12
Intermodal Road and Rail Vehicles and Maritime Vessels

We have seen throughout this book, how road haulage vehicles form the backbone of most intermodal freighting operations. Almost all of the initial and final legs of intermodal journeys are undertaken by standard road haulage vehicles, comprising either articulated or road–train (i.e. drawbar) combinations fitted with platform or skeletal-frame bodywork specially equipped with quick-action twist-lock devices for securing containers and swap bodies. Besides these vehicle types, there are other variations from the standard vehicle theme. First, for piggyback operations, specially strengthened and equipped semi-trailers are necessary in order to withstand the 'lifting-under-load' stresses incurred during loading and unloading; and second, the combined road–railer semi-trailer, or bimodal system, comprising a road-going semi-trailer that converts to run on rail bogies (see Figure 12.1). A number of such systems are in use or have been trialled in the UK and Europe, most notably the American RoadRailer system.

12.1 Road vehicles

The development of combined road–rail/waterway transport operations places great emphasis on the road vehicle link between locations where goods are loaded and unloaded, and the terminal where they are transferred to and from the rail or waterway networks. However, the choice of road vehicle that may be used for this purpose is restricted by legislative requirements. In particular, such vehicles must be able to carry fully laden swap bodies and ISO containers within the constraints of the 44-tonne legal limit on maximum gross weight, bearing in mind that most will be loaded up to the maximum or very near to it. For example, most Category A swap bodies weigh around 34-tonne gross while 40-foot ISO containers generally weigh around 30 tonnes when fully laden, hence the need for a 44-tonne vehicle gross weight, the minimum that would allow fully-laden swap bodies and ISO containers to be legally and safely carried on public roads.

12.1.1 Road vehicle weights and dimensions

Maximum weights and dimensions for UK registered road vehicles are specified in the *Road Vehicles (Construction and Use) Regulations 1986* (as amended) and the *Road Vehicles (Authorised Weight) Regulations 1998*. European Union (EU) limits are specified in European Commission Directive 85/3/EEC as amended by Directive 96/53/EC. Current road vehicle maximum permitted length, width, height, and weight insofar as they are relevant to intermodal transport operations, are as follows:

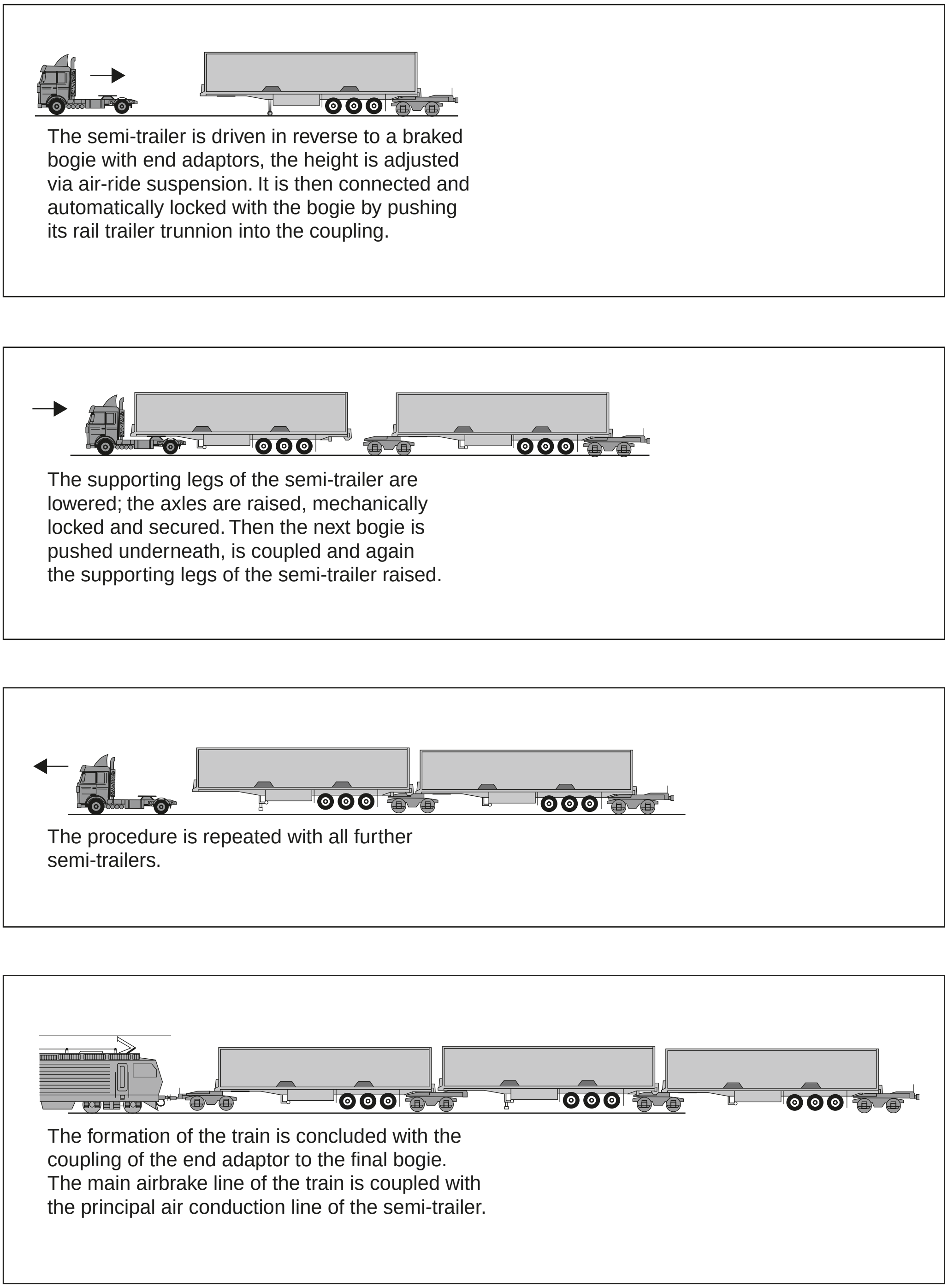


Fig. 12.1 Schematic representation of Kombirail's bimodal system showing semi-trailers being loaded to rail (*Source*: Kombirail).

12.1.1.1 Maximum overall length

- articulated vehicles — 16.5 metres,
  - maximum semi-trailer load space — 13.6 metres,
- drawbar combinations: — 18.75 metres,
  - maximum load space, drawing vehicle, and trailer — 15.65 metres (i.e. 7.825 metres each).

When determining the overall length of a vehicle or trailer, account must be taken of 'any receptacle which is of a permanent character and strong enough for repeated use'. This clearly implies that swap bodies and ISO containers are to be included in the overall length of vehicles and trailers.

12.1.1.2 Maximum overall width

- heavy vehicles 2.55 metres.

12.1.1.3 Maximum overall height

- Europe 4 metres,
- UK not restricted (but must be indicated to the driver if over 3.66 metres).

12.1.1.4 Maximum gross weights

- articulated vehicles and road–train combinations 44 tonnes.

  Note: This weight limit is subject to technical conditions regarding the minimum number of axles (i.e. six), maximum axle weights, minimum axle spacings, the fitment of 'road-friendly' suspension, and the use of a Euro-2 designated engine.

12.1.1.5 Carrying capacity

Intermodal vehicles built to the maximum permitted length and plated (i.e. approved) for 44-tonne operation can carry swap bodies and ISO containers as follows:

- Articulated vehicles
  - 1 × 7.15- or 7.45- or 7.82-metres swap body
  - 1 × 12.2- or 13.6-metres swap body
  - 2 × 20-foot ISO containers
  - 1 × 30- or 40-foot ISO container
  - 1 × 45-foot ISO container (subject to the container having tapered Euro-type corner castings)
- Road–train combinations
  - 2 × 7.15 or 7.45 or 7.82 metres swap bodies
  - 2 × 20-foot containers

12.1.2 Road vehicle specifications

For operation at 44-tonne gross weight as mentioned above, road vehicle combinations comprising articulated tractive units and semi-trailers, and drawing vehicles and drawbar trailers, must comply with statutory requirements as to their construction, the number of axles, their 'plated' weights, and their safe operation, besides the operational restrictions specified under UK law.

12.1.2.1 Construction and use of vehicles

In constructing goods vehicles and trailers, manufacturers and bodybuilders must observe requirements regarding the specification and standards of construction of components and the equipment used in the manufacture. While some of these items are covered by the European 'Type Approval' scheme, the majority of them are included in the UK's domestic Road Vehicles (Construction and Use) Regulations 1986 (Statutory Instrument 1078/1986) and subsequent amendments to these regulations which, collectively, are commonly referred to as the Construction and Use Regulations. Once a goods vehicle or trailer has been built and put into service, it is the operator as the 'user' of the vehicle who must then ensure that it complies fully with the law regarding its construction and use when on the road. It is worth pointing out that where a vehicle on the road is found to contravene the regulations, it is the operator who will be prosecuted and, if convicted, liable to meet the penalties imposed – it may even jeopardize his 'O' licence. It is no defence or excuse to say that the fault rests with the vehicle/trailer manufacturer, bodybuilder, or even the supplying dealer.

12.1.2.2 Authorized weights

In addition to the maximum vehicle weight limits set out in the Construction and Use Regulations outlined briefly above, operators may follow the statutory limits set out in the *Road Vehicles (Authorised Weight) Regulations 1998*, as amended.

Note: Both of these sets of regulations are complex and too extensive to detail here. The reader is recommended to refer directly to the legislation (available from The Stationery Office, TSO) or to the author's annual publication; *The Transport Manager's and Operator's Handbook* (available from Kogan Page Ltd, London) which explains all these in great detail.

12.1.2.3 Plated weights

The UK law demands that most goods vehicles display a manufacturer's plate showing for the vehicle and/or trailer and its individual axles the maximum weights at which it is designed to operate, and an official (Ministry) plate showing the permissible maximum gross combination/train and individual axle weights (pmw) for the vehicle which must not be exceeded on a road in Great Britain (see below for definitions).

12.1.2.4 Definitions

- Gross vehicle weight (gvw) refers to the maximum laden weight of a rigid (load-carrying) vehicle.
- Gross combination weight (gcw) refers to the maximum weight of an articulated combination comprising of a tractive unit and a semi-trailer. When the semi-trailer is uniformly loaded, at least 20 per cent of the weight of the load must be imposed on the drawing vehicle (i.e. tractive unit).
- Gross train weight (gtw) refers to the combined maximum weights of a load-carrying drawing vehicle and a drawbar trailer.

Note 1: In all cases above where the word 'weight' is used, it is common also to see the word 'mass' used instead, as in, for example, gross mass.
Note 2: In the case of articulated vehicles and road–train combinations, it is important that the respective gross weights of both drawing vehicle and trailer are compatible for the combination's maximum load-carrying potential to be legally realized.

12.1.3 Typical vehicles and specifications

A wide choice of heavy-goods vehicle and trailer makes and models, with many differing individual specifications, is available to meet the particular requirements of the intermodal/combined road–rail transport operator, even allowing for the legislative restrictions mentioned above. It is useful to consider, as a typical example, the prototype road–train combination described below. An articulated vehicle designed to operate at 44 tonnes may be expected to have a similar heavy-duty tractive unit chassis; namely, a 3 + 3 axle air suspended combination running at the maximum of 16.5 metres overall length with a 13.6-metre skeletal-framed semi-trailer to accommodate Category A (i.e. 13.6 metres long) swap bodies or 40-foot ISO containers, complete with twist-lock fittings at standard centers. It would have an engine producing 400/500 horse power, or even more, and similar transmission details.

12.1.3.1 Prototype 44-tonne road–train combination

In 1994, a prototype intermodal road–train combination was produced jointly by Foden trucks, King Trailers, RSG (demountable equipment), and Southfields bodybuilders. This vehicle (shown in Figure 12.2) was road tested by *Commercial Motor* in December 1994. It was capable of carrying two Category C swap bodies or 20-foot ISO containers. All-up cost of the rig at that time (1994) was in the region of £105 000. The combination comprised Foden's 4000 series 26-tonne, three-axle (6 × 4) rigid chassis equipped for intermodal drawbar operations with a design gross train weight of 45 tonnes (44-tonne pmw on UK roads). It had a Cummins L10 CELECT (with electronically-controlled engine management system), six-cylinder, direct-injection, charge-cooled 10-litre diesel engine producing 350 horse power at 1900 revolution per minute. Drive was via an Eaton 12-speed, twin-splitter, constant-mesh gearbox through Eaton tandem-drive with spiral bevel differential and lockable inter- and cross axle differentials. The rear axles had air suspension and the vehicle was equipped with RSG ISO truck and Airswop equipment to facilitate swap body mounting and demounting. A VBG air-actuated coupling was fitted to provide

Fig. 12.2 Prototype intermodal road–train combination (*Source*: Ray Smith Group plc).

close-coupled operation within maximum legal length limitations. The vehicle was used in conjunction with a King Trailers, air-suspended, turntable-steered, three-axle (i.e. tri-axle) drawbar trailer operating at 24-tonne gross weight. Like the drawing vehicle described above, this had RSG ISO-standard equipment (bolster-mounted twist-locks set at standard centres) and an air-operated demount system for raising and lowering the body. Southfields-built 7.45 metres Category C swap bodies with curtain sides were carried on both drawing vehicle and trailer. Many vehicles, broadly similar in specification to the prototype described here, are in common use these days in intermodal operations.

12.1.3.2 Rolling sub-frame semi-trailers

An interesting development in intermodal semi-trailers is the rolling sub-frame model designed and built by UK manufacturer Maxilode. These skeletal semi-trailers, designed for 44-tonne operation, are equipped to carry either one 40- or two 20-foot ISO containers. The electro-hydraulically operated rolling sub-frame allows for correct weight distribution over the axles when single but heavier (up to 30 tonnes) 20-foot containers are carried, and to allow containers to be moved to the rear of the chassis for end loading/unloading when reversed up to a loading bay. Other trailer manufacturers produce units similar in concept to the one described here. For example, Dennison Trailers produce what they call a ‘sliding skeletal’ unit which they describe as being a 14-lock patented lightweight design weighing, unladen, just 4740 kilograms. This trailer can carry containers up to the 45-foot maximum length, but when loaded with 20- and 30-foot containers, these can be moved to the rear of the chassis for rear discharge of the container.

12.1.3.3 Piggyback (Huckepack) semi-trailers

Semi-trailers intended for use in piggyback, or to use the continental term, huckepack, operations, while conforming largely to normal road-going specifications and legislative dimensions, are special in being designed and built to withstand the stresses of being lifted in a laden state by heavy-duty forklift truck or by overhead crane with grapple arms from road onto rail and vice versa. For this purpose they have strengthened chassis and sub-frames, and are fitted with reinforced lifting pockets in the underside to accept the forklift tines or the crane’s grapple arms. Typical of such semi-trailers was the Railmaster model built by UK manufacturer M&G Tankers and Trailers for the TIP trailer rental company. The specification of this model followed that of the company’s standard 13.6-metre tri-axle models. It had electronic air suspension and was fitted with a curtain-sided body, running within the European 4-metre height limit, and providing capacity to load 34 Euro-pallets within a 25-tonne payload. Overall weight of the semi-trailer was about 7000 kilograms, which is said to be some 500 kilograms above that of a standard road semi-trailer. The unit was fitted with hinged under-run rear bumper and equipped with lashing points.

12.2 Bimodal semi-trailer systems

Two brand-named road–railer semi-trailer or bimodal systems are currently in use in Europe as mentioned previously: namely, the RoadRailer and Kombirail systems which use a dual-purpose reinforced semi-trailer complying with road-going legislation, and capable of mounting onto special rail bogies for the rail haul. Transfer is simply effected, the whole road-going outfit being backed up to a rail bogie (with a specially-fitted kingpin mounted on the underside rear of the semi-trailer locating in a locking arrangement on the rail bogie), the semi-trailer landing legs are lowered and its road wheels raised by air pressure from the tractive unit. An intermediate bogie is backed under the front of the semi-trailer (raising it to running height) locating and locking on the front trailer kingpin. An articulated coupling that prevents stress being passed down the line from trailer to trailer links each trailer unit. Additional rail bogies and semi-trailers are added to form a complete train. Safety locks built into the system prevent any risk of the train moving if semi-trailers are not properly secured on the rail bogies and the whole system is connected to the train's air brakes.

Such bimodal systems have the advantages of simplicity, by employing only a single load-carrying module (i.e. the special semi-trailer, which can be a box van, curtain-sider, reefer, tanker, tipper, or flat-platform model) compatible with both road and rail operations, by eliminating the need for high-cost transfer/lifting equipment in terminals, and by allowing rapid, horizontal, transfer from road to rail and vice versa. They are also claimed to have greater payload within fixed train weights (for example, a 980-tonne payload within a train grossing 1500 tonnes) compared with swap-body and piggyback trains, and a greater number of units (49) within an overall train length of 700 metres compared with other systems, in both cases resulting from the close coupling arrangement. Potential payloads with these trailers would be in the region of 27 tonnes within the 44-tonne maximum gross weight limit for road vehicles.

The RoadRailer system developed by Wabash National in the USA has been operating in Europe for some years, as well as in many other countries worldwide, and claims to have covered many thousands of kilometres in European trials operating from rail terminals as far apart as Glasgow and Budapest, Stockholm, and Verona. The RoadRailer system has achieved approval for 120 kilometres per hour running on the UK rail system and full UIR approval for high-speed freight running on European railways. It also achieved (in 1996) the notoriously difficult-to-obtain approval for Channel Tunnel operation. UK operator, the Transport Development Group (TDG) has operated a regular Glasgow, London service using this type of equipment.

12.2.1 The Kombirail system

Kombirail's bimodal system is a joint venture between the German companies Ackermann-Fruehauf and Talbot together with French companies Fruehauf France and Remafer who design and build the special Kombitrailers and the rail bogies. This system, which is virtually identical in the principles of its operation to the RoadRailer described above, is now in widespread use in Europe, having been extensively tested in the most extreme of operating conditions and met the approval of European railway companies. Major Kombirail user, Hupac SA, the Swiss road–rail (piggyback) operator, claims that this system effectively utilizes some 68 per cent of train load capacity against only 51 per cent for container and swap body traffic, 50 per cent for semi-trailers carried piggyback and 45 per cent for rolling motorway (complete vehicle) systems.

The Kombirail trailer (i.e. Kombitrailer) requires no complicated infrastructure to change its transport mode. The economic efficiency of any bimodal system depends on the time and costs involved in making the transfer from road to rail. In contrast to conventional intermodal transport systems, the Kombirail road–rail interface does not require huge investments in infrastructure (such as expensive siding and crane systems or special approaches to the road network) that can only be used for one specific purpose. All the Kombirail system needs are modifications to the mainly existing infrastructures. The special bimodal trailers used in the system, appear very similar to normal road-going semi-trailers. They comply fully with all national and EU legislative requirements and satisfy user requirements for road vehicles providing some 26/27 tonnes of payload capacity (i.e. 33 Euro-pallets), depending on body type, within the European 44-tonne gross weight limit for intermodal vehicles. On the road, the Kombitrailer travels on its conventional road running gear with air suspension. The air suspension system is also responsible for adjusting the height of the trailer when it is shunted onto the rail running gear. On rail, the road running gear is pneumatically raised, automatically locked in place for travel and it is automatically monitored for safety.

To keep the unladen weight on the road and the resulting costs for the vehicle owner to an absolute minimum, all components required for rail travel and for safety purposes are accommodated in the rail running gear, with the exception of the main pneumatic pipe which links the air-braking system from the train via the trailers to the rail bogies. The floor assembly of self-supporting Kombitrailers is reinforced to withstand the forces generated in railway operation, consequently, the trailer is also more robust on the road, its weight being approximately 900 kilogrames greater than that of conventional road haulage trailers. On rail too, the deadweight is far lower than with other forms of intermodal traffic, as the trailer forms the actual rail wagon. All conventional trailer body types may be used in the Kombirail system; for example, Kombitrailers can be supplied as flatbeds, tankers, silos, skeletal chassis, or box trailers.

Rail running gear turns the trailer into a rail wagon. An adapter forms the connection between bogie and trailer, and at the same time acts as a coupling between the trailers. The rear of one trailer and the front of the next one are supported by a middle adapter on a joint bogie, the adapter conducting the bearing forces into the bogie while the tractive forces are transmitted through the adapter and the trailer chassis. The actual coupling is a component (i.e. a 'fifth-wheel' coupling) that has been used successfully in millions of road vehicles and reinforced in this type of operation for rail operations. The adapter consists of two couplings in a laterally reversed arrangement, one to take the rail kingpin under the front part of one trailer, and the other for the kingpin under the rear of the trailer in front of it. Once the kingpin reaches its final position in the coupling, a closure hook automatically closes around the kingpin. The rear of the trailer is rigidly coupled to the adapter. The rail kingpin in the coupling and the two horizontal pins form a continuous positive joint, with the taper adapters arranged accordingly under the rear of the trailer. At the front end, the trailer is supported on the coupling plate and is held positively in its transverse and longitudinal position by the intermediate adapter. An end adapter with standard push–pull device is fitted at the front and the tail end of the Kombirail train to provide a fully compatible interface to conventional railway vehicles. The adapter coupling also allows distances between trailers to be kept to less than 400 millimetres with considerable advantages, such as shorter trains, less air resistance, and reduced noise emission, as well as providing the added security that trailer doors cannot be opened once connected into a train.

Changing equipment from road to rail and vice versa is a simple operation carried out without the use of any additional equipment and taking a minimum amount of time. According to Kombirail, when changing vehicles, the truck driver:

> Simply does what he has done a thousand times before: he manoeuvres with the truck. Anyone who can drive an articulated truck can also manoeuvre the Kombirail trailer onto the track. The driver folds up the under-ride guard (rear under-run bumper) and bolts it in position. On a level track, he simply reverses the trailer onto a braked rail running gear. The next rail running gear is shunted into position and automatically coupled on. The driver can now retract the support feet and connect the main pneumatic pipe. It takes about 3 minutes to shunt each unit on or off the track, a procedure every driver can handle. Depending on the length of the track, several groups of Kombirail trailers can be formed at once and coupled together to form a train.

12.3 Rail wagons

Combined road–rail operations are as heavily dependent on the availability of purpose-built rail wagons as on the specialist road vehicles discussed above. In this part of the chapter we look at some of the various forms of rail wagon in use for swap-body, container and piggyback trailer loading, and for rolling motorway operations. Broadly, in the context of this book, rail wagons may be categorized into three distinctive types.

- Mainly flat, skeletal-framed wagons equipped with twist-lock securing devices for swap body and container traffic.
- Special low-height wagons for piggyback (huckepack) carriage of unaccompanied semi-trailers with recessed pockets to accommodate the trailer road-wheels, or spine wagons.
- Purpose-built drive-on/drive-off wagons for rolling motorway (complete, driver-accompanied, road vehicle) traffic – as, for example, Eurotunnel's freight shuttle wagons used on Channel Tunnel services for carrying heavy goods vehicles.

12.3.1 Container and swap-body wagons

Typical of this type of wagon is the French, Multifret-design, low-platform intermodal rail rolling stock, built by Arbel Fauvet Rail (AFR) in Douai, Northern France, a large number of which are in service with English, Welsh and Scottish Railway (EWS), and numerous others of similar design have been supplied to SNCF (French railways) and Intercontainer (the European railway marketing organization). These wagons, designed basically for carrying ISO containers and swap bodies, operate in sets of two with a maximum load capacity of 38 tonnes for each wagon and 38 wagons to a train. They are UIC (Union Internationale des Chemins de Fer) approved and are fully compatible with both British and continental railway loading gauges and capable of running at speeds up to 140 kilometres per hour (90 miles per hour, mph). The wagons have 15.64-metre load platforms to accommodate either a single 13.6-metre swap body or two 7.15-metre units, or a single 40/45- or two 20-foot ISO containers. With a deck height of only 945 millimetres, containers up to 9 feet 6 inches and swap bodies up to 2.77-metre high can be carried within the existing loading gauge on Network Rail's upgraded principal routes to the Channel Tunnel.

German rail wagon manufacturer Graaff has a two-axle flat rail car primarily intended for loading containers and swap bodies. This design has a shock-protected loading platform equipped with 16-foldable locking pins to carry loading units in different combinations. The wagons can accommodate either one 30 foot or one 40/45-foot ISO container or two 20-foot units, and has a load capacity of 32 tonnes. These wagons are approved for operation at up to 120 kilometres per hour.

12.3.2 Spine wagons for piggyback

Prototypes of a 'revolutionary' new rail wagon for piggyback road–rail transport were first trialled in the UK in the late 1990s. Designed by American company Thrall Car Manufacturing Company and operated in the UK through subsidiary Thrall Europa of Glasgow, the EuroSpine is an articulated, four-segment wagon (see Figure 12.3) that can carry road-going semi-trailers (and, if required, containers) within the width and height restrictions imposed by the UK loading gauge. Designed to run as an integral unit to

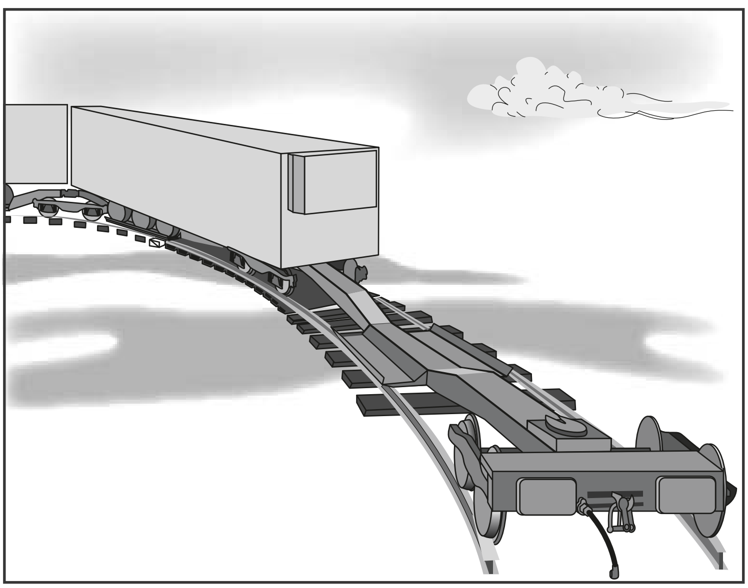


Fig. 12.3 Schematic illustration of the Thrall Eurospine wagon concept (*Source*: Thrall Car Manufacturing Co).

maximize the number of trailers that can be carried per train, this wagon carries four typical 4-metre high, 13.6-metre long intermodal trailers. The EuroSpine's box beam design and minimalized bodywork is claimed to provide considerable weight savings over full-body types, including pocket wagons, and the lowest cost per trailer or container of any wagon designed for such loads. Similar models, operating as five segment or stand-alone wagons, have become the standard method of trailer transport in North America.

EuroSpine characteristics include:

- Four distinct segments weighing 14.5 tonnes each joined in an articulated manner through a proprietary connector that eliminates the need for specialized bogies. Each segment can carry a fully loaded semi-trailer weighing up to 36 tonnes, including those with nose-mounted refrigeration units. Alternatively, 40- or 45-foot ISO containers can be loaded on all segments.
- Total wagon length over the buffers of 59.6 metres with a total unladen weight of 54.8 tonnes, and a minimum curve radius (uncoupled) of 60 metres.
- Depressed wheel support platforms, cantilevered out from the main spine, allow the trailer wheels to travel at just 330 millimetres above the rail. The wagon occupies just slightly more space than a trailer alone while meeting most applicable UIC/W6 gauge clearance requirements.
- Wagon structure stiffness keeps the wheel support platforms from moving out of the clearance envelope, even under extreme conditions.
- Five two-axle bogies; one under each far end and one under each of the three articulated connections. These have a maximum capacity per axle of 22.5 tonnes.
- Disc braking with tread-assist on all bogies, which allows wagon to run at 120 kilometres per hour in high-speed slots.
- Wheels of 920 millimetres diametre, standard in all positions.
- Fewer buffers and coupling points to improve train longitudinal forces and acceleration. The longitudinally rigid articulated connectors reduce a train's tendency to bunch and stretch over uneven terrain and improve ride quality.

12.3.3 Tiphook-type piggyback wagon

Claiming to make terminal turnaround faster for savings in time, money, and manpower, the piggyback system of rail wagon rental company Tiphook Rail enables semi-trailers complying with European weights and dimensions legislation to be driven on to a specially built rail wagon via a swinging centre load-platform (see diagram in Figure 12.4). To carry out the simple (10 minutes) loading/unloading procedure, the wagon-mounted platform is swung out to the loading/unloading position, powered by an auxiliary power pack or by the tractive unit's power system, and the semi-trailer is reversed on to the platform via independent loading ramps. When the semi-trailer is in position, the tractive unit is unhitched and the platform is swung back to its closed (travelling) position. The semi-trailer is secured by its fifth-wheel king-pin locating in a locking plate on the forward superstructure of the wagon. Since no specialized handling equipment is necessary, this operation can take place anywhere adjacent to a rail siding with hard standing. Besides the loading/unloading system described for this wagon, there are other operating possibilities including loading of semi-trailers by means of traditional overhead lifting equipment at existing terminals, or more versatility can be added by incorporating locking points for containers and swap bodies on the wagon platform. These piggyback wagons can form part of a mixed freight train, or a sufficient number of wagons can form a dedicated trainload.

12.3.4 The Modalohr system

French company MODALOHR has developed a combined rail–road, rolling motorway-type, transport concept, which, it claims, meets both road hauliers' and rail operators' current needs by providing simple

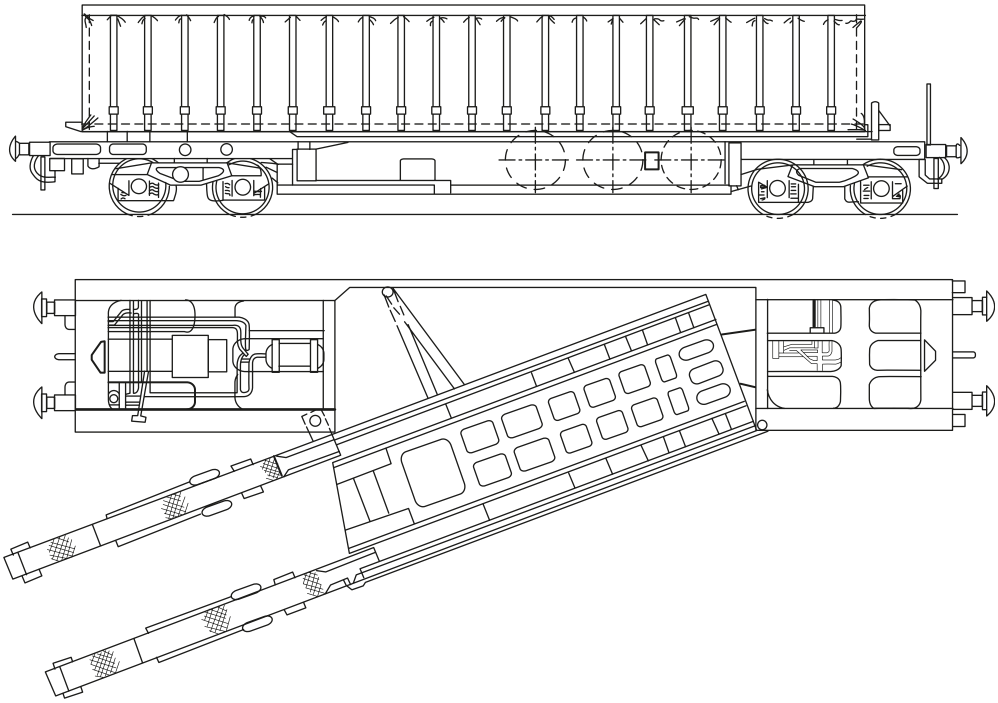


Fig. 12.4 Detail of Tiphook Rail's piggyback loading system showing side view with a 40-feet container/semi-trailer in position and a plan view with hydraulic ramp in loading position.

technical solutions which are compatible with existing railway infrastructures and impose no restrictions for users. The concept is based on the company's design of a low-frame, articulated, rail wagon that can transport standard road semi-trailers. The advantages for the carrier, apart from the possibility of using his own standard road equipment, are that:

- trucks are loaded horizontally directly with the road tractor, without the need for handling equipment,
- the lateral loading of trucks in a 'herringbone' pattern allows simultaneous and fast trans-shipment taking less than 30 minutes in all for the entire train,
- a very low floor means that trucks up to 4-metre high can be loaded within existing UIC and GB1 railway gauges,
- the system is reliable and trucks are strongly secured on the wagons.

The advantages for the rail operator are that:

- the wagons have standard bogies and wheels that can be used in the same way as a conventional wagon and with identical maintenance costs,
- the system of articulation and opening the wagons to allow vehicle access is simple and entirely mechanical, providing reliability, and independent loading and unloading of one or more vehicles at each intermediate stop,
- higher average speeds can be achieved with MODALOHR shuttles travelling at 120, or even 140 kilometres per hour,
- only simple trans-shipment terminals are needed, consisting merely of an asphalt surface on either side of the tracks (i.e. no platforms are necessary).

More details of the Modalohr system can be found on the company's web site, in French, but with moving diagrammatic images showing how the system works, at: www.modalohr.com.

12.3.5 Eurotunnel shuttle wagons

The special open lattice-sided rail wagons used on Eurotunnel's freight shuttle service are specially designed and built by Breda Fiat, Italy, to accommodate lorries up to 44-tonne laden weight, 18.5 metres in length, 2.6 metres width, and 4 metres height.

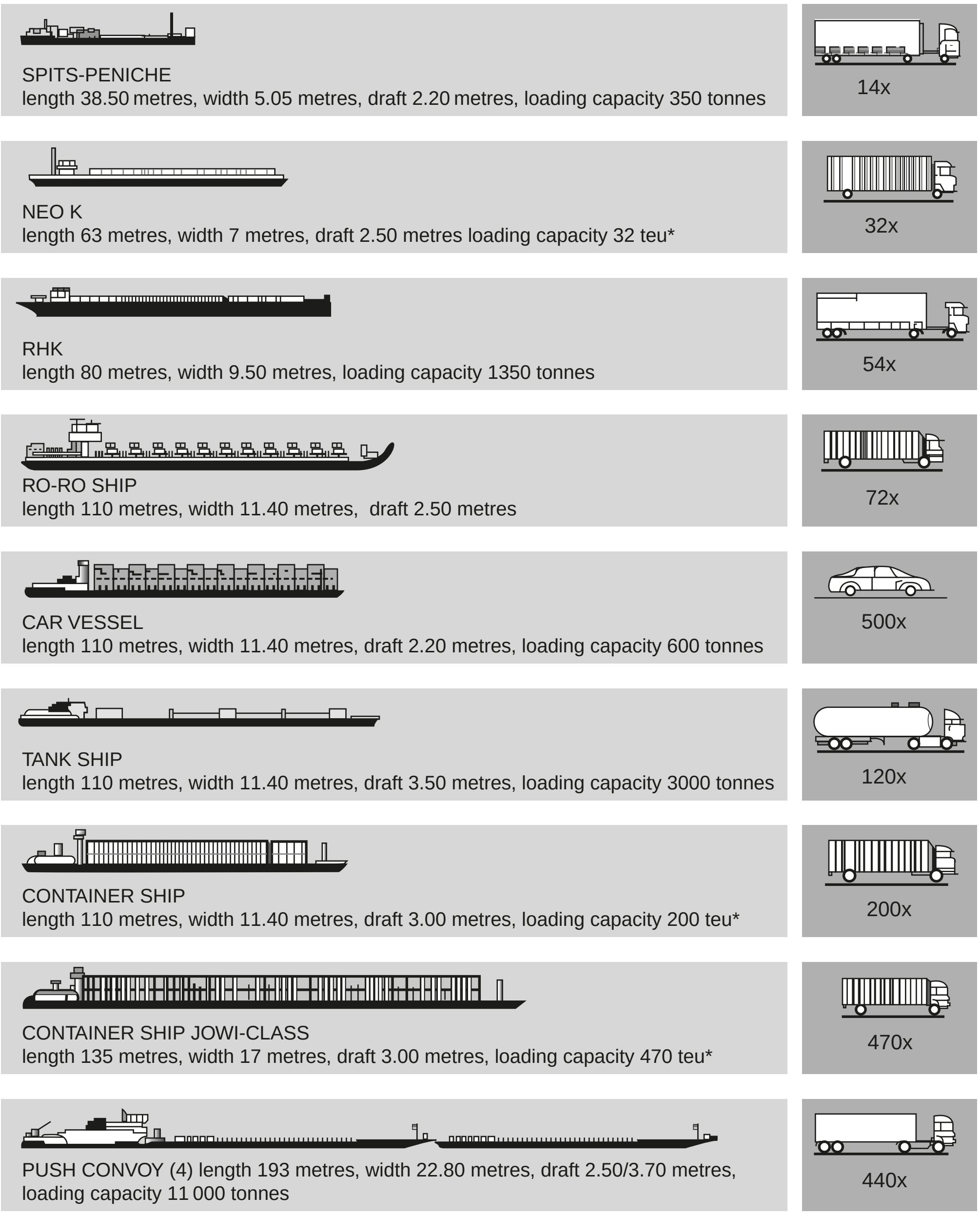
12.4 Maritime vessels

Consigning freight by waterway transport has numerous advantages, not least the fact that it is a very 'green' mode, being particularly quiet in operation, not subject to congestion, an economical user of fossil fuels and relatively pollution free. It also has the bonus of using a largely natural resource in the form of navigable rivers and coastal waters, and the ability, depending on the type of craft used, to carry the equivalent of many lorry loads in a single journey. Most inland waterway craft are defined as 'barges' which are described as large, flat-bottomed, open-deck type vessels normally towed or pushed by a tug, albeit some types have their own motive power. Their size, for inland waterway use is usually governed by two key factors: the size of locks along the route and the wake made by the vessel. As an example of the type of craft used, the smallest vessel is generally a Class 1 'Spitz' type with a load capacity of some 350 tonnes, which equates to 14 , 25-tonne lorry loads. At the other extreme a push convoy of four barges, as typically seen on the River Rhine, for example, would remove up to 440 maximum capacity vehicles from the road network, while a Jowi-class container ship can carry up to 470 teu containers on navigable river, canal or coastal waters. A full list of the waterway vessel classifications and an illustration of the various vessel types and their road-vehicle equivalent capacities are shown in Figure 12.5.

12.4.1 The LASH system

LASH is an acronym for Lighter Aboard Ship. This type of vessel is operated by an American ship operator, Waterman Steamship Company, on its trans-Atlantic services between east coast US ports, such as Baton Rouge, Birmingham, Catoosa, Cincinnati, Little Rock, Louisville, Memphis, Pittsburgh and both Rotterdam on mainland Europe and Immingham in the UK. It is designed to carry up to 82 LASH barges, all of a standard size and with a cargo capacity of 385 tonnes each (giving a total ship payload of some 31 500 tonnes). The barges are towed within ports and on inland waterways by tug (see Figure 8.2 and 8.3 in Chapter 8) to various points where they are loaded and then returned to the ocean-going vessel (i.e. the mother ship) where they are hoisted aboard by a special shipboard gantry crane ready for trans-ocean shipment. LASH ships do not need special docks or terminals and the cargo rarely requires trans-shipment, invariably moving from origin to destination on a single bill of lading. A wide variety of commodities and manufactured goods may be handled by LASH including pipes, vehicles, pallets, bagged cargo, forest products (i.e. timber), and bulk loads. They can also accommodate abnormal loads and heavy cargo such as machinery and construction equipment, which can often be stowed in one piece, eliminating costly disassembly, boxing, and reassembly. Once loaded, LASH barges are water tight with secured hatch covers for each barge and as the barges are legally defined as 'vessels' this means that once cargo is loaded an onboard bill of lading may be issued.

Cargo can be loaded into LASH barges at inland waterway points, ocean ports, and at shallow draft terminals. In the USA, for example, inland waterway points include the Alabama, Arkansas, Mississippi, and Ohio River estuaries from which barges are towed to the port to await the arrival of the LASH mother vessel which does not require special docks or terminals and is often worked at anchor in rivers, roadsteads, and light traffic port areas. This is another advantage of the system; namely, the ability of LASH ships to load and discharge cargo from anchorage so shipments are never delayed by a lack of dock facilities or



*1 teu = 20-foot equivalent unit
Source: INE

Fig. 12.5 European inland waterway vessels shown in profile and with payload comparison against road vehicles (*Source*: European Commission, Energy and Transport DG, Brussels, *Inland Waterway Transport*, 2003).

port congestion. In fact, it is claimed that LASH ships spend far less time in port compared to other vessels. On arrival in port, the LASH mother vessel's 500-tonne capacity gantry crane moves the LASH barges from their positions on board the ship, over the stem sponsons and into the water to be towed to their destinations. In succession, the same onboard gantry crane lifts the outbound loaded LASH barges from the water and places them in the holds, and on the deck of the mother vessel.

12.4.2 The 'Water Truck' concept

A new-concept vessel for inland waterway use has been developed for the Shipbuilders and Shiprepairers Association (SSA) by Armstrong Technology. The idea for the new vessel, designated the 'Water Truck' was first announced in 2004. The design is for small and flexible vessels for transporting freight on inland waterways in an economical and environmentally friendly way. It offers flexibility for carrying unitized or bulk cargoes, a self-loading and unloading arrangement, and has been developed with consideration to the intermodal transportation of goods. The basic hulls can be fitted out in various ways and can carry alternative cargo containment units. One variation is suitable for small inland waterways and is aimed specifically at economical and environmentally friendly freight movement in the UK; for example, along the Thames between the estuary and Windsor. Key features of the vessel include:

- sized for small inland waterways,
- shallow draught,
- low profile,
- intermodal freight transport capability,
- maximum hold capacity for unitized cargoes, bulk or combinations,
- low-environmental impact,
- high manoeuvrability,
- high reliability and safety through dual system design,
- propulsion and manoeuvring control from either end,
- optional and alternative self-loading and unloading arrangements,
- suitable for series build and operation.

12.4.2.1 Principal dimensions of the 'Water Truck'

- Length, overall 50.0 metres
- Breadth, extreme 6.0 metres
- Depth, amidships 3.0 metres
- Draught, operating 2.0 metres
- Air draught, operating 5.0 metres
- Deadweight, approximate 375 tonnes
- Crew 2 persons
- Crew accommodation up to 3 persons

12.4.2.2 Performance

- Propulsion units $2 \times$ azimuthing
- Propulsion motors 2×200 kilo watt electric
- Speed, maximum 8 knots

The propulsion installation is designed to provide a high level of control and manoeuvrability. The power generation and propulsion systems are dualled to accommodate component failure and maintain propulsion at reduced speed should any part of one system be lost.

12.4.2.3 Main machinery

- Generators 2 × 300 kilo watt
- Fuel LPG (optional) or diesel

The generators are designed for use in two principal modes for propulsion, manoeuvring and ship systems, or for loading, unloading, and ballast operations. Machinery space arrangements maximize the utilization of available space. LPG is proposed for good economic and environmental performance.

12.4.2.4 Loading and unloading

The concept as shown includes self-loading and unloading equipment. The equipment comprises a self-contained elevating gantry crane with spreader for 20-tonne containers, a ballast system for draught adjustment and heel control and optional telescopic stabilizer outriggers to facilitate rapid load transfers. Alternative load transfer equipment can be specified or the equipment can be removed if land-based facilities are available. For bulk cargoes the holds can accommodate compatible hopper-sided removable liners.

The concept for this vessel was been developed for the SSA as part of the Integrated Technology for Marine Construction (ITMC) LINK project supported by a grant from the Department of Trade and Industry and with contributions from the following industry partners: A&P Tyne Limited; Lloyd's Register of Shipping; McTay Marine Limited; Richards Dry Dock and Engineering Limited; and Wynns Transportation Consultants. Both the Environment Agency and the Maritime and Coastguard Agency provided information to the project.

12.4.3 Cargo catamaran (the PACSCAT)

A major new European research project was launched at the University of Southampton in December 2003 to develop a novel cargo vessel (i.e. the Partial Air Cushion Support Catamaran, PACSCAT) able to attract freight from roads to major inland waterways. MarinetechSouth was co-ordinating the project, working closely with Independent Maritime Assessment Associates (IMAA) who are providing the principal technical expertise and the University of Southampton who were to carry out the hydrodynamic research and performance assessment. According to IMAA:

> Development of a PACSCAT for Freight Transportation on inland waterways will address the problem of speed and wash which limits conventional freighters on inland waterways … at the same time, such a craft presents significant environmental advantages.

With European freight transportation expected to rise by around 50 per cent over the next 10 years, inland waterways are a genuinely viable alternative to road and rail given the efficiencies of the PACSCAT vessel concept. Carrying some 2000 tonnes (equivalent to some 80 heavy truckloads) at speed of up to 45 kilometres an hour along the Rhine and Danube, PACSCAT is said to be a major step forward in waterborne logistics. The vessel is designed to utilize existing berthing and loading facilities, and its draught height can be optimized to cope with shallow water conditions and with bridge height limitations.

12.4.4 Geest North Sea Line

Geest North Sea Line is a typical example of a successful short-sea operator that leads in its technology developments. For example, it was an industry leader in introducing a new-patented design for the corner castings of 45-foot ISO containers (see Figure 12.6) which enables these units to be carried legally within the maximum permitted turning circle dimension for 16.5 metre-long articulated vehicles, and is in the process of replacing its entire fleet of 40-foot containers with 45 feet long, 9 feet 6 in high units. Similarly, Geest has recently (i.e. in 2004/05) introduced two new 804 teu (i.e. 20 feet equivalent units) container

Fig. 12.6 Geest patented 45-foot container corner casting, which allows vehicles to operate within the limits set by EU legislation (*Source*: Geest North Sea Line nv).

vessels designed to carry the maximum number of 45-foot containers, with a good deadweight able to accommodate heavy 20-and 30-foot containers and a high level of stability because it needs fast turn round times.

The company describes itself as being:

> Totally committed to the expansion of European short-sea shipping and, in particular, to greater use of intermodal options including rail and inland waterway transport in Europe. To this end, we are in the process of replacing all of the 40-foot boxes in our fleet with 45-foot high-cube containers that enable us to compete effectively with 13.6-metres road trailers. Unfortunately, no one yet, to our knowledge at least, has built a containership specifically designed around the 45-foot box and so those vessels available on the charter market are inevitably not ideally suited to the new profile of our equipment fleet … The result is a ship which has holds designed around 45-foot modules rather than 20- and 40-foot modules while the stackweight specifications are such that we will be able to maximize stowage of both 45-foot containers and heavy 30-foot boxes.

It is interesting to note that a typical short-sea container vessel of 340 teu operating for Geest is required to discharge and reload a full cargo in around 8–10 hours. Because of the size of the new ship, more cranes will be in use to discharge and re-load the ship simultaneously. Therefore, they have had to plan very carefully so that a safe level of stability is maintained at all times. With an 804-teu ship, the company will be looking to achieve around 520 lifts during a port call, this figure being based on a typical mix of 45/40/30/20-foot containers. These new 18-knot vessels will have more than twice the container capacity of those currently operated by Geest and will be far bigger than anything that has been used in the North Sea shipping trades before. Once in service, they will operate between Rotterdam and the UK East Coast.

Geest considers its main competitor to be the unaccompanied 13.6-metre semi-trailer market. This has led to it championing the 45-foot container. According to Mr Wout Pronk, Geest North Sea Line's managing director:

> We must offer our customers the same pallet capacity as a 13.6-metre trailer but for total intermodality, we need to be able to top lift and stack. Swapbodies were not an answer. Initially, we thought we would be unable to use 45-foot containers because it seemed that they would be outlawed in Europe but we have found a way around this problem with the patented Geest Euro corner casting.

13

Intermodal Loading Units, Transfer Equipment and Satellite Communications

It could be said, as we have done so earlier in the book, that if the Channel Tunnel was the catalyst, from a UK perspective at least, for developing intermodal road–rail transport across international boundaries, then undoubtedly the standard swap body, along with the ubiquitous International Standards Organisation (ISO) shipping container, of which many millions are in use worldwide, have been crucial to the concepts of load unitization and containerization on a world-wide scale. In fact, achieving efficiency in intermodal transport operations is highly dependent upon, among other key factors, the use of standardized loading units built to conform to a regime of commonality in dimensional and constructional standards; in other words, in accordance with provisions laid down by the ISO.

The concept of standardizing types, dimensions, and technical standards for loading units is absolutely vital to ensure compatibility between the many types of rail wagon, road vehicle, waterway barge, or coastal ship, particularly in regard to the manner in which the units are lifted, positioned, and secured on the transport mode. In an effort to achieve harmony in this regard (as we have already seen in Chapter 2, but it is worth reiterating the point again here) that in 2003 the European Commission published a proposal for a Directive on *intermodal loading units*, the purpose of which it said:

> is to overcome the diversity of intermodal loading units (ILUs) and their handling and securing devices, a factor that hampers the efficiency of trans-shipment operations.

13.1 Swap bodies

Swap bodies (or, in French, *caisse mobiles*) are specially designed loading units capable of being transferred, while under load, from road vehicle to rail wagon and vice versa, and are used mainly, but not exclusively, in international transport movements. They are built of steel, although some models have an aluminium superstructure or ply-panelled bodywork on a steel sub-frame, to conform to international standards of structural strength (albeit not to the stringent strength requirements laid down for ISO freight containers), and to standard dimensions compatible with road vehicle and rail wagon width and length limitations. (It is important not to confuse these units with demountable body systems used in closed-network, domestic transport operations.)

Such bodies are secured on road vehicles and rail wagons by means of quick-release, standard, ISO-type twistlock devices. One part of the fitting (the corner casting) is built into the swap body base frame, positioned at standard centres, to locate with retractable twistlock cones mounted on the vehicle/wagon load platform or skeletal sub-frame. Special pockets are incorporated in the base frame to enable loaded bodies to be lifted by crane, using bottom lift grapple arms, or by heavy-duty forklift truck. Most Category C (see below) swap bodies have folding legs to allow free standing for loading and unloading purposes. This is not possible with the longer Category A units. Unlike freight containers, current generations of swap bodies cannot be stacked when loaded, although some fold-flat models may be so when unladen, generally the open, flat, or short-sided versions. Work is in progress on developing versions capable of being stacked when loaded. Load capacities for swap bodies vary depending on size and type: generally, 7-metre long versions have a maximum gross weight of 16 tonnes, while 13.6-metre versions usually have gross weight of 34 000 tonnes, providing actual payloads of some 13 tonnes and around 28 000-tonnes respectively. In practice, however, swap body payload weights are limited by regulations that restrict the maximum gross weight at which road vehicles may operate in European Union (EU) member states (see the preceding Chapter).

In many ways swap bodies can be compared with the ISO freight containers in terms of their usability for combined road–rail freight operations. However, they do have certain specific advantages over the container, which give rise to their growing popularity. Most importantly, the shorter units being fitted with folding legs are free standing, which allows loading and unloading at loading bay height in warehouses and factories. An additional benefit in this respect is that the driver, single-handedly, can drop off or pick up a swap body using the vehicle air suspension system to raise or lower the chassis for clearance. Most general cargo swap bodies also have side-loading doors, which is another advantage in warehouse or factory loading/unloading situations, whereas ISO containers are invariably restricted to end loading. Furthermore, swap bodies offer greater load capacity, certainly in the most popular size range, with the smallest, 7.15 metres, unit being over 1 metre longer than a standard 20-foot ISO container.

13.1.1 Swap body standards

A number of standards are applied to swap body construction, in particular the international standard for swap bodies in Europe established by the Comite Europeén de Normalisation (CEN). Many swap bodies are built and tested to conform to the German DIN standard and to the German Railway, Deutsche Bahn (DB), standard for swap bodies carried on the European rail network. Some swap bodies also conform to the Convention for Safe Containers (CSC) standard described below. Manufacturers marketing this equipment strongly feature the standards approvals achieved by their products.

13.1.1.1 CEN standard

CEN represents the individual national standards organizations of the EU member states plus those of non-member states such as Iceland, Norway, and Switzerland. Its purpose is to combine individual national standards to form a single-unified standard that is accepted and adopted, without alteration, in each national state to ensure the unimpeded circulation and transfer of swap bodies between road and rail systems throughout Europe. In the UK the relevant national body is the British Standards Institution. The European (CEN TC119) standard for swap bodies is designated EN 284 (testing of such bodies is carried out to EN 283 standard).

Three categories of swap body are identified under the CEN standard as follows:

- Category A: units of 12.2, 12.5, and 13.6 metres length.
- Category B: units of 9.125 and 10.216 metres length.
- Category C: units of either 7.15, 7.45, or 7.82 metres length.

Within the three categories mentioned above, four body types are identified as follows:

- box type (i.e. rigid, closed body with doors),
- opensided (with folding side walls),

- curtainsider,
- drop sides.

Closed-body types may be insulated and fitted with refrigeration equipment.

13.1.2 Maximum width for swap bodies

Most swap bodies were formerly built to a maximum width of 2.5 metres to conform to the legal limit that hitherto applied to road vehicles throughout Europe. However, from 1 January 1996 this dimension was increased to 2.55 metres: by comparison refrigerated road vehicles may be up to 2.6-metres wide.

13.1.3 Overall height

Overall heights for closed-type swap bodies vary according to type and loading requirement from the standard 2.45-metre high unit, which meets rail wagon loading gauge up to C45, the latter being equivalent to a 9-foot 6-inch-high ISO container (i.e. 2.45 metres plus 0.45 metres clearance). For rail carriage, swap bodies must display a UIC (i.e. International Union of Railways) codification plate indicating the loading-gauge standard, for example, 'C30'. It is also important to bear in mind the limitation within most European countries (except the UK) of a maximum overall height of 4 metres for road vehicles. In the UK, while there is no specific legal height restriction for road vehicles (apart from the normal considerations of bridge clearances), nevertheless regulations require the overall travelling height of those carrying containers (including swap bodies), where this exceeds 3.66 metres, to be indicated to the driver in the vehicle cab by means of a notice with letters and figures at least 40-millimetre high. This is a safety measure to guard against the danger of vehicles colliding with and damaging bridges (especially those carrying main line railway trains) and overhead structures. For the purpose of these legal requirements, containers are defined as equipment, other than the vehicle itself, which has a volume of at least 8 cubic metres and which is made wholly or mainly of metal and is intended for repeated use in carrying goods, while overall travelling height is defined as the distance measured from the ground to the highest point of the equipment on the vehicle or trailer, plus 25 millimetres.

13.1.4 Gross and payload weights

While gross weights for swap bodies tend to be standardized, tare weights vary considerably depending on the type of body construction (particularly whether solid or curtain sided), loading door arrangements and the construction materials used. Typical gross and tare weights for standard swap bodies are as follows:

Body length (metres)	7.15	7.45	7.82	13.6
Gross weight (kilograms)	16 000	16 000	16 000	34 000
Tare weight (kilograms)	2850	2900	2950	5100
Potential payload (kilograms)	13 150	13 100	13 050	28 900

13.1.5 Swap bodies in use

Most swap bodies in European, and more recently UK, combined transport operations are either 7.15 or 13.6 metres units, these being the most popular sizes. In fact, the 7.15-metre standard swap body is becoming the norm in international combined road–rail operations. Some 90 per cent of European output of new units is reported to be of this dimension with numbers increasing, while industry estimates indicate that as much as 97 per cent of the Continental intermodal market is served by 7.15-metre units. Two of these units can be carried on an 18.35-metre long road–train combination, one on the rigid drawing vehicle and one on the trailer, located on the combination's standard 20-foot ISO twistlock positions. In the case of 13.6-metre swap bodies, these are carried on maximum length articulated road vehicles. However, these have the disadvantage that they do not offer the same load space or weight capacity as two standard 7.15 metre units, and they cannot be left on their legs as free-standing units at warehouses or in terminals like the shorter units, and are not readily interchangeable between vehicles. Less popular are the 7.45-, 7.82-, 12.2-, and 12.5-metre units. Although two of the former 7.45 or 7.82-metre units can be carried on a standard, maximum length EU-specification road–train, it is unlikely that many operators will change to this dimension (only some 2–4 per cent of current in-use units are of this size) due to their lack of interchangeability and flexibility, and other logistical problems.

In countries where articulated vehicle operation is more popular than road–train operation (such as in the UK where, until March 1994, articulated vehicles held a significant weight advantage over road–train combinations – that is 38 tonnes against 32.52 tonnes), the 12.2-metres (40-foot) swap body had been more commonly used. Such units would readily load on to a 40-foot skeletal-framed semi-trailer and look no different from a normal maximum-length articulated vehicle. A number of major continental multimodal operators use units of this size for road–rail operations across Europe, notably Danzas, Transfesa and Merzario.

13.2 Freight containers

Freight containers in this context are those conforming to the ISO standards of construction and dimensions. They are specially designed to withstand usage in maritime (deep sea) shipping operations (although many are never actually used in sea transport) and are fitted with universal corner, and in some cases intermediate, castings set at standard (i.e. 20-, 30-, 40-, and 45-foot) centres, top, and bottom, which allow them to be secured with matching twistlock equipment fitted to road vehicles, rail wagons, cellular container ships, and to lifting and transfer equipment. Containers are designed and built to have sufficient inherent strength and rigidity for top overhead lifting when fully laden, and for safe stacking eight or more high inside a container ship, on the dockside or in a freight terminal.

Containers are generally of all-steel (mild or stainless) construction, although some have aluminium, plywood (sandwich construction) or GRP panels. Where lightweight (and rust free, corrosion resistant) construction is essential, some containers are built wholly of aluminium, but these are normally limited to three-high stacking. Most ISO containers are of the simple box construction with end-loading doors for dry freight, but a variety of other types are constructed to suit the requirements of particular traffics. For example:

- tankers (for liquids, granules, or powders) incorporated within a standard dimension steel frame (some tankers are insulated and steam heated),
- insulated and refrigerated (reefer) containers (the latter with attached, recessed refrigeration, and controlled atmosphere (CA) units),
- open top (e.g. for top loading/unloading of heavy machinery),
- half-height (for low-density high-weight products: e.g. steel),
- side loading,
- fold flat: flatrack (for ease of stowage when returning empty).

The bulk of the Freightliner domestic road–rail container operation is conducted with 20-foot ISO boxes carried for the road journey on short-length semi-trailer articulated vehicles.

13.2.1 Standard dimensions

Most containers ('boxes' in industry jargon) are built, despite metrication, to standard, imperial, 20-, 30-, 40-, and 45-foot lengths, by 8-foot wide (although Europe has its own domestic containers which are

2.5-metre (8-foot 2-inch) wide to accommodate standard Euro-pallets) with heights varying between 8 feet and 9 feet 6 inches. Standard 20- and 40/45-foot, and 8-foot × 8-foot 6-inch boxes are predominant in European trade. However, increasing use is being made of 45-foot long 9-foot 6-inch-high (maxi-cube) containers (see page 164) which can load 33 Euro-pallets, but these need to be fitted with special tapered Euro-corner castings; for others, they marginally infringe the maximum legal swing clearance dimension by a few centimetres when being carried on road vehicles.

Capacity in container ships and flows of container traffic is measured in teu, representing 20-foot equivalent units. Thus a 40-foot container is counted as two teu. All ISO containers are assigned an ISO type code comprising four alphanumeric characters; the first character indicates the container length (Code 2 being 20 feet; Code 3 being 30 feet; Code 4 being 40 feet), the second character indicates the height and width (i.e. a 9-foot 6-inch-high, 2.5-metre-wide unit is designated Code letter E). The third and fourth characters indicate the type of unit and can be a group designation or a detailed type code designation, of which there are a great number. A full list can be freely downloaded from the SMDG (User Group for Shipping Lines and Container Terminals) website at: www.smdg.org/documents.

13.2.2 Weights and capacities

Gross weights, payloads, and cubic capacity for ISO containers vary quite considerably according to size, type, and method of construction, but for standard dry-freight boxes they may be generally summarized as follows:

	20 feet	30 feet	40–45 feet
Gross weight (kilograms)	24 000	26 000	30 000
Tare weight (kilograms)	2300	3250	4200
Average payload (kilograms)	21 700	22 000	25 800
Cubic capacity (cubic metre)	32.8	49.8	67.0

13.2.3 Other standards for containers

Besides the principal ISO standards of construction and dimensions for freight containers mentioned above, other standards and legal requirements apply to their construction, testing, and use as follows.

13.2.3.1 Convention for safe containers

Owners, lessees, and others in control of freight containers must ensure that they comply with the *International Convention for Safe Containers*, Geneva 1972. In the UK, this international convention is applied by domestic legislation namely, *The Freight Containers (Safety Convention) Regulations 1984* which apply to containers designed to facilitate the transport of goods by one or more modes of transport without intermediate reloading, designed to be secured or readily handled or both, having corner fittings for these purposes and which have top corner fittings and a bottom area of at least 7 square metre or if they do not have top corner fittings, a bottom area of at least 14 square metre. Containers must have a valid approval issued by the Health and Safety Executive (HSE) or a body appointed by the HSE (or under the authority of a foreign government which has acceded to the convention) for the purpose of confirming that they meet specified standards of design and construction, and should be fitted with a safety approval plate to this effect. If they are marked with their gross weight, such marking must be consistent with the maximum operating gross weight shown on the safety approval plate. Containers must be maintained in an efficient state, in efficient working order, and in good repair. Details of the arrangements for the approval of containers in Great Britain (GB) are set out in a document *Arrangements in GB for the*

Approval of Containers available from the HSE. The safety approval plate (issued by the HSE) as described in the regulations must be permanently fitted to the container where it is clearly visible and not capable of being easily damaged (it must be non-corroding and fireproof), and it must show information described in Chapter 18 (see page 246).

13.3 Lifting equipment

Perhaps more than in any other equipment sector for intermodal transport, the variety of different makes, models, and types of lifting and loading equipment available is quite outstanding. The range extends from small mobile units that may be found in a road–haulier's premises to the huge rail-mounted gantry cranes seen towering over docksides and freight terminals. Of course, choice depends on operational requirements; lifting unladen containers from the ground onto a vehicle load platform is one thing, but loading or unloading from ship to shore, or stacking 30-tonne containers, eight or ten units high (as is often the practice) is a completely different matter. For the purposes of this chapter, equipment has been divided into four categories and typical specifications have been outlined by way of example in each category. The four categories are as follows:

- Forklift trucks and reach stackers:
  - for empty container handling,
  - for loaded container handling.
- Vehicle/trailer-mounted loading equipment.
- Rubber-tyred straddle carriers.
- Rail-mounted gantry cranes.

To add to the complications of equipment choice, but not for discussion here due to its complexity, there are the ranges of lifting equipment attachments, most notably spreaders, which by their special or particular design features facilitate the actual handling of containers, swap bodies, or road vehicle semi-trailers. Many crane builders include these attachments as part of their equipment, but there is a whole industry of specialist manufacturers concentrating on nothing else but, for example, designing and constructing spreader attachments (both Bromma and IMA of Germany being well-known manufacturers in this field).

13.3.1 Forklift trucks and reach stackers

There are many forklift truck manufacturers and most would claim to build equipment suitable for handling, at least, Category C swap bodies and 20-foot ISO containers in an unladen condition, that is empty container handlers. Such equipment has obvious limitations of load capacity and reach. Hyster, a well-known name in forklift trucks in the UK and Europe has just such a range of diesel-powered trucks. Depending on individual specification, these trucks can stack empty containers three or four units high. They can handle a wide variety of container types, having 20–40-foot telescopic side-lift spreaders and they have a two-speed hoist system to allow them to operate fast turnround cycles. Load capacity is typically 7000 kilogram and they lift to a height of 13.8 metres. Interestingly, Fantuzzi of Italy advertizes a lift truck capable of stacking empty containers 10-unit high. In a higher weight range for handling loaded containers and swap bodies, Hyster has trucks which can handle loads weighing from 20 to 32 tonnes, or from 36 to 48 tonnes either with fork attachments, or at the higher end of the weight scale, with top-lift spreaders or a telescopic container attachment. Also typical of container handling forklift trucks in the 8–50-tonne range are those of Swedish manufacturers, Svetruck and Kalmar LMV, and also Linde AG of Germany (see Figure 13.1). Container stacking with these and other similar trucks is generally limited to two or three units high.

Reach stackers are a different type of lifting machine having an overhead two- or three-stage hydraulic lifting arm or boom to which a variety of lifting attachments can be added: typically spreaders for container

Fig. 13.1 Linde heavy-duty lift truck with container stacker capability. (*Source*: Linde AG, Germany.)

handling and grapple arms for lifting swap bodies and semi-trailers in piggyback operations. They are highly manoeuvrable machines, being equipped with rear wheel steering giving them a capability for very precise positioning especially when stacking. Many of them have a 'slewing' facility that allows loading units to be turned or to be lifted and carried end-on. They are very stable under load and can operate fast turnround cycles.

Leading manufacturers in this field are Kalmar LMV (mentioned above), French manufacturer Terex-PPM, Sisu of Finland (Figure 13.2), and again, Fantuzzi of Italy. Most of these machines can lift in the region of 45 tonnes and can stack loaded 9-foot 6-inch containers five high at short reach. As the boom is extended lifting capacity diminishes, but generally such machines can reach into a third row of a block stack. These machines are normally fitted with either spreaders to handle 20-, 35-, and 40/45-foot ISO containers or with grapple arms for other intermodal units. However, in some cases both the spreader and grapple arms are combined into a single unit, the grapple arms folding out of the way when not required. This arrangement gives added flexibility in terminal operations, being able to handle a variety of intermodal units, 'as they come', and saves considerable time by not having to make the changeover from one form of lifting attachment to another. Swedish manufacturer Elme's 850 series of top/bottom lift attachments (see Figure 13.3) accomplish this task, taking the operator no more than 20 seconds to fold each pair of grapple arms into or out of the lifting position.

13.3.2 Vehicle-mounted loading equipment

It is not always possible for container and swap body lifting operations to be carried out in purpose-built intermodal terminals or in transport depots with lifting equipment. Often loads need to be assembled or

Fig. 13.2 PPM reach stacker. (*Source*: Terex-PPM, France.)

unloaded at ground level in factory premises where no proper lifting equipment is available. For this reason, a number of manufacturers have devised on-board equipment for road vehicles to enable them to lift and load or lower load units to and from ground level or to carry out a lateral transfer from vehicle to vehicle or vehicle to rail wagon. Generally such equipment can handle 20- and 40-foot ISO containers (loading two 9-foot 6-inch-unit high) and standard swap bodies loaded to a maximum of 30-tonnes gross weight. The equipment is mounted on the semi-trailer, keeping within the European 13.6 metres overall length limit.

One manufacturer of such equipment is Hammar, another Swedish company (i.e. Hammar Maskin AG). Its semi-trailer-mounted model, which can be loaded or unloaded within just 4 minutes, has hydraulically adjustable arms that can be moved along the trailer load platform to accommodate short (i.e. 20-foot containers or 7.15-metre swap bodies) or longer 40-foot and 13.6-metre units (see Figure 13.4). Another manufacturer of such equipment is Containerlift Ltd of Essex, UK (see Figure 13.5). The semi-trailer with the equipment has a maximum payload capacity of 31 tonnes but the equipment itself has a maximum lifting capacity of 33 tonnes. An 8-foot 6-inch-high ISO container can be carried within the European 4 metre overall height limit. The equipment consists of two cranes with two separate hydraulic circuits, one for each crane with sealed pressure control valves to protect against overloading and to protect the equipment. Power for the hydraulic pump is taken from the power-take-off (PTO) on the tractive unit gearbox. Load security valves make the speed of the cranes independent of the weight of the cargo handled, that is the same lifting speed is attained whether 33 tonnes are handled or just 1 tonne. These valves also prevent the load from being dropped in case of a hose breakage. Each crane consists of an upper arm, a lower arm, and two hydraulic cylinders mounted on a heavy-duty frame of hollow beams. The cranes are built of high-grade steel to minimize unladen weight and give maximum

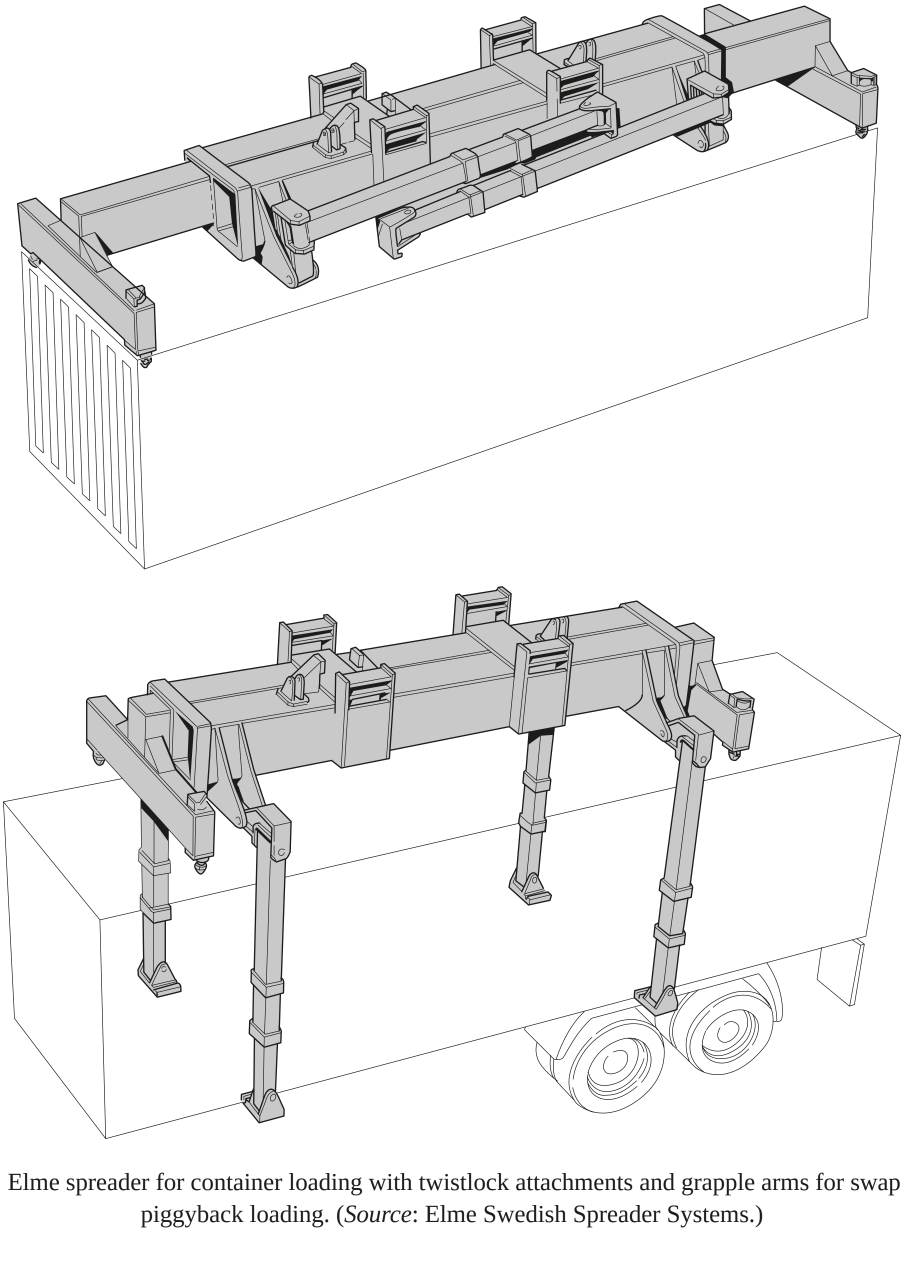


Fig. 13.3 Elme spreader for container loading with twistlock attachments and grapple arms for swap body and piggyback loading. (*Source*: Elme Swedish Spreader Systems.)

payload. Stabilizers provide support against the ground, rail wagon, trailer, or loading bay. Due to the large support area, the surface pressure is very low: a maximum of 13 kilogram/square centimetre when handling 33 tonnes. Adjustment of the lifting units for different container lengths is by means of two hydraulic cylinders that are well protected between the frame members of the semi-trailer. The lifting units are freely adjustable between 20 and 40 feet, and are carried in slide bearings of stainless steel on the semi-trailer frame. The container is secured on the Hammar semi-trailer during transport by four manual twistlocks with drop-forged tops. The Hammar equipment can be operated by one person – the driver – using

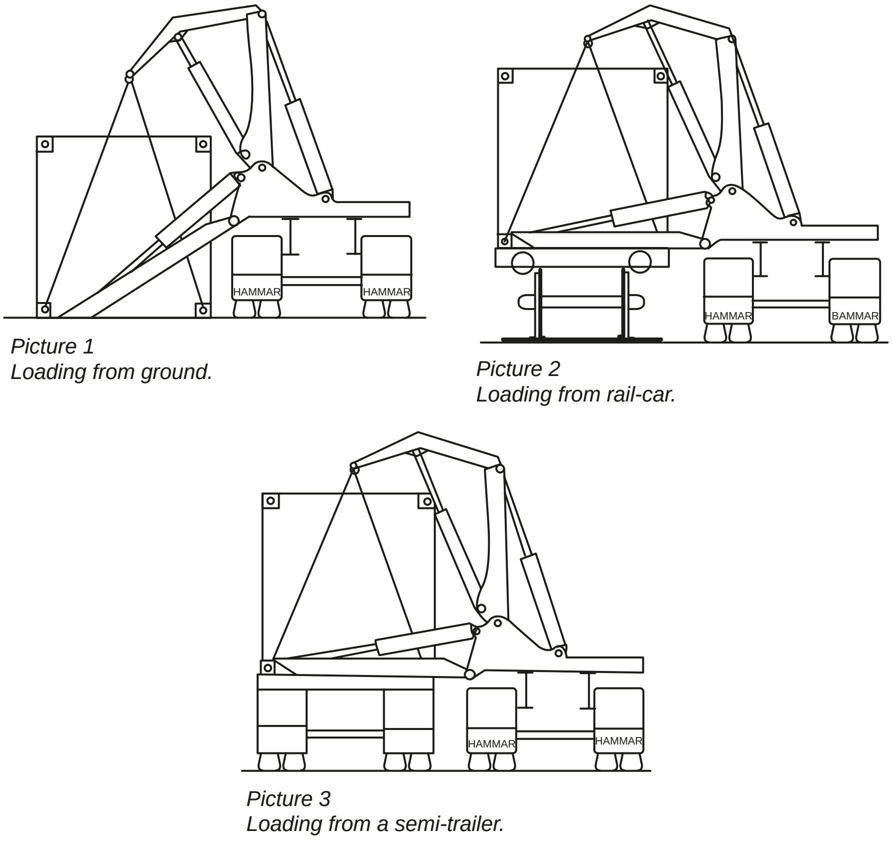


Fig. 13.4 Hammar vehicle-mounted container/swap body lifting system.
(*Source*: Hammar Maskin AB, Sweden.)

the portable control box which allows him to move around during loading and unloading, to get the best possible view of the operation. All the hydraulic cylinders can be manoeuvred separately or in parallel and two-speed operation is provided for all functions. A built-in safety system makes incorrect manoeuvres impossible. In case of emergency, for instance, if there is a malfunction in the electrical system, all hydraulic valves can be operated manually.

A UK company, Containerlift based at Stansted Airport, operates a number of semi-trailers fitted with New Zealand-built Sidelifter equipment. This is very similar in concept to the Hammar equipment described above. It can lift and load or lower both 20- and 40-foot containers and Categories C and A swap bodies at gross weights up to 30 tonnes from the ground. According to the company, many firms are catching on to the idea of safe ground loading of heavy or expensive goods, and this is where the Sidelifter scores with its ability to be taken into industrial premises where space is limited and no lifting equipment is available.

13.3.3 Rubber-tyred straddle carriers

Straddle carriers are specially designed mobile units that can be driven astride containers or swap bodies to lift, carry, or stack as required. They are highly manoeuvrable and can traverse rows of stacked containers with, in the case of the larger models, the operator sitting in a high-mounted control cabin to give a good all-round view of the working area and to allow precise positioning of containers when loading to road

Fig. 13.5 Containerlift vehicle-mounted container transfer device. (*Source*: Containerlift Ltd, UK.)

vehicle or when stacking (generally, up to a maximum of four high). Their ability to hoist while travelling adds to operating speed and provides fast turnround cycles. Telescopic spreaders adjust automatically for precise positioning and fast operation, while safety locks ensure that lifting cannot commence until all four corner twistlocks are secured. Leading straddle carrier manufacturers Noell of Germany offer, among a wide range of models, a small, four-wheel, low-cost version which they call the Easy-Lift, designed for handling 20- and 40-foot containers up to 40 tonnes, which it can carry (at up to 16 kilometre/hour) and stack two high. It has a choice of two- or four-wheel steering controlled by the operator providing exceptional manoeuvrability for negotiating small areas and positioning containers into awkward corners. Either an open or closed driver's control cabin is available and the machine can also be operated by remote control (using infrared technology) allowing the operator to select the best viewing position. In the large straddle carrier range, over 500 large Noell straddle carriers are in use worldwide. These feature three-high stacking capability, eight-wheel steering, and Noell's patented maintenance-free suspension system to provide good handling over poor surfaces. They have the ability to handle full- and half-height containers in all lengths (including 45- and 48-foot-long models) at maximum weights.

Claiming to be the world market leader in straddle carriers, Valmet of Finland (a product name of Sisu Terminal Systems) has over 40 years' experience in building this type of equipment. Specifications are similar to those described above with the emphasis on good traction from four-wheel drive and smooth running, high levels of manoeuvrability, speed of lifting and travel, exceptional visibility, and precise control for the operator from high-level cabins. Above all, this type of equipment is claimed to enable terminals to be set up with a minimum of infrastructure investment, to operate efficiently with fast cycle times (pickup, lift, carry, position, and put-down) and with an economy of labour.

13.3.4 Rail-mounted gantry cranes

The very largest of container terminals, particularly those in ports, invariably feature rail-mounted gantry, or stacker, cranes which can lift and load all types of unit-load equipment at maximum weights and can traverse as many as seven rows of stacked containers and a truck-loading lane. This type of equipment generally features electric drive (DC) with thyristor control to provide infinitely variable speed and AC-drive for hydraulic pumps, spreader operation and lighting. Cable hoists, mounted on trolleys that traverse the gantry (and on which the operator cabin is mounted), are used for lifting and lowering the spreader equipment or grapple arms for lifting swap bodies. Leading names in this field are again Noell and Valmet, while German firm Kransysteme Rheinberg GmbH (KSR) build both rail-mounted (RMG) and rubber-tyred (RTG) versions, the latter having the advantage of flexibility of operation since it is not confined to parallel tracks.

13.4 Other handling equipment

While heavy-duty forklift trucks, reach stackers, and straddle carriers are predominant in the field of container and swap body handling, there are many other forms of handling equipment from giant-sized container cranes that can perform ship to shore container loading and unloading, in some cases straddling 12 or more rows of stacked containers (e.g. by Aumund, Kunz and Hilgers of Germany) to simple roll trailers for moving containers within terminals, dockside tractors, and other forms of container lift-and-carry equipment.

13.5 Satellite tracking of vehicles and loading units

Worldwide tracking of containers, swap bodies, semi-trailers, road vehicles, and rail wagons is possible with satellite-based tracking systems. Being able to know where swap bodies, containers, unaccompanied trailers, or vehicles are at any particular point in time, and their status, is a great help in the management control of transport operations and in logistics planning.

13.5.1 ITF intertraffic – global tracker service

An example of this type of system is the Global Tracker Service of Daimler-Benz subsidiary ITF Intertraffic, in this particular case with the added advantage that it allows retrieved data to be integrated into existing company information systems (a schematic representation of the system is shown in Figure 13.6). This simple system locates intermodal loading units using a small transmitter, often called a Data Terminal or Asset Tracker Unit, unobtrusively fitted to the load unit (in a small rugged housing) which transmits signals back to a confidential electronic mailbox at the ITF Intertraffic Operations Centre identifying the unit's latest position, and if required, other information. Other data, including temperature, shock, weight, humidity, door open, and load status, as well as locally input data from hand-held communication systems, can be provided via modular hardware units and sensors attached to the load unit which feed information to the transmitters. Data terminal interfaces allow the addition of sensors or Radio Frequency Identification (RFID) tags. Data from loading units is transmitted via Low-Earth Orbit (LEO) satellites first to the satellite network owner's ground station, then onto ITF Intertraffic's operations centre and finally the system user's terminal. Operation is simple: the user makes just one mouse click on the 'connect' box on his PC terminal screen, which instructs the programme to dial the ITF Intertraffic database centre. This automatically connects the terminal to the user's personal mailbox and sends the necessary commands to retrieve the positions of loading units. The user can make a number of selections for data retrieval, choosing to collect data relating all units or just to selected containers or trailers, the latest information only or all information covering a number of days.

Information is supplied via a standard modem and in standard data format (e.g. dBase) for easy integration into logistics management software. This means that standard database management systems can access the files and the data can be used to generate charts showing routes taken, daily logs of positions, and other information. MS-Windows-compatible user software displays loading unit positions on vectored maps or in database format. The service relates all the positions provided by the satellite system to

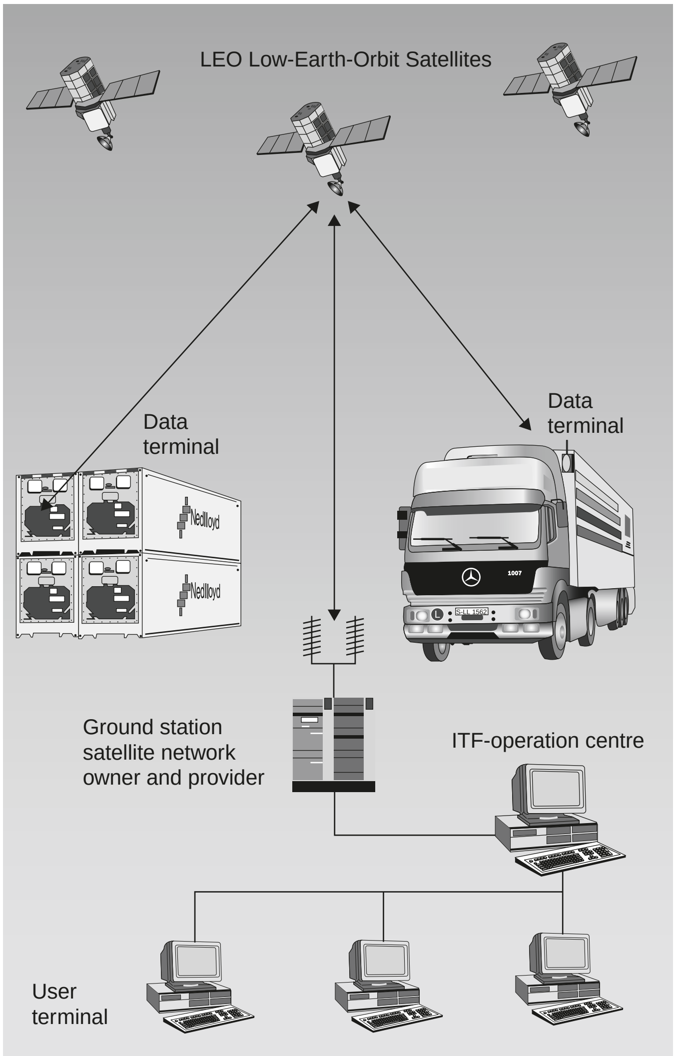


Fig. 13.6 System structure for the ITF Intertraffic Global Tracker Service. (*Source*: ITF Intertraffic.)

reference positions: the 'proximity calculation'. Each position is given as a line of screen text, such as '10 kilometre north of Munich'. The reference positions are those chosen by the user. An ordinary PC and a few simple commands are used to connect the user to ITF Intertraffic's operations centre (the software supplied to users of the service can do this). The user programme requires the following PC system:

- an 80486-compatible computer with colour screen,
- a mouse,
- at least 40 Megabyte hard disk,
- at least 4 Megabyte of random-access memory (RAM),
- an Hayes-compatible modem,
- WINDOWS 3.0 software (or above).

13.5.2 The 'Galileo' global satellite system

The EU's global navigation and positioning satellite system 'Galileo' is beginning to take off in a big way with support from the Community's Trans-European Transport Networks (TEN-Ts) funding programme: in fact, it appears as project number 15 in the TEN-T list of projects in page 148. Galileo is Europe's initiative to create a global satellite navigation system offering precise position and timing services for commercial and personal uses anywhere in the world, using a small and inexpensive receiver. When fully deployed, the system will consist of an array of 30 satellites, together with associated infrastructure on the ground and newly developed applications and services. Importantly, Galileo will make Europe independent in a technological field of strategic importance. Cost benefit analyses carried out for the European Commission estimate that Europe's share of the global market for satellite navigation products and services may be worth as much as €9 billion each year from 2015 as a result of using Galileo, and that up to 140 000 new jobs could be created. A wealth of promising applications is already emerging especially in the fields of transport. The Galileo system is designed to respond to the specific needs of every transport domain, including aviation, maritime transport, and road and tall transport even pedestrians will benefit. But Galileo will also benefit other professional and personal activities, from civil engineering, social and emergency services to agriculture and fisheries, banking and finance, environmental protection, and civil protection. From the user's perspective, Galileo will offer the advantages of complete reliability and unprecedented accuracy. It will allow goods, vehicles, and people to be located with approximately 10 times greater accuracy than global positioning satellite (GPS), to within a few metres. And unlike GPS, the continuity of its signal will be guaranteed. Galileo has been designed specifically for civilian use worldwide, and will provide both a freely available signal and ones restricted to specific groups such as commercial service providers, safety-of-life applications such as aviation, and government users. Galileo will comprise a constellation of 30 satellites orbiting at an altitude of nearly 24 000 kilometres. Ground stations will be responsible for the management and control of the system. It is claimed that thanks to the compatibility and interoperability of Galileo, users throughout the world will gain easier access to signals emitted by the navigation satellites and will benefit from much greater efficiency: the system will also offer greater accuracy than GPS. The services offered by Galileo will be covered by a guarantee of continuity, which can be laid down in a contract; this is seen as very important when risk to human life is involved, as with air transport for example. In a Press statement issued in December 2004, the European Commission stated that Galileo would definitely become operational in 2008:

> A decisive stage had been reached,' it said, and 'it is without a doubt the most wonderful European technological project. We are now on the home straight: next year will see the, launch of the first satellites'; said Jacques Barrot, Vice-President of the Commission, 'Galileo will be as much of a technological revolution as mobile telephony.