who break rules, we need to retrain, but there must come a point if they refuse to work safe, then they are dismissed

SPECIFIC ISSUES

Planning

Nets take away the danger from the scaffolder
Work timing, scheduling, co-ordination, communication
Complex construction requires complex scaffolds – a less qualified workforce makes this problem greater

The design must consider construction (CDM) – there is a need for a properly managed project for scaffold as well; not left for the contractors to develop by themselves

Control of subcontractors

Misuse of scaffolding; undermining foundations, taking out key components, removing ties, overloading of structure, etc is a bigger problem than the erection of the scaffold
Many users don't recognise that a scaffolding becomes their responsibility on handover
If a handrail is in the way for many trades, they will take it out and not replace it – there should be scaffolders on site to maintain it, but industry can't afford it
Maintenance is a problem when scaffolding is modified by others – are any statistics available for this?
On investigating accidents where the user has had the accident on the scaffolds, the client has been found to have caused the problem by either moving boards, moving handrails, or overloading the scaffold

The major problem is not between the scaffolder and the scaffold, but between any other (sub)contractor and the scaffold
Supervision is very important – particularly in refurbishment, where the need to have temporary works or temporary structure is coordinated on the site
We need to target SME's – the organisations who are the cheapest, who flaunt the law and put up scaffolds that don't comply, and don't wear harnesses
There should be a policing system with an HSE officer in the area to receive complaints about any firm blatantly disregarding health and safety legislation
MCG etc., in cooperation with NASC etc., have got to make improvements – the scaffolding industry will not be able to do it on their own

Technical Issues

SG4 is good but doesn't cover all points – it has created other hazards, e.g. clipping on at the foot level
There are anomalies in SG4 – clipping on at the feet at 4m, the operative will still hit the ground because they will fall 2m plus ripcord extension, plus height of the person
SG4 good but only does wall scaffolds and promoted the use of harnesses, but harnesses are not the answer because they don't protect up to a certain height, and when somebody falls you've got the problem of rescue. The answer is a guardrail, from any height, or any type of scaffolding
SG4 only covers façade scaffolds – it doesn't cover birdcages, grandstands and stages
Scaffolders have got to incorporate a method of work by SG4 – to look at an individual job and produce a safe system of work
Through support from NASC, one of the major changes will be the development of advanced guardrails
A scaffolder fell just less than 2m and broke both wrists – he was clipped on, but at foot level – we must give workers proper equipment to prevent this sort of accident
Scaffolders are required to clip on as early as possible, but where do they clip to?
What's the point of clipping on at foot-level, 2m up? The operative is still going to hit the ground
Harnesses and lanyards don't protect the individual until a certain height
Industry must promote the use of harnesses, but they are not the answer every time
An industry change of system needed – driving towards 'passive' safety
Design is important: if system can take the same loading with reduced number of pieces, its an improvement
If it's easier to build, it's easier to handle and it becomes a benefit to safety
Manual Handling: Should be considered – some composite scaffolding halves the weight
Manual handling is a big issue with some systems; the components are wide and heavy and don't make for a safe system of work
On a system where the decking panel is 3m long by 1m wide, there is a handling problem
New scaffold standards, 4m long, caused medical problems by putting pressure on the back, because the operative couldn't run his/her hands up the standard, and had to try and juggle their hands up it
The difference between system scaffolding and tube and fitting: in system scaffold there are one-use components, e.g. a ledger's a ledger. In tube and fitting, tubes do ledgers, transoms, standards etc. With 3 or 4 different load bearing couplings on a tube and fitting scaffold a scaffolder could use the wrong one
EN 12811 is being introduced to replace BS5973:1993 Code of practice for access and working scaffolds and special scaffold structures in steel

NASC are drawing up a new document to rewrite BS5973, which will only cover tube and fittings from now on
Systems scaffolds will have to comply with EN 12811
Quantity surveyors specify an item: 'scaffolding', without a break down; maintenance; purpose; loading
A report of harness suspension says that the worst-case scenario is clipping on at feet, yet, we're asking men to do it and telling them that it's safe
Getting on platform and then clipping on at feet is not working to SG4 – the operative should clip on at the ledger above then climb up, the clip is then at feet height
During early implementation of SG4, appropriate PPE was not available. Since then, equipment has been re-designed to cope with the risks, such as clipping on at the feet
Education is required in using this equipment
Changing work practices also will assist SG4 – for example, by attaching to rear edge of the platform instead of the leading edge takes about a metre and a half out of fall
Manufacturers must design usable equipment – now looking at 2½m and 3m blocks (inertia reel), personal issue that can be worn on the back
For 10m inertia reels, or above, regulations apply to control and maintenance, annual inspections and servicing etc.
A common inertia reel is effectively a car seatbelt – muck gets into it, makes it ineffective
Reels have been used with the block attached to the back, and the shock absorber at the anchorage point – industry needs the blocks light enough to attach to anchorage point, but the operative can still walk around with it
ICI sites in Runcorn and Shell sites in Merseyside have insisted on scaffolders clipping on at foot since 1990 and have not suffered one recordable accident with over 500 scaffolders
Jordan Clamp allows above-head clipping. It is very cost-effective instead of a handrail, and can be incorporated into systems scaffolding. It is believed to be a user-friendly device, and feedback from scaffolders suggest it is a good idea, they liked it
Issues with operatives using all the aforementioned bits of kit, but it's not theirs – it can be costly when materials get easily damaged, lost or stolen
Safety methods are in industry and just need to be made to happen – not harnesses though, except in some very high level circumstances
Industry has to find a way of providing scaffolders with guardrails
Any system that can implement the guardrail before you climb up would be the answer
80–90% system build in Scotland, with little tube and fitting – in the South 90% tube and fitting and 10% system
The technical guide has got to look at methods that are available now until more advanced systems appear

PPE

See 'Technical' above for material on harnesses etc.

ANALYSIS OF FOCUS GROUP 6 – MAINTENANCE AND REFURBISHMENT

CLASSIFICATION OF ISSUES

Most of the issues from the consolidated list have been classified under appropriate headings. Some issues not related to the selection and use of equipment have been deleted.

GENERIC ISSUES

Cost
See below.

Culture/Behaviour/Attitude
See below

Planning
Incomplete stairs to upper floor roped off by steel erection firm – foreman told the guy to bypass rope – stood on loose plate and fell. The erection procedure was subsequently improved to avoid leaving loose plates.
In roofing sub-contract partnerships we have no incidents – incidents occur with ancillary people and usually seem to involve ladders, inspection and light (short–term) work. The reasons for the partnership were safety ***and*** commercial.
A scaffold ladder moved and caused fall – it was not tied because scaffolding was not wide enough to pass. A ladder is for temporary access, and removed, or it is permanent and tied. We have to manage the work accordingly.

GENERAL & SPECIFIC ISSUES

Costs
At the tender stage, the contractor's interest is in cost saving, i.e. "*do we really need them (rope anchors)?*" Anchors were specified but removed – it is a false economy when comparing the cost of temporary access over building's lifetime.
Managers are all for safety when they're talking to the City Council, but I doubt whether they're really for it when they want as much work as they can.
Problems stem from the client looking for cheapest option – we need education of the client.
Employers put in the cheapest system available – guys on square metre rate don't clip on.
Safety all comes down to cost – pressure to get a job done, makes you cut corners.
If there are no cost considerations, the recommendation would be to put a birdcage scaffolding under the whole of the works.
Insurance companies tend to increase their premiums if organisations don't have a proper protection systems in place.

Site Conditions
No issues

Training

At Sellafield every person has 2-day safety course – they are taught to challenge every single safety aspect on site, so there's policemen everywhere.

Information packs are available from HSE on webbing and hardware and stitching; they give practical photos at the back. Safety is all about training, the storage of equipment, the maintenance and cleaning of equipment also needs to be looked at. Training from some plant hirers is recommended: the trainer will show how to use the system in 5-minutes. Organisations should get the manufacturer's specifications, so that they know they are doing it right.

Constant training in product awareness is required, because there are new systems coming in all the time. People can tend to stick with what they know, but they need to know about the new alternatives too.

SMEs need simple guidance: "*a harness can be used in these scenarios, and not in these*". We must be quite explicit. There should be client's responsibility also.

Supervisors are one of the most important factors in refurbishment and maintenance; if they walk by a potentially dangerous situation, then everybody thinks it's alright.

Design/Planning

We must reduce or eliminate risk when by removing any fragile materials from the roof, or have a passive system like a handrail. If passive systems can't be used (e.g. aesthetics), then consider frequency of access. Access need should be minimised by installing as little roof plant and maintenance as possible, e.g. no fragile roof lights (or protect them underneath).

We are still left with many tiled and slated, and asbestos cement roofs – people take little notice of 'fragile' labels as they soon become part of the scenery.

Some safety systems may not be required on complex roofs because access is very limited. However, if there was a problem with the roof that needed somebody up every time it rained, this should lead to a heavy safety awareness programme (which can be costly).

Maintenance problems must be solved before the roof actually is built. There is a requirement for consideration in the early stages, so that it's not reactive, but planned refurbishment.

Avoid refurbishing with like–for–like materials/systems: if a building has roof lights, put back a safe roof-light; consider maintenance that is required in its' new life. If there is a problem with the gutters, change the gutters while you're working there; don't go back up putting men at risk again; reduce the maintenance.

Gull–guards: to avoid going every 3–months to clean gutters, we installed gull guards. Also, if the roof has hot spots, make sure that birds can't sit there – this reduces the amount of maintenance that is required.

Design – architects and designers have to do continual professional development courses, but there's no pressure on what subjects they must cover – they are not obliged to know or do a certain number of hours on height safety, and this leads to a real breakdown when we receive plans. There's nothing there, you have to work with the contractor – so there needs again to be an emphasis on who's responsible for what; designers, operatives, and all between need to have clear–cut responsibility.

Planning

When using fall-arrest harnesses, the risk assessment must cover a rescue plan – all scaffolders must wear ***and*** use harnesses.

We must state exactly what people's responsibilities are, the client, the planning supervisor etc. – also trades that we are killing: make it quite hard–hitting to the lads on site.

Enforcement is an issue – new-build is far more rigid in what you can and can't do, and policed more – maintenance requires more clear guidelines on responsibilities.

Behaviour, attitude, culture

During a fall from tenement roof, the guy had no harness on and had only gone up to do a little bit of mastic work!

With small contractors, supervisors are all for harnesses, but when gang goes out it all depends on effort and culture change.

Most of industry is now wearing harnesses, but are just not clipped on – one of major barriers is behavioural.

Workers do their own risk assessment, and generally believe that "*it will never happen to them*"

Experience: 10% claim that the system is too difficult to work with, and 90% just do not clip on.

Similar excuses come up during the summer; safety helmets are too hot; when wearing gloves we can't use our hands properly.

The PPE industry needs comfortable systems.

The person selecting PPE does not consider the person wearing it and what work they're going to be doing.

Industry properly using harnesses is largely fantasy: they are not used by workmen and not adequately enforced by supervisors/managers. Therefore, we don't stand much chance, in the short term, of changing attitudes.

It is a policing factor – car seat belts were high profile; people were stopped, people were fined, and attitudes changed – it can be done.

Workers don't clip onto the rail when only going on there for 2 minutes – they try to get the job done as easily as possible.

Workers at BNFL have no problem with wearing harnesses – they know they've potentially got a job for 20 years if they don't break safety rules.

It's up to the client – you either do it BNFL's way or you don't do it at all. This is the way it should be, but management strength in the outside industry is difficult.

There is a culture; a way of thinking and mindset of the people who are using equipment.

The problem stems from complacency, '*I can do this with my eyes closed, I'll not use my harness, I'm only going be up here for quarter of an hour, don't need it*'

Control and supervision

A worker fell 130ft down an industrial chimney – he was knocked off by moving steelwork. On this occasion, the whole management system had been bypassed.

Enforcement has to be from the top level, but the most important guy is the supervisor.

Styles and quality of harnesses these days is good, lightweight and flexible; once you've had it on for a few hours, it's not an issue.

Education will be long–term thing – at present nothing actually happens to people not using harnesses.

SPECIFIC ISSUES

Planning

There is a danger in refurbishment work from falling through open joist work when all the floors are stripped out.

A fall through joist work was caused by a joist that was rotten and had subsequently failed.

Risk duration and exposure: carry out a risk assessment, make a judgement – but small maintenance contractors haven't a clue what RA means. We have some sympathy because often we're not sure that we know what we're on about!
If you're going on a roof every day, you must have guardrails and toe boards around it. If access is required every 5-years to clean out the gutters, and do a bit of minor maintenance, then harnesses and lines are acceptable – whether you use a fixed anchorage or a line system depends on the geography of the roof.
The old Construction Regulations: had to have edge-protection on a roof, unless you were doing short-term work, i.e. about a half-day's duration, e.g. re-pointing a chimney head, replacing a few slates, or repairing the flashing. For re-slating a roof, edge protection is required. If you're going onto a roof once a month, you have to start making judgements, how far is the fall? Is it a completely fragile roof or just fragile roof lights? If the roof is not fragile at all, we are just dealing with the eaves or gables, and how to protect those? Where are you going onto the roof? On a flat roof, it may well be you're only going to one small area frequently and can delineate where you're allowed to go – you can make helpful statements about how to make judgements, but it's difficult to be hard and fast – it's doing a risk assessment, but may not be very helpful telling people that's what they're doing.

Control of subcontractors

At BNFL, part of the scaffolding and roofers agreements is that they wear harnesses at all times. They are required never leave cabin without harness on, even if working on the ground the whole day. It is generally accepted that workers would never go ***back*** to cabin for harnesses if they had to go up a height for 5-minutes. Management need to 'buy in' right at the top, and with trade union support the workplace should be a safer place.
When considering safety during maintenance of existing buildings, it is not stringent and there's not the policing that is afforded in new-build. If a worker is changing a couple of tiles, he won't be going to do a half–day induction and prove you've been on a course.
There is a definite difference between well-controlled construction and maintenance / refurbishment on existing premises.

Technical Issues

Harness-type restraint systems limited by the number of personnel that can be attached and once you finish the project, the onus is on the building manager or client to re-validate the system.
A ballasted handrail system is the preferred option.
At BNFL we put a double guardrail with access ladders and restricted access – it's easier to control and there is not the need for extensive maintenance and re-certification after 12-months. This allows more access onto roof and gives more freedom to client. It is endorsed by the HSE and easy to install – we still use specialist anchor points on occasions, but have now got a project to put Safesite handrail system on over 200 buildings. We are also replacing fragile roof lights.
We must assess system suitability for each individual application: factors like frequency of use, frequency of access onto a certain area, aesthetics on some buildings (e.g. Edinburgh Castle won't allow barrier systems).
For frequent access, we should use systems that are 'user-friendly', i.e. they need less training.
A lot of people use harness and just tie off anywhere, without considering falling through roofs, pendulum effects, fall arrest distance – each case requires to be looked at on a site specific basis, e.g. kind of work and building environment.
Workers are not keen to wear harnesses, but we have listened to them and changed to different types of harness and they are now quite happy to wear them.

During some tasks, clipping on by a line makes the task significantly more difficult, e.g. moving across a roof, relying on an anchorage system, maybe running line systems would be better. In many instances you are looking at having 2 lanyards, for example, by way of getting on 4-storey tenement roof is coming through a hatch onto the roof halfway up – you've then got to get from the hatch to the ridge to clip on. 2 lanyards would ensure that you are always clipped on (either in the attic or on the anchor bolt just at the attic).
Birdcage scaffold is big inconvenience to occupants, but it's good fall–prevention – anchors and wire systems also used quite extensively.
Each system has a place: fall arrest mats are recommended for concrete erectors, because safety nets aren't practical with newly–built walls; areas where people are laying roofs, safety netting is the most practical.
Each system has it's merits and it's place – more often than not, you don't have a lot of choices.
Anchor systems and cable–based systems are suitable for short–term maintenance work – but for completely new roof covering, consider something different – for re-covering an asbestos roof, removing the old sheets or not, netting is appropriate. In some cases it is difficult to use nets, e.g. whiskey bonds, with whiskey stacked to within 6-inches of the roof and you can't get a net in. You would then be looking at alternatives like purlin trolleys.
Line and cable systems, permanent or temporary, horizontal and vertical, provide a safe operational base. In asbestos-sheeted roofs, you could have crawl boards ***and*** a complete harness system.
As soon as anyone goes near the roof, they must hook on, and then can operate horizontally and vertically.
For a fragile roof, go with safety netting; but for a pitched roof, roof anchors or a wire system.
If the lad's feel unsafe, they don't go up until it's put right.
For flashings or anything like that, the MEWP is as good as anything.
It is horses for courses; cable-based systems, anchorages and those sorts of things, for short–term work. Also for short–term work MEWPs are great providing you can get them in. Nets are great but it depends on what is in the building below. Purlin trolleys, depending on what the roof is like, are appropriate for complete roof re-covering. When re-skinning asbestos roofs, you can't use a purlin trolley. A whiskey bond could put fall–arrest mats in the gangways, if work only 6–inches above the casks. Some organisations are still using crawling boards on some industrial roofs but not doing it very well. Considering that acres and acres of these roofs need replacing over next 20/30 years, we need to get to grips with it.
Uniline have a cable-based system that can span 30-50m without intermediate brackets, eliminating using roof for anchors (in many circumstances). They build-in structural anchors at the either end of the roof, and the system spans without any load on roof. For re-roofing the whole roof, it's not the ideal solution but some maintenance can use it.
The guide should stress periodic inspections for all forms of equipment, appropriately documented.
There were suggested problems with wear on harnesses and lines, where the line is meeting the harness.
HSG 33 is a good guide for working at heights and on roofs etc. Within the report, more practical examples and photographs would be good for the SMEs.
Certain equipment has a different colour embedded to warn of excessive wear point.
We should have a practice of checking everything, harness lines, and other equipment – not a specific requirement of law, but is a legal requirement.
Organisations should be checking that the equipment that you are buying is up to PPE Directive standard – there is still some equipment on the market that is not CE-certified.

With a running line, there is a danger of tightening the wire too tight; this could act as a catapult if the fellow fell!
We require examples of developed refurbishment or maintenance strategy, the best safety system for that particular kind of roof.
Also, step-by-step hints: e.g. a harness can be used for light work; a crawl board can be used where there's no other system; etc.

PPE
A window cleaner used harness and lanyard; he slipped, his fall was arrested, and he was left dangling – his mate managed to drag him back. He was extremely grateful of having used his equipment on this particular occasion**.**
Workers won't wear difficult and awkward harnesses.

FOCUS GROUP 7 ANALYSIS – SAFETY DECKING

CLASSIFICATION OF ISSUES

GENERIC ISSUES

- HSE appeared very positive about the systems
- Raised issues about decking in position for in excess of 7-days – how is the inspection of this approached in light that it should be inspected and treated as scaffolding (HSG 150)
- Issues raised on trips on the level for all three systems if overlapped
- Ultraviolet degradation issues were highlighted and raised as the biggest cause for 'enemy' for both plastic systems (Sure Deck and Safety Deck)
- The systems can be up to 40% more expensive than other safety systems (e.g. safety nets), however it is believed that clients must look towards the benefits of these systems, as they provide working platforms and a higher degree of protection under the hierarchy of risk control; fall prevention as opposed to arrest protection
- Gary Gillan will approach all three manufacturers to obtain copies of their method statements and risk assessments
- Suggested that clients are looking towards manufacturers being affiliated to recognised regulatory authorities such as FASET – suggested that the safety decking industry go down this route. This was taken on board, with thoughts of potentially contacting FASET to enquire about the specifics of membership
- All systems are non-mechanical, i.e. require no power source to perform their function
- Does the Precast Flooring Federation (PFF) endorse safety decking as a preferred method of fall protection (as they do with nets / mats)?
- A suggestion was to create infill panels for non-standard shapes for all systems
- Also, to provide different coloured (e.g. luminous yellow) decking panels that are raised off of the level to highlight to the user that it is a trip hazard
- Cost issues raised in relation to operative refusal to accept the system is a benefit, as this could lead to a reduction in their rates
- CSCS cards – there exist no competency cards for installers – is there a new card being devised? If not, how do the members expect to comply with CSCS scheme?
- Issues of Manual Handling Operations Regulations in relation to repetitive tasks (installation and dismantling)
- Is it thought that transportation is easier than other systems
- What control measures are in place to ensure that platforms are not used as material storage areas

OXFORD SAFETY COMPONENTS – SAFETY TRELLIS SYSTEM

- Developed by carpenters as there was nothing in place to stand on when fixing and bracing trusses during new build – John and David's company employed 100 men in this industry – PPE was awkward to use and there was a problem of finding suitable anchorage points
- Annually removed from side, tested, reconditioned and put back into service
- Lifespan – recycled after 2-years

- Maintained and tested every 4-6 weeks on site (this is a recorded visit)
- Training given on delivery to site – minimum of 4-hours spent on training at this time – training refreshed at every maintenance visit (if required). On successful completion of the training, the trainer will certify that the individual is competent to use the system, and will issue a card stating this
- Trainers always carry spare mats with them
- The strength of the system is in the trellis configuration; not the rivets
- The system is installed very quickly after toolbox training of the users
- Used in domestic housing market and with Local Authorities for providing a working platform when working in attic spaces, as the mats fold down to sizes small enough to fit through attic hatches – these mats are plastic-coated aluminium (which is a good conductor for electricity), but are plywood laminate (which is non-conductive)
- Construction sequence: the flooring below will always be decked with plywood sheeting or equivalent – this practice is not normal Scottish practice; possibly English practice?
- The mats open up and rest on the joist arrangement and can then be walked on and worked from
- The longer the mats spread out, the stronger they become
- The Safety Trellis System (STS) is flexible in that it forms to the profile of the trusses on which they rest, which aren't always 100% true
- It is a lightweight working platform and is designed to hold approx 150Kg, which equates to one man and his tools
- The mats are definitely not loading platforms and this would be enforced through training, monitoring and quality checking on site
- Gaps – nails and other small objects could go through the gaps, but it is extremely unlikely that anything large could go through the mesh configuration
- Even if the mat were struck by a heavy object (e.g. falling heavy block), the object would not pass through the system
- There is little possibility of using damaged mats as they will not open and close correctly – the system is reliant on the trellis concept of opening and closing
- Manual handling – the mats fold down to 1.0m x 0.7m and weigh around 10/11Kg
- There is no issues of catching the tradesmen's fingers by closing the mats completely as there are 'anti-finger traps' fitted to all mats to prevent full closure of the trellis
- All mats are a 'trellis' configuration connected by aluminium rivets – all of the system is made of the same grade of aluminium
- The mats interlock with each other, and as such provide a level trip-free platform, however if overlapped they will provide a tripping hazard of approx 13mm, but this was deemed to be negligible
- All mats are painted red at the edges to signify to the users that that is the edge of the platform
- Tipping – there are no problems with the mats tipping as they are tied to the trusses at each end on installation, forming adequate restraint
- Using the system breeds confidence, and was likened to walking on a scaffold or in a MEWP – it takes time to get used to it
- Clients are increasingly using the mat systems in conjunction with 'bean bags' to provide fall prevention and arrest in the one installation
- Oxford SC have a quality control procedure in place in the form of a database of history for all mats made – when they are manufactured (date, time), where they have been / are being used, by whom, for what, what maintenance/repairs have been carried out (if any), etc.

- Further, the system is rented to industry only; not sold – this provides adequate control for policing the system by the manufacturers
- The system is still very much in its infancy, hence the emphasis on appropriate monitoring and policing of the system at this time
- The testing of the system is using both dynamic and static loads applied to the positioned mat (further testing information is in the brochures provided)
- OSC also manufacture an Independent Trellis System (ITS) using the same mats, but with props below for works that have not reached roof level – the props require a reasonably level floor surface on which to stand and support the mats
- Also the ITS is reliant on the surrounding walls for lateral support
- Another adaptation of the original STS is the Stair Deck which is tested to support up to 1.5 tonnes – this is a moveable stair protection system, which forms a working surface when closed and secured in position
- There was a recommendation of adapting the system to be used during the refurbishment of whisky bond roofs – David confirmed that the system is designed for maximum joist centres of 600mm, but would consider re-approaching this if required – 1200mm centres in many whisky bonds
- It is not only carpenters who can use the systems – any works in or around the roofing area can be accessed from the system, e.g. roofers
- The STS is not reliant on props, therefore is not reliant on flooring conditions and is also not influenced by verticality of supports – all the system requires is that the roofing trusses / joists are in position
- Environmental conditions – for the environment in which they are used, very little affects the system as it is manufactured solely from aluminium, however care must be taken when working in extreme weather and/or chemically-influenced areas

TARMAC SAFETY DECK

- The system was invented by another organisation approx 7-8 years ago (referred to as the Graceland system), and the company was bought over by Tarmac as they were using the system regularly for various work tasks
- Issues of plumbness and verticality of the support poles (BS 5975 – Falsework) – dismissed as negligible by Roger
- Human-eye judgements are used to assess the verticality of prop components
- The system support props rests on the flooring below and the system is laterally supported by the external walls
- The issue of support by the walls was addressed and concerns were raised about the pressure on the brick/blockwork if they were not afforded the appropriate curing time; this was answered by confirmation that on many occasions the system is being used in the installation of pre-cast flooring panels, thus the walls require sufficient curing time in order to receive the loading from the panels, thus this is not an issue
- As the system relies on lateral stability, the whole working area is normally decked-out at one time. If the area was excessively large, the installation could be progressive, however this raised issues about how stability would be obtained at the leading edge, and how the area would be demarcated to ensure no operatives could approach this exposed edge
- If the flooring below is undulated, the decking will tend to follow this profile as all support poles are the same length and non-adjustable (2.05m in height).

- As the props are attached at the top, severe undulations of the floor will cause the affected props to lift off the floor, particularly when a load is applied to the opposite side of the panel
- The system comprises 'waffle' grip flooring panels (1.2m x 1.0m x 0.05m), supported by plastic supporting props. At the top of the props, a flange arrangement is used to connect the props to the grid – this acts as a connector of the panels together as it is used at the corners of the panels and can take 4 support poles. There are 5 support props used for each panel – 1 at each corner, and 1 in the middle of the panel, though the corner props may support from one to four panels. All fittings are push fittings, i.e. pushed into position with no secure locking arrangement. The props are secured via tying from the top of the panels and connecting onto the poles below
- Decking panel is 7Kg; support props are 1.2Kg
- There exists a restriction on the height of the system as the support props come in one height, and cannot be adjusted
- The decking panels are non-adjustable, therefore they can't be used in spaces smaller than the panel size
- The system is a lightweight working platform positioned just below the working surface area and capable of supporting a person and their light tools – it was suggested that it would support a dead load of a pallet of bricks, but it is not recommended that anything more than the operative and their tools be taken onto the system
- As the decking panel is manufactured with spaces on the surface, there exists a possibility that small objects could pass through these gaps, however as the system is erected using the props at small centres, it is extremely unlikely that there would be operatives working below who would be at risk of being struck by falling objects
- In non-standard room shapes (e.g. at bay windows), the decking panels are overlapped to provide continuous protection, however this provides the user with a tripping hazard of 50mm, and raises issues about the support of the props below if they are raised up higher than the other props. Innovative suggestions were to use different coloured decking panels at any area where an overlap had occurred – this would highlight the danger to the users, and adapting the flange arrangement for use at the bottom of the props as and when required to provide a level supporting surface
- HSE have a recent initiative looking at falls from the level, therefore this area cannot be ignored
- Is always inspected prior to start of work
- The system is currently tested using a series of drop test on the system in a series of different positions, e.g. with or without tie straps, in various stages of prop verticality, etc.
- The system components are inspected for defects and/or damage prior to use and during dismantling.
- Quality control of products from site to site
- Quarantine of components out of service
- The system components are recommended to have a lifespan of 5-years
- The system components are manufactured with a UV-inhibitor added to combat harmful UV-rays causing degradation
- Training is provided to all hirers on how to install and dismantle the system – the trainer will then view the operatives carrying out these functions to assess their competency prior to leaving the site
- Installation times are said to be extremely quick, with a standard dwelling room being installed in approximately 30-minutes

- The system was originally designed for the pre-cast flooring industry, but has evolved to be a product suitable for flooring, roofing and finishing trades
- The system was only ever hired out, but recently Tarmac have started selling the system to users
- When installed, the system allows full freedom of movement in the working area
- It is transported in 7.5-tonne vehicles and is typically installed in the day/s prior to the fall protection being required

HL PLASTICS SURE DECK

- The system is not yet classified as a working platform, but due to recent innovations in the components used to make up the deck (i.e. the introduction of a central support transom and additional support prop), this stance is likely to change in the near future. "The Suredeck system solely provides fall protection and is not to be used as a working platform, for foot traffic or for the stacking of materials" (Suredeck Method Statement)
- The system was originally manufactured with 4-props – one at each corner
- Presently, the system is advertised as 'passive fall protection for working at height inside buildings'
- For use during concrete and timber flooring, and roof truss erection
- Is lightweight (decking panel 10kg, props 2kg each), easy to handle and economical to transport and store
- Each decking grid is 1.22m x 0.82m making the overall size $1.0m^2$
- The system is not installed and used by HLP as they are not classified as a service company, but is distributed on a hire-only basis to an approved user/installer
- The system can be 'tagged' [this is not yet procedure for this system, but is likely to be in the future] with inkjet marking to show date and time of manufacture for improved quality control – this concept was adopted from OSC monitoring and policing procedures
- For replacement of damaged system components, as all components are plastic and HL Plastics are manufacturers of plastic products, the plastic is recycled. For this, HLP adopt a rigorous quarantine procedure for the recycling process – this ensures that no defective components are likely to make their way back into service by mistake
- The system is very similar in concept to the Tarmac Safety Deck system
- Support props are push-fitted to the bracket that is secured to the underside of the decking panel; prop is secured using a pin arrangement
- The system relies on lateral stability from the surrounding walls
- The system is supported by the floor below. All of the props are the same length (1.8m x 0.065m x 0.065m); if the props are resting on an uneven floor, there are designed packing fillets that fit to the bottom of the props to raise the height of the component if required
- Due to the ABS advanced plastic used, the components (in theory) will last for 40-years – this, however does not take account of the physical wear and tear the system will endure on site, and through regular site use
- Gaps – the gap between the slats on the decking panel are approximately 55mm, which provides roughly the same protection for falling tools/materials as the previous two systems
- The components are manufactured from recycled PVC extrusions and injection mouldings
- All platforms are manufactured in the factory, and are made up of decking panels incorporated in a frame, supported by pinned props – all component materials are: HDPE; PVC; polypropylene; ABS; UPVC
- This system appears to have more component parts (i.e. 'bits') than the previous systems

- The components can be stored outside without danger of damage from the elements
- The system can be flat-packed for lower transportation volume (and costs)
- It is said to be quick and easy to install and dismantle, with the decking platform sitting on retainer clips, which are pressed into the box section props. A locking pin is then passed through both the retainer clip and the frame to secure the props in position
- The props are secured using cable straps
- If overlapped, the trip hazard will be 90mm
- The system is strong and durable, but lightweight enough to be easily handled
- Components are tested to ACR[M]001:2000 – the panels passed as Class A under this test
- Up to 500kg can be supported as a distributed load
- The system is normally only erected and used for 'a day or two' at a time
- HLP contributed to Ciria 649 – Safe Access for Maintenance and Repair
- The system is now being sold as a package to interested parties – as part of the package, appropriate training support is provided

APPENDIX 3

SITE INTERVIEW QUESTIONS

APPENDIX 3

The following information details the list of questions asked to managers, supervisors and users of the safety systems within this report. In addition to interviewing industry users, manufacturers of the safety systems were interviewed for technical input and guidance. The following table details the number of manufacturer interviews for each safety system:

System	***Manufacturers Interviewed***
Purlin trolley systems	2
Safety Decking	5
Fall arrest mats	2
Safety nets	2
Cable and track-based safety systems	11
SG4:00	4

MANAGEMENT QUESTIONS

Generic Issues

Planning

1. In your planning for safety, how does this relate to the selection of height safety equipment?
2. How does your organisation plan for safety?
3. When do you plan for safety?
4. Who is responsible for safety planning?
5. Is this practiced planning considered as Best Practice? If not, how could it be improved?

Accident and Incident Experience

1. Do you use history of equipment use in your selection of height safety equipment?
2. If so, what information do you use?
3. How do you use this information?
4. Where does this information come from?
5. Who is responsible for collecting and utilising this information?
6. When would this information be sought for effective selection?
7. Is this usage of information considered as Best Practice? If not, how could it be improved?

Cost

1. Is cost taken into account in the selection of fall prevention/arrest equipment?
2. If so, what costs are taken into account?
3. How are costs taken into account?
4. When are costs taken into account?
5. Who is responsible for taking cost of equipment into account?

6. Is this considered as Best Practice? If not, how could it be improved?

Culture

1. Do you take culture into account in the selection of fall prevention/arrest equipment?
2. If so, how is culture taken into account in the selection process?
3. Where/when is culture taken into account in equipment selection?
4. Who is responsible for taking culture in equipment selection into account?
5. Is this culture consideration Best Practice? If not, how could it be improved?

Design and Supply Chain Issues

1. Do designers influence the selection of fall prevention/arrest equipment?
2. If so, how do they influence the selection process?
3. When do the designers influence selection of fall prevention/arrest equipment?
4. Where do designers have an influence on equipment selection?
5. Who is responsible for the design aspect of fall prevention/arrest equipment selection?
6. Can the design influence be considered as Best Practice? If not, how could it be improved?

Client's Role

1. Should clients influence the selection of fall prevention/arrest equipment?
2. If so, do they influence the selection process?
3. How do clients influence the selection of fall prevention/arrest equipment?
4. When do clients have an influence in the selection of fall prevention/arrest equipment?
5. Is client's influence considered as Best Practice? If not, how could it be improved?

Monitoring and Policing

1. Do you monitor and police the use of fall prevention/arrest equipment?
2. If so, how do you monitor and police the correct use of the safety system?
3. When do you monitor and police the safety systems?
4. What do you monitor and police?
5. Where does this monitoring and policing take place?
6. Who carries out this monitoring and policing?
7. Is this method of monitoring and policing considered as Best Practice? If not, how could it be improved?

Training

1. Do you organise training in the selection and/or use of fall prevention/arrest equipment?
2. If so, who is responsible for organising this training?
3. Who should be trained?
4. How is this training organising carried out?
5. When is the training carried out?
6. What training is organised by the organisation?
7. How is this training monitored to ensure it is adequate and relevant?
8. Is this training regime considered as Best Practice? If not, how could it be improved?

TOPICS TO ASK THE SUPERVISORS OF THE USERS OF THE SYSTEM

Influence on Work Activity

1. How does the system interface with your work?
2. When does the system have an influence on your work?
3. Where does the system have an influence on your work?
4. Is this considered best practice? If not, how could this be improved?
5. Does using this system impose any restrictions on access to other works?
6. Is this considered best practice? If not, how could this be improved?

Rescue

1. Is rescue an issue with mats?
2. If so, what provisions for rescue are made?
3. Who is responsible for providing rescue provisions?
4. When are rescue provisions necessary?
5. Where is the rescue information required?
6. Is this considered best practice? If not, how could this be improved?

Training

1. Is training required for the use of the system?
2. If so, what training is required?
3. Who is required to undergo the training?
4. When would this training be required?
5. Where would the training be carried out?
6. How is the training recorded/documented?
7. Is this considered best practice? If not, how could this be improved?

Reliability

1. Is the system reliable?
2. Is the system technically reliable?
3. Do you have confidence in the system?
4. Is the system robust – strong enough for site conditions, or easily damaged?
5. Is this considered best practice? If not, how could this be improved?

Storage

1. Is the system stored when not in use on site?
2. If so, when is the equipment stored?
3. Where is the equipment stored?
4. How is the equipment stored?
5. Who is responsible for storing the equipment?
6. Is this considered best practice? If not, how could this be improved?

Maintenance

1. Is the safety system maintained – i.e. is maintenance required?
2. If so, what maintenance is carried out?
3. Who is responsible for the maintenance of the equipment?
4. When is this maintenance carried out?
5. Where is this maintenance carried out?
6. How is this maintenance carried out?
7. Is this considered best practice? If not, how could this be improved?

Other general areas to cover:
Simplicity, flexibility, versatility, adaptability etc (in comparison to other systems?)

QUESTIONS TO THE USERS AND INSTALLERS OF ALL SAFETY SYSTEMS WITHIN THE REPORT FOLLOWED THESE SPECIFIC QUESTIONS

We require to establish the overall **advantages and disadvantages** of the system through a series of questions, covering the following areas:

Topics to ask the users/installers of the system (*circle which*):

Influence on Work Activity

1. Does the system affect the way you carry out your work – help *or* hinder?
2. If so, how does the system affect your work?
3. When does the system have an influence on your work?
4. Where does the system have an influence on your work?
5. Is this considered best practice? If not, how could this be improved?

Reliability

1. Is the system reliable?
2. Is the system technically reliable?
3. Do you have confidence in the system?
4. Is the system robust – strong enough for site conditions, or easily damaged?
5. Is this considered best practice? If not, how could this be improved?

Storage

1. Is the system stored when not in use on site?
2. If so, when is the equipment stored?
3. Where is the equipment stored?
4. How is the equipment stored?
5. Who is responsible for storing the equipment?
6. Is this considered best practice? If not, how could this be improved?

Maintenance of Equipment

1. Is the safety system maintained – i.e. is maintenance required?
2. If so, what maintenance is carried out?
3. Who is responsible for the maintenance of the equipment?
4. When is this maintenance carried out?
5. Where is this maintenance carried out?
6. How is this maintenance carried out?
7. Is this considered best practice? If not, how could this be improved?

System Handling

Are there any problems in Handling of the system?

Posture & movement *(task & workplace, effort, duration, load)*
Information & operation *(instructions, signage, dialogue)*

Environmental Issues *(noise, weather, light, PPE)*
Tasks & jobs undertaken *(control, communication, progress)*

APPENDIX 4

SYSTEM-SPECIFIC BRITISH STANDARDS (BS) & EUROPEAN NORMITY (EN) STANDARDS

APPENDIX 4

The following information documents the relevant British Standard and European Normity Standards relating to the safety systems within this research. ***Note:*** Fall arrest mat standards are not listed in this Appendix as the relevant standards are dealt with in Chapters 6.

PURLIN TROLLEY SYSTEMS

All fall arrest systems & PPE equipment need regular inspections and re-certification in accordance with BS EN 355: 1993 Personal Protective Equipment against falls from height - General requirements for instruction for use and marking. The following British and EN Standards (in date order) are considered to be the most relevant to the manufacture and use of purlin trolleys:

BS 5247-14:1975	Code of practice for sheet roof and wall coverings. Corrugated asbestos-cement
BS 476-3:1975	Fire tests on building materials and structures. External fire exposure roof test
BS 6367:1983	Code of practice for drainage of roofs and paved areas
BS 8000-6:1990	Workmanship on building sites. Code of practice for slating and tiling of roofs and claddings
BS 8213-1:1991	Windows, doors and rooflights. Code of practice for safety in use and during cleaning of windows and doors (including guidance on cleaning materials and methods)
BS 5516:1991	Code of practice for design and installation of sloping and vertical patent glazing
BS 8118:1991	Structural use of aluminium
BS EN 501:1994	Roofing products from metal sheet. Specifications for fully supported roofing products of zinc sheet
BS EN 485-2:1995	Aluminium and aluminium alloys. Sheet, strip and plate. Mechanical properties
BS 5427-:1996	Code of practice for the use of profiled sheet for roof and wall cladding on buildings. Design
BS 6399-1:1996	Loading for buildings. Code of practice for dead and imposed loads
BS 6399-2:1997	Loading for buildings. Code of practice for wind loads

BS EN 1172:1997	Copper and copper alloys. Sheet and strip for building purposes
BS 476-7:1997	Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products
BS 8110-1:1997	Structural use of concrete. Code of practice for design and construction
BS 7916:1998	Code of practice for the selection and application of particleboard, oriented strand board (OSB), cement bonded particleboard and wood fibreboards for specific purposes
BS 8233:1999	Sound insulation and noise reduction for buildings. Code of practice
BS 6651:1999	Code of practice for protection of structures against lightning
BS 5950-1:2000	Structural use of steelwork in building. Code of practice for design. Rolled and welded sections
BS EN 10142: 2000	Continuously hot-dip zinc coated low carbon steels strip and sheet for cold forming. Technical delivery conditions
BS 6915:2001	Design and construction of fully supported lead sheet roof and wall coverings. Code of practice
BS EN ISO 13788:2002	Hygrothermal performance of building components and building elements. Internal surface temperature to avoid critical surface humidity and interstitial condensation. Calculation methods
BS 5250:2002	Code of practice for control of condensation in buildings
BS 5268-2:2002	Structural use of timber. Code of practice for permissible stress design, materials and workmanship
BS 6229:2003	Flat roofs with continuously supported coverings. Code of practice

SAFETY DECKING

The following information documents the relevant British Standard and European Normity Standards relating to the safety systems within this research, in date order.

BS 5507-1:1977	Methods of test for falsework equipment. Floor Centres
BS 5507-3:1982	Methods of test for falsework equipment. Props
BS 4074:2000	Specification for steel trench struts (Appendix A)
BS 1129:1990	Specification for portable timber ladders, steps, trestles and lightweight stagings
BS 1139-5:	Metal scaffolding. Specification for materials, dimensions, design loads and safety requirements for service and working scaffolds made of prefabricated elements
BE 13973:2002	Rigid plastics containers. Method for determination of drainability
BE 16929:2002	Plastics. Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test
BS 2037:1994	Specification for portable aluminium ladders, steps, trestles and lightweight stagings
BS 5974:1990	Code of practice for temporarily installed suspended scaffolds and access equipment
BS 6180:1999	Barriers in and about buildings. Code of practice
BS 6399-1:1999	Loading for buildings. Code of practice for dead and imposed loads
BS 648:1964	Schedule of weights of building materials
BS 8118:1991	Structural use of aluminium.

SAFETY NETS

Safety nets control by codes of practice and British Standards is extensive. The following British and EN Standards (in date order) are considered to be the most relevant to the manufacture and use of safety nets:

CP 93:1972	Approved Code of Practice for the use of safety nets on constructional works *Gives guidance for the use of safety nets on construction, demolition and maintenance works. Covers planning, design, erection, dismantling and care of safety nets and includes typical safety net arrangements associated with specific types of structures*
BS 3913:1982	Specification for industrial safety nets *Gives requirements for safety nets to catch personnel and/or debris falling during work at elevated places.*
BS 8093:1991	Code of practice for the use of safety nets, containment nets and sheets on constructional works.
BS EN 1263-1:1997	Safety nets. Safety requirements, test methods. *Applicable to safety nets and accessories used in construction, scaffolding, false work and assembly work. It is not applicable to the installation of safety nets.*
BS EN 1263-2:1998	Safety nets. Safety requirements for the erection of safety nets. *Does not cover small safety nets less than 35m^2 in area and 5m on the shortest side.*
BS 7955:1999	Containment nets and sheets on construction works – Specification for performance and test methods.
BS EN 1263-1:2002	Safety nets. Safety requirements, test methods. *As above.*
BS EN 1263-1:2002	Safety nets. Safety requirements for the positioning limits. *As above.*
BS 8410: Draft for public comment.	*Code of practice for containment nets, sheets and glass-reinforced plastic profiled sheets on construction works*
BS 8411: Draft for public comment.	Code of practice for safety nets on construction sites and other works.

Bs 8410 AND 8411 have been completed for around 12 months, but remains unpublished (February 2004). Various factors were suggested as to why BSI has yet to publish these documents. As the draft standard has now been completed for over 2-years, it is possibly out of date. Industry awaits further clarification as to the possibility of future guidance for safety netting.

CABLE AND TRACK-BASED SAFETY SYSTEMS

All fall arrest systems & PPE equipment need regular inspections and re-certification in accordance with BS EN 355: 1993 *Personal Protective Equipment against falls from height - General requirements for instruction for use and marking*. BS EN 363:2002 *Personal protective equipment against falls from a height*. Fall arrest systems, is the main publication covering protecting against falls from height, to which all other EN's must conform.

The Construction (Design and Management) Regulations 1994 (CDM) identify those responsible (i.e. the duty holder) for the provision of safe means of access. They include persons who have any form of control over a building, employers, subcontractors and building designers. Such duty holders may need to consult any of the following publications (listed in date order):

BS EN 341:1993	Personal protective equipment against falls from a height. Descender devices
BS EN 362:1993:	Personal protective equipment against falls from a height. Connectors
BS EN 364:1993:	Personal protective equipment against falls from a height. Test methods
BS EN 365:1993:	Personal protective equipment against falls from a height. General requirements for instructions for use and for marking
BS EN 516:1995	Prefabricated accessories for roofing. Installations for roof access. Walkways, treads and steps
BS EN 517:1995	Prefabricated accessories for roofing. Roof safety hooks
BS EN 919:1995	Fibre ropes for general service. Determination of certain physical and mechanical properties
BS EN 1496:1996	Rescue equipment. Rescue lifting devices
BS EN 1497:1996	Rescue equipment. Rescue harnesses
BS EN 813:1997	Personal protective equipment for prevention of falls from a height. Sit harnesses
BS EN 892:1997	Mountaineering equipment. Dynamic mountaineering ropes. Safety requirements and test methods
BS EN 795:1997	Protection against falls from a height – Anchor devices – Requirements and testing (N.B. - currently under review)
BS EN 7883:1997	Code of practice for application and use of anchor devices conforming to BS EN 795

BS EN 1891:1998	Personal protective equipment for the prevention of falls from a height. Low stretch kermantel ropes
BS EN 358:2000	Personal protective equipment for work positioning and prevention of falls from a height. Belts for work positioning and restraint and work positioning lanyards
BS EN 353-1:2002	Personal protective equipment against falls from a height. Guided type fall arresters including a rigid anchor line
BS EN 353-2:2002	Personal protective equipment against falls from a height. Guided type fall arresters including a flexible anchor line
BS EN 354:2002	Personal protective equipment against falls from a height. Lanyards
BS EN 355:2002	Personal protective equipment against falls from a height. Energy absorbers
BS EN 361:2002	Personal protective equipment against falls from a height. Full body harnesses
BS EN 363:2002	Personal protective equipment against falls from a height. Fall arrest systems
prBS 8437	Selection, use and maintenance of fall protection systems and equipment for use in the workplace
prBS EN ISO 1140	Fibre ropes. Polyamide 3, 4 and 8 strand ropes
prBS EN ISO 1141	Fibre ropes. Polyester 3, 4 and 8 strand ropes

SG4:00 THE USE OF FALL ARREST EQUIPMENT WHEN ERECTING, ALTERING AND DISMANTLING SCAFFOLD

The following British and EN Standards (in date order) are considered to be the most relevant to the manufacture and use of the equipment utilised during the SG4:00 function:

BS 2482:1981	Specification for timber scaffold boards
BS 1139:1990	Metal Scaffolding
BS 5974:1990	Code of practice for temporarily installed suspended scaffolds and access equipment
BS 5973:1993	Code of practice for access and working scaffolds and special scaffold structures in steel
BS EN 354:1993	Personal protective equipment against falls from a height. Lanyards
BS EN 362:1993	Personal protective equipment against falls from a height. Connectors
BS EN 364:1993	Personal protective equipment against falls from a height. Test methods
BS EN 365:1993	Personal protective equipment against falls from a height. General requirements for instructions for use and for marking
BS 5975:1996	Code of practice for falsework
BS EN 795:1997	Personal against falls from height. Anchor devices. Requirements and testing
BS 6180:1999	Barriers in and about buildings. Code of practice
BS EN 355:2002	Personal protective equipment against falls from a height. Energy absorbers
BS EN 361:2002	Personal protective equipment against falls from a height. Full body harness
BS EN 12811-3:2002	Temporary works equipment – Load testing

prEN 12811-2 Temporary works equipment – Scaffolds – Part 2: Information on materials

All relevant legislation, guidance, and health and safety literature should be researched, as much as is reasonably practicable, prior to carrying out any scaffolding function.

APPENDIX 5

THE WORK AT HEIGHT REGULATIONS 2004: SYSTEM-SPECIFIC REGULATIONS AND SCHEDULES

APPENDIX 5

The following sections of the *draft* Work at Height Regulations 2004 apply to the safety systems included within this report. It is important to note that the above references may be subject to change as the regulations evolve through consultation and subsequent amendment; however they are accurate at the time of submission of this report.

PURLIN TROLLEY SYSTEMS

Interpretation

2. – (1) In these Regulations, unless the context otherwise requires –

"working platform" –

- *(a) means any temporary or permanent platform used as a place of work or as a means of access to or egress from a place of work;*
- *(b) includes any scaffold…which is so used.*
- *(c) does not include a permanent structure*

Avoidance of risks from work at height

6. – (3) …every employer shall take suitable and sufficient measures -

- *(a) to prevent any person falling; and*

General principles for selection of work equipment for work at height

7. – (2) An employer shall select work equipment for work at height which –

- *(a) has characteristics including dimensions which –*
  - *(i) are appropriate to the nature of the work to be performed and the foreseeable loadings; and*
  - *(ii) allows passage without risk.*
- *(b) is in other respects the most suitable work equipment…*

Requirements for particular work equipment

8. – Every employer shall ensure that, in the case of –

- *(a) a guard-rail,…barrier or similar means of protection, Schedule 2 [Requirements for guardrails etc.] is complied with*
- *(b) a working platform, Schedule 2 is complied with.*

Fragile surfaces

10. – (1) Every employer shall take suitable and sufficient steps to prevent any person at work from falling through any fragile surface.

(2)Without prejudice to the generality of paragraph (1), every employer shall ensure that –

- *(a) no person at work passes across, or works on or from, a fragile surface unless suitable and sufficient platforms, coverings… are provided and used so that the weight of any person…is supported*
- *(b) no person at work passes or works near a fragile surface unless there are provided suitable and sufficient guard-rails*

(c) *where any person at work may pass across or near or work on fragile surface, prominent warning notices are…affixed at the approach to the place where the fragile surface is situated*

Inspection of work equipment

12. – (4) Without prejudice…every employer shall ensure that –

(a) *a working platform, other than –*

(ii) a working platform in a position from which a person cannot fall more than 2 metres;

is not used in any position unless it has been inspected in that position within the previous 7 days

SCHEDULE 1: REQUIREMENTS FOR GUARD-RAILS ETC

2. Means of protection shall –

(a) *be suitable and of sufficient strength and rigidity for the purpose…for which they are being used;*
(b) *be so placed, secured and used as to ensure, so far as is reasonably practicable, that they do not become accidentally displaced; and*
(c) *in the case of toe-boards or similar means of protection, shall not be less than 150 millimetres high.*

3. Any structure or part of a structure which supports a means of protection or to which a means of protection are attached shall be of sufficient strength and suitable for the purpose of such support or attachment

4 & 5. Refer to the heights of the guardrails; at least 950mm high, with no gap exceeding 470mm

6. Means of protection shall be so placed as to prevent…the fall of any person…from any place of work.

SCHEDULE 2: REQUIREMENTS FOR WORKING PLATFORMS

Condition of surfaces

2. Any surface upon which any supporting structure rests shall be stable, or sufficient strength and of suitable composition safely to support the supporting structure, the working platform and any loading intended to be placed on the working platform.

Stability of supporting structure

3. Any supporting structure shall –

(a) *be suitable and of sufficient strength and rigidity for the purpose…for which it is being used;*
(b) *in the case of a wheeled structure, be prevented by appropriate devices from moving inadvertently during working at height;*
(c) *in other cases, be prevented from slipping by secure attachment to the bearing surface…provision of an anti-slip device or by other means of equivalent effectiveness;*
(d) *be stable while being erected, used and dismantled; and*
(e) *when altered or modified, be so altered or modified as to ensure that it remains stable*

Stability of working platforms

4. A working platform shall –

(a) be suitable and of sufficient strength and rigidity for the purpose…for which it is intended to be used…

Safety on working platforms

5. A working platform shall –

(a) be supplied with a sufficient means of protection to which Schedule 1 applies;

(b) be of sufficient dimensions to permit safe passage of persons and the safe use of any plant or materials…and to provide a safe working area…;

(c) without prejudice to paragraph (a), be not less than 600mm wide;

(d) be so constructed that the surface of the working platform has no gap giving rise to the risk of injury to any person…;

(e) be so erected and used, and maintained in such condition, as to prevent, so far as is reasonably practicable –

(i) the risk of slipping or tripping; or

(ii) any person being caught between the working platform and any adjacent structure.

Loading

6. A working platform and any supporting structure shall not be loaded so as to give rise to a risk of collapse or to any deformation which could affect its safe use.

SAFETY DECKING

Interpretation

2. – (1) In these Regulations, unless the context otherwise requires –

"working platform" –

(d) means any temporary or permanent platform used as a place of work or as a means of access to or egress from a place of work;

(e) includes any scaffold…which is so used.

(f) does not include a permanent structure

Avoidance of risks from work at height

6. – (3) …every employer shall take suitable and sufficient measures -

(b) to prevent any person falling; and

General principles for selection of work equipment for work at height

7. – (2) An employer shall select work equipment for work at height which –

(b) has characteristics including dimensions which –

(i) are appropriate to the nature of the work to be performed and the foreseeable loadings; and

(ii) allows passage without risk.

(b) is in other respects the most suitable work equipment…

Requirements for particular work equipment

8. – Every employer shall ensure that, in the case of –

(c) a guard-rail,…barrier or similar means of protection, Schedule 2 [Requirements for guardrails etc.] is complied with

(d) a working platform, Schedule 2 is complied with.

Inspection of work equipment

12. – (4) Without prejudice…every employer shall ensure that –

(b) a working platform, other than –

(ii) a working platform in a position from which a person cannot fall more than 2 metres;

is not used in any position unless it has been inspected in that position within the previous 7 days

SCHEDULE 2: REQUIREMENTS FOR WORKING PLATFORMS

Interpretation

1. In this Schedule, "supporting structure" means any structure used for the purpose of supporting a working platform and includes any plant used for that purpose.

Condition of surfaces

2. Any surface upon which any supporting structure rests shall be stable, or sufficient strength and of suitable composition safely to support the supporting structure, the working platform and any loading intended to be placed on the working platform.

Stability of supporting structure

3. Any supporting structure shall –

(a) be suitable and of sufficient strength and rigidity for the purpose…for which it is being used;
(c) in other cases, be prevented from slipping by secure attachment to the bearing surface…provision of an anti-slip device or by other means of equivalent effectiveness;
(d) be stable while being erected, used and dismantled; and
(e) when altered or modified, be so altered or modified as to ensure that it remains stable

Stability of working platforms
4. A working platform shall –
(a) be suitable and of sufficient strength and rigidity for the purpose…for which it is intended to be used…

Safety on working platforms
5. A working platform shall –
(a) be supplied with a sufficient means of protection to which Schedule 1 applies;
(b) be of sufficient dimensions to permit safe passage of persons and the safe use of any plant or materials…and to provide a safe working area…;
(c) without prejudice to paragraph (a), be not less than 600mm wide;
(d) be so constructed that the surface of the working platform has no gap giving rise to the risk of injury to any person…;
(e) be so erected and used, and maintained in such condition, as to prevent, so far as is reasonably practicable –
(iii) the risk of slipping or tripping; or
(iv) any person being caught between the working platform and any adjacent structure.

Loading
6. A working platform and any supporting structure shall not be loaded so as to give rise to a risk of collapse or to any deformation which could affect its safe use.

SCHEDULE 3: REQUIREMENTS FOR COLLECTIVE SAFEGUARDS FOR ARRESTING FALLS
1. Any reference in this Schedule to a safeguard is to a collective safeguard for arresting falls.

2. A safeguard shall be of suitable and sufficient strength to arrest safely the fall of any person who is liable to fall.

3. A safeguard shall –
(b) in the case of an airbag, landing mat or similar safeguard, be stable.

4. Suitable and sufficient steps shall be taken to ensure, so far as practicable, that in the event of a fall by any person the safeguard does not itself cause injury to that person

FALL ARREST MATS AND SAFETY NETS

In relation to fall arrest mats one major reference in the Regulations is that, for the first time in legislation, collective safety systems are cited.

Interpretation

2. – (1) In these Regulations, unless the context otherwise requires –

"personal fall protection system" means –

(a) a work restraint, work positioning, fall prevention, fall arrest or rescue system, other than a system in which the only safeguards are collective safeguards

General principles for selection of work equipment for work at height

7. – (1) Every employer, in selecting work equipment for use in work at height, shall –

(b) *give collective protection measures priority over personal protection measures.*

Requirements for particular work equipment

8. – Every employer shall ensure that, in the case of –

(c)a net, soft landing system or other collective safeguard for arresting falls which is not part of a personal fall protection system, Schedule 3 is complied with;

SCHEDULE 3: REQUIREMENTS FOR COLLECTIVE SAFEGUARDS FOR ARRESTING FALLS

3. Any reference in this Schedule to a safeguard is to a collective safeguard for arresting falls.

4. A safeguard shall be of suitable and sufficient strength to arrest safely the fall of any person who is liable to fall.

3. A safeguard shall –
(b) in the case of an airbag, landing mat or similar safeguard, be stable.

4. Suitable and sufficient steps shall be taken to ensure, so far as practicable, that in the event of a fall by any person the safeguard does not itself cause injury to that person

CABLE AND TRACK-BASED SAFETY SYSTEMS

The forthcoming Temporary Work at Height Regulations has a specific Schedule relating to work equipment. The following sections of the *draft* regulations apply:

Requirements for particular work equipment
8. Every employer shall ensure that, in the case of—

(c) a personal fall protection system, Part 1 of Schedule 4 is complied with;
(f) a fall arrest system, Part 4 of Schedule 4 is also complied with;
(g) a work restraint system, Part 5 of Schedule 4 is complied with

Fragile surfaces
10. – (1) Every employer shall take suitable and sufficient steps to prevent any person at work from falling through any fragile surface.

(3) Where a risk of falling remains…every employer shall provide suitable and sufficient means for arresting his fall, so far as is reasonably practicable.

Inspection of places of work at height
13. Every employer shall ensure that the surface of every place of work at height is inspected visually on each occasion before use.

SCHEDULE 1
REQUIREMENTS FOR PERSONAL FALL PROTECTION SYSTEMS
PART 1
REQUIREMENTS FOR ALL PERSONAL FALL PROTECTION SYSTEMS

1. A personal fall protection system shall be used only if—

(a) a risk assessment has demonstrated that the work can so far as is reasonably practicable be performed safely while using that system;
(b) the use of other, safer work equipment is not justified; and
(c) the user and a sufficient number of available persons have received adequate training specific to the operations envisaged, including rescue procedures.

PART 2
ADDITIONAL REQUIREMENTS FOR FALL ARREST SYSTEMS
1. A fall arrest system shall incorporate a suitable shock absorber or other suitable means of limiting the force applied to the user's body.

2. A fall arrest system shall not be used in a manner—

(a) which involves the risk of a line being cut; or
(b) where its safe use requires a clear zone (allowing for any pendulum effect), which does not afford such zone,

or which otherwise inhibits its performance or renders its use unsafe.

PART 3
REQUIREMENTS FOR WORK RESTRAINT SYSTEMS

A work restraint system shall—

(c) be so designed that—

(i) if used correctly, it prevents the user from getting into a position in which a fall [requiring a fall arrest system] can occur; and

(ii) so far as is reasonably practicable, it does not permit, and cannot be adjusted to permit, incorrect use; and

(d) be used correctly.

SG4:00 THE USE OF FALL ARREST EQUIPMENT WHEN ERECTING, ALTERING AND DISMANTLING SCAFFOLD

The forthcoming Work at Height Regulations 2004 has a specific Schedule relating to safe work on 'working platforms'. The following sections of the *draft* Work at Height Regulations (2004) apply to SG4:00:

Interpretation

2. – (1) In these Regulations, unless the context otherwise requires –

"working platform" –

- *(g) means any temporary or permanent platform used as a place of work or as a means of access to or egress from a place of work;*
- *(h) includes any scaffold…which is so used.*

Avoidance of risks from work at height

6. – (3) …every employer shall take suitable and sufficient measures -

- *(c) to prevent any person falling; and*
- *(d) to the extent that a fall is not prevented, to minimise the distance and consequences of any fall.*

General principles for selection of work equipment for work at height

7. – (2) An employer shall select work equipment for work at height which –

- *(c) has characteristics including dimensions which –*
  - *(i) are appropriate to the nature of the work to be performed and the foreseeable loadings; and*
  - *(ii) allows passage without risk.*

Requirements for particular work equipment

8. Every employer shall ensure that, in the case of –

- *(e) a guard-rail,…barrier or similar means of protection, Schedule 2 [Requirements for guardrails etc.] is complied with.*

SCHEDULE 2: REQUIREMENTS FOR WORKING PLATFORMS

Part 1 - Requirements for All Working Platforms

Stability of working platforms

4. A working platform shall –

- *(f) be so erected and used to ensure that its components do not become accidentally displaced so as to endanger any person;*
- *(g) when altered or modified, be so altered and modified as to ensure that it remains stable; and*
- *(h) be dismantled in such a way as to prevent accidental displacement.*

Part 2 – Additional Requirements for Scaffolding

2. Depending on the complexity of the scaffolding selected, an assembly, use and dismantling plan shall be drawn up by a competent person.

3. A copy of the plan, including any instructions it may contain, shall be kept available at the site for the use of persons concerned in the assembly, use, dismantling or alteration of scaffolding until it has been dismantled.

6. Scaffolding may be assembled, dismantled or significantly altered only under the supervision of a competent person and by persons who have received appropriate and specific training in the operations…and more particularly in –

(a) understanding of the plan for the assembly, dismantling or alteration of the scaffolding concerned;

(b) safety during the assembly, dismantling or alteration of the scaffolding concerned;

(c) measures to prevent the risk or persons, materials or objects falling;

(d) safety measures in the event of changing weather conditions which could adversely affect the safety of the scaffolding concerned.

APPENDIX 6

BS 5973:1993 CODE OF PRACTICE FOR ACCESS AND WORKING SCAFFOLDS AND SPECIAL SCAFFOLD STRUCTURES IN STEEL, SECTION 3, *WORK ON SITE*

Appendix 6

BS 5973:1993 Code of practice for access and working scaffolds and special scaffold structures in steel, Section 3*, Work on site*

18 Erection, alteration and dismantling

18.1 Erection
No portion of the scaffold should be used unless that portion is fully decked, braced and tied. Warning notices should be fixed to draw attention to those parts of a scaffold which are incomplete and should not be used.

18.2 Modifications

18.2.2 ***Access ways through scaffolding***
If access ways through scaffolding are required, the number of standards removed should be as few as possible and these should be replaced on either side of the gap so the total number of standards is not reduced. Bracing should be inserted across the top corners of the gap if extra support to the ledgers is required.

18.3 Dismantling
During dismantling, no component which endangers the stability of the remaining structure should be removed. If dismantling has reached the stage at which a critical member has to be removed…the stability of the structure should be assured by fixing a similar or otherwise adequate member in place…before the member to be taken out is removed. The scaffold…should be inspected prior to dismantling. If the scaffold is defective, it should be made good before dismantling commences.

The procedure of dismantling should be orderly and planned…

18.4 Lowering materials
Materials should be lowered to the ground and not stored on the scaffold. Components should not be thrown on the ground; they should be lowered hand to hand in an orderly fashion…

19 Duties of erectors and users of scaffolds
19.1 General
The statutory regulations and codes of practice detail commonsense requirements and recommendations and accordingly any method of construction or use which is seen to be inadequate or dangerous is likely to be a contravention of one of the documented requirements or recommendations and should be reported to a person in authority on the site for appropriate action to be taken.

It should be ensured that the lower portions of the scaffold are adequately protected against damage through interference, accident, traffic or any other cause.

19.2 Scaffold constructors
Persons constructing scaffolding should ensure that at the time of handing over to the user, it is adequate for the purpose for which it is intended and that it is stable and in a safe condition.

19.3 Training
It is recommended that scaffolders and others concerned in the construction and use of scaffolds have formal training in their specific jobs which should include familiarization with the statutory requirements and codes of practice.

19.5 Persons using scaffolds
19.5.1 *General*
Persons using scaffolds and particularly subsequent users, both employers and operatives, should ensure that the scaffolds are properly constructed and suitable for the purpose for which they require them.

19.6 Protection of the public
…because of the public's unfamiliarity with the dangers and curiosity about the work…high standards of physical protection and more effective systems of work and supervision will generally be needed.

20 Inspection of scaffolds
20.1 Compliance with statutory regulations
Scaffolds should be inspected by the constructor before they are handed over for use. The user should inspect them weekly to see that they remain in compliance with the statutory regulations and should sign the Reports of Weekly Inspections to record his findings.

APPENDIX 7

SAFETY DECKING HANDOVER CERTIFICATE

Appendix 7

The following information is recommended to be the ***minimum*** information required for a handover certificate for a safety decking installation:

Handover Certificate

This Safety Decking System has been erected in accordance with our previously supplied method statement.

The installed components should be inspected at regular interviews (not more than 7-days) by a competent person. These inspections should be recorded for future reference, and made available to whomever requests the information.

Signature: _____

Print Name: _____

Date: _____

Customer: _____

Site Address: _____

_____

_____

_____

Location: _____

Contract Number: _____

Comments: _____

_____

_____

_____

_____

_____

APPENDIX 8

SAFETY DECKING 7-DAY INSPECTION CERTIFICATE

Appendix 8

The following information is recommended to be the ***minimum*** information required for a 7-day periodic inspection report:

Weekly Safety Check

(Tick where appropriate)

Component	Pass	Fail	Comments
Decking panel			
Props			
Collars			
Pins			
Edge piece			
Bracing (if applicable)			

Inspection carried out by: _____

Signature: _____

Print Name: _____

Date: _____

Additional Comments: _____

_____

_____

_____

_____

_____

_____

_____

APPENDIX 9

CONSTRUCTION (HEALTH, SAFETY & WELFARE) REGULATIONS 1996, SCHEDULE 2, REQUIREMENTS FOR WORKING PLATFORMS

Appendix 9

Construction (Health, Safety & Welfare) Regulations 1996

SCHEDULE 2

Regulations 6(2), 6(3) (b) and 8(2)

REQUIREMENTS FOR WORKING PLATFORMS

Interpretation

1. In this Schedule, "supporting structure" means any structure used for the purpose of supporting a working platform and includes any plant and equipment used for that purpose.

Condition of surfaces

2. Any surface upon which any supporting structure rests shall be stable, of sufficient strength and of suitable composition safely to support the supporting structure, the working platform and any load intended to be placed on the working platform.

Stability of supporting structure

3. Any supporting structure shall –

(a) be suitable and of sufficient strength and rigidity for the purpose or purposes for which it is being used; and

(b) be so erected and, where necessary, securely attached to another structure as to ensure that it is stable; and

(c) when altered or modified, be so altered or modified as to ensure that it remains stable.

Stability of working platform

4. A working platform shall –

(a) be suitable and of sufficient strength and rigidity for the purpose or purposes for which it is intended to be used or is being used; and

(b) be so erected and used as to ensure, so far as is reasonably practicable, that it does not become accidentally displaced so as to endanger any person; and

(c) when altered or modified, be so altered or modified as to ensure that it remains stable; and

(d) be dismantled in such a way as to prevent accidental displacement.

Safety on working platforms

5. A working platform shall –

(a) be of sufficient dimensions to permit the free passage of persons and the safe use of any equipment or materials required to be used and to provide, so far as is reasonably practicable, a safe working area having regard to the work there being carried out; and

(b) without prejudice to paragraph (a), be not less than 600 millimetres wide; and

(c) be so constructed that the surface of the working platform has no gap giving rise to the risk of injury to any person or, where there is a risk of any person below the platform being struck, through which any material or object could fall; and

(d) be so erected and used, and maintained in such condition, as to prevent, so far as is reasonably practicable –

(i) the risk of slipping or tripping; or

(ii) any person being caught between the working platform and any adjacent structure; and

(e) be provided with such handholds and footholds as are necessary to prevent, so far as is reasonably practicable, any person slipping from or falling from the working platform.

Loading

6. A working platform and any supporting structure shall not be loaded so as to give rise to a danger of collapse or to any deformation which could affect its safe use.

APPENDIX 10

BS 5975:1996, CODE OF PRACTICE FOR FALSEWORK, SECTION 2.5.2, FALSEWORK CO-ORDINATOR

Appendix 10

BS 5975:1996 Code of Practice for Falsework

Section 2.5.2 – Falsework coordinator

2.5.2.2 The principal activities of the falsework coordinator should be to:

a) coordinate all falsework activities
b) ensure that the various responsibilities have been allocated and accepted
c) ensure that a design brief has been established with full consultation, is adequate, and is in accord with the actual situation on site
d) ensure that a satisfactory falsework design is carried out
e) ensure that the design is independently checked for:

    1) concept
    2) structural adequacy
    3) compliance with the brief

f) where appropriate, ensure that the design is made available to other interested parties, e.g. the structural designer
g) register or record the drawings, calculations and other relevant documents relating to the final design
h) ensure that those responsible for on-site supervision receive full details of the design, including any limitations associated with it
i) ensure that checks are made at appropriate stages covering the more critical factors (see **6.1.3** and **7.4**)
j) ensure that any proposed changes in materials or construction are checked against the original design and appropriate action taken
k) ensure that any agreed changes, or corrections of faults, are correctly carried out on site
l) ensure that during use all appropriate maintenance is carried out
m) after a final check, issue formal permission to load if this check proves satisfactory
n) when it has been confirmed that the permanent structure has attained adequate strength, issue formal permission to dismantle the falsework

APPENDIX 11

BS 5975:1996, CODE OF PRACTICE FOR FALSEWORK, SECTION 7.4.2, ITEMS TO BE CHECKED

Appendix 11

BS 5975:1996, Section 7*, Work on Site*

7.4.2 Items to be checked
*At the stages indicated in **7.4.1**, thorough inspection of the falsework is necessary to ensure that the completed structure will function as intended. Whilst the following list…will give guidance on what to look for in a systematic manner.*

THE RESULT OF CHECKS OR INSPECTIONS SHOULD BE RECORDED IN WRITING AND ACTION TAKEN TO CORRECT ANY FAULTS.

It should be checked that:
***a) general**:*
1) all the drawings and written instructions have been strictly complied with
2) only the correct materials in serviceable condition have been employed

b) at founding level:
1) the setting out is correct
2) the ground has been adequately prepared and is at a satisfactory level
3) suitable sole plates or other bases have been provided and have been properly levelled;

c) above founding level:
1) ties and/or rakers have been fitted, linking all uprights in two directions roughly normal to each other, or at a specified skew angle;
2) upright members are plumb (to do this, a few upright members should be checked with suitable instruments and marked; the remainder can be checked by eye)…
5) the number and position of all bracing members (longitudinal, lateral and plan) are correct with connections close to node points;
6) the restraints are effective where falsework is stabilized by butting, wedging or tying of lacing members, instead of bracing…
10) any necessary web stiffeners and lateral restraint have been provided;
11) all pins, bolts, clips and the like, have been fitted, are of the correct type and are secure…
13) where access is required by workmen, ladders, platforms, guardrails and toeboards are fixed and comply with the requirements of the Construction Regulations.

APPENDIX 12

ADVISORY COMMITTEE FOR ROOFWORK (ACR) GUIDANCE

APPENDIX 12

ADVISORY COMMITTEE FOR ROOFWORK (ACR)

The Advisory Committee for Roofwork (ACR) is a body dedicated to making working on roofs safer. Its membership is made up of nominees from the HSE, the major roof working Federations and Associations and others, who provide the experience of many years of involvement in working on roofs. ACR[M]001:2000 was produced under its guidance.

It is important to ensure that, as much as possible, that the roofing components are not fragile. When considering fragile materials, certain profiles of roof lend themselves to a greater risk of accidents. In the past reference was usually made to HSE's Specialist Inspectors Report (SIR), '*Fragile and non-fragile sheeting materials*' (SIR 30), however, this document is no longer valid and has been withdrawn. The current test, accepted by HSE, to classify non-fragile materials is contained in the Advisory Committee for Roofwork (ACR) document, '*Test for Fragility of Roofing Assemblies' (Second Edition)*, ACR[M]001:2000. (HSE Press Release E184:01).

An overview of ACR[M]001:2000 states the following:

3.2 CLASSIFICATION OF ROOF CONSTRUCTION
To be classed as non-fragile, the material under test shall arrest the fall of the impactor and retain it on the test assembly for a period of at least 5 minutes, but longer if required by the competent person, who must be satisfied that there will be no further deterioration.

3.3 Assemblies subjected to a single drop test:
If after the first impact the impactor is retained on the test assembly, satisfying the conditions set out in 3.2, and no other drop tests are carried out on the assembly, the assembly shall be classified as a **Class C non-fragile assembly**.

3.4 Assemblies subjected to multiple drop-tests:

3.4.1 The impactor may be removed and the test assembly may be subjected to a second drop test at the same locations as the first drop.

3.4.2 If the impactor passes through the test assembly and hits the ground, the assembly shall be classified as a **Class C non-fragile assembly**.

3.4.3 If the impactor is retained on the test assembly, satisfying the conditions set out in 3.2, the assembly shall be classified as a **Class B non-fragile assembly**.

3.5.1 On conclusion of the second drop test, the load shall be removed and the assembly shall be examined by a competent person. If, in the opinion of the competent person, the roof sheet *and* the assembly shows no signs of significant damage that will affect the long term strength and weatherability of the assembly, the assembly may be classified as a **Class A non-fragile assembly**.

This report recommends a move towards a *minimum* specification of Class B non-fragility.

APPENDIX 13

NATIONAL FEDERATION OF ROOFING CONTRACTORS (NFRC) INFORMATION

APPENDIX 13

THE NATIONAL FEDERATION OF ROOFING CONTRACTORS (NFRC)

The National Federation of Roofing Contractors (NFRC) is the UK's largest trade association for the roofing industry. The NFRC covers over 45% of the UK and Irish roof contracting market and has approximately 800 contracting company's branches and franchises and 120 manufacturers and service providers, and operates in trade regions in England, Wales, Scotland, Northern Ireland, and the Republic of Ireland. The following information has been adapted from the NFRC website (www.nfrc.co.uk).

In 1893 the London Association of Slate Merchants and Master Slaters held their first meeting. This association was the forerunner of the NFRC. The NFRC was formed in 1943 when The London Association of Master Tilers amalgamated with the National Federation of Slate Merchant Tilers to form the National Federation of Roofing Contractors, due to the urgent need for a co-ordinated national effort to deal with war damaged buildings.

A Technical Advisory Group (TAG) composed of a small committee answerable to the main Board of the NFRC, is responsible for recommending what the NFRC's technical work priorities should be. The NFRC draws upon expertise within all the NFRC's Technical Committees. The TAS covers advice on:

- Roof detailing product complaints
- Product applications weather proofing problems
- Product selection product application problems
- Design difficulties Health & safety

The TAS is supported by the NFRC's Technical Committees formed mainly of contractors and manufacturers covering; slating and tiling; sheeting and cladding; flat roofing; health and safety; education & training.

The NFRC attends and contributes to the work of the British Standards Institution (BSI), The European Committee for Standardisation (CEN) and the European Organisation for Technical Approvals (EOTA). The TAS helps to create standards, codes of practice, technical approvals and their complimentary test methods.

The NFRC represents members' key business and technical concerns to the UK Government, the European Community and other outside bodies such as the Inland Revenue, BSI and BBA. The NFRC is also an active member of the following organisations:

- The Confederation of British Industry (CBI) (The NFRC are members)
- The Construction Confederation
- The National Specialist Contractors' Council (NSCC)
- The Constructors' Liaison Group (CLG)
- The International Federation for the Roofing Trade (IFD)
- The National Home Improvement Council

- Schemes such as the RIA Hallmark, the Quality Mark and Construction Line to make sure they are practical, value adding and in the interests of members to adopt

NRFC have published a Code of Practice (CoP) for their members to establish high standards for the conduct of the work undertaken and products and services supplied by member firms. Further, the CoP covers guidance and information on the following areas:

- Estimates, quotations and contracts
- Deposits and pre-payments
- Execution of contract and materials used
- Insurance
- Work and material guarantees and material certification
- Advertising
- Health & safety
- Completion of contracts
- Inspection
- Complaints, conciliation, and arbitration
- Compliance and redress
- Publicity and supervision

APPENDIX 14

BRITISH STANDARDS INSTITUTE (BSI) PUBLICLY AVAILABLE SPECIFICATIONS (PAS) SPECIFIC TO FALL ARREST MATS

APPENDIX 14

PAS 59:2003 FILLED COLLECTIVE FALL ARREST SYSTEMS, includes the following content:

PAS 2004:2003 INFLATABLE COLLECTIVE FALL ARREST SYSTEMS, includes the following content:

APPENDIX 15

PHYSIOLOGICAL AND PHYSCOLOGICAL EFFECTS OF FALL SUSPENSION

APPENDIX 15

FALL-ARREST – PSYCHOLOGICAL AND PHYSIOLOGICAL WELL-BEING

The following shows the results of tests carried out on human beings as live test surrogates, as detailed in HSE Contract Research Report (411/2002), entitled: *'Analysis and evaluation of different types of test surrogate employed in the dynamic performance testing of fall-arrest equipment*'

- Average fitness and in good health, no respiratory/circulatory problems, low anxiety levels due to test conditions
- Post fall arrest (shock) obviously did not happen – people were lowered in to suspension in a controlled manner
- Secondary strike injuries and pendulum effect did not happen

US study revealed 14 mins (mean)
French study revealed 23 mins (mean)
German study revealed 26 mins (mean)
} Further investigations ongoing

Before serious medical problems were encountered:

- Extremity numbness
- Respiratory distress
- High/low blood pressure
- Fainting and loss of consciousness

These symptoms could lead to:

- Circulatory collapse - damming of blood means it cannot pump to heart (suspension trauma)
- Rescue death - sudden rush of blood to heart after release of harness restriction

This begs the question - How long does a rescue take and how practical is it?

These findings point towards other fall arrest methods as a first choice, especially in new build.

APPENDIX 16

CONSTRUCTION (HEALTH, SAFETY AND WELFARE) REGULATIONS 1996: SCHEDULES

APPENDIX 16

Information contained within Schedules 1, 2, and 4 of The Construction (Health, Safety & Welfare) Regulations 1996, detail additional requirements of component parts of the equipment utilised during the SG4:00 function:

Schedule 1 – Requirements for Guardrails and Toeboards
Contains minimum standards on the requirements for rigidity of this equipment, and dimensions for installation. Also, part 6) states, *Guardrails, toeboards, barriers or other similar means of protection shall be placed so as to prevent…the fall of any person…from any place of work.*

Schedule 2 – Requirements for Work Platforms
Contains information on the condition of platform surfaces; stability of supporting structure and working platform; safety on working platforms; and loading of the platforms. Also, part 5) d) i) states, *A working platform shall – be so erected, used, and maintained in such condition, as to prevent, so far as is reasonably practicable – the risk of slipping or tripping.*

Schedule 4 – Requirements for Fall Arrest Equipment
Contains information on the requirements for supplementary safety equipment used during a safe system of work, including:

1)…'equipment' means any equipment provided for the purpose of arresting the fall of any person at work…
2) The equipment shall be suitable and of sufficient strength to safely arrest the fall of any person who is liable to fall.
3) The equipment shall be securely attached to the structure…and the means of attachment thereto shall be suitable and of sufficient strength and stability for the purpose of safely supporting…any person who is liable to fall.
4) Suitable and sufficient steps shall be taken to ensure…that in the event of a fall…the equipment itself does not…cause injury to that person.

APPENDIX 17

NATIONAL ACCESS AND SCAFFOLDING CONFEDERATION (NASC) GUIDANCE NOTES

APPENDIX 17

The following list identifies where SG4:00 sits in relation to other NASC guidance:

SG1:02 –	Control of Substance Hazardous to Health in Scaffolding (COSHH)
SG2:02 –	Asbestos Licences and Ancillary Work Involving the Scaffolding Contractor
SG3:02 –	Earthing of Temporary Scaffolding and Similar Metallic Structures
SG4:00 –	***The Use of Fall Arrest Equipment whilst Erecting, Altering & Dismantling Scaffolding***
SG4Train –	SG4 Training Pack (inc CD-Rom training programme, test papers and certificate)
SG5:02 –	Overhead Power Lines
SG6:02 –	Manual Handling in the Scaffolding Industry
SG7:02 –	Guide to Risk Assessment
SG8:02 –	Reporting of Accidents Procedure
SG9:02 –	Use, Inspection and Maintenance of Lifting Equipment in the Scaffolding Industry
SG10:02 –	Requirements for the Use of Brickguards
SG11:02 –	Noise
SG12:02 –	Sloping Roof Protection
SG13:02 –	Health Surveillance
SG14:02 –	Safety Nets
SG15:02 –	Drugs and Alcohol
SG16:02 –	Harness and Lanyard Inspection
SG17:02 –	Fall Arrest Equipment and You
SG18:02 –	Welfare Facilities
SG19:02 –	Safety Harness Rescue Procedure / Risk Assessment
SG20:03 –	Consultation with the Workforce
SG21:03 –	Entry into Confined Spaces
SG22:03 –	Induction Training
SG23:03 –	Safe Systems of Work for Birdcage Scaffolds.
S80 –	Basic Independent Tied Scaffolding Check Guide
S80 –	Putlog Scaffolding Check Guide

APPENDIX 18

NASC ANNUAL MEMBERSHIP AUDIT HEADINGS

APPENDIX 18

NASC Annual Audit. The following headings include various questions leading to the information sought by NASC on an annual basis from ***all*** member companies:

1. General Information
2. Nature of Business
3. Financial Information
4. Insurance Details
5. Employment Information
6. Health and Safety
7. Training Information
8. Security Provisions
9. Technical Information
10. NASC Standing Committees
11. Suggestions and Comments
12. Declaration

Document Check List

APPENDIX 19

NASC REGIONAL COMMITTEES

APPENDIX 19

NASC has established regional committees covering England, Scotland, Wales and Northern Ireland. In addition, the Confederation has standing committees working on a national basis for the benefit of the Industry as a whole. These include:

Contracts Committee: this provides expert advice and guidance notes for members on contractual issues.

Health and Safety Committee: whose regular dialogue with HSE has enabled standards to be consistently improved and evaluated.

Hire & Sales and Manufacturing Committee: who work on revisions to the model conditions used by the Industry.

Marketing Committee: have responsibility for developing a new integrated marketing approach, and help implement this campaign on a long-term basis.

Security Committee: this acts as a liaison between NASC and the nominated police contact officers in over 50 constabularies and throughout the UK.

Technical Committee: this provides invaluable representation from all the major players in the industry. Providing advice and technical support, helping NASC to issue regular guidance notes to all members.

Scaffolding Industry Training Group (SITG): this is the focal point for the Industry on all training matters, including the Construction Industry Scaffolders Record Scheme (CISRS) and NVQ/SVQ.

APPENDIX 20

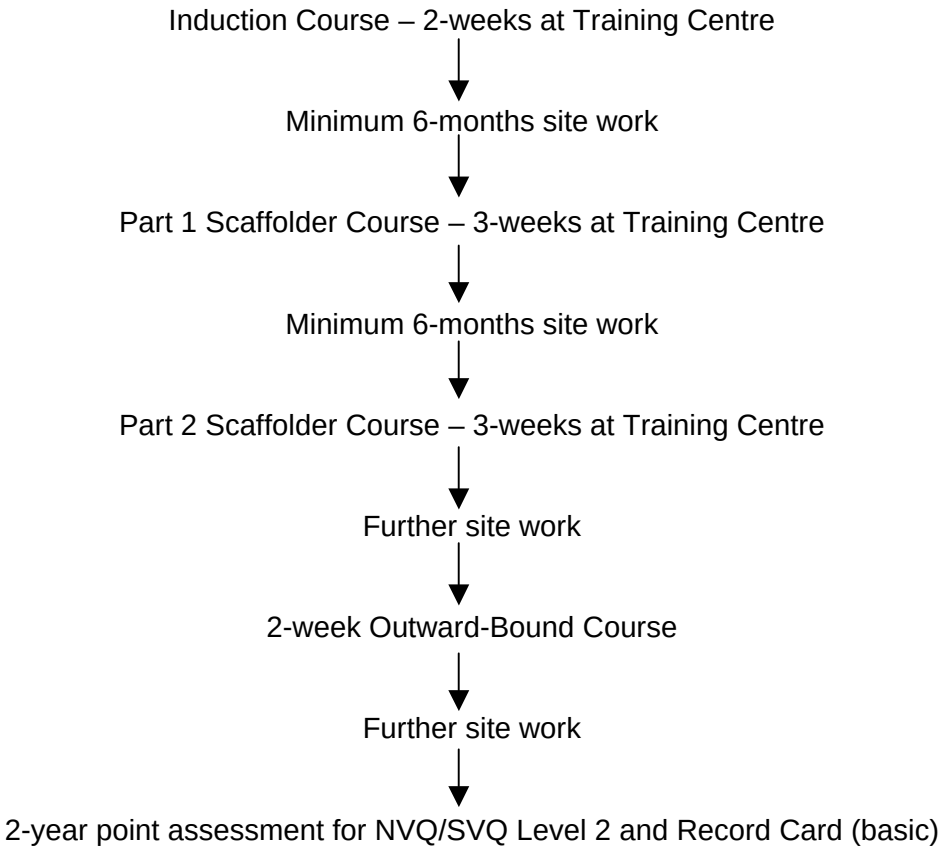
CONSTRUCTION INDUSTRY TRAINING BOARD (CITB) AND NASC TRAINING ROUTES

APPENDIX 20

CITB / NASC TRAINING PROGRAMMES

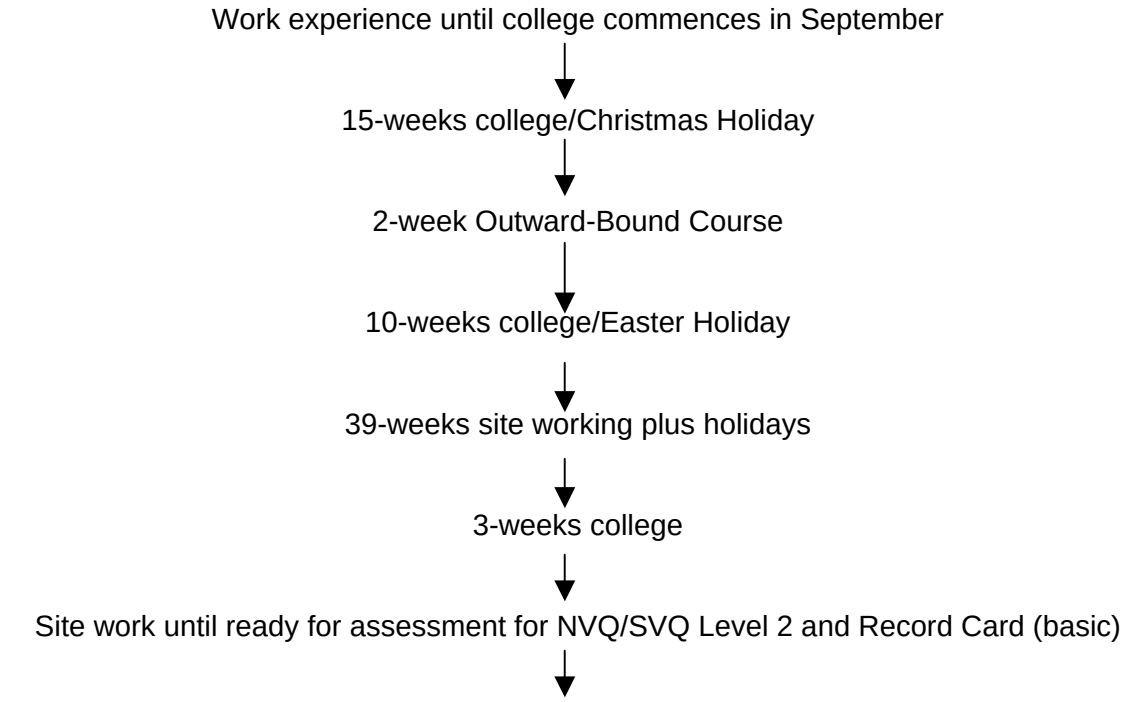
Route A: This scheme allows the trainee to undertake training on site, getting first hand knowledge and experience from the industry. Every 3-6 months the trainee will be sent to an approved training centre to complement the on-site training carried out. In total, approximately 11 to 12-weeks, over 2-years, will be based at the training centre (see below).

Route A



Route B: This scheme allows the trainee to undertake more off-the-job training, spending a total of 42 weeks at the National Construction College (NCC). The employing organisation will decide which route would be more beneficial to each trainee (see below).

Route B



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A technical guide to the selection and use of fall prevention and arrest equipment

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