A Guidebook of Industrial Traffic Management & Forklift Safety

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Section 1. Overview: The System of Work

In an ideal system of work, humans, machines and materials come together in coordinated and efficient processes in a safe and productive environment. What actually happens depends upon management decisions about equipment; processes and facilities; material handling and logistics systems; and space, safety and hygiene in the working environment.

Illustration of a characteristic forklift environment

This guidebook examines a number of key issues with respect to industrial traffic management and forklift safety:

- Logistics, design & safety
- People and tasks
- The site and building
- Management of the traffic system
- Forklift features

The basic challenges are to productivity, which will be increased if good decisions are made but decreased if poor options are chosen, and to safety and health, which will be impeded if known risks are ignored.

Illustration of a possible truck loading/unloading area
**Section 2. Logistics, Design and Safety**

In a rational and safe system of work, perhaps the most important logistics focus is on the movement of people.

To plan and design production and logistics without fully considering the functions, movements and activities of the operators will create problems.

Poorly controlled hazards in the working environment will impede growth and reduce productivity. Incomplete logistics will create hazards and increase costs.

Principles of good design are most economically applied at the start of a project and are more costly to introduce retrospectively.

Design and logistics can determine the economic viability of an entire operation, and must also be at the forefront in renovation, restructuring and rebuilding projects.
The Hierarchy of Hazard Control

Poorly controlled hazards impede growth and reduce productivity. How can a potentially unsafe situation be stopped? A commonly held view in ergonomics and safety management is that there are three general ways:

1) **Remove the hazard** - by designing it out. As will be seen throughout this guidebook this might involve designing the permitted routes of forklifts so that they never come into contact with pedestrians.

2) **Guard the hazard** - to stop the problem occurring. This may be by placing a physical barrier between forklifts and pedestrians, or fitting pressure sensors on the forklift to prevent vehicle overloading.

3) **Warn of the danger** - to try to induce safe behaviour. This might range from painting pedestrian walkway zones on the flooring of forklift environments to general safety notices.

It is a ‘hierarchy of effectiveness’. Removing the hazard is usually more effective than guarding it, which in turn is more effective than warnings. There is, not surprisingly, a correlation between effectiveness and cost of implementation.

For companies that have an existing forklift safety problem then the issues are more complex, and a longer-term safety strategy might be necessary to recover the costs likely to be needed for extensive (and expensive) redesigns.

Again, this emphasises the importance of good initial workplace design.
Publications and tools for safer forklifts

NOHSC practical solutions database

The National Occupational Health and Safety Commission (NOHSC) publishes an OHS information database containing well thought out ideas submitted from industry and the general public. The aim is to build a comprehensive list of OHS solutions for hazards that have been identified in the workplace. At last count there were over 700 listings with around 30 of these providing solutions for forklift related issues.

NOHSC, however, makes the following disclaimer “This solution was not developed by NOHSC but was volunteered by an independent business or organisation as being a solution which was effective in their work situation. However, the advice provided may not necessarily constitute Australian or international best practice. If you plan to apply this information in your workplace, please ensure that any relevant considerations arising from your particular situation are taken into account, that a proper risk assessment is undertaken and that the implementation of the solution is safe, does not represent a hazard and conforms to legal or other requirements applying to your workplace. Neither the NOHSC nor the contributors makes any warranty with respect to the solution.”

Making your forklift work for you.

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Forklift Safety Checklist for employers

- Understanding the Forklift
- Equipment maintenance
- Training
- Preventing coordinator

Making your FORKLIFT WORK FOR YOU

A TUNABLE CHECKLIST FOR MARKETERS & SUPERVISERS

CHECKLIST

Date:

- Prevention.
- Training.
- Maintenance.

NOHSC Nationally Recognised Training.

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Both NSW and Victorian WorkCover have developed a forklift safety check-sheet available free of charge from either authority or via their websites: www.workcover.vic.gov.au and www.workcover.nsw.gov.au

Both take a slightly different approach and in reality benefit could be gained by reference to both documents.

The NSW checklist covers the four major areas of forklift operations:
- The forklift (pre-operation and operation) (Section 1)
- Work environment (Section 2)
- Work processes (Section 3)
- The operator (Section 4).

The NSW version is designed for use primarily by managers and supervisors whilst the primary target for Victoria is the employer, with advice that “you should complete this checklist in consultation with your workers’ health and safety representatives, your forklift operators and any other relevant employees.” Both checklists are valuable for use by any employee or employer.

However, it should be noted that neither checklist will necessarily lead managers and operators to fully evaluate all the safety aspects of their operations. In particular, neither checklist specifically leads to checking if the weight and centre of mass combined are within the capacity of the forklift in all operations.

WorkSafe Victoria “Preventing Forklifts from Injuring People during Loading and Unloading of Trucks”

Another important recent publication for forklift safety is “Preventing Forklifts from Injuring People during Loading and Unloading of Trucks: A Guide to Effective Practices”, produced by WorkSafe Victoria.

“The booklet helps to identify some of the potential risks and provides solutions and tips to help reduce injuries and fatalities resulting from unsafe forklift operations during the loading and unloading of heavy goods vehicles” (Page 1)

The booklet contains key elements of effective forklift traffic management systems (including a comparative chart of tasks and issues, and a section on ‘Dos and Don’ts’).

It also gives an illustrated example of an implemented effective forklift traffic management system for loading and unloading vehicles. This includes the key requirement to separate pedestrians and operating forklifts and to keep drivers in a safety zone.

This booklet can be obtained from www.workcover.vic.gov.au (email info@workcover.vic.gov.au).
Pro maintenance reference chart

Repair and maintenance of forklifts does not simply extend to a grease and oil change plus a check of the brakes. In some cases fatalities involving forklifts have been directly related to neglect of repair and maintenance procedures and intervals. Not only do the mechanical factors need to be addressed during maintenance but compliance and risk management issues. Forklift technicians do not receive vocational training in this regard - for example legibility and accuracy of Load Capacity Plate, condition of warning decals, operation and location of emergency isolation to name a but few - and must pick up the information “on the job”.

Forkpro Australia (www.forkpro.com.au) has developed a reference chart designed for forklift maintenance personnel. The chart complements the normal mechanical regime by giving the technicians the information required to maintain safety and compliance. The chart identifies the critical safety items, explains the relevant document for compliance and highlights the key components for maintenance. Forklift maintenance companies cannot afford to be without this information.
Section 3. People and Tasks

People at Work: The Ghost in the Machine.

Organisations are managed by people, rely on people for most work processes, and exist for the benefits of people. However, quite often people are only considered as ‘cogs’ within the total work system, rather than as individuals that have their own motivations, needs, abilities and limitations.

Ergonomics- fitting the task to the person
Ergonomics studies human abilities and limitations, and then applies that knowledge to improve people's interaction with products, systems and environments.

The are four key factors:

a) Physical,
b) Mental (cognitive),
c) Environmental and
d) Organisational / social issues.

Physical Factors
These are concerned with human body shapes, sizes and strengths, and how they relate to physical activities such as manual handling, workplace layout, working postures and work related disorders.

The use of forklifts has increased in many industrial, manufacturing and transport operations in recent years. Undoubtedly forklifts offer many benefits, such as improving productivity or reducing manual handling. Even so, forklift operators often need to employ their physical strengths and capabilities when performing different tasks, such as occasional manual loading and in the driving task.
Forklift operators and associated workers can fall victim to injuries, especially those involving their lower backs or other soft tissue damage. Causes of this include:

- Lifting too heavy a load
- Lifting too frequently
- Lifting in a constrained, or uneven posture

**Mental (Cognitive) Factors**

These are concerned with individual mental processes such as perception, decision-making, actions and memory. Issues here include human error, work stress, mental workload and training with respect to forklifts.

**Workload/stress:** Prevent the work demands from becoming excessively high. Prevent the operator from becoming excessively overloaded. People generally work best at intermediate levels of workload/stress.

**Perception:** Make the necessary objects in the environment clearly visible or audible (including alarms).

**Memory (both long and short term):** Often psychologists talk about short-term memory being able to hold only a limited amount of information. Make sure that the forklift operator is not required to hold too much information in short-term memory. Requiring too much information to be held in short term memory can make mistakes more likely.

**Training:** Make sure that appropriate training been provided. And ensure that the effectiveness of the training is evaluated. Make sure that the forklift training covers vehicle control (Skill, rule and knowledge based), loading and emergency procedures.

**Environmental Factors**

All of our daily activities are performed in a physical environment. Through knowledge of basic principles with respect to key variables such as sound, fumes, temperature and lighting we can see how such physical environmental variables are relevant to the design and implementation of forklift systems, tasks and equipment.
Organisational Factors

Generally we do not work in isolation from other people, so organisational ergonomics include organisational structures, communication, working hours, organisational culture and teamwork.

Modern theories of job design emphasise features such as task identity, skill variety, feedback and autonomy as likely to improve job satisfaction. Whilst it might not be easy to add all these features to a forklift operator's job, it is still important to make the job as meaningful as possible by (for example) giving them praise when a job is performed well (feedback), allowing the drivers to be involved in other features of the job than just the driving (so increasing variety) and allowing the drivers some flexibility about how they conduct the work (autonomy).

Other important occupational factors are fatigue and boredom/inattention. Some of the main causes of work fatigue are long working time, monotony within a task, sleep loss and time of day at which work takes place.

If shiftwork/nightwork is needed:
- Avoid continuous night work - have at least 24 hours break after a series of nights
- Plan some free weekends into the shift schedules
- Ensure adequate break(s) per shift for nourishment
A safe site will separate heavy transport access from lighter vehicle access, and separate pedestrian from vehicle access. Visibility, space and safety make such separation a necessary and productive option.

In linking site access to the public road system, the need for turning space, queuing at the gate, visibility of approach, and safe temporary parking for visitors and trades people should be considered.

To continue the road signage and traffic engineering solutions through the gate on to the site makes traffic control simpler. To continue to separate pedestrians from trucks, forklifts and other transports on site will define the traffic system principles for all staff and visitors.

Even at quite small work sites, access for staff and visitors should be via separate parking, entrance and reception facilities.
Pedestrian access should be organised in such a way that there will be no perceived or real benefits in taking shortcuts through vehicle access ways.

The layout of the public road and transport system in the immediate vicinity of the site is of direct relevance to the safety of staff and visitors.

Perimeter and landscaping

A secure perimeter represents control over all access and egress of people, vehicles and products.

Landscaping for the management of the site and in-house transport system will make it possible to create separation of levels, space for turning and waiting, and to avoid blind corners and conflicts between different types of movement.

A growing and changing business tends to outgrow the size and space of its facilities. A facility operating at different levels will have greater flexibility for expansion and changing demands.

The layout of the building should be based on a complete analysis of the flow of the work process and all the necessary movements of people, loads, material and equipment of different types, shapes and weights.
By locating functions according to principles of minimal movement of loads and safe access of people, the choice of cargo handling and transporting equipment should follow.
Section 5. Management of the Traffic System

Manage the flow

The analysis of operations will define how the best ergonomic interface of each work station should be configured; what equipment should be combined to assist the flow of tasks and provide the best lifting, shifting or moving solution.

Typically, the shifting of loads or transport of material has to be done - by means of conveyors, hoists, vehicles or people - to bridge gaps between processes. It pays to make detailed analyses of how these process gaps are handled, since they often represent costs in terms of damaged goods and injury associated with manual handling. Such process gaps are also found in supporting activities like repair, cleaning, maintenance and change-over of equipment and tools.

For heavy material handling, the use of counter-balanced forklifts represents the common and most cost-efficient option. However, the design of the traffic environment must provide an acceptable level of safety for the unprotected pedestrian workers in the system. Where forklifts are used they must be regarded as vehicles and the forklift access-ways defined as roads.

Reduce exposure

As a rule, the less a process occurs, the lower the level of hazardous exposure and the less chance of incidents occurring.

Systems of work where forklifts are performing all or most load-handling tasks typically expose pedestrian workers to the highest levels of risk. If tasks can be performed with the help of other less hazardous equipment, or at different stages in the process, improvements in safety could also improve productivity.
If forklift-dependent systems still require tasks to be performed by pedestrian operators in close proximity to forklifts, the versatility of the forklift is frequently put before ergonomics and safety. Such forklift-pedestrian systems of work represent unacceptable levels of risk.

To reduce risk exposure, it might be necessary to reduce forklift movements or substitute forklift tasks with the use of other load handling equipment.

However, care must be taken that by reducing the movements of, say forklifts, an increase in movements of another piece of equally hazardous equipment does not occur.

By separating people and vehicles, a wider range of equipment for moving loads and performing tasks will become necessary, as the safe manual handling of loads requires powered equipment more adapted to the ergonomic needs of the operator and less likely to inflict severe injury.

A rational business employs the principle of fewer but more efficient movements by effective planning and automation. If total pedestrian and vehicle separation is not possible, careful thought must be given to how vehicle movements that create risk for equipment operators can be reduced and slowed and how pedestrian traffic can be restricted. Separation can be achieved by defining different access times for pedestrians and vehicular traffic [temporal separation], for example in work zones.

**General Situation**

**Elevated walkways:**

Complete segregation of pedestrians from plant or vehicular traffic is the best practice. Where possible this should be used, however, it is often difficult within existing layouts. Where a greenfield site exists, complete segregation is the desired layout.
Road rules:
Normal “rules of the road” should apply to all site traffic movements, including, in most instances, a set speed limit. This creates a common understanding and is highly beneficial in visitors to the site understanding the protocol.

Signage:
Signage within the external areas of the site is appropriate as a passive measure to guide all (especially visitors) to their destinations. This is especially important on large and complex sites where locations are difficult to find. Those familiar with the site and its idiosyncrasies soon lose sight of the obvious deficiencies. An untrained eye should be invited to pass judgement upon safe navigation.

Induction:
The principles of traffic and pedestrian flow should be included in all induction processes including a site map. It should especially reinforce the “road rules” and any penalties that may apply. For short term visitors a ‘mini induction’ should include the above as a minimum.

Visitor ID:
Visitors to site are often not fully aware of emergency procedures, “road rules” and the like. It is becoming more common in industry to provide visitors with an easily identified safety vest of unique colour or marking. This identifies the individual as a visitor and requires workers to take additional care, provide assistance or in the case of emergency the nearest staff member ensures that person is taken to the assembly point. This may not be appropriate in office locations but certainly within warehouse and production facilities. Visitors’ badges are often too small, can only be seen from the front and are often covered by personal protection equipment (PPE).

Proximity:
Proximity sensing systems in their simplest form can be used to warn of plant equipment as it approaches set locations ie doorways, blind spots, intersections. In its more complex form, pedestrians can be fitted with a transmitter or other device that warns plant operators of their proximity to the equipment and can even be used to reduce the speed of the equipment until at a safe distance. Again, this may not be appropriate in office locations but would certainly be within warehouse and production facilities.
**Pedestrian Walkways:**

Walkways do not necessarily need to follow the most direct path. They should however take the route that minimises the risks. Further steps are then required to control risks that remain. In fact providing pedestrian walkways may in some instances create a hazard as the pedestrian inadvertently feels they have right of way or that equipment will not veer onto the walkway. Further steps are required to render walkways safe.

In many situations pedestrians must share the aisle or passageway with plant equipment even though a designated walkway is laid out. Ideally pedestrian traffic should be totally segregated via a dedicated walkway or entry to the building from another point.

At a minimum pedestrians must be prevented from entering aisles where plant equipment is operating. An alternative route of 2 or 3 other aisles should be provided. This buffer zone is to prevent inadvertent dislodgement of materials from the rack possibly falling onto pedestrians and/or bystanders.

As mentioned earlier, wherever possible, pedestrian and plant equipment should be segregated by means of a barrier. Unfortunately if this was carried out on many walkways, forklifts would not be able to work in the aisles due to width. Further investigation is required in segregating pedestrians during site development or warehouse layout changes.

Figure 1 below outlines where a potential hazard may exist where plant equipment and pedestrians share the same area yet barricading is not possible. It shows where a pedestrian needs to enter the area, and his/her destination. In this case the most desirable situation would be to force pedestrians to enter the building closer to the destination point.
**Figure 1:** Potential hazards that may exist where plant equipment and pedestrians share the same area

![Diagram showing potential hazards]

**Locations of functions:**
If the safety of pedestrian traffic was truly valued, the positioning of work stations, work areas and control offices requires much more consideration than industry currently affords.

Take this fictitious example:

Company XYZ studied the logistics and productivity of their soon-to-be-built warehouse without an explicit goal of pedestrian separation. At the end of the design project (which was adopted and eventually built) the main control office was placed in the centre of the warehouse (see Figure 2 below). The logic was that the flow of picking always came back to the central point and this would minimise the distance travelled by pickers. Overlooked was the fact that any person wishing to meet with those housed in the office must access the control office by walking through the warehouse from the eastern main office or the western dock area. This route was undertaken several hundred times per day by all sorts of people including those totally unfamiliar with the site, as the control office houses key personnel including the Warehouse Manager. While pedestrian walkways were put in place they required persons to walk through high racking areas often with forklifts working in the aisle. No physical separation between pedestrians and
forklift traffic existed. Along with this were common hazards such as blind spots, risk of falling objects and so on.

As part of the design, building codes required underground escape tunnels in case of fire.

Had the control office been placed on an outer wall the ‘extraneous’ pedestrian movement could have been directed to enter the office from outside the warehouse, thus eliminating hundreds of unnecessary journeys through the working areas of the warehouse, so potentially also improving productivity.

**Figure 2: Locations of Functions illustration**

With control office relocated to an outer wall, there would be no necessity for unauthorised persons to enter the warehouse area. Access via outer wall of warehouse.

**Barricading:**
Most companies are good at protecting buildings, pipes, equipment and so on. However pedestrian access is often on the traffic side of the barricade. Barriers or barricades are designed to protect pedestrians, but also act to enforce the walkway – ie keep mobile equipment off and pedestrians within. Barriers should be provided along as much of a dedicated walkway as possible.
Pedestrian calming:
To prevent pedestrians from taking an unfettered path into vehicular traffic, such as where walkways cross a road, a method should be employed to bring their movement to a momentary halt. One such method is inward opening, self-closing gates. This creates a situation where pedestrians must stop and take a small step back before continuing across the thoroughfare. Coupled with proximity devices or warnings of oncoming traffic, the risk of collision is significantly reduced.

Door warnings:
Considering the introduction of high-speed roller doors, and the fact that often pedestrian walkways pass the thoroughfare, all doors should have audible/visual warnings on both sides to warn of approaching traffic. This could be linked with proximity devices. The warning must sound sufficiently in advance of the door opening to allow pedestrians to clear the door. Due to the speed of door openings it is pointless for the warning to be coupled with the opening process.

Loading/unloading:
Pedestrian/bystander access should be eliminated from all loading/receiving areas. A high percentage of workplace injuries/deaths occur to people not directly involved in the loading/unloading process.

Overhead clearances:
The hazard low clearance poses to forklifts should not be underestimated. The most significant risk is that a partially raised mast may contact a low door, or the like, whilst travelling at an angle to the beam. As the forklift continues to drive under the
equipment with mast jammed, it is easily tipped over onto its side. This is the most dangerous scenario, with the operator potentially being crushed by the overhead guard. It is especially of concern considering industries low adoption rate of seat belt wearing when operating forklifts.

**Falling objects:**
Walkways are often routed via areas where goods are stacked at height. The potential for a dislodged load to fall on a pedestrian is high and even the smallest of items may be catastrophic should it collide with a pedestrian’s skull. Greater focus is required in providing pedestrians with overhead protection where a falling object is possible.

**Blind spots:**
Blinds spots are a common hazard. Not only does building design often create blind spots for forklifts, pedestrians etc but the stacking of goods adds to the hazards. Some of the solutions provided above may reduce or eliminate risks, however greater care is required to provide effective visibility.

**Road registration:**
Some States in Australia deem an industrial site as a public place and require road registration for vehicles and third party liability insurance, particularly where public access is unfettered, eg car parks, factory/warehouse type retail outlets, markets and so on. This has special duty-of-care obligations which must be explicitly addressed.

**Noise levels:**
Considering ambient noise levels are elevated in many workplaces audible warning devices must also be coupled with visual warning. Special note must be drawn to the Occupational Health and Safety Noise Regulations.
Section 6. Forklift Features

Forklift sizes and capabilities

Forklifts may range in capacity from under 1 tonne, handling small pallets of goods, to large forklifts with capacities of 48 tonnes or more used for 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.

Forklifts have a high mass, are of rigid and unyielding construction and often operate in facilities designed for close proximity to pedestrian workers. In addition, forklift tyres are either solid rubber or very rigid pneumatic designs, so serious pedestrian foot injuries occur where feet are run over. Loads are generally transported by being simply supported on the tynes (ie not directly secured to the vehicle), relying on gravity for stability; an inherently unstable configuration. They represent a substantial hazard which must be explicitly addressed.

Because of their typically compact size, the hazards associated with forklifts can easily be underestimated. A forklift 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 2.5 tonnes forklift is about four times the weight of the average family car (1400kg).

Forklift Intelligent Transport Systems

Rational manufacturing, moving, storing and distribution of products, packaging, spare parts and other necessary supplies requires monitoring systems to keep track of operations and product flow through the process.

The time, energy and type of equipment used in the process will decide the productivity and safety of the operation.

Proximity sensing systems in their simplest form can be used to warn of plant equipment as it approaches set locations (doorways, blind spots, intersections). In its more complex form, pedestrians can be fitted with a transmitter or other device that warns plant operators of their proximity to the equipment and can even be used to reduce the speed of the equipment until at a safe distance.
There are different levels of equipment safety required by the variations in forklift use and environments. The basic on-board and vehicle design parameters in a modern forklift should integrate passive safety features (e.g., the design of guarding of forklift wheels to prevent, or reduce the severity, of forklifts driving over pedestrians’ feet) improving the use of the forklift in all environments, including single vehicle, small-scale operations.

In relation to closeness to pedestrians and co-workers, the forklift should be equipped with some form of proximity controls. Such controls must be chosen based on performance requirements and solutions must be adapted to the specific operational environment (lighting, climate, surface, obstructions, etc). Different types of proximity control equipment will be required:

- in relation to certain locations in the facility
- in relation to other forklifts/vehicles, and
- in relation to forklift operator on foot

A simple line-of-sight contact between a fixed point in the environment (a doorway, a corner, etc) or a moving pedestrian and the forklift can be established using ultraviolet light or microwave radio frequency. Such equipment is commercially available (e.g., "AMSKAN", "Tagmaster"). The restrictions are that line-of-sight might provide inadequate distance between the forklift and pedestrian at blind corners or in places where the view is blocked. Microwave frequency will not travel well through water (incl. the human body), which means that tags will require special solutions stitched into garments in order to be detected from any angle. The transmitter in general will need to provide a directional signal to minimise any unnecessary activation of alarms on the forklift or person. For example, activation of the alarm when the forklift and person are in different aisles and separated by racking.

A simple radio frequency tag (RF-tag) with a coded signal, together with a strong forklift-placed receiver, has been prototyped. This is an extremely cheap solution and therefore suitable for inclusion in a retro-fit package, and it should be seen as an extra layer of redundancy and safety, which should operate together with vehicle/pedestrian separation and speed zoning of the facility (see figure 3 below).
As shown in figure 3, the basic link between RF person detection and speed control must be integrated with sensors measuring continuous dynamic stability. The safety control system will ideally define and control the safe operating envelope of the forklift in terms of dynamic load, speed, acceleration, braking, turning circle, and provide feedback to the operator - pedestrian alert, stability alert, speed zoning alert.

The forklift safety system must represent a credible retro-fit option, which includes speed control, dynamic stability feed-back and proximity detection (RF). The system should be economically realistic to retro-fit on single vehicles and thus be independent of, but easy to combine with, fleet management and other logistics/navigational systems.

Further structural additions improving injury minimization are being discussed with forklift manufacturers (ie. pressure-sensitive skirt/belt around the sides and back of the forklift body, wheel cages or wheel covers designed to protect close contact with feet/legs).
Reducing side tipover risk

Forklift stability systems

The 3 points of stability are the 2 front wheels and the centre of the rear axle for a 4-wheel forklift or the rear steer wheel on 3 wheel units. Without this the forklift could not safely negotiate uneven ground. However, the downside is that the stability of a forklift changes constantly due to shifts in the balance of the load coupled with the speed and turning rate of the forklift.

Forklift manufacturers have come under fire for not addressing the issues of inherent instability even though their designs do comply with existing standards.

Toyota Material Handling Company was the first to invest heavily in stability control systems for forklifts. First introduced in 1998 with the introduction of the 7 Series, it has proven to be an effective first step into active stability control. After identifying that lateral tip over was a key in forklift accidents, the design engineers designed a method to reduce the likelihood of side tipover. Toyota named it the “SAS – system of active stability.” The system monitors key forklift operations, detecting instability through a series of sensors. When the computer senses instability, the Active Control Rear Stabiliser – a hydraulic cylinder with an electromagnetic fluid lock - locks the normally pivotal rear axle to help prevent lateral tip-overs.

Toyota were not the first to think of this concept however they were able to develop the mechanics of implementation.

Numbers of manufacturers included features to control the mast angle, especially with a raised load. For example, the Toyota Active Mast Function
Controller senses and reacts to instability by restricting mast angle and speed according to the load’s height and weight. This feature assists in preventing forward tipping due to the reduction in lift capacity caused by the mast tilting function.

Other manufacturers are developing similar technology. Komatsu and Crown provide some options, and Nissan has also developed a system. It will not be too long before we see effective implementation of active stability and other safety controls throughout the industry.

**Speed control.**

As speed is often a contributory factor to both collisions and stability-induced incidents active measures are required to limit speed. Due to a forklift’s high centre of gravity it is likely that overturning (lateral tipover) will occur should the forklift corner at high speed, even without a load- 75% of side tipovers occur when the forklift is empty. As the mast is raised the centre of gravity becomes higher and the likelihood of side tipover increases. Limiting speed can reduce this likelihood. Some manufacturers are currently developing active stability control systems that include speed controls and braking based upon load weight and the effective positioning of the combined centre of gravity. In the meantime options are available to reduce speed without affecting material handling performance.

Many forklift manufacturers provide speed limiters as factory options and in the case of battery powered trucks it is often standard equipment. Various after-market speed limiters are available for internal combustion engine forklifts and other load carrying equipment.

Speed limiting is also vital to prevent collision with other equipment or pedestrians. The dilemma is that while a walking pace speed limit is appropriate within a production area, it may be an unnecessary constraint on productivity in other areas such as outdoor aprons. However, there are systems available that can be set for various zones. For example, as the forklift passes a beam on the door it switches the speed controller to outdoor mode and allows unrestricted travel speed. When entering the building again the beam triggers the speed controller to limit maximum speed to walking pace.

The major issue with external speed limiting is tampering. Some companies have reported problems with employees attempting to disconnect limiters. This not only adds dramatically to the damage bill but speed limiters can create a false sense of security amongst others within the workplace. In some instances not only is the limiter damaged but the forklift rendered inoperative due to system damage. Manufacturers of speed limiter systems are now designing “tamper proof” systems, however in some cases the “tamperer” goes to greater levels to achieve the outcome usually with catastrophic damage to the forklift equipment, especially where these are battery powered and computer controlled.
Limiting speed is not the only option. Systems are also available that visually indicate when a forklift has exceeded a set speed. This system has been successfully adopted in Japan where road transport vehicles are required to be fitted with 3 lights above the cabin. Each light is lit at a set speed. Depending on which light is on at the time if it is above the speed limit within that area, they are an open invitation for the police to apprehend the offender.

The same system is available for use on forklifts within Australia. As an example the speed limit within a warehouse may be 6 km/h yet outside it is open. The controller for the speed light is set to activate above 6 km/h. Should the light be flashing when in the warehouse it indicates that the speed is in excess of 6 km/h and the supervisor is obliged to take disciplinary action.

Speed limiting of LPG powered units has been difficult in the past, mainly due to the large volume of local LPG system fitments that occur. Factory supplied LPG is not popular within the Australian forklift market for various reasons including cost. The Australian supplier of LPG solutions, LPM have developed an effective speed limiting system for LPG powered forklifts. Operating from the governor rather than the throttle butterfly, it has overcome the problems of trying to control engine and travel speed on a “fly by wire” method.

As part of a demonstration project undertaken by the Monash University Accident Research Centre, intelligent speed limiting devices manufactured by the Victorian company ‘Switched-On I & T Services’ were fitted to three forklifts. Drivers, supervisors and managers considered the newly developed and installed systems to be broadly acceptable in operational conditions, and most personnel understood the potential safety benefits of such systems.

Minimising forklift traffic

Radio shuttle.
The Radioshuttle racking system is distributed by BT Industries. It comprises a specially designed racking system, and independent “Radioshuttle” unit. The Radioshuttle loads the racking on one level and packs the pallets deep into the storage system. The goods can then be picked on a first-in/first-out basis or first-in/last out. This gives a high rate of capacity utilization and a high rate of accessibility of the goods. Additionally the forklift does not need to wait for the Radioshuttle unit and is free to
work elsewhere. This produces a high turnover rate while significantly reducing the truck's handling time. Reduction in handling time means less forklift movements and in turn a safer working environment.

Load transfer station
The load transfer station is made by Cascade Corporation. Its purpose is to allow the swapping of goods from one pallet to another without re-stacking of pallets or dangerous shuffling of pallets between forklifts.

The following explains how the system operates.

1. The pallet load is placed in the station and the forks withdrawn from the pallet.
2. The unit cycle switch, or radio controlled cycle switch, is actuated and the station automatically removes and stacks the pallets.
3. The shipping pallet, shelfstock or bare pallets are placed directly under the transfer plate for receiving the load on the narrow facing.
3a. The shipping pallet may also be positioned for receiving the load on the wide facing.
4. The unit cycle switch or radio controlled cycle switch is again actuated. The transfer plate slides out from under the load, transferring it to the receiving lift truck.
5. Once the transfer plate is completely withdrawn, the truck is free to proceed with the load.
Accountability

Access control

Unauthorised use of forklifts can present many companies with hazards they may not even be aware of but for which the company may be held liable.

Those authorised to use forklifts are trained and competent to use individual forklifts. How often does the transport driver decide to take the forklift and unload themself, or the people in the factory next door “borrow” the forklift. The owner of the forklift may be held responsible regardless of whether permission was given for use. The owner may even be held responsible if the forklift is stolen!

Australian Standard AS2359 Part 2 states that keys should be removed from unattended forklifts. Of course this is a basic form of access control, however many same brand forklifts use the same ignition key.

So as to provide managers with the tools to positively restrict use and monitor usage, various electronic systems have been developed. Access can be via various alternatives:

- Swipe card.
- Pin code.
- Security key

Each of these options usually provides for identification of the operator against the time of usage Most usually have a time out function so as if the operator leaves the machine for a period of time, the unit shuts down and log in must occur again. Operators may swap prior to logging out however who would wish to be responsible for another operator’s actions?
Onboard forklift monitoring.
In recent years significant developments have occurred in relation to tracking data from forklift usage. One of the key motivating factors has been accidents and damage to the forklifts and surrounding environment. Various systems are available that can provide data on:

- Impacts
- Driver access
- Speeds
- Idle times, etc

Impact monitoring has been of great interest to industry. Previously it had been difficult to keep a track on where and when impacts had occurred. Existing systems can feed information into computers or simply shut the unit down until the supervisor reactivates the system. Coupled with access control systems these have proven quite effective in improving workplace safety and reducing repair bills.

The systems available vary in complexity from a simple integrated fully contained unit to those that transmit information back to a base station for monitoring and analysis. Additionally the security of the system can be tailored to the conditions including fully enclosed tamper proof arrangements. The popular Shockwatch system has a patented impact sensor that can be adjusted to react to various levels of impact (g force). When an impact activates the alarm a special key is required to deactivate it. Additionally this system can be set to shut down the forklift again requiring intervention by a supervisor.
The Fleet Assist system also provides impact monitoring as well as other data fed back via radio frequency to management computers.

The effect on forklift safety comes about through the increased level of accountability. Management cannot overlook information provided in relation to damage repairs and required maintenance.

The Fleet Assist radio transmitter

Methods to ensure seat belt usage

**Seat belt interlock**

The revision of Australian Standard AS 2359 in 1995 brought about the introduction of the seat belt and operator restraint seat. Getting operators to wear belts - or even company management to require use - has been another matter.

The purpose of the seat belt is not well understood by industry. Operators of counterbalanced type forklifts are at risk of being ejected from the operating position during a side tipover. Due to the overhead guard design requirements it is likely that some part of the body will be entrapped by the overhead guard roof section as the forklift rotates 90 degrees. A properly designed seat and seat belt will prevent this.

There have been attempts at engineering solutions, for example seat belt interlocks that prevent operation of the forklift unless the belt is buckled. Further design improvements include the sequencing of the seat belt switch with a seat pressure switch. The weight of the operator on the seat must be detected prior to the seat belt switch being engaged. The opposite sequence indicates that the seat belt has been buckled prior to the seat being sat upon and forklift operation is not permitted.

A further enhancement can require proper handbrake use, avoiding the potential for forklifts rolling away and impacting pedestrians or causing
damage. The forklift cannot be started unless the handbrake is applied. Additionally, the forklift engine can only be left running if the driver dismounts after having applied the handbrake.

**Condition**

- **Seat pressure only.**
- **Seat belt switch only.**
- **Seat belt buckled prior to seat pressure.**
- **Seat pressure prior to seat belt buckling**

**Operation.**

- ✗
- ✗
- ✗
- ✓

Further development of such devices will ensure that the wearing of seat belts on counterbalanced type forklifts becomes standard operating procedure and will likely be coupled with the correct use of the handbrake. Work undertaken by the Monash University Accident Research Centre with the seatbelt interlock manufacturing company *Switched-On I &T Services* has shown that such devices can be successfully installed in operational conditions.
Hazards of LPG container changing

Low weight LPG containers

Traditionally LPG powered forklifts have their gas tanks located on the counterweight at the rear of the forklift. The mounting cradle can be 1200mm or more from ground level. Considering that a full LPG tank made from steel weighs around 40kg, the task of manually lifting the container to that height requires significant physical effort – especially when considering that during the lift the bottle must be rotated 90 degrees. Gas bottles are fitted with handles however forklift tanks must be mounted in a horizontal manner requiring the bottle to be laid upon its side once hoisted clear of the ground.

LPG tank suppliers are now supplying tanks made from aluminium rather than steel. This change in material has reduced the gross weight by around 15kg. The new 25kg bottles are a significant reduction in effort however still do not eliminate the manual handling issues.

Swing down gas bottle brackets.
The aim is to get the LPG cylinder, traditionally mounted upon the counterweight, closer to the ground for exchange by the operator.

Some manufacturers offer a specially designed counterweight with a lower mounting position of the gas cylinder. Locally developed solutions have also been employed whereby platforms for bottle exchange are now part of normal routine.
Dealing with extreme lift heights

Camera
The onboard camera systems have been developed as a direct result of the trend toward increased mast heights. As forklifts are able to stack at higher levels, operators are less able to view the actions occurring at the set level. Additionally the acute angle that the operator’s head has to rotate can lead to strain injuries. The onboard camera allows the operator to see the proximity of the forklift tynes and load pockets.

Cameras are often mounted on the lift carriage just below the tynes or within the tynes themselves.

Tilting Cabin.
The BT Reflex range of Reach Trucks offer a unique solution to the issue of tall lift height masts. The E Series model is available with tilting cabin that rotates the driver’s compartment allowing the operator to lay back from the vertical. This rotation not only reduces the operator’s need to rotate the head upward but places the field of vision to the outside of the mast channels giving a much clearer view of the lift carriage and tynes when elevated. This is a standard feature on lift heights above 8.5 metres and optional below. Another interesting feature is that the tilting can be set to occur at a pre-selected lift height.
Product dislodgement

Intelligent clamp
Dropping of paper rolls where Paper Roll Clamp attachments are used can be a major safety issue. This can be due primarily to incorrect clamping force of the arms around the roll. Several of the major attachment manufacturers now have intelligent clamps where slip sensors in the pads detect the slightest movement of the roll within the clamp. Any movement detected is input to the microprocessor that adjusts the clamp pressure. The advantage is that the clamp does not squeeze the roll any more than required to hold the roll thus reducing damage whilst ensuring that sufficient pressure is always applied so as not to drop the rolls.

Load stabiliser
Most of the attachment manufacturers can supply a load stabiliser in either mechanical or hydraulic form. As with the dropping of paper rolls, the dropping of other palletised products can also create a hazard within the workplace. Load stabilisers operate via an additional arm or frame that is positioned above the load. Once the load is secured upon the tynes the stabiliser arm is lowered and a small amount of pressure is placed on the load to effectively clamp it between the stabiliser arm and the tynes. This is especially useful
where loads cannot be shrink-wrapped or glued in particular, or handling of bottles and the like. The downside is that, as with all material handling attachments, it will have an impact on the forklifts lifting capacity.

**Tilt control**
The tilt control mechanism developed by Cascade Corporation provides a mechanism by which the mast can be centred in the vertical position simply by the press of a button. Tilt control is designed primarily to prevent damage to loads however, it can also assist in preventing goods from being dropped or inadvertently pushed from racking due to misaligned tynes or clamp. The system comes with 2 options:

1. Tilting forward to vertical, mast stops at vertical.
2. Tilting forward or backward to vertical, mast stops at vertical.

Both models have an override button that allows the mast to be tilted forward of vertical. In addition the two-way model has a 3 second delay that allows tilting to continue.

A similar system is also available on certain Toyota and Komatsu forklifts.
Visibility is always an issue with forklift operation. Operators have to contend with bulky loads, restriction of visibility through overhead guards and mast assemblies, bulbous counterweights, frequent reverse direction travel and pedestrians at close range. The use of mirrors has not always been recommended as the field of view is restricted, however recent developments in material and design have provided a greater field of vision. Convex style mirrors such as this Honisch GmbH mirror give greater vision. On larger forklifts, areas such as behind the counterweight remain out of view, especially where LPG containers may be fitted. Behind counterweight mirrors are available.

Retractable bollards
Forklifts sometimes fall from loading docks. Solutions have included exclusion zones and permanent barriers. The retractable barriers shown here can provide a solution to positive barricading whilst also allowing access when required for truck/container unloading etc. Additionally they reduce the tripping hazard often presented by low, continuous barriers. The retractable bollards are positioned at an appropriate location in from the dock edge and at appropriate spacing to prevent forklifts from driving between. With the use of a key handle the bollards may be raised or lowered.
**Reach truck traction.**

Traction can be a major issue for warehouse equipment working within cool, cold, freezer or wet environments, especially in the case of reach trucks. On low traction surfaces the small diameter solid tyres have little chance of maintaining traction under acceleration or braking, even with specially designed tyres such as the steel embedded type. For reach trucks “wheel spin” may actually cause the truck to track sideways, creating safety concerns. Toyota Material Handling Company has developed an effective system of control for their current stand up model reach truck.

The Toyota traction control system adjusts the torque output of the electric drive motor. The torque is controlled via a micro-processor controller. The controller analyses the difference in speed between the front and rear wheels and thus determines whether there is slippage. An appropriate reduction in motor output torque prevents the wheels from spinning and the truck continues to track in the direction desired.

Coupled with this feature is front assist braking. Reach trucks with conventional rear wheel braking have reduced braking power when loaded and the mast extended. Additionally should skidding occur the forklift will not track straight. The front assist brake system varies braking effort on front or rear wheels to ensure optimum balance. Should the controller determine the rear wheel is slipping the front brakes are applied. Front brakes are not applied so severely as to cause rear end to rise off the ground.

**Tyne gauges**

According to an Australian Fork tyne (fork arm) manufacturer, the most common cause of fork arm failures fitted to “Powered Industrial Trucks” is blade reduction.

For quite some years this company has been providing to the industry an ingenious set of “go – no-go” gauges for easy recognition of the acceptable minimum thickness of the tyne heel.
Handling Traction Batteries

Traction batteries are large lead acid batteries used to power electric forklifts. Commonly voltages are from 36 volts to 72 volts, with a total range of 24 V – 80V. Capacities may exceed 1000 ampere hours.

The market split between electric and internal combustion, for new equipment, is now marginally in favour of the latter. However, there are some 5000 new battery electric forklifts purchased every year. Each one of these has at least one traction battery, some 2 or 3 to cover additional shifts meaning some 7000 – 8000 additional batteries in the workplace, all requiring regular charging and manual handling at varying frequencies.

Battery handling hazards

However efficient forklift batteries or chargers become there still remains significant risks with the use, charging and handling of traction batteries.

Weight:

Traction batteries must maintain a certain weight to retain stability of the forklift. They perform the function of partial counterweight. Batteries can weigh from 500 kg to more than 2000 kg. In many cases these batteries
must be removed and replaced with second batteries so as to allow for ongoing multi-shift usage.

Forklift traction batteries are either removed via lifting from the battery bay (which normally requires some type of crane system) or via side extraction (which requires equipment to receive the traction battery).

In many cases the forklift operator is charged with this responsibility.

**Gas emissions:**

Mainly during the charging process and especially during the battery “gassing phase”, significant levels of hydrogen gas are produced. This can become an inhalation and explosion hazard. Due to requirements under Australian Standard AS2359 the conglomeration of traction battery charging facilities is normal. This in itself creates a greater concentration of gas and a more onerous task in providing sufficient ventilation.

**Handling solutions**

Earlier forklift designs required traction batteries to be lifted from the forklift, via crane, gantry or even another forklift installed with appropriate lifting equipment. With current forklift designs, this method is still commonplace.

New products have been introduced over recent years to reduce the manual handling of batteries that in turn also has reduced the risk of electrolyte spillage.

Forklift manufacturers and local suppliers have developed roll-on/roll-off battery systems to allow interchanging of traction batteries. The systems usually consist of a roller bed within the forklift and an open side of the forklift that allows the battery to be extracted from the unit.

**Battery transfer carts:**

To assist with this process several companies have developed various styles of battery transfer carts. These are hand operated rolling units that extract batteries onto a mobile bed. These are then moved to the battery charge area or conversely back to the forklift for insertion.
The extraction process can be either via a physical attachment (hooks etc), vacuum coupling or electromagnetic coupling. Once the battery is attached it is drawn onto the bed via mechanical or hydraulic means.

The cart’s mobility varies from having its own wheels to being able to be mounted upon a pedestrian pallet truck or forklift.

This process requires a receptacle of some type to accept the dislocated battery coupled with the ability to be able to move the battery to an appropriate position for charging. In situations where multiple batteries are being charged, a need for greater organisation and automation was identified.
Operator controlled change facilities

Equipment that automates the process from battery removal to stacking, charging, watering and back to the forklift is now available.

These systems reduce the manual handling and corrosive substance risk to those charged with the responsibility of battery handling. With most of those available the batteries are connected to charge and watering systems automatically. Additionally the equipment can cater for large numbers of batteries, limited to a small area.
Battery washing.
As a matter of normal operation, lead acid batteries develop acid residue on and around the battery. This residue can create a current flow possibly causing battery and/or forklift damage. Additionally there are other hazards that can be created such as short-circuiting through corroded cable etc.

Simply washing batteries in the open can be hazardous to not only the environment but to personnel as well. Contaminated battery water contains heavy metals such as Lead, Copper, and Antimony. It also contains Sulphuric Acid.

Specifically designed battery wash facilities are available through various manufacturers. These facilities are often coupled with filtration systems to remove harmful substances.

Handling safety and personal protective equipment
Australian Standard AS 2359 1995 part 2 section 2.7 sets out guidelines for safe battery charging and changing. In particular certain equipment needs to be provided with any battery charge operation, eg and in brief:
- Face shields, aprons, rubber gloves.
- Adequate equipment guarding.
- Adequate fire fighting equipment.
- Facilities for quick drenching of the eyes and body within 8 metres of the work area.
- Facilities for flushing and neutralising of spilled electrolyte.
- Adequate ventilation that complies with AS 2548 Part 1 1998

This equipment is readily available through battery and battery ancillary equipment suppliers.
**Section 7. Conclusions**

As we have seen, a large number of factors can influence forklift safety. These include logistics, the design of the site and buildings, forklift equipment, task requirements, work organisation, and human factors.

Forklift safety is not the sole responsibility of the individual forklift driver. Safe systems of work, based on best practice, need to be developed. One of the purposes of this guidebook is to propose workable advice to help improve forklift and pedestrian safety.

The challenge for forklift equipment manufacturers, site managers, researchers, legislators, safety professionals and other stakeholders is to integrate a good work environment with a productive work environment.

This guidebook argues that safety should be a primary consideration, and that all stakeholders should look for the best fit between safety and productivity. This in part can be achieved by paying early attention to the design of the layout, logistics and processes.

Modifications to existing operations are more difficult, but recent work by the Monash University Accident Research Centre which undertook a forklift safety demonstration project at two operational factories in Victoria found that detailed, workable traffic and vehicle engineering interventions can be successfully developed and implemented.
One fast growing area is the development and evaluation of Intelligent Transport Systems, such as speed limiting systems, seatbelt interlocks or collision detection devices. These Systems offer the potential for improvement in traffic management, navigation aids (such as Global Positioning Systems), freight management dispatch systems, driver and pedestrian safety, rescue systems and environmental management. As such, they have the potential to improve both safety and efficiency, and it is anticipated that their use will increase in the near future.

Overall it is stressed that hazards should be tackled as far up the hierarchy as possible - that is, it is better to design safe systems of work in which forklift hazards are eliminated than to place a few warning signs that simply urge workers to work safer around known hazards.

It is hoped that the material presented in this guidebook will help with the process of developing safer workplaces for all people whose jobs involve dealing with forklifts in various ways.
Appendix: Logistics Equipment in Australia

The following compilation lists a large range of equipment classified by Australian Standard AS 2359 as Powered Industrial Trucks.

Internal combustion powered counterbalanced forklifts

The IC powered CB forklifts made up 56.4% of all forklift sales within Australia in 2002. General purpose type forklift that ranges in capacity from .5 tonne to 40 tonne or more if container trucks are included. The most popular range is around the 2.0 to 2.5 tonne capacity. The lower end of the capacity range has relatively low stability factors meaning that lift capacity reduces considerably at taller lift heights.

Certificate of competency required? Y

Battery electric powered counterbalance forklifts

The Battery powered forklifts made up 43.6% of all forklift sales within Australia in 2002. They eclipsed the IC engined sales for the first time in 2001. The counterbalance BE range made up a growing 7.8% of the 2002 sales. The strength of growth of this sector comes from the low emission levels and low noise levels. Some manufacturers are now using highly advanced AC powered units. The horsepower output can now match that of their smaller engined internal combustion counterparts. The other huge growth area has been in what is known as the Warehouse equipment market. As the battery often makes up part of the counter weighting, lateral stability can be increased by placing the battery in a low on the forklift meaning that some of the battery electric range may often have superior lift capacity at height to their internal combustion counterparts.
The Reach truck range is made up of stand up and sit down models with some variations in between such as the variable stance. The Reach Trucks made up 9.9% of all forklift sales within Australia in 2002. Advancements in technology have improved operator seating and lift height while retaining capacity. The tilting cab arrangement is available on a leading brand. The tilt is designed to reduce operator neck strain at high lift heights.

The Reach Truck range is in most part more stable than counterbalanced forklifts however is much more limited in the types of operating surface they can be used upon. Retained capacities at heights of 10 metres and beyond are quite staggering. This is achieved through the conglomeration of the mass within the stability base which allows significant reduction in counterweight weight. This, coupled with a very rigid structure, allows for very little drop in lift capacity as the mast is raised.
Walk behind stackers

The walk behind stacker type forklift is popular in small business operations and made up 9.5% of the new forklift sales market in 2002. These forklifts are however, limited in lift capacity and lift height. A certificate of competency is not required.

Pedestrian powered pallet movers.

The powered pallet truck range made up 13.1% of all forklift sales within Australia in 2002. Variations of the powered pallet truck include ride on versions, centre and end controlled.

With the development of the warehousing market in Australia the powered pallet movers have become increasingly popular.
Pallet trucks

The hand pallet market statistics are not recorded within Australia, however there is a proliferation of brands available from many nations. The simple pallet truck can be provided with a wide variety of options including various lift capacities and lift height. Some are also available with braking ability.

The hand pallet truck range is available in capacities up to 3 tonne. Some models are equipped with a braking system.

It should be noted that the physical effort required to initiate movement of a 2-3 tonne load may be sufficient to put workers at risk of injury.

Sideloaders

Sideloaders are specifically for Low volume use. They are available from several manufacturers and have their lifting mechanism facing in a lateral arrangement. This limits their loading capabilities due to an ability to travel into the load. They also have a limited amount of hydraulic reach. Additionally the lift capacity is relatively low compared to that of similar sized counterbalance type forklifts.
Piggy back equipment

The piggy back style of forklift has grown in popularity over recent years. Used mainly in situations where roadside deliveries are made, this unique forklift is able to reverse its loading capabilities by hoisting itself into position, usually on the rear of delivery trucks, using its own tynes.

Turret trucks

Turret trucks are designed for very narrow aisle use. Only 5 sales were made in 2002. Although expensive it can provide greater warehouse efficiencies through tighter racking configurations and high lift heights with good retained lifting capacity.
The stock picker or order picker made up 3.2% of sales in 2002. They are used in situations where parts are placed into bins or platforms directly from the rack. This manual handling is carried out by the operator who is positioned in the operator platform raised with the load carriage.
Rough terrain

The rough terrain is a special design which was required for definite off road situations such as forestry, due to the limitations of stability with other configuration forklifts. The design provides additional lateral stability for uneven surfaces such as forest floors etc. by the employment of wider track, long wheel base and redistribution of weight. Most of these are 4 wheel drive.

Towing tractors

The towing tractor can vary in size with tow capacities in the vicinity of 7 tonnes up into the 100,000 tonne range. Capacity is varied by trailer configuration, rolling resistance and the number of trailers in tow.

Burden carriers

Burden carriers are supplied by several manufacturers. They are used in warehousing and production locations. These sit down type buggies may be of 3 wheel or 4 wheel configuration.

Stockchasers

Stockchasers are supplied by several manufacturers. In most cases they are a stand up configuration with a load platform protruding forward. They may also be used for towing light trailers. Although statistics are not available on this equipment, they are in the market place in huge numbers.
Low level elevating work platforms. Low level elevating work platforms are a new type of elevating work platform manufactured by only one company at this stage. They have a limited lift height and are commonly used in shelf stacking.

* No certificate of competency required so long as lift height does not exceed 1.5 metres.

Container trucks / Reach Stackers. Container trucks / Reach Stackers are essentially extremely large internal combustion engine counterbalanced forklifts. They are specifically designed for the handling of shipping containers, whether empty or loaded. Some models have raised operator platforms for greater visibility and they are fitted with a container handling attachment to allow containers to be stacked upon each other. The Reach Stacker is designed with a boom lift rather than a mast climbing carriage. Due to their specific nature and limited market within Australia new sales are limited to around 50 per year.

* Forklift (LF) certificate required for mast climbing type load carriage forklifts. Crane (CN) certificate required for Reach Stackers as they are deemed as a "non-slewing mobile crane."
Articulated

The articulated forklift is not a huge seller within Australia however has specific applications. This forklift can rotate its mast assembly, which carries the front wheels, up to 90 degrees allowing significant advantages in narrow aisles or tight spaces. By necessity this unit has a larger size to capacity ratio than its conventional cousins.

Forklift lifting attachments:

There is an absolute plethora of forklift lifting attachments available in the market place. For every application, the likelihood is that an attachment supplier will have an implement that may be attached to a forklift to suit. But what of the stability implications? Is the correct information flowing to the end user? Are attachment manufacturers ensuring users are arranging revised lifting capacities from the forklift manufacturer? Some attachments can have massive influence on forklift stability and in some certain cases it is questionable whether they should be used at all. Attachments are manufactured as either dedicated (permanently mounted) or detachable on (mounted only via the original fork tynes).

Here are a few examples of what is available.
**Sideshift and fork positioners**

The sideshift and fork positioner attachments make up the bulk of all attachment sales. They may also be used in conjunction with other attachments such as a rotator. The general function is to provide a level of lateral displacement (side movement) of the tynes with sideshift and to allow individual positioning of tynes with the fork positioner.

**Twin pallet handlers**

The twin pallet handler can usually be retracted to a single pallet width and then hydraulically extended to handle 2 loads side by side.
Carton clamps

The carton clamp uses hydraulic pressure applied to both of the side platens. The amount of squeeze applied then allows the product to be lifted by this method rather than by implements supporting under the carton.

Note that there should be an interlock with all clamps to avoid unintentional unclamping.

Bale clamp

The bale clamp is designed to lift bales of cotton, wool etc. They have a high clamping force due to the weight and segmented nature of the load. Additionally the bales do not have flat sides (bulged) once again meaning that clamping pressure must be high.
Foam Clamp

The foam clamp is another clamp variation designed with appropriate arms and hydraulic pressure to lift blocks of foam.

Drum clamps

The drum clamp can be operated hydraulically or by clever systems of mechanical advantage. They can be purchased in various configurations such as multiple drum, tilting or rotating.
Jibs

Crane jibs are available in a huge variety. The load centre can be variable as can the angle of the jib arm. There is also the option of lateral swing (slewing) type jibs. The use of jibs brings a set of special circumstances and care in relation to stability, not the least being that swinging loads require the net rated capacity to be reduced to 80%.

Load spreader

The load spreader is usually a slip on attachment that provides extra width for handling of wide loads such as plaster board.

Paper roll clamp

The paper roll clamp is a specifically designed attachment for the paper industry. The attachment can have multiple sets of arms that can clamp a variety of diameter rolls at once. A key factor with the use of paper roll clamps is the prevention of damage to the roll through clamping force versus dropping of the roll due to insufficient force. Integral rotators can also be used for rotating the paper roll.
**Push Pull (Slip sheet)**

The push pull (slip sheet) is an attachment designed to do away with pallets. The goods are usually packed upon a “slip sheet”. The rear frame is hydraulically activated and pushes the load from the platens onto the floor. To remount the attachment, a special jaw grabs the slip sheet and pulls the load aboard the platens.

**Prongs**

Prongs are a very simple attachment that can be in slip or dedicated form. The prong is sufficiently long to penetrate the load it will handle. The prong inserts into cylindrical loads such as carpet, wire rolls etc.
Extendable tynes (Reach forks)  Extendable tynes have specially designed hydraulic cylinders within the main tynes to push the outer tynes forward thus allowing stacking double deep.

Bin tipper  Bin tippers are designed to allow bins or boxes to be dumped either in the forward or side rotation. The bin may be designed as integrated to the dump mechanism or the mechanism may accept separate bins. The dumping may occur through hydraulic or mechanical means.
Rotator

The rotator is a dedicated type attachment used to rotate the lifting implement. The implement can be tynes, clamps etc. Rotators can rotate at various angles including full 360 degrees in some cases.

Tarp Spreader

The tarp spreader is a highly specialised slip on attachment that protrudes to the side of the forklift. A truck cover tarpaulin is rolled into a cylindrical form and the prong is placed within. The tarpaulin is raised into place and the forklift drives along the truck length spreading the tarpaulin over the load.

Work Platform

The work platform is a slip on type attachment is designed for unavoidable necessity to raise personnel via a forklift. There are special requirements for use laid out within the Australian Standards and some states of Australia may require approval for use.
Milk Crate attachment

The milk crate attachment is a highly specialised attachment only designed to handle large quantities of milk crates. The hooks indicated are in several columns and rows that allow the forklift to pack semi trailers one row at a time.

Turn a forks

The turn a forks attachment is designed so as the tynes can rotate 90 degrees allowing them to be used as normal lifting tynes or in the vertical position as a clamping device. The attachment has a clamp mechanism built in which also doubles as fork positioner when the tynes are in the horizontal position.

Tyre Handler

The tyre handler is a specially designed for placing wheels and tyres in a desired location including removal and refitting from the piece of equipment. Tyres and wheels of larger equipment can be extremely heavy.
Bulk box handler

The Bulk Box attachment utilises clamping for support of the box coupled with tynes for lifting. Bulk boxes may not be of extremely sturdy build, especially when it comes to transporting them. The box may only be cardboard. Therefore side and underneath is supported allowing effective movement and even actions such as rotating without having to transfer the goods to another receptacle.

Brick fork clamp

The brick fork clamp is another clamping device that places high pressure one or 2 rows of the brick products. The pressure is enough to support additional rows of bricks stacked above this point.
Drop bottom box.

The drop bottom box is basically a set of tynes with a centre lifting attachment that affixes to the box or bin itself. The box or bin has a floor hinged at the rear. Normally whilst the weight of the sides pushes down, the floor sits flush with the sides, thus keeping the goods within the bin. The centre attachment is operated with a hydraulic ram that, when operated, raises the sides and in turn causing the floor to hinge down and the product flow from within.

Concrete handler clamp

The concrete handler clamp attachment is another clamp variation. The clamp arms are of high strength as extreme hydraulic pressure is used to clamp the concrete products such as pipes.
End hold down

The end hold down is used in conjunction with tynes. Where long products cannot be accessed at the side for lifting, the tynes are inserted at the end. The end hold down is the lowered into position and the hold down clamps the product. The forklift can then slide the product at a very low lift height, to a position where proper handling and load balance can be achieved.

Load stabiliser

The load stabiliser lightly clamps the load from above. It is highly useful for fragile and individual loads that are not likely to remain in place during transport via forklift.
Layer picker

The layer picker is another highly specialised attachment used for mixing layers within a pallet. The unit runs in a dedicated aisle picking a layer from one pallet and delivering to another. Allows for mixed products within one pallet. To use such an attachment, extensive modifications to the forklift are usually required including a specifically designed mast.
Tyne options

A Guide to ITA Forklift Truck Rated Capacities

<table>
<thead>
<tr>
<th>CLASS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPACITY (kgs)</td>
<td>Up to 999</td>
<td>1000 - 2500</td>
<td>2501 - 4999</td>
<td>5000 - 8000</td>
<td>8001 - 10999</td>
</tr>
<tr>
<td>LOAD CENTRE (mm)</td>
<td>400</td>
<td>500</td>
<td>500</td>
<td>600</td>
<td>600</td>
</tr>
</tbody>
</table>
Standard ITA mounting tynes.  

Standard ITA mounting tynes are manufactured strictly in accordance with the dimension set out within the relevant standard. The standardisation of mounting dimensions allows for the safe interchange of tynes and a consistent model for manufacture of all tynes and carriage mounted attachments. Dimensions vary within the 5 ITA classes shown in the chart above.

Although mounting dimensions remain constant, the blade of the tyne may vary according to required applications.

Block type tyne.  

Block handling tynes are designed to be able to fit in pockets within packs of bricks or blocks. All tynes are designed to handle a set load at a predetermined load centre. So long as this load carrying capacity is maintained the shape of the blade section may vary.

Pin (shaft) type.  

In addition to hook type carriage there are tynes to suit carriages that are designed with large pins that support the upper section of the tyne.
Tyre or barrel tynes.
Tyre or barrel tynes have specially designed elliptical cut outs within the blade to allow tyres, barrels drums etc to be clamped by the tynes. Tynes can be lightly clamped where a clamp attachment is fitted.

Timber or block tyne.
The timber or block tyne is designed so as to be able to penetrate under sheets from the ground without damage. They are usually much thinner than conventional tynes to allow this however are of increased width to maintain strength.

Tyne extensions.
Tyne extensions slip onto existing tynes so as to provide additional length. Used where longer loads are to be handled.
<table>
<thead>
<tr>
<th>Folding type tyne.</th>
<th>Folding type tynes fold up to enable forklift manoeuvrability in tight areas or where length must be restricted such as an elevator.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spark retardant tynes.</td>
<td>Spark retardant tynes are designed especially for explosive or flammable environments. Depending upon the situation, they are most often coated with a spark resistant coating or fitted with a special sleeve.</td>
</tr>
</tbody>
</table>
Acknowledgement

In preparing this Guidebook, assistance was sought from a large number of industrial truck and industrial truck equipment suppliers. They were asked to assist through supplying information and photographs and diagrams suitable for inclusion in the document.

The request also required them to grant copyright approval for the inclusion of photographs and diagrams in the Guidebook.

The willingness of all these individuals and businesses to assist is greatly appreciated.