MONASH UNIVERSITY

FORKLIFT TRUCKS AND SEVERE INJURIES: PRIORITIES FOR PREVENTION

by

George Rechnitzer
M.Eng.,MIEAust,MUARC

Tore J. Larsson
IPSO Australia

August 1992

Report No. 30

A project for the
Victorian Occupational Health and Safety Commission

ACCIDENT RESEARCH CENTRE

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE
REPORT DOCUMENTATION PAGE

Report No.	Date	ISBN	Pages
30	August, 1992	0 7326 0026	35p & App

Title and sub-title:
Forklift trucks and severe injuries: priorities for prevention

Author(s)
Rechnitzer, G. & Larsson, T.J.

Type of Report & Period Covered:
General, 1992

Sponsoring Organisation(s):

Victorian Occupational Health and Safety Commission

Abstract:

The use of forklift trucks in industry is associated with severe injuries and fatalities. The problem is well-known and reported in the literature since the 1960s. In this study, funded by the Victorian Occupational Health and Safety Commission, the present regulations and standards in Victoria are reviewed and compared with a number of International regulations, severe injuries and fatalities in Victoria (1987-1990) associated with forklift use in industry are analysed, and critical incidents and risk assessments from a number of worksites in Melbourne are presented.

The main conclusion - from earlier research and the present data - is that the most important injury problem is the result of interaction between the forklift vehicle and pedestrians. Forklift trucks are not recognized as vehicles - in regulations or in industry - and are not subjected to systematic traffic management, with the industrial work environment not designed accordingly.

"Pedestrian-hit-by-forklift truck" make up 45% of the injuries in the study. The three major industrial areas with high numbers of forklift injuries are manufacturing plants, warehouses /coldstores /wholesalers and freight handlers.

It is suggested that the future regulations and standards in the area be more specific and practical, and set forth examples of good practices. It is suggested:

- that forklift truck and pedestrian movements in **freight terminals** only take place at separate levels,
- that all forklift truck movements in **warehouses** be separated - in space or time - from manual order-picking, and
- that forklift trucks movements in **manufacturing plants** be completely separated from pedestrian walkways and work stations.

Recommendations are also made in regard to the need to upgrade aspects of forklift design and load handling practice. An implementation strategy for the report's major findings is also presented.

The study represents a combination of a road safety approach (Monash University Accident Research Centre) and occupational injury research experience (Institute for Human Safety and Accident Research, IPSO Australia).

Disclaimer
The views expressed here are those of the authors, and not necessarily those of Monash University, the Occupational Health and Safety Commission, or of the aforementioned organisations or people.

Monash University Accident Research Centre,
Wellington Road, Clayton, Victoria, 3800, Australia.
Telephone: +61 3 9905 4371, Fax: +61 3 9905 4363

Contents

Acknowledgements

The authors wish to gratefully acknowledge and thank the following people and organisations for their much appreciated assistance with this study:

- The Occupational Health and Safety Commission (OHSC) of Victoria, who commissioned and funded the project.
- Mr Steve Baltas of the Planning and Review Unit, OHSA, for his considerable help with the injury information.
- The project steering committee members: Carolyn Ingvarson (Chairperson); Mary-Jo Renehan (VCEA); Lance Kenningham (VTHC); Mr Ross Ayres (OHSA) and Dr Peter Vulcan, Director of the Monash University Accident Research, Centre for their enthusiastic support and assistance with all aspects of the study.
- The authors are particularly indebted to the various companies, management, staff and forklift operators, who generously assisted us with the study and facilitated the numerous site visits. We refrain from due acknowledgments of each organisation and personnel for reasons of confidentiality.
- Mr Michael Little and Ms Val Bowers, OHSC.
- Ms Sue Conwell and Mr Luke Vinogradov, research assistants, MUARC
- Mr Hendrik Van Der Zweep, Senior Consultant, Henderson Consutants.
- Mr Ted Henderson, Head of Department, Industrial Skills, Holmesglen College of TAFE
- The State Coroner's Office
- Mr Peter Cruikshank, Chairman Australian Industrial Truck association (AITA)
- Clark Equipment, Toyota Industrial Equipment Division, Linde-Lansing and Crown for information on their forklift truck range of products.
- Ms Gayle Burmeister of the Food Union and Ms Deborah Vallance of the Metals Engineering Workers Union.
- Mr Carlos Guzman and Mr Stelios Argyropoulos of the OHSA for their assistance with Spanish and German translation of Regulations.
- The Libraries of Monash University; the Occupational Health and Safety Authority Information Centre; and the Australian Standards Association Information Centre.

1. BACKGROUND

1.1 INTRODUCTION

Since the advent of mechanisation, particularly since the second world war, manual handling has been largely replaced by the use of mechanised lifting and transport equipment. The most conspicuous and successful workhorse for materials handling is the forklift truck, or in more general terms, the industrial truck. With this change in the methods of lifting and moving materials came a significant change in injury patterns: from a reduction of those associated with manual handling to those associated with the use of mechanised equipment.

Internationally, forklift trucks have been identified over a number of decades as a significant contributor to the toll of both serious and fatal industrial injuries. In Victoria, 15 fatalities over the 2 t/: year period October 1987 - April 1990, and some 700 serious injuries per annum, are attributed to forklift trucks. Significantly in the majority of cases, injuries did not involve the driver but adjacent workers. This is similar to the findings in regard to road crashes involving heavy goods vehicles: the other road user is most at risk, not the truck driver. (Rechnitzer & Foong, 1991).

The objectives of this study were to identify the root causes of the injuries associated with the design and use of forklift trucks and identify the most effective countermeasures.

The study method has involved three main phases:

- Review of the regulations standards and codes of practice relating to forklift trucks and a comparison with international regulations (Chapter 2).
- Review and analysis of the injury data associated with forklift trucks in Victoria (Chapter 3).
- The collection of critical incidents and perceived risks amongst forklift truck operators in Melbourne. This involved the visit to some 17 industry sites representing a large variation in environments and forklift usage. Sites included transport distribution centres, major warehouses and cool stores, manufacturing facilities, and large and small users of forklifts (Chapter 4).

1.2 MATERIALS HANDLING, FORKLIFT TRUCKS AND SAFETY

Modern industry is dependent on the speedy and efficient movement of materials of all descriptions to and from places of production, to storage, to distribution. Industry is dependent on the macro transport system of road freight, rail, ship and air. Equally important is what may be termed the micro scale transport, that is the movement of materials within a facility. Virtually at every interface, in this long line of materials handling, is the forklift truck, in all of its diverse range of sizes and capabilities. Forklifts may range in capacity from under 1 tonne, handling small pallets of goods, to large forklift trucks with 40t capacity moving shipping containers. Forklifts have evolved to meet industry needs and vary in shape and configuration significantly. Their versatility is further enhanced by the use of a whole array of attachments which transform the fork of a forklift into mechanical arms suited to specific goods, such as drums or rolls of carpets or soft cartons and so on.

Forklift trucks are inherently hazardous. They have a high mass, are of rigid and unyielding construction and typically operate in close proximity to pedestrian workers. In addition, loads are generally transported by being simply supported on the tynes (ie not directly secured to the vehicle), relying on gravity for stability. This represents an inherently unstable load configuration coupled with a high momentum vehicle, which is unforgiving should it impact pedestrians or other objects. Because of their typically compact size, forklift trucks can be misleading as regards their risk potential. A forklift truck is a heavy vehicle. For the common counterbalanced forklift of 2500 kg capacity, its mass can be over 3 tonnes, making the loaded mass nearly 6 tonnes. In its loaded condition the load on each front wheel is in the order of 2.5 tonnes. A useful perspective is that the common 2.5t forklift is some four times the weight of the average family car (1400kg).

A review of the literature shows various authors highlighting the hazards associated with forklift truck operations, though overall there has been a strong tendency to focus on the driver and to put a heavy onus on his skills. As has been clearly illustrated by Haddon (1980), successful intervention strategies address all three major factors in the injury chain - *the host* (driver or pedestrian), the *energy source* (the forklift or load) and the *environment*. Robertson (1983) highlights the need to distinguish between "active" strategies which focus on individual behaviour change (eg. the driver) and "passive" strategies in which *"other agents, the vehicle or the environment are changed to protect automatically the population at risk, without each vulnerable individual having to take action"*. It is clear that machine guards are more effective in injury prevention than cautioning operators to be careful.

In road safety the general approach focuses on *all* three factors:

- ***the driver*** (licensing, alcohol restrictions, speed cameras and other behaviour enforcement, motorcycle helmets etc.)
- ***the vehicle*** (passive occupant protection requirements, and other vehicle design characteristics)
- ***the environment*** (road system design, traffic lights, road signs, construction, lighting, divided highways, pedestrian separation, etc)

It is significant to note that one of the underlying premises of the 1985 Occupational Health and Safety Act is the implementation of workplace strategies which move industry from the historic and outmoded *"safe worker approach*", to the view that it is more effective to *remove and/or control the hazard* resulting in a "safe workplace". This requires the design of the equipment and environment so that they are *inherently safe*, or more accurately, expose their users to lower levels of risk.

The problems and challenges of materials handling have been commented on for many years. Briggs (1960) noted that the problem with many warehouses is obsolete methods coupled with over crowded conditions. The magazine *Materials Handling* in an article on "Materials Mishandling" (1969) stated that *"many companies had not seen fit to assign someone to the specific task of looking after handling"*. The Australian Bureau of Transport Economics (1978) noted that *"packaging technology has not kept pace with handling changes"* and regarded the consequences as *"chaotic"*.

In an insightful article on forklift safety, Booth (1979) notes that the emphasis on training, supervision, maintenance and compliance with instructions, though all of great importance, omits *the* ***most important*** *factor in the long term*:

"The need for planning of the layout of factories and warehouses to minimise the risk of transport accidents" and that *"the wealth of knowledge and experience from road safety has not been adequately implemented inside that factory gate"*.

Booth lists the most important considerations as:

- segregation of site transport, pedestrians and storage systems; many accidents involve collisions between forklift trucks, which have inherently bad visibility, and pedestrians;
- the need for adequate manoeuvring space, as a number of the accidents involve manoeuvring transport in confined spaces; various standard references provide for excessively tight restrictions on manoeuvring space.

In highlighting lessons from road safety, the points made are:

- greater number of pedestrian crossings;
- use of one way transport routes;
- the need for good visibility and the elimination of blind corners;
- attention paid to the quality and frictional characteristics of the floor surfaces.

In regard to ergonomics and the layout of controls, these are characterised as *"leaving much to be desired"*. The lack of standardisation in pedal layout is noted as hazardous and that *"clearly there is a lot of scope for human error"*. Booth concludes that the prevention of transport accidents involve known factors and are not complex. But the problem is that once a dangerous layout and transport system has been created in a factory or warehouse, it is far more difficult to put the matter right. Thus it is vital that much greater attention is paid to these problems at the planning stage.

A 1980 review of serious injuries associated with forklifts (Williams & Priestley, 1980) supported Booth's conclusions and stated that the *"majority of serious injuries occurred to non drivers;...poor factory layouts, which increases contact between pedestrians and the trucks, must be considered as a major causal factor"*.

In a comprehensive study of all aspects of forklift truck ergonomics, carried out by the British Cranfield Institute (Astley & Lawton, 1971), a number of factors were noted which are still pertinent today:

"Injury causes include body projection outside the trucks; non-standard controls layout; inadequate seating with increased fatigue; and the need to select drivers with the appropriate aptitudes...the need for safety devices such as mandatory dead man cutouts which immobilise the forks and traction of the vehicle; the use of rubber flap guardsfitted close the wheels to deflect pedestrians feet".

The study highlights the resistance to standardisation by various countries such as the USA on the basis that it is *"design restrictive"*. This argument is countered by stating that *"industrial design ergonomics often is restrictive, but the constraints are necessary to render the workplace efficient, safe and comfortable."* (Astley & Lawton, 1971).

In 1969, the Industrial Safety Handbook (Handley, 1969) observed that:

"The mandatory requirements for the general run of both industrial and commercial premises are mostly either outdated or couched in terms too vague to be satisfactory. 'Lighting shall be sufficient and suitable and free of objectionable glare' means different things to different people".

These observations regarding deficiencies in standards appear to be just as pertinent today, some 20 years later. This is discussed in detail in Chapter 2, reviewing current regulations and standards.

There are many aspects of fork lift operations that have improved and evolved over the years. Certainly basic ergonomics and vehicle design have improved dramatically in many models. The impetus for these changes appear to have been driven more by market forces than demands made by standards and regulations. Jenkins (1990) highlights the significant evolution occurring currently in modern warehousing which:

"...is in the process of evolutionary change from an emphasis on storage to flow through of inventory, utilising the concepts of Just in Time (JIT), or Kanban, as developed by Toyota. The result is smaller, more frequent, orders, higher activity and a new emphasis on flow through of materials rather than storage, which brings a new orientation."

These trends are of significance for forklift operations and result in an even greater emphasis on effective and safe traffic management.

In a recent publication, Eastman (1987) notes that *"the operation of a forklift truck is in many ways similar to the operation of a car or pickup truck. Also similar is the potential for traffic accidents"*. Emphasised is the need to *"design the materials handling system to protect personnel, products and equipment against damage and accidents."*

2. REVIEW OF REGULATIONS AND STANDARDS

2.1 INTRODUCTION

The aim of regulations, standards and codes of practice dealing with industrial activities, are to improve safety in the workplace. This is in regard to both property damage and reduction of risk and severity of injury. If the injury control process is to be successful, the full range of the injury process and particularly those factors that can be changed irrespective of human behaviour, must be considered (Robertson, 1983). Thus due consideration must be given to each of the three major factors - the vehicle, the operator and the environment.

In the context of regulations and codes of practice relating to forklift trucks it is pertinent to note Robertson's caution that there are *"clear limitations to human beings' capabilities and these include limited ability to detect and react to movement of vehicles and other objects."*

The review of the Victorian regulations and codes of practice, and the Australian standards relevant to operations involving forklift trucks, has been made with the above considerations in mind. In addition, a review was made of a range of international standards and regulations, aimed at highlighting any items specified which could be of benefit in Australia.

2.2 AUSTRALIAN STANDARDS AND THE VICTORIAN REGULATIONS AND CODES OF PRACTICE

In this review particular attention was placed on the main areas of concern identified in the study. These related to the need to improve the standards for the ergonomic design of the forklift, including upgrading requirements relating to driver comfort (cabin space; seat design, suspension, adjustment; standard layout of pedals and controls), specification of (driver) visibility criterion, including reversing mirrors; warning devices, both visual and auditory; driver training; forklift maintenance; load handling. The major issue related to having a properly planned and developed traffic management scheme within a facility. In Victoria, all plant (including forklift trucks) is covered generally by the Occupational Health and Safety Act 1985. The current regulations under the Lifts and Cranes Act, which cover forklift trucks are as follows:

- The Cranes Regulations 1989, which require Industrial Trucks (includes forklift trucks) to comply with the following Australian Standards:

  AS 2359.1-1985, SAA Industrial Truck Code, Part 1 - Design and Manufacture
  AS 2359.2-1985, SAA Industrial Truck Code, Part 2 -Operation.

Also within the powers of the Occupational Health and Safety Act, the following have been developed, but are not yet made:

Draft Occupational Health and Safety (Plant Safety) Regulations (Draft A 8.1.92),
Draft Code of Practice for Industrial Lift Trucks, OHS No. 24, (July 1991)

2.2.1 Comments on SAA Industrial Truck Code, Part 1- Design and Manufacture, Australian Standard 2359.1-1985.

This standard is comprehensive in the range of items noted as needing consideration in design, manufacture, marking and testing of industrial trucks and attachments. The main categories included in the standard are:

Load rating	Stability
Brakes, Tyres and Rims	Fork arms and attachments
Guards	Controls and Symbols
Electrical equipment	Materials and manufacture
Miscellaneous design requirements	Particular applications, including platforms
Hazardous areas	Markings

Despite the code's wide coverage, its effectiveness appears to be significantly reduced by the division of its requirements into either mandatory (indicated by use of ***"shall"***) or advisory (indicated by use of ***"should"***) categories.

For example, Clause 8.3 (b) regarding control levers specifies that ***"A set of load control levers <u>should</u> have the following sense of control direction..."***. As this regulation is only advisory, this of course permits the current situation of not having standard control positions on fork lifts. This is even more noticeable in regard to foot pedal controls for accelerator, brakes and forward and reverse controls, which can be radically different from vehicle to vehicle (refer Photos 1, 2 & 3, sheet 9, appendix B). As many facilities have a mix of forklifts from different manufacturers, the inherent risks in these arrangements are self evident.

A comparison of an similar regulation from the Australian Design Rules for motor vehicles is salutary. ADR for automatic transmission selectors specifies the standard order that ***shall*** be permissible for cars, to ensure that all vehicles are similar and hence avoid the risk of inadvertent incorrect gear selection, with the attendant risk of serious accidents.

Two important areas that are not currently specified in this standard relate to visibility and seating. The standard does not set out specific design requirements for visibility, an area which is fundamental to the operation of the vehicle, and inherent in reducing the risk of injury to the driver and other personnel. Similarly the proper ergonomic design of the driver's seating (and associated vehicle suspension characteristics) are central to helping to reduce driver fatigue and in turn injury potential.

A major concern relates to the reliance on qualitative (and therefore usually subjective) specifications of requirements. In some areas the Standard is quite specific. For example, in the area of stability and braking, clear performance measures are set, in quantitative terms, and as mandatory requirements. In a number of other significant areas, however, the standard is often general and sets down requirements in qualitative terms only, and often only specified in an advisory manner and not as a minimum mandatory requirement.

2.2.2 Comments on SAA Industrial Truck Code, Part 2 - Operation, Australian Standard 2359.2-1985.

The scope of this standard is the operation, maintenance, repair and modification of industrial trucks and attachments. As with Part 1, this standard is comprehensive in its coverage of topics, and includes: operator qualification and training; rules for operation; site conditions; maintenance, repair and modification. As the coverage of this code is far less technical than Part 1, a significant part of the code is made of long lists of directions indicating good practice, and typically directed at the operator.

The following examples are taken from Section 3: General Operating Procedure. Clause 3.2 lists some 25 items directed at the operator, including the following:

"(u) Carry only loads which are safely arranged and which are within the rated capacity of the industrial truck and attachment combination."

"(q) Turn on sufficient lighting to promote adequate visibility."

And as another example, in Clause 3.4 the operator is required to:

"(g) Drive in a safe manner consistent with the operating surface, physical layout of the operating area and any potential hazard."

And in regard to stacking of loads, Clause 3.5 requires the operator to:

"(p) Ensure the load is securely and uniformly staked after placing a load onto the stack..."

Section 5 of the Standard is concerned with site conditions and includes hazard identification, pedestrian access, warning signs, lighting, atmospheric pollution, marking of access routes, aisles etc. This section is also characterised by general requirements and suffers from being advisory, as many clauses are qualified by "should". For example, on Lighting, Clause 5.7 states that *"Controlled lighting not less than 50lx* ***should*** *be provided in operating areas within buildings. Where lighting is less than 30lx, industrial trucks shall be fitted with auxiliary lights."*

The concern with many of these clauses is that, though of good intent, their generality places too much onus on the experience and skill of the driver and his ability to analyse the work place and his equipment in a comprehensive manner relating to "safe" practice. In reality such major task requires the skills of number of specialists (designers, engineers, health & safety staff, etc) as well as those of the driver.

It would appear that a Standard needs to clearly identify minimum effective (and realistic) performance criteria which ***shall*** be met, and that these are specified in a manner which is measurable, or subject to test or calculation and are essentially unambiguous. Measurable criteria are central to the interpretation and evaluation of a Standard; it could be argued that a low standard is worse than no standard at all, as its very presence creates the impression of "something being done" and obviates the need for further attention. **Standards, one suspects, by definition, can not set a standard unless they are specific and are mandatory.** Generalities and advisory requirements allow a very wide margin for community interpretation, or can of course simply be disregarded.

2.3 COMMENTS ON THE DRAFT OCCUPATIONAL HEALTH AND SAFETY (PLANT SAFETY) REGULATIONS (VERSION DATED 8. 1.92, DRAFT A)

These regulations are comprehensive in their description of general requirements aimed at improving the safety of workplaces and cover the issues of hazard identification, risk assessment and risk control. In addition, the regulations assign responsibility, generally on the employer or occupier, and in other cases on the designer or supplier to ensure that risk is minimised and that a safe environment results. Overall it would appear that these regulations in themselves may not necessarily lead to significant improvements to the safety of the work environment. Rather, the result may well be the creation of a framework of legal responsibility for safety without specifying what is actually "safe".

The following examples are presented to illustrate these observations.

- **Clause 21 Duty of Designer**, states that:

"A person who designs any plant must ensure so far as is practical that this plant is designed to be <u>safe without risk</u> to health when properly used. "

- **Clause 41 Location of Plant,** specifies that:

"The employer or occupier must ensure the <u>proper</u> layout of the workplace and adequate lighting and ventilation is provided, to enable the plant to be operated in a manner that is <u>safe and without risk</u> to health. "

- **Clause 79a** requires that:

"The visibility from the normal driving position of the plant is sufficient to ensure the safety of all people and other traffic."

Under the word *sufficient* is a host of scientific measurable performance requirements defining visibility - none of which are currently specified in any Australian standard or codes of practice. The designer/manufacturer is then left to his own devices or in-house standard, if any, to determine subjectively what is "sufficient". Thus for such a regulation to be effective, it must be accompanied, at some point with a specific performance standard which helps to define what "sufficient" means, and preferably allows testing to ensure that the *"sufficient visibility"* criterion has been meet.

To any designer of equipment, or a warehouse structure, or the layout of a facility for handling forklifts, for example, there is a major gulf between the intent of the regulations and their realistic implementation. This assertion can be readily tested by asking what action is taken by the people who must act on the directives in the regulations. A designer dealing with general regulations is faced with an open-book in regard to his response, and would be dependent on individual experience, the expertise available, client attitudes and demands, and of course financial constraints.

What is considered to be safe and proper by one person (expert or not) may not be to another. As safety is assessed on the basis of relative risk (ie on a probability basis) such general regulations, to be successful, must be supported by clearly specified performance standards or agreed good practice or procedures. Furthermore this expert information needs to be readily available and address the *specific* needs of the particular environment and all of the people involved in the planning, design, manufacture, operation and maintenance of the equipment or facility, such that a *safe environment becomes unambiguously defined*. People need to be able to ask "what level of safety or performance do you really want", and then receive a reasonably objective response.

2.4 COMMENTS ON THE VICTORIAN INDUSTRIAL LIFT TRUCKS DRAFT CODE OF PRACTICE (OHS NO. 24, JULY 1991)

Codes of practice are provided under the Victorian Occupational Health and Safety Act *"for the purpose of providing practical guidance to employers, self employed persons and employees"*. Codes of practice are advisory, though they can be used to support prosecution. (page 4). In its introduction, the Draft Code of Practice for Lift Trucks, states that it "..*aims to <u>provide practical guidance</u> to ensure the health and safety of workers where Industrial Lift Trucks operate"* (p.1).

As with the Plant Regulations, the Code of practice is comprehensive in its description of factors that need to be considered, primarily by employers. However this document would not be regarded, in the authors' opinion, as an effective "code of practice", in the main because of its typically very general prescriptions.

The following examples are taken from **Part 8. Operation**, to illustrate these points. This section justifiably highlights the concern with work place design and states that *"the* *environment in which lift trucks are used can be identified as a major hazard in the operation of industrial trucks and consequently a major cause of injuries and fatalities."*

- **Cl. 50.1 Layout** specifies that:

"Work areas of lift trucks should be <u>separated</u> from those used by persons... Adequate sign posting, safety symbols, convex mirrors, barricading, clear designation of pedestrian areas are basic requirements of workplace layout for the safe use of lift trucks. "

These are all important, fundamental general requirements, which the code of practice unfortunately does not seem to go any further in specifying. For example, there are a host of possible interpretations of the word ***separation*** - some of which could range from a white line marking pedestrian areas to complete separate paths, overpasses and so on. The degree of separation that is required may also depend upon the forklift truck size, the type of load handled and the actual volume of pedestrian traffic.

- **Clause 50.7 on Lighting** requires:

"adequate lighting of the lift truck and workplace... "

For this requirement to result in commonplace compliance, an extension to the Code of practice would be required to illustrate good lighting practice for various workplace types and situations. For example, particular light fixtures and lighting designs would be needed in storage facilities with high racking, as forklift drivers need to look up towards the roof whilst placing pallets. The Australian Standard currently only specifies a minimum level of lighting intensity (50lx), which is, in any case, advisory only.

Another example is from **Section 6 Design**, which directs that particular attention should be paid to;

"ergonomic design; built in safety devices; visibility, etc."

Again what is an acceptable ergonomic standard is not specified. For example for seating, a minimum requirement would be the specification of acceptable vibration characteristics (ie for vibration isolation). Currently As 2359.1 for forklift truck design and manufacture has no performance requirement for seating. Though seating in many forklifts has improved significantly over the years, in many cases the seat and cabin design appears to be an afterthought, particularly when the long hours of driving and the often fairly rigid suspension are considered.

It is the view of the authors that **forklift trucks are a major hazard in environments that lack the appropriate work practices and design to accommodate their presence in a low risk manner.**

The forklift truck should not be regarded as "an item of equipment", but rather as a vehicle, which because of its design and operational characteristics (method of load handling, poor driver visibility, versatility, mobility, high mass, stiff structure, speed) is itself inherently hazardous. A useful analogy can be drawn between lift trucks which operate in the *"road system"* of a warehouse, say, and the design and operational requirements for other transport vehicles such as heavy goods vehicles moving materials on the road system. In the field of road transport, considerable effort has gone into the design of the road system from a safety viewpoint, and is itself the focus of detailed specific design standards and specific manuals on acceptable practice.

As previously stated, the general requirements set out in the code of practice, allow a host of interpretation of what is *acceptable* or *safe* or may simply be cast into the *"too hard"* category, with only token implementation.

It is clear that an *effective* code of practice needs to be just that - a document which clearly sets out and illustrates what good practice is. The form and style of this document may vary depending on the particular audience it is aimed at. For the workplace it could illustrate with diagrams, sketches, specifications and photographs examples of good practice in each of the areas of concern. This document would then be useable by all those involved in the workplace. For new facilities the code of practice would be a practical tool giving clear direction to designers and consultants at the planning stage. Similarly, for existing facilities, it would provide a benchmark and guide for assessing and modifying the workplace and its practices to provide for a lower risk environment.

2.5 SOME INTERNATIONAL REGULATIONS

A review was made of a range of standards and regulations from various countries, aimed at highlighting any items specified which could be of benefit in Australia. In reviewing the requirements for particular countries, the focus was on items not covered effectively by Australian regulations. For documents written in German and Spanish, translators from the Occupational Health and Safety Commission assisted in the review process. The following summarises particular points for each country:

2.5.1 Denmark

The Danish ordinances are similar in structure to the Swedish. Added to this is the EC directives planned to be law from the 1 January 1993. These directives describe in detail the compulsory stability and visibility testing of forklift trucks (refer 2.5.2 below). Nothing in the EC directives pertains to the work environment of those not driving the truck or the surrounding system in which the forklift truck operates.

2.5.2 Germany

Overall it appears that Germany has adopted the regulations common to the European Community. Two items of specific interest were noted:

- **Forklift Visibility Test**

This is set out as Section 13 (Measurement of Visibility for Forklifts and Industrial Trucks, 12.4.1989) of the German language edition of the European Community regulations regarding forklift trucks. This document sets out the acceptance criterion and test procedure for driver visibility for the front structure of the forklift. The test utilises a-series of nine lamps set on the forklift truck, which are used to cast a shadow on a screen in front of the forklift. The test is done with the forklift unloaded. The code specifies the areas and percentage of acceptable shadow. The test procedure is illustrated in Figures 1 A&B, appendix A, reproduced from the document.

- **The handbook for driver training**

This is very well set out using photographs and diagrams, and is distinguished from other training manuals by its clearly illustrated training exercises. The test course for the licence test is also shown (refer Figure 2, appendix A).

2.5.3 Norway

The Norwegian regulations contain rules about rear view mirrors, and includes also a condensed forklift driver training schedule.

2.5.4 Spain

There are some twenty-three separate documents (standards) relating to forklifts. These documents were not requested as they appear to parallel the ISO standards. The document that was reviewed was a comprehensive Spanish document titled "Forklifts - Models, Characteristics and Use". Some of the items of interest noted were:

Classification of forklifts

- based on use: inside building; outside building; all-terrain
- selection criterion - power, work function, ground type, etc
- specification of various aspects depending on classification for example engine type: for enclosed buildings, diesel vs LPG vs electric; tyre specification depending on ground surface.

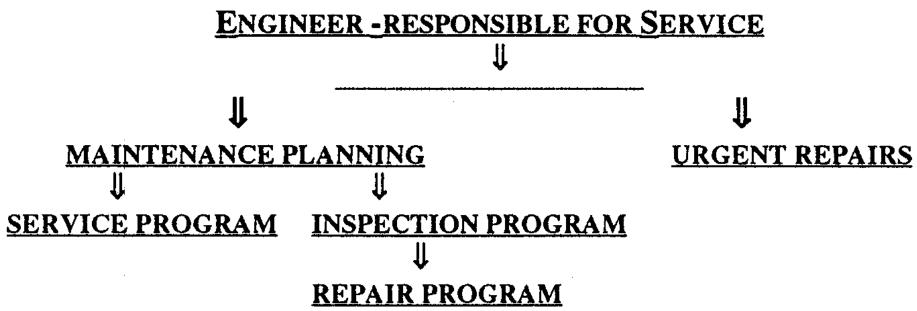
Maintenance, service and prevention

This section states that *"the service of forklifts is a very important element in relationship to the safety of people and goods, and the prevention of accidents"*. It goes on to describe the basis of a good program consisting of three elements:

- organisation - policy, assignment of responsibility and planning
- motivation - teaching the methods of inspection and service
- control

There is also a detailed section on the care, maintenance and safe handling and repairs of tyres, including the use of special cages etc.

In addition, the documents specify a responsibility and planning chart for maintenance:



Traffic management

The major and most significant departure from other codes is the specification of traffic management requirements. *"All companies using forklifts must have internal traffic rules for the forklift specified..."*. The points covered include:

- Work places must be carefully analysed for the use of the forklift. For new work sites, the facility is to be designed to suit the forklift/work flow.
- For existing facilities, equipment must be carefully selected to properly suit the existing conditions.
- A person is to be assigned responsibility for co-ordinating the forklift movements and goods flow in the facility.
- Intersection points are to be avoided where possible, as these areas are key accident points. The need for reduced speed in these areas is stated.
- The manual gives two diagrams illustrating traffic management and corridor layouts. These are reproduced and shown as Figures 3, 4 & 5, appendix A. The key points to note are the clear specification of traffic flow for the warehouse, the separation of pedestrian and forklift routes, the extensive use of traffic signs, one way traffic flow, restricted and no entrance zones, and the layout of corridors for width and visibility at intersections. Speed limits are also specified in certain zones.

2.5.5 Sweden

The Swedish regulations comprise three different ordinances; Powered vehicles and tractors (1985:6), Lift trucks (1986:24) and Lifting persons by the help of lift trucks (1974:101).

Specific for the Swedish regulations are the extensive discussions on the ergonomics of the forklift design; driving position and design of the seat, heating and ventilation of the cab (!), and the outline of controls.

The traffic system of the working environment is mentioned in a general way in the regulations and the Swedish authority seems to be aware of the high risk of foot injuries; surrounding workers are recommended to wear steel-capped shoes.

The Swedish ordinance specifically regulates the way lifting persons by the help of a forklift truck is done - but this working basket lacks protection at the top.

The Swedish Transport Industry Central Health Care also has a specific advisory pamphlet on the design of seating.

2.5.6 Switzerland

A number of items were received, including a manual for forklift operators, specification for forklifts and a report on Swiss accident statistics for the period 197983 for forklifts. The manual for drivers was noteworthy for its clarity and its simple yet effective pictures clearly depicting bad practice and high risk activities contrasted with good practice (refer Figure 6, appendix A). As the diagrams were virtually self explanatory, few words were included and consequently this approach would also be of benefit in a multi-lingual environment.

Two other significant items were noted:

- The actual specification of the seat dynamic characteristics as "the natural frequency to be less than 2Hz".
- The work platform (cage) used to elevate personnel on forklifts, also included a protective *overhead* guard. This contrasts with current Australian Standard (AS 2359.1, C1. 12.3 Using a Maintenance or Work platform) which specifies a 900 minimum height for the sides and a 2m high back, without any overhead guard (refer Figures 7 A & B, appendix

A). An overhead guard is a sensible addition to a platform which can be raised and impact 6verhead items (beams, roofs etc), and offers head protection. The Swiss design is also such that access to items overhead can still be achieved, yet still offering the benefit of head protection for personnel on the platform.

2.5.7 The United States

The US Department of Labour, Occupational Safety and Health Administration (OSHA), has its own standard relating to powered industrial trucks known as "29 Code of Federal Regulations {CFR} 1910.178". In addition, the industry standards used are published by the American Society of Mechanical Engineers (ASME).

There is also a draft standard on visibility, which apparently has not been released yet: B56.11.6 *Test methods and requirements for visibility for counterbalanced forklifts.*

Associated with these standards are a series of ANSI (American National Standards Institute) safety standards dealing with fire safety, electric battery requirements, internal combustion engines. etc.

The foreword to the ASME standards states:

"The use of powered industrial trucks is subject to certain hazards that cannot be eliminated by mechanical means, but only by the exercise of intelligence, care and common sense. It is therefore essential to have competent and careful operators physically and mentally fit, thoroughly trained in the safe operation of the equipment and handling of loads."

OSHA also states that under the Occupational Health and Safety Act, the employer is held responsible for the safety and health of their employees. The design and manufacture of the products is inherently the responsibility of the manufacturer.

The OSHA code provides a list of directions concerning "Travelling", such as *obeying all traffic regulations, including authorised plant speed limits*, and so on. The list is fairly general and common to most manuals giving directions to drivers. Though the ASME standard B56.6 refers to the need for proper traffic signs, the ANSI standard referred to is only concerned with the design of the sign itself, not traffic planning.

Another area of interest was the specification of minimum lighting requirements which were to ANSI/IES RP7. This document appeared to be very useful giving detailed lighting specification for various workplace situations.

In regard to operator training the noteworthy item was "careful selection of operators, considering physical qualities, job attitude and aptitude".

2.5.8 ISO Standards

These were found to be fairly similar to the Australian standards in scope and format. It is noted that the technical Committee ME/26 of the Standards Association of Australia, has been carrying out a review and comparison of the ISO standards and the current SAA standards regarding industrial trucks, with the aim of a possible adoption of the ISO standards for Australia.

3. OCCUPATIONAL INJURIES ASSOCIATED WITH FORKLIFTS IN VICTORIA 1989 -1990 AND FATALITIES BETWEEN OCTOBER 1987 AND APRIL 1990.

3.1 OTHER STUDIES

The introduction of forklift trucks in material handling historically resulted in decreased accident rates, since the trucks took over most of the heavy manual handling. The accident rates increased again as more and more goods was handled at increasing speed (Svensson & Ostberg, 1973).

As pointed out in earlier chapters, forklift trucks constitute a notorious safety problem associated with well-known accident risks to the driver and co-workers sharing work environment. In a study of observed incidents, remembered incidents and accident reports at a big Swedish warehouse (50 forklift trucks), more than one third of the reports were about hitting pedestrian or other trucks (Svensson & Ostberg, 1973).

In a study of forklift truck associated injuries over an 18-month period using hospital material, three out of four injuries were to non-drivers and mostly to their lower limbs (Williams & Priestley, 1980).

An analysis of disabling work injuries involving forklifts that occurred in California in 1980 showed that 31% were cases in which pedestrians were run over by forklift trucks, and in 23% of the cases the worker was caught in, under, or between a forklift and another object (California Department of Industrial Relations, 1982). In a study of data from the US National Electronic Injury Surveillance System (NEISS) supplemented with information from the Bureau of Labor Statistics, an estimated 86,O00 forklift truck associated injuries between 1983 and 1985 were described, and it is concluded that only 12% of the forklift associated injuries occur to forklift operatives (Stout-Wiegand, 1987).

In a Swiss report of fatalities and permanent disabilities associated with forklift trucks reported for compensation, 28% of the cases were pedestrians that had been hit by a forklift and 9% had been crushed by the truck or the load (SUVA, 1988).

In the Swedish Occupational Injury Statistics from 1982 and 1989, 24% and 26% of the forklift associated injuries respectively involved truck hitting pedestrian (Carlsson, 1985; Blom, 1991).

From a thorough analysis of 236 compensation forms submitted for the years 1984/85 and 1985/86 in South Australia, it is clear that in 39% of the injury cases a pedestrian worker has been hit or crushed by a moving forklift truck or its load (O'Mara, 1989).

3.2 METHOD AND MATERIAL

The following is an analysis of injuries associated with forklifts on file with the Occupational Health and Safety Authority and the Accident Compensation Commission, Victoria, for the period January 1989 through December 1990. The OHSA and the ACC systems are not linked in a way that makes combined computer runs, of the nature sought for this study, feasible. It is possible, however, from the computers of the OHSA, to identify single injury cases and descriptions of these in the files of the ACC. The material was compiled manually from computer print-outs generously provided by the OHSA Planning and Review Unit, and analysed in a separate PC with the help of a simple statistics program (Epi Info, 1990).

To ensure that all levels of severity were represented in the analysis, the material was stratified according to number of lost days. All cases with a lost time of more than 60 days for the period under scrutiny were chosen. For cases with a lost time of 60 days or less, samples were randomly chosen from the OHSA files.

Table 1 Sample sizes in the injury material 1989-90

	Severity	n	Sample size
1	< 11 days lost	77	10%
2	11 - 20 days lost	41	30%
3	21 - 60 days lost	49	23%
4	61 - 260 days lost	111	100%
5	> 260 days lost	36	100%
		314 (total)	

The accident descriptions from the files of the ACC were inspected and interpreted for each injury case and the cases were sorted under new headings. The initial sorting of cases in the OHSA and ACC systems group together all injuries that are related to "forklifts, pallets and the like". Out of the 314 cases under scrutiny, nearly one third (29%) seemed to be unrelated to powered forklift trucks. These injuries involved pallets, pallet-movers or other similar manual handling equipment, or were unsatisfactorily described.

The variables compiled for the 314 injury cases were **severity, injury type, total compensation paid, number of days lost, industrial code, company name, free text description of accident.**

As a complement to this, coroners reports on investigated fatalities associated with forklift trucks in Victoria, were analysed. We found 15 such investigations for the period October 1987 and April 1990.

3.3 RESULTS

3.3.1 Injury types

The most important type of injury associated with forklift trucks seems to be that which can be described as "hit by". Not surprisingly, these injuries make up 45% of the forklift truck associated injuries in the material. They also constitute 44% of the forklift truck associated injuries with a lost time exceeding 60 days.

Table 2 Injury type, average lost time and average compensation paid in the material

	Injury type	n	Average lost time	Average cost
1	Hit by forklift	101	99.5 days	$11,578
2	Fall from /by forklift	50	104.3 days	$11,475
3	Other forklift injury	32	93.1 days	$9,263
4	Overexertion (Fl-ass)	41	60.9 days	$6,137
	Subtotal	**224**		
5	Manual handling	36	(142.6 days	$12,730)
6	Unclear /unrelated	54	(102.6 days	$9,810)
	Total	**314**		

Table 3 Injury type by severity among injuries associated with forklift trucks in the material

Severity	Type of injury				Total
	Hit by	Fall	Other	Overexert	
< 11 days	20	12	9	14	
11 - 20 days	15	8	4	9	
21 - 60 days	25	6	3	6	
61 - 260 days	29	19	12	10	
> 260 days	12	5	4	2	
	101	50	32	41	224

Nearly two thirds of the "hit by" injuries are to the lower extremities; legs, knees and feet. Of the forklift associated fall injuries, more than half are from the vehicle. From the descriptions it seems that some of these falls, in turn (about a third), are from the load, standing on raised tynes or climbing on the forklift outside the driver's cab. Of the injuries termed "other" above, about one third are injuries to the driver from collisions, overturns, sudden stops or bumps, and another third have to do with, mainly, hands or fingers getting caught in and crushed by the moving equipment on the vehicle. In half of the forklift associated overexertion injuries, driving the vehicle is reported as the harmful exposure. One in five is from getting in or out of the vehicle, and another 20% are associated with the handling of heavy forklift equipment.

3.3.2 Diagnoses

As the Workcare information system does not record a strict diagnosis code, we have had to make do with what the claimant states on the claims form. Of course, this is not a medically defined diagnosis, but it will nevertheless give some indication of typical consequences from different types of accidents and thus point to priorities for prevention.

Table 4 Self-reported "diagnoses" (%) from claims forms by type of accident among the forklift associated injuries

	Hit by n=101%	Fall n=50%	Other n=32%	Overexertion n=41%
Fracture	25	20	22	-
Amputation	-	-	6	-
Laceration	10	-	13	-
Contusion	24	4	19	-
Strain/sprain	5	44	19	100
Other	-	-	6	-
Unclear	37	32	16	-

The missing information makes this difficult to interpret, but immediate fractures seem to be fairly consistently reported. All overexertion injuries were conscientiously related to the reported harmful exposure in question. Sprains and strains were also the most common consequence after a forklift associated fall. There is likely to be a gross underreporting of amputations, especially under the "hit by" and "other" headings, since a large part of these appear later in the medical process, as was found in a Swedish study (Larsson, 1990). A significant number of "crushed by", reported in the claims forms, and coded "unclear" here, will have become contusions, fractures and amputations during rehabilitation.

3.3.3 Industry

To ascertain the relative risk levels of different parts of working life in regard to forklift associated injuries, studies to evaluate the number of man hours of exposure to the use of forklift trucks must be conducted. No such studies have been found. The main areas of high frequency in this material are, not surprisingly, road freight transport, storage, motor vehicle manufacturing and wholesalers. In Table 5, 40% of the total number of forklift associated injuries in the material are represented.

Table 5 Number of forklift truck injuries by the largest industry types, proportion "hit by" injuries, average days lost and average compensation paid

Industry type	n	Prop "hit by"	Av lost days	Av cost
Short/long dist. road freight	26	46%	81.9	$8,959
Storage (incl. cold & bond)	20	40%	87.5	$9,997
Motor vehicle manufacturing	17	41%	115.5	$11,507
Fruit, veg & grocery wholesale	13	46%	118.4	$13,657
Machine/vehicle parts wholesale	11	18%	108	$12,802

Among the companies that were identified in the material, one major motor vehicle manufacturer contributed more than 11~c of the injury cases associated with forklift trucks - nearly four times as many as any other identified company.

Table 6 Number of forklift truck injuries by broad industrial category, proportion "hit by" injuries, average days lost and average compensation paid

Industry	n	Prop "hit by"	Av lost day	Av cost
Manufacturing	102	50%	91.5	$10,583
Transport/storage	55	42%	73.0	$8,149
Trade	50	42%	118.3	$12,106

Of the different industrial exposure areas, manufacturing seems to contribute almost consistently the largest proportion of injuries over the severity scale. Conclusions must be guarded, however, since the lost time categories of <61 days are samples only, numbers are fairly small, and they stem from populations that differ considerably in size.

Table 7 Proportion (%) of forklift related injuries among different severity levels over industry

	Days Lost				
Industry	**>260 (n=23)**	**61-260 (n=70)**	**21-60 (n=40)**	**11-20 (n=36)**	**<11 (n=55)**
Manufact.	44	41	68	31	46
Trade	35	21	18	22	22
Transp /stor.	13	29	8	39	27

On average, manufacturing industry in Victoria seems to contribute as many forklift related injuries as the trades and the transport/storing industries together. As pointed out earlier, we can only guess how well this fits exposure data. Our suspicion is that the trades and the transport and storing industries perform more forklift user hours than the manufacturing industry, but that risk exposure per unit is higher for forklift use in the manufacturing industries.

3.3.4 Fatalities

One of the 15 fatalities was a 6 year old child killed falling off a reversing forklift at a worksite Christmas party. Apart from this, an astonishingly great proportion of the fatalities occur as the forklift driver, working alone, leaves his vehicle to adjust the cargo or other equipment, and is crushed or run over by his own vehicle. Five of the remaining 14 fatalities were of that nature, in three of these cases the forklift driver was working alone.

In one case, the forklift driver was crushed by what he intended to lift and there were two cases of fatal falls from standing on raised tynes or pallet. Four people were killed by forklifts hitting or crushing them as they were walking by (three in the port, one in a timber yard) and two people were crushed by shifting cargo during loading.

3.3.5 Conclusions

The single most severe injury problem associated with the use of powered forklift trucks in working life seems to be the result of interaction between vehicle and pedestrian. Nearly half the injuries in the analysis were of this character. There are thus very specific conclusions for prevention to be drawn from the injury data: Interaction between forklift trucks and unprotected pedestrians must be reduced or made unnecessary.

> "The fork-lift truck or road vehicle which enters a works for a short time is potentially far more dangerous than most of the machinery which forms the fixed equipment of a factory..."

(Report of Chief Inspector of Factories, 1967).

Judging from the literature, this particular injury problem seems to be a well established fact since the 1960s. The important question today is how high a rate of fatalities and severe injuries, associated with the use of forklift trucks, we are prepared to accept against the continual use of ill-designed and dysfunctional industrial environments and lack of long-term investment in new works.

4. CRITICAL INCIDENTS AND PERCEIVED RISK - FORKLIFT TRUCK OPERATIONS IN MELBOURNE

4.1 CRITICAL INCIDENTS

The technique of systematically tapping the experience of those exposed to risk, in order to prioritize preventive measures, was developed in the armed forces as the equipment and procedures of warfare became more sophisticated (Flanagan, 1954). The most extensive use of ex-post-factum descriptions of incidents has been within the air force and civil aviation, and it is still a routine procedure in air force activities (Fitts & Jones, 1970). The method has also been applied in Swedish occupational risk research, among loggers and for forklift truck operations (Gustafsson et al, 1970; Svensson & Ostberg, 1973).

The purpose of the collection of critical incidents in the present study was to complement the analysis of reported and compensated injuries. An input of expertise from the operators would make the information available through the injury reporting systems more open to interpretation, and would also make conclusions about major injury problems more specific.

The critical incidents were collected at 17 different companies in the greater Melbourne area. Two researchers jointly paid all the companies a visit, the duration of which was between 90 - 240 minutes. In a few cases a second visit was deemed necessary. In all, 85 critical incidents/examples of perceived risks were collected, ie five per establishment.

The companies visited were 5 manufacturing plants (29 examples), 6 freight terminals (28 examples) and 6 warehouses, cold stores and wholesalers (28 examples).

Visits were normally organised directly over the phone and data collection was mostly uncomplicated. It is our experience that informants more readily tell their stories if line management is not immediately present, but have openly recognised that the queries are put (for instance, by hovering around the workshop out of hearing reach). At a few places - for reasons of noise or climate - the interview took place away from the work area.

4.2 RESULTS

There seems to be a difference in focus between the forklift drivers in the manufacturing plants and those who work in terminals or warehouses. More than half the reported perceived risks from the manufacturing plants were risks of driving into other people. The forklift truck drivers in terminals and warehouses had more reports on the risk of dropping loads, colliding and overturning the vehicle, mirroring the lead role of the forklift truck in these environments.

Table 8. Contents of critical incidents collected from forklift truck drivers

	Hit people	Drop load	Collide	Overturn	Other	Total
Manufacturing	17	7	1	-	4	29
Freight handling	4	8	3	3	10	28
Warehouses	7	12	2	4	3	28

4.2.1 Manufacturing

It is obvious that the role of the forklift truck in a **manufacturing plant** poses a threat to unprotected workers or other pedestrians, of which the forklift truck driver is quite conscious. Manufacturing is done at work stations or along a production line stationary man-machine systems, ordered in a rational way, determine the layout of the workshop and the communication and transport routes needed. The raw material for production or assembly is fed to the work stations by the forklift trucks; they also perform lifting tasks, remove finished components and load and unload external transports (refer Photos 1-6, sheet 5, appendix. B). Typical descriptions of forklift truck associated risk in such environments are

> "space is too confined around those machines - there is always a risk of hitting someone or driving over someone's toes",
>
> "anyone might step out from between those stacks and I would not be able to stop",
>
> "if someone is standing there drinking water when I come in to pick up my order, I almost nudge his behind with the mast",
>
> "even if I manage to stop the forklift, the stillage will continue off the tynes and hit the person",
>
> "visibility is very poor on that particular truck, there is a great risk of driving over somebody's foot when turning",
>
> "all doors and intersections here are danger points".
>
> "just before the end of the shift, the operators run like rabbits all over the place, it's not safe to use the forklifts at that time".

The risks thus described seem to relate to the layout and environmental design of the factory and, more precisely, the apprehension regarding the role of the forklift vehicle interacting with unprotected workers.

4.2.2 Storing

In warehouses, cold stores and at wholesalers, the perceptions of the forklift truck drivers differ slightly. Here the forklift truck is a central instrument of production and problems with stability, capacity, speed and ability to perform are in focus. Ideally only vehicles move in a warehouse - in reality there is a lot of interaction between forklift trucks, drivers from delivery trucks, warehouse workers that pick orders with pallet movers or trolleys and other people walking through the warehouse (refer Photos, sheet 3, appendix B). In cold stores there is a basic problem in frequently moving goods between ideally isolated temperature areas, with ensuing icy and wet surfaces and extensively used gates or screens (refer Photos, sheet 4, appendix B). Typical descriptions from these environments include

> "if the load becomes unbalanced, I might crush the truck driver",
>
> "we are supposed to give way to the pickers, but in doing that we sometimes have to go contrary to the traffic system",
>
> "the yard is very cramped and uneven and some loads must be transported on raised tynes, simple because that is the only way to get through",

> "in this place there is always a risk that some customer sneaks by in his car under my load, or comes shooting around a corner",
>
> "there are no forklift wheels that work in the freezer, it's like a skating rink".
>
> "the forklift skidded on the wet floor and pierced my lower leg".

There are of course specific problems in using forklift and reach trucks on icy concrete or steel floors at temperatures under -25° in cold stores. Rubber wheels solid or not - exert virtually no friction at all on this surface, and it is mainly because of its solid mass that the truck can operate at all.

4.2.3 Freight handling

At the f**reight handling terminal** the main concern is the load. Its size, shape and packaging and of course, the continuous interaction between forklift truck drivers and co-workers that help with the loading and the truck drivers. Freight handling operations, that we observed, were typically performed in big hangars with loading bays marked on the floor or on the wall and with forklift trucks, truck drivers and workers manually helping to load and unload, moving over the entire area. Some scenarios from these environments were

> "suddenly the truck pulled away and the forklift fell down between the tray and the ramp",
>
> "the glass panes shifted inside the crate, the crate slid off the tynes and injured the legs of the helper",
>
> "the 2.5 ton horseshoe-shaped girder tilted to the side and changed the centre of gravity - I managed to stay in the forklift as it tipped over sideways",
>
> "I couldn't see as I swung the cargo onto the tray and pushed another pallet off and onto a co-worker",
>
> "I came driving out into the sun, was blinded and hit the pole",
>
> "I was helping to load when I stepped on some cargo that was on wheels; it rolled and I fell down on the quay",
>
> "the long pipes slid to the side and fell down on the other side of the fence".

The forklift truck driver is the key operative in these places. His operations govern all other activity. The rudimentary "systems" that we have observed, have only included a marking of separate loading bays for different destinations. Pedestrian traffic was frequent in all loading areas we observed, except at the container terminals.

4.2.4 Suggestions from drivers

At one manufacturing plant a hook had been welded on at the bottom end of the tynes, fitting new eyes welded onto the bottom of the stillages. This way the forklift truck secured the stillage as it was lifted by the tynes. The solution had been suggested by a new forklift truck driver (refer Photos 5 & 6, sheet 9, appendix B).

At another plant the forklift truck drivers had decided to change the colour of the revolving warning light of the trucks every week - the lights come with three different plastic tops. At another plant the forklift drivers had managed to secure slightly used, curved rear-vision mirrors for the trucks, two per truck (refer Photos 3 & 4, sheet 8, appendix B).

At one freight terminal a visibility test for new forklift trucks had been devised by the management (refer Photo 1, sheet 8, appendix B). At this terminal, sighting a pedestrian in the container area meant that everything stopped.

5. DISCUSSION AND CONCLUSIONS

The main conclusion from this study can be summarised as follows:

> **Forklift trucks are not recognized as vehicles - in rules, regulations or industry - they are thus not subjected to systematic traffic management, and the traffic control systems required for forklift truck use, in different industrial environments, have not been specified.**

The present views on forklift safety - in regulations, workplace information and training - are focused on the behaviour of the driver, not the systems requirements of the work environment. To decrease the number of fatalities and severe injuries associated with the use of forklift trucks, a shift in focus is necessary.

The analysis of forklift associated occupational injuries and fatalities in Victoria, and the review of Australian and overseas research in the area, indicate that the major injury risk pertaining to the use of forklift trucks in industry is their association with unprotected pedestrians.

The fatalities highlight this; in a collection of fifteen cases, five forklift drivers, having stepped out of their vehicle to tend to the cargo, were crushed by their own forklift trucks, and four further pedestrians were hit and killed by forklift trucks in operation. An automatic brake ("dead-man's handle") seems to be an absolute necessity on all forklifts (AS 2359.1 clause 8.2.2.a; "should" should be exchanged for “shall”).

There are other types of injuries associated with forklift trucks; fall from the truck, injuries resulting from collisions, sudden stops and overturns, and hands or fingers getting caught in the operations of the forklift equipment. But the incidence of these occurrences is relatively modest compared to forklifts hitting pedestrians.

We have tried to compare real Standards - that describe how to do something to a measurable specification - to the present rules, regulations and codes that pertain to the use of forklift trucks in Victorian working life. It is clear to us, that the present framework of regulations and codes of practice, describing the use of forklift trucks, is of very limited applied use. We also feel that the general nature of these regulations constitutes a remarkable contrast to the very clear and uncomplicated picture of injury problems associated with the use of forklift trucks.

Regulating the extreme high risk areas of working life should not be considered a controversial political issue. The rules made should be functional to their purpose. We think that good work practices in areas of high risk could be exemplified in future codes of practice, and that practical examples would be of much more use to industry, unions and the responsible government authority than the present reliance on well intentioned, but ill-defined, requirements.

Rules on the use of forklift trucks will have to be applied to the pertinent systems in question - rules for forklifts trucks in a manufacturing plant must be different compared to forklift truck rules in a freight terminal or a warehouse. The practical operational prerequisites of the system will decide how the vehicle in question will be used - and this will determine the safety requirements of the system.

To exemplify the principles of good work practices - as in functional and safe systems of forklift truck use - we would like to put forth the three following practical rules within the three main problem areas of the study.

- In a **freight terminal**, no forklift and pedestrian movements should ever take place at the same level, in the same space.
- In a **warehouse**, all forklift truck movements should be separated from manual picking in space - by the forklift truck filling shelves from one side and picking performed from the other - or in time.
- In a **manufacturing plant**, forklift trucks should be limited to specific areas and completely separated from pedestrian walkways and work stations.

Any enterprise, of any kind, wanting to utilize a forklift truck, should be required to specify (to the OHSA) how the operational system would be safe enough, compared to the main requirement for manufacturing, terminals or warehouses.

Specific regulations, exemplifying the systems design needed for these three industrial areas, should be developed. In describing the systems requirements, such regulations would also conform to the new type of rules evolving around the "systems inspection" concepts of Scandinavia, EC and the USA.

This is not to suggest a more prescriptive, regulatory approach to safety, neither is it identical to the thrust towards general and legal performance requirements. We believe that the level of acceptable risk - in regard to hazardous occupational exposures resulting in severe or fatal injuries - must be clearly established and the practical elimination of certain identified critical parameters in the systems be brought about. We see the avenue of legal procedures - to test individual employers on performance **after** severe or fatal injuries - if used as the sole strategy for prevention as a cumbersome waiting game. Unacceptable exposure problems should be dealt with **preventively, constructively and jointly** - by employers organisations and unions - in development projects that incorporate new technology and safe practices.

To rid the issue of prevention of serious occupational injuries of its contentious character and link practical technological development to safe practices - in industry specific projects - could be an important step towards more constructive attitudes in the workplace and would result in decreased exposure to severe and potentially fatal occupational risks.

Three such industry specific projects - emanating from the results of this study would bring together those that share an interest in the future of Victorian freight handling facilities, warehouses and in-plant transport systems. They could draw up some or most of the blueprints for the technologically and economically updated next facilities to be built, where safe operations of forklift trucks would be completely integrated.

The result of such activities - outlined in an instructive manner - could also be used as practical guidance for industries in their safe use of forklift trucks. An approach like this has been used repeatedly since the 70's in the Swedish sawmilling industry. With the support of the Work Environment Fund, the Sawmilling Employers organisation, together with the Union and experts from the College of Forestry, have produced brochures depicting updated work environment solutions for the industry (Ager, 1977; Söderqvist, Ager & Wiklund, 1983). Practical solutions to injury problems in sawmills, based on the analysis of compensation data and systematic risk assessment activities, make up the parts of a current International sawmill project along similar lines (Larsson, 1991).

A successful and comprehensive injury prevention strategy must - in addition to what has been proposed regarding systems and environmental changes above - maintain a focus on the driver and the vehicle.

There is little doubt that forklift driving is a skilled operation, requiring constant vigilance and alertness in regard to vehicle manoeuvring, hazard perception and safe load handling. From the site visits and literature review there is clear emphasis on the need for both appropriate training programs (including site specific instruction) and the selection of drivers with the appropriate aptitude for the task. Some companies interviewed had developed skill and aptitude profiles pertinent to the task of fork lift driving, and this was seen as a sensible and practical element in risk reduction. Standardisation of driver training and licensing requirements is seen as an important step in ensuring at least minimum aptitude and skill levels are achieved. Lessons from some of the European driver training programs may be useful in this regard.

The reliance on training and driver skill to overcome deficiencies in vehicle design (poor visibility and different control layout on different forklift models, for example) is considered by the authors to be a high risk strategy which will only ensure a continuing high level of accidents and injury. A clearly demonstrated principle of injury risk reduction is the utilisation of sound ergonomic design to reduce the ongoing performance demands made on the operator to avoid accidents. This leads to the need for visibility standards to be adopted for the design of forklifts and, at the very minimum, standardisation of controls for vehicles used at a particular site.

The other aspect of forklift operation which needs attention and was evident from the critical incidence surveys was load handling. Issues included the problem of handling awkwardly shaped loads, loads slipping from the forks, and in some cases load stacking. Once again deficiencies in the design of load handling systems and load stacking have often been tackled by placing a large measure of responsibility on the driver to "be careful', and maintain "safe" practices. The authors do not wish to diminish the importance of driver performance and care, but reliance on this in lieu of the development of improved vehicle design and load handling and stacking is a strategy intended to maintain the status quo of injuries and not one aimed at effective risk and injury reduction. We see a clear need to improve the system of load handling (for example positive restraint of the load to prevent slipping from the tynes) and in some industries (such as timber) the stacking of loads. The issue of load handling needs to be the subject of a separate study, and would be industry specific.

One final observation from this study is that the Workcare injury information in its present format, does not easily lend itself to the kind of criteria-based problem solving that we suggested above. More specific information on exposure, equipment, activities, injurious processes, diagnoses and medical consequences should be readily available. Such information is essential in making strategic decisions concerning the elimination of severe occupational hazards. We suggest that the computer systems presently containing relevant injury information in Victoria - the Workcare system, the Coronial data base on fatalities and the Victorian Injury Surveillance System (VISS) - be reviewed and restructured to include the above noted variables, so that they can be used to their full potential; for selective, constructive, and applied prevention (Larsson, l991b).

We recommend that:

1. Forklift trucks be recognised as a "heavy goods vehicle" which require appropriate facility design for their operation. Develop industry specific models for the layout of new facilities which incorporate the principles of effective traffic management and separation of forklifts, pedestrian and other traffic.

   These models would be developed by working with specific industry leaders on new facility designs, which are being developed. This process would bring together the skills of the materials handling specialists, the client requirements and the occupational health and safety requirements.

2. Publicise and raise industry awareness and interest in the reports major findings and conclusions regarding strategies to improve the safety of forklift operations and reduce the incidence and severity of injury. This publicity could include a short brochure targeted at all companies and organisations involved in forklift operations and facility design, highlighting the study and its findings with appropriate illustrations and recommendations for improvements. It could also invite interested parties to inquire and participate in joint reviews aimed at the improvement and upgrading of their existing or planned facility.

3. Support generalised performance requirements with specific, measurable performance standards and/ or models of good practice.

   - Upgrade the Australian Standard (or Codes of Practice) to include sections dealing with plant layout and traffic management. These should be specific, detailed and with clear illustrations and design criterion.
   - Upgrade the Australian Standards relating to forklift design, to incorporate quantitative performance criterion for visibility, driver ergonomics and control layout.
   - Review the standard in regard to many of its optional "should" requirements and change the critical criteria to "shall". Include the compulsory requirement for an automatic brake ("dead-man's handle").
   - Develop codes of practice for load handling and stacking requirements covering industry specific requirements. This would include freight handling, manufacturing and storage and distribution facilities.

REFERENCES

A Guide to the Occupational Health and Safety Act 1985 (1991). Occ. Health & Safety Authority, Victoria.

Ager, B (1977): Better working environment in Sawmills. Today's problems tomorrow's environment. Timber Industry Ergonomics Group, Stockholm.

Astley, R W & Lawton, R H (1971): The Ergonomic Aspects of Fork Lift Truck Design. Bedfordshire; Cranfield Institute of Technology.

Blom, K (1991): Fakta om arbetsolyckor med gaffeltruck 1989 (in Swedish). Swedish National Board of Occupational Health, ISA.

Booth, R T (1979): Making factories safe for forklift truck drivers. Occupational Health, April; 193-197.

Briggs, A J: Warehouse Operations Planning and Management. John Wiley & Sons, 1960

California Department of Industrial Reladons (1982, August): Disabling work injuries involving forklifts. In California Work Injuries and Illnesses. San Fransisco, CA: Division of Labor Statistics.

Carlsson, J (1985): Olycksfal1 med truckar 1982 (~n Swedish), Swedish Nahona Board of Occupational Health, ISA 1985:1.

Eastman, R M (1987): Materials Handling. Marcel Dekker, USA.

Epi Info, Version 5 (1990): A Word Processing, Database, and Statistics System for Epidemiology on Microcomputers, CDC, Atlanta GA & WHO, Geneva.

Fitts, P M & Jones, R E (1970): Analysis of factors contributing to 460 "pilot-errors" experiences in operating aircraft controls. In H W Sinaiko (Ed.), Selected papers on human factors in the design and use of control systems. New York: Dover Publication, pp 332-358.

Planagan, J C (1954): The Critical Incident Technique. Psychological Bulletin, Vol 51; 327-358.

Gustafsson, L, Lagerlof, E & Pettersson, B (1970): Analyses of near accidents in logging. Research Notes of the Department of Operational Efficiency of the Swedish College of Forestry, No 37.

Haddon, W Jr (1980): Advances in the Epidemiology of Injuries as a Basis for Public Policy. Public Health Reports, Vol 95; 411-421.

Handley, W (Ed) (1969): Industrial safety handbook. McGraw-Hill, London.

HM Chief Inspector of Factories Report, London, 1967.

Jenkins, C H (1990): Complete Guide to Modern Warehouse Management. Prentice Hall, USA.

Larsson, T J (1990): Severe Hand Injuries among Swedish Farmers. Journal of Occupational Accidents, 12; 295-306.

Larsson, T J (Ed) (1991): Safety in Sawmills - three Swedish studies 1988-1990. IPSO Factum 30, Institute for Human Safety & Accident Research, Stockholm.

Larsson, T J (1991b): We need applied prevention - not statistics. Journal of Occupational Health & Safety - Australia and New Zealand, 7 (4); 287-294.

Materials Handling, (Australia) April 1969, Materials Mishandling, p9.

O'Mara, N (1989): A study of fork lift truck accidents in S-outh Australia. South Australian Health Commission, Occupational Health and Radiation Control Branch.

Rechnitzer, G & Foong Che Wai (1991): Truck Involved Crash Study. Report on fatal and injury crashes of cars into the rear of trucks. Monash University Accident Research Centre, Melbourne.

Robertson, L S (1983): Injuries; Causes, Control Strategies and Public Policy. Lexington Books, Massachusetts.

Stout-Wiegand, N (1987): Characteristics of Work-Related Injuries Involving Forklift Trucks. Journal of Safety Research, Vol 18; 179-190.

SUVA (1988): Berufsunfalle mit kraftbetriebenen Flurforderzeugen wahrend der Jahre 1979 bis 1983 (in German). SUVA, CNA, INSAI Arbeitssicherheit.

Svensson, G & Ostberg, O (1973): Fork-lift trucks, drivers, and safety at the warehouse: An analysis of critical incidents. Goteborg Psychological Reports, University of Goteborg, Sweden, No 1, Vol 3.

Söderqvist, A, Ager, B & Wiklund, M (1983): Sagverk 85-90. Ett idesagverk med tonvikt pa manniskans roll (in Swedish). College of Forestry, Garpenberg.

Williams, E A & Priestley, S E (1980): Fork Lift Truck Injuries. Journal of the Society of Occupational Medicine, Vol 30, no 4, 149-152.

References (cont.)

SELECTED STANDARDS PERTAINING TO FORKLIFT TRUCKS

Powered Industrial Trucks - Safety Code, ISO 3691-1980

Related standards are:

ISO 1074	Counterbalanced lift trucks - Stability - Basic Tests
ISO 2330	Fork lift Trucks - Fork arms - Technical Characteristics and testing
ISO 3184	Reach and straddle fork lift trucks - Stability tests
ISO 3287	Powered Industrial trucks - Control symbols
ISO 5053/1	Powered Industrial trucks - terminology, Part 1: Classif. and Nomencl.
ISO 5766	Pallet-stackers and high lift platform trucks - Stability tests
ISO 5767	Industrial trucks operating in special condition of stacking with mast tilted forward - Stability Tests
ISO 6055	High-lift rider trucks - Overhead guards - specification and testing
ISO 6292/1	Powered Industrial Trucks - Brake performance - Part 1: High lift, low-lift and non-lifting
ISO 6500	Powered Industrial Trucks - Service Brakes - component strength performance requirements

SOME OTHER PAPERS OF INTEREST

Driver Visibility-Report prepared by the Federal Advisory Committee on Waterfront Accident prevention for the Benefit of users of Container Handling Forklift Trucks or similar Equipment, .1980.

Visibility Testing on Fork Lift Trucks of 10 tonne Capacity and Over, Victorian Department of Labour and Industry, Div. of Technical services, Feb. 1980.

ASME/ ANSI	**(US STANDARDs)**
B56.1-1988	Safety Standard for Low Lift and High Lift Trucks
B56.6- 1987	Safety Standards for Rough Terrain Forklifts
B56.11.3- 1988	Load handling Symbols for Powered Industrial trucks
B56.11. 4-1988	Hook Type Forks and Fork carriers for Powered Industrial trucks.
B56.11.5- 1989	Measurement of Sound emitted by Low Lift, High Lift, and Rough Terrain Powered Industrial Trucks

APPENDIX A

FIGURES 1-7

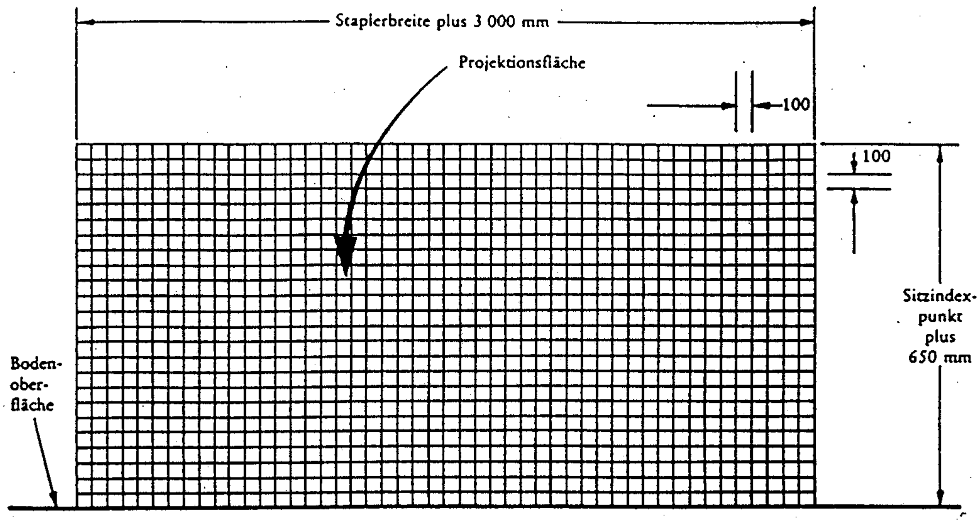
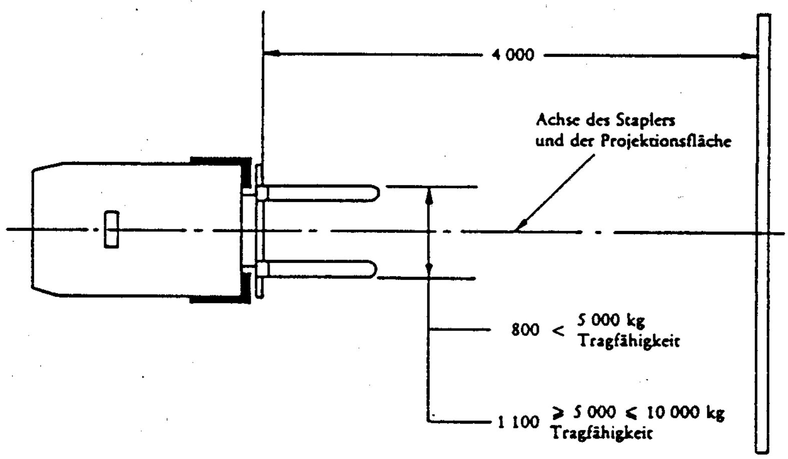


Bild 2



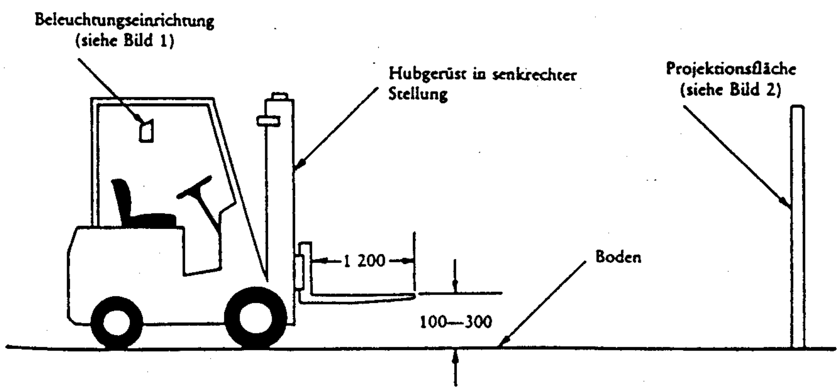


Bild 3

Figure 1a:	Forklift visibility test procedure from the German regulation. Also see Figure 1b.

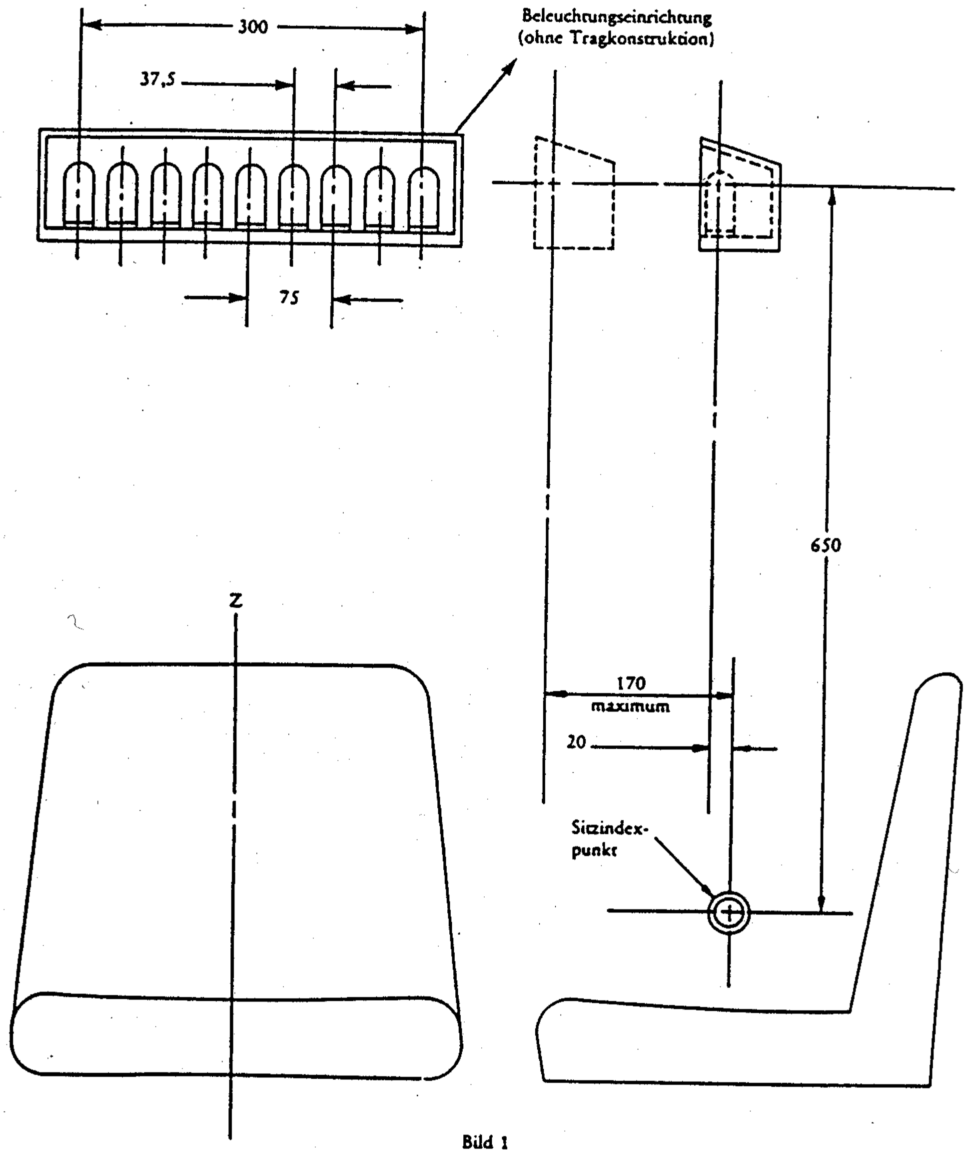


Bild 1

Figure 1b:	Forklift visibility test procedure from the German regulation (Section 13).

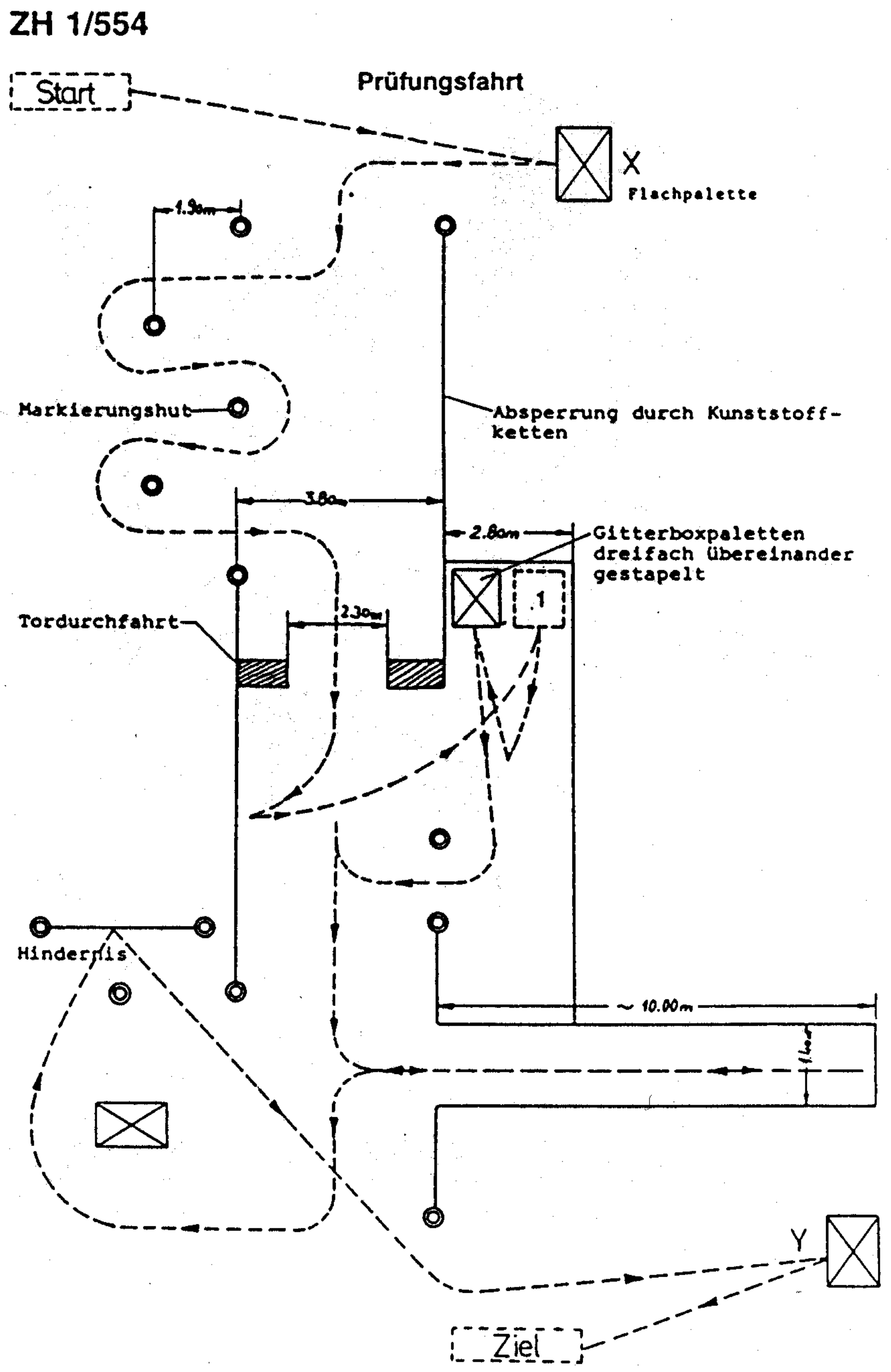
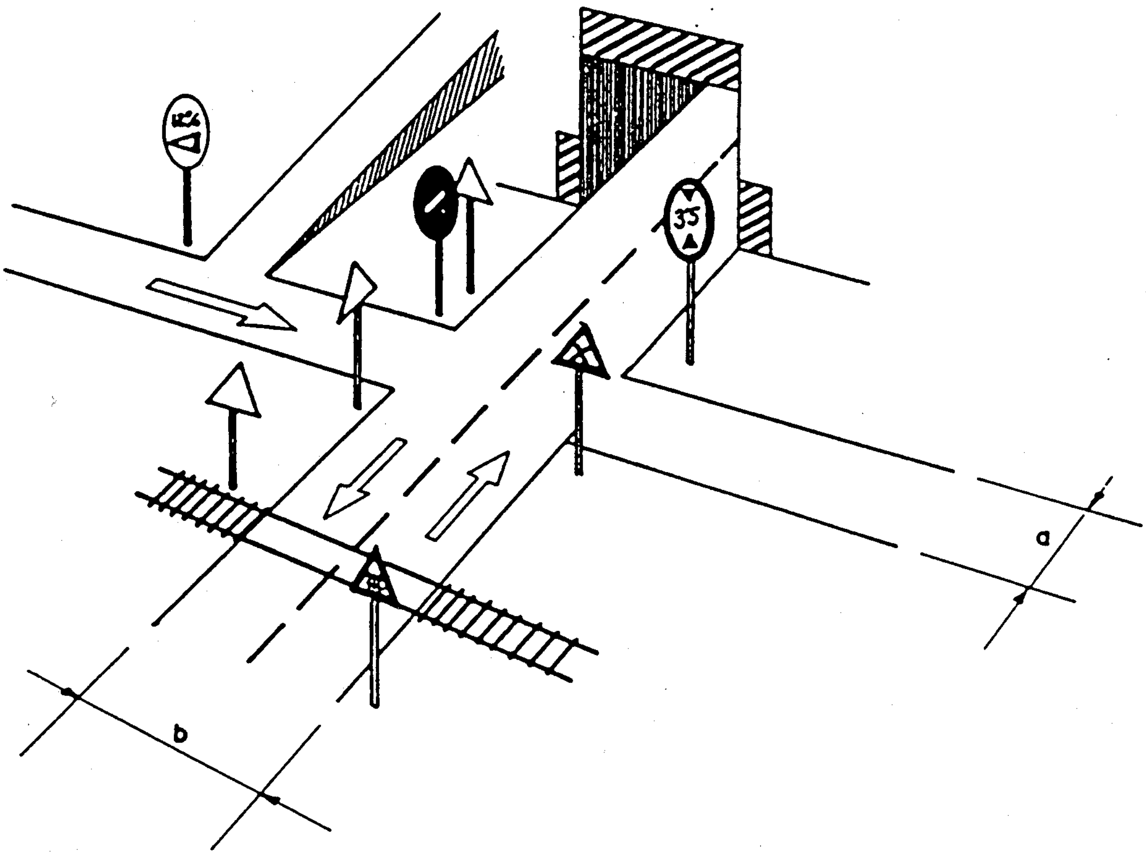


Figure 2:	The test course for the German forklift driver license test.



EJEMPLO DE SEÑALIZACION

Figure 3:	Example of external traffic management required as set out in the Spanish code of practice for forklifts.

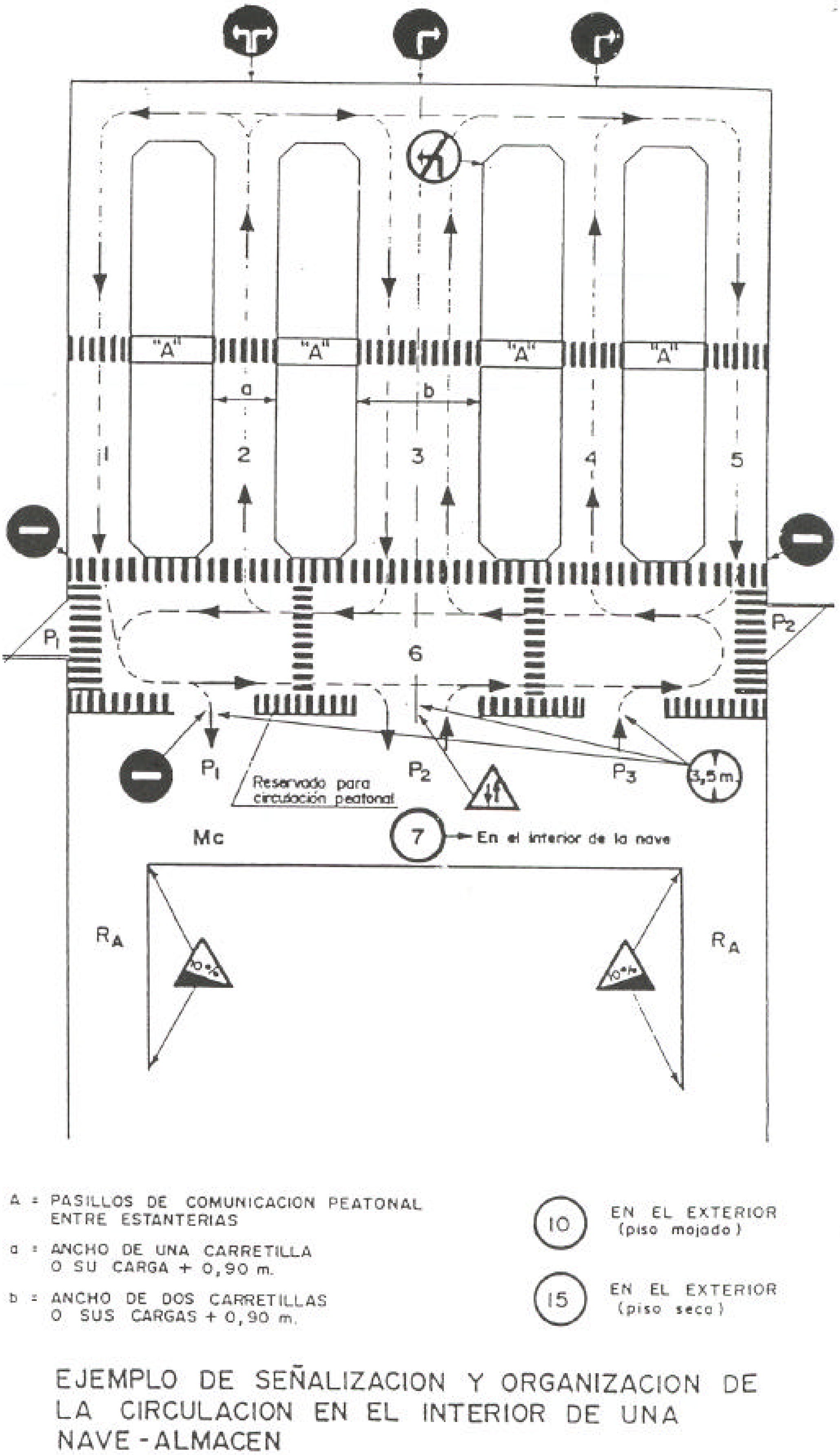


Figure 4: Example of traffic management system within a facility. (From the Spanish code of practice.)

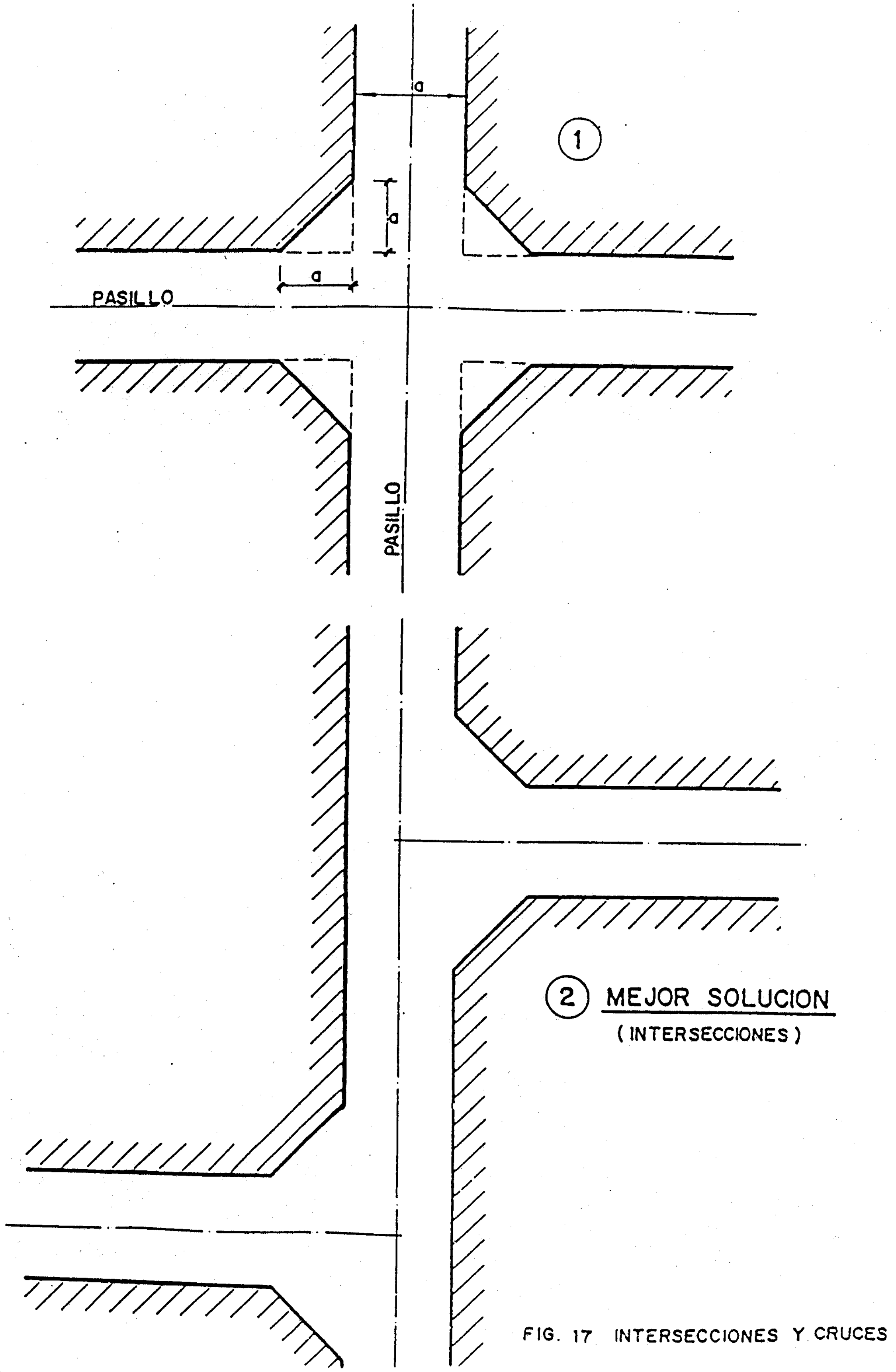


Figure 5: Example of intersection layout requirement for main forklift routes (Spain).

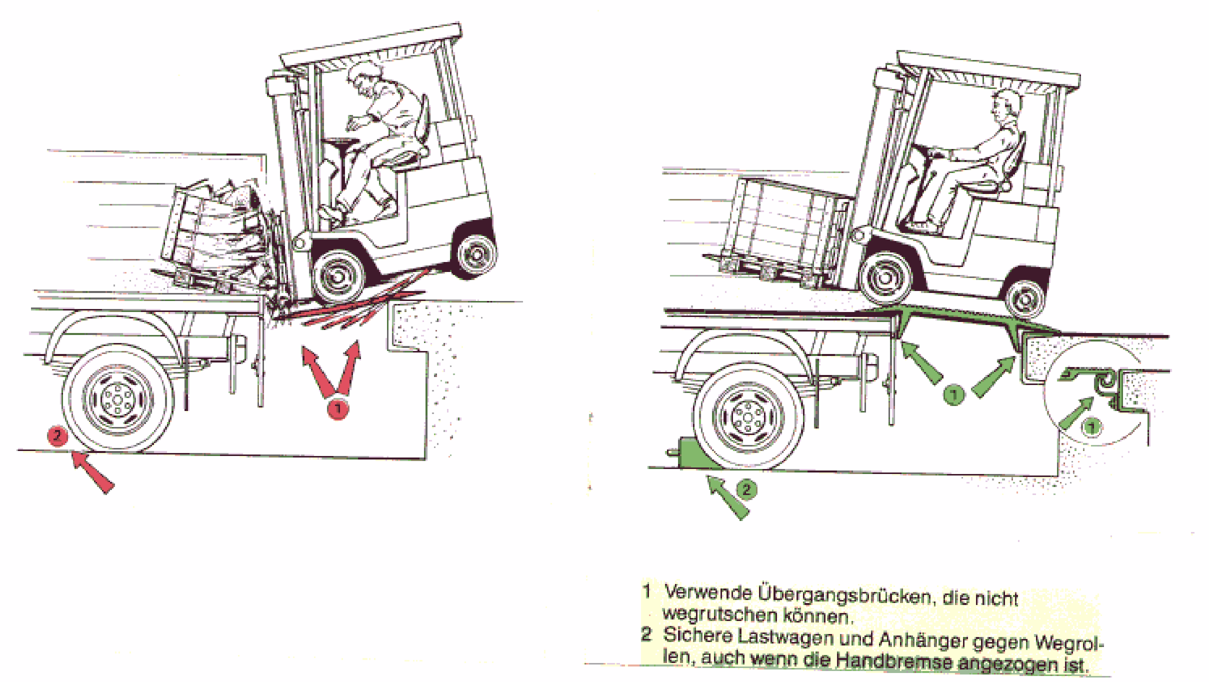
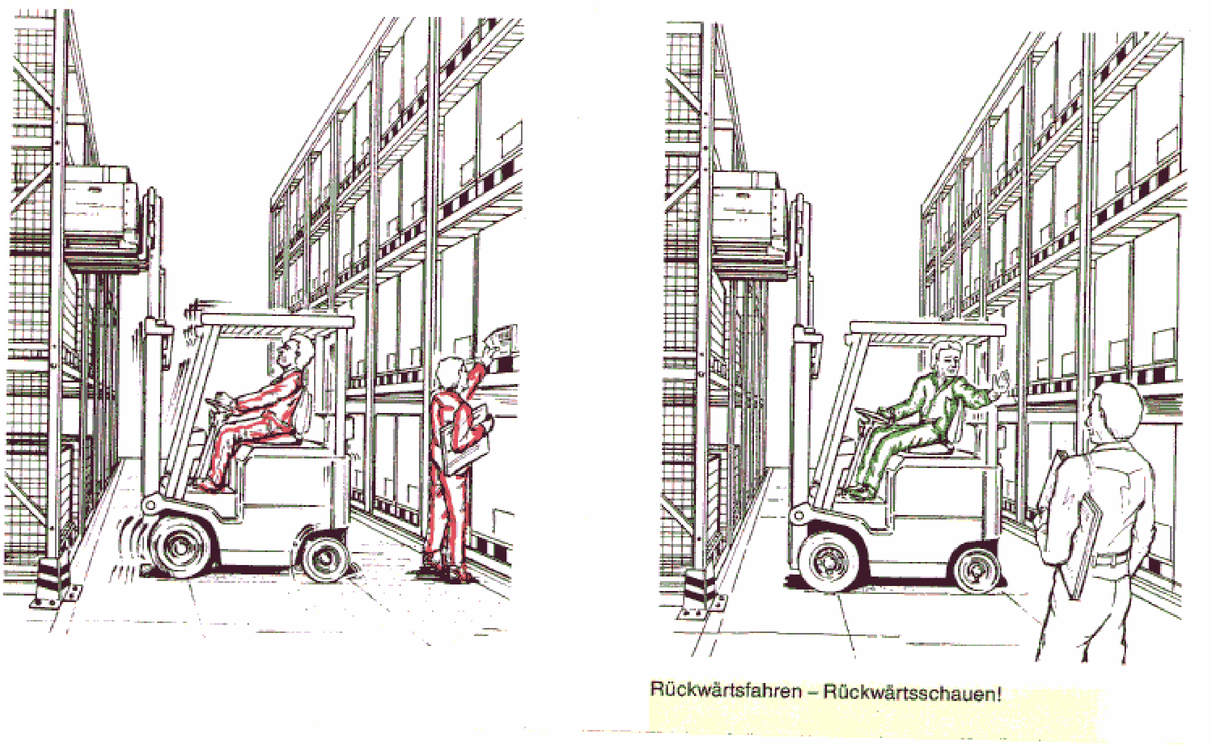


Figure 6: Examples of sketches from the Swiss driver's manual. Note the simplicity and clarity of the two-colour presentation.



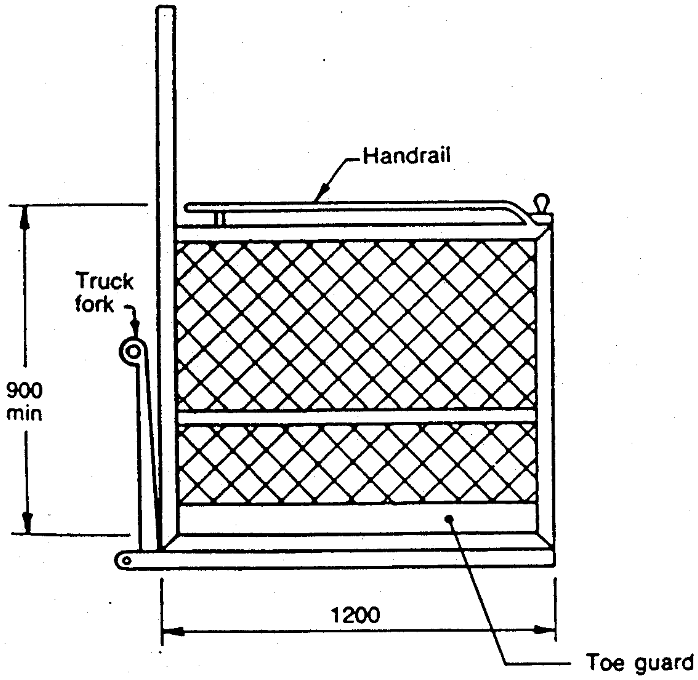


Figure 7a:	Work platform requirement to Australian Standard AS 2359.1-1985

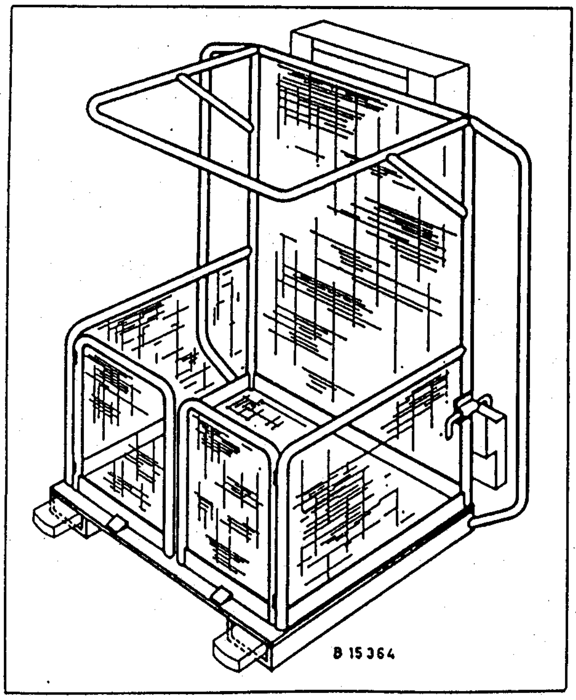


Figure 7b:	Work platform requirement as per the Swiss Regulation. Note overhead guard.

APPENDIX B

PHOTOGRAPHS
SHEETS 1-9

SHEET 1

PHOTO 1: Example of floor layout of freight distribution centre

PHOTO 2: Example of handling of mixture of package sizes.

PHOTO 3: Example of pedestrian traffic in freight distribution centre.

PHOTO 4: Storage and movement of goods.

PHOTO 5: Example of loading and unloading of trucks.

SHEET 2

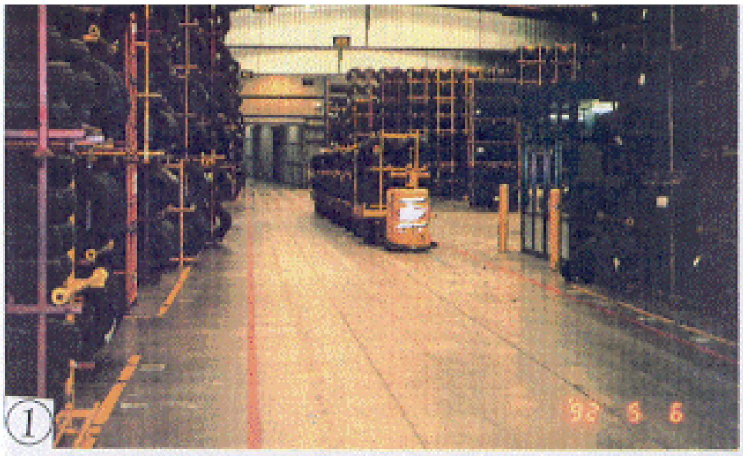
PHOTO 1: Example of materials handling in proximity of public footway.

PHOTO 2: Example of forklift operation on uneven ground.

PHOTO 3: Example of forklift with large load sharing route with other user.

PHOTO 4: Modern forklift.

PHOTO 5: Older model forklift carrying long load.



SHEET 3

PHOTO 1: View of automatic guided vehicle operating in large warehouse.

PHOTO 2: Example of intersection showing mirror.

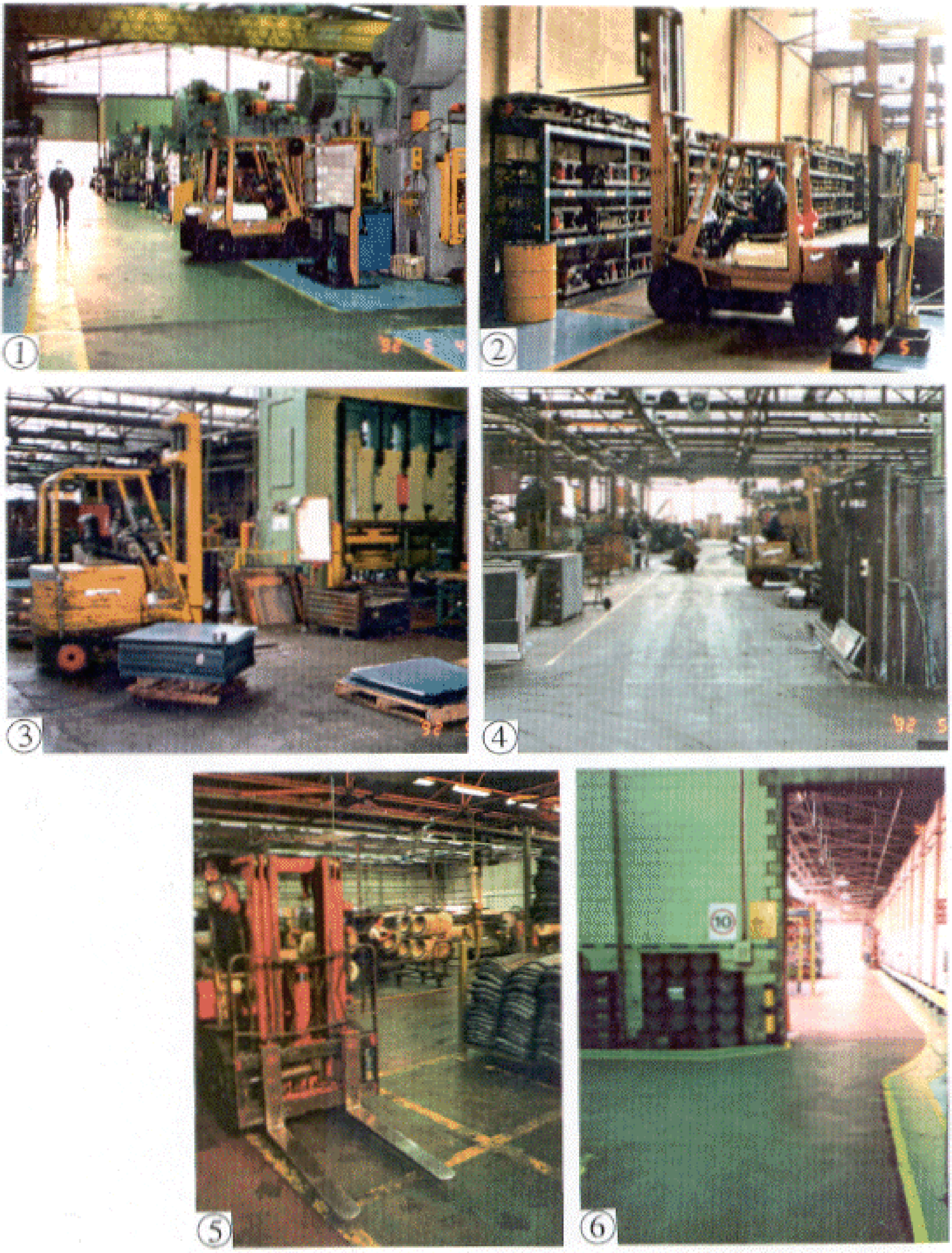
PHOTO 3: Example of high lift onto storage racking.

PHOTO 4: Example of distribution centre with high-lift forklift.

PHOTO 5: Example of distribution centre showing pedestrians in aisleways.

SHEET 4

PHOTO 1: Example of forklift and pedestrian traffic in coolstore.
PHOTO 2: View of coolstore floor showing ice buildup.
PHOTO 3: Example of pallet stacking and forklift operation in coolstore.
PHOTO 4: View of freezer section storage racking in coolstore.
PHOTO 5: View of driver showing special clothing required for coolstore operation.



SHEET 5

PHOTO 1: Example of forklift operating near workstation
PHOTO 2: Forklift manoeuvring in tight spaces.
PHOTO 3: Example of forklift operating in a manufacturing facility.
PHOTO 4: Example of layout in manufacturing plant.
PHOTO 5: Forklift operating in manufacturing plant.
PHOTO 6: Example of intersection.

SHEET 6

PHOTO 1: Straddle carriers for container handling. Pedestrians are strictly excluded from this area.
PHOTO 2: Large capacity forklift loading truck.
PHOTO 3: Pedestrian route in container handling area.
PHOTO 4: Major container facility showing sharing of routes by train, road vehicles and forklifts.
PHOTO 5: Large forklift moving containers.
PHOTO 6: Forklift with adaptor for handling large paper rolls.

SHEET 7

PHOTO 1: Example of modified forklift handling awkward load.

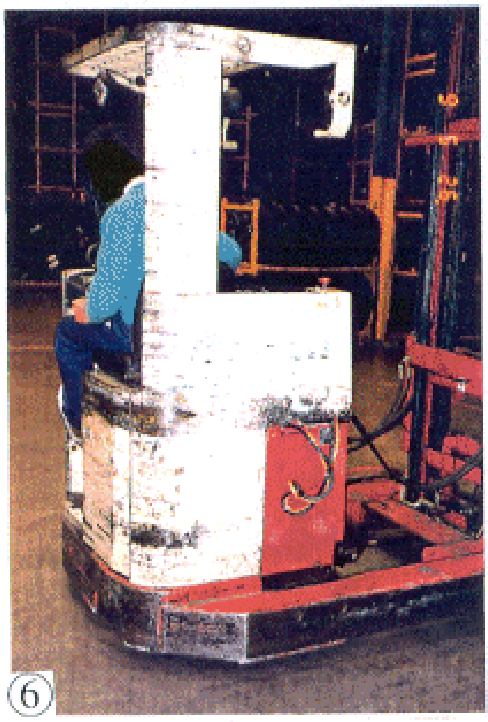
PHOTO 2: Example of forklift being used to assist load stacking.

PHOTO 3: Regulation cage being used for repair work.

PHOTO 4: Example of different stillage designs with and without tyne restraints at base (arrows).

PHOTO 5: Storage facility showing variety of packaging.

PHOTO 6: Use of pallets in handling dangerous goods.



SHEET 8

PHOTO 1: Example of grid used to test forklift visibility.

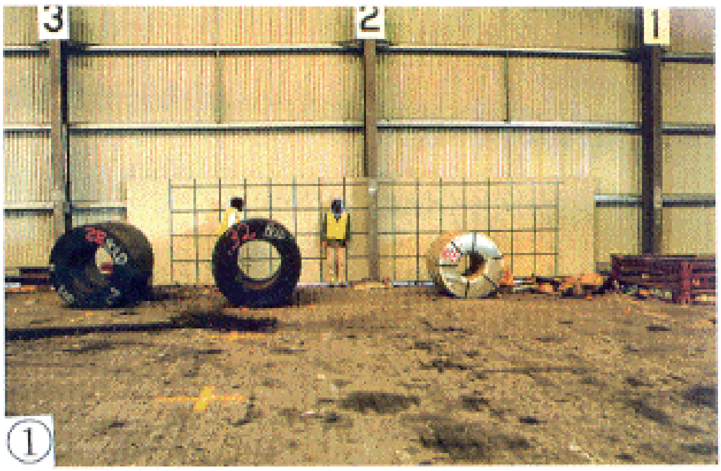
PHOTO 2: Example of inadequate visibility for forklift operator (note small slot provided).

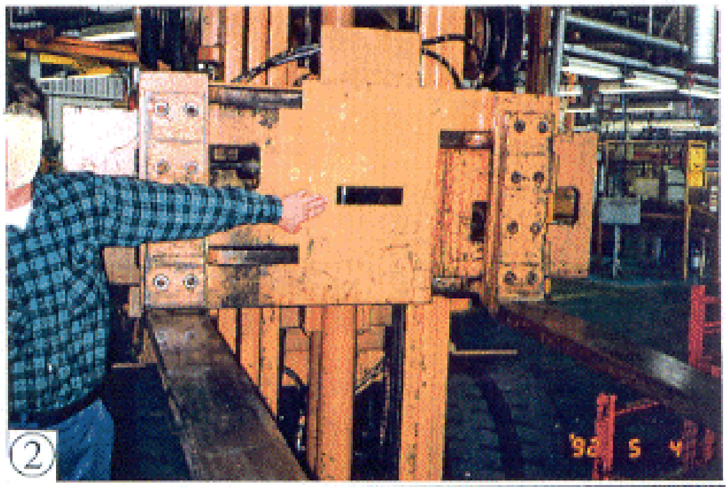
PHOTO 3: Rear view mirrors are effective.

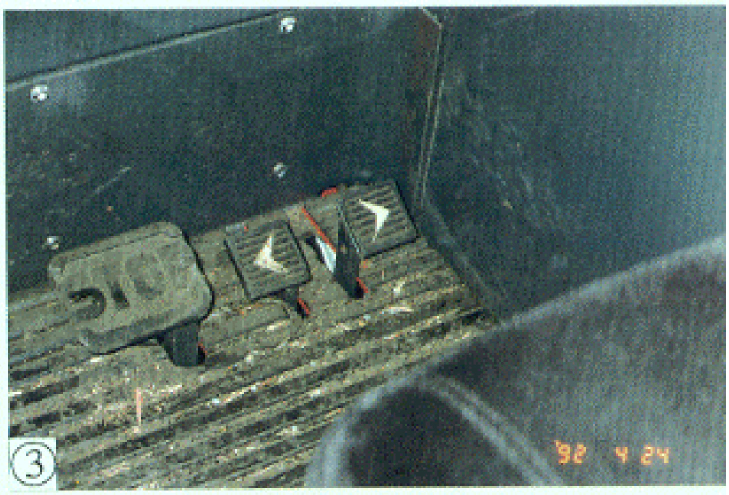
PHOTO 4: One company varies color of flashing warning lights weekly to ensure conspicuity.

PHOTO 5: Illustration of poor placement of handbrake lever resulting in likely knee contact.

PHOTO 6: Small driver compartment resulting in frequent protrusion of body.





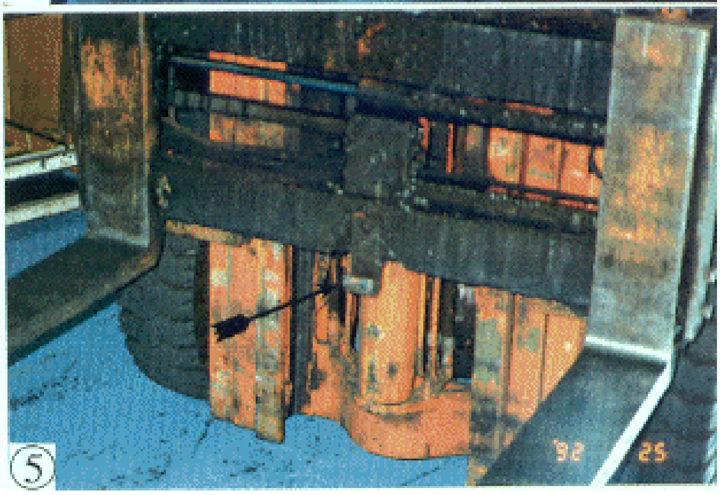


SHEET 9

PHOTOS 1, 2 & 3: These illustrate significant variation in pedal control layout between different models of forklift.

PHOTO 4: Illustration of vulnerability of pedestrians to lower leg contact.

PHOTOS 5 & 6: These show addition of small hook to forklift to restrain stillages from falling from tynes.



APPENDIX C

FORKLIFT VIDEOS

16 video productions, available at the video library of the OHSA or from forklift truck manufacturers, have been viewed and are commented briefly in the following.

"Lifting the load", 30 min, ENTREG for CROWN, 1985.

This is a clear and instructive description of all different sorts of forklift trucks, their general handling, how to place loads, lifting dynamics, attachments and how to park them. Factors like economy and safety, interacting with pallet trucks and pedestrians, driving on ramps and lighting conditions are covered. A fairly good half hour ad for CROWN. **

"Getting it right: The Forklift Way", 12 min, Film Victoria, 1985.

The do's and don'ts of driving a forklift truck. Filmed on a faked driving range, in an industrial exhibition area (or truck selling department) and cheaply so; many repeated sequences indicates a one day filming production. Poor. -

"Action FLT: The Supervisor", 20 min, Monitor, UK, 1990.

This utterly British-toned strategy for safe forklift truck use, is aimed at supervisors and instructs them to assess work environment and install safe practices, maintenance, organization, truck routes and pedestrian walkways, to carefully select the operators, to train them, install a system of authorization, organize follow up of training, monitor and review, and perform the necessary supervision. A reasonable idea is marred by the slightly cheap filming, the staged unsafe practices and old UK views on Unions and their role. Could be used as discussion material, though! *

"Action FLT: The Operator", 20 min, Monitor, UK, 1990.

The same as above, but directed at the forklift driver. Same British style and dialect, simpler language and different cuts. When you've seen the Supervisor version first, this script talks down to you. *

"Safety and Forklifts", 16 min, Safetycare, 1989.

This movie, starring TNT, is a thorough description of the general good and safe practices of forklift use: pre-operating checks, clothing (footwear, vests), travelling (corners; driving technique and walking technique), crossing bridgeplate, working together, stability, lifting the load, stacking the load and unattended forklifts. This is a good systematic training film, similar to "Lifting the load" above. **

"Clark Omega", 7 min, Clark, 199-.

Promo production mentioning visibility, ergonomic design and other safety factors. -

"Clark M-series", 7 min, Clark, 199-.

Promo production comparing Clark's trucks to the competition; operator control (visibility), control design and seats (safety seats are optional). The driver is wearing a seatbelt. -

"Tailgator - Clarks", 5 min, Clark, 199-.

The film promotes the new Clark Tailgator All Terrain forklift/reachtruck, which also is a selfloader (special equipment mounted on a truck tray). The new three-wheeler spins around in uneven terrain, slides around in mud, but gets the job done. Exciting, new and, probably, quite useful invention. There is not one word about safety, however, and the vehicle looks likely to overturn now and then. There is no protection at the back of the vehicle (the driver could fall out here) and no visible seat belt. Considering what is known about ATV:s, it's surprising that safety wasn't even mentioned! -

"The Hard Facts on Cushion Tyres", 9 min, Toyota, 199-.

Promotion video made at Toyota spare parts warehouse to show off the new forklift truck line. Longer wheel base and improved stability, low noise and low vibration are factors held forth, as are improved seats (bucket seat with belts). I couldn't see a rearview mirror, however. -

"The Obvious Choice - Battery/Electric Forklifts", 6 min, Toyota, 199-.

This is an ad for Toyotas four different types of battery/electric operated forklifts. The three-wheeler's new turning system is impressive. Otherwise, bland promo. -

"Operator Restraint System", 9 min, Hyster, US, 199-.

A proud description of Hysters research on forklift turnover, the purpose of which has been to establish the optimal driver restraint system design. A number of crash tests, with dummies and human beings, are shown in slow motion. The new design criteria, with seat belt, tubular hip restraints and specifications to the mounting of the seat, are described and shown. Quite impressive research film and this is good factual material in the workplace discussion about forklift safety and design. **

"Fork Truck Training", 21 min, Millbanks, UK, 197-.

This production initially gives examples of unsafe and dangerous acts and its purpose is to instruct on the requirements of the UK draft code of practice in the late 70s. Its main focus is on training requirements; steering, turning, lifting, driving up ramps, stability and overturning (fatality risks), checking the vehicle, tests on theory and practical driving, applied worksite training (brewery, car parts store) and work familiarization. Apart from the exaggerated initial examples of unsafe driving, this is a systematic, good and explicitly visual training video. **

"The Reach Truck Cowboy", 25 min, Rolatruc/BT, UK, 197-.

Story of an incomprehensibly careless worker instructed in the use of a new reach truck - the worker making all possible mistakes, and the instructor showing him the proper way. The idiot forklift truck driver is also - for reasons of instruction - shown that a lady is easier to lift close to your own body than with stretched arms. Language and teaching style not really up to date! -

"In Safe Hands", 23 min, Millbank, UK, 1975.

The introduction shows some unsafe practices, but not in an exaggerated way. The film contains a very detailed driving instruction for absolute beginners; lifting, blind corners, ramps, open trailers, etc. Stability theory is clearly shown - seesaw. Even if the teaching is somewhat uneven and the film is aged, this is a very clear and concise training material and quite a good film, made for the UK Road Transport Industry Training Board. **

"Forklift Safety and You", 17 min, Educational Resources, US, 1988.

In this production, sponsored by Clark, the main focus is on the use of forklift trucks in and around areas, where there are chemicals, vapours or electrical equipment; the right truck in the right place. Most of the information on standards seem to be specifically US, but the video also contains information on hazardous spills and fire protection, associated with the use of forklift trucks. The talking forklift truck could have been dropped, though! *

"Forklift Safety - It's up to you!", 24 min, Toyota, 1990.

The film focuses on the forklift driver as the professional, reliable, precise and safe operator. The script is good, the examples are instructive. Most safety issues are covered and safe operations - and how and what not to do - are shown. Maybe the production is somewhat long, making it a bit hard to remember everything. But you could watch it again, I guess. **

"Skid Steer Loader Safety Starts with You", 11 min, Toyota, 1990.

A driver precaution and "don't be careless" video about skid steer loaders that contains all the what to do and what not to; visual examples are crossed and ticked. An interesting feature is the presentation of the new entry and exit "control bar" for the models 2SDK 4, 6 and 8; in spite of the general message (that safety is entirely up to the driver), Toyota introduces a functional "dead man's handle" for the skid steer loader. Good! *