

TECHNICAL SPECIFICATION

SUBJECT : Single Lift Diesel Electric Straddle Carrier
DOCUMENT NO : TPT_TS_SL_DESC
REV NO. : 0
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1. Scope

This specification is for a single lift, engine driven, diesel electric, automatic transmission, four-high straddle carrier.

The straddle carrier shall be utilised for the handling of 20ft, 40ft and 45ft ISO containers, 20ft tank containers, cargo flats and other loads.

The straddle carrier shall be supplied complete and fully assembled in all respects, including standard equipment supplied by the manufacturer and shall comply with the South African Occupational Health and Safety Act, Act 85 of 1993/as amended or equivalent international standard for mobile lifting equipment such as ISO, DIN, etc.

2. Operational Requirements

2.1 Equipment Functionality

2.1.1 The straddle carrier shall have a lifting capacity of 40 tons under the telescopic spreader.

2.1.2 The straddle carrier shall be capable of handling containers that are empty or fully laden up to the maximum load as allowed for in the ISO standard. The tank container can have a total mass of 38,000 kg. In the case of the 20 ft ISO containers, the total mass of each container is 30,480 kg.

2.1.3 The straddle carrier shall be capable of stacking containers four high. The height of each container is 9 feet 6 inches.

2.1.4 The straddle carrier shall be capable of handling 45 foot containers with corner castings in the 40 foot position.

2.1.5 The straddle carrier shall be capable of handling cargo flats as low as 500mm (20 inches).

2.1.6 The straddle carrier shall be capable of handling other loads using wire ropes or slings.

2.1.7 The straddle carrier shall be capable of achieving the following **minimum** speeds:

- Operating speed of 25 km/hr. with a 40 ton load, both forward and reverse
- Hoisting speed of 20 m/min with a 40 ton load
- Hoisting speed of 24 m/min with an empty container
- Lowering speed of 18 m/min

2.1.8 The straddle carrier shall have the ability to perform both hoisting and lowering functions while travelling.

2.1.9 The straddle carrier shall be equipped with a tramp iron removal system.

2.1.10 The straddle carrier shall be able to operate in a wind speed of 72 km/hr.

2.2 **Constraints**

Refer to Works Information for straddle carrier workshop details regarding specific requirements or restrictions e.g. bay clearances, turning circles, etc.

2.3 **Ergonomics**

2.3.1 **Operator's Cab**

2.3.1.1 The operator's cabin shall be ergonomically designed, with large windows all round including floor and upper windows. Front and back windows shall be inwardly inclined from top to bottom.

2.3.1.2 The cabin shall be dustproof and waterproof.

2.3.1.3 The cabin shall have a double floor (for cabling) with removable galvanized checkered plates.

2.3.1.4 The walls and roof of the operator's cabin shall be fitted with suitable thermal insulation.

2.3.1.5 A locally serviceable heavy duty, split type, marine air-conditioning unit is to be provided with due consideration to the high ambient temperature, solar, operator and equipment heat loads and humidity levels. It must be capable of maintaining the temperature in the cabin at 20°C at roughly 50% relative humidity for outside temperatures of up to 40°C and 90% relative humidity.

2.3.1.6 In addition to the air-conditioning unit, the operator's cabin shall be fitted with an air exhaust fan with dust filters on the intakes. The fan and enclosures shall be corrosion resistant.

2.3.1.7 Demisting of the windows shall be provided for.

2.3.1.8 An ergonomically designed, fully adjustable, upholstered chair with armrests and adjustable height and backrest shall be provided for the operator and a tip-up seat for an assistant. Seat belts shall also be provided for both chairs.

2.3.1.9 The noise level inside the operator's cabin shall not exceed 80dB during normal operation.

2.3.1.10 A mild steel, hermetically sealed door, opening outwards onto an exterior access platform, with a window and having an industrial grade lock, hinges and handles of robust construction, shall be provided, arranged for exterior locking but allowing exit from the inside without a key.

2.3.1.11 The main access route to the cabin will be directly from a fixed access platform.

2.3.1.12 A secondary emergency escape route from the cabin must also be provided.

2.3.1.13 All the glazing of the operator's cabin is to be of anti-glare, solar heat-reducing hardened safety (shatter proof) glass of 5mm minimum thickness.

2.3.1.14 The safety grid over the floor window directly in front of the operator must hinge open. Latches shall be provided to hold the safety grid in the open position during cleaning.

2.3.1.15 Fixed safety grids shall be provided over all other floor windows.

2.3.1.16 A sufficient number of side windows shall slide open to allow the cleaning of all windows that cannot be reached from the access platform, and to allow good ventilation in case the air-conditioner fails.

2.3.1.17 Electrically operated self-parking windscreen wipers and washers shall be provided for the front, side and rear windows.

- 2.3.1.18 A microphone and amplifier of 50 watt RMS power shall be mounted on the console in front of the operator and shall be operated through a foot or push-button switch to horn type loudspeakers mounted underneath the cabin.
- 2.3.1.19 A suitable locker for operating manuals shall be provided in the cabin.
- 2.3.1.20 A suitable shelf for mounting the radio and telephone equipment shall be provided in a position that would allow the operator easily access to the radio. Two 24V DC power points with 10A fuse protection shall be provided in close proximity to the shelf.
- 2.3.2 Operator's Controls
- 2.3.2.1 The operator's cabin shall contain control equipment, integrated into the fully adjustable right armrest of the operator's chair. The design and positioning of the chair and control consoles shall be such as to ensure maximum visibility and accessibility. All the necessary controllers, selector switches, push buttons etc. for manual control shall be mounted on the consoles.
- 2.3.2.2 The steering column shall be adjustable to enable the following: tilting of the steering column, tilting of the steering wheel and telescoping of the steering column.
- 2.3.2.3 The angle of the brake and accelerator pedals shall be adjustable.
- 2.3.2.4 The man machine interface computer display shall be mounted in a convenient position. The display position and type shall be such as to prevent excessive glare and eye-strain.
- 2.3.2.5 It shall be possible to easily inspect or change equipment without removing any wiring or other equipment.
- 2.3.2.6 Robust digital joystick controllers of the stepless type are preferred for the control of the main mechanisms. The controllers shall be fitted with artificial steps and shall be fitted with definite spring checks in each working position. The effort required to operate the controllers shall be such that no fatigue shall be suffered by the operator during long spells of duty.
- 2.3.2.7 The main controllers shall be equipped with a dead man facility causing the straddle carrier motions to revert to a safe situation when the operator's grip on the controllers is released.
- 2.3.2.8 Each controller shall be fitted with an engraved plate label secured with rivets clearly indicating the motions controlled and the direction of motion corresponding to the lever positions.
- 2.3.2.9 Indicator lamp colours shall be as varied as possible, and all indicators shall be adequately marked. The use of embossed tape is not permitted. LED type indicator lamps are required.
- 2.3.2.10 The console layout shall be as similar to the Employer's existing straddle carriers as possible. All motion controllers shall be in the same position and orientation.
- 2.3.3 Operational Aids
- 2.3.3.1 The straddle carrier shall be retrofitted with a radio link based display and communication system (to enable the operator to receive and acknowledge stack management instructions), by Others. Sufficient space and facilities (shelf and power point) shall be provided in the operator's cabin for these modules to be fitted.
- 2.3.3.2 The straddle carrier shall be equipped with a driver stack selection mode that will enable the automatic handling of containers to the one, two, three or four high position.
- 2.3.3.3 The straddle carrier shall be fitted with a suitable load monitoring system.

- 2.3.4 Each straddle carrier shall be equipped for effective and safe night-time operation without the need of external terminal illumination.
- 2.3.5 The straddle carrier shall have a camera system that will be used to reduce blind spots, assist with spreader placement, enable driver identification and record all operations in a memory bank for a period of 7 days. This camera system will record the operation even if the driver has not initiated the camera operation.

2.4 Terminal Specific Requirements

- 2.4.1 The straddle carrier shall be required to negotiate speed bumps and work on uneven surfaces.
- 2.4.2 In terms of terminal specific technical requirements, the Supplier shall refer to the Works Information for the following items, included but not limited to:
- Environmental conditions including altitude, ambient temperature and relative humidity
 - Critical dimensions and clearances for access in and out of existing workshops including any specific requirements or restrictions in terms of platform heights, turning circles, etc.
 - Details of the cabin layout
 - Quantity of spreaders and spreader test panels
 - Any requirements for twin lift machines

3. Technical / Technology Requirements

3.1 Design Requirements

- 3.1.1 All structural elements shall be designed and treated for optimal corrosion protection and arranged to facilitate easy and effective corrosion maintenance.

3.2 Power Plant

- 3.2.1 The engine shall be Caterpillar or Cummins.
- 3.2.2 Engine emissions shall comply with at least European Standards stage III requirements.
- 3.2.3 The engine and generator shall be mounted on suitable structural skids and shall be housed in fully weatherproof, steel framed and pre-painted, steel clad cubicle. The cubicle shall be arranged to provide easy access and sufficient space for maintenance and service. The doors and door openings shall be designed and fitted to prevent the ingress of moisture, even under conditions of driving rain.
- 3.2.4 The engine skid shall be arranged to be removable as a complete integral unit.
- 3.2.5 Fork lift truck pockets shall be provided to transport the engine / generator skid.
- 3.2.6 The fuel tank supplied shall have sufficient capacity to provide for 36 hours of operation before refuelling. A facility shall be provided on the straddle carrier for earthing during refuelling by fuel bowser.
- 3.2.7 The exhaust shall exit at a level above the position of the operator's cab and shall be arranged to prevent the ingress of rain and water.

- 3.2.8 The following minimum engine safety devices shall be provided:
- Low lubrication oil pressure
 - High coolant water temperature
 - Excessive engine revolution
- 3.2.9 The engine instrument and control panel shall be equipped with the following as a minimum:
- Engine tachometer (measuring rpm's)
 - Odometer (measuring distance)
 - Meter measuring speed
 - Hour meter
 - Voltmeter
 - Oil pressure gauge
 - Water temperature gauge
 - Fuel level gauge (and warning light)
 - Key switch for engine off-run-start
 - Push buttons for lamp test, alarm cancel and alarm reset
 - Indication lamps for over speed, over voltage, lubrication oil low pressure, coolant high temperature, low fuel level and radiator water low level. In each case pre-alarm indication and shut-down indication must be provided.
- 3.2.10 All the above signals of the engine instrument and control panel shall be monitored and interrogated by the PLC for display to the operator and for monitoring and diagnostic purposes. This information will be recordable for a period of six months.

3.3 Hoisting

- 3.3.1 The hoist mechanism components shall be mounted on a common, rigid frame in such a way as to ensure easy and reliable adjustment of the alignment and sufficient access to all maintainable parts.
- 3.3.2 The hoist service brake shall be a spring applied, electrically or hydraulically released, self adjusting disk brakes with manual release. It shall be of an approved make and must be fitted with reliable brakes open/closed limit switches.
- 3.3.3 The main hoist drum shall be fitted with an emergency disk brake, with the disk mounted directly onto the rope drum. The emergency brake must engage in case of a hoist overspeed, emergency stop, and when the straddle carrier is powered down. The emergency brake shall be capable of safely stopping and holding the rated load from 20% overspeed.

3.4 Spreader

- 3.4.1 The straddle carrier shall be provided with a reeved-in spreader.
- 3.4.2 The spreaders supplied shall be Bromma.
- 3.4.3 The straddle carrier shall be supplied with spreaders capable of single lift container handling.
- 3.4.4 Spreader end beams shall be permanently marked with reflective yellow and black parallel bands in a chevron pattern.
- 3.4.5 Spreaders shall be equipped with fixed bolt-on side guides.
- 3.4.6 Unobtrusive, optical type indicator strips must be provided in the operator's cabin for indication of twistlocks open, twistlocks closed and spreader landed.
- 3.4.7 The spreader control system shall be designed to offer the logging of monitoring and diagnostic information.

3.5 Electrical Enclosures and Mounting Panels

- 3.5.1 The electrical, electronic control and protection equipment not located in the operator's cabin shall be housed in totally enclosed metal cubicles with lock-up hinged doors mounted in a convenient position. All doors shall be gasketed and the complete enclosure shall be dust tight and weatherproof, and fitted with air filters if required. These enclosures shall have a minimum degree of protection of IP 65 and shall be provided with anti-condensation heaters.
- 3.5.2 The enclosures shall be designed to provide free and easy access to all equipment for maintenance and calibration purposes and adequate space for internal wiring.
- 3.5.3 Panels shall be arranged for bottom entry of cables via gland plates. Unused openings in the gland plate shall be closed and sealed. Cables shall terminate on suitable terminals before being wired further in enclosure troughing. All equipment shall be front mounted, front assembled and front wired. Enclosures shall be internally fitted with a fluorescent light (or incandescent light if close to interference sensitive equipment) and a South African standard 15A 230V 3 pin switched and interlocked socket outlet, in full compliance with SANS 164-1.

3.6 Access

- 3.6.1 Suitably designed stairs, platforms, walkways and ladders shall be provided to provide safe and sufficient access all round for operation, inspection, service and maintenance, including access to the following:
- Operator's cabin
 - All sheaves
 - All lubrication points
- 3.6.2 Access shall be provided from ground level all the way to the operator's cabin and the straddle carrier deck.
- 3.6.3 Further to the requirements of Employer specification EEAM-Q-006, all handrail ends shall be finished off properly by the use of closure bends spanning from knee-rail to handrail.
- 3.6.4 No vulnerable equipment or components shall be mounted at ground level where it will be prone to collision damage.

3.7 Lighting, Heating and Power Points

- 3.7.1 Lighting shall be provided according to Employer specification EEAM-Q-12 and EEAM-Q-18.
- 3.7.2 All luminaires shall be locally available.
- 3.7.3 Anti-glare variable level lighting shall be provided in the operator's cabin.
- 3.7.4 Power points
- 3.7.4.1 Automatic earth leakage protection, rated at 30mA and complying with SANS 767-1, shall be provided on all socket outlets.
- 3.7.4.2 Additionally to the socket outlets fitted inside the main electrical panels, the following South African standard 15A 230V 3 pin switched and interlocked socket outlets, in full compliance with SANS 164-1, shall be provided:
- Two in the operator's cabin in close proximity to the radio and computer shelves
- 3.7.5 The straddle carrier shall be fitted with a shore power connection point to match the following shore box type: 63 amp, 6h, 3 phase + N + E, 400 V (Male). A cable shall be supplied with each straddle carrier for connection to the shore power supply when the straddle carrier is not

in operation. The cable shall be stored in a lockable cabinet (for safe and secure storage) with an integrated reel onto which the cable can be retracted.

- 3.7.6 An interlock shall be supplied to prevent the straddle carrier from starting while it is still connected to the shore power supply. A suitable message shall be displayed in the driver's cabin to alert the operator.

3.8 Air-conditioner

- 3.8.1 Ambient temperatures encountered may range from -5° C to +45° C dry bulb, with relative humidities varying from 15% to 100%.
- 3.8.2 The air must be distributed environmentally and not directly onto the driver, and must regulate the temperature between 18° C and 24° C (dry bulb).
- 3.8.3 The refrigerant must preferably be R134a.
- 3.8.4 The unit must have an integral heating facility.

3.9 Control System

- 3.9.1 Control, monitoring and interlocking shall be carried out by means of a Programmable Logic Controller (PLC) using hard wired safety circuits and distributed inputs/outputs (I/O) systems. The particular make of PLC shall be readily available and supported in South Africa for the full lifespan of the straddle carrier. The model utilised shall be the latest model available in the particular range.
- 3.9.2 A communication port for connecting a notebook type computer to the PLC for must be provided.
- 3.9.3 The necessary software to maintain and program the PLC system and drives shall be provided.
- 3.9.4 Control data must be displayed on the operators control screen.

3.10 Computer Systems

- 3.10.1 A management computer system with graphical display of the straddle carrier and its states, limits selected, fault indication to the operator, storage of operational and condition monitoring data, and data logging for fault finding purposes must be provided.
- 3.10.2 The system shall be based on a supervisory control and data acquisition (SCADA) type system (or equivalent) and must allow for detailed monitoring as well as fault annunciation by means of graphics and text.
- 3.10.3 The system shall run under the latest stable version of Windows.
- Sufficient data storage capacity shall be provided on the system to enable production data, condition monitoring data and fault messages to be stored for at least a 12 month period before being archived.
- 3.10.4 The following minimum functionality and screen displays must be provided in the SCADA system:-
- Main (default) screen with static and dynamic overviews of all operations, alarms, and specific status information for equipment control and monitoring
 - Various sub-system screens with further details and static and dynamic overviews, which are selected by clicking on the item

- A complete and effective fault finding system to record snapshots of chosen parameters for assisting fault tracing
- A self diagnostic function that will prioritise possible causes of faults detected
- A subsystem screen dedicated to the display, trending and interpretation of condition monitoring data.
- Real time and historic trending of motor currents, etc.
- Status, alarm and fault logging screen for listing of all alarms and faults
- Recording of emergency stops and other abnormal conditions
- Report of all disabled functions and program changes
- A report on all operational indicators, e.g. the number of containers handled, the number of 20' and 40' containers respectively, the average mass of containers, hours and total duration of use
- Hours at which the machine is operated without a load i.e. travelling without a container

3.10.5 The SCADA systems shall preferably be based on WinCC or In-Touch or alternatively on another proven software package (or equivalent). The system shall be based on coloured graphics, flashing and colour changing icons, messages, etc. and shall include an overview screen as well as various sub-system screens. Warnings/faults shall be displayed by pop-up windows requiring the operator to acknowledge the message.

3.11 Main Drive Systems

3.11.1 Simultaneous operation of the hoist and travel drives is required.

3.11.2 Smooth acceleration and deceleration must be provided on all motions.

3.11.3 All hoist and drive motors shall be rated for continuous duty (S1) with insulation class H and temperature rise class F.

3.11.4 All electrical motors mounted outside shall have a minimum rating of IP55.

3.12 Painting

3.12.1 The straddle carrier shall be painted in accordance with the Employer Specification EEAM-Q-008 (Corrosion Protection).

3.12.2 The manufacturer's standard painting procedure can be used if it is equivalent or better than that called for above.

3.12.3 The total paint dry film thickness shall not be less than 250µm.

3.12.4 The colour scheme shall be red to colour specification RAL 3020.

3.12.5 No other colours shall be accepted.

3.12.6 All joints must be thoroughly sealed with an approved sealer to prevent rusting between mating surfaces.

3.12.7 Drain holes must be provided in areas where water can accumulate.

3.12.8 The paintwork shall be covered by a five year corrosion guarantee.

3.13 Signage and Marking

- 3.13.1 Two Employer logos shall be supplied and fitted, one logo on either side. The design, colours, dimensions and position of the logos shall be as indicated by the Employer.
- 3.13.2 All necessary warning notices, i.e. emergency exits, no entry, warning signs, no unauthorized persons signs, etc. shall be provided where necessary and as accepted by the Project Manager.
- 3.13.3 A notice, stating the starting up and shutting down procedure, mounted in a glass frame, shall be provided in a prominent position in the operator's cabin.
- 3.13.4 The SWL shall be indicated in tonnes in a conspicuous position on each side and shall be readily legible from ground level. The straddle carrier number shall be indicated next to the SWL inscription.
- 3.13.5 Each lifting attachment shall bear a permanent inscription on each side, stating its SWL in tonnes.
- 3.13.6 The straddle carrier shall be prominently and permanently marked with a metal nameplate bearing the following information:
- Employer's name and straddle number
 - Manufacturer's name and serial number
 - The year of manufacture
 - Rated lifting capacity
 - Classification with state of loading and class of utilization
 - Classification of each mechanism with state of loading and class of utilization
- 3.13.7 Durable, ultraviolet resistant and weather resistant warning signs shall be provided at all locations that impose a danger.
- 3.13.8 Durable, ultraviolet resistant and weather resistant information signs shall be provided in specific locations to assist the driver/maintenance staff with the operation/maintenance.
- 3.13.9 A fuse diagram shall be displayed at the fuse box.

4. Safety and Environment

4.1 Safety Requirements

- 4.1.1 The straddle carrier shall comply with the South African Occupational Health and Safety Act, Act 85 of 1993/as amended.
- 4.1.2 Access steps and safety handrails shall be provided.
- 4.1.3 All surfaces where operating or maintenance personnel shall tread must be laid out with non-slip material.
- 4.1.4 Suitable galvanically insulated stainless steel brackets and fire extinguishers shall be provided.

4.1.5 The following minimum principle safety devices shall be included:-

Main hoist

- Interlocks to prevent hoisting or lowering unless the twist locks are in the fully locked or unlocked position
- The in hoist mechanism shall be fitted with miss-winding, slack rope and over-tension protection devices, independent of the straddle carrier's load monitoring system
- An electronic overload safety device with load indication and cut-outs. This device shall protect the hoisting mechanism from overloads and eccentric loads i.e. prevent further hoisting when the total admissible loads are exceeded, but shall not be used for drive control purposes. A key-switch to override the cut-out signal shall be provided
- A load indicator that gives an audible and visual indication to the operator when the lifted load exceeds the nominal load including the dead weight of the telescopic spreader. Separate indication lights must be used to indicate overload and eccentric load

Spreader

- Telescopic motion shall be prevented when the spreader is engaged with the container
- Preventing twist lock operation while load is suspended on hoist.

4.2 Environmental Requirements

4.2.1 The engine shall comply with 'EUROMOT III' with regard to emission standards.

5. Maintenance

5.1 Lubrication

5.1.1 All lubrication supplied shall be in full compliance with Employer specification EEAM-Q-011.

5.1.2 A grouped, centralized, manually operated lubrication system shall be provided.

5.1.3 All bearings on shafts and axles, and other bearings, exposed gears, drive chains, articulated hinge points, etc. must be included in the lubrication system.

5.2 Accessibility

5.2.1 All replaceable items including (but not limited to) critical components shall be designed for easy access, removal and replacement.

6. General

- 6.1 All components supplied and fitted shall be new.
- 6.2 All components shall be installed and fitted according to the manufacturer's recommendations.
- 6.3 The machine shall be to I.S.O. Metric Standards, and instrumentation gauges, dials, etc. shall be graduated in Systeme International (S.I.) units.
- 6.4 All hydraulic fittings shall be Denso wrapped.
- 6.5 Pulleys shall be to an established standard.
- 6.6 Bearings shall be rated for a L10 service life under the stated maximum loads and conditions encountered in a Port working environment.

7. Referenced Specifications

Standard specifications

The following, not necessarily comprehensive, list of standard specifications are relevant:

ISO 4308	Cranes and Lifting Appliances – Selection of Wire Ropes
ANSI/AWS D1.1	Structural Welding Code - Steel
BS-EN 287 Part 1	Approval testing of welders/fusion welding
BS-EN 288 Part 3	Specification and approval of welding procedures for metallic materials
BS 5135	Metal arc welding of carbon and carbon manganese steels
BS 4360/SABS 1431	Weldable structural steel
BS 3923	Methods for ultrasonic examination of welds
BS 2600	Radiographic examination of fusion welded butt joints in steel
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion
DIN 1026	Metric channels
ISO R657	Angles
SANS 094	The use of high strength friction grip bolts and nuts
SANS 135	ISO metric bolts, screws and nuts (hexagon and square) (coarse thread, free fit series)
SANS 136	ISO metric precision hexagon-head bolts and screws, and hexagon nuts (coarse thread medium fit series)
SANS 064	Preparation of steel surfaces for coating
SANS 164-1	Plug and socket outlet system
SANS 763	Hot-dip (galvanized) zinc coatings
SANS 1091	National colour standards for paint
SANS 1431	Weldable structural steels

Regardless of which specifications are actually worked to when manufacturing Plant and Materials, such Plant and Materials shall be capable of satisfactorily passing all tests laid down in the standard specifications called for.

Employer specifications

The following Employer specifications are relevant:

EEAM-Q-002	Hydraulic Plant
EEAM-Q-003	Steel wire ropes, rope drums and sheaves
EEAM-Q-004	Gearing, shafts, bearings, brakes, lubrication, vee-belts, keys and keyways
EEAM-Q-006	Structural steelwork
EEAM-Q-008	Corrosion protection
EEAM-Q-009	Quality Management
EEAM-Q-011	Maintenance cranes and hoists for use on port equipment
EEAM-Q-012	General electrical Plant
EEAM-Q-014/015	Electrical motors and generators
EEAM-Q-017	Medium voltage Plant for port equipment
EEAM-Q-018 / 021 / 030	Electrical equipment
EEAM-Q-020	Testing and commissioning of electrical Plant
EEAM-Q-029	Air-conditioning Plant

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