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Project: Current State of Standardisation and Future Standardisation Needs for Intermodal Loading Units in Europe

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EXECUTIVE SUMMARY

Experience has shown that the European situation in the field of loading units does not cover all needs of the trade and forms a hurdle to the further development of intermodal transport.

This is due mainly to two facts:

- The current ISO containers, as standardised in ISO 668 and 1496, do not fit into the needs of European logistics. They do not offer as much volume as comparable road vehicles and are, in consequence, not competitive against road transport. Furthermore, and even more severe, the standard pallet accommodation patterns of the ISO containers are very bad compared to those of similar size class road and rail vehicles. Thus, the ISO container is rarely used in inter European transport.
- The current swap bodies as standardised by CEN are optimised for road and rail transport only, and do not offer economic solutions of inland waterway and short sea transport. If these two modes shall be included into a truly intermodal European concept, loading units have to be designed that are stackable and that are fitted with top corner fittings for lifting by spreader. Such units can offer greatly improved transport economics for these two additional modes and contribute to a truly intermodal system in Europe with a positive effect on the overall political aim of sustainable mobility.

Therefore, building on the work of different standardisation bodies and keeping in mind the importance of technical harmonisation in the field of intermodal transport, the European Commission has launched the UTI-NORM study, in the framework of the Communication on "Intermodality and Intermodal Freight Transport in the European Union (COM (1997) 243)".

This study looks after the operational conditions and design requirements of a future European loading unit that overcomes the current shortcomings by:

- offering as much interior volume for cargo accommodation as European road vehicles, and offering similar palletisation patterns, thus being fully competitive with European road transport as far as the design of the cargo carrying device is concerned,
- offering improved transport economics for inland waterway and short sea transportation while keeping full compliance with road and rail operation needs as current swap bodies.

In consequence, the study has elaborated recommendations to standardise a future European loading unit with the main dimensions of current standard swap bodies, and to include stackability, top corner fittings and certain additional strength requirements to the design. These recommendations are based on the findings of the study team and on the results of a discussion with European experts in a workshop that has been organised in the course of the study efforts.

The future European loading unit will fit into the current European transport modes as follows:

Road transport

The proposed European loading unit is recommended in two sizes, one size designed for European road trains as a twin unit, one to be carried on the rigid truck and the other on the trailer, and the other size designed for transport by European articulated road vehicle carried on the semi-trailer. The unit is proposed with a height making full use of current design in road vehicles and the European legislation allowing an overall road vehicle height of 4000 mm. The proposal takes care of the possibility to achieve a light weight construction to avoid tare penalties compared to conventional road vehicles. Furthermore, the proposal aims at a loading unit that can be built rather cheap.

Rail transport

The proposed unit takes care of the current loading length of railcars, making best use of the loading patterns offered with the majority of the current European railcar fleet. The loading unit is proposed with an outside height that can be accommodated in most important European rail corridors when carried on standard platform height railcars, and in many other corridors, that offer reduced gauge on railcars, with special design for lower platform height, such railcars being state of the art.

Inland waterway transport

The European loading unit is designed to be stacked at least four high in inland waterway transport making full use of the loading patterns of the most important European inland waterway, the Rhine river and its coastal canal connections. By merits of stacking, the loading unit offers greatly improved transport economics in inland waterway. The loading unit includes some difficulties in transport within the Central European canal network, because its width impedes full loading of inland waterway barges that are designed to pass through the locks in this system. Further considerations are needed in this area.

Short Sea Transport

Once a stackable loading unit is offered, modern Roll on/Roll off ships can switch from one layer transfer and transport to double stack transfer and transport on board of the ship. This development will considerably improve the economics of loading and discharge, and the volume accommodation patterns on board ship. Roll on/Roll off ships are so flexible in their loading unit accommodation that the proposed sizes of the future loading unit do not create any difficulty. Cellular ships operated in short sea transport create more difficulties to adapt to the sizes of the future loading unit, because these ships are mainly built to accommodate ISO containers with other width and length. While the width problem can be overcome rather easily (and today short sea cellular ships are already operated that can carry either ISO containers or pallet wide containers, the adaptation of the cell guides to the different length of the future unit might create difficulties - not in technical design as adjustable cell guides are state of the art -, but daily in operation because these ships might have to carry a changing mix of ISO containers and European loading units. No experience has been gained yet about the feasibility of cell adjustment in the short period when the ship stays in a port terminal.

Another problem will come up if stacks of more than two layers are incurred in short sea operation. Normally, such ships are built for stacks of three layers on deck, and of six layers under deck. The design of a large European loading unit with full six high stackability ability in sea transport will need to a difficult construction, leading to a rather heavy and costly unit that might no longer be competitive in road and rail mode. Further considerations are needed in this field, once first experience has been gained about concrete conditions of operation of such units. In general, European short sea shipping will benefit from a move to standardised units that might replace the great variety of different sizes and shapes that are today used in this trade. Standardised units will contribute to more efficiency and more safety in this operation.

The study team has, finally, suggested a series of recommendations toward future European standardisation, policy and research in the field of intermodal transport, based on its findings and on the results of a discussion with European experts in a workshop that has been organised in the course of the study efforts.

1.THE CURRENT SITUATION

1.1 THE CURRENT STANDARDISATION WORK IN THE FIELD OF INTERMODAL TRANSPORT

1.1.1 General considerations

Intermodal transport is only possible when the various technical features of vehicles, cargo compartments, handling devices and ancillary equipment fit into each other.

This harmonisation can be achieved by individual agreement between some parties that decide to establish such a transport system. This approach is normally not to be recommended because it covers only a small part of the total transport and needs many devices that can only be used in the close circuit system.

The multilateral approach is generally more successful. This is normally generated through standardisation. Standardisation, in opposition to a cartel of some parties that arrange for similarities in the offer to the market, is an open process that allows all interested parties to join into the deliberations. This process gives the best guarantee to safeguard competition on the one hand, and to arrange for harmonised interfaces in the various applications.

Various international associations are currently organising international standardisation. For our deliberations, the main interest focuses on two of them:

- International Standadization Organization (ISO), located in Geneva, and having practically all national standardisation associations of the world as members,
- European Standardisation Committee (CEN), located in Brussels, and comprising most standardisation organisations of Europe.

Further international standardisation organisations are busy in specific fields such as standardisation of electrical, electronic and communication matters, both on European and world wide level (IEC, ETSI, CENELEC, EDIFACT Board).

Keeping in mind the importance of such technical harmonisation in the field of intermodal transport, the European Commission and the Council of Ministers have repeatedly, lately in the EC Communication on „Intermodality and intermodal freight transport in the EU“ [COM (97) 243], pointed out the paramount role they see in standardisation to ensure efficient intermodality. This chapter describes the framework in which such standardisation has taken place over the last 30 years and provides a picture of the current state in this field.

1.1.2 The work of ISO TC 104

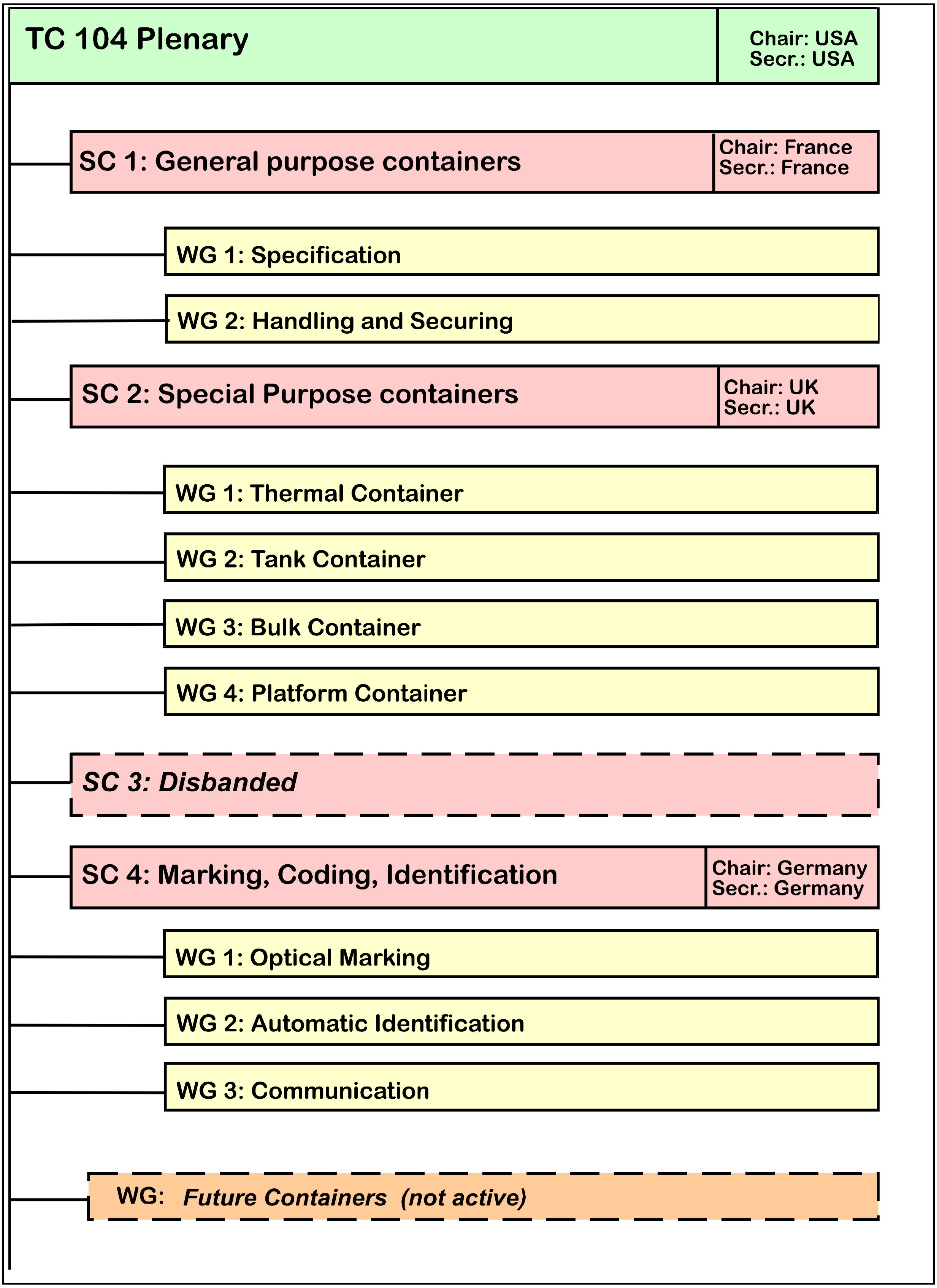
1.1.2.1 Structure of TC 104

Other than CEN standards, ISO standards are voluntary in national application: The national standardisation associations that make up ISO are free to take over an ISO standard or to standardise a specific matter in a national standard that might deviate from an agreed ISO standard.

ISO standardisation works widely on consensus basis. A wide majority (in many cases 75 % of all votes given) is needed to lead a technical specification into an ISO standard.

Within the overall structure of International Standardization Organization, various Technical Committees deal with specific fields of action and specific technical matters. One of these Technical Committes (TC) is TC 104 Freight containers. This TC deals with standardisation in the field of freight containers, and related matters. Technical Committee 104 Freight Containers is an independent standardisation body within the framework of International Standardization Organization (ISO).

The working structure of ISO TC 104 is as follows:



Structure of ISO - TC 104

The secretariat of TC 104 is held by ANSI American National Standardization Institute, New York, N.Y. Chairman is currently (1999) Mike Bohlman, a senior technical officer of Sea-Land Service, Inc., the biggest US container ocean carrier.

TC 104 convenes a plenary meeting in two or three years periods. The last one was convened in 1997 in Beijing, Peoples Republic of China. The next one is scheduled to be convened in the year 2000 in Cape Town, South Africa.

TC 104 has the following working structure:

Sub-Committee 1 Freight containers - General purpose containers -
deals with the details of standards on general purpose containers (i.e. box type containers with and without open top features), and it fixes many basic technical requirements such as dimensions and strength features that apply to special purpose containers as well.

Sub-Committee 1 has two permanent working groups :

- WG 1 dealing with specification of ISO general purpose containers - mainly dimensions, strength
- WG 2 dealing with handling and securing; mainly with corner fittings on the container and the interface to handling (lifting) devices and rolling stock.

Sub-Committee 2 Freight containers - special purpose containers
deals with all special aspects of containers built and designed for special purposes with the following working groups

- WG 1 Thermal containers - dealing with temperature insulated containers and their refrigeration equipment. A special group worked out a standard on remote monitoring, i.e. a standard communication interface between temperature monitoring devices attached to each individual container on board ship and the central control unit on the bridge of the ship that informs the officer about the actual state of each container.
- WG 2 Tank containers deals with a wide range of tank containers with various specialisation such as IMO classes for dangerous liquids, or with qualification for the carriage of liquid foodstuff (wine, milk, beer), and items for pressurised discharge.
- WG 3 Bulk containers deals with various types of containers specialised for the transport of commodities in bulk (grain, powder, granulate). They differentiate in two basic design types of bulk containers: Bulk containers that discharge by gravity (with WG 3 scope), and bulk containers that discharge by pressurised air/gas (in the scope of WG 2).
- WG 4 Platform containers deals with a wide range of platforms, flat racks, collapsible units and the more.

Sub-Committee 4 Freight containers - Marking, Coding, Communication
deals with the software of the container system. It has three working groups:

- WG 1 Optical markings and their coding: This group deals with the decals to be marked on the outside of the container showing its identity, its type and size, its maximum gross weight/mass, tare weight/mass, maximum payload, cubic capacity, and as far as applicable warning marks, and the coding of such data.
- WG 2 Automatic equipment identification deals with the specification of systems that allow for automatic reading of the identity of the container and of other permanent container related data, with the coding of the data sequence transmitted to a reading device, and with techniques and procedures near to these functions such as automatic recognition of container seal' s integrity.
- WG 3 Communication has established a comprehensive list of codes and definitions for spare parts of the container, its damages (type, size, location), repair needs, repair actions and the more. The functions of these standards are described in chapter 1.2. Initially, this working group discussed related messages and message structures for container related communication. But this function was transferred to the EDIFACT Board in mutual consensus.

1.1.2.2 Current standards of TC 104

ISO TC 104 has over the last 35 years elaborated many standards. Most of them are in wide use today and are well applied by the transportation industry.

This is by far not a common feature. All international standards are voluntary in their application, and the industry is, generally speaking, free to apply an International Standard or to take their individual solution. In container transport, most ISO standards are applied, but not always in all details. The following report will give information of the nature of the various standards and some considerations about their current application.

All standards are designed by a number attached to them by ISO Central Secretariat. The individual number is followed by the year in which the most recent version of a standard has been accepted.

ISO 668: 1988 Series 1 freight containers - Classification, dimensions and ratings
with some later amendments, mainly inserting the 2900 mm high containers.

ISO 668 in a basic standard in the field of container transport, giving the outside dimensions, the positioning of the corner fittings and the maximum gross mass. These values and dimensions are orientation points for other technical systems and their interface: Cellular ships are designed to the outside dimensions of containers and their tolerances, cranes are designed to their lifting capacity taking note of the maximum gross weight of containers, spreaders are designed to lift the container at the top corner fitting location, railcar and chassis twist lock locations are placed in conformity of ISO 668 bottom corner fitting location.

The classification gives dimensional codes for containers, such as

- A for 40 ft. containers 8 ft. high
- C for 20 ft containers 8 ft high,
- AA for 40 ft. containers 8 ½ ft. high,
- AX for 40 ft. containers less than 8 ft. high,
- AAA for 40 ft. containers 9 ½ ft. high.

The gross weight (= mass) fixed in this standard is not always followed in practical operation. Some containers are operated that offer more gross mass as foreseen in ISO 668. While the European Union limits the maximum gross mass of road vehicles operating in international European transport to 40 000 kg (and North America applies normally even lower maximum gross mass for road vehicles), European Directive 96/53/EC allows in specific „combined transport" pick-up and delivery operations, when carrying a 40 ft. container, a road vehicle gross mass of 44 t. This allows normally to make full use of the 30 480 kg gross mass of a 40 ft. container, but may add up even to higher maximum mass intermodal loading units when using specific light weight trucks and trailers. These units occur in exceptional cases.

The existence of containers with higher ratings than foreseen in ISO 668 has always created some delicate questions:

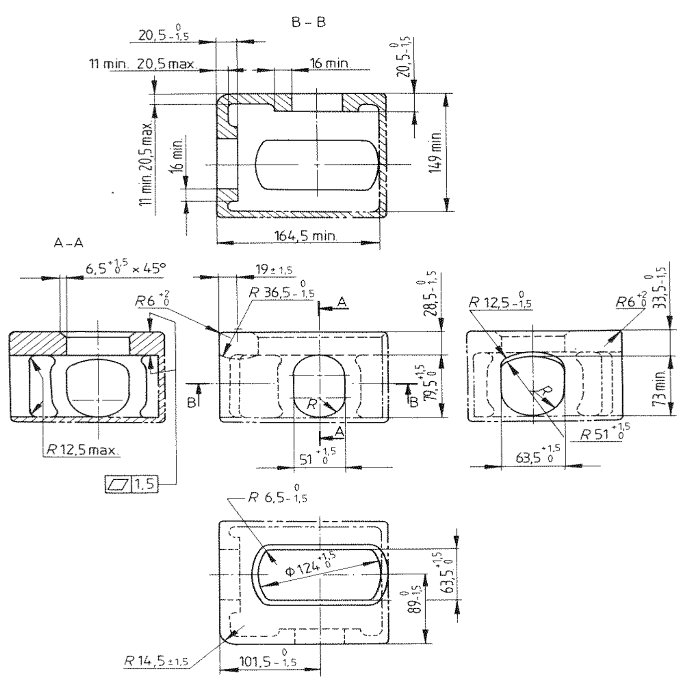
- What weight/mass capacity shall be marked outside on the container - the actual design value or the (possible more restricted) standard value?
- What weight / mass capacity shall be marked on the CSC approval plate?
- What does the higher rating mean for the various test values specified in ISO 1496?

The current marking often follows a dual way, showing the standard rating for certain types of operation, and indicating that the container has been built and tested to a higher weight capacity.

<u>ISO 830 - 1981 Freight containers - Terminology</u>

The International Standard 830 is mainly a follow-up of other container related standards: It collects all definitions contained in these standards in a systematic order and produces them in the three official ISO languages English, French and Russian. The standard includes terminology related to container components and special purpose etc. Two further amendments, one of 1981 and one of 1988, give additional definitions.

ISO 1161 - 1984 Freight Containers - Corner Fittings - Specification



While ISO 668 describes the location of the corner fittings, ISO 1161 gives specifications as design and strength of the corner fittings. Insofar, it is another basic standard for many other systems interfacing with container transport.

As figures 1 and 3 in ISO 1161 demonstrate, the top corner fittings show a slightly other design than the bottom corner fittings. This had, some years ago, created a debate related to a „uniform corner fitting“ which would facilitate container production and spare part warehousing in the repair shops. In the end, the experts in ISO TC 104 decided that the small advantages resulting of the concept „uniform corner fitting“ did not justify the additional costs created by the change.

The corner fitting specified in ISO 1161 has very many „illegitimate“ brothers and sisters: Many containers and swap bodies show concepts deviating from ISO standards, and have their own design of corner fittings. But all such changes in design clearly keep the main interfacing patterns: All top corner fittings are designed for a standard spreader lift, and all bottom corner fittings (in many cases no longer located exactly at the bottom corner of the unit) are designed to interface with standard twist locks fitted on railcars and road chassis. But many bottom fittings do not offer lifting capability.

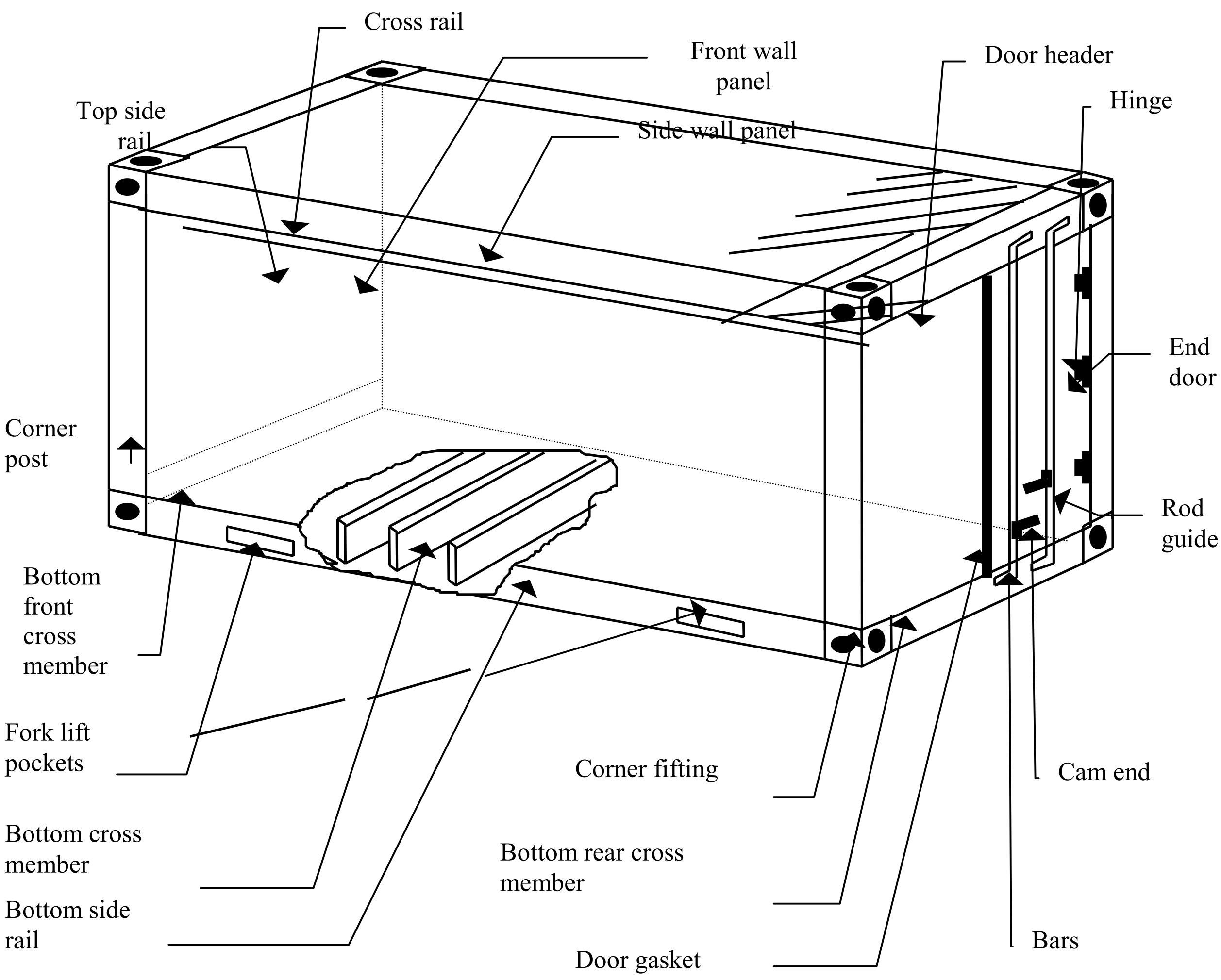
ISO 1496 Freight containers - Specification and testing

The ISO 1496 series of standards form the basic technical pattern of the container transport system. This series of standards describes all basic elements and strength values for the container system. The ISO 1496 series is basically made up in that way that ISO 1496-1 specifies all matters and patterns that are more general for the system. The following standards in this series (ISO 1496-2, ISO 1496-3 etc.) often quote these general patterns, i. e. repeat them as far as applicable.

ISO 1496 - 1 Freight containers - Specification and testing - Part 1: General cargo containers for general purposes

ISO 1496-1 : 1990 gives the main specifications of the various parts of ISO containers and, in another part, a detailed description of all tests that such a container has successfully to undergo, giving for all such tests the reasoning, the test procedure, and the test loads.

ISO 1496-1 says that, after such a test, the container shall show neither permanent deformation which will render it unsuitable for use nor abnormality which will render it unsuitable for use, and the dimensional requirements affecting handling, securing and interchange shall be satisfied.



This more general formulated clause had been debated within ISO TC 104. Some experts considered a clear and precise measurement to be included in the standard, i.e. some fixed value, kind of „if the remaining bend value of the longitudinal side bearing member after completion of the lifting tests does not deviate permanently more than 2,5 mm from the ideal horizontal line, the container is rendered to have successfully undergone the lifting tests “ Mainly the experts from the classification societies contradicted to such an idea. They said that a permanent deformation after test is a composite value depending from the material, construction method and design of the container and may be only judged in connection with all these factors. A given value of permanent deformation on a steel container may be tolerable, on an aluminium container not. ISO TC 104 followed these arguments and fixed the wording as quoted above in a more general sense, leaving the final decision to individual the expertise of the classification society’s personal.

Some smaller features have been added later: When the 40 ft. long and 8 ½ ft. high container came into operation, road operators needed a goose-neck chassis to keep the intermodal unit container and chassis within the legal road vehicle height limitation. So, the dimensions and location of a gooseneck tunnel had been added to the standard. This gives guidance to the manufacturers of a chassis how to design the gooseneck to fit exactly into the tunnel at the bottom side of the container.

In Europe, railways came into the container transport business at an early stage of the development. Railways in USA and Europe often used grappler arm fitted lifting devices in place of spreaders. Container owners wished to avoid that these grappler arms would take the container at the two longitudinal bottom side bearing members and possibly damage them. So, a grappler arm recess at the container had been specified in design and location as an optional feature.

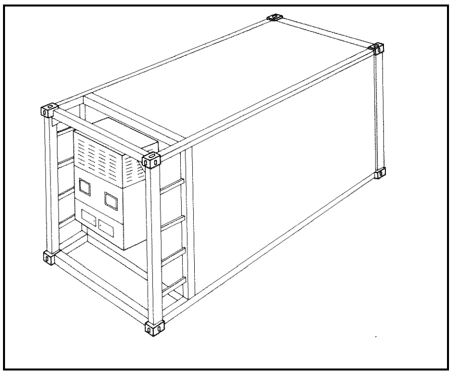
Another design feature of the container invited for frequent damages: the interface container -chassis. The design philosophy of the ISO container aims at a load transfer only through the corner fittings which are designed as the strongest part of the construction. Transferring this principle to road transport: The container shall have contact to the chassis and take over all load transfers only by and through the four bottom corner fittings. This created some problems with the road chassis design. It is rather costly to design a chassis on which all forces between chassis and container - i.e. a 30 480 kg static weight plus various acceleration factors during movement in road traffic - only are transferred through the four twist-lock bearing points. Some manufacturers sold „weak“ chassis. Under full load the container would rest on some intermediate bearing members of the chassis with its bottom construction during road operation. In consequence, frequent damages at the container bottom zone in the contact area occurred. So, ISO TC 104 established the principle that, if a contact between container bottom and chassis surface occurs in addition to the contact and load transfer through the bottom corner fittings, this contact area should be well defined to give opportunity to container and chassis manufacturers to reinforce such areas.

In the 1980’s, a further principle was added to the standard concept: It said: If the container is equipped with load securing devices, such devices shall be standardised in location and strength values. So, an annex F about cargo securing system had been added.

Most containers are built completely to the ISO 1496 specifications. The only deviation from this standard that rather often occurs is the fork lift pocket in the 40 ft. container. ISO 1496 clearly forbids such a fork lift pocket because this lifting method seems to be too dangerous in daily operation with 40 ft. units. Nevertheless some owners specify „their“ containers to be equipped with fork lift pockets mainly to facilitate empty movement on the yard. We have to state clearly that a 40 ft. container equipped with fork lift pockets does not qualify for the attribute „ISO container“ because it is not built to all specifications of ISO 1496.

Another deviation from the main features of ISO 1496 are so-called „weak containers“, i.e. containers that do not follow all strength values set out in ISO 1496, mainly in the test section. Practically all special domestic units in Europe and in North America belong to this „weak“ design class. Normally they do not create a specific hazard to trade and operation because they have other dimensions and a visibly other shape than ISO containers; so they normally will not be included in an ISO container operation by error. On the other hand, some containers are in operation that show all ISO dimensions, and have an outside appearance rather similar to that of ISO containers but less strength capability. Some ideas were discussed and finally realised to mark them in a way that this difference is noted (details in ISO 6346).

<u>ISO 1496-2 Series 1 freight containers - Specification and testing - Part 2: Thermal containers</u>



This standard deals with the most common special purpose container, i.e. with a container that is specially designed to carry cargo in a temperature controlled environment.

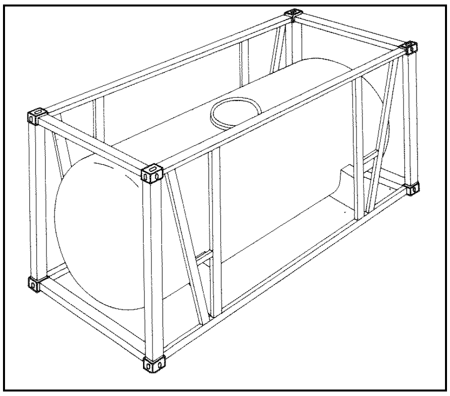
The basic feature of all thermal containers is the special insulation of walls, bottom and roof to hamper the heat transfer between the inside of the container and the outside environment. According to the various operational conditions the following basic design types are operated (and covered by the standard):

- only insulated, no machinery attached,
- equipped with machinery for heating and/or refrigeration, this machinery being detachable,
- equipped with fixed machinery for heating and/or refrigeration.

ISO 1496-2 covers a wide field of separate issues such as

- reduced inside dimensions caused by the insulated walls which are thicker than those with general cargo containers,
- air inlets for air duct inside the container,
- sockets for clip-on refrigeration machinery,
- heat leakage factors and their testing,
- performance features, i. e. how long the container is able to maintain a given inside temperature when the outside temperature has a given different value,
- electrical appliances of the refrigeration equipment.

ISO 1496-3 Series 1 freight containers - specification and testing - Part 3: Tank containers for liquids, gases and pressurised dry bulk



ISO 1496-3 covers a wide range of different tank containers . A large part of these containers is built in a way that a tank is fixed inside a complete framework of longitudinal and transverse bearing members. Such construction follows the principle that the outside bearing framework has to show all design features, notably strength features, of box containers , and that the inside tank must be designed according to its specific purpose. Later, some special design tank containers came into operation; in these design types the tank itself is a part of the bearing construction („beam tanks“).

Tank containers are classified generally in

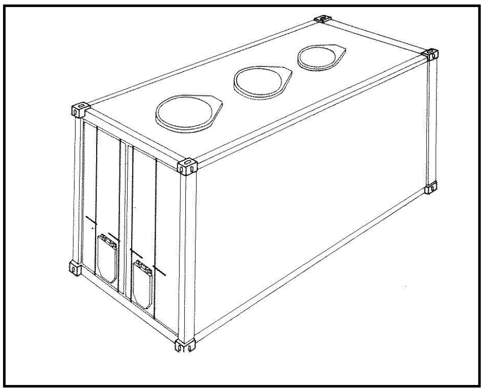
- tanks for non dangerous liquids,
- tanks for dangerous liquids,
- tanks for gases,
- tanks for pressurised bulk with horizontal discharge,
- tanks for pressurised bulk with tipping discharge.

ISO 1493-3 is by far not the only technical regulation a tank container has to follow. As tank containers are mainly used for the carriage of food stuff or dangerous commodities, a wide range of specific conventions and national legislation refers. Tank container design had been always a most complicated matter because this design had not only to incorporate the relevant standard, but as well many of the regulations and laws, some of them being contradictory to each other. Transport related legislation had been traditionally developed separately for each mode (e. g., ADR for road, RID for rail, IMO/IMDG for marine), and now a type of transport equipment appeared that can be carried in all modes.

The discussion on the development of tank container related standardisation was over all the years not only related to technical and operational features, but in addition about adaptation of legal regimes to the intermodal reality of today. In the earlier days, absurd things could happen: A tank container was filled in a chemical plant in Frankfurt. As this container was planned for carriage by rail to the port of Hamburg, this filling followed the legal requirements for a national rail transport in Germany (Gefahrgutverordnung Schiene - GGVO-Schiene). Now, a small delay occurred and the tank container was re-routed via Antwerpen to catch the same vessel that called at the port of Antwerpen some days later. The carriage to Antwerpen was to be operated by road, and for this the ADR has to be applied. But ADR and GGVO Schiene have different prescriptions as regards correct filling of a tank. So, the chemical plant managers had normally to empty the tank and to fill it again to remain legal. The absurdity of such scenarios is aggravated by the fact that there is a wide range of partly contradicting legal rules, but the governmental control authorities such as the highway police can by far not apply this complicated set of rules because they cannot know all details.

Tank containers are rather often designed to heavier loads than foreseen by ISO 668. Design types with a maximum gross mass up to 36 000 kg are in operation.

<u>ISO TC 104-4 Series 1 freight containers - Specification and testing - Part 4: Non-pressurised containers for dry bulk</u>



ISO TC 104-4 covers a design of containers that is not very frequent and covers a very specific market segment.

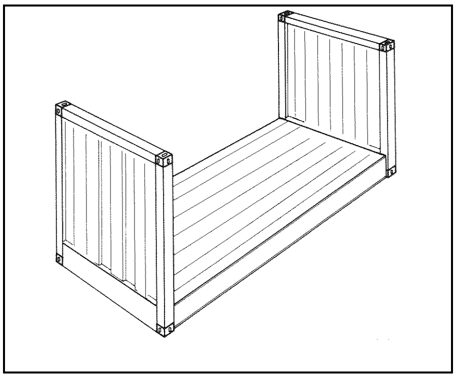
Non-pressurised dry bulk containers are either built as box type and look rather similar to general purpose containers, or they are designed hopper type to facilitate discharge by gravity.

As far as exchange with the outer air is foreseen such bulk containers are classified

- closed,

- vented,
- ventilated (i.e. enforced air draught),
- airtight.

ISO 1496-5 Series 1 freight containers - Specification and testing - Part 5: Platform and platform based containers



ISO 1496-5 covers a wide range of design types that are rather far away from the box container, but are designed to fit into the same system.

This standard includes design types such as

- platforms, i.e. flat equipment without any superstructure; the top corner fittings are located directly above the bottom corner fittings;
- platform based containers with fixed free standing posts;
- platform based containers with folding end structure or folding posts,
- platform based containers with roof,
- platform based containers with open top, some of them in addition with open ends (skeletal).

Platform containers are rather often operated for very heavy items, and so they are often rated higher than in ISO 668.

ISO 1496-VI c) Series 1 freight containers - Specification and testing - Part VI c): Platform based containers, open-sided, with complete superstructure.

ISO 1496-VI c is a standard from the early days of ISO container related standardisation work, covering a specific design of platform containers.

ISO 2308 - 1972 Hooks for lifting freight containers up to 30 tonnes capacity - Basic requirements

This rather old standard deals with a case that is, under today' s operation, rather exceptional: the lifting of a container not by spreader but by a conventional crane using hooks that are guided into the top corner fittings of the container.

This way of lifting has been widely abandoned in European ports and inland terminals.

ISO 3874 Series 1 freight containers - Handling and securing

The standard on handling on securing of freight containers is rather exceptional because it does not prescribe a specific technical assembly but describes best practices in container handling and securing.

The standard mainly describes the various methods to lift a container - laden and/or empty - and tells the people dealing with that problem details about lifting devices and access points at the container to introduce lifting forces, giving details as regards the various types of general purposes and special purpose containers.

Further details are dealing with the securing of containers on rail and road vehicles and on board ship. Specific attention is given to the securing on board ship because in such cases the container is almost always carried in stacks that need intermediate fixing, and because the ship's movements incur considerable dynamic forces with the stacked containers. Such details include lashing devices such as hooks, chains, turnbuckles, sockets, locks etc.

A further annex is in preparation that describes functions and minimum strength of various intermediate fixing devices.

ISO 6346 Freight containers - Coding, identification and marking

ISO 6346 is, together with ISO 668 and ISO 1496, the basic standard of the container transport system. ISO 6346 describes the software of this system.

As each container looks like the other, a clear identification of each single unit is essential to control the container flow. ISO 6346 establishes such a system including

- the definition of the structure of a data element indicating the individual identity of each container - incidentally: This data element was defined in the late 1960s, but is so modern in its shape that it fits fully into current information and electronic data interchange systems,
- the check digit that allows to detect more than 90 % of all incorrect identity data entries including the mathematical formula how to calculate it;
- the way how to obtain the owner' s code being a vital part of the identity data element,
- details how to display this information on the outside of a container.

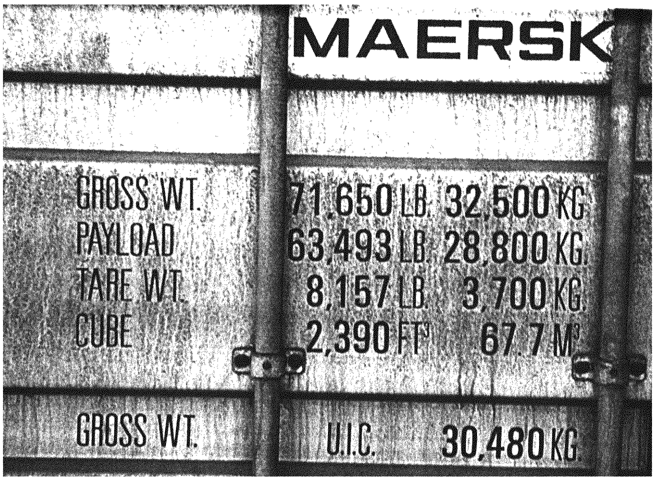
Example: HLCU 201989 4 is a 20 ft. container owned by Hapag-Lloyd Container Line. „HLCU“ is the owner's code, „201989“ is the current number, and „4“ is the check digit.

The identity marking system is widely used for non-ISO containers as well; this is according to the rules of ISO 6346 which allow identity marking to be used for non-ISO containers as well.

The other feature that ISO 6346 covers is a code on sizes and types of containers that allows to give in a four or five digit alpha numeric data element all details that are necessary to handle a container and to accommodate it on a vehicle or on board ship. ISO 6346 specifies that its size and type code may not be used for any other container than a unit with full strength features of ISO 1496. This prescription has been made to give to terminal staff a clear indication whether they are confronted with an ISO container having full strength or with a non-ISO container with lower strength features - the latter does not show the ISO marking for size and type code.

The third part of ISO 6346 describes markings related to safety of transportation and handling such as

- maximum gross mass,
- maximum payload,
- tare mass.



These three main elements of container marking

- the identity data element,
- the type and size code,
- the operational markings

have proved very successfully: Practically all container owners and operators keep their container marking strictly to the details of this standard, even in the case of containers that otherwise do not include all ISO standards features.

The certainly most successful part of ISO 6346 relates to the identity marking and the owner' s code. This code is meanwhile used for various additional purposes such as

- three-letter owner' s code and a „U" as fourth letter indicate a container owner's identity,
- three-letter owner' s code and a „Z" as fourth letter indicate the identity of a chassis owner,
- three-letter owner' s code and a „J" as fourth letter indicate the identity of the owner of container attached equipment such as detachable refrigeration clip-on units or intermdeiate bearing frames,
- three-letter owner' s code is further used as a stand alone code in order to identify a specific ocean carrier.

The success of this system of marking is such that the swap body related standardisation body, CEN TC 119, recently has published prEN 13044 which takes over practically all main features of ISO 6346 and applies it to swap bodies.

Finally, ISO 6346 gives rules for design, size and location of further operational marks, e. g. warning signs.

ISO 8323 - 1985 Freight containers - Air surface general purpose containers - Specification and tests
has been withdrawn by ISO TC 104 because it was not applied and used in practical operation.

ISO 9669 Series 1 freight containers - Interface connections for tank containers
ISO 9669 describes interface connections for tank containers such as

- testing and welding requirements for interface connections,
- flange connections,
- man-hole openings,
- screwheads.

ISO 9711-1 Freight containers - Information related to containers on board vessels Part 1 Bay plan system
and
ISO 9711-2 Freight containers - Information related to containers on board vessels - Part 2: Telex data transmission
The two standards ISO 9711-1 and ISO 9711-2 are out-mode meanwhile. They intended to give a standard system how to describe the scheme of container loading on board of a cellular ship, and they give some rules for the transmission of such an information by telex. Meanwhile practically all terminals create this information as an EDI / EDIFACT message (see chapter 4) and transmit the information by EDI mostly using a value added service.

ISO 9897-1 Freight containers - Container equipment data exchange (CEDEX) - Part 1: General communication codes
ISO 9897-1 relates to modern ways of automated communication, mainly in case of

- container damage description,
- container repair cost estimate,
- container repair order,

- container repair invoice.
-

ISO 9897-1 gives a large number of standard definitions and related codes for details for the above mentioned type of communications such as

- condition of container,
- condition of repair,
- location of damages,
- types of damage,
- material type,
- repair action type,
- repair work scale,
- responsibility for damage, party identification,
- components of container.

As a follow-up, ISO 9897-2 was intended to describe telex transmission details. But this work was stopped because the parties concerned - mainly leasing companies, depots, ocean carriers and repair shops - introduced widely electronic data interchange and telex data transmission of such data was out-mode.

ISO 9897-3 Freight containers - container equipment data exchange (CEDEX) - Part 3: Message types for electronic data interchange

The work scope of ISO 9897-3 and the related message development has been transferred from ISO TC 104/SC 4 to the EDIFACT Board so that the messages using the CEDEX codes and definitions are now developed and standardised within the EDIFACT system, while the responsibility for further development in the area of data elements and codes remains with ISO TC 104.

ISO TC 104/SC4/WG 3 currently enlarges the code lists into the area of special purpose containers and container chassis.

ISO 10368:1992 Freight thermal containers - Remote condition monitoring

Thermal containers on board ship normally need cold air supply. This air supply will vary from container to container according to desired range of inside temperature and the outside conditions.

Normally thermal containers are connected to a cold air supply system on board ship, the cold air is centrally produced on board ship. On land in terminal areas and on vehicles, these containers are equipped with an additional clip-on unit that consists of a motor, a refrigeration aggregate, and a temperature monitoring and regulation system. On board ship, each thermal container is monitored individually and the cold air supply is regulated according to the individual needs of the container. Furthermore, an electronic surveillance system will inform the crew on the bridge of the ship about the individual status of each container.

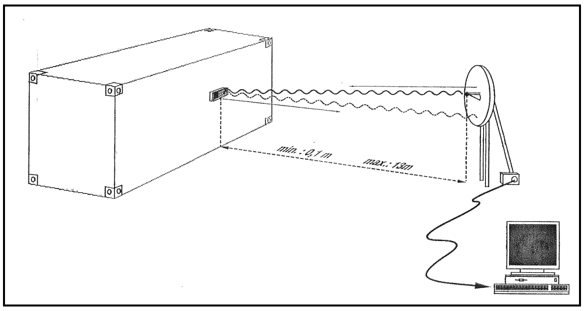
ISO 10368 standardises the communication interfaces of these surveillance systems with the container monitoring system.

ISO 10374 - 1991 Freight containers - Automatic identification

ISO 10374 describes the requirements of a system for automatic identification of containers based on communication exchanging signals between a tag (data carrier) on the container and a way-side reading device installed at a distance of 1 - 12 metres.

The main body of the international standard ISO 10374 describes the technical features that any system of automatic identification for containers has to fulfil.

The automatic identification itself means the automatic reading of the identity markings of containers as laid down in international standard ISO 6346, and the transmittal of this information into automatic data processing systems.



The automatic reading and transmittal of the container identity is accompanied by some other data that are automatically read out of the electronic data carrier and transmitted as well. Such data relate to

- outside dimensions of the container
- tare weight of the container
- maximum gross weight (mass) of the container
- type of the container as coded in ISO 6346.

Automatic identification does not only aim at automation of this process. But it aims at a large improvement of reliability of the recognition of container identity markings. ISO 10374 specifies a maximum error rate of 1 : 10 000 in an error resulting in a "no read", and an error rate of 1 : 1 000 000 in an error resulting in a "wrong read". The system is not just automation; it is a quantum leap in recognition reliability compared to identity recognition and transmittal into data processing systems by human activity.

Some operators wish to introduce freight information systems that use a "dynamic" tag, i. e. a tag that is not only able to store data transmitted into it, to have these data ready for reading, but to offer as well the capability to change such data. Other operators argue that simple data storage in the tag is sufficient. The best compromise in that field is a system specification as asked by the European Standardisation Committee CEN: Any system of automatic identification should be capable to be eventually enlarged into a dynamic (= read and write) function, if the application side desires so, without a change of system installations. Practically all systems that are today installed or under discussion for automatic container identification according to ISO 10374 are capable of such an enlargement.

ISO TC 104 SC 4 currently works on first ideas for performance and data content in such a dynamic tag, especially to monitor and transmit data concerning the inside temperature of thermal containers.

ISO 10374 Annex B describes a protocol and encoding scheme for the transmission of data between reader and data carrier that had been patented by a private company. When the owner of the patent for the protocol as described in ISO 10374 Annex B had announced to give any desired license for all intermodal transport applications practically free of charge, ISO TC 104 decided to suggest Annex B to become normative. A clear majority voted in favour of such a normative character of ISO 10374 Annex B, and today it is an integral part of the standard.

CEN, the European Standardisation Committee, followed this move and decided ISO 10374 including all Annexes as a European standard EN 10371.

Some ocean carriers have fixed electronic tags according to ISO 10374 on their containers, so that today more than 1 million containers may carry such a tag.

All applications of this technology on ISO containers, swap bodies, and rail-cars will use, in Europe, the 2450 MHz frequency band. This feature safeguards that there cannot occur interference between these applications and future European road transport and traffic telematics which use frequencies in other frequency bands.

1.1.2.3 Short history of TC 104 standardisation

ISO TC 104 had been founded in the 1960s to standardise the features of the new container system that was introduced by a US road carrier, McLean, who subsequently installed Sea-Land Service Inc. as his ocean carrier department.

Containers had by far not the shape and sizes as today. In the starting period the experts had to choose between the width concept of the European Continent (2500 mm) and the Anglo-Saxon world (USA, Great Britain, Ireland, India ...) with eight ft. = 2438 mm width. When the USA politicians indicated that they were not inclined to expand current width for road vehicles to 2500 mm, the decision was already inevitable. The container was standardised to a width of eight ft.

At the same time, the height was standardised as well at eight ft. so that a seems-like logical concept was achieved: 8 x 8 ft. diameter.

The length concept was equally under controversy. Sea-Land Service had established a large fleet of containers with a length of 35 ft. (10,7 m). This had been the maximum trailer length in some important US States at the East Coast at the late 1960, and the main business of Sea-Land was to carry the trade between the US East Coast and San Juan, Puerto Rico.

ISO TC 104 experts preferred a modular system, so that 2 short containers would make up the same length as one long container. This should enable road carriers to load either one long or two short containers on a similar length road chassis. In the first move, the modular system based on container lengths of 10 ft., 20 ft., 30 ft. and 40 ft. was accepted while Sea-Land experts tried in vain to include their company size of 35 ft. into the ISO system.

Interesting to know that the full 40 ft. length was legally not permitted in most European and North American States at that time. It was a length created at the designers' desk with little connection to the reality. But soon more and more governmental authorities granted exceptional permits for the road operation of 40 ft. containers, mainly for the reason to include the future economic blessings of the new system into their transport industry. Furthermore, the US Armed Forces made use of 40 ft. containers for their military logistics, and in many areas they had the right to operate their units over the road under a general exemption of local legislation concerning road traffic.

The Europeans hesitated to agree into the dimensional concept of this new container system. They indicated that the limitations of their infrastructure did not allow for the operation of 40 ft. long semi-trailers; furthermore they said that regarding the average size of a consignment in European foreign trade the ISO container was by far too large. They would prefer smaller containers, e.g. boxes with 5 tons capacity. So ISO TC 104 found a compromise: The Europeans agreed to the US generated size concept, and ISO TC 104 established a Sub-Committee 3 „Freight Containers - medium size containers". The secretariat of this SC 3 was given to the Soviet-Union who claimed to operate very large amounts of such medium size containers. In the years to follow, SC 3 never initiated any standardisation work, and after some decades of inactivity it was dissolved.

Container operators introduced rather early a concept of 8 ½ ft. (2496 mm) high containers achieving some 7 % additional volume per unit. This concept was taken over quickly by the industry. In that period ISO container standardisation had been in a dilemma: The vast majority of the world container fleet was outside the ISO standards - either with a height of 8 ½ ft. or a length of 35 ft., both values not incorporated in ISO 668 and ISO 1496.

Finally, ISO TC 104 decided in the 1970s to include the 8 ½ ft. height concept into international standardisation, and once more rejected the inclusion of 35 ft. So, Sea-Land was forced to give up their company size and to switch over to the ISO 40 ft. system. ISO had again caught up with the reality and covered the majority of the world container fleet with its standards.

Another problem was related to the standardisation of the corner fitting - a vital detail for the container handling system. The corner fitting design was covered by a patent owned by Strick Corp., a major US road vehicle manufacturer. When Strick gave up their patent rights, the road was free for ISO 1161 and the current standards on corner fittings.

The conflict between the European logistic system based on pallets and the ISO series 1 container system remained, and so did the debates about the „right“ system approach (see chapter 1.3).

This created concern in the developing countries too. They had experienced the introduction of the ISO container system as a serious affront against their endeavours to participate in world sea borne trade. When they had purchased their first conventional multi use ships in the 1960s, the industrial nations introduced containerisation and made the ships of the developing countries out-mode.

The developing countries feared that a second step of this development would follow. Once the developing countries have fully invested into the ISO container system, the experts in ISO TC 104 would convene and abandon the ISO Series 1 container and replace it by a new optimised unit, leaving once more the developing nations with their investments behind.

In consequence, UNCTAD as a speaker of the interests of the developing nations made a move towards the establishment of an International Convention on Container Standards. This Convention was intended to give ISO container standards a sort of legal status, making any change of these standards to a matter of an intergovernmental conference.

The industrial countries strongly contradicted this concept and emphasised the voluntary aspect of international standardisation - both in creation and in application of standards. After two international conferences UNCTAD finally gave up the idea of such a convention and ISO promised to keep container standards stable and to discuss any major change with the world community well in advance.

Another feature of ISO standardisation was included into an international convention: In 1972, the United Nations convened an international conference that concluded the „International Convention for safe Containers (CSC)“ which came into force in practically all major countries in the following years. CSC is very much based in its technical content on the container safety and strength concept set out in ISO 1496.

In the late 1980s, a new debate about container sizes started. This debate was inspired by the a major change in US road vehicle legislation. As a result of the new Interstate highway system the USA started a federal initiative towards uniform legislation concerning commercial road vehicles operating on the federal highway network. As a result, US trailers were allowed with an increased width of 8 ½ ft. (2596 mm), and with increased lengths. The length concept changed over the years, starting at 40 ft. (12,2 m), changing to 45 ft. (13,7 m), thereafter to 48 ft. (14,6m) and has arrived today at 53 ft. (= 16,2 m).

Ocean carriers and US rail-roads developed non-ISO containers taking over the new enlarged sizes.

ISO TC 104 recognised the everlasting demand of trade for larger unit and developed the concept of an ISO series 2 container. Details of this development and the discussions to follow are given in chapter 3.3. Finally, ISO TC 104 decided to „freeze“ this concept, i.e. to stop all further discussions and to stop the further procedural development of this matter, leaving open whether the concept would be re-vitalised one day or abandoned forever.

Only one feature remained from this debate about larger containers: ISO TC 104 acknowledged the „high cube“ container, i. e. the 40 ft. container with an increased height of 9 ½ ft. (2900 mm) and included this container into the ISO standards, mainly into ISO 668. Since then the introduction of high cube containers into the maritime transport has accelerated and today 1/3 of all 40 ft. containers might be built as high cube units.

In the same period, i.e. in the beginning of the 1980s ISO TC 104 increased their work on the software of the container transport system, i.e. on matters such as

- computerised communication,
- automatic identification,
- common data elements and codes, and common data base structure.

For this purpose, the Working Group on coding and marking was promoted to Sub-Committee 4 Freight containers - Marking, coding and communication.

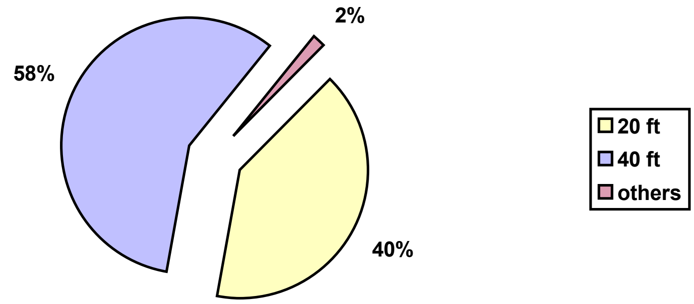
Today the technical or physical concept of the ISO container is rather stable, and only smaller refinements are debated in ISO while the software development of the system moves forward, and ISO TC 104 SC 4 remains rather active.

1.1.2.4 Number of containers in operation

An official statistic of containers in service does not exist. But the monthly journal ***Containerisation International*** used to publish a well established world container count set together from data researched by their expert. The last container count was published in 1996 and gave the following figures:

	TEU
maritime 8´ widtht	10.025.141
domestic 8´ width	92.485
Intermodal US 8´6´´ width	156.979
Trailer 8´6´´ width	41.350
inland container Europe 2,5 m breit	41.862
swap bodies	215.225
swap tanks	7.547
Total	**10.580.589**

Maritime containers - length classes



Maritime containers - length classes

length	20 ft	40 ft	24 ft	30 ft	43 ft	45 ft	48 ft
TEU units	4.014.840	5.804.378	11.736	13.164	9.976	119.187	1.860
TEU %	40,25	58,19	0,12	0,13	0,10	1,19	0,02

(World Container Census 1996)

1.1.3 The Work of CEN TC 119

1.1.3.1 Some basic questions related to European CEN standardisation

European standardisation includes some particular questions of general nature that need to be addressed for full understanding of some issues mentioned later.

While ISO standards are voluntary in their application, CEN standards, once agreed by a majority of European standardisation associations, have to be implemented in the national standards collection of all European member countries. If CEN decides to start standardisation work on a given issue, all European national standardisation organisations have to interupt their national standardisation work in that field and co-operate on European level. This „Standstill Agreement“ is surveyed by the member countries of the European Union according to Directive 83/189/EEC.

CEN and ISO have agreed on co-operation in the Vienna Agreement. Furthermore, many national standardisation associations outside Europe co-operate with CEN. Mutual Recognition Agreements on European Standards have been completed with Australia, New Zealand, the United States and Canada and are developed with third countries as well as with countries in the accession phase to the EU. [United Nations Economic and Social Council, Economic Commission for Europe, Committee for Trade, Industry and Enterprise Development, Working Party on Technical Harmonisation and Standardisation Policies, Report on the 8th Session, Geneva 18-20 May 1998, par. 15.]

The degree of governmental influence on the standardisation process varies in Europe from country to country. The statement *„the European standards organisations function as quasi-government entities“* (as given in the report on standardisation, prepared for the 2nd EU/USA Workshop on Intermodal Freight Transport, 22

September 1998: „INTEROPERABILITY IN INTERMODAL FREIGHT TRANSPORT“), is certainly not applicable to the majority of European standardisation associations. The standards are usually not developed by a combination of internal staff, paid contractors and technical representatives from industry who write the standards (as wrongly indicated in the document quoted above). In Germany, e. g., DIN standards are developed by industrial experts who volunteer to do their work, and who are not paid by the standards association or the government for their endeavour. Even their travel expenses to attend the meetings have to be borne by themselves or their employers. The DIN administration is financed by membership fees from the German industry, the revenues from sale of printed standards documents, and from a limited governmental grant. Most European standards associations show rather similar structures.

The European swap body standardisation, e. g., is completely independant from any governmental influence: The secretariat of CEN TC 119 is fully financed by FAKRA, the German Standards Association for Automobiles, and this Association is fully financed by the German Automobile Industry. A „paid contractor“ never appeared in European swap body standardisation.
The European industrial partners of the standardisation process recommend clearly the principle of industry’s responsibility for standardisation, and warn about governmental guidance in the process. [Daimler-Benz: „Normung 2010“, Stuttgart 1998, p.19-21.]

On the other hand, the European Commission has in the past, and continues to do so, given clear comitments to CEN Committees to develop and agree on European standards as a means of urgent technical harmonisation and removal of trade barriers in the European Union. Such orders have been normally accompanied by a limited financial aid to speed up the process.

Most European national standards associations (and, incidentally, ISO as well) demand full participation from all parties interested in the results of standardisation, especially users and producers of the equipment under consideration, and professional agencies caring for operational safety. The German rules for standardisation, DIN 830, say that a valid standard committee must consist of such wide representation. If a Committee would close attendance and limit participation, they were, under German law, regarded as a cartel seeking to agree on joint technical conditions, and subject to legal prosecution.

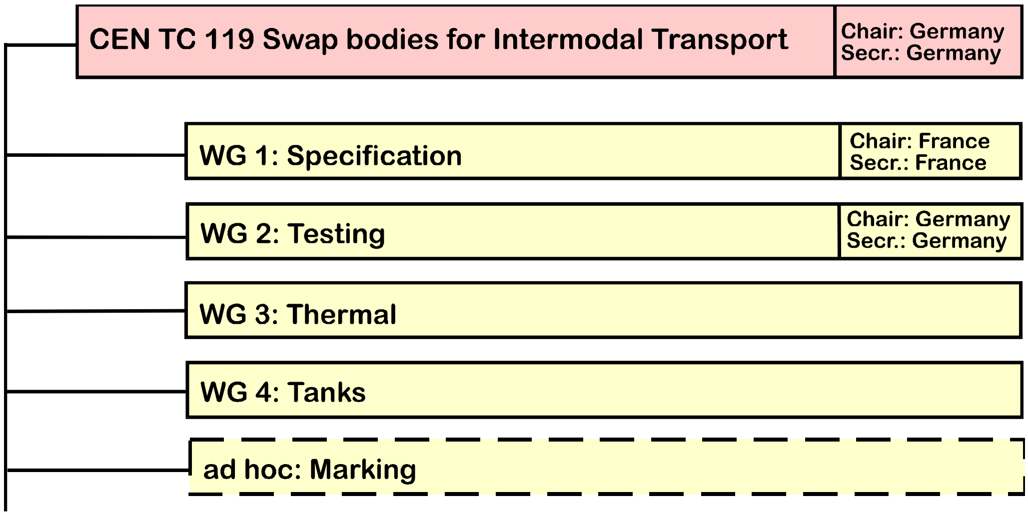
1.1.3.2 The structure of CEN TC 119

The scope of CEN TC 119 is as follows: "Standardisation of swap bodies intended for transport within Europe, including interchange between the different modes of transport. Standardisation of the minimum requirements and best methods for lashing points on commercial vehicles, with a gross vehicle mass exceeding 3,5 t and their trailers.“

This scope had been initially limited to road/rail, but when the first deliberations about stackable swap bodies started, it was well understood that such unit loads would be mainly interchanged between waterborne transport means and road/rail, so this limitation had been dropped and the scope of CEN TC 119 covers now swap bodies for all modes of transport.

CEN TC 119 has no Sub-committees but works mainly through its plenary as decision body. This plenary meets normally once per year.

Details are discussed in Working Groups. These working groups consist of various experts who come together, discuss and eventually vote on behalf of their personal expertise, while the plenary works on basis of delegations representing their National Standardisation Association and voting on behalf of them. This working structure is similar to that of ISO.



CEN TC 119 is, since its foundation, chaired by Dr. Christoph Seidelmann, Germany.

The most active working group of CEN TC 119 is WG 1 Dimensions and general specifications. This working group deals mainly with the outside and internal dimensions and the handling features of swap bodies, mainly on base of general purpose swap bodies. This working group is traditionally chaired by a French expert.

The strength features and safety related details are dealt with in CEN/TC 119/WG 2 Testing. This working group is chaired by a German expert.

Two further working groups deal with special purpose swap bodies, partly working on an ad hoc basis, i.e. only if standardisation work in this specific area is needed and with changing ad hoc chair and administration:

CEN/TC 119/WG 3 Thermal swap bodies
and
CEN/TC 119/WG 4 Swap tanks.

A special ad hoc working group, chaired by TC 119 Plenary chairman, has worked on a new standard on swap body marking, coding and identification.

1.1.3.3 Current standards of CEN TC 119

The following standards have been elaborated and set in force by CEN TC 119:

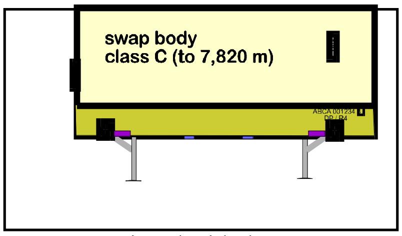
<u>EN 283 : 1992 Swap bodies - Swap bodies of class C - Testing</u>

This standard gives the strength requirements for swap bodies and describes the test cycles. It is very near to the relevant UIC leaflet concerning the same matter, i.e. UIC 592-4. As a full convergence of both sources for safety requirements for swap bodies is desirable, both CEN and UIC are planning to enter a dialogue how to streamline the procedure.

<u>EN 284 : 1992 Swap bodies - Swap bodies of class C - Dimensions and general requirements</u>

This standard gives the specification, mainly inside and outside dimensions and handling features, of the 7 m long family of swap bodies that are intended to be carried in road transport on road trains. The standard fixes three length categories:

- 7 150 mm
- 7 450 mm
- 7 820 mm



The 7 150 mm length was in 1992 the standard length of the overwhelming majority of swap bodies in operation in Europe. When the European Union decided on a new concept of road vehicle dimensions, two new features were added:

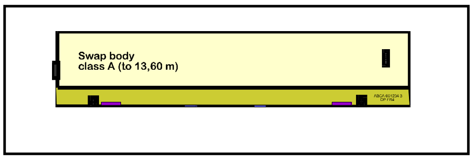
- additional lengths of 7 450 mm and 7 820 mm
- additional width of 2 550 mm.

Meanwhile the swap body manufacturers report that the vast majority of new built swap bodies are ordered with the extended lengths of 7 450 and 7 820 mm, and with the new width of 2550 mm. This fact invites for the prediction that the traditional. swap body of 7 150 mm length and 2 500 mm width will run out one day and might be later removed from this standard.

<u>EN 452 : 1995 Swap bodies - Swap bodies of class A - Dimensions and general requirements</u>

deals with swap bodies for use on semi-trailers. Currently three length categories have been included

- 12 200 mm equalising the 40 ft. ISO container,
- 12 500 mm representing the traditional semi-trailer length in Europe,
- 13 600 mm representing the maximum semi-trailer length allowed today in international European transport.



EN 1432 : 1997 Swap bodies - Swap tanks - Dimensions, requirements, test methods, operation conditions describes a small but commercially very important part of the European unit load family, the swap tank.

EN ISO 6346 : 1995 Freight containers - Coding, identification and marking
and
EN ISO 10374 : 1997 Freight containers - Automatic identification
are taking over identical international standards prepared by ISO.

This feature needs an explanation: While the acceptance of ISO standards is voluntary, a CEN standard gives a higher quality and rigidity. Once a CEN standard is decided on, all national standards in CEN countries dealing with the same subject have to be withdrawn by their national standardisation association and to be replaced by the CEN standard.

Once a CEN Technical Committee has decided to work on a specific item for European standardisation all CEN member associations are obliged to stop national standardisation activities in this field.

Public authorities in the European Union are obliged to base any tender for purchasing material or installing new systems on the technical specification contained in the relevant CEN standards if the subject concerned is covered by European standards.

CEN TC 119 has decided to put more emphasis on these two ISO standards concerning identification by incorporating them into the European standards list. Details of these ISO standards are given in chapter 1.1.2.

Another CEN standard has arrived at a final voting status: prEN 12406 Swap bodies - Thermal swap bodies Class C - Dimensions and general requirements.

In addition to the standards already decided on, CEN TC 119 works on the preparation of some additional standards covering new subjects, these drafts yet being in the pipe-line (as per April 1999) :

Draft European standard on swap bodies stackable in laden condition.
The document CEN/TC 119 N 135 „Swap bodies for combined transport - Stackable swap body type C 745-S16 - Dimensions, design requirments and testing“ is a draft that has reached a well advanced state. It describes a class C swap body with 7 450 mm length and 2 550 mm height equipped with fixing devices on the bottom, located at ISO 20 ft. distance, and with top corner fittings prepared for lifting and stacking forces, located at ISO 20 ft. container position, i. e. symmetrically inside at 6 080 mm length and 2 438 mm width position. CEN TC 119 has recently decided to specify this box at full ISO strength features. So, the stackable swap body C 745 must be able to withstand a six high stacking load at 1,8 g gravity factor (this factor simulating the additional vertical force introduced into a container or swap body on board ship on rough sea, or when lifting it with high acceleration quay side cranes) and with the full racking load of ISO containers as given in ISO 1496.

During the discussions on this standard a minority view was noted saying that a three high stacking and a reduced racking load was sufficient.

In the year 1999, CEN TC 119 WG 1 intends to start the work on a similar standard for a 13600 mm length stackable swap body. The preparatory discussion was covering the issue whether a 13 600 mm length or a 13 720 mm length (= 45 ft.) would be more appropriate, noting that the European legislation allows only a maximum length of 13 600 mm for semi-trailers and unit loads carried over the road. But a small protrusion in the area of the front end is legally allowed, as long as the corners of the construction remain at the 13600 mm length distance. This protrusion can be used to fit a refrigeration unit, or to achieve some additional internal cubic space. In such design the total length of the unit may go to 45 ft. or 13720 mm. CEN TC 119 has decided to base its future standard on stackable class A swap bodies on the 13 600 mm length concept (rather than the 45 ft. = 13 720 mm length concept using the protrusion). The experts represented in the plenary reported unanimously that the design of a 13 720 mm long unit with rounded corners at 13 600 mm distance would create, on the one hand, additional costs and complication in manufacturing, wile the gain in inside length is minimal and does practically not allow for the accommodation of additional pallet loads. (When exercising a most complicated stowage pattern, one might possibly accommodate 1 more pallet load, but this at the price of difficult loading and discharge operation.)

Another discussion was dealing with a swap body being stackable only in empty condition. Finally, the CEN TC 119 experts found that there was no commercial need and justification for such a design type and abandoned the idea.

<u>prEN 13044 Swap bodies - Coding, identification and marking,</u>
has reached a well developed state.

Swap bodies must currently be approved and receive their identity number under the rules described in UIC leaflet 592-4 and 596-6 to be allowed in European rail transport, i. e. to fit for intermodal operation.

Today, both procedures

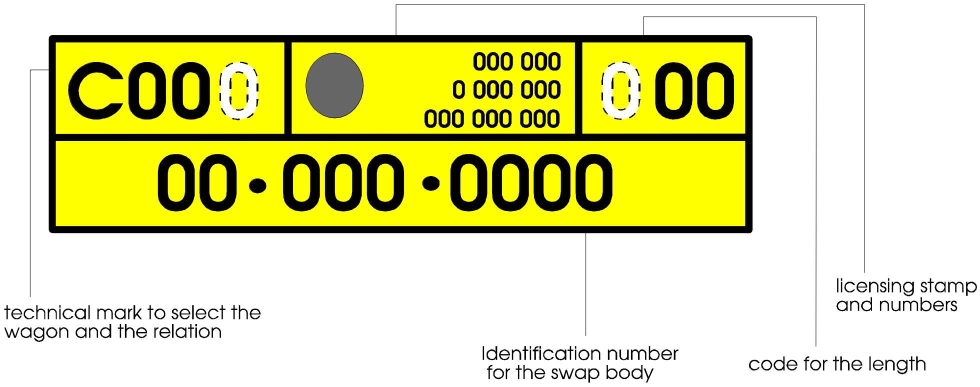
- allocation of a unique identity, and
- technical approval for intermodal transport

are executed in a common regime.

The owner of a swap body receives, together with the approval according to UIC rules, an individual number. This number consists of

- a 2-digit number to specify the railway administration that granted the approval,
- a 2- or 3-digit number to specify the owner of the unit approved,
- the individual number that this owner has allocated to that specific unit, in most cases a 3- or 4-digit number.

This number is today part of the codification plate (see following picture) and displayed in the lower line of this plate. Each swap body that is operated in intermodal transport in Europe must carry such an approval plate.



Current Codification plate for swap bodies

The owner of the swap body may, if he wishes, apply for an owner's code similar as for ISO containers with Bureau International des Containers following International Standard ISO 6346 and mark the unit, in addition to the approval plate, with an identity marking according to that of freight containers. Some forwarders, mainly those engaged in the tank business, do so since some years.

The combining of technical approval and allocation of an individual number in one procedure creates unnecessary difficulties: When an UIC approved swap body is sold to another party, the new owner must remove the previous identity number and mark the swap body with his owner number and his individual number. But as the procedure of identity number allocation has been integrated into the procedure of technical approval, any change of the numbers implies a full new approval procedure. This may go over four weeks time. This means the swap body will be immobilised for four weeks. This incurs additional costs that will be allocated to intermodal transport operation.

The current regime of marking and approval of swap bodies has developed over the last 25 years. It does no longer meet all needs of today. Therefore, Bureau International des Containers and its partners check the current procedures with the aim to suggest modernisation by the new standard. This is executed within a PACT project under co-financing of the European Commission.

So, the new draft European standard suggests to organise the indent number allocation similar as the procedure with ISO containers, and to design the data element „Identity of the Unit" according to the same rules. This includes the following principles:

The identity number is no longer allocated within the procedure of technical approval.

Each European carrier and forwarder may apply with Bureau International des Containers for a European Owner Code. This must be done once in his life, and this code will be allocated by Bureau International des Containers to the company as long as the company is commercially active, without any intermediate change. The code can be used for all units that are operated by this code holder. The principle is: One company, many intermodal transport units, one owner's code.

Each forwarder will mark his units with an identity marking, consisting of the 4-alpha owner's code (allocated to him by Bureau International des Containers), an individual number composed of 6 numerals in free selection of the owner, and a check digit that is calculated according to the rules set out in ISO 6346.

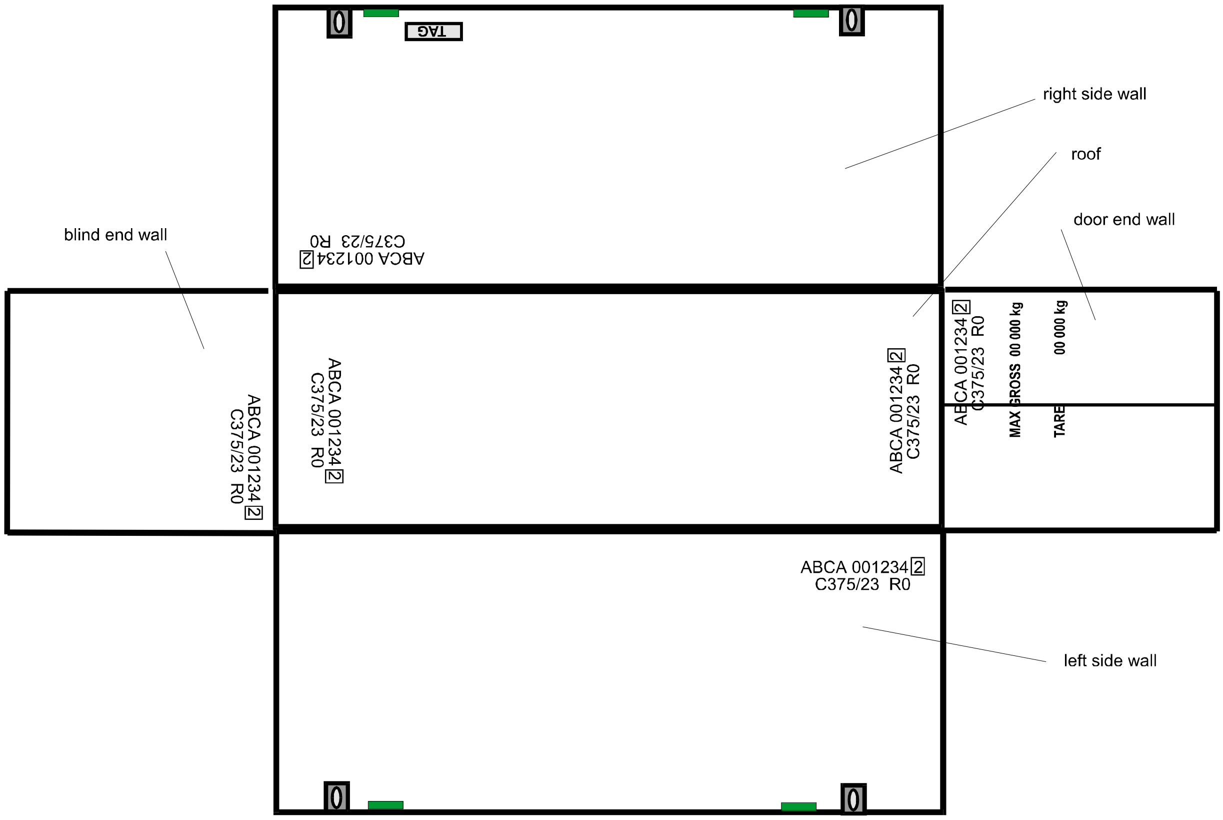
In parallel to the new identify marking regime the other markings on a swap body must be re-considered with the aim to adapt them as far as possible to the marking regime well established with ISO containers. Therefore, the new European standard suggests, together with the new identity markings (e. g. „DAXE 000145 9" or „CNCK 206005 4"), the following new elements of swap body marking:

All swap bodies shall carry, the railway profile code and the length code for swap bodies. The profile code has been elaborated by UIC together with Interunit. This code shows on which railway lines such a swap body, when carried on a standard platform height railcar, can be operated without difficulties. The length code has been elaborated by the Technical Committee of Interunit and has been incorporated into prEN 13044 as an Annex. This code describes the length of the loading unit and the location of its bottom corner fittings. Example for a profile and length code: C 358 / 23.

All swap bodies shall carry, adjacent to the profile code and length code, a type code that describes the design type of the swap body. The code tables for selection of the correct type code are contained in the standard as a further annex. Example: A stackable swap body, box type, 34 t max. gross weight, will show the type code „D0".

All swap bodies shall show, on their front end, a marking of their maximum gross mass and of their tare mass. Example: MAX GROSS 16 000 KG; TARE 2850 KG.

Some swap bodies will have to carry, in addition, warning signs. Such warning signs will indicate, e. g. for stackable swap bodies, that some limitations in stacking feasibility incur, or they indicate extraordinary height of the swap body. If the roof of the swap body allows people walking on them, a warning sign indicating the danger of high voltage overhead electric wires with most European railway lines will be indicated.



Picture 3: Markings at a swap body

1.1.3.4 Short history of CEN 119 standardisation

In the early 1980s, the swap body transport system based on a national standard in Germany, Austria and some other countries had well developed. It had become clear that the swap body was to become the backbone of European intermodal transport.

In this time, two initiatives led to the establishment of a European standard CEN Technical Committee.

The EU Commission had some concern that various swap body systems might develop separately and without any harmonisation in Europe. The Germans and their main trading partners had standardised the 7,15 m swap body. France worked on a swap body with a length adapted to the French semi-trailer; this swap body had a specific, out of common standard front end corner fitting. Sweden and Norway developed their own systems.

So, the EU Commission asked a consultant to prepare a survey on the various systems in operation in Europe, and elaborate suggestions for a European harmonisation of the developments.

In the same period, the French and the German intermodal transport operators had been confronted with some difficulties in international swap body transport because French and German railways had differences in judgement what on criteria of swap body safety in rail transport. So the intermodal transport operator and railway experts established a French-German co-ordination body to harmonise these small differences.

In the end both developments resulted in the establishment of CEN Technical Committee 119 Swap bodies for intermodal transport road/rail. The French and the German standard experts took over the main responsibility for this work.

In the beginning of the work the parties agreed on an approach that the German 7,15 m swap body was the basis for the future class C swap body and the French design was the basis of the future class A swap body.

The work progressed less quickly than thought, partly because the standardisation work proceeded in a period when the main configuration and dimensions of road vehicles were under debate and later on changed in Europe. The parties of CEN TC 119 wished to adapt their dimensional concept to changing legislation. When this debate came to a conclusion in 1990, the standardisation work on class C was completed and settled.

The standardisation of the Class A swap body followed, and work continued on some special purpose swap bodies.

In the years to follow, CEN TC 119 started two further great projects: The adaptation of swap body marking to that of ISO containers promoted by a PACT project, and the elaboration of standards on stackable swap bodies that would fit for waterborne transport on ships in stack. Both projects are currently (April 1999) underway with good auspices for European agreement.

A side activity was established in the late 1990s. CEN decided to standardise cargo securing devices built in road vehicles and swap bodies. CEN TC 119 took over this task and developed the appropriate standards.

1.1.3.5 Number of standard swap bodies in operation

Interunit organises a count of such swap bodies that undergo the approval procedure for intermodal transport road-rail as foreseen in the UIC leaflets 592-4 and 596-6. These figures have to be noted with the following infringements:

- Not all administrations that approve swap bodies according to that scheme regularly communicate the numbers of approvals made by them.
- A great number - possibly the majority of swap bodies - are never approved for intermodal transport road-rail and so are never counted in this approval list.
- The count does not take into account that a given number of swap bodies goes out of service after the normal depreciation and service period. So, the figure gives the annual addition to the fleet, but not the number of units that go out of service.

- The table shows only the results from such countries where approval of swap bodies according to UIC leaflets 592 and 596 normally takes place. Swap body owners from other countries normally have their swap bodies, if need be, approved in one of the countries as shown in the table.

Table: combined transport units codified in Europe

country	box length or length class							
	swap body / container						semi-trailers	combined transport units total
	= 20 ´	class C	< 7,82 m to 30 ´	< 30 ´ to 40 ´	< 40 ´ to 13,60 m	box type total		
AT	295	8.392	503	750	486	10.426	1.733	**12.159**
BE	116	333	1.268	213	699	2.629	1.888	**4.517**
CH	390	3.196	156	8	-	3.750	464	**4.214**
DE	1.171	69.289	929	194	1.786	73.369	10.143	**83.512**
DK	-	120	-	-	-	120	20	**140**
FR	1.732	1.012	1192	79	2.959	6974	1.900	**8.874**
IT	63	7.202	2926	351	3.151	13.693	2.025	**15.718**
NL	259	479	125	32	211	1.106	4.411	**5.517**
total	**4026**	**90.023**	**7.099**	**1.627**	**9.292**	**108041**	**22.584**	**130.625**

Source: Interunit - units codified until June 1997

1.1.4 Standardisation of the logistic chain

1.1.4.1 Standardisation of palletised unit loads

In the 1950s the pallet was introduced in European distribution systems. The pallet became soon the universal means of movement of packages, covering all fields of material flow (within the production flow and warehousing system of the industry), ramp activities (at the interface between production and transport on public infrastructure), consolidation activities and intermodal transfer (at the interface of less than truckload collection and consolidated truck load long-distance transport, and in transfer points road/rail, road/water transport and rail/water transport).

The wooden flat pallet offered important advantages: The entry into the system is rather cheap, but the system can be enlarged into a fairly well developed degree of automation. A pool pallet of 800 x 1 200 mm with a well maintained quality standard will cost about 7 Euro, and fork lift vehicles with a capacity for maximum lift at 300 - 1 000 kg are available at rather low price. In this range of activities, even some hand driven equipment is available.

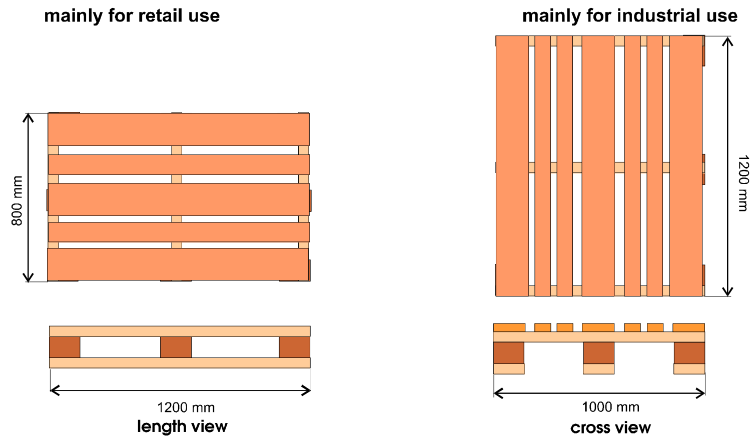
At the other end, automatic guided and controlled conveyor belt or automatic guided vehicle systems are available that move pallet loads without the need of human guidance or surveillance over the factory grounds. In addition fully automated multi-story warehouses have been built with computerised control of each pallet storage place.
Freight consolidation centres use as well pallets but with less automation because of the diversity of freight items to be handled. These freight centres are normally organised to the principle: Each item, when it arrives, will as a first activity be loaded onto a pallet if it fits for this.

In transport, pallets have an extremely valuable attribute: They need in empty movement less than 10 percent of the space they fill in laden movement. With other words: the eventual empty return movement can be performed rather cheap and efficient.

The main discussion in the 1950s and 1960s was about the base dimensions of flat pallets in Europe. The consumer goods industry preferred the size 800 x 1200 mm. The main reason for this was the need for hand labour in commissioning. Normally, the consumer goods whole-sale trade would buy each item in full pallet loads and store these laden pallets in multi-story warehouses. Each retail outlet would give daily orders for items to refill their self-service shelf - but practically each item in a less than pallet load quantity. So, hand workers have to walk or drive through the whole-sale warehouse and pick single pieces from the various pallet loads and to complete a mixed commission for the retail client. The pallets in the warehouse will be stored with 1 200 mm transverse and 800 mm depth, allowing each normal grown worker easily to reach until the last item on the backside area of the pallet. The whole-sale people were concerned that a 1 000 x 1 200 mm pallet would be to deep for an easy and quick commissioning of the items stored backwards on the pallet.

On the other hand, some industrial branches had completely other distribution patterns, such as the breweries and soft drink producers and the chemical industry. Their main argument was that a 1 000 x l 200 mm pallet could accommodate almost 25 percent more cargo. So they would move with each handling 25 percent more volume, or, with other words, they could transfer the same volume with considerably less handling activities.

ISO Standard palletised unit loads



The pallet 800 x 1 200 mm received much promotion when the European railways decided that this pallet size will become the basis for the European railway pallet pool.

The pallet pool was organised mainly for rail clients delivering rail-cars completely loaded with palletised cargo through their private rail sidings. These clients could deliver a rail-car with, say, 24 palletised unit loads on pool pallets and receive in exchange 24 empty pool pallets. At the receiving end, the consignee would take over the rail-car and hand out to the local rail agency 24 empty pallets. Similar exchange was made on European scale between national railway organisations.

The pool did, at first, only cover 800 x 1 200 mm wooden flat pallets. Pallets of 1 000 x 1 200 mm had not been included in the pool.

Later the pool was enlarged to box pallets made from steel. In the 1970s, both pools more and more broke down and were replaced by individual exchange arrangements which were easier to be controlled. Anyway, the years of the pallet pool brought a clear dominance of the 800 x 1 200 mm unit loads in Continental European consumer goods distribution.

Only Great Britain went a slightly other way. Until the 1970s, the common road freight vehicle had been the „Lancashire flat“ semi-trailer with an open platform of eight ft. width. The best method to accommodate palletised cargo on this platform was to use a 40 x 48 inch pallet. Two of them side by side made excellent capacity use of the loading platform. The 40 x 48 inch pallet of Britain is very near to the 1 000 x 1 200 mm pallet of the Continent and so the standardisation people covered both by the same standard using the instrument of allowed tolerances to equalise the small dimension difference.

National. and international standardisation finally divided the work on pallets on two issues:

- material of pallets, quality of pallets, design and specification of pallets,
- base dimensions of palletised unit loads.

The base dimension standard concentrates on length and width of the unit load leaving the height open. It was discussed that the shipping industry needed at least one dimension free in designing their transport and warehousing systems.

In the 1980s, some moves had been made to come to a standard recommendation for heights of palletised unit loads. This was meant to give indications to other partners in the transport chain e. g. design of warehouse height spacing and of door height for rail-cars. This movement resulted in three different height categories:

- 1100-1200 mm, for normal consumer goods, such unit loads eventually to be moved in two layers with an intermediate deck on road vehicles,
- 1500 mm for unit loads with bottled or canned drinks,
- 1800 - 2000 mm for unit loads with extreme light weight items such as paper towels.

1.1.4.2 Standardisation of packages

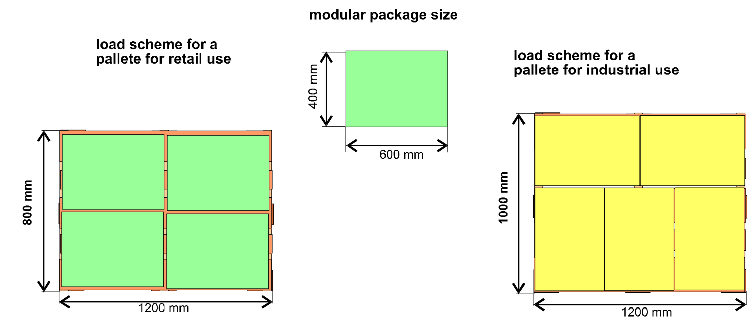
In parallel to the standardisation of palletised unit loads, the European standardisation associations worked on standards for packaging. The single parcel was regarded as the module, so to speak the brick stone, that made up the palletised unit load. So, a system of package dimensions was discussed. These dimensions add up, one to the other, and finally form a well shaped unit load.

In this context the principle was developed that each palletised unit load must be clean shaped without any overhang on either side of the flat pallet. In consequence, the package standards were worked out only with minus tolerances so that they, even in worst case, could not add up to an overhang pallet load.

Basis of all packaging standards was the basic module 400 x 600 mm. This package size has two important advantages:

- The 400 x 600 mm base dimension card board box is an item that can be easily picked up and carried by a normal grown man or woman with their hands.
- The unit 400 x 600 mm fits with best capacity use on both types of standard pallets in service in Europe: four of them fit on a 800 x 1200 mm pallet, and five of them on a 1000 x 1200 mm pallet.

Loading schemes



This package standardisation must be regarded as an issue strictly related to transport packaging. Sales packaging, i. e. presentation of consumer goods in the retail shop, will follow other commercial principles than optimisation of pallet space. Nevertheless, many articles are packed even in sales packages that fit into the module of the 400 x 600 mm transport package.
A specific case has been the standardisation of the Euro beer bottle in Central Europe: The diameter of this bottle is standardised to fit exactly into a case containing 20 bottles, and the out-side dimensions of a standard case is fixed to fit on a 1000 x 1200 mm pallet.

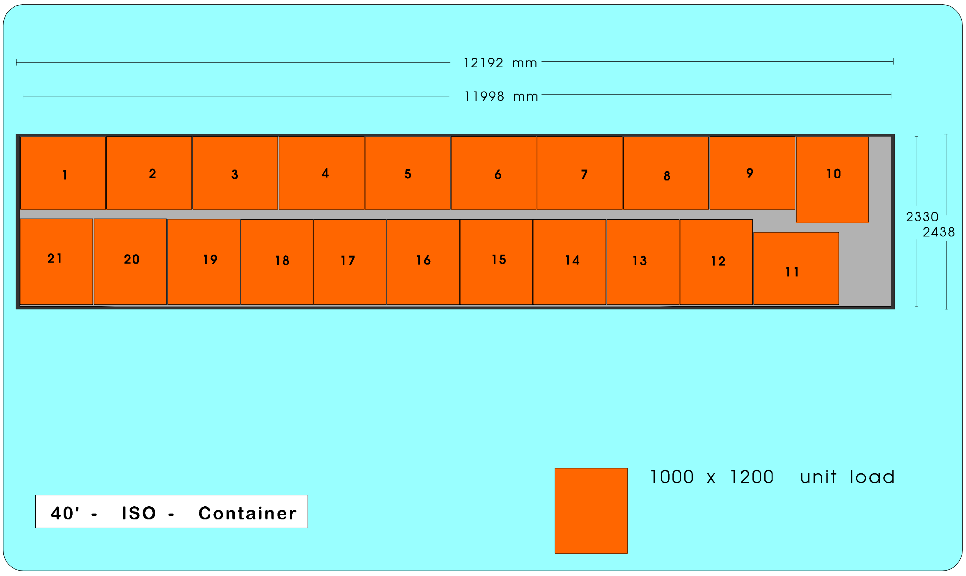
Standardisation of transport packages brought in the end much more overall efficiency than only better capacity use in the distribution chain. It brought a considerable reduction in variety of different empty packages (mainly delivered in card board cuts). So, the production and warehousing of packaging material became more efficient in Europe as a consequence of unit load standardisation.

1.1.4.3 Conflicts and solutions

The European logistic system, as described in 1.3.1 and 1.3.2, is designed as a seamless trade pattern with consequent modular optimisation. Nevertheless, some points of concern remain:

- The European logistic system does not fit into the ISO container system.
- The European system is not world-wide recognised. Japan and its neighbour states have, as some reports say, no preferred pallet standards that are widely used in the industry, but it seems that the size 1000 x 1200 mm is rather popular.

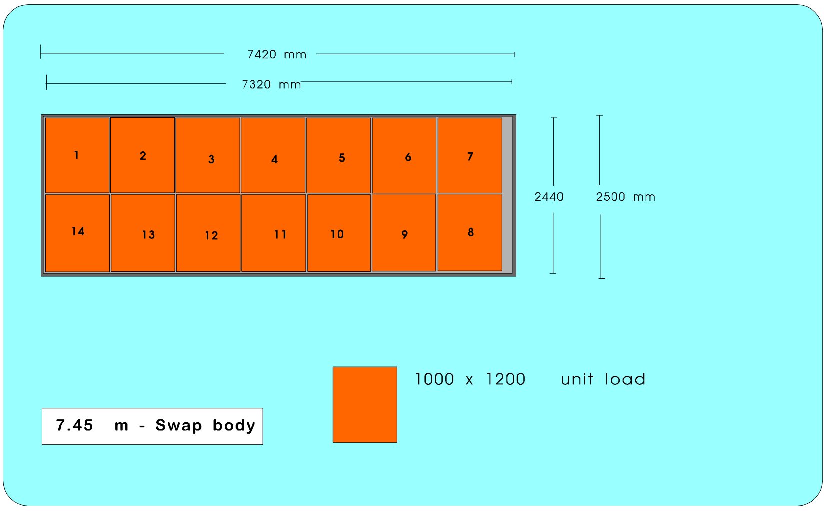
Some logistic systems prefer a square pallet, possibly adapted to the inside of ISO containers. Such square pallets could be designed at 1140 x 1140 mm.



The system of European standardisation of logistic modules has been repeatedly questioned, mainly by parties trading into areas outside Europe because it does not easily fit into ISO containers, as the picture above shows. On the other side, experts from European logistics pointed out that this system is very efficient and offers great benefits for the European trade, and that the European industry will severely suffer if the system is weakened or even abandoned. These experts have repeatedly made moves to bring the philosophy of modular standardisation into a system of agreed European standards. This has not been achieved until today.

Another conflict arose between the modular system and European transport legislation. This legislation fixed the outside dimensions of road vehicles at 2 500 mm (in Great Britain and Ireland initially at 2 438 mm). The Continental road vehicle with box type cargo containment could - as the European domestic container and swap body - only offer an inside width of maximum 2 440 mm. This was theoretical sufficient to accommodate two 1 200 mm pallets side by side together with the necessary side shift for manoeuvring - but many experts said that a 40 mm side shift space was rather tough for daily work under time pressure.

The main complaint came from the less than truck load operators. They say that an industrial loaded palletised unit load, often shrink-wrapped on an automated filling and packaging line, would possibly fit on a 1 200 mm wide pallet without overhang. In small consignment business, many pallet loads are man made, and this does not give a guarantee for exact spacing without any overhang. These experts said that an internal width of 2440 mm for containers, swap bodies and road vehicles was not sufficient for their business and asked for the possibility of having an internal width of 2460 - 2480 mm. In the end, the European Commission followed this suggestions and the member countries of the Union introduced it into their legislation, so that the possible incompatibility of road vehicles width with the European modular distribution system has been finally removed.



This change of legislation gave solution to another conflict of similar origin: The box pallets followed the modular system of European distribution, but with their own logic: The flat pallet fixes an outside dimension for the load of 800 x 1200 mm or 1000 x 1200 mm without overhang. The box pallet must offer the same sizes as inside dimension to fit into the same modular package system. So, the box pallet adds to the inside dimensions the thickness of two side walls and ends up with an outside dimension of 820 x 1220 mm or 1020 x 1220 mm - again too much for a road vehicle with an inside width of 2440 mm. This problem has been solved as well by the European initiative to come to an outside width of 2550 mm for road vehicles, swap bodies, and domestic containers.

1.1.5 Fringe activities in container standardisation

1.1.5.1 Aircraft unit load devices standardisation

Air transport always discussed two different concepts of unit loads:

- unit load build-up by devices completely adapted to the shape of the aircraft,
- unit loads to be carried truly intermodal in aircraft and with ground transportation means.

Unit load devices designed for aircraft are normally adapted to the specific outer appearance of the aircraft. They do not show the shape of a cuboid with 8 rectangular corners but they follow the rounded shape of the aircraft main body. They consist mainly of large pallets that can be anchored on the floor of the aircraft. The cargo is loaded on these pallets and secured by a net or an igloo. The other typical device is the lower deck container (LDC), a container fully adapted to the rounded shape of the aircraft below the main deck.

The main standardisation work on such unit loads is done by IATA. An ISO standard exists, too: ISO 4128 Aircraft - Air mode modular containers.
Both unit loads can be carried by road or rail vehicles, but these vehicles must be equipped with a roller bed to take over the flat and soft surface aircraft unit loads. Early 1970, Boeing designed an all cargo version of the Boeing 747 (the Jumbo Jet) with a special main deck to accommodate containers with ISO dimensions and shape up to 40 ft. length. Some experts predicted that this was to become the regular way or air cargo carriage in the future while others were more skeptic saying that the tare weight of the standard ISO container was too high for air transport and that the ISO boxes would be by far too large for the average size of normal air transport consignments.

Some users made trials with ISO shaped 10 ft. aircraft containers and some leasing company purchased such devices.

So, ISO experts decided to elaborate a standard on such containers and formed a joint working group of air cargo transport experts and of members of ISO TC 104.

The debates in this working group focused on two issues: As the ISO container was obviously a design too heavy for the economies of air transport, a light weight and light strength concept was looked after. The discussions were about the questions which strength features of ISO 1496 could be decreased to a value that allowed light weight construction.

The other issue was the design of the bottom of the box: All aircraft unit loads are designed with an absolute flat bottom. They are transferred only horizontally on roller bed conveyor systems. This transfer system would block immediately if an uneven bottom box like an ISO container with its protruding corner fittings would be loaded to it.

The ISO container has intentionally a bottom design with the corner fittings protruding some milli-metres. This design follows the idea that the ISO container when lowered to the ground shall rest mainly on the corner fittings (which cannot be easily damaged) and that the container bottom shall not have intensive contact with the ground because otherwise the bottom would be easily damaged.

A similar principle concerns to containers in stack on board ship. The containers shall be stacked with the four lower corner fittings of the upper layer container sitting exactly on the four top corner fittings of the lower layer container. So, all stacking forces resulting of the gravity and acceleration and side movement impulse is conducted only through the corner fittings and the four corner posts assembly. The protrusion of the corner fittings below bottom and above roof allows for an empty space between the bottom of the top container and the roof of the lower container. Even if the top container is fully loaded and its floor deflects down, it does not touch and damage the roof of the lower container during transport movement.

The mixed air transport cum ISO container group drafted a flat bottom air/surface container with rather widely protruding top corner fittings. So, the full free space was intended to remain and the flat bottom design allowed for horizontal transfer as well. In addition the stacking and racking load was reduced to save tare.
This concept resulted in an ISO standard that was finally agreed on:
ISO 8323 : 1985 Freight containers - Air /surface (intermodal) general purpose containers - specification and tests.

1.1.5.2 Standardisation of off-shore containers

The upcoming boom of off-shore oil drilling and pumping created a large industry designing and building off-shore platforms. The material supply for these sites is often performed by special containers.

Some contacts had been established to eventually harmonise the technical approach of such off-shore supply containers and ISO containers. But in the end this did not materialise, and both sides went their individual way.

1.1.5.3 Safety standards in Ro-Ro vessels

The principal factor governing safety standards for intermodal units on Ro-Ro and other vessels transporting these units is their securing and support. It is imperative to the safety of the ship and the protection of the cargo and personnel that the securing of the cargo is carried out properly and that only appropriate securing points or fittings should be used for cargo securing.

In an attempt to promote the safe carriage of cargo it has since July 1996 been a requirement that all ships carrying cargo except those engaged solely in the carriage of bulk cargo must carry a cargo securing manual. SOLAS regulation VI/5.6 states that "Cargo units, including containers, shall be loaded, stowed and secured throughout the voyage in accordance with the cargo Securing Manual approved by the administration."

The manual provides information on the strength and instructions for the use and maintenance of each specific type of securing device.

The forces acting on a unit are determined by the motion experienced by the vessel in a seaway, the unit must be able to withstand forces resulting from extreme conditions. Lashings and other means of securing and support must be capable of transmitting the resulting forces to the ship's structure with a suitable factor of safety without damage or distortion.

With reference to Ro-Ro ships in particular, SOLAS Conference Resolution 13 requires that, "In designing securing arrangements for cargo units, including vehicles and containers, on Ro-Ro passenger ships and specifying strength requirements for equipment used, forces due to the motion of the ship, angle of heel after damage or flooding and other considerations relevant to the effectiveness of the cargo securing arrangement should be taken into account."

The forces acting on the cargo units can be a combination of transverse, longitudinal and vertical loads, resulting from the rolling, pitching, heaving and other responses of a ship in a seaway.

The magnitude of these forces will depend on the following.

- Weather conditions,
- Height of stow,
- The ship's metacentric height
- Anti roll devices

Weather Conditions

This aspect is often outside the operators control. Cargo should therefore be sufficiently secured to withstand forces which may arise during adverse weather and sea conditions.

Height of Stow

The forces experienced by the cargo will usually increase with height of stow and the distance from the ship's centre of motion. Cargo should therefore be distributed, where practicable, within an acceptable upper limit to minimise such forces.

The Ship's Metacentric Height

The transverse forces exerted increase directly with the metacentric height. The metacentric height (GM) is a measure of the ship's stability. Ships with a low GM experience larger angles of roll and a longer period of roll resulting in lower transverse accelerations. Ships with a high GM have smaller roll angles and shorter roll periods leading to higher accelerations. GM is a function of the underwater form of the ship and the distribution of loading including ballast, fuel etc. the ship designer has to achieve a suitable compromise between maintaining adequate stability over a range of sailing conditions and limiting transverse accelerations/forces.

Anti Roll Devices

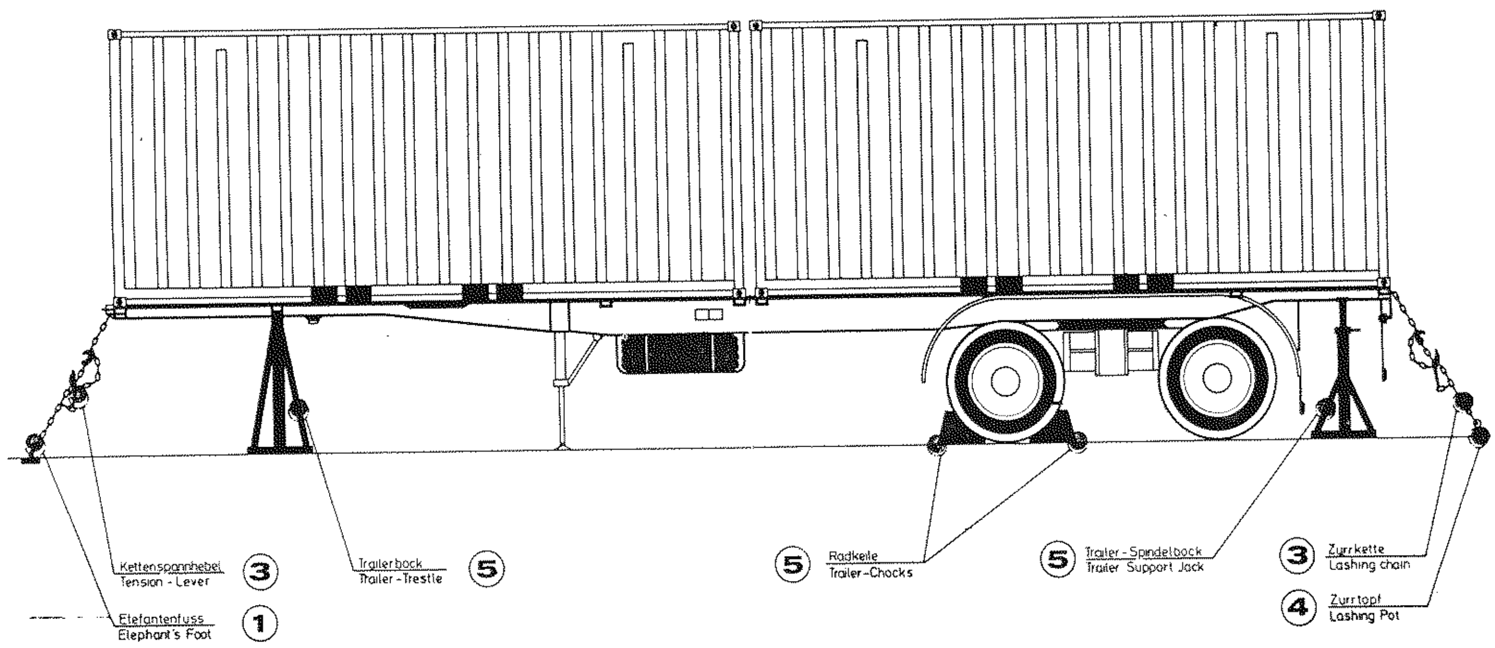
Anti roll devices such as fin stabilisers will also have an impact on the forces experienced by the cargo. The effect of fin stabilisers is an apparent increase in the ship's GM. The roll angles will be reduced but the lateral accelerations may be increased. This will have two effects, firstly by reducing the roll angles the static forces on the cargo will drop, but by increasing the accelerations the dynamic forces will rise. The benefits will usually outweigh the disadvantages, however the beneficial effect should not be taken into account when planning the securing of cargo. The main benefits of fin stabilisers affect the comfort of crew and passengers.

In addition to forces which are a result of the motion of the ship, if cargo is being stored on open decks account should also be taken of the forces arising from the effects of wind and green seas.

Assuming that the cargo has been stored in the correct manner the safety of the ship cargo and personnel will only be compromised if the cargo starts to shift. As has already been mentioned the forces acting on the cargo must be considered. Another imposing issue is the arrangement of the securing devices.

On a Ro-Ro vessel the cargo can range from a motorcycle to a 50 ft. trailer carrying containers. As can be imagined the securing devices and fittings must be adaptable to the full range of cargo securing requirements. A typical securing arrangement for a container trailer is illustrated in the picture below.

Trailer-Zurrmaterial
Trailer lashing equipment



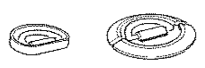
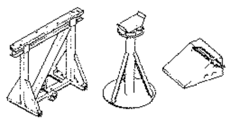
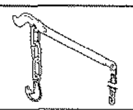
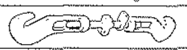
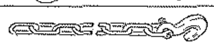
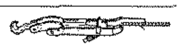
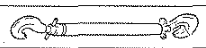
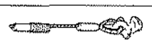
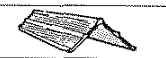
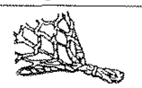
Typically a Ro-Ro ship's cargo deck will be divided into lanes, the width of each lane is determined by the maximum width of the expected cargo units. Sufficient space is also provided for safe passage between the units. The lanes are divided by a series of fittings to which the cargo securing devices can be attached. The result will be in the form of a grid of securing fittings which can accommodate all three securing requirements.

The fittings in the deck are known as „lashing pots" ; these are basically slots into which the feet of the securing devices can be fixed.

Lashing pots can be fitted to be flush with the deck; this makes the deck surface smooth to drive on but they can accumulate water and debris over time requiring occasional cleaning. Lashing pots which protrude above the deck are cheaper to fit but are more prone to damage than the flush fittings.

The securing devices are known as 'lashing units' and these connect the cargo unit to the lashing pots.

Lashing units are generally flexible and include some sort of tensioning device. The lashing units come in a number of grades to suit the expected loads.

SYMBOL	DESCRIPTION	TYPE	PURPOSE
FIXED PARTS			
	TWISTLOCK POCKET	LSF-..., LF-... LT-..., LS-ZU...	CONTAINER STOWAGE
	DOVETAIL FOUNDATION	APT-...L	
	CONIC GUIDE UNIT	J-81 R SERIES	
	LASHING POT	ZU-1, F-4 ZU-2, F-3	CONTAINER LASHING TRAILER LASHING CARGO LASHING CAR LASHING
	FLUSH LASHING EYES	FL-...	
	LASHING EYES WITH PROTECTION RINGS		
CONTAINER SECURING FITTINGS			
	BOTTOM TWISTLOCK	K-17 FL, K-17 FL-V	ONLY CONTAINER LASHING
	TWISTLOCK	CV-9, K-6 GS	
TRAILER SUPPORTS			
	TRAILER TRESTLES	TT-1/-2/-3	ONLY ROAD-TRAILER LASHING
	TRAILER SUPPORT JACKS	TS-1	
	WHEEL CHOCKS	RK-1/-2/-3	
LASHING UNITS			
	TENSION LEVER	C-2, C-3 S-9, S-11, S-13	CONTAINER LASHING ROAD-TRAILER LASHING ROLL-TRAILER LASHING CARGO LASHING FLAT LASHING
	CHAIN TURNBUCKLE	CTB-...	
	LASHING CHAIN	K-...	
	QUICK RELEASE LASHING	KBZ-...	
	TURNBUCKLES	TBS-..., B-...	
	LASHING WIRES	SEL-...	
	CORNER PROTECTOR		CARGO LASHING
	NET		
	CAR LASHING		CAR LASHING

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The layout of securing fittings make Ro-Ro ships very adaptable to all sorts of unit loads, not only wheeled cargo. A selection of typical securing units is illustrated in the above picture.

The safe carriage of cargo does not only depend on ensuring that sufficient securing devices are provided. Certain dangerous cargoes should be stowed according to the requirements laid down in SOLAS VII/6. These requirements are summarised below.

- Dangerous goods should be segregated from incompatible goods.
- Dangerous explosives should be carried so as to minimise the risk of explosion.
- Dangerous goods which give off dangerous vapours should be stowed in a mechanically ventilated space or on deck.
- Ships carrying flammable liquids or gases or material which are prone to spontaneous heating or combustion, should provide for special precautions to be taken where necessary against fire or explosion.

The safety items discussed here do not ensure that the safety of the ship, the cargo and the personnel is guaranteed. The principles of good seamanship must also be maintained in consideration of safe routes and weather.

As far as road vehicles to be carried on board ship are concerned, an International Standard has been elaborated to describe the necessary arrangements:

- ISO 9367-1 Lashing and securing arrangements on road vehicles for sea transportation on Ro-Ro ships - General requirements - Part 1: Commercial vehicles and combination of vehicles, semi-trailers excluded
- ISO 9367- 2 Lashing and securing arrangements on road vehicles for sea transportation on Ro-Ro ships - General requirements - Part 2: Semi-trailers

1.2 NON STANDARDISED UNITS AND THEIR ROLE IN INTERMODAL TRANSPORT

1.2.1 General

The early success of the ISO container created a widespread opinion in the transport world that this unit was to become the universal unit load in world-wide transport and replace all other types of unit loads such as small boxes, box pallets, flat pallets, rail containers. Box type semi-trailers and rail box cars were to be replaced by skeleton trailers or platform railcars to carry containers as superstructure.

On the other hand, the ISO container as any other world-wide standard unit was a compromise that could not fully meet all logistic systems requirements in all parts of the world.

Generally speaking, most industrial countries have a rather high salary level and an excellent infrastructure. Road vehicle drivers are costly, and the economic forces look for a solution with a road vehicle plus driver carrying as much cargo as possible to achieve low unit costs. The infrastructure allows for long and heavy vehicles - roads are wide with a strong surface and heavy duty bridges. These countries would look for vehicles and containers as big as possible.

Many developing countries will have low drivers salaries, so there is no great economic pressure for large vehicles. The infrastructure, mainly on road, is considerably poor and cannot accommodate heavy vehicles. So, these countries prefer smaller vehicles and containers.
These considerations are by far not only theoretical: Inland transport in USA and Canada is almost entirely performed by 40 ft. containers , while inland transport in India is performed mainly by rigid trucks of 8 - 10 m length or 20 ft. containers.

In effect, the advantages of a concept of world-wide uniformity have to compete against the disadvantages of such vehicles and containers on local markets that can be served, alternately, by tailor-made units that are optimised to the local economic conditions.

Another problem of rather similar nature is generated by differing needs of the industry. While ISO standardised a „general purpose container“ and a wide selection of „special purpose containers“, standardisation could not and cannot cover all logistic needs that might come up. The garbage removal companies, e. g., have meanwhile developed their own container system that is almost completely outside the standardised international and domestic container field. Such special needs will certainly remain and containers outside the standard system for such needs will be continuously developed and used.

In the end, the idea of a world-wide uniform transport systems clashed against the reality of local economies, and the ISO container was partly replaced by various local developments with more or less deviations from the basic principles laid down in ISO 668, ISO 1496 and ISO 6346.

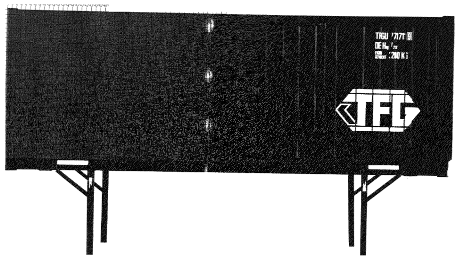
1.2.2 The European domestic container - rail

The development of a European domestic container demonstrates how cautious the economic driving forces had been in their way to leave the ISO development and to migrate towards their own local optimisation.

In the 1960s, European railways looked at the container mainly as a means to establish door-to-door offers for clients without private rail siding. Another attitude was brought forward by British Rail: They dropped the idea to modernise their over-aged railcar fleet for the markets of today, and they decided to organise a new operational concept for the day after tomorrow: They replaced the single wagon load traffic operated by conventional box cars by a system of dedicated trains connecting road-rail transfer terminals. The cargo was carried in containers of 8 ft exterior width (according to the British legislation on road vehicles maximum width at that time). These containers did by far not show the strength features fixed in ISO 1496 because they were not intended for sea transport in stack. This service was called Freightliner. The ISO container could easily fit into the Freightliner system, and Freightliner took over the inland rail transport of ISO containers as far as rail could offer competitive services for the relatively short distances between the British ports and the industrial hinterland.

Some years later, Spanish rail copied the system and introduced the TECO Service. At that time, Spanish road transport legislation allowed for a vehicle and container width of 2 500 mm, but the TECO service was so dedicated to the ISO container and Freightliner container models that they introduced containers with only 8 ft. (= 2 438 mm) width.
In a similar way, the European railways co-operating in UIC elaborated a specific rail container standard for a unit called „T“ container (T standing for „terrestre“). This container had all outside dimensions of ISO 668 containers, but only very limited strength, having only such strength features that were needed in rail and road operation and in inland terminal transfer.

This first step to leave the dimensional concept of ISO containers when creating a European container was taken by Deutsche Bundesbahn (DB - German Rail) which dared to make the large step to dimensional variation and conceived the „Binnen-Container“ with a width of 2500 mm, the low strength values of the UIC T container, and the modular length concept of ISO 668. The top corner fittings remain at the top corners of the box but they are located a bit inside to accommodate the twist locks at the same width as ISO containers so that all spreaders which can handle ISO containers easily can lift these „Binnen-Container“ as well. This box was standardised in Germany as DIN 15 190. This container design was rather successful, but road transport on the Continent continued to offer larger boxes. To meet this competition, rail took finally over some features of the concept developed with swap body standardisation and designed the Htg 7, a domestic container with 2 500 mm width and 7 150 mm length.



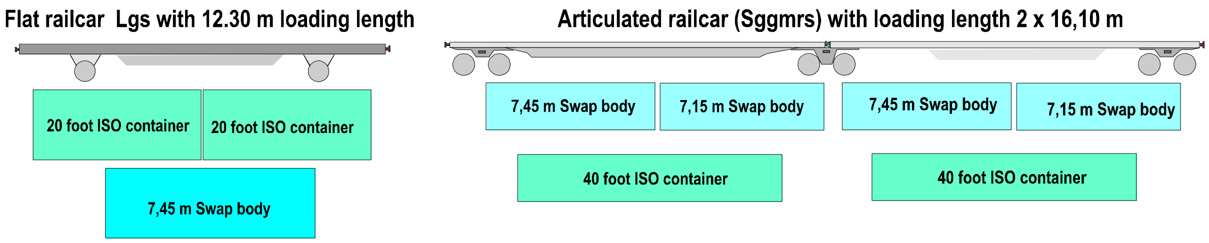
Looking back into this development, this leaving of the ISO concept one step after the other, needs some explanations, mainly on the questions:

- Why did European Railways develop a „weak“ container , when it is well known that the tare weight savings and the cost savings in manufacturing of such a weak unit are - compared to those of an ISO container - minimal, but the infringements in international operation was severe?
- When the German rail expert decided to abandon the ISO width concept to gain more cubic space, why did they not abandon the ISO length concept as well to generate even more additional cubic space?

The main reason for the design of a weak container was created through the necessity of a side door. A large part of road-rail container operation was moved in transport chains departing from a private siding, where the rail container was loaded when mounted on a railcar. The container went through the container train network to a road/rail terminal in the delivery area with final delivery over the road. So, the container was presented on the one side for loading through a rail ramp, on the other side through a road ramp. The roadside ramps offered easy access to the container mounted on a road chassis through its end door. But on a classical rail ramp, loading through the end door was a most cumbersome process needing a complicated arrangement of transfer bridges - all of them must be capable to be used safely by a 5 t fork lift truck - and a direction change of the fork lift driving into the railcar. It was much more practicable to offer a container with a side opening and direct access from the side ramp. At best, the container should offer free access over the whole side.
This motivated railways to design containers with side doors. But in such a case the strength values of ISO 1496 matter greatly. It is quite easy and state of the art to design a container with full ISO 1496 strength features as long as this container has a full bearing side wall made from corrugated steel panels. But once such a side wall is left open and only covered by a curtain, the problem of racking and stacking under high forces becomes difficult to be solved. Difficult means in practical life: more expensive and less payload. So, railways preferred to go the less strength way and to design „weak“ containers with side door openings.

The length question followed as well specific rail transport related considerations. The main market for European railways in container transport had been always the hinterland transport of sea borne ISO containers. So, railways organised their fleet of platform railcars accordingly:

- 2 axle railcar 40 ft. loading length,
- 2 bogies railcar 40 ft. loading length,
- 2 bogies railcar 60 ft. loading length.



This railcar fleet was initially built with loading lengths according to the ISO length module. Any longer box would disturb this system. Later, when 7 150 mm swap bodies came in large numbers into combined transport, other rail-car types were designed (such as the current 2 x 18 m loading length articulated car), and a rail transport offer for longer units was made easier. Today, the main owners and operator of domestic rail containers (other than European swap bodies) are

- DB Cargo AG, Germany,
- DSB, Denmark,
- ÖBB, Austria,
- Freightliner Ltd., Great Britain,
- CNC Transports, France.

1.2.3 The European domestic container - road

Road transport followed the line of local container development with even more consequence and changed both, the width and the length to allow for a maximum of cubic space. The length concept followed a calculation as follows:

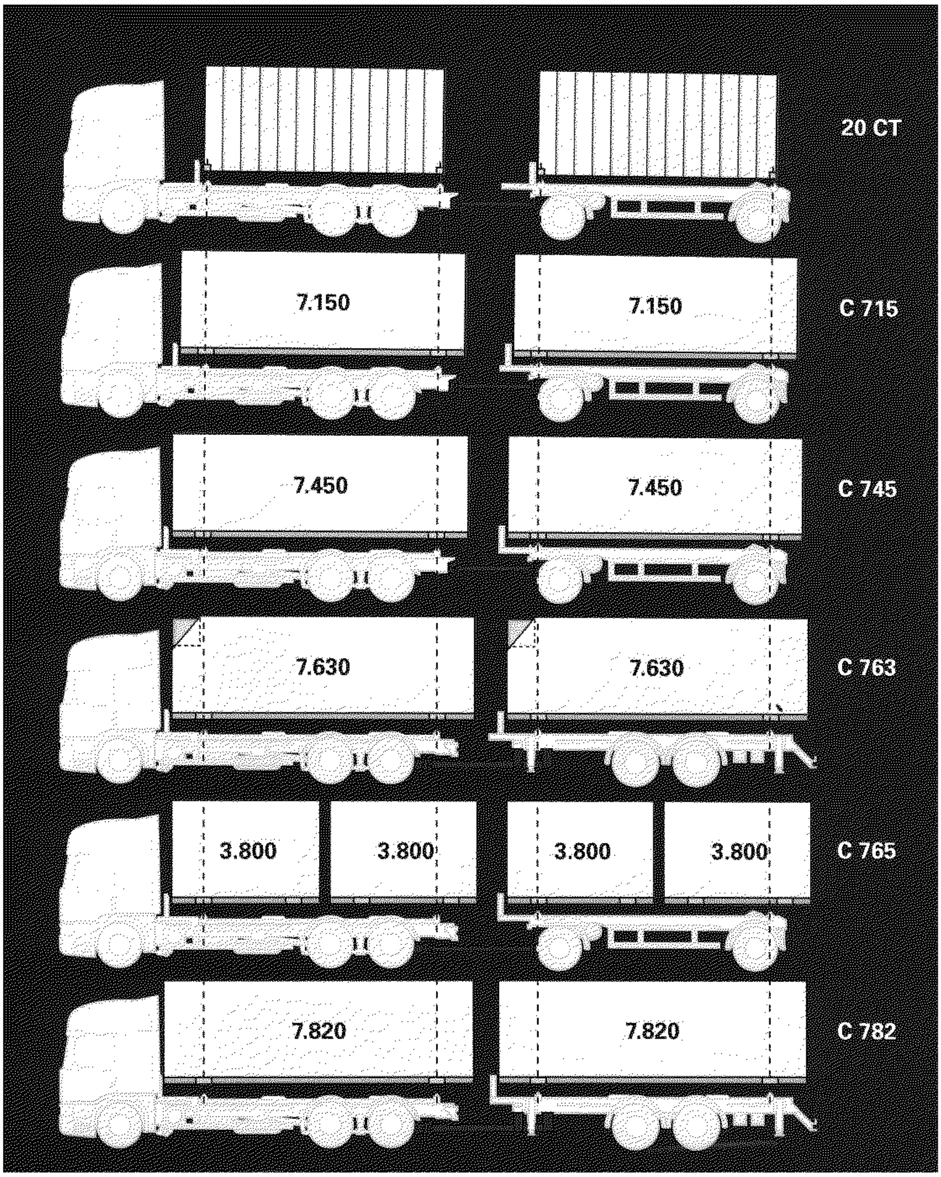
allowed road train length	18 000 mm
- truck-trailer coupling device	1 200 mm
- driver' s cabin incl. berth	2 500 mm
= load space length	14 300 mm

This 14 300 mm available length could be divided

either in 6 100 mm + 8 200 mm,
or in 7 150 mm + 7 150 mm.

The first concept was near to the classic German road train with a 2 axle truck (with a 6,1 m loading length) + a 3 axle trailer (with a 8,2 m loading length). Soon it became evident that the system 7 150 mm + 7 150 mm was more practicable because the swap bodies of similar length could be easily exchanged between truck and trailer. In the end, the concept of 2 swap bodies of similar length was standardised in Germany and later in Europe (see chapter 1.2.2 and 1.2.3.).

The swap body is today moving some 65 % of all European intermodal volume. This success story has two main reasons:

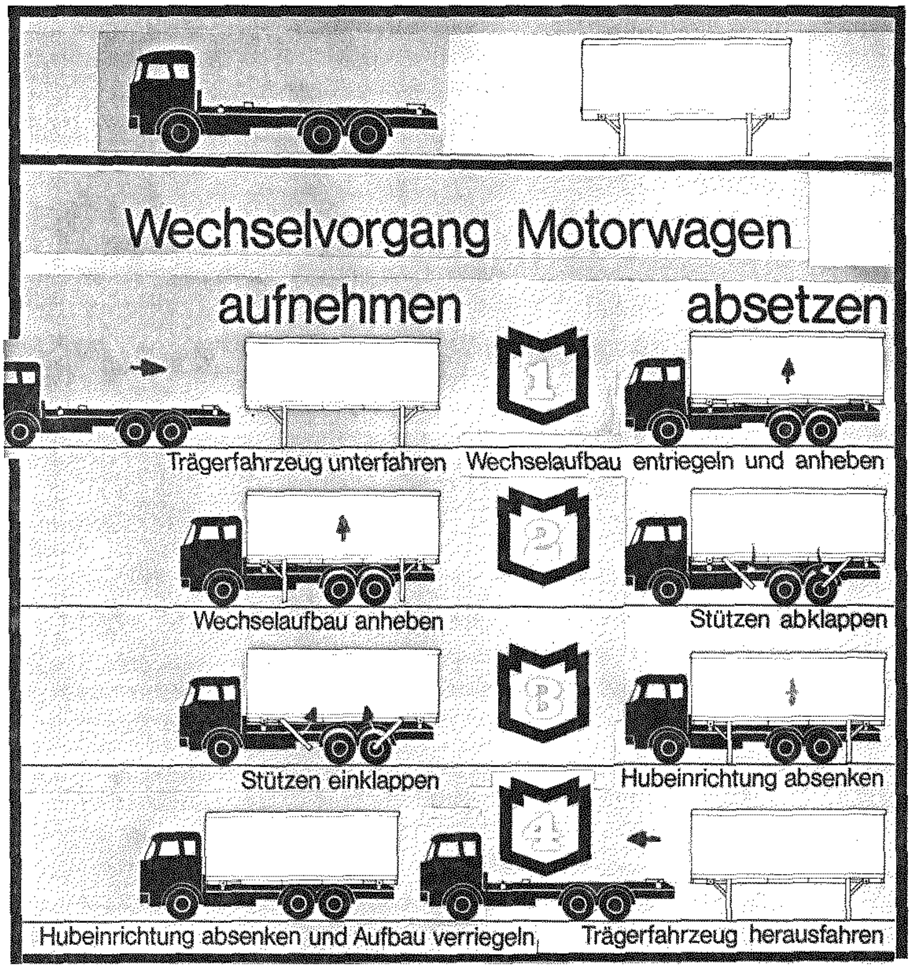


The swap body was the first domestic container that appeared at the shipper's ramp with all features of a common road vehicle. Since road transport is the overwhelming market leader in European freight transport, most logistic systems are designed to meet the basic conditions offered by road transport. Any other transport system would have to overcome this hurdle, i.e. its promoters must request at the shipper's freight department to install special equipment and organisation to meet the new systems requirements - a task that is, as any experience tells, most difficult. Very often the shipper will tell that he is not even willing to consider a change in his shipping organisation just because the service provider requests it. The swap body had not to overcome this hurdle: A road train equipped with swap bodies appears at the shipper's ramp in the same manner and shape as a conventional road train - there is nothing specific to be prepared for or organised.

This does not only relate to the physic interface at the ramp. The swap body is a transport unit offered by road operators - the most successful cargo carriers in the last decades. These enterprises could rely on well established business relations between shipper and the transport economy, and they integrated the swap body into their successful strategy to conquer the freight markets.

The second feature that contributed to the success of the swap body system has been the inherent advantages of this engine: The swap body, when used with road trains, is a very useful instrument to promote efficiency in road operation, alone by the possibility to exchange the swap body easily between various road vehicles.

The freight motor industry offered, together with the swap body system, the air suspension for truck and trailer. The air suspension is somewhat more expensive, but it contributes to a smooth run of the road vehicle and its cargo. Most important, it enables a simple swap body exchange without the need for lifting devices or additional personal to serve it. The driver can remove the swap body by a simple operation: He unfolds the standing legs of the swap body until they touch ground. Then he unlocks the twist locks that have fixed the swap body on the chassis. Now he can release air pressure out of the air suspension system: The road chassis will lower some centi-metres and now it is free to drive alone, leaving the swap body free standing on its legs. The take-over of a swap body goes similarly easy: The driver lowers the chassis by its air suspension and manoeuvres it under a swap body standing free on its legs. This operation is facilitated by a guidance tunnel in the bottom construction of the swap body that guides the truck and swap body assembly into the exact position.



When the swap body standardisation was completed, many operators changed to the system chassis + standard swap body and were able to exchange such units freely within their fleet and between partners. This grants, even in pure road operation, a wide set of organisational advantages:

- If the shipper needs more time for loading and discharging at the ramp, the road operator can leave the swap body on its standing legs at the ramp of the shipper while the vehicle and its driver is available for other activities.

- Swap bodies enable the establishment of a relay system: On a north to south run, the driver stops at an intermediate place to meet his colleague who drives, in the same night, the south to north run. They exchange their set of swap bodies and return to their home base. So, each driver will be at home after his shift, driving all the way with the motor vehicle he is responsible for. Drivers welcome this working scheme, and the operator saves costs for overnight stay of drivers.

- Swap bodies can easily be exchanged between long distance operation and local pick-up and delivery. In less than truck load business, the forwarder can set the swap body on a truck to pick up some consignments. Then the swap body will be set down on its legs at one specific ramp position of the forwarders cargo assembly centre. Some additional consignments will be loaded into the swap body, and when the swap body is completely loaded it will be taken over by a long distance road vehicle or by combined transport for the main course. Local deliveries in the arrival area can be organised in a similar manner.

- Swap bodies will facilitate downtown delivery. Many downtown areas do not permit access to large road vehicles and to road trains. So, the driver can un-couple the trailer with the second swap body at a freight station in the outside area of the town and deliver, this time as a single truck, the first swap body at its destination. Afterwards he returns, picks up the second swap body, and drives again downtown for the second delivery.

The various combinations and separations that the swap body system granted to road operation led to a development that, in the end, the vast majority of road operators in Central Europe, when purchasing a road train, ordered it in the version „swap body + chassis“ - even if it was slightly more expensive than a rigid truck + rigid box trailer. The savings that could be achieved through the increased flexibility would easily offset the additional purchase costs of the swap body system.

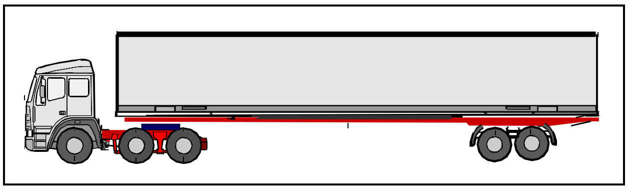
So, the road transport industry, without needing any additional incentive, equipped its fleet with standard swap bodies, even if they never intended to participate in combined transport. But they were fully equipped for such a change at the very moment when the intermodal carriers would offer them interesting line haul services.

This history of swap bodies as the most successful domestic containers in Europe is limited to class C swap bodies , i.e. the 7 + m long type that normally is carried by road trains. The road carriers that have based their operations on semi-trailers hesitate to alter their transport system into a combination „platform trailer + swap body“. This is caused by the reason that the combination truck + semi-trailer offers practically the same flexibility as the swap body for road train: the separation of the costly motor engine part and driver from the cheap cargo carrying device. A further separation of the semi-trailer into a platform chassis and swap body does by far not generate the same amount of additional flexibility as the separation of road trains into chassis and swap bodies. Furthermore, the class A swap body, i. e. the 13,6 m long box for semi-trailer, cannot be that easily exchanged as the class C swap body because the long and heavy unit cannot be set on standing legs for interchange. All interchanges between one chassis and another (road/road) and all intermdoal interchange operations (e. g. road/rail) need a lifting device with some 34 t lifting capacity. So, there is practically no incentive to overcome the additional investment costs and the potential loss of payload when separating the road vehicle in platform chassis + class A swap body.

In the end the European road vehicle market shows a clear segmentation:

- Many long distance carriers prefer truck and semi-trailer combinations and remain outside combined transport .
- Other operators, mainly those in the less than truck load business, prefer road trains, and very often purchase these road trains as a combination platform truck + platform trailer + 2 class C swap bodies. Most of these swap bodies are operated in road transport only.

- Some forwarders operating into countries with clear dominance of semi-trailer in road transport have purchased class A swap bodies and hire local drayage capacity from carriers that own platform chassis. These class A swap bodies are mainly operated in combined transport.



1.2.4 Units used in European short sea transports

European short sea carriers are faced with a widespread variety of units offered to them by road transport companies and forwarders.

The main type of units are

- semi-trailers with a length up to 13 600 mm,
- swap bodies according to European standards, Class A and mainly Class C,
- ISO containers, mainly 40 ft. and 20 ft., mostly in on-carriage after or before a deep sea carriage,
- European containers of any shape and almost any size.

These European containers come in width of

- 2 500 mm side walls width, but corner posts at 2438 mm to offer palletisation and to comply with ISO containers,
- 2550 mm to make full use of European road vehicle width allowed,
- 2600 mm with temperature isolation.

A similar variation exists in lengths offered. The main sizes in current use are

- 6,1 m and 12,2 m (20 ft. and 40 ft.) as main ISO sizes,
- 7150 mm and 7450 mm and 7820 mm for standard swap bodies class C,
- 13 600 mm for larger boxes to fit on semi-trailer chassis,
- 13 720 mm (45 ft.) to meet some individual carriers systems.

Finally the strength features will vary as well. Standard swap bodies and ISO containers have well known strength features as given in the relevant standards EN 283 and ISO 1496. The other boxes may be built for stacking or not, and the overstacking capability may vary.

This wide variety creates some problems in operational safety. Normally, Ro-Ro carriers have to make certain which exact type of unit with which strength values they are confronted with before organising the transfer on board ship and the lashing.

The most interesting compromise between ISO container dimensions and the need for better palettisation patterns has been approached with special containers designed for the trade between Ireland, Great Britain and the European Continent. The first design had been realised by Bell Lines, a short sea carrier operating in these markets. These containers had an outside width of 2 500 mm and offered an inside width of 2 440 mm. They were carried on specific short sea ships of cellular type. The cell guides of these ships were laid out to carry either these containers or ISO containers. The inside width of 2 440 mm needs some additional consideration. As already pointed out in chapter 1.4.3, the European logistic service providers asked for an inside width of vehicles of 2460-2480 mm and argued that 2440 mm was not sufficient. On the other hand, the operators of these pallet wide containers with 2440 mm width inside reported that their clients had no difficulties to accommodate palletised cargo in theses boxes. Some experts even say that any width beyond 2440 mm inside could be detrimental to sea transport because it offers too much room for slippage and creates the need for additional load securing [Wolfram Bläsius: Neue palettenbreite Seecontainer für die EU-weite Küstenschiffahrt, in: Der Containerverkehr, Frankfurt am Main/Neu-Isenburg, JAN/FEB 1999, p.7].

These containers need rather wide cells, with other words a cellular ship for ISO containers with rather generous tolerances in the cell guides. A new design for pallet wide containers has been meanwhile offered, the SeaCell container. This container has specific corrugation in the side walls that makes it fit even in more narrow cell guides.

Finally, the North Sea operator Geest Lines introduced a pallet wide container with 2500 outside width and 45 ft. (13 720 mm) outside length.

All these developments try to find a compromise between the need to compete with European road transport (or to offer optimised short sea crossing for European road vehicles) under the basic condition that the logistic service providers ask today for maximum cube and palletisation patterns, and the need to use ships that have been designed to carry ISO containers. The further considerations in chapter 5 will balance these two main issues against each other and suggest a solution.

1.2.5 The US domestic container

Domestic (non-ISO) containers have been used in the USA for over ten years. Their principal purpose is the carriage of low-density general cargo in intermodal service within the USA. The major movement of these containers is in the east-west domestic trade on long-haul routes between major market city pairs.

Principally, the movement is between Chicago and major rail hubs on the east and west coasts, with line-haul carriage via rail on double-stack rail cars and local delivery via highway on purpose-built chassis. Major users include less-than-truckload (LTL) highway and intermodal carriers, as well as the domestic intermodal divisions of ocean carriers.

Domestic containers are owned by major users as well as a number of leasing companies, the principal ones being Transamerica Leasing and XTRA Intermodal.

Fleet of US domestoc containers per end of 1998

type	number
48 ft. can be overstacked	73650
53 ft. can be overstacked	7000
other length, can be overstacked	2350
48 ft. cannot be overstacked	11000
53 ft. cannot be overstacked	10000
total	104000

source: ***Containerisation International,*** *April 1999, p. 97.*

Most domestic containers are handled with ISO-type container handling and securing devices and follow domestic standards discussed below. However, J. B. Hunt, a major highway carrier, uses a special container that meets the dimensions of the domestic standards but with more relaxed structural and handling ratings and using special handling fittings; the J. B. Hunt containers and containers of similar design may not be overstacked. They must be carried in rail mode either in one layer only or, when double stack operation is organised, in the upper layer on top of over stackable containers.

Standardisation of USA domestic containers is governed by two documents, both of which are current as of the end of 1998: American National Standards Institute (ANSI) Standard MH 5.1.1.5 (1990, reaffirmed 1998) and the Association of American Railroads (AAR) Standard M-930-98.

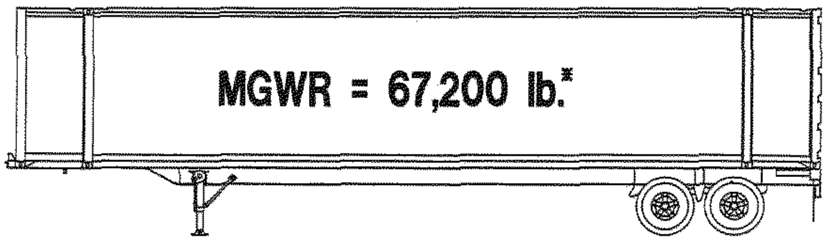
Compliance with the AAR standard M-930-98 „Closed van containers for domestic intermodal service“ is considered more critical as it is the basic requirement for rail carriage. North American railways normally refuse to meet a claim because of damage if a unit has not been designed to this specification.

Other than the relevant European railway standards the US Standard M-930-98 gives detailed dimensions and specification, in addition to strength requirements, tests and approval procedures.

The US domestic containers are primarily either 48 or 53 feet (14,63 or 16,154 meters) long, 8 feet 6 inches (2 591 mm) wide and 9 feet 6 inches (2896 mm) high. Interior height must be at least 104.5 inches (2 654 mm), although actual containers generally have an interior height of 107 inches (2 718 mm) and some may have interior heights as great as 110 inches (2 794 mm). (Interior heights are reduced in the vicinity of the top handling fittings.) Details of the features distinct from those of ISO containers are summarised below.

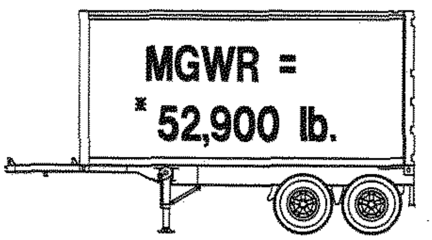
40', 45', 48', 53' CONTAINERS
MAX. GROSS CONTAINER
WEIGHT= 67,200 lb.

(PAR 4.5)



20'-0" CONTAINER
MAX. GROSS CONTAINER
WEIGHT= 52,900 lb.

(PAR 4.5)



* DOES NOT INCLUDE CHASSIS WEIGHT

Exterior dimensions of North America domestic containers

	feet	m
length	20	6,1
	40	12,2
	45	13,7
	48	14,6
	53	16,2
width	8	2,44
	8 ½	2,59
height	8	2,44
	8 ½	2,59
	9	2,75
	9 ½	2,89

The AAR standard also incorporates provisions for thermal containers in the sizes specified in the standard. It is not known whether domestic thermal containers are in general use, although it is thought that some of these containers are in use in Canada.

Issues Covered in AAR Standard M-930-98

General requirements and specifications such as

- handling fittings
- exterior dimensions
- interior dimensions
- gooseneck tunnel dimensions
- maximum gross weight

Strength requirements

- Loads acting through handling fittings
- side walls
- end walls incl. doors
- floors
- roof
- side and straddle lift area

Testing

- Dimensional requirements
- Stacking
- Lifting from the top
- strength for side and straddle lifting
- Restraint - longitudinal and transverse
- wall strength: end wall, rear end, side wall
- strength: roof, floor, racking
- weatherproofness

Certification plate

Appendix A: 28 foot closed van dry cargo domestic container

Appendix B: Requirements for containers equipped with electrical power

Appendix C: Thermal domestic container

Appendix D: Truck Trailers Manufacturers Association Recommended Practice

The US domestic containers are made with two pairs of frames: a frame at each end of the container and a pair of intermediate frames set at the normal longitudinal spacing used in ISO 40 ft. containers and set at equal distances from the respective end frames. These intermediate frames are the principal interfaces for handling, stacking and securing.

Fittings at the intermediate frames are wider than ISO corner fittings to compensate for the extra 6 inches (150 mm) of container width. These fittings have apertures on the outward-facing horizontal and vertical surfaces. The respective top and bottom apertures of the intermediate fittings are recessed 3 inches (75 mm) further from the extreme vertical edges that are the corresponding apertures of ISO corner fittings, in order to permit mating with conventional spreader and straddle-carrier beams that are used to lift 40 ft. ISO containers. Thus, the container may be handled with the same equipment as is used in rail, truck and marine terminals for ISO containers. While the domestic container is normally handled by ISO-style top lifting equipment, domestic containers are capable of being handled by US domestic bottom straddle-lift equipment known as „piggy packers“. The bottom side rails of the containers optionally may be fitted with overlapping „lifting pad“ reinforcements for this purpose - a feature rather similar to the grappler arm recess in the standard European swap body.

A recess is provided in the bottom side rails just beyond the bottom intermediate fittings in the direction towards the ends of the container to permit access to hardware that secures the container to a railcar or to a lower container at the 40 ft. intermediate frame position.
Additional fittings (end fittings) are placed at the extreme lower corners of the outermost frames. Apertures are provided principally for securement of the container to highway chassis, although optional apertures may be fitted to the end fittings to permit other, non-standardised types of handling.

The railcars used to carry domestic containers can handle a double-stack of containers, with the upper container being a maximum of 48 or 53 feet long and the lower container being a maximum of 40 or 48 feet long. The lower container is never longer than the upper container, in order to limit bending forces on the lower container. Stacking is effected through the intermediate frames at the ISO 40-foot position, and securement is through „interbox connectors“, which may be semi-automatic twist locks that are used in marine service.

Movement by highway is in a single-stack mode only, in order to satisfy highway bridge clearances and weight limits. The special J. B. Hunt domestic containers are not capable of being stacked.

The strength requirements of USA domestic containers are to a maximum gross mass limit of 67,200 lb. (30 480 kg) as in the ISO series, but other testing requirements are relaxed compared to those of ISO containers. Stacking is designed for three-high at the full load to the maximum gross mass R. The stacking test imposes a 3R loading on the top intermediate fittings, representing a static 1R load of the middle container and a dynamic

2R load of the uppermost container being dropped onto an existing stack of two containers. Side-wall strength is 0,3 of payload rather than the 0,6 of payload in ISO containers, and roof strength is similarly reduced.

Domestic containers are marked with "U"-ending container prefixes generally in conformance with ISO 6346 except that no size/type code or check digit is generally used. Supplementary marking of interior dimensions is often provided on the left-hand door. Insofar, the owners of US domestic containers use the system of ISO 6346 to allocate identity to their containers, a method perfectly in accordance with the spirit of that standard which allows non ISO containers as well to be marked with the identity markings provided by the relevant ISO standard. Some of these owners have been reported to register these markings not, as foreseen in ISO 6346, with Bureau International des Containers, but with the US National Motor Freight Traffic Association (NMFTA). As this might create duplications with operators of ISO containers using owners codes ending with a „U“ to identify their containers as well, some difficulties could arrive out of this practice. Bureau International des Containers has already initiated actions to exclude such difficulties by internal co-ordination with NMFTA to avoid any possible duplication, even between identity of ISO containers in international use and US domestic units.

While special containers may be built in other dimensions or to other strength ratings for very specific, limited service, the domestic container dimensions and strength standards are not likely to change in the foreseeable future. Highway clearances and weight limits for highways and railbeds are similarly unlikely to change in the near future for long-distance, multi-state travel. In the USA, highway laws are made by individual states with national authority very limited (and primarily governing movement on the interstate highway system, not most local roads).

Additionally, the intermodal movement of ISO containers in the rail mode continues to grow in the USA, which relieves some pressure for additional intermodal domestic containerisation.

Wabash National has developed a new 53 ft. container design with the same general dimensions but with special top fittings that are shallower than existing fittings for less intrusion and greater inside clearance. This type of container is just entering service. Other, similar ideas are being considered as well.

Lastly, the 1998 edition of the AAR standard also contains provisions for a 28 ft. (8,5 m) domestic container with a maximum gross mass rating of 36 000 lb. (16 330 kg). A single intermediate frame is provided such that, when two 28 ft. containers are laid end-to-end on a railcar, a single 40, 45, 48 or 53 ft. container may be carried stacked above the 28 ft. containers. Such containers do not now exist in sizeable numbers, but there number may increase in the future.

Inland waterway transport is, due to the topographical Situation of North America, a rare item. While ISO containers carrying import and export cargo are distributed between main ports and smaller places along side the US Atlantic coast and partly in the Mississippi river system, no use of domestic units in this type of operation is reported. Similar features can be stated for short sea shipping, which mainly refers to the trade between the US mainland and Hawaii, Puerto Rico and Alaska. These trades use mainly ISO containers.

1.2.6 Small and medium size containers

As already reported earlier, small and medium size containers dominated the discussion in the period before the ISO containers came into operation.

The United Nations Economic Commission for Europe made a clear set of definitions for containers of various sizes that shall be used in this report as well:

- small containers: freight containers with an internal volume of 1 cubic metre until 3 cubic metres,
- medium containers : freight containers with an internal volume of more than 3 cubic metres, but an exterior length of less than 6 m (20 ft.),
- large containers : freight containers with an exterior length of 6 m (20 ft.) and more.

In the field of small containers the railway owned A-, B-, C-containers dominate: Boxes equipped with small wheels to carry consumer goods from factory into railcar, from railcar into downtown delivery truck, and then into the department store to become unpacked there. They had been used mainly for glassware, china ware, toys and similar consumer goods.

In the field of medium containers the European railways had various designs of containers with a loading capacity of 5 - 10 cubic metres. Central and West European railways had designed the „pa container“ for easy interchange between railcar and road vehicle. This type of container needed very specialised equipment on road and rail and was mainly used in the 1950s and 1960s to carry small bulk consignments. Some of these containers had been especially designed to be carried intermodally on transport chains road-rail-deep sea. The containers are practically out of service today.

A very comprehensive report on all these historic developments in the field of small and medium size containers had been elaborated and finalised by the United Nations Economic Commission for Europe in 1967, published as Document W/Trans/WP 24/94 and Add.1; a German language version had been published in Rationeller Transport [Frankfurt am Main] No. 06/1967, p. 189...245.

Russian Rail was reported to operate large numbers of medium size containers, specially designed for road-rail operation in the Soviet-Union. No clear information is available whether these containers continue to be in service and which economic role they play in the East European transport system.

ISO standardised in ISO 668 a medium size container of 10 ft. (3,05 m) length with 8 x 8 ft. diameter. Some of these boxes had been built and operated. When the air cargo industry made some experiments with air / surface intermodal containers of ISO dimensions, they built a small number of 10 ft. containers. This type never gained any importance.

Since 1995, a new discussion about medium size containers had started from two ends:

- Railways planned to consolidate their small consignment business (which created high deficits) and discussed to use medium size containers that could possibly be integrated into existing combined transport systems.
- Freight forwarders active in the consolidation business tested medium size containers, modular fitting into their swap body transport system, for better separation of consolidated consignments.

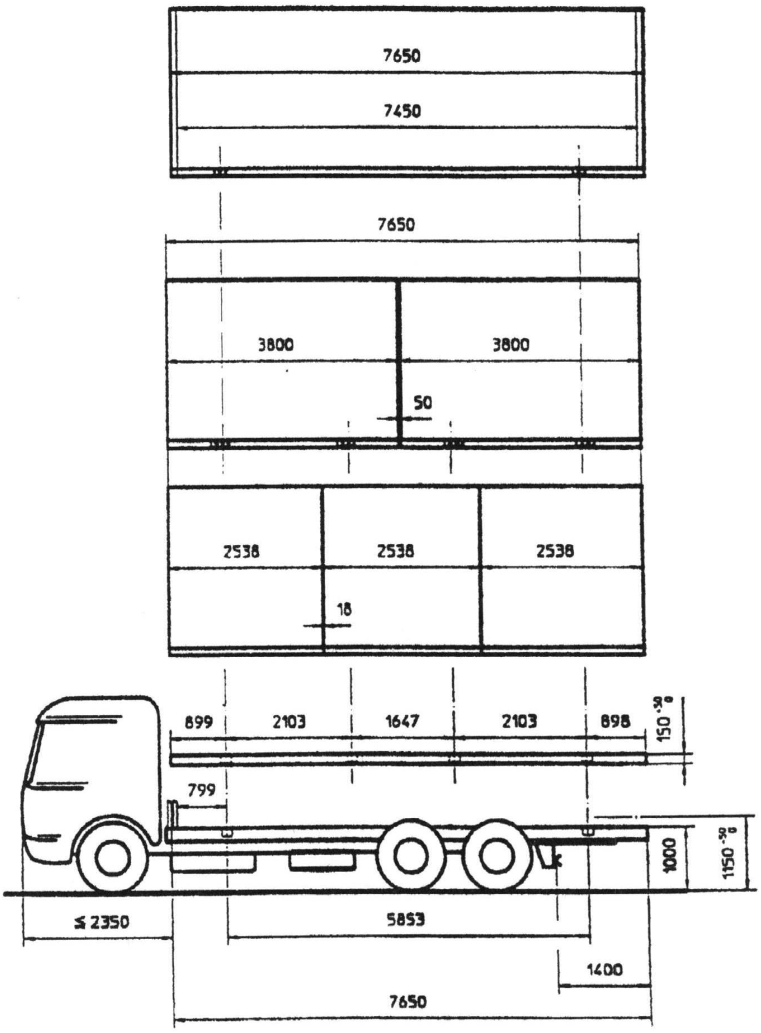
A specific consideration was to use such systems for downtown and supermarket delivery. Such deliveries might easily combine items of various temperature control needs such as

- ice cream and deep frozen products at -15° - 20°C,
- refrigerated products (milk, fresh cheese, meat products) at +5° - 10° C,
- normal products at outside temperature.

The basic idea was to pack these items in separate containers each of them with a specific temperature regime and to carry all of them with one delivery turn to the retail shop.

Most systems of medium size containers are modular designed,

- either bottom-up as a multiple of pallet loads,
- or top-down as a cut of standard swap bodies, either 1 swap body of 7650 mm length cut into 2 units of 3800 mm length each, or in 3 units of 2538 mm length each, offering inside 2400 mm clearance for palletisation.



System for small and medium sized containers (class D and E)

The top down approach led to one half or one third swap body design, i. e. boxes of 2550 mm width and lengths of 2500 mm or 3710 mm or 3900 mm.

Deutsche Bahn (German Rail) introduced for their less than car load freight traffic a new organisational approach and based this on new medium size containers of 2500 x 2500 mm. The basic idea was

- such a container can be loaded lengthways of transverse on a load carrier,
- this container can take over 6 pallets of 800 x 1200 mm,
- 6 of such containers can be carried on a road train with a loading length of 7500 + 7500 mm.

Discussions were conducted how such containers could be introduced into current German and European intermodal transport systems. One idea aimed at an intermediate frame to accommodate 3 of these medium containers. The terminal would have to lift only the frame, and so in one move to transfer 3 containers. Or some special railcars would have to be equipped with additional fittings to accommodate these containers without intermediate frame. In the end, both ideas were rejected: The intermediate frame was regarded as too costly and to complicated to manage, especially in intermodal transport terminals which are anyway often overcrowded and have management problems. The transfer of these containers one by one from road vehicle to railcar would involve prohibitive costs: An efficient well organised terminal charges today per transfer some 17 Euro to the client. A six-pack of such small containers to be transferred between a road train and a railcar would involve costs of more than 100 Euro at both ends - this is an amount that allows to buy in road carriage for a considerable distance, possibly up to 300 km. In the end, these boxes did not appear in intermodal transport.

The line of development that starts with pallet based small containers has culminated in a work on European standard on „Small load carrier system". Three parts of such a standard are envisaged:

- Small Load Carrier Systems - Part 1: Requirement and test methods
- Small Load Carrier Systems - Part 2: Column stackable systems (CSS)

Small Load Carrier Systems - Part 3: Bonded stackable systems (BSS)

A rather similar consideration on a family of intermediate containers is generated by a Dutch team that has lately elaborated a report on loading units. [TRAIL and RUPS: „Continental Loading units for intermodal transport", Schiedam, August 1998.] They go the same way as CEN TC 261 Packaging and look for a series of small load carriers to avoid packaging waste, going up from there to a series of boxes that make multiple of the main European pallets and keep within the framework offered by European road vehicle sizes. The main boxes suggested in this study are as follows:

- Pallet box with external dimensions of 1220 x 820 x 1020 mm (length x width x height) that accommodates practically one pallet load, bringing the same patterns as the box pallet;
- Tribox box with external dimensions of 2550 x 1280 x 1350 mm (l x w x h) that accommodates two 1200 x 1200 square pallets or smaller units, limited in loading height;
- Urban box with external dimensions of 2550 x 2150 x 2150 mm (l x w x h) that accommodates 4 pallets 1000 x 1200 mm or double of it in two layers when each pallet load does not exceed 1000 mm height;
- Midbox with external dimensions of 2550 x 4300 x 2900 mm (l x w x h) that represents practically a European standard swap body of 7820 mm length with extra height cut in two half pieces.

The European Union has in 1998 started a COST action to study technical and commercial aspects of medium size containers in Europe, COST 339. The results will be available after the termination on this report on European loading unit standardisation needs and should be, when available at a later stage, attached to this report.

1.2.7 Semi-trailers in combined transport

1.2.7.1 *Semi-trailers in combined transport road/rail*

The semi-trailer had been the first large unit load to be carried in combined transport road / rail, in North America and in Europe.

In North America the railways carried two 35 / 40 ft. trailers on 85 ft. long flat cars. The trailers had been standard design, and the flat cars had a full height platform. The semi-trailer were mainly loaded by circus ramps on the flat car assembly. Most US railway networks allowed such type of operation - full height semi-trailer on full height flat cars - because they had a rather generous gauge profile. Only some networks in the East - at that time the Pennsylvania Railroad - had a more narrow gauge and made some experiments with box type units that were moved in road transport with a running gear (double axle with suspension and tires) added. This system was called Flexi-Van. But all other major networks moved TOFC = Trailer On Flat Car as combined transport .

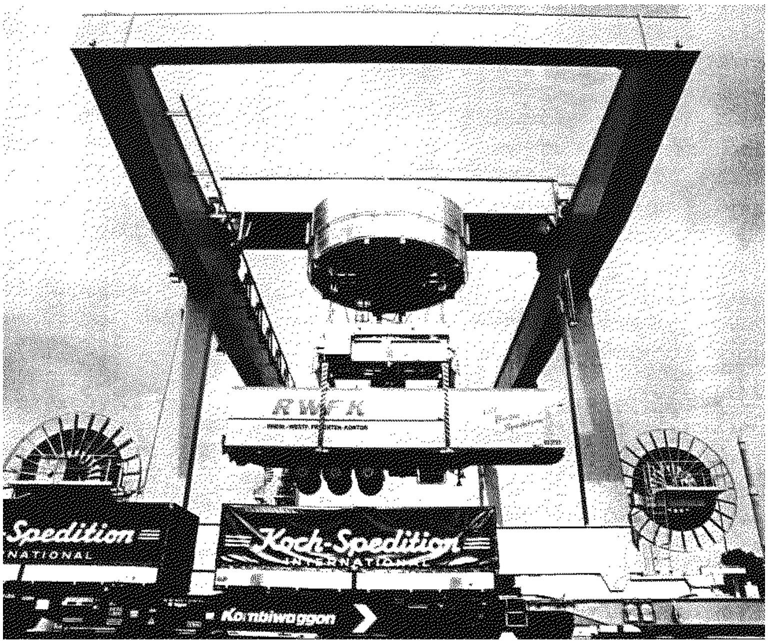
Europe had from the start many difficulties to achieve a combined transport of a similar technique, because practically no European rail network has a gauge that allows a full height trailer to be carried on a normal height platform car. Another problem aggravated the situation: As each network has another gauge - and as some differences are rather severe - , there was no opportunity for an initiative to develop a joint strategy to overcome such a problem.

The most infringed networks are in Great Britain, France, Italy (mainly Central and South). Great Britain decided to go the way of box traffic and developed the Freightliner system. France and Italy developed special type semi-trailer with infringed roof construction and special wheel arrangements to lower the added height of semi-trailer and flat car. The main problem was that all these solutions were based on a special design semi-trailer, while the great fleet of standard design semi-trailers never had a chance to enter intermodal transport.

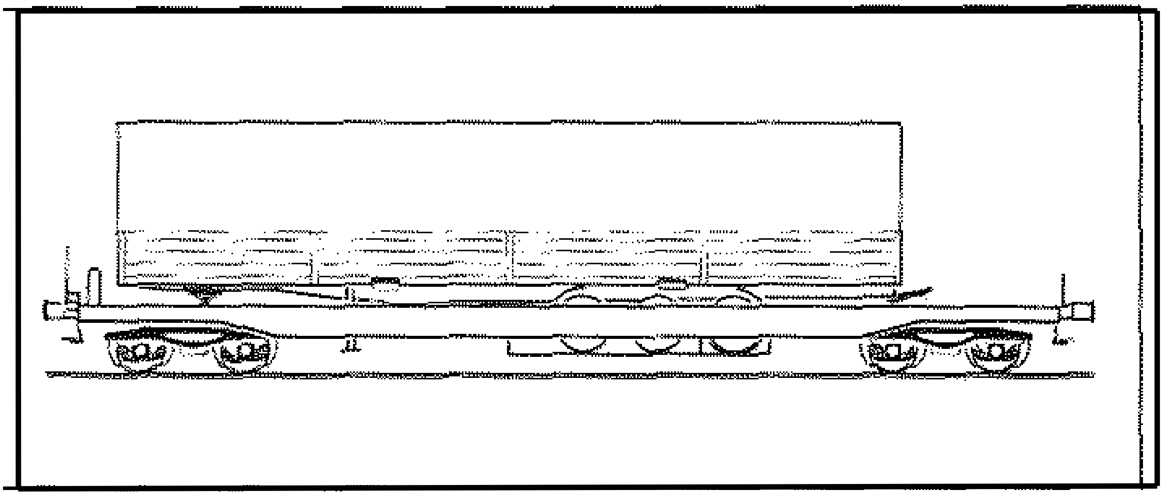
The railways with a more generous gauge profile, mainly in Central Europe and in Scandinavia, tried to design rail-cars that could accommodate full height semi-trailers. The problem was that a standard semi-trailer had to be driven onto the rail-car assembly via a circus ramp and then to be driven over all platform towards the end of the train. But the specific place on the flat car that took over the semi-trailer wheel assembly had to be lower than the general platform to allow full semi-trailer height within the gauge line. One design in Germany was the „Wippenwagen“: On this special rail-car, the part of the platform on which the wheel aggregate of the semi-trailer rested was lowered down after loading. This decreased the general height of the unit and contributed to the fixing of the semi-trailer on the rail-car. In the 1980s this technique was given up because the loading and discharge process was too time-consuming and too costly.

Another design foresees a pocket in the platform of the flat car between its axles. The pocket is situated between the bogies of the flat car and can thus be considerably lower than the platform height of the car. This type of rail-car (pocket wagon, wagon poche, Taschenwagen) is today very popular in European intermodal transport because it can carry semi-trailer or swap body or containers alike.

The main problem of this technique is the fact that the semi-trailer must be vertically transferred on the pocket wagon, i. e. the semi-trailer must be prepared for lifting. This needs some minor reinforcements mainly in the longitudinal bearing member and slightly increases the price and the tare weight of the semi-trailer. In consequence, most operators prefer the cheaper version without lifting capability. Major German producers estimate that some 98 % of all semi-trailer produced are light design without lifting capability and only 2 % can be lifted. This relation limits the market potential of combined transport in Europe considerably.



semi trailer prepared for lifting during the handling process in the grappler arms of a spreader



Semi trailer at a pocket wagon

Another problem was removed quickly: the preparation of lifting facilities for semi-trailer transfer. Most container cranes in the inland terminals in Europe could be easily equipped additionally with grappler arms and a lifting mass capability to lift a semi-trailer with 33 t from the ground into a pocket wagon.

The other serious problem remains: The networks of France and Italy and the Alps transit lines cannot accommodate the assembly of a full height semi-trailer on a pocket wagon. Swiss Rail has announced that from the year 2000 onward the Loetschberg - Simplon transit route will be capable to accommodate full height semi-trailers on pocket wagons, but all other parts of the mentioned networks do not. This limitation becomes grave in these days because more and more lightweight cargo comes into the transportation market, and the road operators generally tend to order semi-trailer with maximum cubic capacity, i.e. with full height. These units cannot be carried intermodally in Great Britain, France, Italy ... - whatever rail-car design is realised.

Currently, some 30 % of all UIRR combined transport movements are executed by semi-trailers on pocket wagons.

1.2.7.2 *Semi-trailer in roll on/roll off - transport*

While the carriage of the semi-trailers in intermodal transport road/rail decreased in market share in Europe, the semi-trailer became the most important unit load on short sea crossings, mainly between Great Britain and the Continent and Scandinavia and Central Europe.

Until the 1950/1960s, the main method of short sea crossings had been the unloading of road and rail vehicles in the port, loading the cargo on board ship, sea crossing, and to re-loaded into road or rail vehicles in the destination port.

A limited amount of intermodal transport existed: Some short sea crossings were served by special ferry boats that were equipped with rails on the main deck. In the port, the railcars had been shunted into these ferry boats, and in the arrival port the rail-cars entered the other rail network. Most of these ferries had been owned and operated by the railways.

Since 1968, ISO containers had been added to this market, mainly between Great Britain and the Continent. Some short sea carriers specialised in that type of business and operate small ships of cellular type. The load and discharge operation is performed by lift on/lift off technique. The short sea lines operating this trade have partly introduced special non-ISO containers. Some other containers of non-ISO design are used, in addition to semi-trailer based roll-on / roll off traffic, between the South Europe mainland and some islands in the Mediterranean Sea. Details are given in chapter 1.5.3.

But the semi-trailer became the main means of short sea crossings in Europe. Currently, the roll on / roll off-traffic with semi-trailers is the most important means in Europe. The rail equipped ferry boat has widely disappeared. Only some Scandinavian trades continue to use this method.

Safety of short sea roll on/roll off operation became an issue of standardisation. So, a standard was elaborated covering the fixing devices attached to road vehicles that are designed to be used in roll on/roll off transport. This standard fixes the localisation and the strength of such fixing points. This standard has been agreed on in ISO, CEN, and national standardisation associations with similar wording. Road vehicles operating in short sea shipping in roll on/roll off transport are not mandatory required to be equipped with features according to the standard. But fixing and lashing of such vehicles on board ship is greatly facilitated if features according to this standard are included in the road vehicle design:

- ISO 9367-1 Lashing and securing arrangements on road vehicles for sea transportation on Ro/Ro ships - General requirements - Part 1: Commercial vehicles and combination of vehicles, semi-trailers excluded
- ISO 9367-2 Lashing and securing arrangements on road vehicles for sea transportation on Ro/Ro ships - General requirements - Part 2: Semi-trailers

Besides the semi-trailer, the swap body plays a major role in some short-sea crossings. Normally, the swap body is loaded on a platform equipped with small wheels and trucked on board ship.

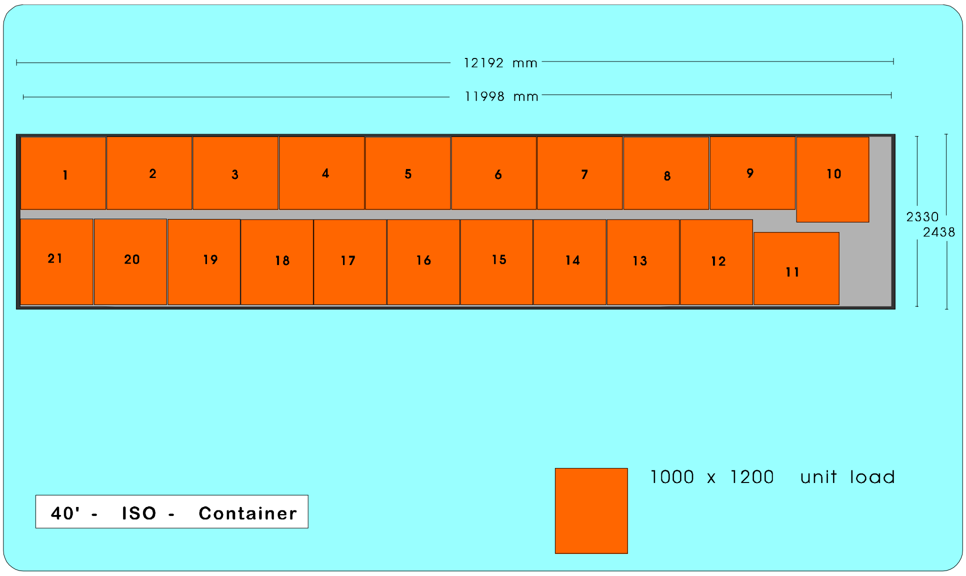
A very specific competitor has been added to the Great Britain / Continent market: the tunnel service that offers corridor facilities for combined transport trains, mainly loaded with swap bodies, between England, France, Spain, Italy. Furthermore, the tunnel operators offer shuttle services between the English Coast Line and North France carrying complete road vehicles including motor truck and driver.

Similar new transport patterns will appear when the various links - tunnels and bridges - between Sweden and the Danish Islands and the Continent come into service.

1.3 SUMMARY OF THE MAIN DEBATES ABOUT CONTAINER STANDARDISATION ISSUES

1.3.1 The case of ISO container versus ISO pallet

As already outlined in chapter 1.1.3 and 1.3.3, the debate about container and pallet standards had accompanied the technical discussion for more than three decades.



The picture above shows clearly that both systems do not fit into each other. All those who were enthusiastic about a common world transport system either asked the pallet people to change their standards or to the ISO container people to re-design the container .

Today, the European distribution system is operated by a dual technology: Most domestic European movements are carried in trucks or swap bodies optimised for palletisation, while the overseas import and export flows are moved in containers with individually made up load assembly.

Some concern might be at the level of packaging standardisation. As pointed out in chapter 1.4.2., the European standard packages have developed to fit exact into the European pallets. Now, a line of argumentation said: „At the end of the production line, normally an automated packaging is organised - and this packaging process cannot make a difference between overseas export and European distribution. In the end there will be one standard package only that either will go into one or the other distribution channel“.

Obviously, the Europan industry has overcome this difficulty. In the end, the ISO containers go well loaded into export as the swap bodies and road vehicles do with palletised unit loads for European distribution. One of the reasons for this flexibility might be the fact that ISO containers for overseas export are anyway very seldom loaded with unit loads on standard pallets, because the use of standard pallets with more than 100 mm height would create too much losses in cubic space utilisation. It is obviously not too difficult to achieve even in the limited interior of the ISO container a good utilisation pattern taking non standard one way pallets with reduced height and packages in individual stowage. A great number of export containers loaded with less than container load consignments by a consolidator. They do not concern with any standard on packages or palletised unit loads - variety is the daily business in that operation.

So, the industrial concerns about a dual distribution system seems like have calmed down.

Nevertheless, a basic conflict remains, and will be always vital: The big shippers wish to have provided logistic systems that are tailor made for their needs, their specific rype of shipments, and their distribution patterns. Up to now, nobody ever has offered a competitive service with loading units prepared for European palletised loads in overseas transport markets. Regarding the hugh investments necessary, and regarding the uncertainty of commercial success, no ocean carrier has dared such a move. The logistic service providers and the carriers wish to operate equipment as general purpose as possible, to remain flexible for the needs of various clients, and to combine forward and return trips, most of them for different clients, with one set of vehicles.

1.3.2 The conflict on European domestic containers

The other concern remains: The problem ISO container versus ISO pallet has motivated the Europeans to design their own domestic container, and ISO containers and European unit loads are moved in separate operations, partly using the same equipment, partly needing special devices.

Currently, the flow of import and export containers between the main ports and the hinterland is rather separate from the flow of European swap bodies. Hamburg, a major source for combined transport volume, has e.g. three main points delivering unit loads into the rail system: the HHLA deep sea container terminal, the Eurokai deep sea container terminal, and the inland terminal at Billwerder. Basically each terminal is capable to handle ISO containers and swap bodies alike, but organisation, special market approach of the rail, and different range of clients create a separation of the business. This is certainly not advantageous for intermodal transport, because this transport technique gains its main economics from concentrating large volumes into block trains, while the separation of ISO container and swap body business cuts the volume into smaller pieces.

The intermodal carriers in USA combine overseas import/export container flows and domestic consignments. The big ports at the Pacific coast form major concentration points for import and export container flows, but the related inland terminals serve as well local industry handling domestic units such as semi-trailers and domestic containers. One of the reasons for the commercially successful operation of US railways is their ability to concentrate both flows, the import/export and the locally generated cargo, into one block train system.

These block trains carry both types of units - US domestic containers and ISO containers. With other words: The economically detrimental separation of combined transport flows into ISO container movement and European swap body movement is not a result of differing container design following differing modular patterns, but of market separation as a strategy of the inland carriers.

Insofar, the conflict ISO container versus ISO pallet and European distribution system remains, but the European industry has obviously well arranged with the dual system. The economic problem of two different types of containers in the European transport system remains. But the main problem is obviously not caused by the physical difference, but by market and product differentiation that tries to keep both units in a separate transport regime.

1.3.3 The conflict on ISO series 2 containers

In the mid 1980s, ISO TC 104 made a new move that eventually would create another revolution in transport: ISO TC 104 set up a working group on a new design container, taking over all experience gained over the last 20 years, and incorporating the trend to larger units in road transport, namely in North America. At those days, the USA allowed trailers of 8 ½ ft. (2,59 m) width and 48 ft. (14,64 m) length on the highway system.

So, one idea brought forward was to overcome the container/pallet problems by offering a new container with 2 480 mm inside width and a cube capacity that would meet competition with conventional US road vehicles.

The fact that the marine experts represented mainly in ISO TC 104 focussed their attention mainly on competition of their containers in US road transport seems strange but had some specific background with the cost structure of a door to door movement of a container: In a complete overseas transport chain, the deep sea part is by far the cheapest way per km of carriage, while inland road transport is far more expensive per km. An ISO 40 ft. container from a European North Sea port via Suez to the Far East pays less than 1 000 $ per trip, i.e. less than 0,12 $ per km. Road transport in Europe will charge 0,80 - 1,00 $ per km. While hinterland transport over the road is a rather short distance matter in Europe (Hamburg-Berlin or Rotterdam-Dortmund are 300 km trips, Southampton-London is less than 150 km), the US hinterland carriage often includes distances of some thousand kilometres. With other words: In import / export operations involving North America, road transport counts for the major part of the costs, and the pressure to cut road transport costs is extremely high. Any chance to move a larger volume at rather similar cost per km will be followed. A 48 ft. length, 8 ½ ft. width and 9 ½ ft. height box can carry more than 30 % additional cargo compared to the conventional 40 ft. container .So, it was easily understandable that US interests moved the concept of a new generation of containers forward.

At that time, the outline of an optimised swap body with a width of 2 555 mm and a length of 7 430/7 450 mm came into the discussion, this swap body being rather optimal for accommodation of European palletised unit loads. So, the Europeans suggested to maintain the basic ISO philosophy to have a modular system, but no longer at a 20 ft. (6,1 m) module, but with a new module of 7 450 mm with a 14 900 mm long container as the larger unit. This would appear in USA as a 24 ½ ft./49 ft. modular concept. Since many US states were prepared to accept trailers up to 53 ft., this unit should not provide any difficulties in road transport while the Europeans would concentrate on the 2 x 7 450 mm version.

In detailed discussion, it was found that because of combination spacing and tolerances the half module unit was better defined at 7 430 mm (which would not affect the palletisation patterns), so the proposal was

ISO Series 2 containers

length	width	height
mm	mm	mm
7 430	2 590	2 900
14 900	2 590	2 900

This proposal generated considerable discussions all over the world. Two parties joined particularly into that discussion:

The European Commission was afraid that their work on a compromise in common European rules for maximum road vehicle dimension was jeopardised if a standard asking for a 14 900 mm trailer length was tabled. It was clear that many European countries - especially France, Germany, Great Britain, Italy would strongly oppose such a long dimension.

The UNCTAD acting as speaker of the developing countries was equally in opposition. They found their old fears coming into reality (see chapter 1.2.3): Once the developing countries had adapted their equipment to participate in the new transport system based on ISO containers, the industrial states would find a pretext to alter this system leaving the developing countries behind one more time.

Two International Conferences organised by United Nations Economic Commission for Europe were convened to discuss the new situation. The European Commission ordered a large study and initiated a COST action (COST 315) to come to a conclusion based on careful research and well organised discussions.

In the end, the European Union working group co-operating in the COST 315 action, published a final report that came to the following summary conclusions:
„Within COST 315 (COST = European Co-operation in the Field of Scientific and Technical Research) a world-wide survey has been undertaken on the consequences of an introduction of a series 2 containers. The study has led to the following main conclusions:

- Series 2 containers cannot be transported in the cells of existing container ships. In maritime transport, these containers would ultimately lead to the need to provide new ships. For an interim period, they could be transported in limited numbers on the decks of the existing container ships, but only at the expense of a reduction in the capacity of the ship.

- Some newly designed ships are capable of being converted to carry a mix of series 1 and series 2 containers.

- Most port terminals would have to adapt or, more probably, replace, their ship-to-shore lifting equipment and their transfer rolling stock in order to be able to accommodate 49 ft.

There will be a loss of capacity on the existing 40 ft. and 60 ft. railway wagons in Western Europe. To solve this problem railways in Western Europe will have to invest in specialised rolling stock and in some networks to undertake extensive modifications to the loading gauge. Even where it is possible to use existing wagons, this will incur a loss of capacity. Some railway lines with limited loading gauge will incur further difficulties.

Due to the lack of special container wagons, the railways in Eastern Europe would, in any event, have to invest in new rolling stock in order to carry ISO series 1 containers or ISO series 2 containers.

The railways in North America are generally prepared for the transport of ISO series 2 containers.

In most developing countries rail is until now little used for container transport. In those developing countries where rail is used for container movement, the introduction of ISO series 2 containers would require costly adaptation, at least of rolling stock.

- In almost all Western and Eastern Europe, road transport of 49 ft. containers is outside the permitted dimensions for road transport. Two half size 7,43 m long units could be accommodated, as far as the length is concerned, on a road train within the legal length limit. The proposed width of 2,59 m for 49 ft. and 24 ½ ft. containers is in any case in Europe outside the permitted dimensions for non-refrigerated road transport. The proposed height of 2,90 m could only be accommodated within the general road vehicle height limit of 4,00 m by the use of special road transport equipment.

- Road transport in North America is generally adapted to the carriage of ISO series 2 containers which fit with the North American legislation concerning road vehicle dimensions of maximum 48 or 53 ft. length.

- Inland waterway transport is very significant in the Rhine valley at present, but is expected to grow into additional areas, e.g. the Central European canal network. Inland waterway vessels for the Rhine can transport ISO series 2 containers without major modifications, but only at the expense of severe loss of capacity. Inland waterway vessels for canals have limited dimensions due to the classification of canals. This means that for class IV ships series 2 containers would lead to a loss of capacity, as only 3 in stead of 4 rows in width can be stacked on board. The existing bridge clearance on a great part of the European canal system does not allow the passage of an inland waterway vessel with two layers of 2,90 m high containers.

- In Europe combined transport rail/road and -/inland navigation is increasingly used. In this system the series 2 containers would complicate the interchange between the various modes.

- Most inland road, rail and inland waterway terminals would require adaptation of their lifting equipment and spreaders in order to be able to handle 49 ft. containers. Lack of space, particularly in urban road and rail terminals, will cause difficulties with the management and stacking of different sizes. The 49 ft. containers creates much larger problems than the 7,43 m unit.

- The width of the proposed ISO series 2 containers permits a more efficient loading with ISO standard unit loads than the existing series 1 containers. However many shippers have arranged their exports to fit into the ISO series 1 containers and do not see a need for a change. For other shippers in Western Europe, the 7,43 m unit could offer an efficient intermodal transport unit particularly for palletised unit loads. For most shippers, the 49 ft. container is too large in volume taking into account its weight limitation.

- Without doubt, the introduction of ISO series 2 containers will require a significant investment for the adaptation of the infrastructure and the rolling stock. This cost burden will be higher for the 49 ft. container than for the 7,43 m container. Whether shippers will, in the end, be able to secure a return on this investment through increased transport revenues is uncertain. This is particularly true for 49 ft. containers where the logistical advantage for the carriage of low density cargo will only apply to very few shippers.

[COST 315 - large containers - Final report of the action, edited by the European Commission, Luxembourg 1994, EUR 15 775 EN, p. IX-XI; some small printing errors have been corrected in the quotation.]

ISO TC 104 in its meeting in 1991 in Seoul, South Korea, had a final discussion on the project of an ISO Series 2 container, and a majority voted in favour of a move to abandon the work.

So, the discussions on this item in ISO TC 104 were terminated and the working group was disbanded.

While the discussion in ISO TC 104 was closed, various parties developed their own concept of containers larger than specified in ISO 668.

In North America, domestic containers with a length of 48 and 53 ft., a width of 8 ½ ft. and a height of 9 ½ ft. were introduced (see chapter 2.5), while some European ship operators introduced containers of 45 ft. length and 8 ft. width. But nobody, up to today, has decided on major investment to offer ocean carriage capacity for containers following the concept of ISO series 2 containers.

2. CONFLICTS IN CURRENT STANDARDISATION AND THEIR POSSIBLE SOLUTIONS

2.1 SCENARIOS OF INTERMODAL TRANSPORT SYSTEMS

2.1.1 General Situation

The scenarios set out in the following chapter illustrate some possible and likely situations of future intermodal transport and describe the environment in which a future European unit load has to be operated.

We assume the following basic situation as far as unit loads and their development is concerned:

- The European logistic system will maintain its basic orientation towards palletised unit loads with 800 x 1200 mm and 1000 x 1200 mm base dimensions.
- ISO containers will continue to dominate overseas transport, with a distribution of some 30-35% of the fleet being 40 ft containers, while 65-70% of the fleet will consist of 20 ft containers. Other sizes will not play a major role in world transport. A growing number of 40 ft containers will have a height of 9½ ft (2900 mm).
- Swap bodies according to CEN standards will dominate European intermodal transport, the perferred size will be 7450 mm / 7820 mm length and 2550 mm width.
- More than 2/3 of European international road transport will be carried by semi-trailer, the preferred length being 13600 mm. A very small minority of such trailers is prepared for lifting in intermodal transport.

As far as transport policy is concerned, we assume the following:

- Road transport will continue to be the dominant mode in European international transport.
- Even with additional bridges and tunnels crossing short sea legs, short sea shipping of cargo will increase.
- Import and export flows in containers will increase, until 2010/2015 it will double or triple, and so will the number of ISO containers to be carried.
- Political emphasis will continue to be in favour of combined transport, and combined transport will continue to develop at less momentum than the political hopes and expectations.

In the following, we shall discuss - mode by mode - how the situation might develop when a future European unit load as described in WP 4 "General specification" will be introduced into that environment. These scenarios, as described in chapter 2.1.1 - 2.1.5, will be followed by a detailed discussion of the conflicts that will arise and the solutions suggested.

2.1.2 Road

As far a intermodal units are concerned, European road transport will be faced by two types of operation. Intermodal transport units must be carried in pick-up and delivery between intermodal terminals and shipper's or forwarder's ramp, and they must be carried in long distance tranport over the road. This latter point is important, as road carriers or forwarders will need to switch their equipment between intermodal transport and pure road transport with some flexibility and they might have to organise specific intermodal transport chains with considerable long haul pick-up or delivery journeys.

Road transport will have to carry all types of intermodal transport units, and any new European container will be just an additional unit.

The road vehicle industry will develop transport units that can be adjusted to the various sizes of loading units in operation. It has to be emphasised that under current European legislation a pair of Class C loading units needs a basic system change from articulated road vehicle to road train, the road transport industry will continue to see this as an economic obstacle.

2.1.3 Rail And Terminal

Railway transport is in a similar situation to road transport. Rail will be confronted with a similar mix of units as in use today and rail will have to decide between specialised rolling stock or flexible multi-purpose railcars.

Rail has to be aware of the increasing need to carry rather high intermodal units. But this need has not led to the development of a new European intermodal tranport unit, this is due to the overall logistic patterns. In other words, even if no other unit than the existing families of ISO containers and swap bodies were to be transported, the development to very high units, ie boxes with a height of 2900 mm and a width of 2550 mm, would continue.

As in road transport the non-modularity between articulated road vehicles and road trains will create less than optimum solutions because rail cars have to be prepared to carry either 2 x 7820 mm units or 1 x 13600 mm unit, the latter generating a loss of space.

The new situation will be in terminal transfer. Current swap bodies cannot be stacked, and this means that the terminal management will try to avoid taking laden or empty swap bodies into storage. Since they can be kept only in one layer, each depot activity needs much space and space is normally something in short supply in terminal areas. In consequence, terminal management tends to limit offers for such depot activities. Swap body owners are charged if they do not pick-up their units shortly after arrival of the intermodal transport train. While ISO containers are often carried to the port well in advance of the ship's departure, and then wait in the terminal for the departure day, such a regime is today rather difficult with swap bodies.

This pattern might change if a certain percentage of European units can be stacked. Terminals can offer a depot function. Of course, that might create the need for additional equipment for some terminal companies, mainly reach stackers to operate the depot area. Intermodal transport can be organised with a time buffer in between and this will be a useful feature for some trades.

We must not overestimate the promotional aspects of such an offer. Most intermodal transports are time sensitive, and the road carriers prefer to deliver their units at the intermodal terminal not earlier than one hour before train departure, and to pick them up immediately after arrival of the train. But some cases may exist when such a depot function offers favourable conditions for intermodal transport, and so it might benefit from a future stackability of European units.

2.1.4 Inland Waterway Transport

Inland waterway transport today carries only ISO containers (and in some special cases semi-trailers on Ro-Ro platform ships).

Current design swap bodies cannot be carried efficiently in inland waterway transport.

The new European intermodal transport unit is especially designed to facilitate inland waterway transport, and so we have to face a situation when inland waterway transport will have to carry ISO containers and European units. ISO containers are almost only carried between sea ports and inland points (such as Rotterdam and Strasbourg), while European units will move as well on such routes, and on pure inland corridors (such as Duisburg-Strasbourg).

2.1.5 Short Sea - Ro-Ro Technique

Roll on/roll off cargo is carried today in a broad variety of intermodal units, and this will certainly not change.

Such units are

- semi-trailers up to 13600 mm length,
- other self propelled and wheeled units,
- swap bodies and similar not stackable units on MAFI trailers in one layer,
- other container shape units up to 13720 mm length and 2900 mm height in 2 layers,
- ISO 20ft, 30ft and 40ft containers.

If the new type of European stackable swap body appears in large numbers, roll on/roll off ships will carry in addition

- stackable swap bodies up to 3100 mm height in 2 layers. The platform height of the MAFI trailer is 700 mm. When loading 2 unit of up to 3100 each, the total height of the loading unit will arrive at 6900 mm, while the height of door openings and part decks of modern roll on/roll off ships is 7000 mm.

2.1.6 Short Sea - Lift On/Lift Off Technique

Short sea vessels of small and medium size today carry ISO containers between gateway ports such as Antwerpen, Rotterdam, Bremerhaven, Hamburg, Tilbury and smaller ports in Great Britain, Norway and the countries at the rim of the Baltic Sea. Similar operations exist in the Mediterranean with for example Cadiz, Gioia Tauro, Alexandria as gateway ports, and other ports all over the Mediterranean and Black Sea.

Normally, the ship cells of the container vessels are designed for ISO standard containers only, so that a European unit with 2550 mm or 2600 mm width and 7450 mm or 13600 mm length, even when stackable, would need a change of the cellular structure or a new design of ship. Such ships with flexible cell structures can be built and indeed there are already some in service. The future operational concept of vessels of this design may be:

- ISO containers only, or European units only
- ISO containers in one part with European units in another part within a fixed cell guide arrangement
- both types of container in a flexible cell guide arrangement adopting the arrangement for each voyage to suite demand.

2.2 TECHNIQUES AND ECONOMICS OF SHORT SEA TRANSPORT

2.2.1 Introduction

Short sea shipping in the context of this study, is the transport of Intra-European cargo in the form of containers or trailers. Short sea shipping is an integral part of a multimodal transport network.

Typically the container operator will provide a door to door service, the price quoted will include all haulage and transfer costs. The majority of the cargo is in the form of full container loads, although some part loads operating via intermediate packing and distribution centres do exist.

As such, short sea routes must have interfaces with inland waterways, rail and road networks. Ideally this should provide a system where shippers could choose the most cost-effective route for their cargo movements, taking advantage of the various benefits of each mode of transport.

The benefits that short sea shipping has to offer are as follows:

- Low cost per tonne per kilometre especially over longer distances
- Reliable and regular services
- Environmentally friendly in terms of the quantity of units carried
- Large choice of routes to suit individual customer needs
- Rest periods for driver accompanied loads on overnight Ro-Ro routes

However short sea shipping also has the following shortcomings:

- Terminal handling and storage costs
- Fixed sailing schedules
- Fixed port locations not always close to the point of origin or delivery
- Slow compared to most other modes of transport

The ships operating on short sea shipping routes can be broadly divided into two types, those that load and unload containers on trailers over ramps between shore and ship (Ro-Ro ships) and those that load and unload containers using cranes (Lo-Lo ships). The benefits described above will vary in their significance for the two ship types.

In the case of Ro-Ro ships the major factors for consideration and possible improvement are regularity and reliability of the service and the speed of the short sea crossing.

Lo-Lo shipping on the other hand is more sensitive to inefficiencies in terminal handling. Lo-Lo vessels are therefore suited to more lengthy coastal routes where increased terminal times are proportionally less significant. This, in addition to the higher number of containers required to make the service cost effective, means that the majority of Lo-Lo operators are involved in the distribution of ISO containers from major inter-continental terminals to the smaller ports distributed around Europe. Given the right circumstances there is potential for Lo-Lo ships to be involved in the transportation of the new European unit.

The success of any mode of transport, including short sea shipping, as part of the intermodal transport system, will depend on the following points:

- Marketing / shippers perception of the mode of transport
- Quality of service
- Safety of cargo (damage and security)
- Regularity and reliability of service
- Time taken for delivery
- Cost
- The inertia attached to currently used modes of transport

If operators of both Lo-Lo and Ro-Ro vessels wish to improve their share in the network, then these points need to be improved. The following areas can be worked on to achieve these aims:

- Design and construction of the vessels
- Ship operations
- Terminal handling

This section of the report deals with these aspects of the short sea industry in turn, identifying the various factors which influence the economics and acceptance of short sea shipping and assesses the impacts that a future standard European unit load may have on each factor.

2.2.2 Ship Design And Construction

For many years there has been a great variety in container dimensions. The need for flexibility in container carrying vessels is a well established design requirement. What is apparent however, is that ship owners are reluctant to take the initiative and risk in designing specialised ships to carry standard containers which are not already in widespread use in other modes of transport. This design inertia could impact on the success of the introduction of the new European standard units, into short sea shipping.

In this section, after a brief description of the types of vessel used in the transportation of containers over short sea routes, the views of designers and shipbuilders on the impacts of a new standard container on ship design are related.

Typical builders of vessels for the European short sea trade specialise in mid-size ships, mainly cellular and roll on/roll off ships.

2.2.2.1 Vessel Types In Short Sea Trade

A variety of vessel types are used in the short sea trade. This section will look at the principal vessel types used in the transportation of containerised cargo. These fall into two broad groups; Ro-Ro ships and Lo-Lo ships, these two vessel types have very different design requirements.

Ro-Ro or Roll on Roll of ships are, as the name suggests, vessels designed to carry cargo which is loaded and unloaded on wheels. Access to the cargo decks is gained by ramps which may be an integral part of the vessel and can be positioned at the stern or the stern quarter and the bow depending on the expected terminal configuration for the ship. The cargo is secured to the decks using a variety of lashing arrangements.
Vessel loading and discharge may be at one end of the vessel only (normally the stern) or drive through using both bow and stern, it may also be single tier, or two tier loading simultaneously, depending on terminal arrangement and the speed of turn around required.

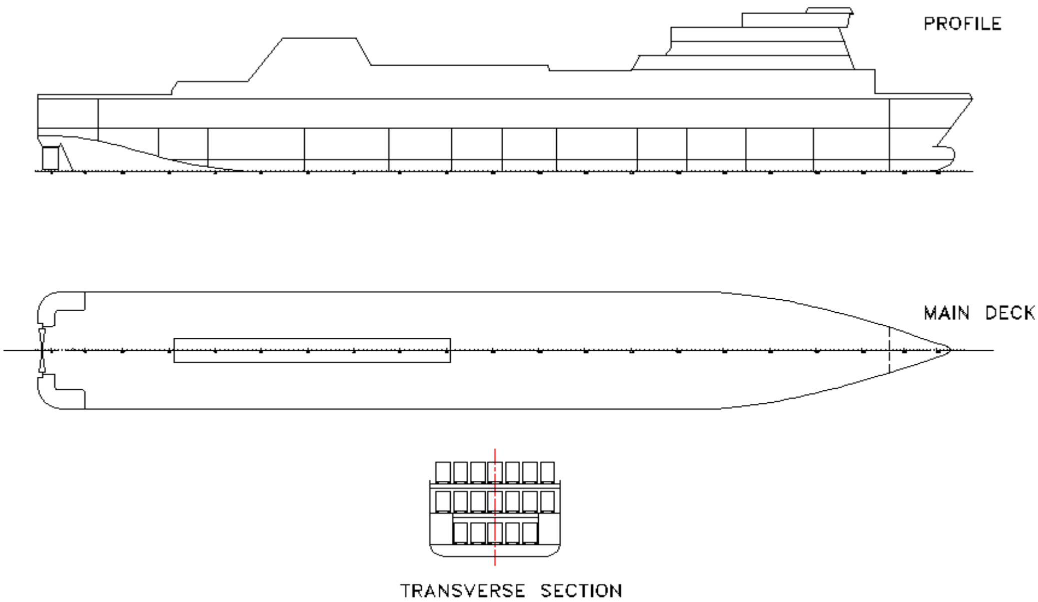


Diagram:
Typical Ro-Ro Vessel

Lo-Lo or Lift on Lift off vessels, on the other hand, are exclusively loaded by cranes. Access to the cargo holds is gained through hatches in the upper deck of the ship. The containers are then positioned and held in position during the journey using a framework of guides set to the dimensions of the containers to be carried. These guides are known as cell guides. Containers can also be positioned above the main deck and on top of the hatch covers, increasing the capacity of the vessels significantly. Containers on deck are secured in place by devices known as twist-locks located between tiers or by rod or wire lashings.

Some Lo-Lo vessels are designed without hatch covers, these hatchless ships offer obvious advantages in the loading and unloading of cargo. The penalty for this type of ship is that the containers below the main deck are offered less protection from the weather and sea.

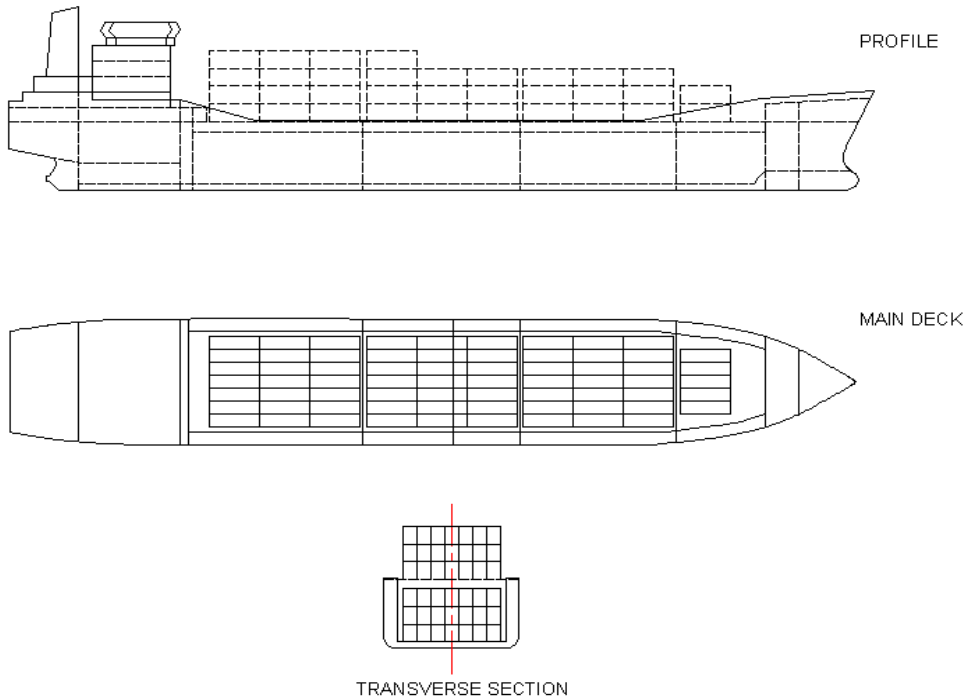


Diagram:
Typical Lo-Lo Vessel

There are recent examples of design studies and actual building and operation of vessels which combine the functions of a Ro-Ro and a Lo-Lo ship. This hybrid ship improves the flexibility of operation but can encounter difficulties in handling of cargo. Most terminals will be geared up for either Roll on Roll off or Load on Load off handling, a combined vessel is limited in the number of ports it can visit. However, Hamburg located HHLA terminal handles combined Ro-Ro/Lo-Lo ships operated by Wilh. Wilhelmsen from Norway.

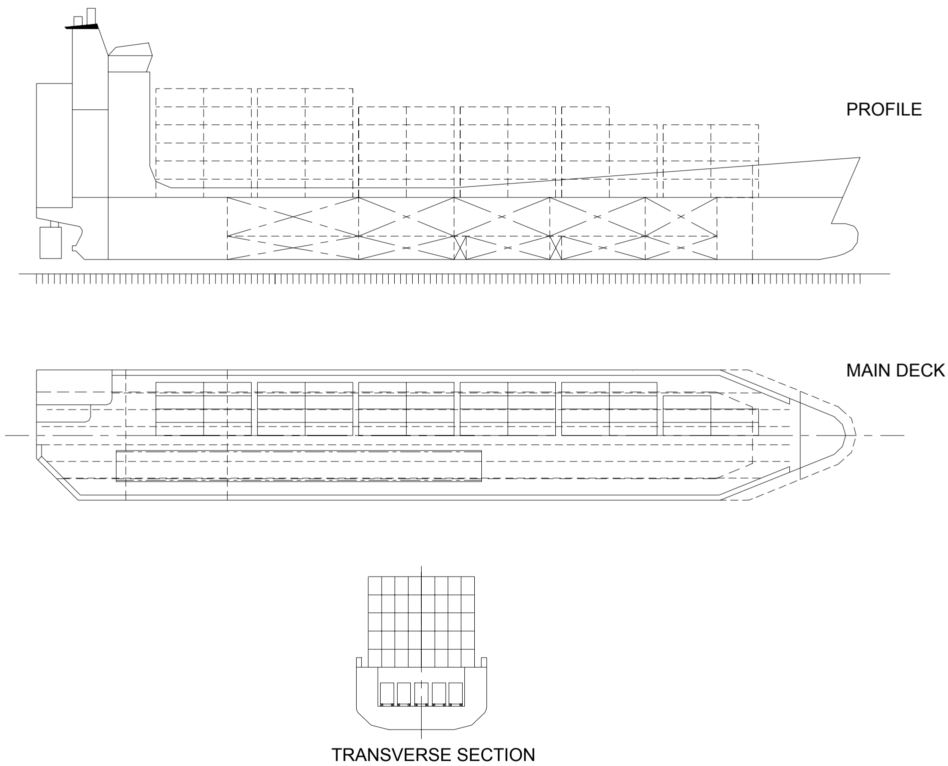


Diagram:
Combined Ro-Ro/Lo-Lo vessel

2.2.2.2 ***Cellular Ships Or Roll On/Roll Off Ships?***

There is a view that there will be a long term trend towards cellular ships because this type of ship, when built to the same size as a roll on/roll off ship, can carry double the number of units. For ships of similar size the cellular ship is also less complex than the Ro-Ro ship both in terms of structural design and cargo equipment although a cellular ship may be equipped with its own container handling crane(s).

The outcome of this is that the cellular ship can operate in sea voyage at less than half the cost per unit carried compared to a roll on/roll off ship. On the other hand, roll on/roll off ships offer greater flexibility and speed as far as various units to be carried are concerned, and the quay to ship cargo transfer can be cheaper under certain conditions.

The designers of the latest generation of Ro-Ro ships and stackable European loading units have provided for the possibility of carrying these units in two high stacks (double stack) on a single trailer, thus reducing terminal handling and improving space utilisation on-board. Although in theory this should lead to a reduction in freight rate per unit, this may not be realised in practice, as ship operators charge per unit irrespective of whether it is loaded in single or double stack.

Cellular ship designers believe they must design their ships with increased flexibility in terms of the dimensions of loading units that can be carried. Such a ship could offer a viable alternative to roll on/roll off concepts in markets with various types of loading units. Such a design will follow the demand of its clients. The ship owners require a cellular ship that will be able to carry all existing unit sizes and those still to be introduced such as the future standard European Unit.

Such healthy competition between the proponents of the two types of vessel design can only be a good thing and will lead to further innovation to meet the demands of the market.

2.2.2.3 *General Design Considerations*

Cellular or Lo-Lo ships are generally of a fairly traditional design with aft superstructure and engine room, and with cargo holds positioned forward. The propulsion is usually mechanical drive to a single propeller. This system has the advantage of being simple to maintain but efficiency and use of space are not optimised.

Modern Ro-Ro ships and some Lo-Lo designs are using diesel electric propulsion systems where the diesel engines are used to generate electric power and the propeller(s) are driven by large electric motors. Although this method of propulsion has a higher initial cost than conventional diesel propulsion it allows a more flexible machinery arrangement which can lead to higher cargo carrying capacity and hence greater freight earning capacity for the vessel. These systems also allow, improved efficiency of electrical power for auxiliary systems and reduced emissions. These benefits can be taken advantage of more in the case of Ro-Ro ships where wing voids lining a lower hold can easily be used to house the diesel generating equipment, this allows the lower hold area to extend further back, into the space previously taken up by main propulsion equipment.

Speed is often a key parameter in Ro-Ro ship design. This promotes the use of podded propulsion which also further increases the space available for freight. It has been estimated that an increase in lower hold capacity of around 30% could be achieved in this way.

The size of vessels is usually dictated by the expected flow of freight and the length of the route. Generally a large ship will carry large quantities over long distances whereas a smaller ship is suited to more frequent trips carrying fewer freight units over shorter distances.

The length of the freight spaces on a traditional Ro-Ro ship is often determined by the requirements of damage stability. A number of high profile disasters in recent years has lead to an increase in the stability requirements. This in turn has lead to existing vessels needing to be upgraded to meet the new standards. Typical modifications include the subdivision of the large freight spaces. These, being positioned as a result of damage stability calculations, do not necessarily coincide with efficient use of the space in terms of freight units, and can seriously impact on the utilisation of the space.

Lo-Lo ships are not so restricted by stability criteria. It is more usual that the longitudinal length of compartments will be determined by strength requirements. A container ship being basically a box would have very little racking strength. The addition of transverse divisions in the hold provides the necessary strength. The positioning of these divisions is usually optimised for expected freight unit dimensions.

The width of short sea vessels can be a result of numerous factors. In the case of Lo-Lo vessels it is often proportional to the ships length but optimised for the intended freight units. In the case of Ro-Ro ships the high speed requirements will make hydrodynamic aspects of the hull form play a large role in the width of the vessel, however the value will still be optimised for lane widths.

Another aspect which can limit the width of vessels is that created by any restrictions in the route, for example a lock which must be passed to reach non tidal waters. The draught of the vessel is likely to be limited by similar factors as the beam.

2.2.2.4 Impacts Of The Height Of Cargo Units On Cellular Ship Design

Variation in height of loading units is very common in the container transport business and ship operators have for many years had to deal with such a problem. Containers are positioned on cellular ships with cell guides, the height of these is generally designed to suit a particular size of container, if non standard containers are then loaded the utilisation of available space can be reduced considerably.

Modern cellular ships include a higher degree of container height variation when designed and built without hatch covers, although these ships become more complex in structural design and operation with the large pumps needed to remove seawater from the open holds. The traditional container ship accommodated a stack of up to 6 containers under deck; the deck is closed by hatch covers and on top of these another stack of 3 or more containers high is stowed and secured. The ships without hatch covers can load a column of up to 9 containers from the lowest layer to the top. This saves time in loading and discharge, because the closing and fastening of the hatch covers is no longer required. Furthermore, the new stack pattern offers more variation as regards containers of different height, however, there may be a loss of flexibility in load planning as most ISO containers are not designed for 9 high stacking under full load.

The new designed European loading unit is proposed to have a height of 2900 mm. This is within the current range of height occurring in the container trade and does not provide any problems in addition to those that exist today.

Although the height dimensions of the new container do not pose any problems for the ship designer the strength will. The cell guides described above are designed for ISO containers that can be stacked up to 6 high when fully loaded. The proposed new European unit is to be stackable two high for sea transport, taking into account possible imposed dynamic loads experienced in a seaway. To accommodate the new containers, load bearing supports will have to be incorporated into the cell guide design, or special loading units with increased stacking strength are required.

Whilst such an arrangement is feasible, its use will introduce a complication which will add time and cost and possibly mitigate against the widespread use of the European unit in Lo-Lo operation. To avoid the introduction of such load bearing devices the European unit would have to be restricted to the top two layers in a container stack or restricted to two high stacks on deck. Such limitations will impact on loading patterns which may lead to additional handling and space utilisation.

Whilst the proposed unit will be limited to two high stacking for sea transport where dynamic loads may be expected, for inland waterway transport where effectively static conditions apply to loaded containers 4 high stacking can be contemplated.

2.2.2.5 Impacts Of The Height Of Cargo Units On Ro-Ro Ship Design

As already mentioned Ro-Ro vessels are loaded with either road going trailers or slave MAFI trailers. The latter can carry a stack of two containers, which greatly improves the utilisation of cargo space. The usual deck clearance for Ro-Ro ships is in the region of 5.2 meters with some decks up to about 7 metres for double stack loading, this is more than adequate to accommodate the new European unit.

2.2.2.6 Impacts Of The Width Of The Cargo Unit On Cellular Ship Design

Containers with small variations in width are already common in European short sea operations. The majority of containers have a width of 2500 mm although containers with a width of 2438 mm (8 ft) are also common.

The cellular ships are prepared for such containers by designing the cell guides at 2500 mm width (+ tolerance). If ISO containers with a width of 2438 mm are loaded, the excess of internal cell width can be reduced by inserting small distance pieces into the cell to cover the gap. These ships can therefore carry either 2438 mm or 2500 mm wide containers with only small alterations in the cell that can be inserted or removed quickly. Unfortunately, not all ship operators include these securing parts when they have to accommodate ISO width containers on board so that these containers are not very firmly fixed in their cells. This may create safety hazards during ship operation at sea, despite the ease of using the system with flexible cell widths.

Today the need for accommodation of loading units with 2550 mm width is approaching. Cellular ships with cells of this width are under construction, the cells can still be reduced to 2438 mm for ISO containers by addition of distance pieces. If the client requires cells of 2600 mm width for European thermal units or for US domestic containers, again this can be designed, and even these cells can be adjusted to 2438 mm width if required.

It is most probable that only selected cells within the ship would be provided with adjustable width so as to limit the impact on the overall beam dimension of the ship.

Cellular ships with adjustable cell width within the range of ISO containers (2438 mm) up to the width of European thermal units of 2600 mm are obviously state of the art. The operation of such ships is not too complicated, and the adjustment of the cell width should not impact on turn around times too severely. These ships can carry containers with different cell widths in their different sections. A European loading unit with 2520 - 2550 mm width does not create difficulties in addition to those that are daily routine in European short sea operation already.

2.2.2.7 Impacts Of The Width Of The Cargo Unit On Ro-Ro Ship Design

Standard lane widths for Ro-Ro vessels are in the range of 300m to 330 m, the full range of container widths from 2438 mm to 2600 mm can clearly be accommodated within this space. The width of the new unit would therefore have no impact on the design of future Ro-Ro vessels in this respect. However, attention would have to be paid to the stowage of the widest units in the narrowest lanes to ensure that reasonable access between units can be maintained.

2.2.2.8 Impacts Of The Cargo Unit Length On Cellular Ship Design

The most difficult issue with regard to container dimensions is the different length of the loading units because the degree of variation is much greater than in height and width. In theory, we have to prepare for the following mix of length values:

Length (mm)	6100	7150	7450	7820	9150	12200	13600	13720
Length (feet)	20.0	23.5	24.5	25.5	30.0	40.0	44.5	45.0

Again, a system of adjustable cell guides can be adapted for most variations. Whilst it is not expected that the adjustment of the cell guides will significantly increase turn around time it is another factor which will impact on time and cost in a similar way to variable width cells. An additional problem with the use of adjustable cell guides is, however, that they have to be operated within the fixed limits of the hold which in turn form the structural and watertight subdivision of the hull. If the ship is designed to carry a certain type of container then any variation will result in less optimum utilisation of the cargo space. It may become the case that ships are designed with different length holds to suit the different container sizes.

2.2.2.9 Impacts Of The Cargo Unit Length On Ro-Ro Ship Design

Ro-Ro vessels are designed to accommodate standard length units, depending on the route these unit lengths may include the tractor units or just the trailer. Typical lengths for trailer units are 13600 mm and for those including the tractor a typical length would be 15500 mm. It is not usual for the vessel length to be finally set by multiples of such units as, in practise, many variations are carried.

Another design factor which could be affected by the length of a new standard unit is that of turning circles on the freight decks. This is particularly the case for vessels where the freight decks are accessed from one end of the vessel only.

The proposed units are to come in two lengths with the largest being less than double the length of the smallest i.e. the container units are not modular. This will be a disadvantage in terms of the space utilisation on Ro-Ro ships as a slave MAFI trailer designed to carry two of the larger standard units will not be able to carry four of the smaller units. The ship will have to cater for a wider variety of slave trailers or sacrifice the utilisation of space.

2.2.3 Ship Operations

As was the case for ship design considerations, ship operations must be divided into two main fields, those for Ro-Ro ships and those for Lo-Lo ships.

2.2.3.1 ***The Impacts Of The New Standard Units On Ro-Ro Ship Operation***

Ro-Ro ships, as has been mentioned, load vehicles and a variety of trailers carrying cargo over ramps. These ramps may be part of the terminal or ships equipment or a combination of both. When stowed they may also form an integral part of the ships watertight hull. No other cranes or loading equipment are required to load or discharge the cargo on or off the ship.

The cargo remains on the trailers on which it was brought on board the ship for the duration of the sailing. The trailers are fixed in position using a grid of lashing points located on the cargo decks. This gives extreme flexibility in terms of the variety of load dimensions which can be carried.

Containers or swap bodies are either brought on board the vessel on the road going chassis that delivered them to the terminal or they are transferred onto slave trailers known as MAFI platforms and stacked up to two units high, that is providing the containers are of sufficient strength and the Ro-Ro ship has sufficient clear deck height to accept the units.
By the nature of the variety of loads which can be carried on Ro-Ro ships there is often a relatively high proportion of unutilised space which is non revenue earning. It is unlikely however that Ro-Ro operators will

place restrictions on the dimensions of cargo units carried on their vessels as one of the most attractive features of Ro-Ro ships is their inherent flexibility.

The new European standard unit will benefit the Ro-Ro operators in that a larger proportion of containers will be stackable, this can only improve the utilisation of the freight space. This will be further enhanced because the internal dimensions of the new units are set to accommodate European standard pallets improving the cargo density within the containers. It is not anticipated that the new container will have any negative impact on the operation of Ro-Ro ships as the majority of existing vessels operating in this trade are already well suited to carry such units.

2.2.3.2 The Impact Of The New Standard Units On Lo-Lo Ship Operation

Lo-Lo ships have a very different system of operation. These vessels are loaded by shore cranes or sometimes on board cranes. The containers are loaded into the holds in the ship equipped with cell guide structures, the holds are then made watertight by closing with hatch covers. Containers can then be stacked on top of the hatch covers limited only by the strength of the containers or the required visibility from the bridge. Alternatively some cellular ships may be of an open hatch arrangement, in which case the cell structure extends above the deck.

The vessels are generally designed with a particular unit size or mix of unit sizes in mind and can potentially be loaded to a very high degree of utilisation. When the containers are loaded they are guided and fixed into position using a framework of cell guides. As can be imagined these can seriously impact on the variety of container sizes that can be carried. Cell guides which can be adjusted to carry containers of varying length and width, are in use and these do improve the Lo-Lo vessels flexibility, however, their use can be expected to impact on the turn around time of the vessel when in port and the cargo carrying utilisation of the ship.

Most existing swap bodies cannot be stacked, and those that can are currently limited to two high. This creates a further problem for Lo-Lo ships and although cell guides which not only position but support containers are available, their use further delays the time in port.

In summary then a new standard European cargo unit will generally have a detrimental impact on the operation of existing Lo-Lo ships in the short term, especially if the tolerances incorporated in the cell guides are insufficient to accommodate the new standard units and load bearing capabilities are not incorporated. However, this will have to be balanced against the potential benefits of the new unit in road transport. In the longer term with the introduction of new Lo-Lo design, with increased flexibility these disadvantages may, at least in part, be overcome.

2.2.4 Economics Of Terminal Handling

Terminal handling forms the interface between short sea shipping and the other modes of transport. The efficiency of the terminal will be affected by the following factors:

- Port access (river passage, locks etc.)
- Ship arrival rates
- Ship sizes
- Number of containers loaded/unloaded
- Time lost for container handling
- Time lost for equipment failure
- Terminal location relative to principle transport links (road, rail, inland waterway)
- Extent to which stackability of units is utilised (intermediate storage vs direct transfer).

Terminal handling must initially be separated for Ro-Ro ships and for Lo-Lo ships.

Containers are loaded on and off Ro-Ro vessels on trailers. If these are of a road going type (self driven) then the tractor units travelling with them can take the containers straight off the ship and on to the road network. This is an optimum flow and will not be affected by variations in container dimensions. The only restriction will be the legal requirements governing drivers travelling time. Overnight Ro-Ro ferries provide the ideal solution to this problem allowing maximum utilisation of drivers time.

The majority of other cargo units will be loaded on and off the vessel as unaccompanied trailer units or on slave MAFI trailers using the terminal stevedores and tractor units. The containers are then taken to a handling area where they are taken off the MAFI trailers for further transfers.

Lo-Lo ships are loaded and unloaded using either shore or ship cranes. The containers are then taken to the handling area using terminal equipment. One significant disadvantage of Lo-Lo terminal operations is that it relies on a small number of crane units either ship or shore based, failure of a crane unit has a serious impact on cargo handling.

Once at the handling area the processes for containers from Ro-Ro and Lo-Lo vessels are generally the same.

In the handling area the containers can be transferred to the other modes of transport serving the terminal. The containers can also be loaded or unloaded before continuing their movement towards their final destination, although the majority of units handled are door to door full unit loads.

Costs in the terminal develop due to blockages to the cargo flow and the amount of under utilisation of handling equipment.

The introduction of the new European standard unit will have very little effect on the terminal operations for Ro-Ro vessels unless storing is required at the terminal before further movement. Lo-Lo terminal handling will be more affected. Initially it is likely that the addition of a new standard unit will only further complicate terminal logistics.

Assuming the widespread acceptance however, the following benefits can be foreseen:

- The new unit can be stacked allowing for more efficient storing, if required. The stacking capability will also assist in terminal planning, it will no longer be necessary to plan for containers with two different stacking characteristics
- The new unit can be lifted by the full range of terminal handling equipment allowing the most efficient method suited to the transfer to be used, top lift is also more efficient.
- The new units are based on standard European pallet dimensions, this will improve space utilisation and ease any loading and unloading of containers which may take place at the terminal or elsewhere
- A standard unit will assist in the development of mechanised cargo handling for Lo-Lo ships

It is clear that the introduction of the proposed standard European unit could improve the flow of containers through a terminal and improve the terminals utilisation of handling equipment. This will in turn reduce the costs incurred in the handling process. This applies not only to the short-sea terminals but also deep sea terminals, where underutilised quay space could be made available to short-sea feeder services, thus reducing trans-shipment costs between deep-sea and feeder services. The proposed standard European unit could also offer freight forwarders a wider range of choice for transport of a unit with the minimum of delay to or from the most appropriate mode of transport for the goods carried and the origin/destination. If such savings can be translated into a reduction in freight costs, or at least a slowing down of any increase, then the container operator would be more inclined to use the new units for which it could offer cheaper and a more competitive rates to its clients. This would in turn increase the proportion of container traffic carried by short sea operators and ultimately increase the number of containers passing through the container terminals.

2.3 TECHNIQUES AND ECONOMICS OF RAIL TRANSPORT

2.3.1 General Considerations

As pointed out in chapter 4, any European loading unit has to follow certain requirements that are rather mandatory. The following basic features have to met by techniques and economies of rail transport:

- The European loading unit must be designed to fit in most European rail corridors.
- The European loading unit must fit into well established systems of intermodal transport, especially regarding to existing investments in lifting devices on terminals and in rolling stock; these investment reach an amount of some 5000 - 6000 million Euro.
- The European loading unit must allow a better competition to road transport in future by optimising the utilisation factor within the given restrictions for weight and length for train operation in the relevant European rail corridors.

2.3.2 Dimensions And European Rail Corridors

European railways have developed a procedure for codification that reflects the combined features of

- specific railway gauge available on a certain corridor or a network,
- the platform height of the railcars,
- the height and width of European loading units.

The codification system consists of

- the railcar code,
- the European loading unit code,
- the corridor gauge code.

Box type loading units are marked with a C-Code, semi-trailers are marked with a P-Code.

The coding procedure is administered by UIC. UIC publishes leaflets that contain the mandatory provisions for all European railways and intermodal carriers.

The C-Code, mandatory for swap bodies, is based on a standard railcar with a platform height of 1175 mm above rail. Semi-trailers are marked with a P-Code that is based on the design of a pocket between the bogies of the railcar to accommodate the running gear of the road vehicle with a pocket height of 330 mm above rail.

Some specific intermodal transport techniques have their special codes, such as:

- H for semi-trailers built to a specific Italian system used by CEMAT,
- R for semi-trailers and bogies of the Road-Railer system.

In parallel to the coding of railcars and loading units, the most important European rail corridors are codified according to the tunnel gauge available. Swap bodies with a width of maximum 2550 mm refer to a 2-digit code, e. g. "C 45", swap bodies with a width of 2551 - 2660 mm refer to a 3-digit code, e. g. "C 346".

Once the concrete platform height of a railcar and the gauge code of the rail itinerary is known, these codes allow easily to fix the maximum corner height of loading units that may be carried.

To facilitate operation, all loading units must be tested and approved by the railway administration concerned. This procedure includes a check of the corner height of the loading unit when loaded on a platform railcar of 1175 mm height. This procedure is normally executed in co-operation between railway administration and manufacturer of the loading unit as a type approval. A swap body or a container with a corner height of 2900 mm is marked with the code "C 45".

In parallel, the platform type railcars are marked according to their platform height. A platform railcar with a standard height platform is marked with "C". A railcar with a platform height of 945 mm above rail is marked with "C+23" (standard platform of 117,5 cm minus actual platform height of 94,5 cm = 23). This railcar may carry a loading unit with a C 45 code on a rail itinerary that has a corridor code of "C 22".

2.3.3 Analysis Of Tunnel Gauges Available In Europe

The north European countries Sweden, Denmark, and the central European countries Germany, Netherlands, Belgium, Luxembourg, Austria, and Hungary offer on their trunk lines a gauge of "C 70" which allows the carriage of boxes with a width of 2550 mm and a height up to 3150 mm on railcars with standard platform height. Some rail lines in these counties have smaller gauges, but that does not matter much for the overall system.

Northern Switzerland offers a "C 60" gauge which allows to carry loading units with a width up to 2550 mm and a height of maximum 3050 mm. When loading units with 3100 mm height must be carried, railcars with a platform height of 1125 mm (50 mm less than a standard platform railcar) are needed.

France offers on its main trunk lines for European transit traffic a C 45 gauge (similar to Spain). But some French lines are limited to a C 32 gauge which allows only loading unit height up to 2770 mm on standard height platform railcars. Loading units with a height of 2900 mm, 3000 mm, or 3100 mm need platform railcars with a platform height of 1045 mm, 945 mm or 845 mm. The gauge line of the main connection between France and Italy via Modane has, mainly due to the tunnel, a very restricted gauge line: C 30. This means that platform railcars must be used with a height that is lowered by additional 20 mm.

The Italian network as well consists of various gauge lines. The most important terminals in North Italy are connected to the north by Alps transit corridors through Austria and Switzerland that offer C 45, or C 50 (St. Gotthard - Chiasso - Busto Asizio). These gauge lines allow for a loading unit height of 2900 mm or even 2950 mm. Loading units of 3000/3100 mm height must be carried on platform railcars with a platform height of 1075/1070 mm or 975/970 mm. South of the geographical line Bologna-Milano the gauge lines are far more infringed and rail can only offer C 32 or C 22.

The most grave infringement can be found in Great Britain. The British network offers, in theory, only C 9 gauge which would allow for a maximum loading unit height of 2540 mm (less than 8 ½ ft.). But many important lines that connect England with the Channel Tunnel (which does not incur any serious gauge infringement) have been codified with the special gauge S 32 which relates to a special railcar with a platform height of 945 mm. This fits for loading units with a height up to 2770 mm. Loading units with a corner height of 2900 mm would need in Great Britain a platform railcar with a height of 815 mm.

country	rail profile (2,55 m - width)	allowed height for boxes (standard railcar)	necessary loading height of the railcar for box height		
			2.900 mm	3.000 mm	3.100 mm
Sweden Danmark Germany Netherlands Austria Belgium Hungaria Luxemburg	C 70	3.150 mm	no downseizing necessary		
Switzerland	C 60	3.050 mm	-	-	1.125 mm
Spain	C 45	2.900 mm	-	1.075 mm	975 mm
Italy-North	C 50 C 45 C 32	2.950 mm 2.900 mm 2.770 mm	- - 1.045 mm	1.080 mm 1.075 mm 945 mm	980 mm 975 mm 845 mm
Italy-South	C 32 C 22	2.770 mm 2.670 mm	1.045 mm 945 mm	945 mm 845 mm	845 mm 745 mm
France	C 45 (C 32)	2.900 mm (2.770 mm)	- 1.045 mm	1.075 mm 945 mm	975 mm 845 mm
Great Britain	S 32 (“C 9”)	2.540 mm	815 mm	715 mm	615 mm

Table 2.3.3: Available Rail Profile For Intermodal Transport In The European Rail Network (Main Lines) And Resulting Consequences For Box Height-Railcar Loading Height

2.3.4 Platform Railcars And Their Technology

According to a count of Interunit, some 37420 special railcars are available for combined transport in Europe. This number includes 630 railcars of the type Rollende Landstrasse. Some companies own further railcars that have not been included in this count (such as Intercontainer-Interfrigo with a stock of about 6000 railcars) so that one can assume a total current stock of nearly 45000 platform railcars in Europe, which represents an investment value of some 2500 million Euro.

Most railcars of this rolling stock have a height of 1155 - 1180 mm, i. e. they are in the area of the standard height of 1175 mm that is the base for the gauge code calculation. In addition, a smaller part of this stock offers considerable lower platform heights:

- Some 160 railcars operated by CEMAT of Italy have platform height of 920 and 945 mm.
- Some 120 railcars operated by HUPAC of Switzerland have platform heights of 860 and 940 mm.
- 220 railcars operated by Novatrans of France have platform height of 945 mm and 950 mm.
- Intercontainer-Interfrigo operates a larger stock of railcars with a platform height of 945 mm ("multi-fret").

These low platform height railcars are mainly operated in those countries that have infringed gauge profiles. This can be seen already from the nationality of the owner company of the low platform railcars. The low platform railcars enable these operators to carry Jumbo swap bodies with heights of 2900 mm and more and ISO containers with 9 ½ ft. height. DB Cargo of Germany has purchased a stock of 200 railcars with very low platform height that shall be used mainly for automobile industry logistics. This type of transport needs swap bodies with an outside heights of 3180 mm, and the DB Cargo platform railcar with its loading height of 845 mm can operate these types of swap bodies even on networks with infringed gauge profile.

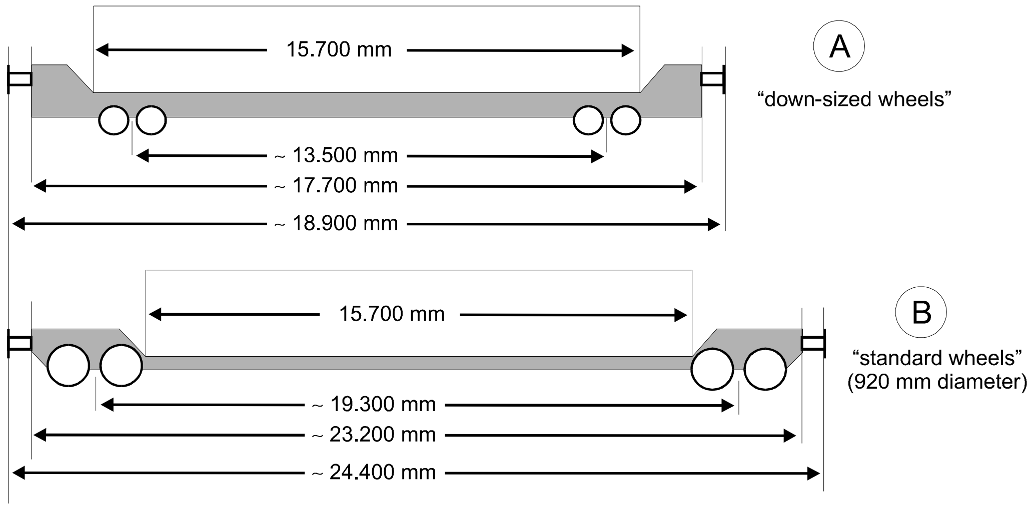
A low platform height railcar can be achieved by two technical design methods:

- The designer can keep the full diameter wheels and standard height bogies, and lower the load carrying platform down between the bogies.
- The designer can foresee reduced height bogies with a wheel diameter of 840 mm - this enables a platform height of 945 mm - or a wheel diameter of 730 / 760 mm to enable a platform height of 860 or 845 mm.

When lowering the platform between the bogies, the degree of loading length utilisation (compared to total railcar length) is considerably low. The total train length - which is limited in most networks - is much less used for accommodation of loading units. The loss of length per railcar is about 5 m. This worsens, in further consequence, the degree of utilisation of the available rail tracks in the intermodal transfer terminals.

Another problem: The distance between the turning plugs (which transfer the load between the bogies and the platform, and support the platform above the bogies) will be increased. In a case of a railcar designed to carry 2 x 7,82 m loading units, this distance will be increased to full 19000 mm. Such a distance leads to a wide turning circle and this leads to a further infringement of the gauge line. So, a part of the advantage achieved by lowering the platform is abused.

This type of railcar is often used in US railroads for double stack container transportation. But as the US



	A	B	ΔB/A
length over buffers	~ 18.900 mm	~ 24.400 mm	+ 5.500 mm (+ 29 %)
length without buffers	~ 17.700 mm	~ 23.200 mm	+ 5.500 mm (+ 31 %)

railroads use stronger rail profiles, they can allow heavier axle loads. This enables them to use articulated railcars. This design reduces the share of unused space or loading length.

Furthermore, in double stacking the upper layer loading unit may be longer than the lower unit, and the overhang may use the free space between the platforms. The European axle load and railways gauge do not allow for an imitation of this technology out of technical-economic reasons (see chapter 5.3.6 about double stacking).

In consequence, the European railways prefer to use railcars with bogies with low diameter wheels. This incurs a possible disadvantage because the axle load is limited to 18 t with a 840 mm wheel diameter and to 16 t with a 730 /760 mm wheel diameter, while standard platform railcars offer an axle load of 22,5 t. But some promising development projects are under way to increase the axle load to 20 or 18 t when small diameter wheels are used.

	Standard	Low I	Low II
loading height above rail	1.175 mm	945 mm	845/860 mm
wheel diameter	920 mm	840 mm	730/760 mm
allowed axle load	22,5 t	18,0 t	16,0 t

Table 2.3.4: Technical Aspects For Down-Seized Railcars (Low- Platform) In Comparison To The Standard Railcar In Intermodal Transport

Taking into account the currently existing limitations of axle loads, the new low platform railcars of DB Cargo offer a payload of 46 t with an axle load of 16 t. This results in an allowable gross weight per class C swap body (7,15 - 7,82 m length) of 23 t - far more than these units may carry in road transport. The only realistic limit occurs with the carriage of fully loaded 20 ft. containers (24 t gross mass each) or with 20 ft. tank containers. But this infringement of load carrying capacity occurs only when wheels of 730 / 760 mm diameter are used.

If the allowable axle loads will be increased by 2 t, even this problem will almost no longer matter.

These low platform railcars have been purchased in relatively small numbers. This results in higher purchase prices and maintenance costs compared to standard railcars. This cost increase may be around 15 %. If we account that railcar costs in interest, depreciation and maintenance (no administrative overhead included), amount to a share of some 10 % of the total costs for rail operation, the use of special low platform railcars results in an cost of 1,5 % in rail operation costs. If we further assume, that rail operation represent some 50 - 70 % of total combined transport costs, the cost increase over the total transport chain will be at 0,75 - 1,0 % (depending on rail haulage distance). If the extra low platform railcars will become a more common feature, this amount of additional costs will further decrease.

2.3.5 Alternative: Improvement Of Infrastructure Or Low Platform Railcar

Road transport can carry swap bodies with a height up to 2900 mm on standard road vehicles for swap body transport which normally offer a platform height of 1140 - 1170 mm. This might result in a very small over height which, it would appear, is generally acceptable.

Currently an increasing number, (though relatively few compared to the total stock), of swap bodies with a height of 3000 - 3200 mm comes into service mainly to serve very special markets. These swap bodies need special road vehicles with platform heights of 800 - 1000 mm. Insofar, a swap body height limit of 2900 mm might be regarded as “standard” for the height that have to be expected in future intermodal transport.

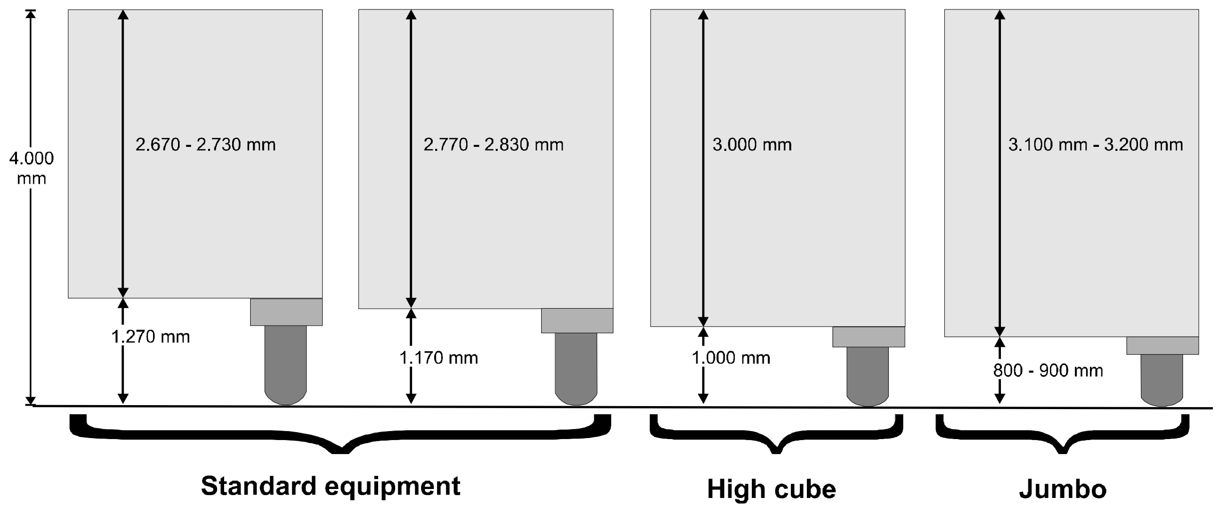


Table 2.3.5: Swap Bodies – Road Transport (Height)

Rail operation with swap bodies with 2900 mm does not provide specific problems in most parts of the European rail network. Existing standard platform railcars can be used. Even in France and Spain, these swap bodies can be transported in standard platform railcars in the important corridors. But some infringements in the Alps crossing parts of the European rail network exist, and these parts are important for intermodal transport.

Currently the gauge on the Brenner route is enlarged and shall allow in the near future a gauge profile of C 70 - as far as the terminal of Verona. This would allow the transport of 2900 mm high swap bodies on standard railcars.

The transit corridors through Switzerland also allows a swap body height of 2900 mm.

Restrictions apply to

- the itinerary to some terminals in North Italy,
- in all transports into South Italy,
- in the rail connection between Italy and France via Modane.

When using a railcar with a platform height of 94,5 cm, these areas would even allow a loading unit height of 3000 mm. The infringements of the Modane tunnel and some parts of the southern Italy network would allow even a loading unit with 2900 mm height on these lower railcars.

In theory, these bottlenecks in the existing infrastructure can be removed, which would allow the use of standard height railcars.

But this alternative would include some important aspects to be considered:

- Building activities of the infrastructure especially when tunnels and other superstructure constructions are affected need long time periods for planning and realisation, mostly some or many years.
- Such infrastructure building activities would need very considerable budgets - such high budgets cannot normally be justified only by the facilitation of intermodal transport which (even when doubling its volume on rail), will at best arrive at a market share of 15 % in total rail cargo volume.
- When infrastructure is enlarged by building activities - especially when tunnels are enlarged - these activities will considerably hamper the daily rail operation on this line, both in passenger and in cargo transport; this will result in losses of market share and revenues. (A French railway expert has recently stated that a fundamental enlargement of the Modane tunnel - if financing could be assured - would include a building period of 10 years, during which period the tunnel would have to be completely closed for rail passage. Actually the French and Italian railways are planning a new line and a new tunnel with a sufficient tunnel gauge for intermodal transport between France and Italy although it is understood that this is intended mainly for TGV passenger services. . The realisation will be in medium to long term.)

If one assumes a necessary expenditure for infrastructure enlargement of some 50 million Euro, this would lead to an annual capital cost expenditure (interest and depreciation) of 2,5 million Euro. This amount distributed over 250 traffic days per year results in costs of 10000 Euro per day. If one further assumes that on this part of the network 20 intermodal transport trains per day operate, and each train carries 25 combined transport consignments (1 combined transport consignment is either 1 x class A swap body or 1 x 40 ft. container, or 2 x class C swap bodies or 2 x 20 ft. containers), the capital costs would lead to additional costs of 20 Euro per consignment.

On the other hand, the costs of a railcar with low platform can be calculated as follows: An international shuttle service with 48 h circulation of the rolling stock results in railcar costs of some 60 - 70 Euro per combined transport consignment. If, due to the use of special low platform railcars, these costs would increase over 15 %, this would finally result in a cost increase of 9 - 10,5 Euro per combined transport consignment on low platform railcar.

This cost comparison demonstrates that an infrastructure improvement, gives a relatively high cost for intermodal transport improvement and is economically a problematic decision, especially when railcar design technologies offer a realistic and market-friendly alternative.

Infrastructure improvement may get another aspect when intermodal transport of semi-trailers is incorporated into the economic view. This view has to take into account that the semi-trailer is currently the most important means of transport in Europe, especially in the south European countries. Semi-trailers have a share of 15 % with the unaccompanied transports of the UIRR companies (without Rollende Landstrasse transports).

Regarding the Alps transit, the Brenner transit route will be enlarged in the near future to allow the transit of swap bodies with full height. But the French and the Spanish network and specifically problematic, the main transit route from France to Italy, do not allow to operate semi-trailers with 4000 mm height. The current technology of pocket railcar, having lowered the pocket for accommodation of the wheel set of the semi-trailer between the bogies to a height of 270 mm above rail, cannot be further improved because the railway gauge is restricted in lower part of the railcar section as well.

But even in case of deliberations to facilitate semi-trailer transport in European combined transport, the aspects of costs incurred, of rail service obstructions during the building period, and long term orientation of all activities create serious doubts whether this will be the right way to go. It is recommended to check which alternative techniques in railcar design are available, and how far containers or swap bodies offering full semi-trailer cargo volume can be made popular in European combined transport. Both ways to go seem more realistic than gauge enlargements.

2.3.6 Conclusions And Recommendations

Large parts of the European rail network allow for the transport of loading units (containers or swap bodies) with a corner height up to 3150 mm, using readily available platform railcars techniques. This is possible on most intermodal transport corridors without infringements. Even when operating in the French, Spanish and Italian network, this is true for loading units with a height up to 2900 mm, with the exception of some terminals and corridors.

Platform railcar height can be lowered to 955 mm, keeping axle loads within commercially feasible limits. This has been demonstrated by special design railcars on some of the problematic corridors. This should make possible the operation of loading units up to a corner height of 3000 / 3100 mm in the gauge class C 45.

If the most problematic parts of the network, the Modane tunnel and the South Italian network, are included in the review, low platform railcars can carry on these lines only loading units with height up to 2900 mm. If a loading unit with a height of 3000 mm has to be carried in these areas, a railcar with a platform height of 845 mm is needed.

Comparing the additional costs incurred with the rail operation of very high loading units, the calculation shows that the preferable solution is to operate low platform railcars rather than to enlarge the gauge, taking into account that such gauge enlargements normally include very high costs, long term building sites and considerable obstruction of rail operation during the building period. But this is a more general conclusion. The specific economy of an eventual gauge enlargement has to be checked individually in each case.

Insofar, a European loading unit with a height of 2900 / 3000 mm does not create greater problems. This relates as well to road vehicle technology which allows to carry loading units with a height up to 3000 mm on standard road vehicles, possibly including a small exceedence beyond legal height limit in road transport.

If a European loading unit with greater heights is considered, specialised road vehicles are necessary. Such vehicles will be available for pick-up and delivery operation only on a very small scale, except with logistic traffic on specialised routes where operation of such rolling stock might be justified.

Railways discuss currently to increase axle loads for wheels of 840 mm and 730 / 760 mm diameter. This should be encouraged and quickly realised to allow platform railcars with small wheels to carry heavy weight loading units as well.

The railcars purchased in the last years offer loading lengths for 2 swap bodies of class C, i.e. 2 x 7,15 - 7,82 m. If standardisation of European loading units goes beyond this module, this would endanger an investment of some 2500 million Euro in the current stock of platform railcars which have a technical life time of 25 years. Road vehicles and swap bodies may adapt quicker, since they have life cycles of 5-7 years (road vehicles) and 7-10 years (swap bodies).

Insofar, any new standardisation of European loading unit shall not go beyond this value of 2 x 7,82 m. Standard road trains in European traffic designed according to European legislation do not offer any problem in the carriage of 2 x 7,45 m loading units. If a loading unit of 7,65 m length is to be operated (such lengths are needed when an end side door with jalousie characteristic is added to the standard swap body), a special road train with extendible coupling device or with low bed coupling is needed. Both solutions need special features with the road vehicle, but can be achieved with a limited extra expense.

2 x 7,82 m loading unit length on a road train within the European legal limits needs a very special construction with an extreme short coupling distance, mostly realised with a tandem axle at the trailer. This creates specific problems for correct loading in weight distribution on the trailer. Furthermore, such road trains are difficult to manoeuvre especially when approaching or leaving a ware-house ramp.

Insofar, the 7,82 m swap body is today only used by such road carriers that see maximum volume as the paramount imperative.

7,15 m swap bodies are still operated in large quantities. A current road train cannot carry any combination of swap body lengths, but only certain combinations, e.g. 7,15 m + 7,45 m, or 7,45 + 7,65 m , today most orders are placed for 7,45 m length. But when the 7,15 m swap body has finally disappeared, a greater number of 7,65 m loading units than today will become increasingly important for certain operators, although this unit does not show advantages as regards additional pallet loads compared to the 7,45 m swap body.

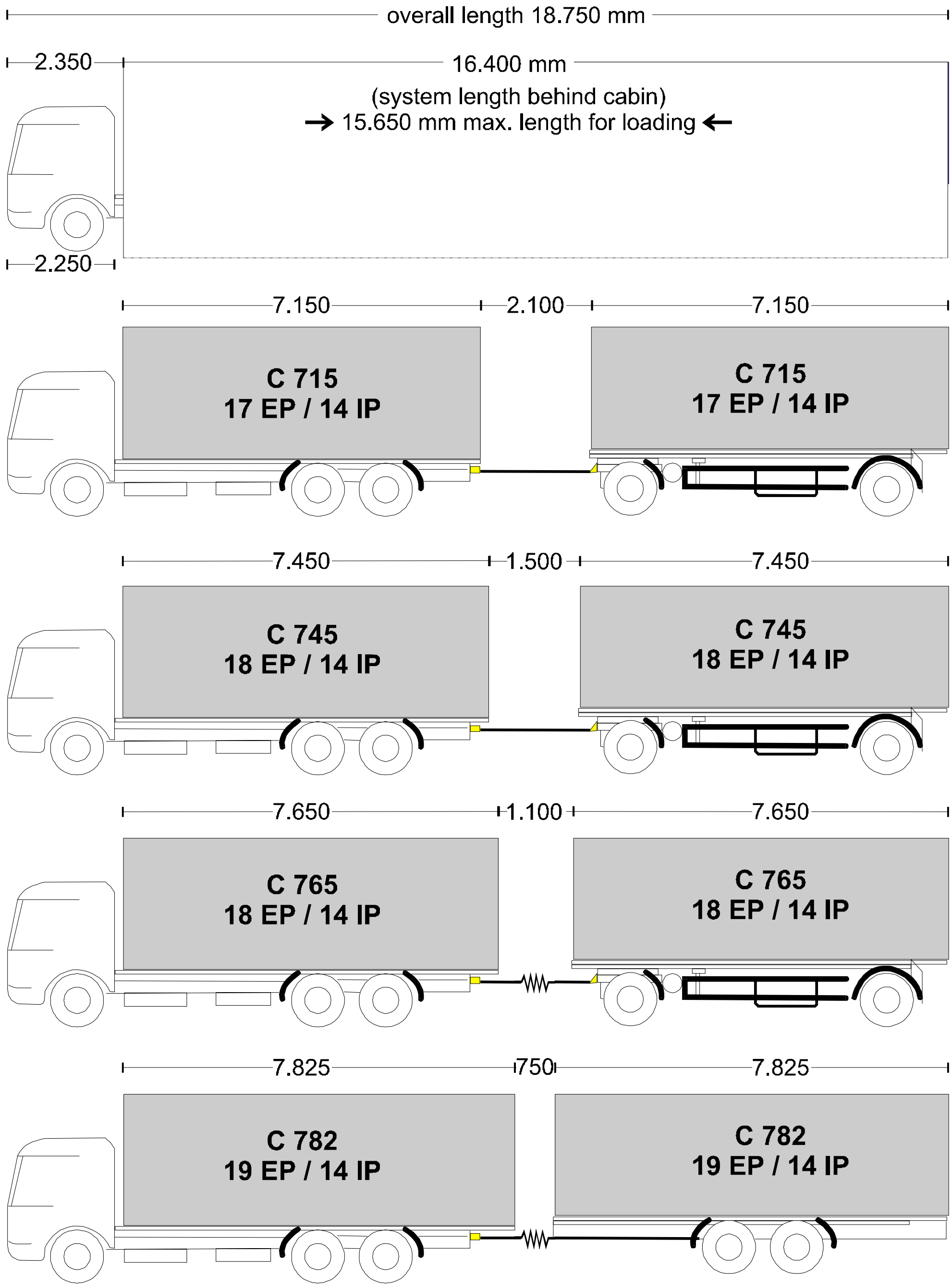


Diagram: Transportation of swap bodies under current regulations for trucks in Europe

2.3.7 Special Review: Double Stacking In European Rail Transport

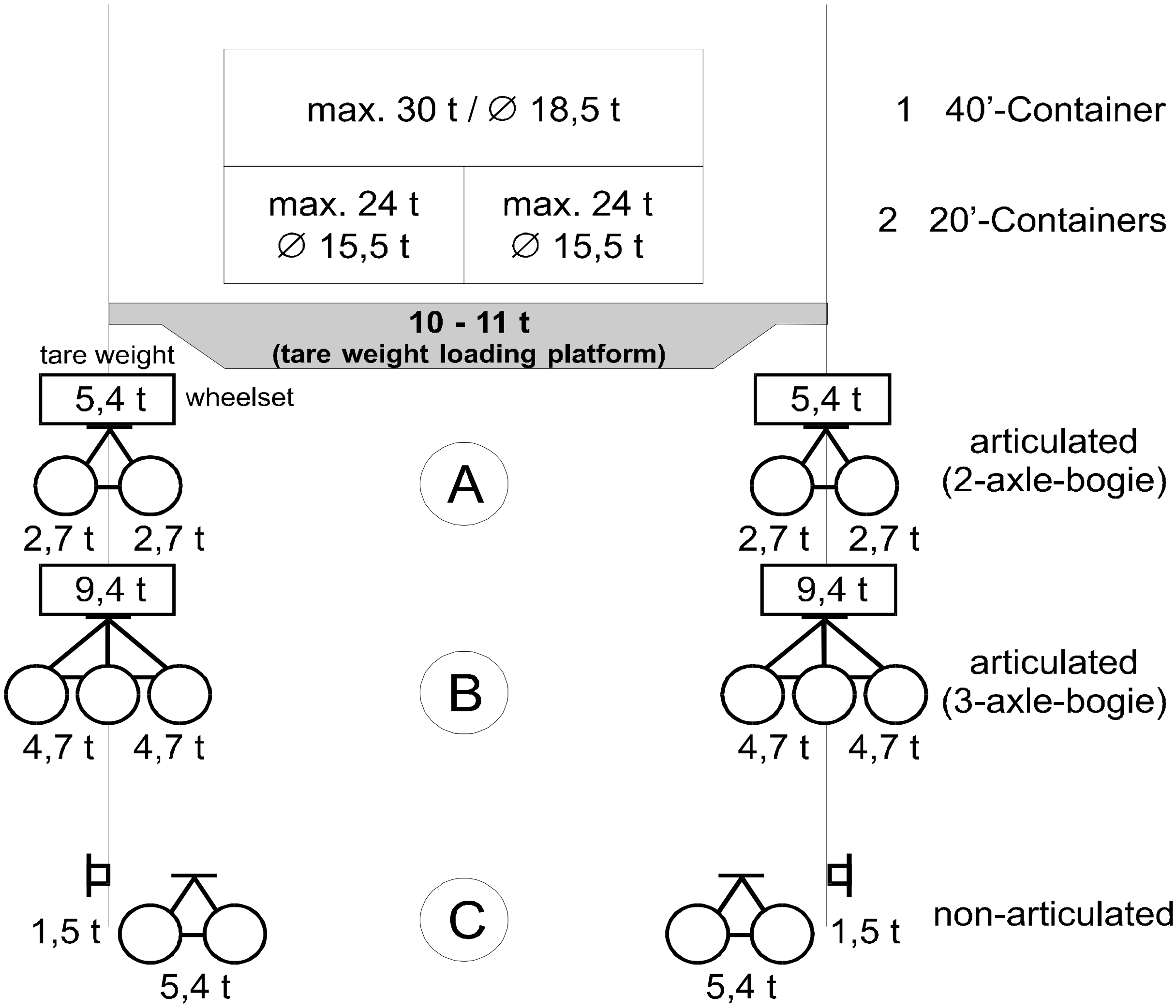
A recent study, financed by the German Ministry for Research, has dealt with the possibility to operate double stack container transport on some selected German rail lines between the sea ports Hamburg and Bremerhaven and their hinterland. The following text summarises the most important results of this study.

The study looked at issues of both, platform railcar technology and infrastructure patterns. A very important issue with platform railcar technology is the European axle load limitation to 22,5 t.

The US solution of double stack container transport includes an articulated railcar with 2 axle bogies, carrying 2 x 20 ft. containers in the lower layer and 1 x 40 ft. container (or an even longer loading unit), in the upper layer. This solution cannot be realised in Europe. If the railcar tare + the maximum mass of 2 x 20 ft. containers (2 x 24 t) + the maximum weight of 1 x 40 ft. container (30 t) are added, this would result in an axle load of 47 t. If the calculation does no longer take into account maximum weight of containers but average weights, 15,5 t for a 20 ft. container and 18,5 t for a 40 ft. container, this reduction would lead the calculation to an axle load of 33 t. The problem would be aggravated because in such a case each train loading operation must be carefully pre-calculated not to exceed the average weight on each of the railcars.

Even when using 3 axle bogies, (which are compared to 2 axle bodies more expensive in purchase and maintenance), this calculation would result in axle loads of 32,8 t or 23,3 t. Meanwhile the extension of axle loads to 25 t is discussed, possibly for some dedicated rail lines. This increase must often include a re-enforcement of bridges. But even such heavy duty rail lines would not offer sufficient capability because such an operation cannot be based on an average mass/weight calculation.

In consequence, double stack transport would need in Europe a single unit railcar with two 2 axle bogies. This would result in an axle load of 18 t when average load is carried, and of 25 t when maximum load is carried. But the railcar must be designed with the platform lowered down between the bogies. This would result in an overall railcar length of 19 m to carry 1 x 40 ft. in lower layer + 1 x 40 ft. on top layer, compared to a current European railcar with 20 m overall length carrying 3 x 20 ft. container length. So, the additional capacity achieved within the maximum available train length limit is relatively small and does not compare with the quantum leap achieved in US rail operation.



Resulting axle-loads:

A	max. load-weight	:	~ 47 t
	average load-weight	:	~ 33 t
B	max. load-weight	:	~ 32 t
	average load-weight	:	~ 23 t
C	max. load-weight	:	~ 25 t
	average load-weight	:	~ 18 t

Diagram: Double Stack Technologies And Resulting Axle-Loads

Double stack operation would furthermore need a considerable improvement of rail infrastructure:

- The overhead wires of the electrical supply for traction must be set higher.

- The current gauge profile must be enlarged to 5,80 m above rail if a combination of 1 x 8 ½ ft. high container + 1 x 9 ½ ft. container is realised, and to 6,10 m if a combination of 2 x 2900 mm or 2 x 9 ½ ft. container shall be carried.

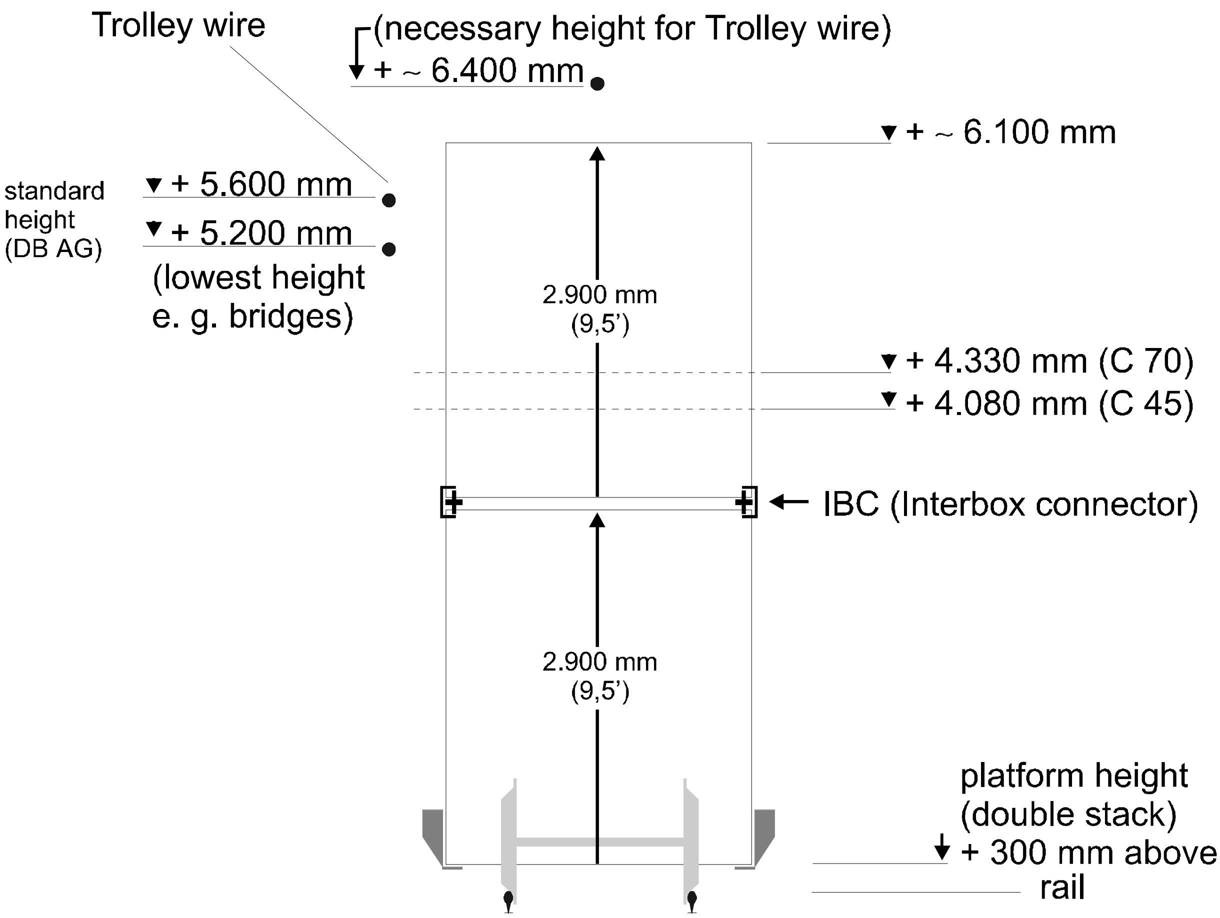


Diagram: Resulting Problems For Double Stack In The European Rail Network

The above mentioned study made an estimation of the necessary investments budget on various rail lines, taking into account the current situation with buildings that have to be changed or removed. Five rail lines having lengths between 11,5 and 177 km have been selected for this estimation. The investment necessary has been, according to the various track characteristics, between 350000 and 1 300000 Euro per km, in average 800000 Euro per km (price basis 1990).

Transferring these amounts in a more general calculation, the realisation of a European trunk line network of e.g. 5000 km rail tracks prepared for double stack would need an investment budget of 6000 million Euro (a building cost increase of 50 % compared to the 1990 level has been included in this value). On the other hand, the efficiency gains of double stacking are only marginal, taking into account the European axle load limits. So, the study came to the result that such a gauge improvement to allow double stacking cannot be commercially justified, if only efficiency improvements in combined transport are calculated.

Further problems in such a complete re-shaping of rail infrastructure would involve obstructions in daily operation due to building activities. Even today, the very limited building activities in the area of freight line nodes lead to a considerable decrease in quality, mainly in punctuality of service, so that currently the punctuality quota for the daily top network of combined transport trains has decreased to 80 %.

Insofar, the vision to build a European double stack rail infrastructure by increasing the gauge of some existing trunk lines is not a realistic view considering the existing technical and commercial restrictions.

2.4 TECHNIQUES AND ECONOMIES OF INLAND WATERWAY TRANSPORT

2.4.1 Current Economies Of Inland Waterway Transport In Intermodal Transport

2.4.1.1 Inland Waterway Transport On The Rhine River System

Combined transport on inland waterway has continuously increased over the last 20 years. Although no official statistics exist that count combined transport on inland waterway, some estimations are available. These estimations see a volume of some 1 million TEU per year carried by barge on the Rhine river system which forms the main market in Europe. In this context, the term "Rhine River system" includes the main stream and its network of high capacity canals and its branching out in the Netherlands, including its connections to the lower Schelde and Maas river system.

The inland transport patterns of hinterland movement of maritime containers have dramatically changed between 1982 and 1996:

- The share of rail transport decreased from 28 % to 18 %.
- The share of inland waterway transport grew from 2 % to 8 %.
- The share of road transport has remained stable at some 65 %, but with a considerable shift between various geographic parts of Europe.

["Intermodal barges ahead", in World Cargo News, 12/1998, p. 30.]

Practically all combined transport on inland waterway relates to hinterland carriage of ISO containers between European sea ports and their final inland destination or origin. The most recent projection of future development estimates a further annual increase of 5,5 % of combined transport on inland waterway over the next 10 - 15 years. [PLANCO Consulting: "Prognose des Kombinierten Ladungsverkehrs der Binnenschiffahrt bis zum Jahre 2010", Essen 1998].

The most important economic advantage of inland waterway transport is its low cost character. A modern inland waterway container barge of the type "Jowi" can accommodate a capacity of 398 TEU in ISO containers; this equals the carriage capacity of 5 block trains under European rail operational conditions.

These advantages are mainly based on the fact that the Rhine river valley between Rotterdam on the North Sea coast and Karlsruhe fairly distant upstream has no locks and a generous height bridge underpass that allows inland waterway transport to carry under normal water condition up to 4 layers of containers in stack, in exceptional case even 5 layers. Regulations by the Central Rhine Commission in Strasbourg have recently extended the allowed maximum dimensions of barges in single movement on the Rhine to

- 135 m length, and
- 17 m width.

2.4.1.2 Side Rivers And Canals

The economics of combined transport on inland waterway rapidly worsen once the traffic leaves the Rhine main river system. Wherever they go, the barges will have to pass locks that limit length and width, and they must underpass bridges that limit the stowing height of cargo on board and, in consequence, the transport capacity of the barge.

This is due to a traditional feature of inland waterway transport. The inland waterway barges usually carry mainly heavy commodities in bulk, such as iron ore, scrap, coal, cement, petroleum. So the barge capacity in terms of weight is normally terminated before its volume capacity has reached its limits. In traditional bulk trade, nobody needs to consider how to increase the available volume of a barge.

This feature radically changes when inland waterway transport enters into the combined transport market. The first type of cargo offered to inland waterway in intermodal transport had been the re-positioning of empty maritime containers between sea ports and hinterland depots, so that inland waterway transport started in this market with an extreme lightweight commodity. Later on, more and more laden containers have been added to the cargo mix. In all cases, inland waterway transport had been confronted with a new challenge, i.e. to carry light weight cargo. Now the available space became the limiting factor of economic operation, and the space above deck available for cargo plays a major role. In terms of container transport on inland waterway increased economy means mainly the number of layers that can be accommodated on board of a barge when passing under one of the numerous bridges that cross European inland waterways.

While the Rhine river system has generous height bridges that allow 4 - 5 layers of containers, to pass beneath, the number of container layers is immediately reduced when the barge goes into side rivers or into the canal network with their lower bridges. A barge can normally go from Rotterdam or Anterwerpen to Mainz with 4 layers of containers on board; when the barge enters the Main river to go to Frankfurt the operation must be reduced to 3 layers, and when going further upstream to Würzburg - Bamberg and into the Rhine-Danube Canal the barge can continue only with 2 layers. In other words, the capacity offer of the barge is reduced by 50 % in canal operation while the operation costs practically do not decrease, i.e. the costs per unit of transport double.

The economic fringe conditions worsen even further when a barge leaves the Rhine valley and enters side rivers and canals:

- All side rivers, all canals, and the Rhine upstream of Karlsruhe are regulated by locks. The locks will limit the size of the barge. Locks in Central Europe offer normally a width clearance that limits the barge width to 11 450 mm (compared to 17000 mm on the Rhine).
- The locks furthermore require considerable time for passage; under normal conditions, the operator has to add some ½ hour extra time per lock to be passed.

- Most locks close over night. In consequence, a small delay of an inland waterway barge, e.g. of 2 hours, might increase to 12 - 14 hours when the ship arrives at a lock after evening closing hour and has to wait for the next morning to continue.
- While the Rhine almost never freezes in winter (so it offers a year round open passage), some rivers and canals may not be passed in winter due to ice.
- While the Rhine has sufficient water almost year round, other rivers may dry down specifically in summer time and further limit barge capacity.
- While the Rhine allows a speed of 15 km/h, side rivers and canals allow only a maximum speed of 10 - 11 km/h.

In consequence, the economics of inland waterway transport on these side rivers and canals is, as far as container transport is concerned, very much worse than in the Rhine. Normally, this network allows for inland waterway barges with a capacity of some 80 TEU, and this means that one barge carries as much container capacity as a block train, and rail has a good chance to meet the competition.

So, the Rhine carries today almost 90 % of all container movements in inland waterway transport.

2.4.2. Barge Types And Their Influence On European Loading Unit Design

2.4.2.1 Cellular Barges

The most modern and most competitive container ships on the Rhine are the "Jowi" and the "Amistad" built for a Dutch owner from Zwijdrecht. The ships operate for Combined Container Service (CCS), the market leader on container transport on the Rhine.

The main dimensions of these ships are:

- length 134,16 m
- width 16,84 m
- capacity 4600 t, or 398 TEU in 4 layers, or 470 TEU in 5 layers,
- motor power 3 x 675 kW.

The ship carries containers in 6 rows side by side, and it offers lengthways 8 sections of 40 ft. length each + 1 section of 20 ft. length.

The wheel house can be elevated by hydraulic machinery to allow the pilot to overlook the river even when the container load is stowed at full height, and to be lowered in case that a narrow bridge must be passed.
These ships have cell guides adjusted to ISO container dimensions, i.e. to a 2438 mm width and a 20 ft./40 ft. length module. These cell guides facilitate and speed up loading and discharge of containers, and they contribute to a stowage plan that maximises the container capacity of the barge. [Jumbo-Container-Binnenschiff “Jowi”, in HANSA - Schiffahrt, Schiffbau, Häfen, 09/1998.]

Such a type of barge would have to undergo considerable alterations if loading units with other dimensions than ISO containers must be carried. Currently the ship design is fully optimised for the carriage of ISO containers, and any other type of loading unit would lead to a sub-optimum loading pattern.

On the other hand, this problem is limited because in the European inland waterway transport of containers only three barges have been built with such cell guides, the "Jowi", the "Amistadt", and the "Myriam". All other barges are not equipped with cell guides.

2.4.2.2 Non Cellular Barges

Traditionally, container transport on the Rhine has been operated by multi-purpose ships. These ships are fully and unrestricted open over all their hull, and the containers are stowed on board in block free standing as on terminal ground. As inland waterway transport does not incur rough water motion, no considerable acceleration has to be taken into account, and cell guides to take hold of the container blocks are not needed.

The main "extra" feature of such ships is a special construction that allows the wheel house to be elevated by means of a hydraulic lift, and to lower it.

The barge fleet currently in operation in Central Europe offers the following variation in loading capacity:

- available widths for loading unit accommodation: 7,12 - 10,5 m;
- available length for loading unit accommodation: 59,50 - 105 m.

A census by the Dutch Ministry of Transport and Waterways indicated a considerable number of vessels operating in container transport:

- approximately 140 motor vessels
- approximately 55 pusher barges

All had an outside width of 11.4m offering an inside clearance of 10.5m (reference: letter from Dutch Ministry to European Commission dated 28 June 1999).

Table 2.4.2.2 Basic data of some selected barges that operate currently in container transport on inland waterway.

Barge name	outside dimension		loading capacity	
	length	width	length	width
	m	m	m	m
Nordland	84,95	8,20	59,50	7,12
Ludwig	104,94	9,45	77,50	7,44
Josephine	105,00	9,45	80,00	7,45
Frankenwald	99,97	9,46	75,50	7,49
Böhmerwald	101,08	9,46	76,50	7,49
Aviso III	84,92	9,40	58,80	7,52
Express 81/82	94,82	9,46	68,00	7,70
Dettmer	109,89	10,46	81,58	8,09
Geertje	95,00	9,50	65,00	9,45
Neuburg	135,0	11,40	105,50	10,06
Götz	105,00	11,45	81,50	10,12
Myriam	125,00	12,00	ca.95,00	ca.10,50
Jowi	135,00	16,84	110,00	15,30

(European Development Centre For Inland And Coastal Navigation: "Entwicklung Eines Technischen Konzeptes Für Den Transport Von Binnenschiffen Für Den Transport Von Wechselbehältern Auf Binnen-See-Schiffen", Duisburg 1999).

2.4.2.3 Conclusion

For the considerations about a future European loading unit, this situation of current intermodal transport on inland waterway invites for the following conclusions:

- A stacking capability up to 4 layers without the need to add additional strength for vertical acceleration is sufficient.
- Racking forces do practically not occur and need not be taken into account.
- Many barges in operation today can accommodate 3 container rows side by side, and they are capable to accommodate 3 European loading units of 2550 mm width side by side as well.
- Many motor ships and push barges are designed to a loading width of up to 10.5 m. These ships can accommodate 4 containers of 2438 mm (8 ft.) width side by side, but only 3 rows of European loading units with a width of 2550 mm side by side.

- Barges with varying loading lengths are in operation. As the future mix of loading units and their lengths in inland waterway transport cannot be foreseen, the loading pattern of each of these ships must be optimised individually.

2.4.3 Lock Width, Barge Width, Box Width

2.4.3.1 *The Situation In Europe's Inland Waterways*

The most frequently discussed problems with the design of future European loading units on board of inland waterway barges deal with the available width.

First of all the facts:

While the Rhine has no locks and allows currently to operate a barge with a width of 17000 mm, the locks of the Central European river and canal network have a nominal width of 12500mm offering accommodation for ships up to 11450mm width. This leads, regarding the necessary tolerances, to a limited maximum width of inland waterway barges operated on this network. This width had been traditionally fixed at 11400 mm and recently been enlarged to 11450 mm.

The barge needs for its side walls and various construction elements on the side walls a width of 2 x 250 mm, and furthermore a free walk way on both sides of the container block on board of the barge of 600 mm each. This calculation ends up, in theory, at an available loading width of 9750 mm. In practical operation, the barges "Bolivar" and "Götz" have an outside width of 11 450 mm and an inside width of 10 450 mm. This can allow for the accommodation of 4 rows of ISO containers side by side. But this is obviously the end of the current engineering possibilities.

A European loading unit with a design width of 2550 mm would necessarily lead to 3 rows of containers on board, i.e. to a loss of 25 % of the capacity.

2.4.3.2 Strategies

In this technical-economic conflict, four different strategies are available and under discussion:

1. The European loading unit must be limited to an external width of 2500 mm to fit in 4 rows into a barge with an outside width of 11 450 mm. This strategy contains a doubtful issue. The logistic service industry normally will select, without compromise, the largest available unit as standard. The possible advantages of using the European canal network as an additional transportation possibility in intermodal transport are certainly not that big that the industry will give away available volume capacity in their loading units.

2. The European loading unit is standardised at 2 550 mm, and the carriage of such units on the European inland waterway network will be very limited. In addition of all those restrictive factors for intermodal

transport on this part of inland waterways as mentioned in chapter 5.4.1.2, this capacity loss of 25 % will further limit the economic feasibility of this type of transport. This limitation might be taken as not too serious because the outlook of the use of the Central European side river and canal network of intermodal transport is anyway very poor. Many factors demonstrate that rail will be normally able to compete successfully with block train services against inland waterway transport with barges of some 80 TEU capacity. Insofar, the option of inland waterway transport on canals with intermodal loading units might be understand as not too realistic, and the loss of this option would not very much matter.

3. The third strategy would include an endeavour to elaborate a barge design with greater inside width offering, but keeping the outside 11 450 mm width which is imposed by legal regulation and infrastructure limits. The European Development Centre for Inland and Coastal Navigation in Duisburg is currently working on various projects that aim at an increased inside width offer. Such projects include research on possibilities to reduce the side wall installation needs to design with a smaller construction width, or to replace the two walk ways on both sides of the container loading block by one walk way in the centre. The latter measure would gain an additional available width of some 600 mm.

4. Another way to avoid the problem is to operate a mix of ISO containers and European loading units, loaded in separate rows. A ship with an inside clearance of 10500mm can operate a mix of 2 rows of ISO containers and 2 rows of European loading units side by side (2 x 2438mm + 2 x 2550mm = 9976 leaving 524mm for side shift and tolerances).

2.4.4 Additional Aspects

2.4.4.1 Inland Waterway Networks Outside Central Europe

Many European countries have an infrastructure of inland waterways in navigable rivers and canals. The large traditional networks in Great Britain and in France have not been enlarged in the 19th and 20th century so that they today are almost not used for commercial inland waterway transport.

The river and canal network in the Netherlands and the coastal region of Belgium offers widely modern capacity features, and is consequently used in container transport.

The German canal network is extensive and covers wide areas of the country. Its main limit in intermodal transport is the lock clearance of 12,5m.

The East European network of canals and rivers has not yet been fully exploited as regards the possibilities of intermodal transport. But as a general economic infringement, this network can be used normally only in summer when the waterways are not frozen.

Sweden and Finland have various canals, rivers and inter-connected inland lakes with access to the Baltic Sea. These inland waterways offer often more lock width that the German canals. So, they possibly offer better economics for the carriage of European loading units of 2 550 mm width. But this network cannot be used in winter time due to ice.

The Danube offers, as well, generous capacity for barges, at least downstream from the German/Austrian border region. The upper part with the connection to the Rhine-Danube Canal is limited in barge size and in commercial possibilities.

2.4.4.2 Non Stackable Swap Bodies In Inland Waterway Transport

Some tests are in preparation to operate current standard swap bodies, not stackable, in more than 1 layer on board of inland waterway barges. This can be achieved by cell guides with intermediate horizontal bearing parts that can be folded to allow vertical passage of the swap bodies in the cell guides, and that will be unfolded after the passage of the lower layer swap body to support the upper layer swap body. This technique would enable inland waterway transport to create a competitive offer even for swap bodies that cannot be stacked.

2.4.4.3 River-Sea Transport

Various projects deal with special ships designed to operate commercially on inland waterway transport and to continue in short sea transport on open waters.

2.5 TECHNIQUES AND ECONOMICS OF ROAD TRANSPORT

2.5.1 Dimensions

The European loading units proposed in Chapter 4 “Draft specification of a European loading unit” do not offer any specific problem with the length and width dimensions of European road transport vehicles as laid down in the European Directives currently in force. This is mainly due to that fact that the European loading unit has been basically defined to fit into this legal envelope. As road transport is by far the most important mode of transport, and as road transport is a necessary part of almost any intermodal transport chain, the legal conditions of road transport need to be observed fully.

Some trades ask for an inside height of 3000 mm which leads to difficulties in realising a European loading unit that fits on European standard articulated road vehicles. Meanwhile the automobile industry is working on technical solutions such as chassis with adjustable frame height.

2.5.2 Maximum Gross Mass

The maximum gross mass for road vehicles has been fixed on European level with 40000 kg, some European countries such as the Netherlands and the Scandinavian countries allow greater gross masses.

A general exemption for a maximum gross mass of 44000 kg has been made on European scale for the carriage of 40 ft. containers in combined transport, and some European countries have enlarged this exemption to other units of combined transport as well.

The reasoning for this exemption has been, amongst other points, to balance the specific tare disadvantage of intermodal transport road vehicles. Because the loading unit is separated from the chassis, and because both, the loading unit and the chassis, have to be designed as self supporting units, a re-enforcement has to be built into both units that creates an additional tare weight of approximately 2000 kg. As in most road vehicle configuration a gross mass beyond 40000 kg needs an additional axle to meet the maximum axle load regime, another 2000 kg have to be added for the additional wheels and their suspension.
This exemption allows the road transport of European loading units with 30500 kg gross mass, fully laden, within the European legislation. Unfortunately, the current regulation does not cover the majority of European loading units, but only the 40 ft. ISO container. Road transport of swap bodies and of 20 ft. containers is not covered by this 44000 kg exemption. This limit mainly affects the economics of intermodal transport with 13600 mm swap bodies and with tank containers of 20 ft. length of swap tanks of class C.

If light weight equipment in road transport is used, the 44000 kg gross mass exemption regime would allow for a class A swap body even with a gross mass of 32500kg. European standardisation of swap bodies goes into this direction.

The European Commission has already prepared an initiative to change current European legislation towards the desired and necessary regime to allow 44000 kg gross weight in the road transport part of most intermodal movements, and the discussions with the European Parliament are under way. The suggestions of this study endorse this initiative of the European Commission, and it is recommended to keep this point on the agenda.

2.5.3 Strength Requirements

Basically, road transport does not impose any strength requirements to swap bodies and containers in addition to that already needed in sea and rail transport. So the recommendation can conclude that all European loading units that are suitable for rail and sea transport are automatically suitable for road transport as far as strength is concerned.

The only problem comes from the specific economy of road transport. As the needs for strength are rather low in road transport, the road operators will react with reluctance towards any loading unit that is heavier and more costly than needed from their point of view because it has to follow strength requirements of other modes. So, any European loading unit that shall be competitive with road transport vehicles with fixed superstructure must be designed to accommodate all these additional strength features with a minimum of extra tare and building costs.

2.5.4 Door Openings

Many semi-trailers are today designed with a full side opening, covered by tarpaulins against weather influence during transport. The design of all boxes, ISO containers and stackable swap bodies, is based on a full side construction mostly from corrugated metal sheets that considerably assist the overall strength of the unit. These loading units have only end door openings.

If a full side opening and considerable stacking and racking strength has to be incorporated in a loading unit, this might lead to the need for an extra heavy frame bearing member design that might create boxes that are too heavy and too costly for competitive operation. The market development must show which of the solutions will be the most preferred:

- class A loading units with open sides and reduced strength requirements,
- class A units with full strength and permanently covered sides (as currently often operated in the Continent to Great Britain traffic),
- class A units with s special design combining a fairly well, but not totally, open side, the strength needed for sea transport in stack and an agreeable tare weight.

2.6 EFFECTS OF STANDARDISATION

Today, a wide variety of different boxes is moving in European intermodal transport. This affects the economics of the transport system.

Transport operators have to care for a wide variety of solutions with trailers and platform railcars to be able to participate in various segments of the market. This adds to operation costs and, in certain situations, reduces optimum space utilisation.

The most difficult problems are incurred with short sea transport. Quay to ship transfer has to care for an ever growing variety in design for handling. Top corner fittings, grappler arm lifting recess, no lifting possibility at all, arrive in mix. The loading units arriving in the sea port terminal vary in width and in strength features. Each box has another specific maximum overstacking mass, racking capability, side wall strength and more. In such a situation, the ship officer has, as usual under time pressure, to decide for each unit how and where to stow it on board ship. This situation incurs some unnecessary risks in European short sea transport.

In addition to the variety of European loading units, short sea transport is confronted with the usual range of ISO containers for re-distribution out of gateway ports alongside the European coast lines. A European loading unit designed to similar strength features as ISO containers would certainly facilitate this situation and add to traffic safety.

Insofar, a standardisation that on the one side includes the main needs of road, rail, sea and inland waterway transport, on the other side brings a wider degree of uniformity into European intermodal transport, will add considerably to the economy of the European transport system as a whole. When aiming at such a standardisation, not only dimensional features must be looked after. Safety of European transport needs as well standardisation of strength requirements and standardisation of a clear outside marking which forces can be applied to the unit.

2.7 RECOMMENDATIONS

2.7.1 European Transport Policy

Keep the legal framework on dimensions of road vehicles stable

As road and rail have different investment cycles, European combined transport operators have a paramount interest in stability of current regulations of dimensions of road vehicles.

UIRR operators and the International Associations of rail and road operators such as UIC and IRU do not favour a 15 m semi-trailer length.

Promote the evolution of road transport rolling stock towards a combination of pallet wide stackable freight container + platform chassis configuration

The current habit to operate rigid built semi-trailers in European long distance transport has to be replaced by a policy investing in 2 pallet wide stackable freight containers and platform semi-trailers. Such containers are a necessary pre-requisite for competitive intermodality in Europe. By this operation, rail and waterborne transport can become more competitive against road transport in Europe.

The European container can be operated:

- on platform railcars of current technologies on practically all rail networks in Europe (except some lines in Great Britain),
- in inland waterway on the Rhine, the Danube and some coastal waterways in Netherlands and Belgium in stacks of 4 layers, on most other waterways such as the Central European canal network in 2 layers,
- on European sea routes with Ro/Ro ships in double stack with considerably increased space utilisation and economic benefit,
- on European sea routes in cellular ships with specifically adapted cell structure in stack,
- on current road transport platform chassis.

Compared to this intermodal quality of containers, current semi-trailers show poor performance in many road/rail and Ro/Ro operations and even poorer performance on inland waterway barges and cellular ships. Swap bodies as used today, i. e. non stackable units, also show poor performance in inland waterway transport and European sea transport.

To foster a development towards increased use of stackable European loading units in place of semi-trailers in European trade, the European Commission is invited

- to pursue the introduction of a 44 t maximum weight allowance for road vehicles operating in intermodal transport to compensate for the extra tare weight included in this configuration,
- to promote the standardisation of a European loading unit that fits on a 13,6 m European articulated road vehicle and offers a competitive alternative to the rigid built semi-trailer,
- to consider further incentive schemes, such as tax incentives, exemptions from driving bans, to promote this development on national or European basis,
- to organise further consultation between standardisation experts and operators of inland waterway and sort sea cellular ships, regarding the exact width choice of the future unit in the range between 2,52 and 2,55 m. However, as currently inland waterway transport ships are only loaded 60 % to 70 %, they can take a load mix with some 25-30 % share of wider European loading units without significant additional costs. PACT should support pilot projects in the form of new services using these units, provided the other selection criteria are fulfilled.

Once a CEN standard for loading units fitting the above requirements has been decided, the Commission is invited to propose a Council resolution to endorse it and stress that governments should only procure and support such units.

The European loading units shall have a length of 13600 mm (class A) and of 7450 mm (class C), a width of 2550 mm, a height of 2900 mm and a stackability that should try to ascertain transport in at least 4 high stack under sea transport conditions.

44 t maximum gross weight in road transport must be allowed in intermodal transport operations

As any combination of container + platform chassis will result in more tare weight than a rigid built semi-trailer of similar capacity, intermodal transport needs to be compensated for this additional tare weight.

The European Commission is invited to renew their efforts in a European legislation that allows 44 t maximum gross weight for intermodal transport loading units when carried in pick-up and delivery operation before or after a main run on rail or water mode in Europe.

Concerns that have been offered recently can be answered by detailed explanations:

- that such a regime is already in place for 40 ft. containers,
- that such a regime is needed for improved competitiveness of intermodal transport in Europe,
- that this regime has been applied successfully in some European countries, and that these countries have had good experience with the necessary surveillance regime avoiding too much bureaucracy but preventing fraudulent application of these rules.

2.7.2 Standardisation

Standardisation of a stackable European loading unit of 13,6 m length must be promoted.

As the 13,6 m long semi-trailer is the most important cargo carrying unit in European trade, a stackable loading unit of this size is urgently needed to include European railways with limited gauge, inland waterway transport and short sea transport into intermodal transport.

Currently CEN TC 119 Swap bodies for combined transport has successfully prepared the standard on a 7,45 m stackable loading unit, but the work for a standard on a 13,6 m unit is urgent but has not yet started.

Standardisation in CEN TC 119 is based on voluntary European co-operation and the experts are not paid for their contributions. As the European manufacturers of swap bodies have only limited interests in such a development, the future of standardisation work in that field , when based on voluntary work only, will only move forward in slow speed. The standardisation work can be greatly accelerated if CEN sets up, in close conjunction with the European Commission, a selected experts team, paid with a normal commercial salary for their effort, with the clear task to draw up the necessary draft standard documents in a given short time period.

The instrument of speeding up European standardisation by promotion through the European Commission has been successfully applied in many cases, and should be seriously considered in case of a stackable European loading unit of 13,6 m length as well.

2.7.3 Research

Demonstration projects should be made eligible under the 5th framework program once a CEN standard for loading units has been decided.

European research shall look after the development of European inland waterway transport barges that can accommodate 4 rows of European loading units side by side.

Barges that can accommodate 4 rows of European loading units side by side and keep the maximum width (currently 11,45 m) for operation in Central European inland waterways are currently technically not possible. As most Central European inland waterways are equipped with locks of nominal 12 m width allowing only the passage of barges up to 11,45 m width, a barge design that offers an inside clearance of some 10,5 m to accommodate 4 rows of European loading units with 2,55 m width each of them side by side plus the necessary tolerance can greatly improve the economics of inland waterway transport in Europe. Various concepts have been suggested to overcome this problem, and European research is invited to take over this question in research, prototype development and pilot operation.

European research shall look after the development of European railcars with platform height of 800 - 900 mm above rail and sufficient cargo carrying capability.

The development of European railcars with platform height of 800 - 900 mm above rail and sufficient cargo carrying capability will lead to the development of increased axle loads with small diameter wheels. Such small wheels can be used today, but only with reduced axle loads that might infringe the payload of the railcar.

While a 2900 mm high European loading unit can be carried on most parts of the European rail network without too serious gauge problems, European intermodal transport is meanwhile faced with the need to operate units with an inside height of 3000 mm resulting in an outside height of 3150 mm. Such demands come currently from the European automobile industry which is a major client in intermodal transport. A loading unit with a height of 3150 mm would need a platform railcar with low diameter wheels which will lead to limited load carrying capability. Research can contribute to find technical solutions that offer a low platform railcar with sufficient payload for European intermodal transport.

European research in technical, commercial and economic patterns of European short sea transport with a view to optimise transport conditions for future European loading units shall be intensified.

This research must aim at a technical development to improve inter-operability and cover items such as:

- flexible cellular systems,
- ship design in general,
- ship propulsion systems,
- sea terminal optimisation, especially in ro/ro operation of stackable loading units,
- specific design and operation concepts for tri-modal terminals connecting road, rail and inland waterway transport,
- information flow in intermodal road-rail-sea transport systems such as already initiated in the European research projects APRICOT and MARTRANS.

The inclusion of small European short sea carriers into harmonised EDI and Internet systems for communication between ocean carrier, terminal operator and forwarder shall be promoted by pilot projects.

While communication using harmonised EDI systems, partly via Internet and partly via current added value services, is state of the art for larger ocean carriers, many of the smaller shipping companies that operate in European short sea traffic have not realised such systems. On the other hand, a harmonised information system will greatly reduce commercial transaction costs, speed up communication between the partners and assist to achieve high quality services. A close look must be taken on the current patterns of such small ocean carriers to determine the reasons why they did not realise such systems up to now and how to promote the use of them in the future.

3. RECOMMENDED GENERAL SPECIFICATION FOR A SYSTEM OF EUROPEAN LOADING UNITS FOR INTERMODAL TRANSPORT

3.0 General considerations

Any European loading unit has to follow certain requirements that are mandatory. The following basic features of European logistics have to be met under almost any consideration:

Considerations from the logistic demand side:

- The European loading unit must offer a good answer to the logistic demand of the European industry.
- The European loading unit must offer as much cubic space as technique and legislation allows.
- The European loading unit must give good loading patterns for European pallets and small load carriers 800 x 1200 mm and 1000 x 1200 mm base dimensions.
- Since the European loading unit operates mainly on short and medium length corridors, it will be loaded and discharged frequently, and it will must be designed to offer easy access to the inside loading room.

Consideration from the side of the transportation industry:

- The European loading unit must keep within the dimensional envelope of European road vehicle legislation.
- The European loading unit must be designed to fit in most of European rail corridors.
- The European loading unit must be designed to fit in most of the important European inland waterway corridors.
- The European loading unit must be designed to fit in European short sea shipping.
- The European loading unit must fit into well established systems of intermodal transport, such as container and swap body transport systems, especially as regards lifting devices and fixing on vehicles.
- The European loading unit must offer a good safety record, as the well established systems of intermodal transport do today.
- The European loading unit must keep within the marking and coding systems used by the established systems of intermodal transport.

3.1 Dimensions - outside and inside - and payload

3.1.1 Length

The length consideration offers many parameters that ask for optimisation:

- European palletised unit loads ask for an inside module of 800 mm, 1000 mm, or 1200 mm.
- European road vehicle legislation allows for an outside load carrier length of the articulated road vehicle of 13 600 mm, and for the road train of 7 820 + 7 820 mm.

Transport economics would prefer a system of units, that is modular, i. e. 2 smaller units make up 1 larger unit, e. g. the 2 units that form a road train make up 1 full load of a semi-trailer.
As a rule of thumb, a need of 100 mm for each end wall or end door must be calculated, so that from any selected outside dimension 200 mm have to deducted to arrive at the inside length offered for loading. The actual value for these wall and door construction will finally depend from the strength feature needed for such parts of the unit (see chapter 4.3.2).

Furthermore, if the inside is organised as a multiple of pallets, one must consider that palletised units loads need a certain plus tolerance for loading, because they might come into transport not correctly stowed, i. e. with an overhang, and the loading operation needs some small side shift to manoeuvre the pallets by fork lift truck. In the end, a need of 10 to 20 mm space between all palletised units and the unit and the side or end wall must be realistically calculated to offer sufficient room to offer accommodation for such needs.

If the 3 pallet dimensions that are mainly occurring in European logistics are taken into account, i. e.

- 800 mm,
- 1000 mm,
- 1200 mm,

the first common denominator is a length of 12 000 mm. 100 to 300 mm further length for space between the pallets + 200 mm additional length for the walls is needed, so the theoretical calculation ends at a need for 12 500 mm outside length to form an optimum in flexibility of accommodation of palletised loads.

If the rigidity of the common denominator is reduced, as one can assume that pallets can be loaded lengthways or transversally in the unit, the optimum must take into account only the 800 or the 1200 mm of the above pallet values, and the calculation ends up with some additional nominal optimums of

- 6000 mm + 50/100 mm space + 200 mm end walls = 6 300 mm,
- 8000 mm + 100/200 mm space + 200 mm end walls = 8 400 mm,
- 16000 mm + 200/400 mm space + 200 mm end walls = 16 600 mm.

If transport operators desire to realise a modular system of European loading units that would best fit into transport optimisation of road trains and articulated road vehicles alike, two possible concepts can be designed:

- 6 250 + 6 250 mm length for the road train, and 12 500 mm length for a semi-trailer, or
- 8 300 + 8 300 mm length for the road train and 16 600 mm length for a semi-trailer.

These optimum concepts have their short comings in current practical life:

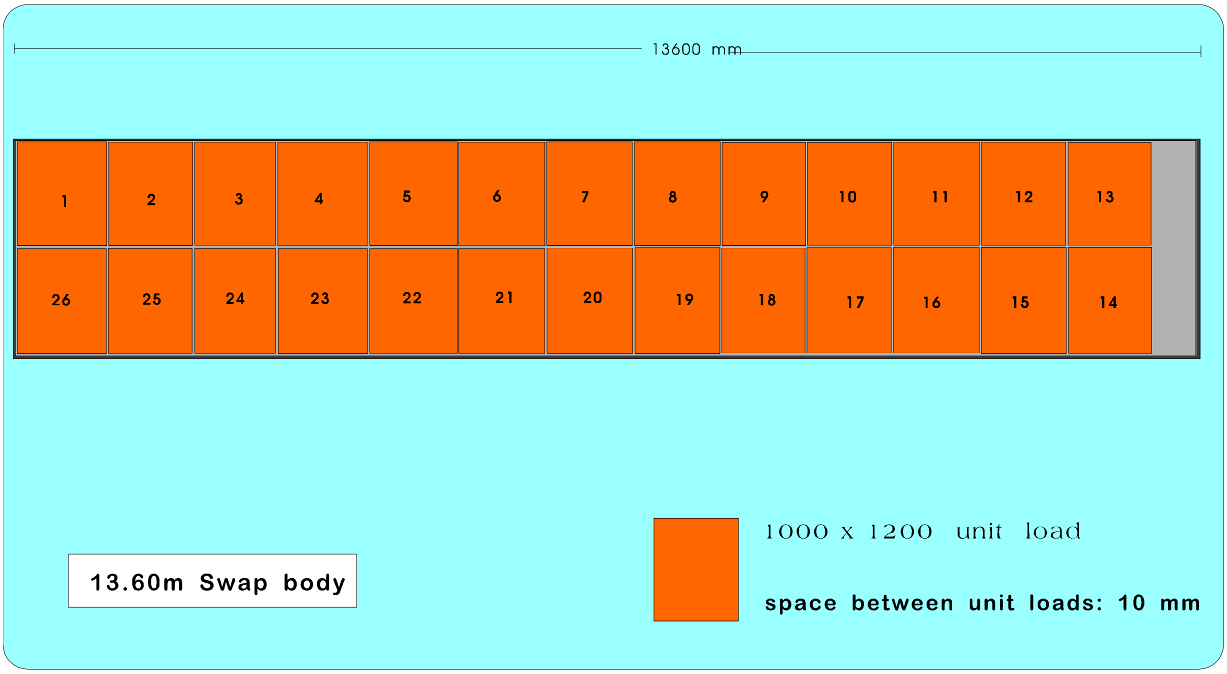
- Since road transport carries some 80 % of all European freight volume, we have - whatever we do - to consider the compatibility with the legal environment and the infrastructure of road transport as a main issue.
- The 6250 + 6250 mm length for the road train, together with the 12 500 mm length for a semi-trailer concept reduce currently possible road vehicles loading length by some 10 %, and decrease overall productivity of the system road transport considerably. Such a concept will not be acceptable for the European economy and for the European Council.
- The 8300 + 8300 mm length for the road train and 16 600 mm length for a semi-trailer ends up at a road vehicle with some 20 000 mm overall length, and this seems currently not accepted by the public and the transport policy. Nevertheless, most modern highways in Europe would be capable to accommodate such units. The main problem from the point of view of infrastructure is the operation of very long road vehicles in downtown areas and in historical villages. The USA allow such length semi-trailer, but it is reported that this size cannot be operated even in certain areas of the USA because it is too long.

Given these considerations, the optimum concept from a view of palletisation must be dropped, and a "second best" solution must be approached. When doing so, the maximum length currently allowed must be checked against the palletisation patterns and the modular concepts.

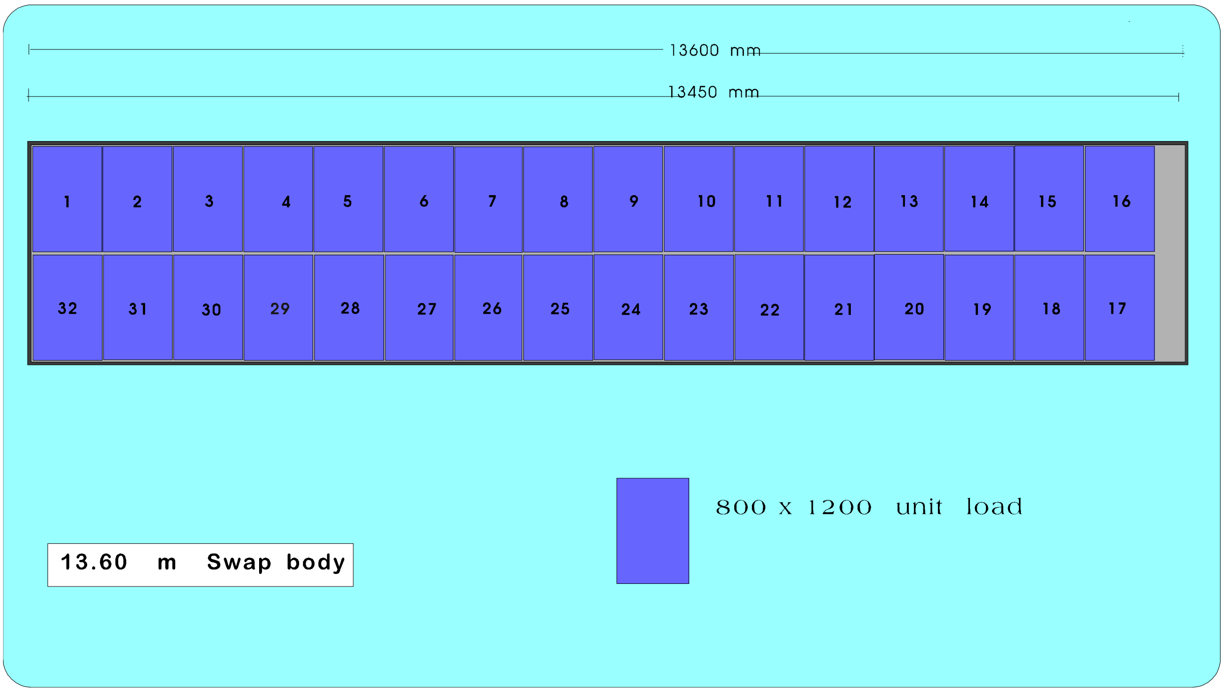
A European loading unit optimised to European semi-trailer legal length would have an outside length of 13 600 mm, offering an inside length of 13 400 mm. This would allow for pallet loading (including a 15 mm space between the pallets) of

- 13 rows of 1000 mm pallets, resulting in a total loading length of 13 210 mm with a loss of 190 mm, or
- 11 rows of 1200 mm pallets, resulting in a total loading length of 13 380 mm with a loss of 20 mm, or
- 16 rows of 800 mm pallets, resulting in a total loading length of 13 055 mm with a loss of 545 mm
- 33 pallets of 800 x 1200 mm with some pallets loaded lengthways, some sideways.

Summing up: A 13 600 mm long European loading unit loaded at a lengthways loading pattern can achieve a space utilisation of 96 % to 98 % in normal case; this is a fairly good figure that approaches nearly full optimum.



13,6 m swap body loaded with palletised unit loads 1000 x 1200 mm



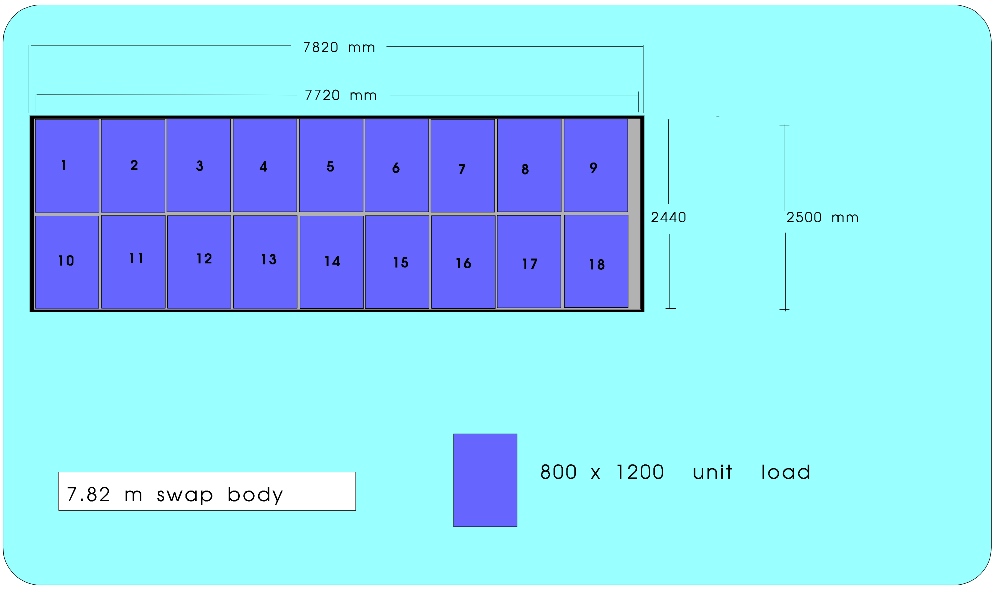
13,6 m swap body loaded with palletised unit loads 800 x 1200 mm

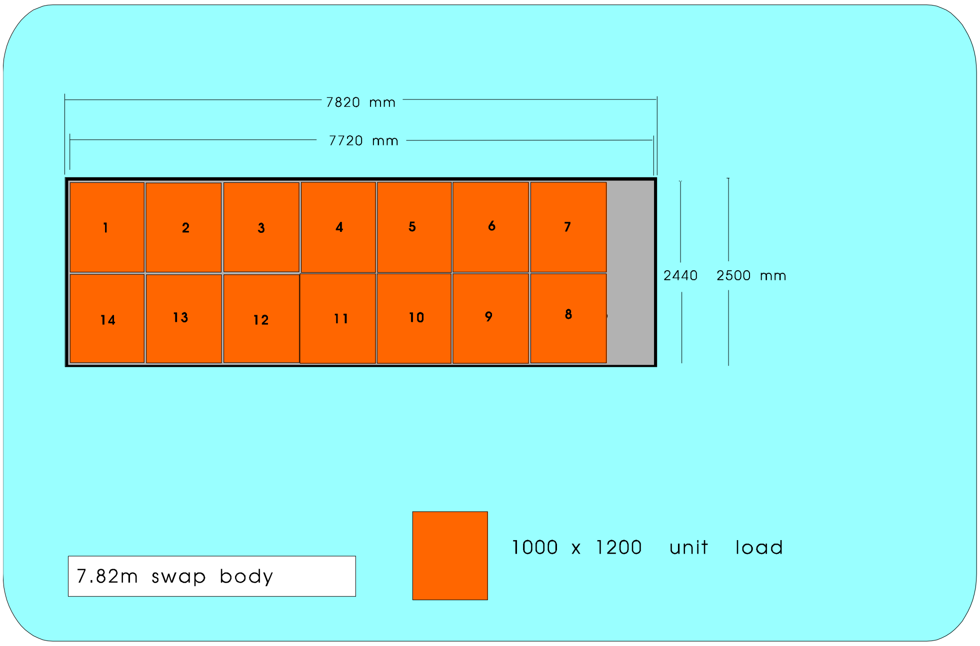
A 45 ft. semi-trailer would offer additional some 120 mm inside loading length; this would not add up in any additional pallet loading. The offer of additional loading length must be further reduced, because for legal requirements such a unit must have placed the front corner posts at a 13600 mm length concept so that any additional lengthways loading space cannot be offered over the full width of the unit.

A European loading unit optimised to European road train dimensions includes a small additional complication: The operator can select a road train with special short coupling device (which is rather costly and cannot be freely coupled to each available trailer) offering a loading length of 2 x 7820 mm, or European road train with a "normal" coupling system offering 2 x 7450 mm loading length. In all cases, the calculation must be based on a solution with 2 similar "twin" European loading units on a road train. This allows to change them freely between lorry and trailer, and it follows a concept that is widely preferred by European road operators that use such road trains.

Taking the 7 820 mm units that offer 7 620 (max. 7 720) mm inside length, this would allow for a pallet accommodation (including 15 mm space between the pallets) of

- 7 rows of 1 000 mm pallets, ending at 7 120 mm, having a loss of 500 mm, and achieving a length utilisation value of 93 %,
- 6 rows of 1 200 mm pallets, ending at 7 305 mm, having a loss of 315 mm, and achieving a length utilisation value of 96 %,
- 9 rows of 800 mm pallets, ending at 7 350 mm, having a loss of 270 mm, and achieving a length utilisation factor of 96 %.

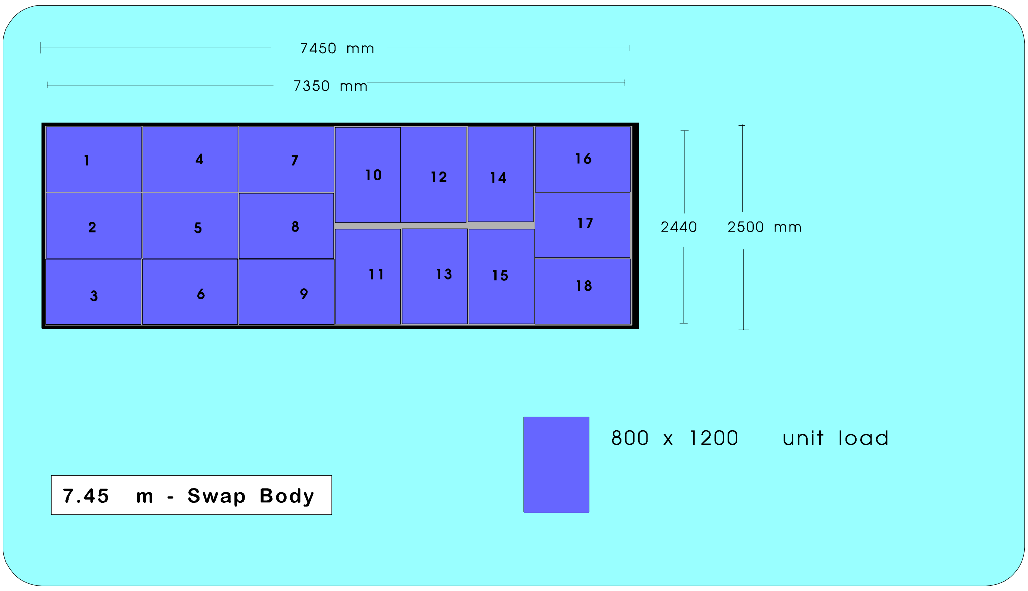


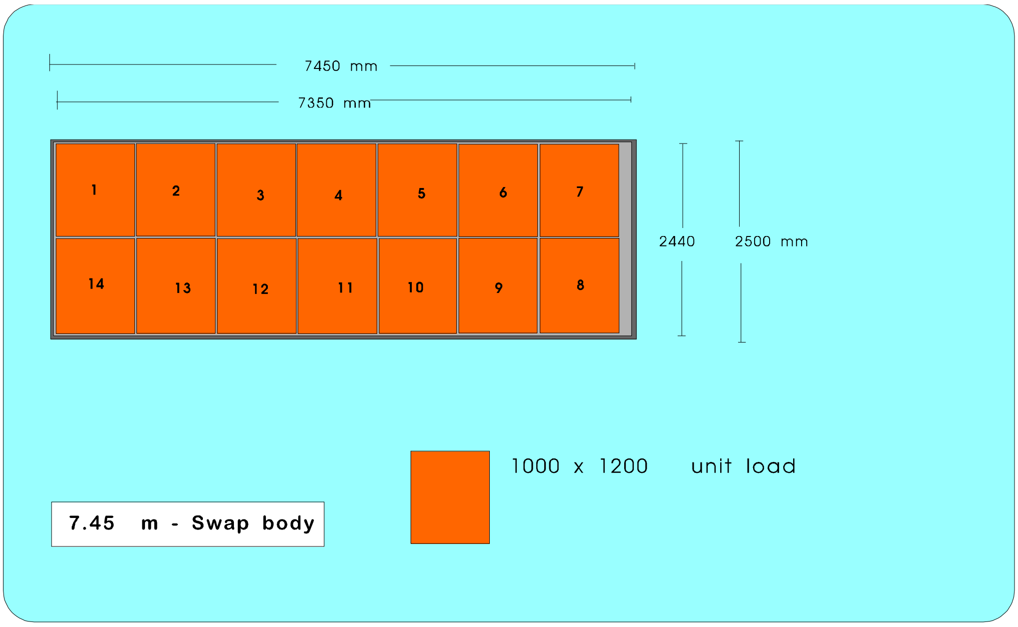


7,82 m swap body loaded with palletised standard unit loads

Taking the 7 450 mm units that offer 7 250 (up to 7320 max.) mm inside length, this would allow for a pallet accommodation including 15 mm space of

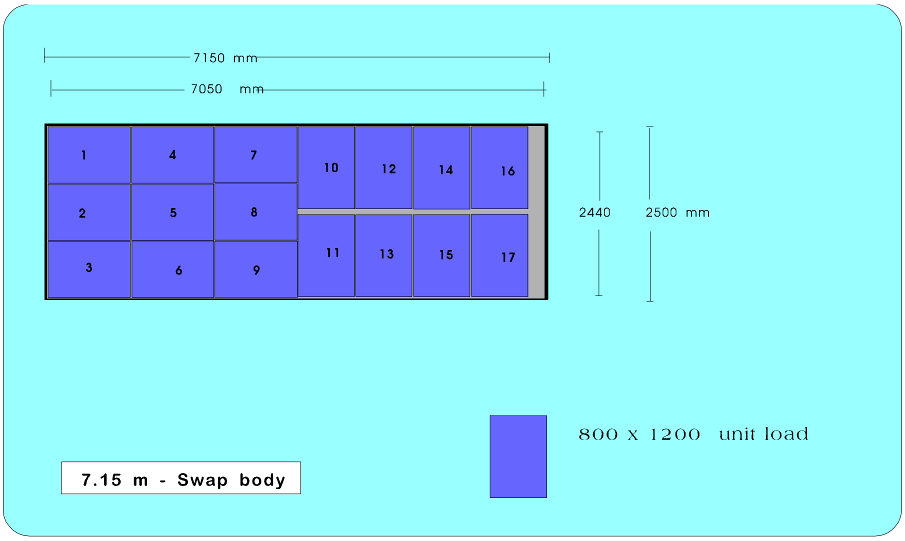
- 7 rows of 1 000 mm pallets, ending at 7 120 mm, having a loss of 130 mm, and achieving a length utilisation value of 98 %,
- 6 rows of 1 200 mm pallets, ending at 7 305 mm, needing a special design to achieve additional 50 mm inside length (e. g. by smaller width of front end wall), and then offering a length utilisation value of 100 %,
- 9 rows of 800 mm pallets, ending at 7 350 mm, which would come up with a rather complicated design to achieve a further increased inside length, but if this can be really achieved, offering a length utilisation factor of 100 %.





7,45 m swap body loaded with palletised standard unit loads

The traditional 7,15 m swap body does, compared to these configuration, not provide any advantages.



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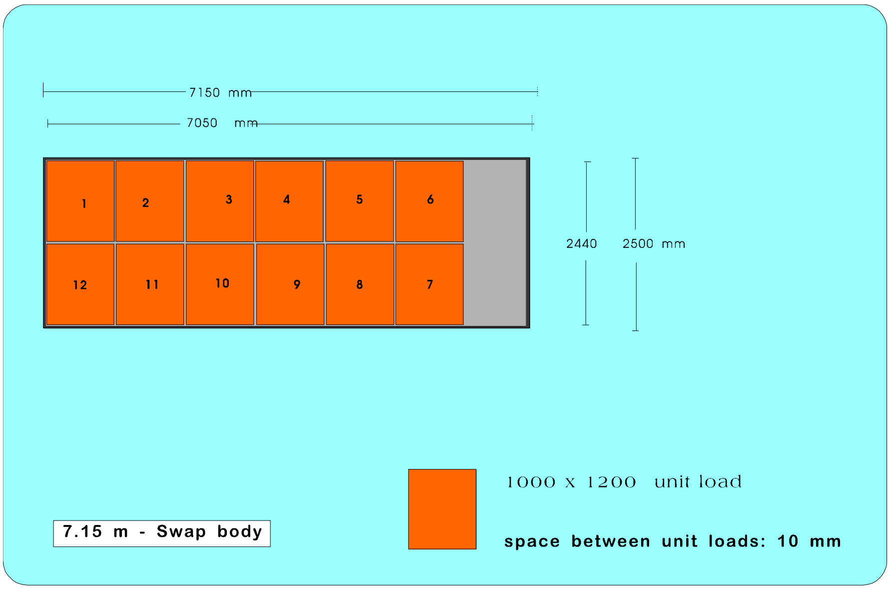


Pallet loading capacity of a 7,15 m swap body

Summing up: The 7 820 mm unit does not offer additional pallet accommodation compared to a 7 450 mm unit with an inside length of some 7 300 mm which can be achieved under realistic strength features. The 7 450 mm box does not need a specific coupling system road train. It can be operated by standard road equipment, and can be basis for a standard solution.

But some cases may occur when an operator has to carry palletised cargo into one direction, and non-palletised high volume items into the other direction. In such a case, the use of a swap body with maximum cube, i. e. a 7820 mm long unit, can be desirable even if such a unit does not accommocate any more pallets than a standard 7450 mm long swap body.

The solution with a class A European loading unit with 13 600 mm length and a class C European loading unit with 7 450 mm length creates a system

- with the disadvantage to be not modular,
- with the advantage to fit into current European legislation on road traffic,
- with the advantage to offer load space utilisation for palletised European loading units between 97 and 100%.

Possibly, a swap body used for delivery operation might need specific additions such as doors that can be folded upwards, or a hydraulic lift at the end door, which will add to the outside envelope. But as 7450 mm length is not the very limit of European road legislation, there should be sufficient room for such additional features within the envelope legally allowed.

Recommendation:

Under current legislation, the study expert team recommends a class A European loading unit with 13 600 mm length and a class C European loading unit with 7 450 mm length.

3.1.2 Width

The discussion of an optimum width concept will be organised the same way as the consideration with the length question.

Basic assumptions are:

- A construction depth for the two side walls of 50 mm each is needed so that the side walls use some 100 mm of the total available width. Special side wall constructions with less thickness are available, but with either less strength or with some infringements for the design. Such side walls would end up at a thickness of 35 mm each, and so need a space of 70 mm for the side wall construction.
- A 10 - 20 mm space between the pallets and the pallet and the wall is needed, in average 15 mm.

Two 1 000 x 1 200 mm pallets side by side need an available width of 2 445 mm, three 800 x 1200 mm pallets need an available width of 2 460 mm. If we add 90 mm for the side wall, we arrive at 2550 mm. This value is similarly the legally allowed maximum in European road transport. A design with small thickness side walls could save another 20 mm outside width and arrive at a unit of 2530 mm. When reducing the inside possibilities for pallet side shift, possible another 10 - 20 mm width can be saved. Some experts have offered the opinion that especially units that go on short sea routes might preferably built to smaller inside to offer a minimum of space between the pallet loads and so to avoid a side movement of the cargo during sea transport.

In rail transport, most corridors that can accommodate intermodal transport loading units with a height up to 2 900 mm and a width of 2 500 mm, can as well accommodate such units with 2550 mm width. The additional 50 mm upper corner distance has to be checked carefully, but today such units are operated without too much trouble in most parts of the European intermodal rail network. A semi-trailer with full 4 000 mm height can be carried in Central and East and North European rail networks, and cannot be carried in West and South European networks, whether it is 2 500 mm wide or 2 550 mm wide.

The value of 2 550 mm seems ideal mainly from the point of view of road transport and road/rail intermodal transport, but includes two smaller disadvantages:

- The US domestic system of loading units has introduced a width of 2 590 mm, and European thermos-insulated units have a width of 2 600 mm. These variation might create difficulties when later all loading unit systems merge to a world wide system.
- The European inland waterway vessels, as far as they are specially designed to operate in the West and Central European canal network, have to follow the standard width of the locks in these canals and can, under consideration of the need for a free board, not offer more than 10 000 mm inside width, allowing for four rows of containers with a width of up to 2 500 mm each. A container of 2 550 mm width could only be accommodated in three rows, this resulting in a capacity loss of some 25 %. This argument does not apply to

such container transports that are operated on the Rhine and the Danube, because these two river systems do not have locks, or have wider locks.

- A European loading unit with reduced outside width of 2520 mm might offer some advantages in short sea transport: It might be designed similarly to the current SeaCell concept and so carried in the cells of a container ship that has been designed to carry containers with 2500 mm width. But the length deviation (ISO 20/40 ft. containers have a length of 6180/12200 mm, the proposed European loading units have a length of 7450/13600 mm) has to be solved anyway, and this will inevitably create the need for either an adaptiation of the cell structure or for the design of a flexible cell structure when uisng cellular ships.

Recommendation:
Under current legislation, a loading unit width of 2550 mm is recommended by the study team.

3.1.3 Height

When considering the height, the height limits offered in various modes of transport shall be investigated, and the needs of European logistics shall be asked for, basing all these considerations on the obviously everlasting need for additional cube capacity of the logistic service providers.

European road traffic legislation foresees a height limit of 4000 mm. Taking into account bridge underpass height in most European through roads, this height limit reflects the possibilities in large parts of the infrastructure.

The loading platform of a semi-trailer is normally 1000 - 1100 mm above road surface, so road transport as a general rule will be able to move a European loading unit up to 3000 mm height. Platform heights of 800 mm (and even less) seem to be technically possible, but go together with difficulties in design and operation. Special design tractors with very low 5th wheel and low diameter tires that might infringe the load (mass) carrying capacity are needed. These special features will be certainly more costly than normal design vehicles. So we conclude that road will be confronted with some difficulties when loading units exceeding 3000 mm height have to be carried.

Rail is certainly much more infringed. ISO containers of 8 ½ ft. height (2590 mm) can be operated on almost all major European rail corridors. ISO containers with 9 ½ ft. height (2950 mm) can be moved rather freely in Central, North and East Europe, but need very specialised equipment for Italy, France, Spain, and in Alps mountain transit, especially when they are 2 550 mm wide. Units of almost 3 200 mm height have been reported in rail traffic operation between Germany and Spain, so that we may conclude that railcars are available even for the operation of such units on rail. Chapter 5 will deal in more detail about the options in this type of movement. Generally speaking, it seems like that rail can move - sometimes with special equipment needed - a European loading unit with a height up to 2900 mm.

Short sea shipping often transfers two loading units one on top of the other mounted on low bed special trailers on board ship in Ro-Ro operation on some of their decks. Many modern ships are prepared for such type of transfer. These decks are normally equipped with door openings and deck clearance of 7000 mm height that care for the combined height of two containers up to 9 ½ ft. height + the low bed trailer with a 700 mm platform height. Loading units with a height of 3000 mm or more would create difficulties in this type of two layer transfer. They must be moved in one layer on board ship, decreasing the productivity of the transfer operation by almost 50 % for loading and unloading of the decks that allow double height stacking.

It is more difficult to calculate from the outside height to the inside loading height offer, since this calculation includes some far reaching assumptions about the design construction of the unit. If the design of the loading unit is based on a steel frame and full supporting material (e. g. corrugated steel panels) side and end walls, bottom and roof construction need some 150 - 200 mm. If a swap body type design is applied with a floor part to take over alone most of the load stresses, and eventually a full side wall left open and covered only by a tarpaulin that does not add anything to the strength of the construction, the floor will have to be designed considerably stronger, i. e. with higher longitudinal bearing members resulting in less usable height for the interior. Furthermore, some design of corner fittings in units longer than 40 ft. will result in infringements of usable height in the roof area (see chapter 4.2.1).

Chapter 1.3.1 has discussed loading heights of European palletised loading units. Taking over these ideas, we come to loading height needs as follow:

- Light weight cargo in normal mixed distribution will be stowed in pallets of some 1 800 mm height, needing door heights and inside heights of the vehicle or the European loading unit of 1900 mm. Road transport offers for such cargo high cube trailers that can accommodate up to 3 000 mm loading height inside.
- Normal weight cargo in general distribution will come up with 1100 mm/1200 mm height palletised cubes. Road transport can take 2 layers of these unit loads, either one stacked on top of the other, or with an intermediate loading deck inside the vehicle or swap body. All this results in loading height needs of 2450 / 2500 mm.
- Heavy weight items, e. g. bottled liquids, may be loaded up to 1 500 mm height. In many cases one single layer fills the weight capacity of the road vehicle or swap body.
- Meanwhile some new small load carriers are introduced in European logistics, mainly in the logistic pipe-line from sub-contracting delivery plant to the assembly factory. Such small load carriers have the same base dimensions as standard pallets, and heights up to 1000 mm. As long as they carry rather light material, the logistic industry will wish to have them carried in three layers, and road transport can follow this desire offering vehicles with an inside height clearance of 3020/3050 mm. If intermodal transport wishes to be included in this trade, it has to consider similar offers. If intermodal transport carries only 2 layers, it will offer 33 % less capacity than road in certain trades, and has to offset such limitations by a transport price reduction of 33 %, and this seems to be a rather hopeless case.

Recommendation:
An outside height of 2900 mm for the European loading unit is recommended. Increasing demand for special European loading units offering an inside loading height of 3000 mm can be foreseen and may have to be accommodated in standardisation in future.

3.1.3 Payload

Class C swap bodies are today rated to 16 t, taking into account the normal gross weight limits of a European road train.

Class C tan containers are rated to 30,5 - 32,5 t to achieve a maximum of payload within the possibility to operate with a 44 t gross weight in intermodal transport pick-up and delivery.

Class A swap bodies have been discussed, and some current types have been designed, to a gross weight of 32,5 t. Such a weight can be carried legally in European road transport if a lightweight tractor and a lightweight chassis are used and if a 44 t operation is allowed. Normally, the lifting equipment in European terminals are capable to handle units with 32,5 t.

The European loading unit has, as far as possible, to show similar cargo accommodation patterns as road vehicles, and insofar the maximum weight concept shall be followed here.

Recommendation:
The expert team recommends to foresee the following gross weights (masses) for the European loading units: The 13600 mm long unit shall be designed to a maximum gross weight of 32,5 t, the 7450 mm long unit shall be designed to a gross weight (mass) of 16 t, and specific heavy duty loading units of 7450 mm length can be designed with a gross weight (mass) up to 32,5 t.

3.2 Lifting devices

3.2.1 Corner fitting

Europe is covered with intermodal transport terminals, all of them being equipped with lifting devices with spreaders to meet a standard corner fitting according to ISO 1161 or compatible to this design. So, there is no question that a European loading unit needs to be equipped with such corner fittings.

While ISO containers are equipped with top corner fittings for top lifting, European swap bodies are designed bottom lift only without such top fittings.

The top corner fittings are not only needed for lifting but for stacking , so that any unit designed for stacking will necessarily be equipped with top corner fittings. As the future European loading unit must be specified with some stacking capability to meet the requirements of inland waterway transport, short sea operation, and some type of terminal handling, these units will be equipped with top corner fittings for top lift transfer (more details in chapter 4.3.3).

Most modern spreaders are adjustable to meet all length distances of corner fittings between
20 ft. (6 058 mm) containers and 40 ft. (12 200 mm) containers. As width is concerned, the standard width of 2 438 mm for ISO containers has set a standard that even wider boxes adhere to. Insofar, corner fittings on wider units normally offer a design with the openings to take in the twist locks at a 8 ft. distance, i. e. exactly the same distance as ISO series 1 containers.

The top corner fittings for the class C units can be positioned at 20 ft. distance or at the corners of the units, i. e. at 7 450 mm length distance. Experience from intermodal transport terminals say that transfer operation by spreader lift is much easier and quicker, if the spreader can meet corner fittings at the real corner rather than some what inside located fittings. Insofar, a location of the fittings at the outside corner will be preferable. As most spreaders can be easily programmed to adjust automatically to such a length configuration, this should be the preferable location.

Having the corner fittings at the outside corner gives another advantage: In such a case, the corner fitting can be integrated into the corner post construction, and most vertical forces introduced into the container when carried in stack aboard a ship can rather easily be accommodated by this design without too much additional tare penalty. So, a rather lightweight container with 4 - 6 high stacking capability in sea transport can be realised.

Bottom fittings shall follow another regime, i. e. the compatibility with ISO 20 ft. bottom corner fittings location. Most road chassis and platform railcars have twist locks foreseen at 20 ft. distance position, so that even larger units should offer the accommodation for such twist locks at 20 ft. ISO container location.

Bottom corner fittings of ISO containers are built and tested at a strength value that they can hold the container on a moving road and rail vehicles during transport, and so that they can be used for lifting by slings (with some minor limitations such as certain sling angles). This feature might add to the building costs when the bottom fitting is located inside mainly as a hole to accommodate a twist lock in the longitudinal side beam. If so, it might be reasonably considered not to foresee lifting forces applied through them.

During transport and storage of the units in stack, the vertical forces are mainly guided through the corner fittings from the upper layers to the lower layer units. This means that a loading unit of 7 450 mm length with a top corner fitting at the outer top corner has to be equipped with enforced areas at the floor underside in the same location, i. e. at the very outside corner. The vertical load transfer within the stack must be transferred from this reinforced area into the top corner fitting of the bottom layer unit, and from there through its four corner posts further into the floor of the bottom unit.

The class A European loading unit incorporates specific problems with the top corner fitting, and in consequence of the vertical load transfer. As practically all spreaders in European inland terminals end at 40 ft. length distance, the openings of top corner fittings must not exceed a length distance of 40 ft. (12 200 mm). So, either one or both pairs of corner fittings have to be located inside the roof construction and cannot be integrated in the corner post assembly. This will create extra problems with full strength container design because the vertical load transfer in stack has to be guided either through the fittings at 40 ft. distance - creating the need for re-inforced load transfer zones in the side walls and on the underside of the units -, or through the corner post, or through both construction parts of the units. The other problem is that such corner fittings will infringe into the interior of the container and limit its inside usable height. Some special design should be looked after to limit this effect as far as possible.

If the container has to be designed to be operated in 4-6 high stack in sea transport, this would result in very heavy stacking forces to be accommodated in its construction. Normally, these vertical forces have to conducted through re-inforced parts of the side-walls at 4o ft. distance. This is not only a cumbrsome (and consequently costly) design; it might as well lead to a side-wall thickness in these areas that abuses all inside clearance for palletisation that has been achieved through the 2550 mm width concept.

The other question concerns corner fitting location: They can either have a rather symmetric inside location, each top corner fitting of a 13 600 mm European loading unit being 700 mm inside, or one pair of top corner fittings can be at the corner of the box and the other pair 1400 mm inside. This question has to be carefully considered from a viewpoint of container design and of container transfer operation.

Terminal experts point out that a rather symmetrical location of the corner fittings at 40 ft. distance is a paramount issue of handling safety, so that this concept will be preferable.

The bottom corner fittings at a class A unit shall be similarly as those of the class C unit mainly designed to take in the twist locks of rail and road vehicles and to take over forces generated through road and rail movement. It might be rather difficult to design such corner fittings for lifting purposes taking into account the bending forces that will be introduced into the container during such an operation.

Recommendation:
The European loading unit shall be equipped with top corner fittings. Such fittings shall be designed compatible to ISO 1161. The fittings on top of a class A unit shall be a 8 ft. width and 40 ft. length distance and preferably symmetrically located inside the frame, the fittings on a class C unit shall be at 8 ft. width and 7450 mm length distance and integrated into the corner posts. The European loading unit shall have bottom corner fittings at 8 ft. width and 40 ft. length (class A) and 20 ft. length (class C). The bottom fittings must not be designed to take over lifting forces. The underside of the unit must be equipped with reinforced load transfer zones at the same dimensional location as the top fittings.

3.2.2 Grappler arm recess

Most European swap bodies are lifted by means of grappler arm lifting devices that meet the swap body at a grappler arm recess built into the bottom construction. A similar grappler arm recess is foreseen in semi-trailers prepared for vertical transfer.

If a European loading unit is equipped with both, top corner fittings and grappler arm recess, terminals will prefer to use the top corner fitting for spreader lifting rather than the grappler arm equipment, because the lifting by spreader and corner fitting is normally quicker and more safe than the lifting by grappler arms. So, it might be easily considered to drop the need for grappler arm recess once the European loading unit is equipped with top corner fittings.

This does, of course, not remove the need to have dual mode lifting equipment in European terminals with spreaders and with grappler arm devices. Whatever success a possible European loading unit without grappler arm recess might have, the current more than 150 000 swap bodies will continue to be in intermodal transport operation, and a semi-trailer continues to offer only grappler arm lifting capability.

Recommendation:
Once the European loading unit is equipped with top corner fittings for lifting, grappler arm recess in addition to that is not needed.

3.2.3 Fork lift pockets

Many containers are equipped with fork lift pockets. This enables operators to use rather cheap terminal equipment to move such units, mainly when they are empty. This is especially true for repair shops and for depots that handle only empty units.

ISO has recognised the need for fork lift pockets with 20 ft. ISO series 1 containers. But ISO TC 104 experts have considered that a fork lift pocket on the large 40 ft. units might invite for dangerous handling and therefore such fork lift pockets shall not be foreseen by the manufacturer. Some major users of ISO containers ignore these considerations and order their 40 ft. ISO containers "with fork lift pockets".

We suggest to follow the safety considerations of ISO TC 104 and specify the small European loading unit Class C with "fork lift pockets as an optional feature", and class A "no fork lift pockets to be provided".

Recommendation:
The small European loading unit Class C shall foresee fork lift pockets as an optional feature, and class A shall not be provided with fork lift pockets.

3.3 Strength requirements

3.3.1 Side wall strength

The side wall must withstand the forces of all modes that the European loading unit is operated in.

We foresee this unit for road, rail, inland waterway and short sea shipping. While road, rail and inland waterway operations introduce only limited forces from the cargo into the side walls, short sea shipping might create similar forces as deep sea shipping. As many European short sea corridors lead over waters where often very heavy weather occurs, and as schedule reliability is a key factor in typical European short sea operations (so that the captain of the ship cannot wait for calm sea before leaving the port), a unit in European short sea operation must be designed to withstand forces created by similar movements as occur in deep sea transport. Insofar, they need a similar side wall strength as ISO containers.

On the other hand, a major European manufacturer of stackable European loading units often operated in sea transport has reported, that according to his experience the container does not need full ISO side wall strength but a less strong design.

Recommendation:
The European loading unit shall be equipped with side walls offering the same strength capability as those of ISO series 1 containers. Further enquiries must ascertain whether possibly a lower value might render sufficient strength.

3.3.2 End wall and end door strength

Whatever has been stated for side walls is, as well, true for end walls and end doors. Insofar, end walls and doors must show similar strength values as those of ISO series 1 containers.

Recommendation:
The European loading unit shall be equipped with end walls and end doors offering the same strength capability as those of ISO series 1 containers.

3.3.3 Stacking capability

The stacking capability of a European loading unit must refer to the various situations in which such a unit will be operated.

In road transport, no stacking will be applied.

In rail transport, no stacking will be applied. Rail transport in double stack seems not to be possible under commercial considerations with European rail operation (details given in chapter 5).

In inland waterway transport, stacking is a normal feature. Stacks on Rhine barges are up to 4 layers high. Given the slow motion of inland waterway barges, no acceleration forces have to be added to the value of the overstacked mass when calculating the stacking capability.

In current short sea transport using Ro-Ro ships, stacking in 2 layers on a low bed trailer is normal operation. The stack on board ship has to consider an additional vertical acceleration force introduced by the ship motion. These additional vertical forces may go up to 0,8 g.

In short sea transport on board of cellular type ships, the stacking values will vary according to the ship design. Deep sea ships operate container stacks of 6 layers and partly even for 9 layers), and short sea cellular ships might be designed to similar loading height. An additional force created by vertical acceleration through ship motion must be added, this additional value being 0,8 g.

On intermodal transport terminals laden units will be seldom stacked more than 3 or 4 layers high. A small acceleration might be added if a loaded container is dropped on top of a stack. Generally speaking, the stacking capability of a European loading unit will improve the economy of intermodal transport terminals by offering more flexibility in handling organisation and better land use, especially with interim storage of units.

Summing up: Stacking capability is advantageous in terminal operation and in Ro-Ro ship loading. Stacking capability is compulsory in efficient inland waterway operation and in short sea transport using cellular type ships. Insofar, stacking capability must be a feature of the European loading unit. Handling of intermodal loading units in stack can often be not performed by use of grappler arm lifting equipment, so that a European loading unit with stacking capability must be equipped with top corner fitting for spreader handling.

The 7450 mm long European loading unit will have to bear the vertical forces of the stack mainly through its corner posts. This is a considerable strong part of the construction, and full ISO stacking load should not create too much additional tare weight for reinforcement.

As long as the 13600 mm long European loading unit has its top corner fittings inside at 40 ft. position, and as long as the main vertical forces are pressing onto these corner fittings and have to be conducted through them into the side wall, a full ISO stacking load design would need reinforced side walls; this design could create prohibitive additional costs and tare weight, and could give the need that the reinforced side walls protrude into the inside of the loading unit reducing the inside width clearance. Insofar, great care has to be taken for a compromise between stacking capability and design of the unit especially to take into account the need to operate such loading units on cellular type ships on longer European sea voyages such as voyages from North Europe into the Mediterranean Sea. Possibly, engineers will find a solution that combines high stacking capability with low tare.

Recommendation:

The European loading unit must be designed as a stackable unit with top corner fittings. The minimum stacking capability must be at 4 layers without additional vertical acceleration. This includes a capability of 2 layers with additional vertical acceleration of 0,8 g. Full ISO series 1 container stacking capability will be advantageous and can be easily realised with 7450 mm loading units. For 13600 mm long loading units, an acceptable compromise between stacking capability and acceptable tare has to be found.

3.3.4 Racking capability

Racking forces are mainly introduced into a container when it is moved in a stack and external forces act upon it e. g. a ship rolling. The racking force is greater on those containers that form the bottom layers of a stack that is subject to the external motion. The magnitude of the racking force will depend upon:

- the height of the stack,
- the mass of the units in the upper layers of the stack,
- the speed and intensity of motion of the vehicle carrying the stack.

A European loading unit will be carried in stack on board of

- an inland waterway vessel in maximum 4 layers, but without any heavy vehicle motion,
- a short sea Ro-Ro ship in 2 layers, with heavy motion in rough sea,
- a short sea cellular ship as a deck load in 3 layers, with heavy motion in rough sea areas.

R**ecommendation:**

A European loading unit must be designed to withstand limited racking forces if moved only on Ro-Ro ships. If such units will be carried in stack on deck of short sea ships, a racking capability up to that of ISO series 1 containers is needed.

3.3.5 Floor strength

ISO TC 104 has foreseen in ISO 1496 a floor strength for its containers that enable the containers to withstand the forces introduced by a fork lift truck with full load diving into the box during loading and discharge operation.
CEN TC 119 has foreseen in EN 283 a somewhat less floor strength. Manufacturers report that many clients order their swap bodies with "full ISO floor strength". Therefore, it may be questioned if the lower value as given in EN 283 really covers the needs of the market.

As a future European loading unit will be operated in marine environment as well, and as the actors in this field may assume automatically ISO floor strength, it might be advisable to foresee full ISO floor strength for such units.

Recommendation:
The European loading unit shall have the same floor strength as that of ISO containers, specified in ISO 1496.

3.3.6 Roof strength

The relevant standards foresee a minimum roof strength (if a roof is provided) to allow a man walking on the roof without breaking through the roof. Furthermore, doubler plates are foreseen in the area of the apertures of the top corner fittings to shelter the roof construction against eventually mis-guided spreaders coming down, and otherwise punching a hole into the roof by their twist locks.

Similar features make sense with a European loading unit.

Recommendation:
The European loading unit shall have the same roof strength as that of ISO containers, specified in ISO 1496.

3.4 Marking requirements

Currently, various marking concepts for containers and swap bodies are in operation The main concepts are

- ISO 6346, to be applied generally for all containers, parts of the concept reserved for full strength ISO series 1 containers only;
- UIC 596-6 prescribing a yellow approval plate for all swap bodies for road-rail transport in Europe; this approval plate consist of coded data giving the swap body dimension, further coded data indicating the approving agency, and an individual number of the unit;
- prEN 13044 which establishes a new marking concept for swap bodies, partly based on the concept of ISO 6346, partly based on special European needs;
- The International Convention on Safe Containers (CSC) prescribed a Safety Approval Plate as a compulsory marking on all containers, while the member states of the European Union have agreed not to apply this regime to European swap bodies which are not stackable and not equipped with top corner fittings.

At this stage of the work, it seems like that the new European Standard on marking of European units will be widely accepted and applied.

This new standard EN 13044 (see chapter 1.2.2) takes full regard of current and future European load units. It is elaborated to be as near to the ISO 6346 standard as possible. Therefore, it should be easily fit for the marking of the future European loading unit as well, when it is once accepted.

The exemption from the provisions of CSC installed for European swap bodies does no longer concern to the units specified here. Insofar, the European loading unit has to undergo the approval procedures of CSC and be marked accordingly. The strength requirements as discussed in chapter 4.3 cover all relevant requirements of CSC as well.

Recommendation:
It is recommended to mark the European loading unit according of the provisions of prEN 13044.
It has to be noted that the European loading unit has to be approved under the CSC Convention and be equipped with a CSC approval plate.

4. CONCLUSIONS AND RECOMMENDATIONS.

4.1 Recommendations for the design of a future European loading unit

Under current road vehicle dimensions related legislation, the study expert team recommends a class A European loading unit with 13 600 mm length and a class C European loading unit with 7 450 mm length and a width of 2550 mm.

An outside height of 2900 mm for the European loading unit is recommended. Increasing demand for special European loading units offering an inside loading height of 3000 mm can be foreseen and may have to be accommodated in standardisation in future.

The expert team recommends to foresee the following gross weights (masses) for the European loading units: The 13600 mm long unit shall be designed to a maximum gross weight of 32,5 t, the 7450 mm long unit shall be designed to a gross weight (mass) of 16 t, and specific heavy duty loading units of 7450 mm length can be designed with a gross weight (mass) up to 32,5 t.

The European loading unit shall be equipped with top corner fittings. Such fittings shall be designed compatible to ISO 1161. The fittings on top of a class A unit shall be a 8 ft. width and 40 ft. length distance and preferably symmetrically located inside the frame, the fittings on a class C unit shall be at 8 ft. width and 7450 mm length distance and integrated into the corner posts. The European loading unit shall have bottom corner fittings at 8 ft. width and 40 ft. length (class A) and 20 ft. length (class C). The bottom fittings must not be designed to take over lifting forces. The underside of the unit must be equipped with reinforced load transfer zones at the same dimensional location as the top fittings.

Once the European loading unit is equipped with top corner fittings for lifting, grappler arm recess in addition to that is not needed.

The small European loading unit Class C shall foresee fork lift pockets as an optional feature, and class A shall not be provided with fork lift pockets.

The European loading unit shall be equipped with side walls offering the same strength capability as those of ISO series 1 containers. Further enquiries must ascertain whether possibly a lower value might render sufficient strength.

The European loading unit shall be equipped with end walls and end doors offering the same strength capability as those of ISO series 1 containers.

The European loading unit must be designed as a stackable unit with top corner fittings. The minimum stacking capability must be at 4 layers without additional vertical acceleration. This includes a capability of 2 layers with additional vertical acceleration of 0,8 g. Full ISO series 1 container stacking capability will be advantageous and can be easily realised with 7450 mm loading units. For 13600 mm long loading units, an acceptable compromise between stacking capability and acceptable tare has to be found.

A European loading unit must be designed to withstand limited racking forces if moved only on Ro-Ro ships. If such units will be carried in stack on deck of short sea ships, a racking capability up to that of ISO series 1 containers is needed.

The European loading unit shall have the same floor strength as that of ISO containers, specified in ISO 1496.

The European loading unit shall have the same roof strength as that of ISO containers, specified in ISO 1496.

It is recommended to mark the European loading unit according of the provisions of prEN 13044.

It has to be noted that the European loading unit has to be approved under the CSC Convention and be equipped with a CSC approval plate.

4.2 Conclusions

4.2.1 Recommendations to European Transport Policy

Keep the legal framework on dimensions of road vehicles stable

As road and rail have different investment cycles, European combined transport operators have a paramount interest in stability of current regulations of dimensions of road vehicles.

UIRR operators and the International Associations of rail and road operators such as UIC and IRU do not favour a 15 m semi-trailer length.

Promote the evolution of road transport rolling stock towards a combination of pallet wide stackable freight container + platform chassis configuration

The current habit to operate rigid built semi-trailers in European long distance transport has to be replaced by a policy investing in 2 pallet wide stackable freight containers and platform semi-trailers. Such containers are a necessary pre-requisite for competitive intermodality in Europe. By this operation, rail and waterborne transport can become more competitive against road transport in Europe.

The European container can be operated:

- on platform railcars of current technologies on practically all rail networks in Europe (except some lines in Great Britain),
- in inland waterway on the Rhine, the Danube and some coastal waterways in Netherlands and Belgium in stacks of 4 layers, on most other waterways such as the Central European canal network in 2 layers,
- on European sea routes with Ro/Ro ships in double stack with considerably increased space utilisation and economic benefit,
- on European sea routes in cellular ships with specifically adapted cell structure in stack,
- on current road transport platform chassis.

Compared to this intermodal quality of containers, current semi-trailers show poor performance in many road/rail and Ro/Ro operations and even poorer performance on inland waterway barges and cellular ships. Swap bodies as used today, i. e. non stackable units, also show poor performance in inland waterway transport and European sea transport.

To foster a development towards increased use of stackable European loading units in place of semi-trailers in European trade, the European Commission is invited

- to pursue the introduction of a 44 t maximum weight allowance for road vehicles operating in intermodal transport to compensate for the extra tare weight included in this configuration,
- to promote the standardisation of a European loading unit that fits on a 13,6 m European articulated road vehicle and offers a competitive alternative to the rigid built semi-trailer,
- to consider further incentive schemes, such as tax incentives, exemptions from driving bans, to promote this development on national or European basis,
- to organise further consultation between standardisation experts and operators of inland waterway and short sea cellular ships, regarding the exact width choice of the future unit in the range between 2,52 and 2,55 m. However, as currently inland waterway transport ships are only loaded 60 % to 70 %, they can take a load mix with some 25-30 % share of wider European loading units without significant additional costs. PACT should support pilot projects in the form of new services using these units, provided the other selection criteria are fulfilled.

Once a CEN standard for loading units fitting the above requirements has been decided, the Commission is invited to propose a Council resolution to endorse it and stress that governments should only procure and support such units.

The European loading units shall have a length of 13600 mm (class A) and of 7450 mm (class C), a width of 2550 mm, a height of 2900 mm and a stackability that should try to ascertain transport in at least 4 high stack under sea transport conditions.

44 t maximum gross weight in road transport must be allowed in intermodal transport operations

As any combination of container + platform chassis will result in more tare weight than a rigid built semi-trailer of similar capacity, intermodal transport needs to be compensated for this additional tare weight.

The European Commission is invited to renew their efforts in a European legislation that allows 44 t maximum gross weight for intermodal transport loading units when carried in pick-up and delivery operation before or after a main run on rail or water mode in Europe.

Concerns that have been offered recently can be answered by detailed explanations:

- that such a regime is already in place for 40 ft. containers,
- that such a regime is needed for improved competitiveness of intermodal transport in Europe,
- that this regime has been applied successfully in some European countries, and that these countries have had good experience with the necessary surveillance regime avoiding too much bureaucracy but preventing fraudulent application of these rules.

4.2.2 Recommendation towards European Standardisation Policy

Standardisation of a stackable European loading unit of 13,6 m length must be promoted.

As the 13,6 m long semi-trailer is the most important cargo carrying unit in European trade, a stackable loading unit of this size is urgently needed to include European railways with limited gauge, inland waterway transport and short sea transport into intermodal transport.

Currently CEN TC 119 Swap bodies for combined transport has successfully prepared the standard on a 7,45 m stackable loading unit, but the work for a standard on a 13,6 m unit is urgent but has not yet started.

Standardisation in CEN TC 119 is based on voluntary European co-operation and the experts are not paid for their contributions. As the European manufacturers of swap bodies have only limited interests in such a development, the future of standardisation work in that field , when based on voluntary work only, will only move forward in slow speed. The standardisation work can be greatly accelerated if CEN sets up, in close conjunction with the European Commission, a selected experts team, paid with a normal commercial salary for their effort, with the clear task to draw up the necessary draft standard documents in a given short time period.

The instrument of speeding up European standardisation by promotion through the European Commission has been successfully applied in many cases, and should be seriously considered in case of a stackable European loading unit of 13,6 m length as well.

4.2.3 Recommendation towards European Research

Demonstration projects should be made eligible under the 5th framework program once a CEN standard for loading units has been decided.

European research shall look after the development of European inland waterway transport barges that can accommodate 4 rows of European loading units side by side.

Barges that can accommodate 4 rows of European loading units side by side and keep the maximum width (currently 11,45 m) for operation in Central European inland waterways are currently technically not possible. As most Central European inland waterways are equipped with locks of nominal 12 m width allowing only the passage of barges up to 11,45 m width, a barge design that offers an inside clearance of some 10,5 m to accommodate 4 rows of European loading units with 2,55 m width each of them side by side plus the necessary tolerance can greatly improve the economics of inland waterway transport in Europe. Various concepts have been suggested to overcome this problem, and European research is invited to take over this question in research, prototype development and pilot operation.

European research shall look after the development of European railcars with platform height of 800 - 900 mm above rail and sufficient cargo carrying capability.

The development of European railcars with platform height of 800 - 900 mm above rail and sufficient cargo carrying capability will lead to the development of increased axle loads with small diameter wheels. Such small wheels can be used today, but only with reduced axle loads that might infringe the payload of the railcar.

While a 2900 mm high European loading unit can be carried on most parts of the European rail network without too serious gauge problems, European intermodal transport is meanwhile faced with the need to operate units with an inside height of 3000 mm resulting in an outside height of 3150 mm. Such demands come currently from the European automobile industry which is a major client in intermodal transport. A loading unit with a height of 3150 mm would need a platform railcar with low diameter wheels which will lead to limited load carrying capability. Research can contribute to find technical solutions that offer a low platform railcar with sufficient payload for European intermodal transport.

European research in technical, commercial and economic patterns of European short sea transport with a view to optimise transport conditions for future European loading units shall be intensified.

This research must aim at a technical development to improve inter-operability and cover items such as:

- flexible cellular systems,
- ship design in general,
- ship propulsion systems,
- sea terminal optimisation, especially in ro/ro operation of stackable loading units,
- specific design and operation concepts for tri-modal terminals connecting road, rail and inland waterway transport,
- information flow in intermodal road-rail-sea transport systems such as already initiated in the European research projects APRICOT and MARTRANS.

The inclusion of small European short sea carriers into harmonised EDI and Internet systems for communication between ocean carrier, terminal operator and forwarder shall be promoted by pilot projects.

While communication using harmonised EDI systems, partly via Internet and partly via current added value services, is state of the art for larger ocean carriers, many of the smaller shipping companies that operate in European short sea traffic have not realised such systems. On the other hand, a harmonised information system will greatly reduce commercial transaction costs, speed up communication between the partners and assist to achieve high quality services. A close look must be taken on the current patterns of such small ocean carriers to determine the reasons why they did not realise such systems up to now and how to promote the use of them in the future.

ANNEXE 1

STANDARDISATION OF COMBINED TRANSPORT LOADING UNITS AND OPERATION RELATED DATA MANAGEMENT

A.1 GENERAL

Intermodal transport is a specific operation with many actors working together. This needs not only standardisation of the physical interfaces, but also harmonisation and organisation of data flow and communication.

If several parties wish to exchange data successfully, they have to agree on

- a common semantic: each word /data element must be defined so that each party understands a similar interpretation to this specific expression;
- a common grammar that describes the function of each data element in a wider context; e. g. the first date shown in a message is the date that describes when the message had been dispatched;
- a common message description that shows which facts in which sequence have to appear in a message so that it can be used for an un-ambiguous commercial transaction;
- A common protocol that regulates the formalities of message exchange, i. e. through which communication channels a message is transferred, how the transfer of a message is announced, and how the correct reception of a message is confirmed.

All these details of communication have to be agreed on between co-operating partners independent of whether the communication is executed

- by telephone call,
- by letter mail,
- by fax transmission,
- by electronic data interchange.

Electronic data interchange needs a higher degree of commonality in detail because the computer normally does not understand data elements that are „almost“ correct while human actors often can assume the right interpretation.

Any common approach to such harmonised communication can be agreed on bilateral or multi-lateral. Intermodal transport shows numerous examples of these agreements.

Multi-lateral agreements are normally achieved through standardisation of data communication. Such standardisation activities are carried out in the world of intermodal transport mainly by

- standardisation bodies such as ISO,
- electronic data interchange harmonisation bodies such as the EDIFACT Board,
- International Trade Associations such as ICS, IICL, UIRR, Interunit, UIC.

Currently, data interchange standardisation in intermodal transport is carried out in two worlds:

- in intermodal transport road/rail through UIRR, Interunit, UIC,
- in intermodal transport in marine mode using ISO containers through ISO standardisation in conjunction with some fringe regulations elaborated by International Chamber of Shipping (ICS) and International Institute of Container Leasing Companies (IICL).

Both worlds use, at least partly, electronic data interchange standards created by the EDIFACT Board.

In general, all regulations and standards developed by such umbrella organisations compete in application with a wide variety of individually agreed solutions. A survey of applications currently in service is contained in the publication ***„Electronic Commerce and container shipping“, compiled by Cargo Systems, London***.

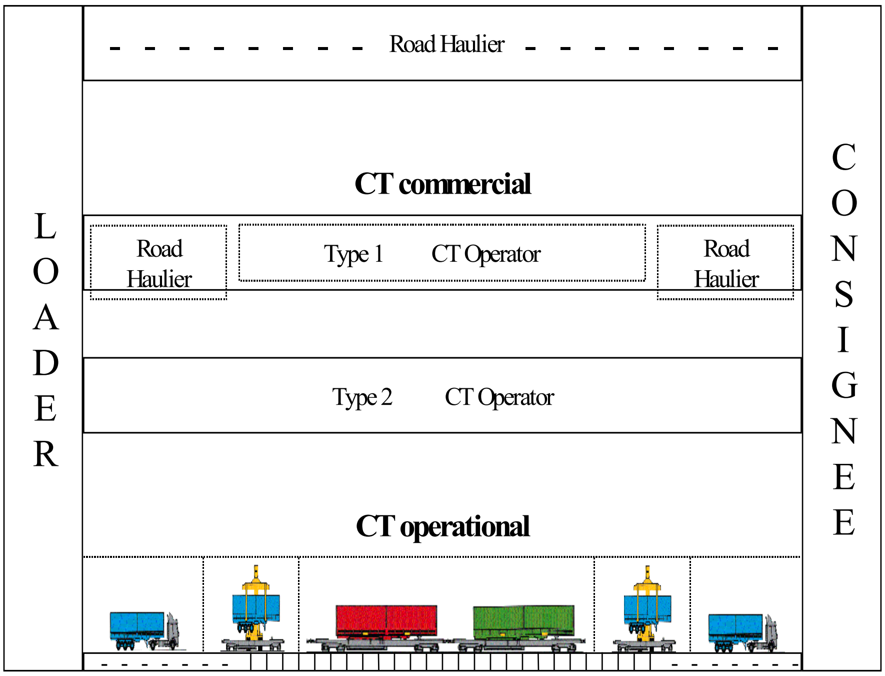
A.2 ELECTRONIC DATA INTERCHANGE PROPRIETY CODES AND STANDARDS IN COMBINED TRANSPORT ROAD/RAIL

A.2.1 Introduction: EDI propriety codes and standards in combined transport

This chapter gives an overview on EDI codes and standards which were developed and are used by the operators with main activity in the combined road-rail transport of continental units (swap-bodies and trailers as well as complete trucks).

Compared to road haulage, where the transport company is providing the door-to-door transport, the communication in combined transport chains is different. The first type, where the combined transport is organised in co-operation between (road) transport companies and combined transport operators is the most successful variant, being offered by the UIRR companies. (UIRR = International Union of Combined Road-Rail Transport Companies).

Organisation patterns of combined transport



Whereas in pure road transport the driver may continuously observe the merchandise and report on status requests by mobile phone, for the railway part this has to be organised by the operator who has to support their clients with communication systems.

The combined transport chain requires activity in three fields of communication:
1. Communication between operators and railways (railway traction and network providers),
2. Communication between combined transport operators, in international traffic it is usual that two or more operators are collaborating,
3. Communication between operators and clients (logistic companies).

A.2.2 The actors

EDI and telecommunication is one of the fields where the collaboration of operators and between operators and railways requires harmonisation and where in the last decade industry standards have been developed. The institutions related with this work are:

UIC	Union International des Chemins de Fer, Paris
UIRR s.c.	Union Internationale des sociétés de transport combiné Rail-Route, Brussels
Interunit	Joint association of the UIRR companies and their related railway-partners.

UIC

The UIC was founded in 1922, with the aim of creating uniform conditions for the establishment and operation of railways. Today it is the world-wide organisation for co-operation among railway companies. Its activities encompass all fields related to the development of rail transport. The role of UIC is to promote co-operation between railway enterprises at world level and to carry out activities to develop international transport by rail.

The UIC's tasks include preparing standards, regulations and recommendations to facilitate international traffic.

At the beginning of 1999, the UIC had a total of 142 members, from all five continents.

UIRR

The International Union of combined Road-Rail transport companies was founded in 1970. Nineteen operators who are mainly run by their own clients are members of UIRR. International traffic is always organised by the two or three companies concerned on a specific axis. This means that all operative work and most commercial business is completely decentralised and service is very closely customer-oriented. On the European level the

UIRR members are co-ordinating and harmonising their work in working groups and this might include the creation of industry standards in some cases.

Interunit

Interunit is the joint association of the UIRR companies and their related railway- partners. Presidency is alternating between UIRR and UIC's working group on combined transport. Interunit consists of a number of partly ad hoc working groups. A high level liaison committee is instituted once or twice a year to treat important subjects or to propose solutions to current conflicts. The work of the Technical Commission is especially important. In the Technical Commission, questions of common interest for the development of technical standards are discussed and prepared. The results are recommendations for decisions or standardisation work mainly in UIC.

A.2.3 Communication between operators and railways

All issues, directly related to specific railway safety have been treated up to now by UIC who has developed various standards in the UIC leaflets. Today more and more of the European standardisation work is carried out in CEN. One of the standards containing important codes for EDI and telecommunication in combined transport is the UIC leaflet 596-6 concerning the codification of loading units. (Leaflet title: "Conveyance of road vehicles on wagons – Technical organisation – Conditions for coding combined transport load units and combined transport lines.")
Annexe 8 contains a two digit **"nationality code for railways and combined transport companies"** which appears in the codification number of the "yellow plate", determining the dimensions of the loading units, which is also used on other occasions such as to control wether the loading unit fits into the gauge line of the railway concerned.

Facing the railway reform the two digit code will not be sufficient to cover all future railway undertakings and combined transport operators in Europe and has to be enlarged and changed into a country code and an operator code. In parallel, CEN Technical Committee is preparing (with the assistance of the European Commission in its PACT project scheme) the European standard prEN 13044 which offers a new system of identity allocation for swap bodies which partly replaces these codes. While this CEN standard system is expected to be applied in parallel to the current UIC system, experts expect that eventually the CEN system will be the only identity code system to survive.

UIC is also managing a code of locations, consisting of a two digit nationality code for the railways, a 5 digit code for the sites and one control-bit. The combined transport terminals are a subset of this code.

A.2.4 Communication between operators

All full members of UIRR co-operate with their foreign partner companies to organise international traffic. They have created a **UIRR data-message** which enables the electronic transfer of the transport data required for the transport contract: Especially all data necessary for the CIM contract for railway transport and a number of additional data, required only from the corresponding UIRR partner. The UIRR data-message has been used for about a decade and has proved its success as an European industry standard in a restricted area (data transfer between combined transport operators, members of UIRR).

The UIRR data-message has a flexible design containing 14 records with a number of mandatory and facultative fields inside the records. Actually eight codes are used inside the message. The whole description of this propriety data-message which is managed by the Swiss company Hupac in co-operation with the UIRR link office in Brussels consist of about 50 pages.

The UIRR data-message was initially transferred by modem and telephone lines then by the X-25 protocol. The future transmission will probably be by Internet and via ISDN connection.

To minimise bits within the data transmission, UIRR companies use a number of codes within the data message. Ten years ago, when data transmission was slow and expensive, the UIRR companies put special emphasis to reduce the amount of data. For this reason UIRR created their own three digit **terminal code** instead of using the eight digit UIC location code. The terminal code was initially managed by the UIRR member Novatrans and after the transformation of the association UIRR to the UIRR co-operative company with an own staff, the link office in Brussels took over this task. With the increase of member operators and traffic volume, the three digit terminal-code is today nearly saturated. The UIC code was evaluated for use instead, but tests showed that this code is not believed to be unequivocal and flexible enough by all railways, so that UIRR is currently searching for a solution to cover their needs. (Currently investigated solutions: UIRR code alphanumeric instead of numeric, enlargement of the UIRR terminal code by a two digit country code from 3 to 5 digits, or use of UIC code with internal UIRR annex of 2 digits.)

The second and most important code managed by UIRR in Brussels is the **customer code**. For all regular clients of UIRR companies a five digit code is attributed. This means the UIRR companies do not have to exchange the names, addresses, telephone and fax-numbers etc. between up to three involved companies per transport: invoice, delivering company and pick-up company this reducing greatly the amount of information transferred. Today the UIRR database contains about 6000 active customer codes.

The customer codes are only used for regular, unaccompanied traffic. As the Rolling Motorway technique, just like Ro-Ro ship ferries, may accommodate a large number of occasional clients, this traffic is commercially and electronically treated in a different way.

Besides the two main codes within the UIRR data-message, the terminal code and the customer code, some propriety codes of minor importance are used, for example a code for the length classes of loading units (Interunit code), as well as official codes like the ISO country code.

A.2.5 Communication between operators and clients

While initially, each combined transport operator tried to set-up its own system applications, it soon became clear that the costs and scope of the work involved went well beyond the means of a single company. In European combined transport there is a general trend towards a limited number of data processing and telecommunication systems. For instance, Cemat, Trailstar and Novatrans have joined Goal-Online, the computer solution developed by their Swiss colleague, Hupac and which they jointly developed further. On the other hand, the decentralised communication system, Ali-Baba, developed by the German operator, Kombiverkehr, is also used by Bohemiakombi, Combiberia and Swe-Kombi. In both systems a special software was developed to create a customer-operator interface. This is mainly used by big clients. Some companies, like the British CTL and Novatrans have directly developed Internet interfaces, first for information on timetables, later for booking and status messages.

Considerable progress has been made under the CESAR project (Co-operative European System for Advanced Information Redistribution) which is being promoted by the European Commission and the Swiss Federal Office for Education and Science under the 4th framework programme. Working under the management of the UIRR's Brussels office and with the scientific assistance of the Frankfurt-based SGKV, a research body for combined transport, European standards are being developed for customer interfaces in combined transport. With the Internet as the data transmission medium it will allow for all participating operators to receive on-line reservations and for customers to obtain status details. A centralised status monitoring database and common guidelines for ordering shipments via Internet paves the way for combined transport services throughout Europe that will be simple, efficient and uniform, and therefore customer-friendly. In July 1999, the project partners set up a joint CESAR server, (http://www.cesar-online.com) to be managed by a high-capacity Internet provider based in Amsterdam. Initially, all the information on the various consignments of those operators participating in the project, will be exchanged via the central servers containing the common database. If everything goes as planned, all the regular customers of Cemat, Hupac and Kombiverkehr will be able from January 2000 to place orders via the Internet and monitor on-line the progress of all shipments within the areas covered by the three operators. Those currently involved in the CESAR project intend to open up the system to other partners and for new services from the year 2000 and hope that the European Commission will continue to support this activity.

The CESAR system does, at least in ist current state of development, not intend to replace the existing communicatiion ystems of the operators involved. It aims mainly at two levels of harmonisation:

- Combined transport cosignments that run over the networks and services of two or more operators will be monitored in the CESAR system to allow the client direct information rather than asking one opertor after the other about the current tate of his consignment.
- The participating operators plan to offer, in addition ot all well established individual EDI interfaces with their clients, one standard CESAR interface so that a client dealing with various operators can, if he wishes, communicate to all of them through a similar EDI interface.

A.3 STANDARDISATION OF ELECTRONIC DATA INTERCHANGE IN CONTAINER OPERATION

A.3.1 Containers and computers

When considering the transport revolution created by containerisation it is usual to think of big depots full of boxes stacked in multi-layers, of giant quay-side gantry cranes lifting containers aboard ship and block trains moving containers inland. All this hardware certainly has greatly contributed to the success of this new system. But the other part of the development had been a revolution in the treatment of information: container transport has brought computer applications into day to day transport operation.

The quick and highly efficient flow of boxes between depot stack and ship in the port needs computerised planning of all movements, and strict control of each single box. The container people started in 1965 to introduce a marking system that gave an individual character to each box, based on a data element with a unique format. Each single freight container (out of more than 10 million units that exist today) has a unique identity mark, coded in a uniform data element, displayed at a standardised location outside of the container in a standardised form.

The identity code consists of the owner's code, ensured world-wide unique by central administration through Bureau International des Containers, and a 6 numeral current number allocated by the owner or operator. This system has been fixed in International Standard ISO 6346, one of he most successful standardisation documents: Practically every container operator has registered with Bureau International des Containers his owner's code.

All these systems are today administered by computers (BIC registration business as well!). So, the computer has been the other part of the container success.

A.3.2 Information flow new organised

The other important application of new organised information flow has been the habit to pre-announce the arrival of loading units and consignments: All necessary information regarding a container is today sent in electronic speed ahead of the box movement. When the truck with the container moves from the hinterland to the port, a message is transmitted to the receiving end (usually the container terminal) giving container number, actual weight, ship and sailing number for which the container is booked, name and address of the port agent responsible for handling.

Rail operators apply the same organisation. They send a list of containers on a block train en route to the port to the container terminal at latest when the train leaves the inland rail terminal, i. e. about 8 to 12 hours before arrival in the port rail network.

By this set of data the port handling company, i. e. the terminal is able to prepare all necessary documentation and physical activity for the on-carriage of the container. When the container then physically arrives, every necessary preparation activity has been executed already, and the container can, if need be, immediately moved onwards.

On the maritime side of the transport chain similar organisation features are today common: The shipping line sends a complete cargo manifest and a bayplan of a ship's voyage ahead of the ship sailing to the first port of call on the other side of the ocean. Using this information, the liner agent in the import sea port can inform the forwarder of the consignee about the loading unit and the consignments that are due to arrive in some days and get all necessary instruction for the on-carriage: immediate departure inland or departure after some days, carriage by rail or truck or inland waterway. The import forwarder can meanwhile prepare customs clearance. Again, this information flowing ahead of the cargo contributes greatly to a quick container clearance and on-carriage after arrival in the destination port.

In the early days of containerisation, some of these documents had been sent by air mail; so they normally arrived one or two days before the ship. Today, the information is conveyed at electronic speed, in most cases via satellite transmission or through the internet.

A.3.3 Container Repair and Maintenance

International Standardisation Organisation TC 104 SC 4 and the EDIFACT Board have, in close co-operation, developed a system of data elements defining all parts of a container, all repair activities, all repair qualities, all areas (e. g. on the container side wall) that might come out of repair, all types of damages etc. This has been laid down in International Standard ISO 9897 CEDEX (Container and Equipment Data EXchange). Furthermore, a set of messages has been developed that is based on these data elements and covers the various commercial activities of a repair cycle.

The cycle of messages starts when a surveyor acting for a leasing company, an ocean carrier or for an insurance company, surveys a damaged container and creates a „damage report“. This damage report is organised as an EDIFACT message („DESTIM“) and transferred from computer to computer per EDI to the container owner and stored in his data bank. The message contains information such as

- container identity (BIC Owner's code and container number including check digit),
- container type and size code (ISO 6346),
- type of damage,
- definition of the part damaged, and if needed of the location of the damage,
- name and address of the party that is supposed to be liable for the damage and that will be invoiced once the damage is corrected,
- corrective action needed,

- information whether the container has immediately to go to repair or whether this damage can be corrected later within a major container maintenance action.

Containers are not necessarily repaired immediately after each minor damage. This would be too costly, as containers often have minor damages that do not render them improper for commercial use. Normally, such minor damages are described and stored together with the name and address of that party that is responsible for the damage and that has to meet the repair bill in a special file. If the container has been badly damaged, or when it is due for a major refurbishment, such minor damages will be corrected and the total bill will be split into parts for each party that has been held responsible for a part of the repair work.

This data set is attached to the container data set and migrates together with the container from party to party. Everybody taking over a container from a third party can have a look into this data file and ascertain which of the damages have been already been reported so he will not be made responsible for them.

When the container goes to a repair shop, all these data sets are available in the data bank of the container owner. Now the container owner can attach the price list containing repair action prices set up by the local contract repairer to this data set. The price list is built up using the same data elements as DESTIM. So the computer can automatically calculate the repair bill to be expected for each container.

The computer generates another EDIFACT message, the repair order, and transmits it per EDI to the repair shop. This order contains all data of DESTIM, possibly in multiple sets if several damages have to be removed.

After the repair has been executed, the repair shop will send - again per EDI - a repair invoice to the container owner, using an EDIFACT message format together with the data elements as standardised in ISO 9897. The computer in the container owner's headquarters will receive the invoice and acknowledge it. Those parts of the repair invoice that are based on damages created by third parties will be forwarded to them.

The total information cycle, starting with the notification of a damage, until the payment of the repair bill and the establishment of the related statistics and business reporting, can run almost automatically without anybody interfering. This gives to the officers of the container owner company at decision level time and opportunity to select those cases that need more detailed observation and improves the quality of decision.

All this is based on the work of some standardisation experts who decided in the late 1980s to establish such a system and to elaborate the necessary data element dictionary and message set. The main work has been done in ISO Technical Committee 104 Sub-Committee 4 Freight containers - Marking, Identification, Communication. A specific working group on the standard 9897 CEDEX („Container and Equipment Data EXchange“) is continuously upgrading and enlarging the list of data elements to enlarge the use of this standard EDI message cycle to further application areas. Additional data elements for container chassis and some special containers (such as thermal containers and tank containers) are currently being added to the list.

Not all major container owners use this system. Some large ocean carriers (such as Maersk or Hapag-Lloyd) had developed in-house systems for similar purposes prior to the standardisation results and continue to use them today, while all those parties establishing new systems make use of the standard solution based on ISO 9897 CEDEX. Some of these users add small individual components to the standard.

Large size repair shops normally have conversion software so that they can communicate per electronic data interchange with those parties using CEDEX and with those who use individual designed communication systems.

A.3.4 Electronic data interchange messages for container handling

A well developed system of communication specifically between sea port terminals and ocean carriers based on standard EDI, mainly EDIDACT, has been established. Three types of communication functions are covered by such EDI/EDIFACT messages:

1. Messages moving ahead of a container operation informing the parties forward in the transport chain about details of the container due to arrive at their premises, telling these parties what has to be done once the container has arrived.
2. Messages following such a container related operation reporting what has been done, especially whether all orders received could be executed, or - if not - what has been done otherwise.
3. Messages concerning the operation of the ship that carries the containers.

The container identity number, a standardised data element (ISO 6346), will be used as a „common access reference“ to combine data about the container, the cargo loaded in it, and the operation to be executed.

Specifically the communication flow between ocean carrier and sea port terminal is based on EDI solutions, many of them using EDIFACT messages. Such messages are, one after the other, developed, tested and finally introduced in commercial communication. All this work is currently (1998/1999) under further progress; the following list may not be complete, or some messages may receive new code names.

Messages ordering a container related activity

COPARN Container announcement
COPRAR order to transfer a container on board/off board of a ship (loading/dis-charge order)
MOVINS Stowage instruction

Messages reporting that a container related activity has been executed

COARRI Confirmation that the container has been loaded on board ship/ unloaded off board ship

TPFREP Terminal performance report

CODECO Gate in/out message

Further messages exist concerning the ship operation. Most of these messages are related to ship's management and similar technical details. As far as container ships are concerned, some special EDIFACT messages are underway.

CALINF announcing that a certain ship will arrive

VESDEP reporting that a ship has departed

The most important information for the receiving sea-port terminal is BAPLIE, the electronic bayplan of a container ship. In this plan, all rows, tiers and bays of the ship are described in detail giving information of any specific container on board with all individual data the arrival sea port terminal must know, such as

- container identity (BIC owner's code + individual number + check digit),
- port of loading and port of discharge of this specific container (a container from New York to Bremerhaven will have the international agreed coded abbreviations, USNYC/DEBRV),
- container type and size code according to ISO 6346,
- actual container gross mass,
- eventual oversize of the container,
- coded information about the on-carriage of the container (if already known),
- coded information about eventual hazardous goods loaded, in most cases IMDG code number of the cargo item.

This message is created by the computer of the port terminal of dispatch, and it is transmitted directly into the computer of the terminal at the receiving end. The computer in the arrival port removes from the bayplan all containers that have been discharged, and adds all containers loaded, then it will transmit this up-dated bayplan as an EDIFACT message to the next port of call of the ship.

Such an EDIFACT bayplan message might show the following data

container information	**data segments *(explanation)***
stowage position bay/row/tier	LOC+147+0010214++5´
	location bay 147, row 0010214 etc.
Container number	EQD+CN+HLCU2260003
	equipment details: container number, BIC owner's code for Hapag-Lloyd, check digit
size and type code	+2200
full/empty	+++5`
port of loading	LOC+6+HKHKG
	location dominion of Hong Kong, city of Hong Kong
port of discharge	LOC+83+DEBRV
	location Deutschland, City of Bremerhaven
actual gross weight	MEA+WT++KGM:12000´
	measurement, weight, kilograms 12000
Shipowner	NAD+CA+HLC´
	name & address, Hapag-Lloyd owner's code as given in BIC register
Dimensions (off standard left)	DIM+8+CMT:120´
	dimensions, centimetres, 120 overhang left
cooling temperature	TMP++2+013:CEL´
	temperature in degree Celsius

While communication between large ocean carriers and sea port terminals is, in general, based on EDIFACT standard messages (as far as they have been up to now fully developed and tested), communication with smaller ocean carriers such as European feeder lines has not yet advanced so far. This might be due to the fact that some EDIFACT messages are too complicated and contain too many details, and partly due to the fact that many small shipping companies have not yet developed a computerised administration.

Finally, the container related communication between sea port terminal and the hinterland carriers has to mentioned. Other than in deep sea related transactions - no international agreed communication code is available or in use. EDIFACT offers some message types that refer to these transactions, but the main communication follows an individual design adapted to the specific way the business is executed in the relevant port. So, each port has one (or more) local electronic data interchange solutions, some of them are based on EDIFACT standards. [Such a local message set is described in „Paperless Port Hamburg - User Manual" Eurogate, Hamburg 1996.]

This relates to communication functions such as:

- The ocean carrier tells the terminal that a given container is released, i. e. may leave the terminal and be handed out to an inland carrier.
- The receiver’s forwarder tells the terminal which carrier on which date will take over a container that has arrived (or will shortly arrive) for hinterland transport.
- The terminal is told that customs clearance is completed.
- The terminal is told by the ocean carrier (who has received the booking) or the exporter’s forwarder (who has received the transport order) that a given container is moving towards the port and shall be loaded on a given ship for a given voyage.

In addition, various communication is related to the monitoring of dangerous goods in transport, telling public authorities about the danger approaching, telling the operators and the terminal to prepare adequate precautions etc. This type of communication is greatly complicated by the variety of legal regimes dealing with modal transport of dangerous goods.

The wide variety of individual solutions is partly due to the fact that many European ports have traditionally a different way of doing the business, and a different follow-up of commercial parties involved in the cargo transfer transaction. Possibly, standardisation in electronic data interchange has to follow a step by step approach for many of these transactions.

A.4 FUTURE HARMONISATION NEEDS

While data structure and data flow harmonisation in the field of road-rail combined transport is obviously on a well organised path forward – the CESAR system will be introduced in autumn 1999 and enlarged in fnctinlities and participants over he following years (this activity within CESAR II project), data flow harmonisation in the field of sea port terminal container handling – especially between hinterland carriers and ocean carriers – is yet under-developed.

This is partly due the traditionally different port organisation patterns in each European port, so that any harmonisation has to go forward carefully looking for a way that respects individually grown trade patterns but promotes easy EDI for future efficiency. As regards container handling related messages, many Euroopean ports co-operate already in the development of EDIFACT standard mesages in this field.

Another field of successful action is with the small ocean carriers that operate mainly on Euroopean short sea and coastal trades. These operators have not joined into the port related EDI systems, partly because some of the messages might be too complicated for their limited business scope, partly because they lack organisational background for this work. A Euroopean action in this field, checking the realistic EDI needs of these short sea carriers vis-à-vis their type of operation, and assisting them in establishing modern comminication, could create some benefit in this area.

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