



Australian Government

Australian Transport Safety Bureau

ATSB RESEARCH AND ANALYSIS REPORT

Marine Safety Research Grant – 200667474

Final

Marine Pilot Transfers

- A preliminary investigation of options

Fiona Weigall

Certified Professional Ergonomist

Health & Safety Matters Pty Ltd

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Published by: Australian Transport Safety Bureau
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Marine Safety Research Grants Program

This report arose from work funded through a grant under the Australian Transport Safety Bureau's Marine Safety Research Grants Program. The ATSB is an operationally independent bureau within the Australian Government Department of Transport and Regional Services. The program funds a number of one-off research projects selected on a competitive basis. The program aims to encourage researchers from a broad range of related disciplines to consider or to progress their own ideas in aviation safety research.

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DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN
200667474	September 2006	67	1 921164 05 0

Publication title

Marine Pilot Transfers – A preliminary investigation of options.

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Funded by

Australian Transport Safety Bureau
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www.atsb.gov.au

Acknowledgements

This review and report was prepared with assistance and support from Captain Chris Haley, Master Mariner and Marine Safety and Environment Consultant. Captain Haley provided his extensive knowledge and experience in maritime issues and in marine pilotage, and also provided editorial support. Thanks too to Alison Bell, Ergonomist, who assisted with critical feedback.

Many Marine Pilots also contributed their information, experiences and advice regarding pilot transfer arrangements, and special thanks must go to Captain Malcolm Armstrong and Captain Alex Amos.

Abstract

This paper provides a preliminary review of options for making marine pilot transfers safer, as the traditional method of transferring via a pilot ladder has resulted in fatalities and serious injuries. The project included a review of the literature, interviews with pilots and a survey of methods used in other industries for similar tasks. Results indicate that the safety of the current transfer arrangement would be increased through strategies including ladder design improvements, use of fall protection systems and/or use of mechanical personnel elevation systems. Each of these strategies requires further investigation to determine the design criteria best suited to the task, the pilot population and the marine environment. The report also identifies a number of additional initiatives requiring review that contribute to reducing the risks in the pilot transfer task.

ACKNOWLEDGEMENTS

The author acknowledges the funding support provided by the Australian Government, through the Australian Transport Safety Bureau.

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Many Marine Pilots also contributed their information, experiences and advice regarding pilot transfer arrangements, and special thanks must go to Captain Malcolm Armstrong and Captain Alex Amos.

ABBREVIATIONS

AMPA	Australian Marine Pilots Association
AMSA	Australian Maritime Safety Authority
AS	Australian Standard
AS/NZ	Australian and New Zealand Standard
ATSB	Australian Transport Safety Bureau
EMPA	European Marine Pilots Association
HSE	Health & Safety Executive, UK
IMO	International Maritime Organization
IMPA	International Marine Pilots Association
ISO	International Standards Association
NIOSH	National Institute for Occupational Safety & Health, USA
NOHSC (ASCC)	National Occupational Health & Safety Commission (now the Australian Safety & Compensation Council)
OHS	Occupational Health and Safety
OSHA	Occupational Safety & Health Administration, USA
SOLAS	International Convention for the Safety of Life at Sea
WCA	WorkCover Authority NSW

EXECUTIVE SUMMARY

The pilot's task of transferring between vessels at sea using the pilot ladder has long been recognised as hazardous. This has resulted in marine pilot fatalities and serious and disabling medical conditions from body stressing, being hit, and falls. The aim of this project was to undertake a preliminary investigation of the options for making these transfers safer, with the specific objectives:

- to determine the rationale for the current pilot ladder design, and identify if the existing research on ladder design is consistent with and supports the pilot ladder design; and
- to identify and describe transfer and climbing systems used for similar tasks in other industries, including fall protection systems and mechanical methods.

The findings highlight the large number of laws and agreements impacting on the pilot transfer task which together form a complex legal web for occupational health and safety issues. This is compounded by the ships and crews being from many different countries, with operators and personnel reportedly demonstrating varying levels of skill in achieving safe transfer arrangements.

Historical documents suggest that the transfer system has not changed over many years, with the pilot continuing to rely on a rope and timber ladder, with no mechanical assistance or protection. The rationale behind the design features of the current IMO ladder was not uncovered. The ladder design and rigging arrangements are not within the control of pilots but are affected by the needs and preferences of many international stakeholders.

The ergonomics and safety literature regarding ladder design and use confirm that the pilot ladder is extremely difficult to climb compared with other ladders. If a ladder is to continue to be used in this task, a number of design changes could enhance its usability and safety, including better attachment systems and use of more modern and reliable materials. The rules relating to positioning and securing combination ladders also require review.

Fall protection systems are not currently used in the transfer task despite their common use in other industries where personnel are working at heights. The report outlines the challenges in achieving a good fall protection system, and the risks associated with poor systems. Mechanical hoists are now rarely used for pilot transfers, and evidence suggests they were only in use for a brief period more than 30 years ago. These systems quickly fell out of favour as a result of a number of design and control problems. Considering the developments in technology, there are likely to be improved methods that could now be applied to the process.

The use of helicopters for sea transfers was outside of the scope of this project; however a brief review suggests this system has advantages for the marine pilot's health and safety.

The findings suggest there has been a lack of research into improving the safety of the pilot transfer task, with widespread acceptance of this traditional system despite the many documented problems and dangers. There is also an understandable reluctance from pilots to change the ladder or transfer systems with which they are familiar, particularly if a change requires additional reliance on the skills and actions of others. While none of the options identified in this preliminary review

has immediate or simple application to the pilot transfer task, many areas require further investigation to improve the safety of different aspects of this task, and these include:

- Conducting a comprehensive analysis of ladder design features suited to the transfer task and marine conditions;
- working with specialists in fall protection to review the transfer task and consider options;
- investigating personnel elevation systems and elements applicable to the transfer task;
- assessing ship and pilot boat design and interaction and determining how different vessel designs and manoeuvres impact on the task, and the role of communication systems and personnel in the task;
- reviewing pilots' personal protective equipment and the safety equipment used on pilot boats;
- reviewing administrative controls such as methods for managing adverse weather conditions and shiftwork; and
- providing training and practice in the transfer task including assessing pilots' functional fitness for the transfer task and providing appropriate remedial assistance where required.

The risks to pilots and other personnel involved in the pilot transfer task can be reduced if changes to the current arrangements are based on evidence, user trials, and consultation with all stakeholders.

1.1 Background

The Australian Transport Safety Bureau (ATSB) contracted Fiona Weigall of Health & Safety Matters Pty Ltd to undertake a preliminary review of the ergonomics and health and safety issues associated with marine pilots transferring at sea using pilot ladders and hoists.

The aim of this review was to provide the ATSB with an initial investigation of potential risk control options for the task of transferring pilots at sea. This project was designed to build on the findings from a risk assessment of pilot ladder transfers which was undertaken for Sydney Ports Corporation in association with Sydney Pilot Service in 2005 (Weigall & Simpson 2005).

Specific objectives of this review were:

- to investigate the rationale for the current pilot ladder design and compare this with the scientific literature to determine if changes may be required to improve safety; and
- to identify and describe other options for pilot transfers, considering mechanical access systems and fall protection systems.

In addition, the main mechanisms of injury in the task were investigated to ensure that any controls were designed to address and counter the specific hazards faced by pilots in this task.

This review is part of the process of controlling risk. It follows the approach as required under Australia's risk management model and the International Maritime Organization's method of Formal Safety Assessment. It also follows the required 'hierarchical' approach to considering and investigating potential control options, with the priority being to eliminate or to redesign tasks.

Applying this hierarchical approach to improving the safety of the pilot ladder task requires consideration of each of the following:

1. Eliminating the ladder transfer task – not using pilot ladder transfers, but using other means, such as helicopters
2. Redesigning the ladder transfer task to eliminate or reduce the risks – using other related systems to transfer the pilot between the pilot cutter and the ships such as mechanical access systems
3. Using other aids for the task – such as fall protection systems
4. Modifying the equipment - such as improving the design of the ladder and its fastenings to the ship
5. Applying administrative controls – such as only performing the task in agreed environmental conditions, having more personnel to assist with the transfer, and/or altering shifts
6. Introducing personal protective equipment - such as helmets, specialised footwear, EPIRBs etc to assist in the case of a fall

This report focuses on the 2nd, 3rd and 4th steps in this hierarchical approach, however often the best solution requires a combination of approaches.

1.2 OHS rights and responsibilities in pilots transfers

1.2.1 The legal context

Pilots and pilot employers operate within a complex legal framework relating to occupational health and safety matters. From a brief review of the legislation and associated literature, it appears that the key OHS requirements that must be considered by pilots when undertaking a ladder transfer include:

- State, Territory and Commonwealth OHS Acts
- The OHS (Maritime Industry) Act 1993
- The International Maritime Organization Regulations
- The SOLAS conventions

Other Acts and regulations relating to Navigation, Transport Safety Investigations and ports and waterways operations also influence OHS issues for pilots and their employers in the transfer task.

1.2.2 OHS Acts

Australian pilots are covered under the different OHS Acts under which their employers work. While each of the various OHS Acts differ, they all impose a 'duty of care' upon employers to provide their employees and others at their place of work with a safe work environment, safe equipment, safe systems, training, supervision etc. Regardless of where the employee's place of work may be (a car, a boat, or an interstate or overseas destination) the employer continues to have a duty and responsibility to the employee to ensure that wherever they are working is safe and suitable.

When the employee (such as a pilot) is working at another employer's worksite (such as another company's ship) more parties have responsibility. The level of responsibility varies according to each party's degree of control and influence over each situation. This is a common situation as many employees conduct 'work' or have to use another site in the course of their work.

The challenge with working at others' work sites is to manage the mutual obligation for the employee's OHS. For example, under the NSW Act the employer is expected to do all that is considered "reasonably practicable" to achieve a safe workplace for their employees, again regardless of where the workplace is. Where the employee's employer cannot satisfy themselves that the worksite or sites are safe, they can refuse to allow the employee to enter the site until the situation is improved to their satisfaction. However the great variation reported in the equipment, systems and personnel working on foreign ships make this task complex for the marine industry.

In addition to the various general state OHS Acts, the federal OHS (Maritime Industry) Act 1993 applies. The Act outlines the 'Duties of operators in relation to contractors' (such as pilots) and explains that these responsibilities are the same as

those for the operator's employees for where the operator has control or is usually expected to have had control.

Where the operator of the site fails to provide a safe place of work AMSA's Inspectorate can enforce the application of this Act and can prosecute offenders.

Port operators also impose various OHS requirements on personnel and operators entering their port.

1.2.3 International maritime agreements

Australia is a member of the International Maritime Organization (IMO) and has international agreements with IMO. This organisation currently has 166 'member states' that are expected to follow the various Regulations and Resolutions put forward by IMO. IMO oversees the International Convention for the Safety of Life at Sea (SOLAS), and this is still considered the most important of all treaties dealing with maritime safety. Flag States are responsible for ensuring that ships under their flag comply with its requirements.

The international pilots association (IMPA) also provides recommendations to their members regarding safe pilot arrangements and the Australian association (AMPA) as a member organisation of IMPA would generally adopt IMPA's recommendations.

So in addition to the various Australian Acts, Regulations and standards, the Australian marine industry has an obligation to follow the requirements of various international agreements such as IMO Resolutions and the SOLAS convention.

1.2.4 Pilots' OHS duties & concerns

Most Australian pilots are employees of government or private companies, and all employees have OHS obligations under the various OHS Acts. The general obligations include following the agreed OHS procedures, co-operating with the employer to enable compliance with relevant Regulations and to take reasonable care for others at work who may be affected by the employee's acts or omissions. They must not knowingly or wilfully place someone at risk of injury or behave in a reckless manner that could contribute to an accident. The employee's duty generally extends to the areas within their control and influence.

There are also requirements on employees to report and/or take action on hazards that impact on their personal health and safety or the health and safety of others in the workplace. This reporting is further encouraged by AMSA and also by ATSB under the new Confidential Marine Reporting Scheme (ATSB 2004).

All pilots interviewed for this study and in a previous study (Weigall & Simpson 2005) appeared very familiar with various IMO and other requirements for ladder transfers (eg A.889 and SOLAS) but were less clear of their personal rights and responsibilities regarding OHS. Also anecdotal information from informal discussions with pilots suggest that many pilots do not like to be too pedantic regarding some OHS issues or rules relating to transfer arrangements where they perceive the issue as relatively minor. As many pilots have worked as ships masters in the past it appears to make reporting more difficult as they are aware of the potential impact on the master. Some pilots have also indicated that if they waited for the perfect ladder, ship movements would be limited.

This anecdotal information appears consistent with data obtained from 26 observations of pilot transfers from the risk assessment study of pilot transfers (Weigall & Simpson 2005), and as reported to the AMPA conference (Weigall 2006). In a convenience sample of 11 transfers, 12 'non-compliant' issues were identified, with some ladders and rigging having more than 1 problem. The most common breaches were knots at the end of manropes (4 cases) followed by tripping lines attached (2 cases).

2.1 Literature and data review

The first step in this investigation was to undertake a comprehensive review of all available literature relating to the task of sea transfers by pilot ladders. As little data was located on pilot ladders, pilot accidents or rope ladders, the search was then extended to capture any material on ladder climbing, working at sea, ladder design, falls, fall protection systems and mechanical access systems.

Databases from Australia and internationally used in this project included:

- Oceanic Abstracts
- Compendex – Engineering Index
- NTIS - National Technical Information Service – USA
- CSA Technology Research Database
- Health and Safety Science Abstracts
- Materials Research Database, Metadex database
- Materials Business File
- MicroPatent Materials Patents

In addition to scientific databases, advice and information was sought from the following marine and safety authorities and associations in Australia and overseas:

- IMO
- AMSA
- IMPA
- EMPA
- OSHA
- NIOSH
- NOHSC/ASCC
- HSE

The legal rights and responsibilities in this transfer task were also briefly reviewed by looking at the OHS legislation impacting on the task.

2.2 Interviews with marine pilots

A convenience sample of twenty marine pilots in Australia and overseas were contacted for their information, experiences and advice regarding use of the pilot ladder as well as their use of other transfer arrangements. Information was particularly sought regarding the history and rationale for the current systems and equipment used in the transfer task. This anecdotal and historical information was critical as there was limited documented evidence regarding any ladder design

issues or descriptions of hoists and why these were and continue to be so unpopular with pilots.

This information was gathered via informal, semi-structured interviews by phone, face-to-face and via email both for this project, and also using data gathered in a previous project looking at the risks with the pilot ladder transfer task (Weigall & Simpson 2005).

2.3 Review of other systems used in industry

Commercially available products and systems from other industries were also investigated. Equipment of interest included:

- Ladders and attachments
- Hoists
- Other mechanical access systems; and
- Fall protection systems

The aim of this review was to consider if equipment or methods used in other industries and by other occupational groups may have an application for the pilot transfer task, with the view of making this safer for pilots and others involved with the task.

3 RESULTS

3.1 Ladders

3.1.1 Pilot ladder design

Current design requirements

IMO and SOLAS

The IMO Resolution A.889 outlines ‘recommendations’ and ‘requirements’ for the design features of the pilot ladder, including dimensions such as:

Maximum length	9m
Step size	Not < 400mm between the side ropes
Step width	Not < 115mm wide
Step depth	Not < 25mm
Step spacing	300 – 380mm apart

It is not clear if in this context the ladder dimensions and other design criteria are mandatory, as the wording in this Resolution consistently uses the term “should” rather than “must” as used in past Resolutions.

One obvious difference between the current and previous ladder requirements (Res A.667) is that the earlier Resolution required that the ladder “must rest firmly against the ship’s side within the parallel body length of the ship and within mid-ship half-length...” while the current Resolution does not make this recommendation.

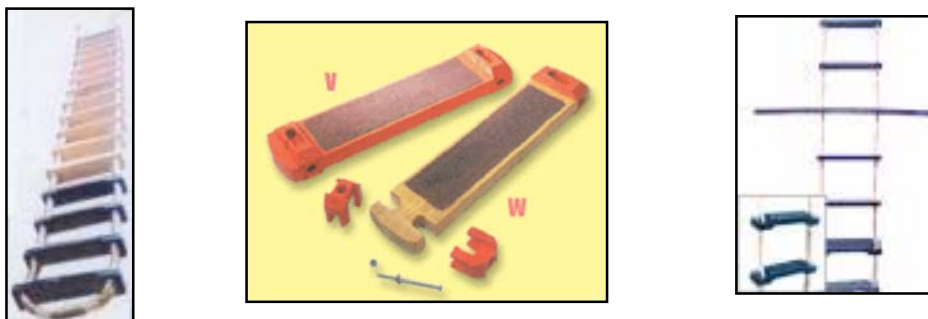
The SOLAS Chapter V, Regulation 23 recommendations seem to be consistent with the earlier IMO Resolution, also describing the ladder position against the ship’s side. The other difference between SOLAS Regulation 23 and the IMO Resolution A.889 is that the Regulation states that two manropes must be provided (not less than 28mm in diameter), as well as other “associated equipment”. In Australian waters it is a requirement that vessels meet both the SOLAS Regulation and current IMO requirements (eg Marine Notice 9/2006).

Based on the current SOLAS and IMO requirements and recommendations, and depending on the construction method, a 12 metre long pilot ladder may have 314 separate components (Haley 2006) including:

- 30 steps;
- 4 spreaders;
- 272 spacers (up to 8 per step or spreader);
- 4 side ropes;
- 2 man ropes;

- 2 ladder securing ropes or shackles; plus
- lashings used to hold the steps in place.

Figure 1: Example of component parts



If the climb height of the ladder is greater than 9 metres then an accommodation ladder will need to be rigged in combination with the pilot ladder. Depending on the method of construction of the accommodation ladder the component count may be doubled. Failure of any one of these components can lead to non-compliance or failure of the pilot transfer system.

Various companies manufacture pilot ladders and one company that received much praise and endorsement for their ladder was the COMAR model. According to a very experienced pilot who has done many years of work in the area of pilot ladder safety including writing the 'bible' of pilot ladder safety, this ladder is the best on the market, and has been developed with input from many pilots (Armstrong 2006). It is also reportedly built to the IMO design requirements.

International and Australian Standards

The current standards for Pilot Ladder Design are:

- Australian: AS 2933 – 1987 Shipbuilding – pilot ladders (AS 2933)
- International: ISO 799 – 2004 Ships and marine technology – Pilot ladders (ISO 799)

While these standards provide similar requirements, they are not the same as each other or the same as the IMO and SOLAS requirements. The main difference is the step spacing, with AS 2933 requiring a distance of 310mm +/- 5mm (ie 305 – 315mm), the ISO 799 requires 330 +/- 20 (ie 310 – 350mm).

Interestingly no marine pilots or personnel from AMSA or ATSB are listed in the Standards as having either contributed to or been represented on the committee that developed the Australian Standard. The International Standard was reportedly developed by a 'Technical Committee' and members of this committee are not listed in the standard.

Other ladders used for boarding vessels

The Australian Navy also use a 'pilot ladder' however this varies slightly from the requirements from IMO and SOLAS. For example the manropes they use are 24mm and these are to "terminate with a manrope knot" (McCue 2005).

Another group in Australia using ladders for boarding are Customs Officers. These ladders have not been investigated in this study but are reported to involve securing with grappling hooks, and the steps have 'spacers' behind them to hold the steps from the hull and so provide toe room for climbing.

Rationale for current pilot ladder design

The rationale and background for the criteria for the ladder design and the 9 metre 'rule' is unclear as no data was located for this project that provided any references to these decisions. This lack of evidence was despite searches and requests for advice and background information from organisations including the IMO, IMPA, AMPA, AMSA, ATSB, and from extensive and systematic searches of public literature. Experienced and long-standing marine pilots in Australia and overseas were also contacted for advice, however no information was provided.

An earlier study (MMS Ergonomics 1979) was also unable to locate background data regarding the pilot ladder's unique design and the authors concluded:

"It is not known on what criteria these dimensions are based, but it is considered likely to relate more to tradition and convenient modular design than to anatomical or physiological considerations"

The evolution of pilot ladders may not be unusual, as a recent Australian study into ladder design (Shepherd et al 2006) made similar conclusions about ladder design in general, noting:

"The design of portable ladders seems to have simply evolved, rather than been subject to formal design process, including ergonomic criteria."

Figure 2: A cutter coming alongside for a transfer



Proposed design changes from IMPA

An IMPA working party, the Ladder Working Group Committee (2006), is currently working to alter the design of some aspects of the IMO ladder including dimensions of ladder components. The rationale for such design changes was not disclosed but it is assumed to be based on user feedback on the current design. A copy of the working party's report and their background data or literature was requested for review, but this is not yet available for inclusion in this report.

In the past, representatives from Italy reporting to the IMO also proposed changes to the ladder design. The group developed a new design for pilot steps that incorporated handholds in the steps as they had reportedly found this made the tasks of both embarking and disembarking vessels safer (NAV 44/5/2) . The Italian group requested trials of this new design as they believed this would demonstrate its value however their proposal "did not receive any support". The IMO provided no reasons or comments on which to dismiss this idea.

3.1.2 Ladder design – general issues

The climbing task

Ladder climbing is a complex biomechanical task requiring excellent balance and coordination. However it is also a task that is quickly learned and becomes an almost unconscious task with practice (Hammer & Schmalz 1992).

Figure 3: Pilot climbing the ladder, using manropes



Compared with other ladders, climbing a pilot ladder appears to be the most physically challenging as the ladder:

- is vertical
- may have considerable negative slope
- is not rigid, but flexible
- has the user's feet typically forward of their body, so not in a balanced posture
- is moving laterally and vertically, and possibly twisting
- lacks continuous handholds of consistent dimensions

In addition to the skill required once on the ladder are the added tasks of reaching and gaining access to the ladder and then moving off the ladder at the other end. The different structures and platforms such as the pilot boat and accommodation gangway are generally moving independently and with different rhythms to the ladder due to the effect of roll and pitch motions, making these tasks particularly difficult. The transfer process is made even more complex when it occurs at night and in adverse weather conditions.

Vertical ladder design

The key design features impacting on ladder usability and safety have been identified in the scientific and ergonomics literature as:

- Step spacing
- Tread depth / foot clearance
- Ladder angle
- Handgrip orientation
- Handgrip location
- Handgrip dimensions
- Step length
- Ladder materials
- Ladder attachment/stability

Each feature is briefly described below.

Step spacing

While there are many standards and guidelines on the required spacing for ladder steps, much of this data appears to have been based on historical issues unrelated to climbing. For example in The Netherlands, window cleaner ladders are spaced with a 300mm gap because the vertical height of the 'ships mesh' in the 17th Century was reportedly 300mm (Hoozemans et al 2005). This gap height was copied when window cleaning became a profession, except that the timber steps added 50mm, resulting in a total step separation of 350mm. This remains well beyond the ladder guidance in The Netherlands which specifies 250 – 300mm step separation.

The existing literature from ergonomics studies is inconsistent and has also often been conducted with people from taller races rather than from Asian races and the difference in anthropometry (or body dimensions) has been identified as relevant for this task.

A summary of the limited available data follows:

For vertical ladders

Advice in AS 1657-1992

- 250-300mm, unless ladder is <1.5m, in which case 200-250mm is recommended

General comment from a study of pilot access (MMS Ergonomics 1979)

- 280mm recommended, but no experimental studies provided to support this figure

Comparing 305mm with 381mm (Bloswick & Chaffin 1990)

- Rung separation was not an important factor on hand and foot forces as compared with the effect of ladder slant and did not effect risk of falls

For steeply sloped ladders – 77 degrees (eg extension ladders)

Comparing 300 and 350mm (Hoozemans et al 2005)

- 300mm better for mechanical load at the hip, knee and ankle joints
- 350mm better for keeping knees within the ladder sides/rails, avoiding abduction moments at the knee
- No significant differences for energetic workload or for perceived discomfort

General advice on extension ladders from OSHA (OSHA 2003)

- 150 – 310mm

Comment on 305mm rung separation criteria in Utah, USA (Bloswick et al 1984)

- 305mm considered “suitable with no basis for deviation from this”

There were also recommendations for ladders in general, but these failed to specify if the step separation was for step ladders, extension ladders or vertical ladders. Most ladder data was for standard portable, hinged step ladders.

Figure 4: Rigging the pilot ladder



Step design, tread depth and foot clearance

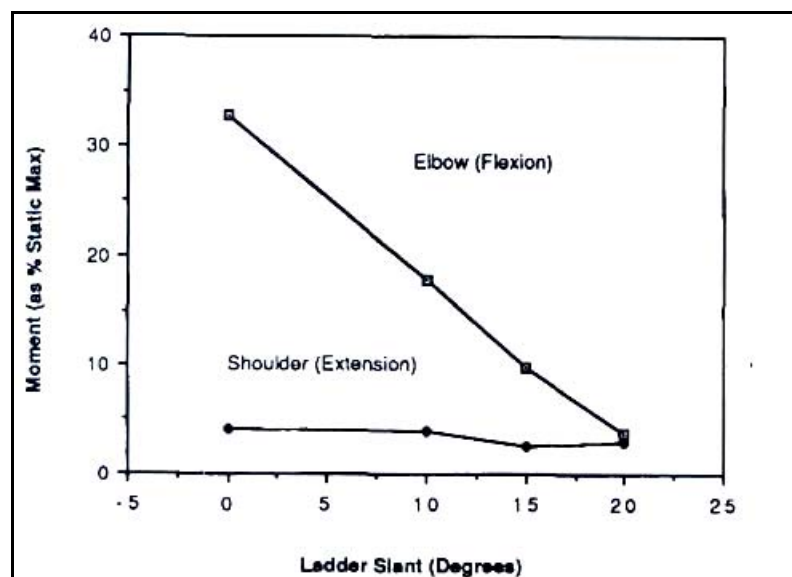
All guides regarding ladders talk of the need for foot clearance. This is to allow climbers to generate ankle torque to push off and move to the next step. Recommended clearance distances are: 180 to 200mm behind a ladder rung; and 150mm from the front nosing of a step ladder. Researchers have recommended that toe clearance of 155mm behind a ladder rung is required to allow an “average-sized user” with low (5th percentile) strength to generate the ankle torque required to support the body, and that this prevents ankle dorsi-flexion (bending the foot up) and downward slip of the foot (Stobbe 1982). However compared with sloped ladders, the vertical ladder requires less ankle moment (30% of static maximum on vertical as compared with 50% on sloped ladders) (Bloswick & Chaffin 1990).

Ladder angle

A vertical ladder as compared with a ladder angled at 70 degrees from horizontal poses the following issues for climbers (Bloswick & Chaffin 1990):

- High slip/fall hazard due to the forces on the hands and feet
- High one-hand force (nearly 30% of body weight)
- High hand torque
- High elbow moment (peak of 45% of maximum static strength)
- No difference in shoulder moment
- Minimal difference in hip and knee moment
- Twice the shear forces on the spine

Figure 5: Graph illustrating elbow and shoulder moment (as a percent of static maximum) by ladder slant, showing the increasing elbow moment with increasing ladder steepness (Bloswick & Chaffin 1990)



The mean elbow flexion moment has been identified as 33% of maximum static contraction for a vertical ladder in contrast to only 4% of maximum for a ladder angled at 70 degrees from horizontal. Achieving static contractions is fatiguing,

and is more fatiguing than dynamic or moving contractions. For long climbs or when holding one position still, climbers will be prone to physical fatigue. Musculoskeletal problems in the elbows such as epicondylitis were evident in a sample of pilots from an earlier study (Weigall & Simpson 2005).

Handgrip – orientation, location & dimensions

The strongest handgrip is achieved with the wrist in a ‘neutral’ or fairly straight posture, with the middle finger in line with the forearm (Halpern & Fernandez 1996). Maximum grip strength is not achieved instantly but takes on average approximately 0.5 seconds (Barnet & Poczynok 2000). Maximum grip force also fatigues rapidly with sustained and/or repeated gripping. In right dominant people the dominant hand is typically much stronger than the left, whereas left handed people have less variation in their hand grips (Schmidt et al 1970).

Studies of hand forces on vertical ladders indicate that they require 30% of body weight, as compared with less than 10% of body weight for a 20 degree slant from vertical (or 70 degree from horizontal) (Bloswick & Chaffin 1990). They report that hand torque required for use on vertical ladders has been estimated at 60% of maximum hand torque capability.

The orientation and location of the hand is also relevant. Strangely there is no clear guidance in ladder articles and safety guidance about where the climber should hold the ladder – on the side or on the ladder rungs. Where some guides have advocated one way, the guidance is inconsistent between guides.

When gripping with the arms in an elevated posture, there is an association between applying handgrip force and shoulder activity. The loading on the shoulder is high, with the static muscle work affecting the rotator cuff musculature (Sporrong et al 1996). This work impacts on the climber’s shoulder fatigue and comfort.

Considering the biomechanics of the hand and the task of climbing, a hand can provide support for the body when it can assume a hook like shape, and curve the fingers over a horizontal structure that is designed to fit under the fingers. This posture and hand use is more efficient than squeezing or grasping a strong point (rail or a rope etc) to the side.

A preliminary study comparing gripping the ladder rung versus gripping the side rail suggests advantages with the hooked, rung grasping strategy (Barnett & Poczynok 2000). For extra protection the horizontal structure can be squeezed but this is not necessary in a normal climb. Observations of grasping the side rail showed that this provided less protection where footing was lost, and the speed of gripping was often too slow to be effective to prevent a fall. Using the side rail the climber must maintain a strong power grip, but by using the hook-like geometry of the fingers on a horizontal rail, fall can be arrested. Also for side rail use, the wrist posture may also be deviated (bent to the little finger side) and a deviated wrist is a weaker posture for grip strength than a straight wrist posture.

The dimensions of what the hand has to grasp also impacts on grip strength, with both narrow and large items being the most difficult to grip. Some further data is required to be able to provide detailed advice in this area.

Step length

There is also a lack of data on step length, and only one article was located that recommended a length. 380mm is reported as being suitable for most users, with short-heavy users requiring a slightly larger step, recommended at 400mm long (Bloswick & Chaffin 1990).

Ladder materials

As previously noted, the current ladder design is made from a large number of components including parts in timber, rubber and manila rope. Some problems reported with these materials are the timber splitting and ropes stretching and breaking. For example timber steps may have knots and weak points and can rot from within, as evidenced recently in a pilot ladder failure in Singapore Harbour (Lloyds List 2006).

There are currently many materials available for ladders including metals, timbers, and various reinforced plastics. Minimal data was located on the advantages and disadvantages of ladder materials.

The approved ropes for pilot ladders are manila or other material of “equivalent strength, durability and grip” (IMO A.889), and there are ropes on the market that have various polyester based fibres that claim to meet this requirement. For example one company from Germany claims that their 20mm, 3 strand ‘GeoHemp’ rope is one third stronger than a 20mm manila rope and that it is superior in withstanding marine conditions. A supplier claimed that grip characteristics of this material are similar to those of manila ropes (Underhill 2006).

As well as new ropes, there are new composite materials in use now. For example a company in Italy is promoting a new product for use in gangways for boats (currently targeting large yachts) (Exit Engineering 2006). It is a carbon composite structure that is reportedly much lighter and easier to manage than steel or wood structures. It is of a sandwich construction using carbon/epoxy and the structure is vacuum bagged and autoclave cured. A spray-on anti-skid paint is used for trafficked areas.

According to a senior retired pilot (Haley 2006), the key features of materials that should be considered for use in pilot ladder construction are:

“Optimised design for human use – promotes safety and minimises mistakes

Durability and marine-worthiness – minimises failures

Lightweight – makes rigging simpler – minimises mistakes or omissions

Cost effective – more likely to be acceptable internationally.”

Synthetic or man-made material may avoid the potential problems of natural materials, and features such as non-slip surfaces, localised strengthening, weight reduction and homogenous structure are currently all readily achievable.

Figure 6: Pilot ladder and accommodation ladder

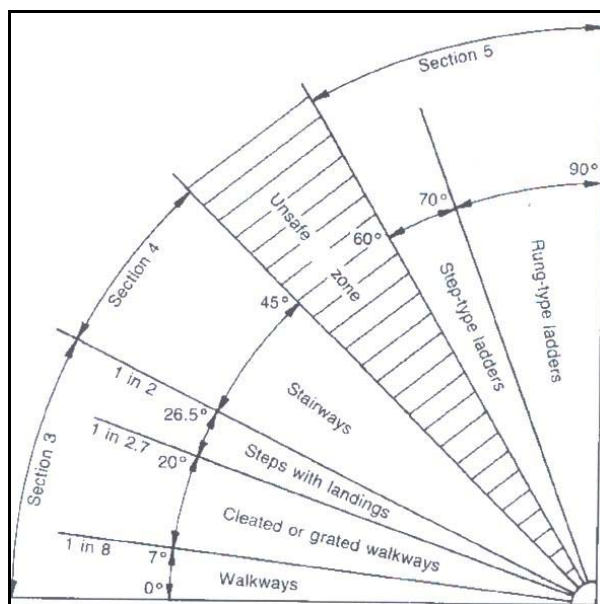


3.1.3

Accommodation ladders

Accommodation ladders were not specifically included in this review, and only very general guidelines for these ladders are provided in the IMO and SOLAS documents regarding pilot transfer arrangements. However one requirement under the IMO A.889 is that the accommodation ladder “angle of slope does not exceed 55 degrees”. The rationale behind this is not known and it is clearly a difficult situation when the height of the vessel from the water constantly changes. The problem with this angle is that it is neither a climb nor a step, as the angle falls between what is commonly used to create a stairway or a ladder (Templer 1992). This angle is also inconsistent with those recommended in the Australian Standard (AS 1657) and is in fact in the middle of the reported “Unsafe zone”. Please refer to the following diagram.

Figure 7: Definition of ‘Limits of Slope’ as defined under AS 1657

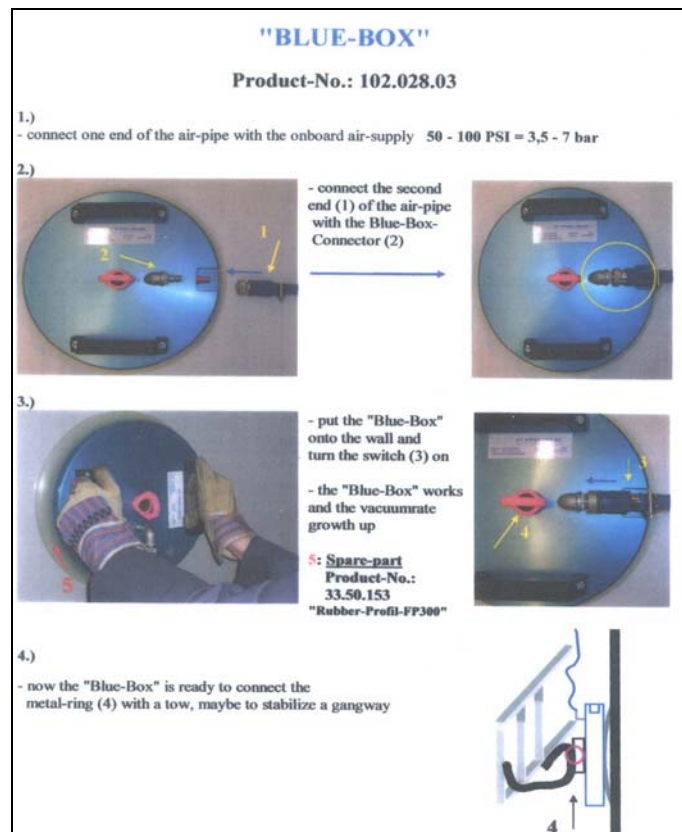


3.1.4 Ladder attachment

Ladder attachment remains a major problem for pilot ladders as they are generally just suspended from the vessel's upper deck or bulwark, with no other method to secure the ladder to the hull. Similarly, accommodation ladders frequently lack any attachment points. The result is that often neither the pilot ladder nor the accommodation ladder can "rest firmly against the ship's side" as required.

A product from Germany is now available in Australia (Freise 2006) that claims to provide a temporary anchor point to assist in stabilising pilot ladders and accommodation ladders, as illustrated below. This device uses a vacuum system to attach round discs to the side of the boat. The discs are fitted with anchor or tie off points for fastening. This and other new devices may provide additional and easier methods for securing ladder and accommodation gangways to ships and so improve the safety of the transfer for marine pilots.

Figure 8: Product designed to provide attachment points on ships' hulls



3.2 Injuries from pilot ladder transfers

3.2.1 Injury and accident data

Background

Sea transfers using pilot ladders are reported by Australian marine pilots as posing the greatest hazard to their personal health and safety (Weigall & Simpson 2005; Darbra 2006).

Data regarding marine pilot injuries and accidents from ladder transfers from around Australia were not available for this review. It appears that this detailed data is not held in a central repository as was presumed, and so this data could not be reviewed and analysed to properly identify problems or trends. As pilots are employed in different states throughout Australia by government and by commercial enterprises, and there are different accident reporting requirements, the reports are likely to be kept with each jurisdiction and/or insurer.

The only available Australian data regarding pilot injury or fatalities at work was from the NOHSC (NOHSC 1998) based on fatality data from 1989 – 1992. This analysis identified ‘Ships Pilots and Deck Officers’ as having one of the highest rates of work-related traumatic fatality in Australia, with 54 deaths per 100,000 persons per year, as compared with the overall rate for all workers in Australia of 5.5 deaths.

Despite the lack of formal records, some data was obtained from searching past reporting of pilot fatalities (Irving 1995; IMO 2006; British Ports Federation 1991), newspapers (Lloyds Register 2006; The Daily Astorian 2006), and from the recent Marine Pilotage conference (Taylor 2006). These reports confirm that pilot ladder transfers have resulted in death and serious injury, with 6 deaths attributed to this task internationally over the past year, with the primary mechanism of these deaths relating to falls from the ladder.

A brief review of the descriptions of these accidents indicates they resulted from:

- Falls from a height;
- Drowning (after being unconscious from head injuries);
- Crush injuries;
- Struck by cutter after fall from a height; and/or
- A combination of these mechanisms.

Some Australian pilot companies, port organisations and the Australian Navy provided injury data for the earlier study undertaken for the Sydney Ports Corporation (Weigall & Simpson 2005). This data showed that the most common mechanisms* of injury during the transfer process were:

- body stressing from being jarred or being twisted by a sudden movement of the ladder or accommodation system, or from the cumulative effects of repeated reaching and grasping etc - resulting in various sprains and strains and overuse diseases
- being hit or hitting a moving object such as being struck by the pilot boat when on the ladder - resulting in crush and strike injuries
- slips and falls from ladders resulting in orthopaedic and soft tissue injuries.

[*Injury mechanisms are defined as “the action, exposure or event which was the most direct cause of the most serious injury or disease” (NOHSC 2002)]

This data was supported by advice from some additional pilot employers and from anecdotal information from pilots.

Each of these mechanisms is briefly outlined as each should be considered when attempting to reduce the risks and improve the safety of the pilot ladder transfer task.

Body stressing

Description

Body stressing refers to:

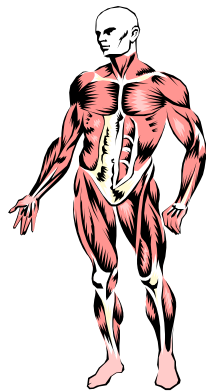
“...injuries or disorders resulting from stress placed on muscles, tendons, ligaments and bones. It includes the development of muscular stress while handling objects as well as muscular stress developing from turning and twisting movements where no objects are handled.” (NOHSC 2002)

These injuries may develop from a brief exposure to trauma or more commonly, from long term and cumulative exposure to load that exceeds the tissue’s capacity for repair. Injuries may also be a combination of acute and cumulative traumas (Burgess-Limerick 2003).

Body stressing contributes to the development of ‘diseases’ such as: disorders of nerve roots and nerves (such as nerve compression syndromes like carpal tunnel syndrome); and diseases of the musculoskeletal system and connective tissues such as disorders of muscles, tendons, soft tissues, joints and intervertebral discs. Common body stressing disorders include Occupational Low Back Pain, Rotator Cuff Syndrome, Epicondylitis, Nerve compression syndromes, Tenosynovitis etc.

Musculoskeletal disorders contribute to significant levels of disability, and injuries such as sprains and strains remain the most common injury group (accounting for 64% of all workplace injuries in NSW) and the most expensive injury group (with 70% of costs) (WorkCover 2002).

Figure 9: The musculoskeletal system is affected by body stressing



Risk factors for body stressing

Factors known to be associated with the development of body stressing and diseases include physical and individual risk factors (OSHA 1999) as outlined below:

Physical Risk Factors	Individual Risk Factors
Task factors: - Repetition - Weights and forces - Posture - Vibration Work environment issues Work equipment issues	Increasing age Pre-existing musculoskeletal disorders Lack of skills and experience

Body stressing in pilot ladder transfers

With ladder transfers some of the evident physical risk factors include working and moving in awkward postures (eg with the neck bent, shoulders elevated, wrists deviated, back bent etc); the use of force (to pull and grasp); repetition; and a combination of these factors.

Pilot accident reports analysed in a previous study (Weigall & Simpson 2005) showed a high rate of musculoskeletal disorders from body stressing. The injuries were considered consistent with jarring, twisting, landing heavily onto surfaces and from the cumulative effects of force and body stress. Musculoskeletal assessments confirmed disorders in the pilots' elbows, shoulders, wrists necks and backs. Knees were also a common site of injury.

Informal discussions with other pilots who were not part of the above study and others in pilot organisations confirm that sprains and strains and other musculoskeletal disorders from body stressing are the most common injuries and diseases resulting from the pilot ladder transfer task.

Being hit

Description

This group of injuries are the result of

“the action of an object hitting a person” (NOHSC 2002)

...such as being crushed by a vessel, struck by a ladder, or whipped by a loose rope.

Risk factors

In any environment where there are moving parts, moving vehicles or other objects this risk exists. There is also the risk of having an object dropped from the ship onto the pilot ladder or pilot boat deck.

Being hit in pilot ladder transfers

The pilot's work environment poses extreme risks for being hit as there are no fixed or stationary areas, with the 2 vessels both moving independently. The ladders are also moving independently and tend to swing out and fall back against the side of the hull as they are not fastened to the side of the vessel. The size and speed of the

movements are also relevant with a high risk of being struck by force and by hard objects.

Data from the study in Sydney (Weigall & Simpson 2005) provides the following examples of when “being hit” was the primary mechanism of injury:

- Crushed between ladder and cutter when the ladder became caught in the cutter
- Foot jammed between cutter and ship
- Arm struck by ladder

Falls

Definition

Fall injuries are classified as

“from a height” or “on the same level” (NOHSC 2002).

Between 10 – 15% of all work related fatalities in Australia and overseas are from “falls from a height” (NOHSC 1998; NIOSH 2000). In Australia this is equal to vehicle accidents (15%) and second to being hit by moving objects (35%).

Falls from ladders specifically account for over 1000 injury claims per year in Australia (ASCC 2005). Analyses highlight that the higher the fall, the higher the rate of serious injuries and fatalities, and fatality rates increase with age (Bjornstig & Johnsson 1992; NIOSH 2000). The following data was based on more than 8000 fatal falls in the USA (NIOSH 2000). Death rates ranged as follows:

- 0.23 deaths per 100,000 workers for 16-19 year olds;
- 0.40 for 25-34 year olds;
- 0.86 for 55-64 year olds; and
- 1.57 for 65 year olds and above.

The high fall fatality rates in older workers are reportedly due to more medical complications and prolonged recovery periods. This data has important implications for Australian pilots whose average age is 52 according to past studies (Parker et al 1997; Weigall & Simpson 2005).

Falls on hard surfaces

Low falls

Even in relatively low falls (less than 3 metres) a medical study found that 59% of injuries were ‘moderate’ or ‘serious’. In falls of over 4 metres, 86% of injuries were ‘moderate’ or ‘serious’ injuries. ‘Moderate’ injuries included concussion or uncomplicated fracture, and ‘serious’ included femur fracture or spleen rupture (Bjornstig & Johnsson 1992).

Falls from less than 6m

A similar study (Helling et al 1999) investigated 176 falls of less than 6 metres (not limited to ladder falls), finding:

- 35% of patients sustained head injuries

- 22% of patients sustained spinal cord injuries or vertebral fractures (including quadriplegia and paraplegia)

Falls from 9 metres

Forensic studies of falls from 9.8 metres revealed the following outcomes (Christensen 2004):

- In falls from 9.8 metres the human body aligns and lands in a horizontal position
- The amount of stress sustained by a body in a fall is related to the impact of force and the size of the force area, where the same force dissipated over a larger area produces less force per unit area (and less stress and therefore less injury)
- Fractures of the skeletal system result from stress exceeding the strength of the bone so are related not only to the angle and amount and force of the impact but also the properties of the bones such as porosity, rigidity and collagen orientation etc.
- By flexing joints at impact, deceleration forces are dissipated through the soft tissues (eg parachutists can reduce the deceleration forces by as much as 36 times through joint flexion and distributing the forces over larger areas).

Falls into water

The maximum height to be climbed by a pilot on the ladder is 9 metres above the surface of the water (SOLAS), however the Japanese Pilots' Association Handbook (1994) states that 5 metres has been identified as a maximum safe climbing level, and that pilots in Canada and Mexico have lowered their ladder climb criteria to this level.

People can fall and/or jump into water from great heights and survive, however this is uncommon as demonstrated by the following analyses of falls and jumps from major bridges:

- Sydney Harbour Bridge, from 59m - 15% survival from falling, with those entering the water in a feet first, vertical position being most likely to survive (Harvey & Solomons 1983)
- Westgate Bridge, Melbourne, from 58m – 11% survival from jumping*, however each of these jumps were with suicidal intent (Coman et al 2000)
- Golden Gate Bridge, San Francisco – only survivors of falls were those who entered the water feet first and in a vertical posture (Lukas et al 1981)

*Interestingly a study investigating injury patterns from intentional versus unintentional high falls (101 subjects) found no significant difference in the injury patterns on the recovered bodies (Richter et al 1996).

In studies into falls from a height into water, impacts that were feet first consistently produced less fractures and injury than those that were horizontal because of the longer deceleration experienced (Christensen 2004).

As well as being injured from the impact of the fall, other injuries developed as a result of the climber attempting to catch themselves and prevent a fall to the ground or other surface. These injuries often result in musculoskeletal injuries such as sprains and strains.

No studies relating to falling from the side of ships and the potential effects of ship movements and propellers etc were located.

Risk factors for ladder falls

A comprehensive analysis of workplace accidents with step ladders in the USA (Cohen & Lin 1991a) identified 4 key groups of risks affecting the task:

- working condition variables;
- ladder use related variables;
- personal and occupationally related variables; and
- personal and non-occupationally related factors.

The study found that variables that were the strongest predictor and were the ‘most important’ contributory factors of ladder falls were working conditions and ladder use. Personal non-occupational characteristics (such as health problems, physical characteristics, life stressors, personality, risk-taking behaviour, body dimensions) were found to be the ‘least important.’

The analysis reported the major predictors of ladder fall accidents as:

- Working on night or evening shift
- Working longer hours than the control group
- Working in awkward or uncomfortable positions
- Less able to control work flow or order of tasks
- Work requiring great strength

The ladder-use related variables were:

- Working longer hours on the ladder – resulting in fatigue and greater exposure to the task
- Less experience with ladders
- No choice of ladders for the task

Other reports of ladder falls (Bjornstig & Johnsson 1992; Cohen & Lin 1991b) have also identified the following situations as contributing to the fall event:

- Transitioning onto or from ladder
- Having to over-reach
- Being thrown from the ladder
- Slippery steps
- Miss-stepping

Falls during pilot ladder transfers

Pilot ladder transfers require working at heights, often at a minimum heights of 2 -3 metres. Maximum elevations are estimated at approximately 15 metres from the cutter deck and 17 metres from the water. Many of the scenarios listed under

‘risks’ are applicable to many pilot transfer situations. The risks associated with transitioning (eg between the cutter and pilot ladder, and pilot ladder and accommodation ladder) and being required to over-reach to ropes etc are considered to pose major risks in this task.

Past fatalities from falls onto the cutter decks and into water confirm the risks of this injury mechanism.

3.3 Fall protection systems

3.3.1 General requirements for personnel working at heights

State OHS Acts and associated OHS Regulations

As previously outlined, pilots work under various OHS Acts depending on where their employer is located, and the Acts have slightly different Regulations and other requirements. Although there are slightly different provisions, each demands systems that reduce the risk of falls for workers exposed to this hazard. Pilots and employers should therefore follow this advice wherever reasonably practicable in order to comply with the relevant laws.

For example employers in NSW must follow the requirements in the OHS Regulation (2001) which is called up under the NSW OHS Act (2000). Chapter 4 Division 6 outlines how falls from heights must be prevented. This Regulation states:

“An employer must ensure that risks associated with falls from a height are controlled...”

The first preference is for the provision of physical barriers such as fenced work platforms or handrails and other physical barriers, however if these controls are not

“reasonably practicable”,

then:

“.. an employer must ensure... the provision and maintenance of...other forms of physical restraints that are capable of arresting the fall of a person from a height of more than 2 metres...”

The Regulation then outlines the requirements for fall arrest devices with descriptions and minimum standards for: anchorage points; harnesses; safety lines; staff training; and rescue methods. The Regulation ‘calls up’ a number of Australian Standards, a Code of Practice (Safety Line Systems) and WorkCover NSW Safety Guides, so these can be referred to as evidence of non-compliance with this Regulation and the related OHS Act 2000. Other Acts call up very similar Regulations as falls from a height are a common cause of death and serious injury in the workplace.

Australian Standards

Industrial fall-arrest systems

The Australian Standard relating to general fall protection systems (AS/NZS 1891.4) outlines the requirements for workers who are working at heights in general, and is not confined to one industry. All employers are expected to follow this minimum standard as a guide, and to apply the hierarchy of controls to manage the risks. This requires the following process in each situation where a fall is identified as a hazard to personnel:

- Identify the hazards (eg a fall) and assess the likelihood and consequence of the hazards (eg injury or death)
- Eliminate the need to access the fall risk area
- Substitute the access method to one that reduces the risk of a fall, such as by way of a walkway or elevating work platform rather than a ladder etc
- Isolate the area so that the fall risk area cannot be accessed
- Provide fall protection which either prevents a fall or reduces the severity of a fall

The 'fall protection' options are outlined as follows:

Fall restraint

- Provide the worker with personal restraint hardware that allows access to work areas without encountering risk of a fall.

Work positioning

- Enclose or encapsulate workers in elevating work platforms, maintenance units or other systems (eg industrial rope access systems) so that the risk of a fall is minimised.

Limited and restrained free fall arrest

- Equip workers with personal hardware that will limit distance of a fall (to no greater than 600mm) and limit severity of a fall, but not prevent a fall.

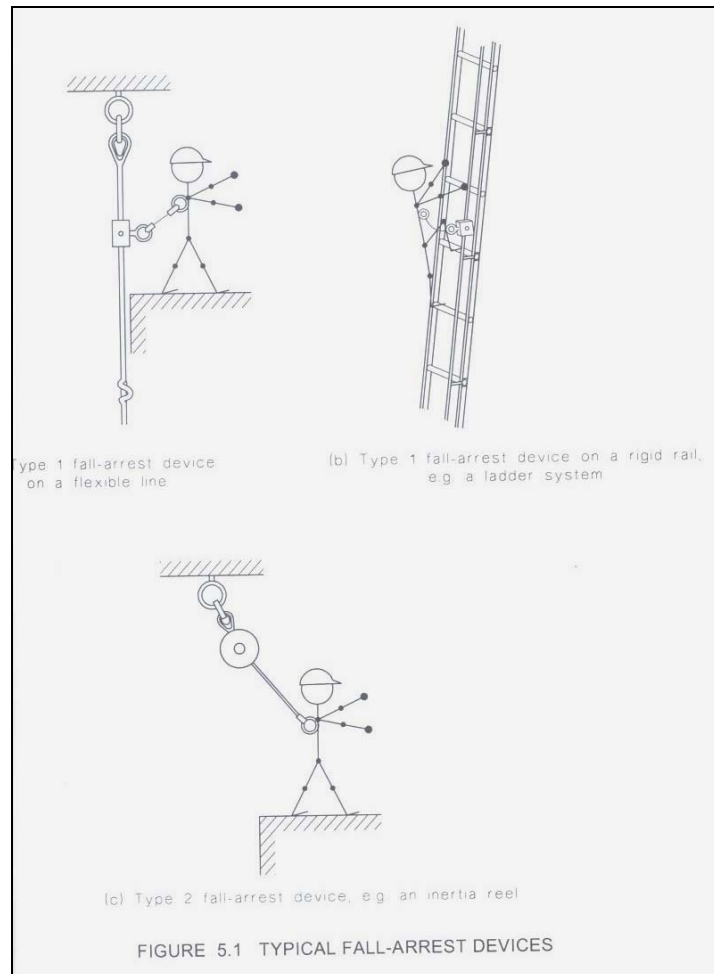
Free fall arrest

- Equip workers with personal hardware that will minimize risk of injury from a fall, but not prevent a fall.

Some guidance is also provided about selecting equipment that reduces injury risk from the worker impacting on structures or the ground, and reduces risk of injury from the harness itself.

As these standards provide a minimum level, employers may be able to demonstrate systems or equipment that are different but superior to the standard.

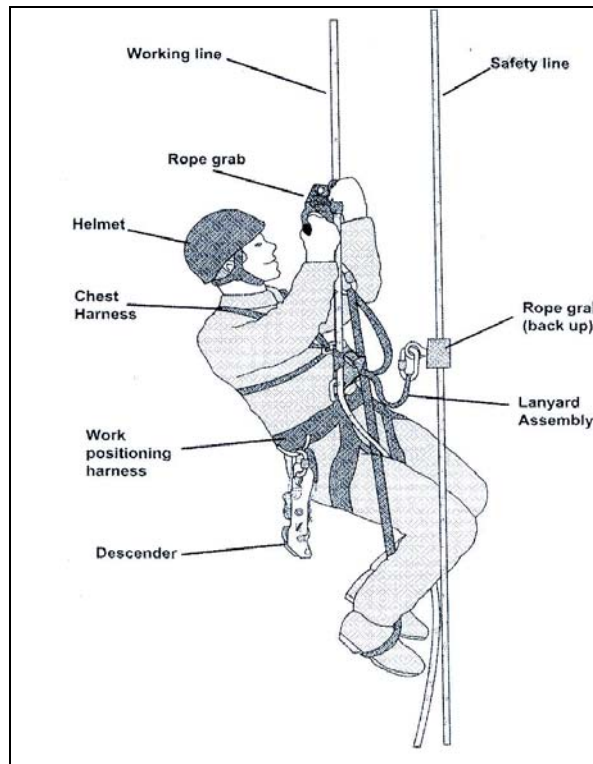
Figure 10: From Standard AS/NZS 1891.4 illustrating various fall arrest systems



Industrial rope access systems

Rope access systems provide access to and from the work site and provide support while performing a task at a height. These systems hold the worker in suspension and allow the worker to move up and down via ropes. Australian Standards (AS/NZS 4488.1 & 4488.2) describe these systems and outline the requirements. These systems were originally used in recreational areas such as mountaineering, but have been adapted for industrial applications. Rope access systems have some similar components to fall protection systems, but include the use of ascenders, descenders and various swing chairs etc. Workers using rope access systems may use a fall protection system as a back up.

Figure 11: Ascent or descent using rope grabs only, from AS/NZS 4488.2, Industrial Rope Access Systems



The Industrial Rope Access Systems standards are called up in the Seafarer's Code of Safe Working Practice (AMSA 1999) in relation to working aloft in Bosuns chairs and may therefore be used as evidence of non-compliance in this area.

International Standards & Regulations

In addition to the Australian requirements and Standards are the International Standard, European Standard and Canadian, USA and other Standards relating to fall protection and rope access. They all have slightly different requirements, tests and criteria regarding these systems, but are similar in principle and purpose.

The USA's OSHA is encouraging increased use of fall protection by industries and has produced a series of 74 'Disaster Facts – Accident Report' that outline different fall accidents that occurred when workers were not adequately protected (OSHA 2006).

Commercial systems

There are a number of companies in Australia that provide 'height safety equipment' such as fall arrest blocks and retracting lanyards to limit mobility and falls when working at heights (Combined Safety 2006; Gotchasafe 2006). They also provide various anchor devices, safety lines, and permanent and temporary anchor points. This equipment is most commonly used by personnel in roofing, maintenance, construction, tree lopping, search and rescue, manufacturing, forestry and mining.

3.3.2 Requirements for seafarers working at heights

The Commonwealth OHS (Maritime Industry) Act 1993

In addition to the various state OHS Acts, the OHS (Maritime Industry) Act 1993 applies to all personnel who are visiting or working on vessels between states, between places outside of Australia and between Australia and places outside Australia. This Act refers to the need for safe systems onboard vessels and the use of appropriate equipment etc to eliminate and control risk. This would include managing hazards associated with working at heights.

Code of Safe Working Practice for Australian Seafarers

The Code of Safe Working Practice for Australian Seafarers (1999) has a section dedicated to the safety issues with “Working aloft and over the side”. This Code lists the following general provisions (Section 15.1):

- “Working aloft or over the side should not be permitted if the movement of a ship in a seaway makes such work hazardous
- All seafarers should wear safety harnesses and restraints appropriate to the conditions
- Safety nets should be rigged where necessary
- Persons working over the side should wear life jackets or other suitable flotation devices
- A competent person should continuously supervise seafarers working aloft or over the side”

As previously noted, this Code makes reference to the Australian Standards for rope access systems.

Although these requirements are for seafarers, this provides useful guidance regarding the sorts of measures that are available and expected for personnel working “over the side”.

AMSA ‘Marine Notices’

In 2003 AMSA reminded shipowners, operators, masters and crew of the hazard of working at heights, listing 4 recent incidents onboard various vessels. The Notice urged compliance with the Code of Safe Working Practice for Australian Seafarers and the Australian Standard on fall protection systems (AMSA 2003). This notice demonstrates AMSA’s interest and commitment to reducing fall risk in the industry.

3.3.3 Fall protection systems and equipment

Description

All fall protection systems are aimed at minimising the effects of a potential fall and arresting the fall with limited impact forces.

The 4 phases of a fall are:

- initiation of the fall
- the fall
- arrest of the fall; and
- suspension following the fall (Seddon 2002)

After a fall, when the worker is suspended in the harness he or she is likely to be in a state of shock, and may or may not be physically injured. The casualty may be able to rescue him or herself, or may need to await rescue. Depending on the injuries sustained in the fall the casualty may be unconscious, have broken limbs or otherwise be unable to move, including being totally motionless.

The design and position of the harness on the body has been identified as having a significant impact on: the angle of the body after the fall; the user comfort; and the potential for traumatic injury caused by the arrest (Seddon 2002).

Types of equipment used

The basic equipment required for fall protection systems consists of:

- A lanyard or free-fall device incorporating an energy absorber (to dissipate the kinetic energy)
- An anchorage point
- A harness

Figure 12: Example from Safemaster



Figure 13: Example from Combined Safety Services



Typical systems in the Australian Standard (AS/NZS 1891) are described as Type 1, 2 or 3, and each has slightly different applications and requirements.

Type 1 – Rope and rail grabs

- Typically used on ladders
- Device is attached to a vertical rail or a fixed vertical line and can move up and down the rail or line
- User is connected via a short lanyard to the activating lever which locks the device in the event of a fall

Type 2 – Fall arrester, inertia reel, self-retracting lifelines

- Attached to an anchorage point and pays out a line
- Line is attached to user's fall arrest harness
- Line is controlled by a spring-loaded reel which adjusts the line length as the wearer moves up and down in the course of their work
- Reel locks by means of the inertia reel or similar mechanical principle

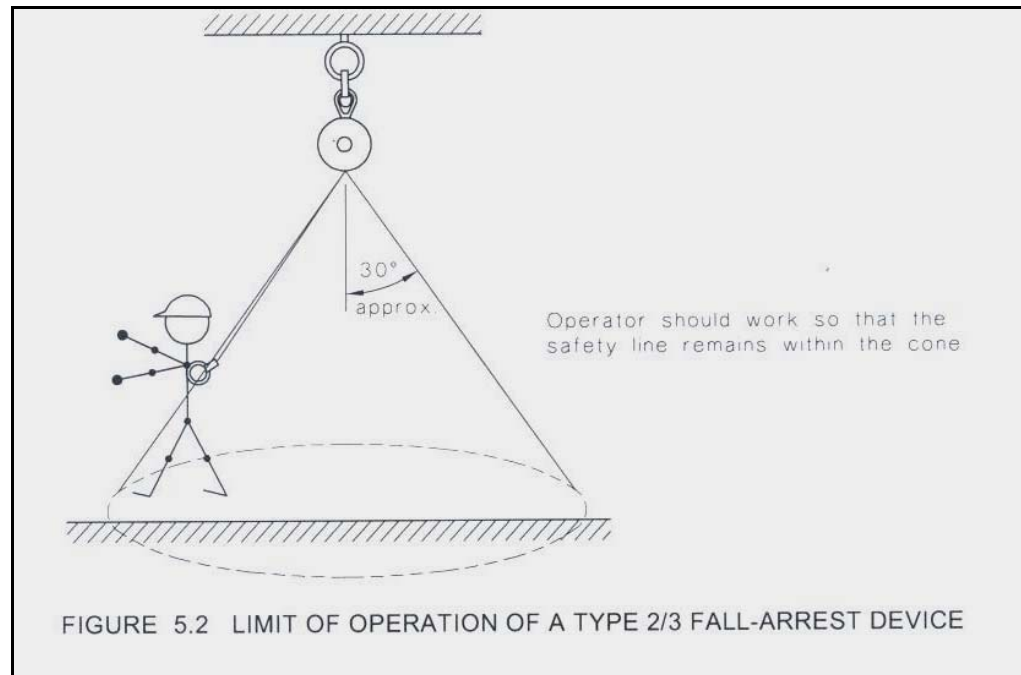
Type 3 – Similar to Type 2

- Used as for Type 2, with the addition of a winching mechanism which permits retrieval of a wearer who has suffered a fall or is otherwise in distress

Types 2 & 3 should be anchored to a point above the user which will not be offset by generally more than 30 degrees from the vertical or such other angle as the manufacturer recommends. This is illustrated in Figure 14.

Aspects of each of these fall protection ‘types’ appear to have potential application for the pilot sea transfer task..

Figure 14: From AS/NZS1891.4



Harnesses

Harnesses can be used in fall prevention, work positioning, fall arrest and for rescue. The design of the harness has a major impact on the body during the fall, the arrest, and the suspension phase.

A major study into harness design (Seddon 2002) outlines how the orientation of the body at the initiation of the fall and during the fall will determine which part of the body will take the first and more important impact during the arrest phase. Belt harnesses have gone out of favour due to injuries they caused, and various full body harnesses are currently promoted. The attachment point of the harness will affect the degree of neck movements, rotation of the body, compression on the spine etc and so will impact on the location and severity of injury to the body. The size and fitting of the harness is also critical as incorrectly fitted or fastened harnesses will fail to provide adequate protection.

Horizontal lifelines

Depending on the fall protection system, and if some horizontal travel is required, temporarily installed horizontal lifelines may be required. These are designed to provide a continuous horizontal anchor for the fall protection system. According to a recent investigation into these systems (Riches 2004) many are incorrectly fabricated and installed, and fail to work properly. The author warns that while they may appear to be a simple device, they require skilled engineering to achieve their purpose and allow safe access.

3.3.4 Fall protection used by marine pilots

Representatives from AMPA are not currently aware of any fall protection systems currently in use by any marine pilots located in Australia, and believe that none have ever been considered or trialled. They also report that to their knowledge no fall protection systems are used by marine pilots in other countries.

A Regulation located from the UK (The Merchant Shipping Regulations 1999) discusses the use of harnesses and fall arrests for pilots, with the system described as being an ‘accessory’ to the pilot ladder. It is not clear whether the harness and fall protection system in this instance is mandatory or optional. Searches did not locate any other references to fall protection systems used by marine pilots.

One company was located that promotes an aid for marine pilots – the ‘Protecta’ fall arrest device. However after following up with the UK company that sell this device, they admitted that they were not aware of any pilots that used this product as yet.

3.3.5 Perceptions and problems with fall protection

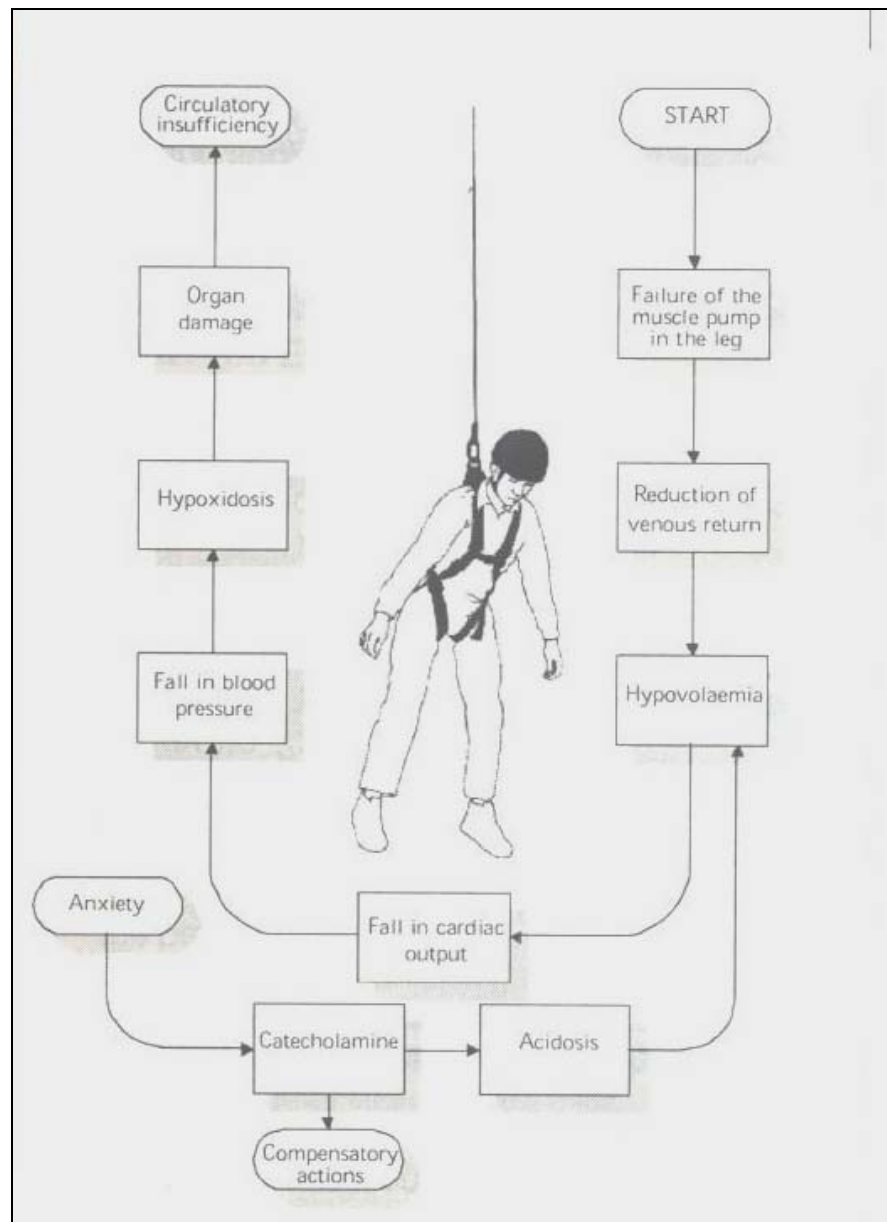
Fall protection is now widely used in industries such as construction, manufacturing etc, but many workers are reportedly reluctant to use the devices. Reasons given for this attitude include:

- Harness awkward and annoying to use
- Harness and lanyards too restrictive
- Strapping around legs uncomfortable impacting on groin area
- Difficulty working with anchor points
- Fear of suspension and slow rescue
- Belief that task will be slower if using a device
- Belief that they will not fall so do not need protection
- Belief that consequence of fall is not major
- Peer or supervisor pressure not to use the device

(Zupanc & Burgess-Limerick 2003; Rushworth & Mason 1987)

A very real problem relating to fall protection systems is the period of suspension immediately following a fall. The person is held suspended in an upright position and may be unconscious. This posture can result in ‘orthostatic shock’ or ‘orthostatic syndrome.’ This syndrome occurs from the impact of venous pooling, and reduced cardiac output on the body’s circulation, as illustrated in Figure 14. Death can occur if a person is suspended and unconscious for periods of even less than 10 minutes (Seddon 2002). Immediate rescue and careful treatment following suspension is also critical to achieve a good outcome for the casualty.

Figure 15: Description of orthostatic shock



Despite the risks, a review of 91 fatal falls from a median height of 8metres (NIOSH 2000) found only 2 were related to fall protection ‘failure’ and none were attributed to orthostatic syndrome. In contrast 54% of the fallers who died wore no protection. A further group of 13% wore fall protection but had it incorrectly fastened. The incorrect wearing of personal protection is a risk in itself as the wearer may have a false sense of security.

From informal discussions with a number of marine pilots the topic of fall protection appeared to be of no interest, with a common view that this would only further increase their risk. Pilots have reported that this system would make the task more complicated and that they would have to be more reliant on the skill and expertise of others, such as the crewmen onboard the vessels. The general view appears to be that some ships have enough difficulty with properly securing a ladder and that introducing a new or more complex system would introduce further or greater risk.

3.4 Mechanical access systems for transfers

3.4.1 Background

Current methods used in industrial applications for transferring and lifting people include:

- Passenger lifts and elevators
- Hydraulic work platforms to reach up from below
- Access equipment suspended from above (such as hoists)
- Personnel baskets suspended by crane
- Helicopters – either with or without winching.

In marine pilotage, hoists and helicopters have been used in the past, and helicopters continue to be in use at many ports.

3.4.2 Hoists

Hoists in general

There are a wide range of hoists used in industry for powered lifting using electricity, batteries, and air operation. They can be fitted with handling devices such as hooks, clamps, probes, vacuums, and baskets, and are operated from jib cranes, tracks etc. They generally have safety devices such as automatic cut off switches, option for manual operation for controlled ‘wind downs’ and/or battery back up power. Hoists are often custom-made to suit the load and the work environment.

Pilot hoist design requirements

Mechanical pilot hoists are currently permitted for transferring marine pilots between vessels at sea under the IMO Resolution A.899 (21) part 4, and SOLAS Regulation 23, part 3.3.3. According to the IMO Resolution the parts of a hoist system are to include:

- A mechanically powered winch
- Two separate falls
- A ladder or platform consisting of: a rigid upper part for the transportation of any person upwards or downwards; and a flexible lower part consisting of a short length of pilot ladder which enables any person to climb from the pilot launch to the rigid upper part of the ladder to be lifted and vice versa.

It is the rigid section of ladder or the platform that is then hoisted. To access the hoisted component, the pilot must first transfer between the pilot cutter and the pilot ladder in the usual way, then climb 8 steps to the height of the rigid ladder and/or lift platform section.

Pilot hoist background

No records or documentation regarding the introduction of hoists were available from IMPA, AMPA, AMSA or ATSB to assist in determining the rationale or situations surrounding their introduction. The best reference was Captain Armstrong's book 'Pilot Ladder Safety' (1979) which clearly describes some of the initial issues with hoists.

Due to the lack of other available data, anecdotal information was sought from retired and older pilots who had some first hand experience with hoists. Their advice suggests that the introduction of hoists coincided with the introduction of vessels that had freeboards well over the 9m rule, and that pilots were concerned about the increasing heights, together with the general injury risks with pilot ladder climbs.

The hoists appeared to have been in use internationally for a short period from the late 1960s to the mid 1970s – so more than 35 years ago. The following hoists were reportedly in use for some or all of this time (MMS Ergonomics 1979):

- Steen hoists
- White Major hoists
- Schatt Davits (custom made hoists)

In addition the Welin Pilot Embarkation Platform Systems (PEPS) were available.

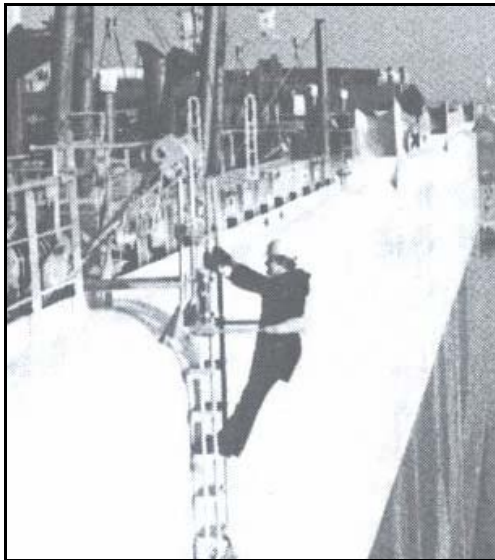
A description of pilot hoists from this report from the 1970s outlined the following common features:

- Short section of conventional pilot ladder leading to the rigid section
- Power hoisting by means of an electric, hydraulic or pneumatic motor
- Winch drum on the deck or superstructure above
- Winch controls usually located on the framework of the system, or permanently installed on or near the railing or bulwark adjacent to the boarding position
- Some hoists have controls or emergency stop line on the pilot ladder for the pilot to operate
- Often the winch operator cannot see the base of the ladder and relies on hand signals from others

This old report noted that some hoists had the following additional features:

- A hooped backrest or support for the pilot (as illustrated in Figure 15)
- A system of electromagnets and nylon rollers located on the rigid portion of the pilot ladder to ensure the ladder remained firmly in contact with the ship's side during hoisting.

Figure 16: Welin power hoisted pilot ladder system



Only one other article about pilot hoists was located – dating from 1985. This information from a journal ‘Safety at Sea’ (Francey 1985) is consistent with current anecdotal information in reporting problems with some early hoist systems. The author describes:

- The system swinging outboard then twisting in the wind leaving the pilot facing the water and with the ropes crossed
- Operators inaccurately estimating the amount of rope to let out and stopping the ladder at the right distance from the pilot cutter
- Fear of power failure so requiring options for hand winching

Pilots today explain that the hoists tended to increase the safety risks and there were many incidents where pilots became ‘stuck’ in the hoist or otherwise felt unsafe and at risk. The reasons for the hoists’ unpopularity appear to be the result of:

- The slow speed of the hoist (specific speed unknown)
- The hoist stopping unexpectedly or mid-way through the hoisting from the wire jamming, motor problems, operator error or a combination
- The pilot did not have control over his/her movement and speed of movement

This ‘slow’ speed may have been less than the IMO requirements (average lifting and lowering of between 15-21 metres per minute), but this is not known.

Captain Armstrong’s book (1979) provides further lists and descriptions of problems with hoists.

The pilots’ combined advice suggests that these were not isolated events. For example one Australian pilot explained his experiences and his conclusion:

“I think I probably used hoists about 10 times in the early 80s and had two problems:

1. The air motor started and stopped several times over a period of perhaps 2-3 minutes before I reached the deck.

2. The operator sent the hoist the wrong way, down instead of up, so I descended about a metre before jolting to a stop and then ascending.

Both were unpleasant experiences and I decided after the second that I would not use a hoist again.” (Haley 2006)

Pilots have reported that hoists were often designed and built by the ship employees, and they suspect that the employees may not have had special experience or expertise in hoists. This may have resulted in the hoists not being the safest designs and maybe also not strictly complying with IMO requirements.

Pilot hoists today

Very few pilots working in Australia today use pilot hoists. According to anecdotal information, there are only 2 vessels that visit or use Australian ports that currently use a hoist system, and the hoists are only used occasionally. The vessels with these hoists are the Endeavour River and the Fitzroy River, both of which carry bauxite between Weipa and Gladstone. The operator is believed to be ASP Ship Management. To use the hoist the pilot must first transfer onto a pilot ladder, then transfer to a platform, and the platform is then hoisted up.

Despite a search of marine engineering companies who reportedly made pilot hoists in the past, only one company was located that currently manufactures and sells hoists. This company, A.B. Welin of Sweden, claims to provide hoists in accordance with the requirements. However on their website (Welin 2006) the company lists the 1973 IMCO Resolution as being the standard to which their hoists are built, and this was revoked with the IMO Resolution adopted in November 1999, suggesting the company may be somewhat out of date with the current requirements.

The Welin range of hoists includes:

- A davit hoisting mechanism for an aluminium ladder (covered in plastic tubing) that brings the pilot to a platform, which the pilot then transfers to
- A platform fitted to the lower end of an accommodation ladder, with the pilot ladder entering the platform via a trap-door (PELS)
- A platform fitted to the lower end of a rigid framework (instead of the accommodation ladder) and the platform and frame are hoisted (PEPS)

Figure 17: Welin Pilot Embarkation Platform System (PEPS)



The pilot transfer systems described above appear unchanged since the 1970s and the images from the Welin website appear identical to those from the 1970s.

A pilot who is familiar with and has used the Welin platform systems in the past provided these observations about why the platform system was slightly difficult to use:

“Because the ladder was suspended from the platform it was not firmly against the ship side

Transferring from the ladder through the trapdoor required climbing at an angle of about 110 degrees and was an awkward transition

The trapdoor opening in the platform was a little small for some pilots”
(Haley 2006)

Other hoist companies searched included: Schatt davits; Steen Hoist; White ‘Major’; and ‘Pilotsafe’, however no information was located and it is not known if these companies continue to either manufacture or sell pilot transfer equipment.

Pilot hoist use overseas also appears to be uncommon or non-existent, as no one within the IMPA executive has been able to identify any countries or regions where ships use this equipment.

Pilots’ current impressions of hoists

A recent article published in the Australian Maritime Pilots Association magazine (Ladder Working Group Committee 2006) proposes that:

“Mechanical Hoist use should now be prohibited/abandoned”.

This advice is being proposed by a small working party who has been reviewing a number of recommendations from the Japanese Pilots Association relating to sea transfers. The decision to prohibit hoist use for pilot transfers appears to be unanimous within the working party of 5 members. This recommendation, and others, will reportedly be prepared as a ‘Draft Resolution’ and circulated to IMPA

members for review and comment in the near future. The data on which this opinion was formed is not known.

3.4.3 Passenger lifts and elevators

In addition to hoists, many industries use lifts and elevators to move personnel and goods along vertical planes. A range of Australian companies who design and manufacture industrial personnel lift systems were contacted for information to see if any aspects of their equipment may have any application in the sea transfer task (See 'Companies contacted' 2006) .

For example Alimak (2006) provide a wide range of custom made rack and pinion drive systems with bases measuring from a minimum of 1m x 0.8m, that can travel at speeds from 0.5m to 1.2m per second (as compared with the average requirement from IMO of about 1m in 4 seconds or 15m per minute.) Alimak claim that their rack and pinion system has the following advantages over conventional industrial passenger lifts:

- No machine room as the lift carries its own machinery;
- Installations suit curved or inclined surfaces;
- Lifts are very narrow and streamlined; and
- Accurate floor levelling irrespective of load or lifting weight.

Please refer to the following illustration of a rack and pinion system.

Figure 18: Alimak rack and pinion lift



One potential problem identified in the technical specifications is that in the event of a power failure the lift can be brought down by gravity at a controlled speed, but

in the pilots' transfer situation they would in most cases prefer to be brought back up to the deck...

The other major barrier to the successful implementation of this sort of device is that the lift equipment would require either permanent or temporary tracks fitted to the ships' sides.

3.4.4 Personnel baskets

According to the Australian Offshore Support Vessel Code of Safe Working Practice (AMSA 1997) personnel can be transferred between vessels and the installation via a basket. The following transfer devices are used in offshore industries for moving personnel:

- Personnel transfer 'nets' (also sometimes referred to as baskets) that consist of a circular ring or base that people stand on and face inside the base while grasping netting lines. This includes most of the Billy Pugh models (Billy Pugh 2006) and the Danish Esvagt device (Esvagt 2006). Please see Figure 19.
- Personnel 'baskets' that consist of a basket that personnel stand within that may be of a rigid or collapsible construction
- A rigid design where a person sits in a bucket seat in a semi-enclosed frame in a tepee shape, known as the Frog (Reflex Marine 2006). Please see Figure 20.

There have reportedly been many accidents with personnel transfer baskets over the years (Strong 2006) despite their frequent use (Bailes 2006). The Construction Safety group with the Centre for Disease Control in USA (CDC 2006) also warns that these baskets should:

“Only be used when there is NO OTHER safe means of performing the work!
Personnel baskets are the tool of last resort.”

Even with new and apparently improved designs, each of these personnel transfer devices requires a crane and a stable base from which to operate. As pilot transfers occur between two moving vessels, and generally in open waters, none of these devices are easily applicable to the pilot's transfer task.

Figure 19: A Billy Pugh Personnel Transfer Device, Model X-904



Figure 20: A 'Frog' by Reflex Marine



3.4.5 Self-hoisting devices

An Australian company specialising in mooring and rigging equipment for marine industries is currently investigating a possible new system for pilot transfers involving the pilot using a self-hoisting device to pull themselves up onto the ship and then use the same device to lower themselves down from the ship (Underhill 2006). No further details have as yet been provided.

3.4.6 Helicopters

Helicopters have been used for pilot transfers for many years. For example, European countries using helicopters include:

- Germany – since 1974 (Hopken 2006)
- Norway west coast – since 1994, with 80% land on, 20% winch on (Price 2006)
- The Netherlands – since 1992 (Delaporte 2006)

In the USA helicopters have been used by the Columbia River Bar Pilots following extensive trials in the mid 1990s. They report using helicopters for 70% of all transfers with no injuries or deaths with between 2200 and 3000 helicopter transfers per annum. The conditions in this area are reportedly difficult with heavy swells, confused seas and high winds (Lewin 2006).

Each of the pilotage organisations can provide detailed information on the particular helicopters selected for the transfers and the vessels on which they land or winch to and from.

While helicopters are not widely used in Australia, they are regularly used in ports such as Newcastle and Gladstone and within the Great Barrier Reef. It is understood that at least one other pilot organisation is currently investigating the feasibility of this transfer method too, due to the concern of injuries with the traditional ladder method.

In Australia there is a Code of Safe Practice for Ship-Helicopter Transfers (AMSA 1995) for guidance in this area.

4 DISCUSSION

4.1 Summary and Analysis

4.1.1 OHS laws

The web of laws, international agreements, and standards affecting OHS for the pilot transfer task is complex. The pilots appear unclear on this area and on what laws or agreements take precedence. The employers' understanding and actions in exercising their duties in OHS is also not known within the context of all their other legal responsibilities.

The situation for occupational groups such as pilots is complex when they routinely enter others' worksites. While this is not an uncommon situation for many Australian workers and in many industries, the added difficulty for marine pilots stems from the transient nature of their workplace and the reported wide variation in OHS standards on the various vessels on which they work.

4.1.2 Pilot ladder design

The current pilot ladder design and aspects of the accommodation ladder as required under the IMO appear at odds with Standards and ergonomics and safety literature.

This preliminary review of the current available evidence suggests that the following aspects of the pilot ladder require further investigation:

- Step design – to achieve more foot clearance. For example this may be achieved by either by increasing the depth of the step tread or providing space behind the step, possibly by way of a spacer mechanism to hold the ladder a fixed distance off the vessel
- Step spacing – to reduce the step spacing, but exact dimensions can only be determined with proper trials
- Hand holds – to review the location, design and dimensions
- Ladder attachment

Ladder design and any proposals by the IMPA Ladder Working Group Committee on changing the pilot ladder should be based on a scientific evaluation considering joint power at the key body joints, shear and compression forces, horizontal and vertical slip forces, user comfort, and other specific quantitative and qualitative data relevant to the user groups and the different work environments.

This preliminary review also indicates that as well as the pilot ladder design, the accommodation gangway system and its attachment require review.

4.1.3 Injuries from ladder transfers

Mechanisms of injury in pilot ladder transfers have been identified as body stressing, being hit by a moving object, and falls, and the consequences of these events are often serious and include catastrophic outcomes.

Without good data regarding pilot ladder accidents it is not possible to identify trends, so the available scientific literature of large samples of climbers should be used to inform and guide policies and procedures regarding pilot ladder transfers.

The literature regarding falls from a height into water suggest that injury is largely dependent on the body's orientation. However past pilot ladder accidents show that the pilot often hits the cutter prior to entering the water. Falls from less than 3 metres onto a hard surface can cause serious injury or death, and the consequences are more serious in older age groups.

As well as injuries from falls, the task of pilot ladder transfers impacts on musculoskeletal health, and may result in long term disability and an inability to work as a pilot. These injuries are likely to be a result of both acute and cumulative traumas. Many of the resultant injuries – whether they be from body stressing, being hit and/or from falling - result in permanent disabilities and being certified 'medically unable to return to be in command of a vessel', with the pilot unable to ever resume their career in pilotage (Transportation Safety Board 1997; and confidential personal communications).

Any changes or improvements to the current system of transfers must aim to:

- reduce the physical demands of this task to reduce the impact of body stressing
- better manage the risks associated with working between moving objects; and
- eliminate or significantly reduce the risk of falls from a height.

4.1.4 Fall protection

Fall protection would appear to be a logical and important approach to reducing risk in pilot transfers if the task continues to require use of pilot ladders.

As previously noted in this report regarding falls from a height, falls from a distance of even 2 or 3 metres can cause serious injuries or death. The human body is not designed to tolerate unexpected falls, and as the body ages it copes less well as demonstrated by higher rates of serious injuries and fatalities. The background literature and laws are consistent in demanding systems and mechanisms to prevent workers from falling. One would assume that the sea transfer task posed the same or greater risks than many tasks where fall protection is currently required.

However the data also shows that the use of fall protection systems is not straightforward. The application for pilots and ships requires further investigation by engineering specialists in this area. It is anticipated that for use on ships most components of the fall protection system would most likely have to stay on the vessel, and be lowered to the pilot for embarkation. The pilot could however have their own harness and lanyard. Where equipment is ship-based it requires the ship to take responsibility for the proper fabrication, installation and maintenance of the various components of the systems. Fall protection equipment that is incorrectly secured may give personnel a false sense of security at best, and at worst may fail to provide protection.

4.1.5 Mechanical access systems for transferring people

There has been a surprising lack of development work in the area of pilot hoisting. The only systems that were located that are commercially available today all come from one company and they do not appear to have evolved or improved since the models in the 1970s, and from some accounts these models required some modifications to make them easier and more comfortable to use.

The mechanical hoist should have the advantage of reducing the total climb, and so reducing the physical loading on the body. The unfortunate aspect of the pilot hoists is that they continue to require a transfer between the pilot launch and the ladder and observations and assessments suggest that this is the most hazardous aspect of the transfer task (Weigall & Simpson 2005). Use of the hoist may also require a transfer between the ladder and the accommodation, often via a small trap door and at an awkward climbing angle.

Without further data from the apparently short hoist period it is not possible to determine important facts such as if:

- particular makes or models of hoists were more problematic than others;
- there were specific design features that contributed to problems;
- other factors were the main problems (such as poor maintenance, lack of manpower, incorrect use etc); and if
- the use of hoists in general was more or less hazardous than the use of just the pilot ladder.

It is likely that there were a combination of factors contributing to the risks.

Although very few pilots working today have had first-hand experience with these hoists, and many of the stories are from hearsay or from recollections from more than 30 years ago, their stories are consistent, and consistently negative. However this data may not necessarily reflect a great number of incidents, but may reflect a few incidents that are widely reported and remembered. Also it is common for any changes in work methods to be met with some scepticism and concern, and this may bias peoples' recollections and reporting of the hoist system as opposed to the one with which they are more familiar and comfortable, despite the problems with ladders too.

It appears that rather than work to improve hoist designs both manufacturers and pilots have preferred to leave the issue, or as is the case with the IMPA Ladder Working Party, to recommend that their use be prohibited. Considering the huge development in technologies over this period one would assume superior methods and approaches to engineering would now be available that would rectify the earlier problems.

Before dismissing hoists, it is recommended that more work is undertaken with engineers and others who are expert in the field and with current technologies. It is also acknowledged that given the negative stories and experiences circulating within the pilot profession this will be a challenging area to work in and to develop systems that properly meet the pilot's safety requirements.

Of the other options, only helicopter use appears immediately feasible, as existing data suggests it is both safer and easier to arrange than access lifts or personnel baskets. The preliminary work into self-hoisting devices sounds interesting but it is

likely that this would be similar to rock climbing or abseiling so require a high level of physical skills and capability. In this case the self-hoist device may not be suited to the pilot population who are typically in their 50s and are likely to have pre-existing musculoskeletal conditions.

The current system of marine pilots transferring at sea using pilot ladders without any protection from falls or strikes requires many changes to make the task safer. The transfer system appears little changed over the years and there is no evidence of any formal or comprehensive review to determine where improvements could be made. This lack of review is despite evidence of fatalities and serious injuries affecting pilots throughout the world.

The rationale for decisions regarding ladder designs and transfer methods were not located in this project, and it is assumed they may have been based on past practice and assumptions rather than scientific evidence based on data. This transfer task appears to be long overdue for a thorough and objective review that takes all of the factors that impact on the task into account.

Based on this preliminary assessment, and from the findings of past reports and accident records, the following strategies are therefore proposed to assist industry work towards reducing the risks in transfers via pilot ladders:

- Survey pilots regarding their experiences and opinions regarding transferring with the pilot ladder – this includes conducting a brief ‘audit’ of ladder rigging and compliance with the current requirements, and also to gather pilots’ perceptions of the pilot ladder and rigging and where design improvements could be made to make the transfer task easier and safer.
- Further investigate the possible use of fall protection systems – engage personnel who specialise in these systems to review the task and advise on options.
- Review the current safety equipment used and/or available in the transfer – this should include a review of the personal protective equipment used by pilots and the safety equipment used on pilot boats. The aim is to reduce the severity of any mishaps such as falls onto the deck, falls into the water, being struck, and to reduce the general wear and tear on the pilot’s body from the physical demands of this task.
- Review and improve administrative controls – this includes considering and managing adverse weather conditions, the effects of shiftwork, working in different lighting conditions such as darkness, and personnel requirements.
- Continue to investigate ladder design features including conducting assessments in laboratory settings – this includes developing mock-ups of various designs and conducting scientific trials to determine their value. Any new designs would incorporate findings from the pilot survey as well as available data from the safety science, materials science, engineering and ergonomics literature.
- Investigate ship and pilot cutter design and their interaction – this includes assessing if changes to cutter and/or ship design could facilitate safer transfers, and reviewing communication systems and ship preparation with regards making a lee and ship speed for the transfer etc. The role of cutter crew and ship personnel in the task should also be reviewed, ensuring the pilot has appropriate assistance where and when required.
- Provide pilots with training and practice in the transfer task – this includes assessing and ensuring the pilots’ functional fitness for the task so that neither

the pilot nor the crew are placed at additional injury risk; and providing pilots with appropriate remedial assistance to help them to achieve safe work methods.

The industry's actions depend on if pilot ladder transfers are continued, as the evidence suggests that ladder use should be replaced by another or other safer transfer systems. Helicopters are already well known and in use in many ports, and anecdotal reports suggest that this system is effective and poses less risk to pilots than the ladder transfer. Other methods of personnel elevation such as hoists and work platforms are not commonly in use, and these warrant further investigation for places where helicopters are not available.

The risks to marine pilots and others in the transfer task clearly must be reduced, and any changes to the current pilot transfer arrangements must be based on thorough testing, analyses and evidence. The marine pilotage community and other personnel involved with the transfer task must be confident that any changes to the pilot transfer system do not introduce new risks, but eliminate or reduce the current health and safety problems in their work environment.

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