CEMENT CONCRETE
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DESIGN GUIDELINES FOR BULK CEMENT TANKER SAFETY PLATFORMS

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CCAA's intent in producing this document is to improve safety in accessing the top of tankers. CCAA expects that should member organisations wish to adopt these guidelines they may need to establish a transition phase for implementation in view of their available resources and required capital expenditure. Members should obtain their own independent advice in respect of such matters.

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1 BACKGROUND

These guidelines have been prepared by Cement Concrete & Aggregates Australia, for use within the Australian Cement Industry, to provide guidance for organisations which operate facilities that load bulk cement into road and rail tankers.

Bulk tankers are typically loaded with cement from gravity fed silos through a loading spout or sock positioned above the vehicle. While bulk cement rail tankers are normally loaded by site personnel, bulk road tankers are usually loaded by the driver of the cement tanker prime mover.

Prior to loading, tanker-top pressure hatches must be opened and this normally requires loading personnel to climb onto the top of the tanker. Traditionally, this access has been provided by on-board ladders fitted to the sides or ends of the bulk tanker. An example of a common ladder arrangement fitted to the rear of a bulk road tanker is shown in Figure 1.

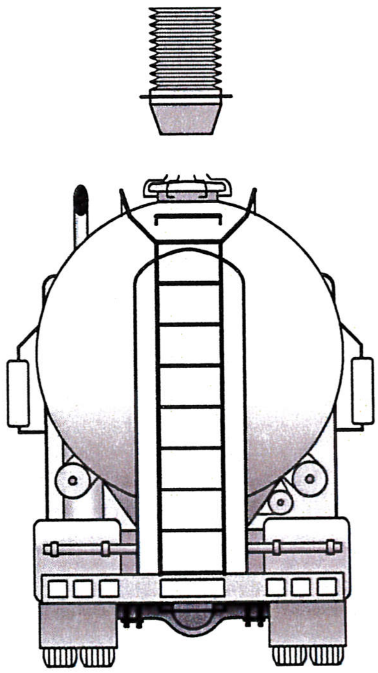


Figure 1 - A typical onboard ladder system fitted to the rear of a bulk cement road tanker

In a typical loading sequence for a road bulk tanker, the driver positions the tanker directly beneath the loading spout, exits the vehicle and climbs onto the top of the tanker to open the pressure hatch. The driver then climbs down from the tanker and operates the loading control equipment, usually filling the bulk tanker to the legal load limit. After filling has been completed, the driver climbs back up onto the tanker, closes the pressure hatch and climbs down once more. With loading completed, the driver leaves the facility and delivers the cement to the customer.

To reduce the fall risk for the driver whilst on top of the tanker, some facilities have installed safety rails on either side of the loading spout and a number of vehicles have also been fitted with fall protection equipment, such as folding guardrails or TRAM systems. While these on-board systems have the advantage that they can provide fall protection whenever or wherever there is a need to access the tanker top, many bulk tankers, which have a life expectancy of over 25 years, do not have this equipment fitted. In addition, although these systems reduce the fall risk for personnel on the top of the tanker, they are not effective whilst personnel are climbing the tanker ladder or moving between the top of the ladder and the tanker top.

Recognising these risks, a number of companies that operate bulk cement loading facilities have initiated, over the last two years, the installation of loading platforms and stairs to provide safer access for personnel loading bulk cement tankers.

In August 2005 a tragic incident occurred at a Brisbane cement terminal when a cement tanker driver slipped and fell whilst climbing the ladder to the top of his tanker, resulting in serious back injuries and the driver becoming a paraplegic.

Late in 2005, Cement Concrete & Aggregates Australia convened a working party to develop Industry-wide guidelines in an effort to control the fall risks associated with loading bulk cement tankers. These guidelines are the result of the activities of that working party.

These guidelines are based on the installation of stairs and loading platforms as the preferred method of providing safe access for the loading of bulk cement. Whilst the focus in the document is directed toward loading of bulk road tankers, the guidelines can also be used to design systems to control the risks for loading rail tankers.

2 Scope

This document sets out proposed design criteria for platform installations to be used for accessing the tops of road and rail bulk cement tankers during loading.

This document also includes tanker design guidelines to facilitate safer use of tanker loading installations.

3 Application

These guidelines are intended for application in the design of new bulk cement loading stations and in the upgrading of existing installations.

While the recommendations specified in this document are intended to be applicable to all bulk cement tanker loading stations, site-specific requirements, differing tanker configurations or other factors may mean that some modifications to the suggested designs may be necessary.

In all cases, it is the responsibility of the designer to check and confirm the information presented in this document is correct and appropriate for use in any given application. In addition, the designer must conduct a suitably detailed hazard and risk assessment for the proposed installation as an integral part of the design process.

4 Objectives

These guidelines have been developed to provide a common, industry-wide approach for safe and convenient loading of bulk tankers.

The stairs, platforms and associated guarding proposed here are intended as the primary method for safely accessing the tops of bulk cement tankers to facilitate loading, whilst also allowing convenient access for inspection, limited equipment maintenance and other activities.

Although the future adoption of remotely operated hatches will eventually reduce the need for accessing the top of tankers during the loading process, some access will still be required for inspection and occasional unplanned maintenance, such as dealing with leaking seals. Consequently, some method for safely accessing all tanker tops will be required for the foreseeable future.

While onboard fall protection systems can also be used in this application, the convenience and security associated with a properly engineered stair and platform installation fitted with secure guarding makes this the preferred method for primary tanker top access during loading. In addition, such platform and stair systems also make it more likely that site loading safety requirements are met, and duty of care obligations of site owners are fulfilled.

5 REFERENCED DOCUMENTS

AS 1657	Fixed platforms, walkways, stairways and ladders – Design, construction and installation
AS 1664	SAA Aluminium structures
AS 3661	Slip resistance of pedestrian surfaces.
AS 4100	Steel structures
AS 4024	Safeguarding of machinery
AS 4360	Risk Management

6 DEFINITIONS

barrier gate – a gate which restricts exit unless the loading platform and spout have been raised.

latching gate – a gate which prevents direct access to the safety cage unless it is safe to do so and also isolates the cage movement mechanism when latched open.

onboard fall prevention system – handrail or TRAM system fitted to a tanker top to prevent falls.

pivoting walkway – a walkway section between the fixed platform and the safety cage comprising either a ramp or stairs, which can be inclined at various angles to access tankers of different heights.

platform – a platform or walkway fixed to the loading station structure which provides access to the pivoting walkway and safety cage.

remotely operated hatch – hatch operated by compressed air or other motive power source which can be opened and closed from ground level, obviating the need to access the tanker top for loading.

safety cage – a movable frame equipped with guardrailing which can be positioned around the hatches of a bulk tanker to provide safe access while loading.

tanker – road trailer or rail wagon fitted with a pressurised tank or vessel used for transport of bulk cement.

tanker alignment system – A system or equipment used to help align the tanker hatches with the spout or sock in preparation for loading of bulk product

tanker height – height in metres measured from ground level to the highest point of the tanker body, usually the top of the highest hatch. This is not taken with reference to cabin or exhaust stack height.

TRAM (Total Restraint Access Module) – a proprietary method of fall prevention based on a harness and movable frame which slides along a dedicated rail fixed to the top of the tanker.

7 General Requirements

a) Loading Platform Location

For weather protection during the loading cycle and shortened loading time, the platform structure should preferably be integrated with the loading spout. However, where structural or other limitations do not permit this, external, or stand-alone platforms may be required for opening and/or closing the hatches. Where external platform arrangements are used, some form of roofing should be fitted to protect against moisture ingress prior to, and after loading.

b) Road Tanker Heights and Platform Clearances

Because bulk road and rail tanker configurations, especially heights, vary widely, individual loading platforms must be designed to accommodate the range of tanker heights likely to use that facility. Although initiatives are underway to standardise road tanker dimensions around the current average tanker height of ~3.9m (Appendix B), tankers ranging up to 4.3m and below 3.5m may be encountered, especially where a large number of different transport hauliers are used. In some situations, tankers up to 4.5m in height may even be encountered where there are no road height restrictions. This large range of heights makes it critical that the designer is clear on the tanker types and height envelopes which must be loaded.

Although the platform may need to accommodate tanker heights between 3.5 and 4.5 m, the majority of tankers are close to 3.9 m in height, and where possible, platform design should preferably be optimised for tankers of this size (Figure 2). Similarly, a minimum headroom of 2.1m should be available around the loading spout when the safety cage is set to accommodate tankers of maximum height.

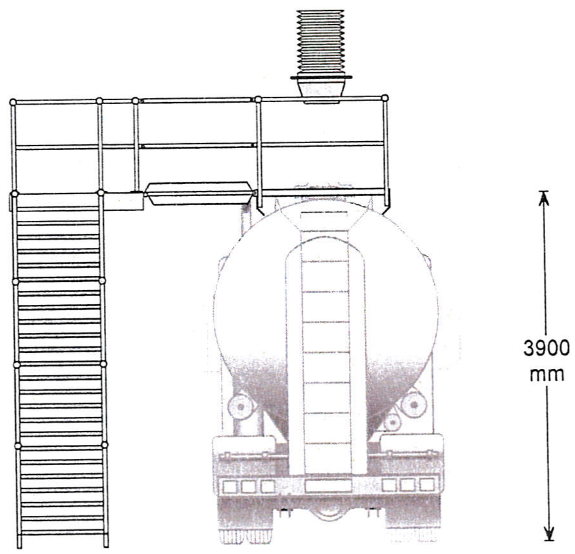


Figure 2 - Suggested platform configuration for a typical tanker

Where circumstances permit, a minimum clearance of 4.6 m from ground level to the lowest point on the integrated loading platform structure will allow use by tankers of all heights, including those which marginally exceed normal vehicle height limits. With adequate spout and headroom clearance, this setup should also permit opening and closing of most hatch covers while the tanker is in position directly under the loading spout. However, in most existing loading stations, clearance will probably be lower than this due to loading spout height restrictions and/or structural constraints.

In cases where it is not practicable to modify the installation to increase the loading height clearance, the access platform may need to be located separately from the loading spout. However, this will contribute to increased loading time as the tanker must be repositioned for opening and closing the tanker hatches.

Where height clearance is limited to below a height of 4.6m, some type of height clearance bar or warning device should be fitted before the loading entry point to warn tanker drivers of the low clearance and reduce the probability of drive-through damage to equipment.

c) Rail Tanker Heights and Platform Clearances

Due to the limited numbers and types of rail tankers dedicated to bulk cement transport, rail loading stations can usually be designed for a much more restricted range of tanker heights and loading configurations than those which must be accommodated by a typical road loading installation.

While this simplifies the design process, the principles outlined below should be applied equally to both road and rail bulk cement loading stations, recognising the differences imposed by the various tanker top layouts and loading requirements.

d) Platform Design and Configuration

The platform design and structural configuration employed at a particular site will depend upon the equipment and structural constraints and supply arrangements which apply at that location. Although no specific Australian Standard exists for this type of installation, AS 1657, AS 4100, AS 1664 and AS 4024 are considered to be most relevant.

Consequently all guardrails, handrails, stairs, ramps, landings and associated fittings and fixtures should comply with AS 1657 and for structural aspects all fabrication and construction should comply with AS 4100 and/or AS1664. Guidance in safeguarding machinery, including interlocks, may be obtained from AS 4024. Each proposed installation should also undergo a suitably detailed hazard and risk assessment conducted in accordance with AS 4360 as part of the design process.

In addition to the storage, delivery and weighing systems, a typical integrated loading platform installation will comprise the following elements:

i) tanker alignment system

ii) stairway

iii) fixed platform

iv) safety cage control gear and interlocks

v) pivoting walkway

vi) safety cage.

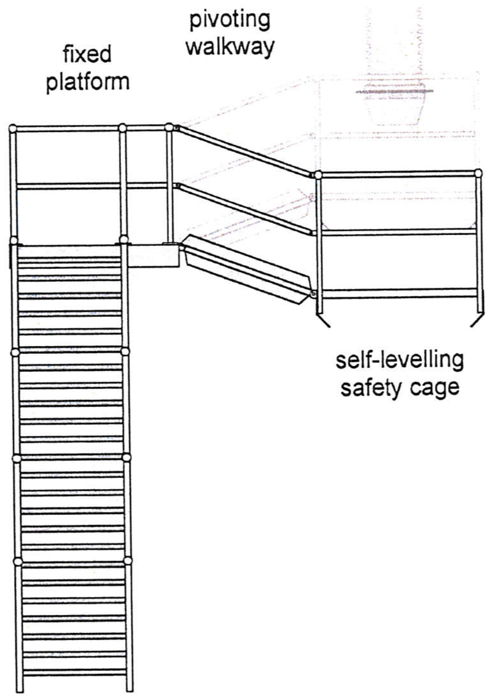


Figure 3 – Structural elements of a typical integrated loading platform installation

(i) Tanker Alignment System

A practical method for enabling rapid and precise alignment of tanker hatches with the loading spout should be implemented at every loading station. Methods for achieving this include photo-electric detectors, magnetic and/or electronic positioning systems, video cameras as well as the widespread approach based on customised paint markings applied by the tanker drivers.

The recommended solution for road tanker alignment is the application of graduated distance scale set alongside the loading station, parallel to and set out far enough from the tanker centreline for clear and convenient viewing by the tanker driver. With the spout aligned at zero and numbers placed at 10 cm intervals, increasing toward the exit, a common, but effective alignment system should be possible at all road loading sites.

Although a similar system may also be beneficial at rail loading stations, the limited numbers of personnel usually involved in the rail loading process and the likely existence of well established site methods probably do not justify changing site-specific rail tanker alignment methods.

(ii) Stairway

Stairs with landings are recommended for accessing the loading platforms and control gear. Although ladders may be necessary in some situations, stairs and landings with appropriate guarding provide the most convenient and safe method for accessing elevated platforms and should be used wherever possible.

Whether stairs or ladders are used for access, the design, materials and construction should comply with all aspects of AS1657 and the relevant structural codes.

(iii) Fixed Platform

The fixed platform or walkway provides access to the pivoting walkway and safety cage. Where the fixed platform serves more than one loading spout, it should be of an appropriate size and layout to permit safe, obstruction-free access for personnel when multiple tankers are being loaded.

(iv) Safety Cage Control Gear and Interlocks

The control gear for lowering and raising the safety cage and loading spout should be preferably be located on the fixed platform to allow clear viewing of the loading process. Positioning the control gear at ground level or on intermediate landings should be avoided where possible. Locating the controls on the fixed platform, but not within direct reach of the adjacent pivoting walkway or safety cage, will allow closest monitoring of the loading process and should minimise the risk of spills.

Where possible, the safety cage control gear should also be located in an air conditioned, dust proof cabin adjacent to, and with a clear view of the loading spout. In addition to allowing the driver some respite from any ambient dust and excessive temperatures, such a cabin could also provide a safe retreat should any spillage problems occur during loading.

The safety cage control gear should be designed with appropriate guarding and interlocks to ensure safe operating conditions are maintained. AS 4024 is particularly relevant in this context and should be considered in the design of the interlocking, control and lifting mechanisms.

Fundamental interlocks which should be incorporated in every installation include :

Tanker positioning interlock – some form of interlock and physical barrier, such as a latching gate, is required to prevent access to the safety cage unless it is correctly positioned over a tanker.

Tanker clearance interlock – the safety cage control gear should be configured to automatically position the safety cage at the correct loading height to regulate the clearance between the tanker top and the protective cage and minimise the associated fall risk. Clearance between the tanker and safety cage should not become excessive as the tanker settles during loading. The controls should also position the safety cage at the upper travel stop when loading has been completed.

Safety cage interlock – a suitable interlock is required to prevent the safety cage being inadvertently raised during the loading process.

Drive-off prevention interlock – a method for preventing the vehicle leaving the loading station before the spout, pivoting walkway and safety cage have been raised is also required. Some of the methods for limiting drive-off risk include :

- programming the loading software to print-out the delivery docket only after the loading spout, pivoting walkway or safety cage has been raised and sequencing this activity so that the driver cannot short-circuit the process.
- using a combination of gate interlocks and visual and audible signals to warn the driver when the safety cage, pivoting walkway or spout has not been raised to the parked position.
- fitting each vehicle ignition key-set with an individual access captive key system for initiating and finalising loading. This ensures a tanker cannot be moved until the loading sequence had been completed.

Examples of the application of some interlocks are presented in Appendix A.

(v) Pivoting Walkway

The pivoting walkway is a tilting section connecting the fixed platform and the safety cage. The walkway comprises either a ramp, for inclinations ≤20°, or variable pitch stairs for greater slopes. For ease of access and use, ramps should be used where-ever possible.

The pivoting walkway should be designed as a fail-safe system, whether actuated by hydraulic or pneumatic cylinders, an approved cable winch system or counterweights. Combinations of these actuation systems may also be used.

The control system, preferably based on a suitable proximity sensor system, should be capable of positioning the safety cage so that the maximum clearance between the underside of the safety cage and the nearest part of the tanker top is no more than 50 mm. When the safety cage is thus positioned, there must be no gaps larger than 150 mm between the lowest section of the safety cage and the tanker surface.

In addition, the final step height from the safety cage or walkway onto the tanker top should not exceed the maximum step height specified by AS 1657.

The pivoting walkway may be oriented either transverse, or parallel to, the main tanker axis, with the safety cage placed either as an extension of the walkway or offset to it (Figure 4).

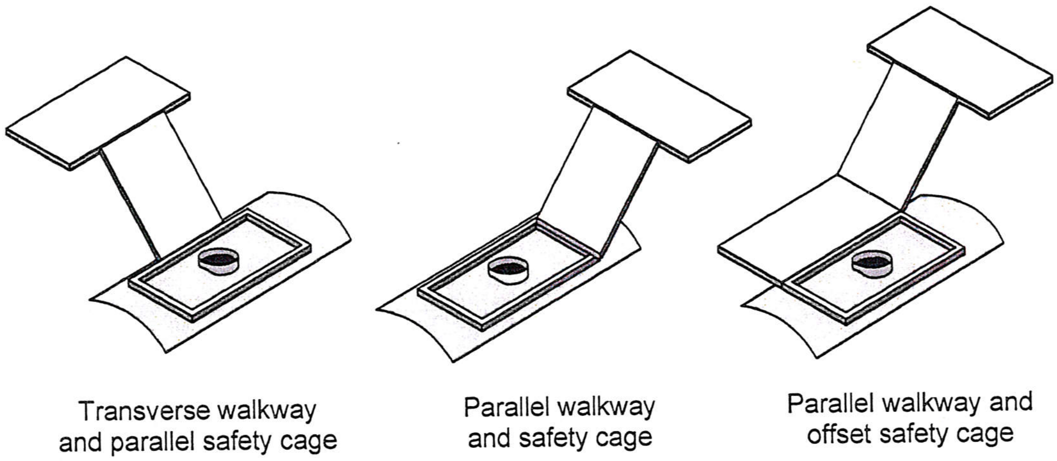


Figure 4 – Possible pivoting walkway and safety cage arrangements

Ramps

Where possible, the walkway should be designed as a ramp with maximum angles of less than 20°, in preference to variable pitch stairs. The ramp floor should consist of metal grating, cleated plate or some other suitable non-slip surface and AS 1657 provides some guidance in material selection and design.

Ramps are particularly suitable when they are positioned transverse to the main tanker axis and set up so they are approximately level when loading a tanker of average height (~3.9m). This configuration minimises ramp length while allowing a range of tankers to be loaded with a ramp of acceptable slope (Figure 5).

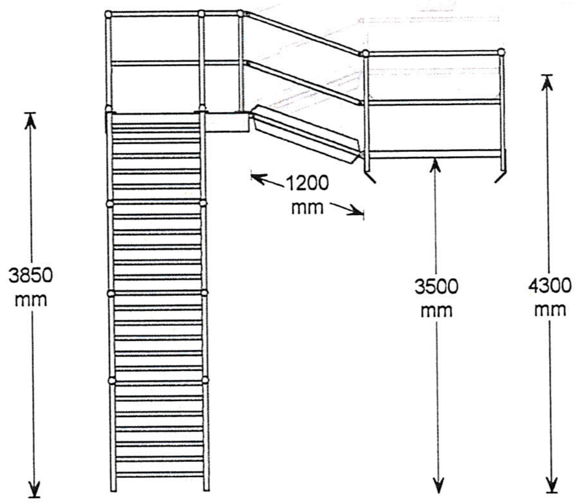


Figure 5 – A 1.2 m ramp centred at 3.9 m can accommodate tanker heights between 3.5 and 4.3m

A transverse ramp of 1200 mm length, set at a height of 3.9 m should accommodate most road tanker heights between 3.5 and 4.3m without exceeding a slope of 20°. Longer ramps, and/or higher fixed platforms may be required to load bulk tankers based on shipping containers and other non-cylindrical configurations.

Longer ramps are also needed when the walkway and safety cage are positioned directly above and parallel to the main tanker axis. With this arrangement and a ramp length of ~3.8 metres, tankers between 3.5 and up to 4.5 metres in height could be loaded with a minimum platform clearance of 4.6 metres without exceeding a 20° ramp angle (Figure 6).

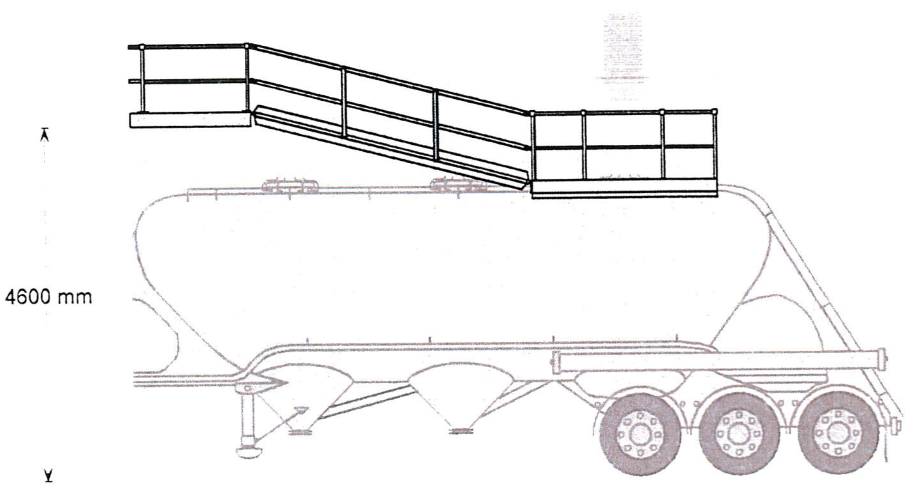


Figure 6 - A 3.8m ramp set at 4.6m will allow loading of tankers between 3.5 and 4.5m in height

Variable Pitch Stairs

Variable pitch stairs are more appropriate for walkway use when ramp access angles above 20° are required. Variable pitch stairs are an alternative when the installation space may be insufficient for a ramp, such as with a pivoting walkway positioned directly above, and parallel to the main tanker axis.

Where variable pitch stairs are used, they should preferably be designed for an operating slope between 26.5° and 45°. Stairway angles between 20 and 26.5° are not within the slope envelope recommended by AS1657 and should be avoided wherever possible.

(vi) Safety Cage

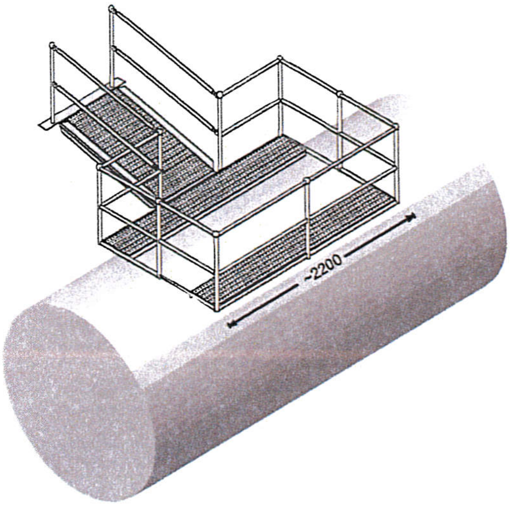
The safety cage is designed to protect the driver against falls while working on top of the tanker and for safe use with tankers of differing heights, it should be self-levelling.

The safety cage consists of a pivoting frame with guardrails and an open base to make use of the tanker top as the main working surface. It must be adequately sized to allow sufficient space to safely operate the tanker hatches and associated loading equipment. To reduce the risk of personnel slipping between the safety cage and the tanker top, the frame must be positioned as closely as possible to the tanker surface, but not so close that tanker mass is affected during loading. The correct clearance may be gauged by fitting proximity sensors to the end rails on the bottom of the safety cage frame and integrating these with the safety cage controls.

The safety cage may be designed with or without floor sections, depending on the available space and the range of tanker configurations and fixtures which must be accommodated. To ensure the cage can be correctly positioned and safely used in some instances it may also be necessary to relocate some of the ancillary tanker-top equipment, vents or fittings closer to the tanker hatches to ensure they remain accessible or visible from inside the cage perimeter. As noted previously, clear headroom above the cage and platform should also be kept above a minimum of 2.1 metres.

Keeping the length of the safety cage to around 2.2 metres should provide sufficient room for safely opening and closing longitudinal hatches without creating an excessive gap when filling bulk tankers through end hatches.

A wider cage fitted with inset floor sections will obviously provide maximum accessibility where conditions allow this option to be used (Figure 7).



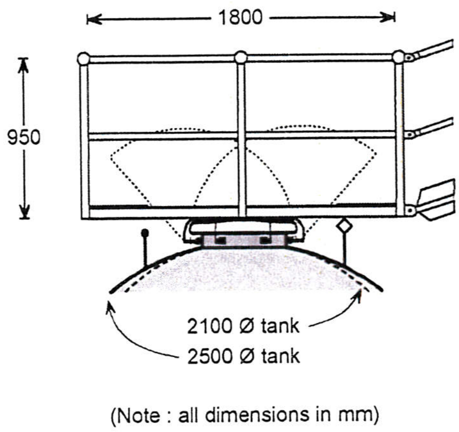
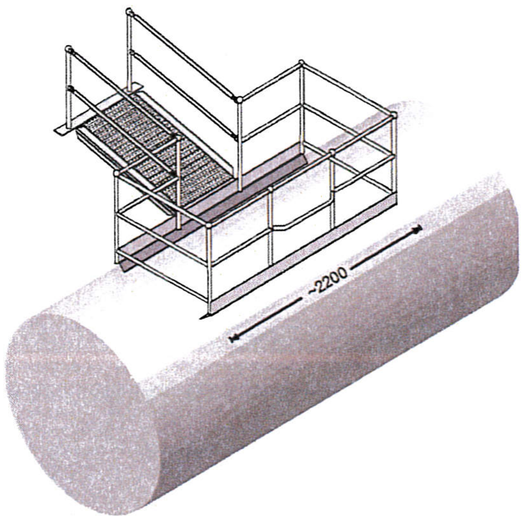


Figure 7 – Perspective and end views of a safety cage fitted with floor sections

With floor sections fitted inside the bottom frame of the safety cage and separated with sufficient clearance, this arrangement should allow loading through hatches of any orientation whilst minimising the gap between the safety cage and the tanker top. A separation distance of about 1 metre between the parallel floor sections should allow sufficient clearance for opening most hatches, but this dimension must be checked and adapted as necessary for each specific installation and the configurations of the tankers to be loaded.

The safety cage can also be fabricated without floor sections, although this makes it more difficult to ensure that the clearance between the frame and the tanker top is maintained for all tanker sizes and configurations. To accommodate the widest range of tanker dimensions and minimise reach distance, the safety cage should be kept as narrow as possible. It should also be fitted with some form of angled skirt to reduce the gap between the tanker and the safety cage frame.

To accommodate transverse opening hatches with this arrangement, the middle guardrail sections of the safety cage parallel with the tanker sides may need to be extended outwards slightly more than the uppermost guardrails. When fitted in conjunction with low-set bottom guardrails and adequately separated support posts, this arrangement should allow standard hatches of almost any orientation to be opened without interference (Figure 8).



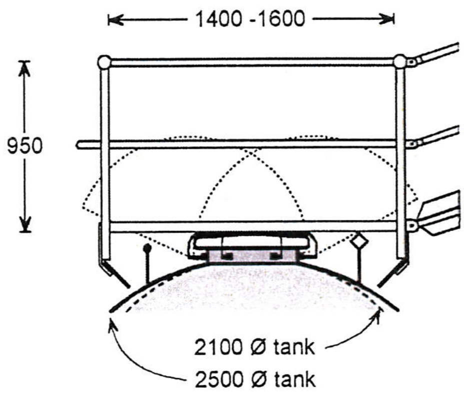


Figure 8 – Perspective and end views of a safety cage without floor sections

Irrespective of design, in some situations the safety cage may need to be fabricated as two separately actuated sections which work together to provide complete guarding around the tanker top work area. Where access is limited and it is necessary to attach part of the guardrail assembly to the platform structure, telescopic handrails may be a suitable option.

8 Appendix A – Interlock systems

Two systems for controlling access to, and movement of the safety cage, and minimising the risk of "drive-off" damage to loading installations are recommended. These are based on :

a) a dual gate system

b) a single gate and key system

Where other arrangements are used, the designer should ensure that all suggested minimum interlocks are incorporated.

e) Dual Gate System

This arrangement relies on entry through a barrier gate, which is normally closed, and a second latching gate which can only be opened when the platform is correctly positioned on the tanker.

The normal operating sequence would be:

1) After positioning the tanker under the spout the driver enters and closes the barrier gate.

2) The driver then lowers the safety cage onto the tanker, which also activates the barrier gate lock and alarm system. (Note : the barrier gate locking system should be designed so that it can be opened with reasonable force in an emergency, albeit with an alarm sounding.)

3) With the safety cage correctly positioned on the tanker, proximity switches allow the latching gate to be opened and latched, which isolates the safety cage and prevents further movement.

4) The driver passes through the latching gate and loads the tanker.

5) With the tanker loaded, the driver returns and closes the latching gate. This allows the driver to raise the safety cage.

6) With the safety cage in the fully raised position, the barrier gate can then be opened, allowing the driver to depart.

This system may also be used where multiple loading points fitted with individual latching gates are accessed through a single barrier gate. In this application each gate would be opened or closed using some type of magnetic card, I-button or similar unique identifier, which would allow only a single user to control the safety cage and loading process for any given loading point. Exit through the barrier gate would only be permitted for users who have finished the loading cycle.

f) Single Gate and Key System

This system uses a combination of a latching gate and access key fixed to the truck ignition key-ring. With this arrangement the platform can only be activated with the access key in place, and the access key cannot be removed unless the platform is in the fully raised position.

The normal operating sequence would be:

1) The driver positions the tanker under the spout, switches off the ignition and removes the set of keys.

2) The driver uses the access key to unlock the switch gear and lowers the safety cage onto the tanker.

3) With the safety cage correctly positioned on the tanker, the proximity switches allow the latching gate to be opened and latched, which isolates the safety cage and prevents further movement.

4) The driver passes through the latching gate and loads the tanker.

5) With the tanker loaded, the driver passes through and closes the latching gate. This allows the safety cage to be raised.

6) With the safety cage in the fully raised position, the access key can be removed, allowing the driver to restart the vehicle and depart.

9 Appendix B - Proposed Specification for Bulk Road and Rail Tankers

The following specifications are proposed for future bulk tanker design to facilitate safer bulk tanker loading.

g) Tanker Dimensions

Road tanker height should be between 3.8 and 3.9 metres, when measured to the top of the highest closed hatch and with the bulk tank empty. No part of the vehicle, including the prime mover should exceed 4.1 m in height.

Where cylindrical bulk tanks are used, the minimum tank diameter should be 2.1 metres.

Rail tanker height should be between 4.0 and 4.1 m, when measured to the top of the highest closed hatch and with the bulk tank empty.

h) Tanker Hatches

Tanker hatches with a opening diameter of 510 mm should be fitted along the tanker axis and arranged so that the covers open to the rear. End hatches should be positioned at least 1.2 m in from the point where the tanker top commences sloping to the front or rear.

i) Tanker-top Access Equipment

To eliminate tanker-top fall risk, on-board access equipment is not recommended.

Where on-board tanker top access equipment must be fitted, folding guardrails or a TRAM system used in conjunction with a ladder or stairs complying with AS 1657 may provide an acceptable alternative for fall prevention during occasional tanker-top access. Tankers fitted with these access systems must be designed to ensure that fall protection is maintained during the transition from the access ladder to the top of the tanker. Possible methods for achieving this include the use of a ladder cage and/or self-raising guardrails, which allow three point contact to be maintained while moving onto the guarded tanker top area. All such access equipment, including stairs, ladder, ladder cage and guardrails must comply with the respective requirements of AS 1657.

Where a folding guardrail system is installed, it should be fitted so that when the guardrails are in the retracted position, the highest point of the rails are level with the top of the adjacent hatch(es). Alternatively, where a TRAM system is used, the rail should be positioned as close to the tank surface as possible, consistent with proper operation, so that the highest point of the folded attachment arm is no higher than the top of the nearest hatch.

Tankers equipped with onboard access equipment should also be fitted with kickrails or toeboards. These should be installed parallel to and 450 mm either side of the tanker centreline, and set to the same height as the top of the nearest open hatch. As far as possible, the tanker top should be kept free of attached walkways and other fittings which could interfere with safety cage use. Similarly, any fixtures or fittings which could present a potential trip hazard should be removed, or at least be positioned where they will not impede safe tanker top access.

j) Tanker-top surface

The tanker top area bounded by the toeboard or kickrails should be coated with a non-slip surface providing a coefficient of friction factor>0.4, as stipulated in AS 3661. Where toeboards or kickrails are not fitted, the coating should extend the full length of the tanker top and out to at least 450mm either side of the tanker centreline.
