COMPETITIVE AND SUSTAINABLE GROWTH (GROWTH) PROGRAMME

INTERMODAL LOADING UNITS

Working Paper

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Author:	**Studiengemeinschaft für den Kombinierten Verkehr**
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1 INTERMODAL LOADING UNITS USED IN EUROPEAN TRANSPORT MARKET

1.1 Current Situation

In European transport market, there exist various intermodal loading units (ILU). The use of these ILU depends on different factors, e.g. the specific relation served and the transport mode used for this relation.

The most important ILUs in European intermodal transport market are swap-bodies, maritime containers, domestic containers, and semi-trailers.[1] [2]

These ILUs exist in different variations regarding features like construction type (tank, open/closed top, high cube…), dimensions (length, width, height), strength, or stackability. The ILUs can be defined as follows:

1.1.1 Definitions

Maritime containers conform to strength requirements that enable it to be used in a cellular ship for sea transport. Most maritime containers conform to International Standards Organisation (ISO) and are called “ISO Containers”. As a result, there exists a clear number of quite exactly specified types (compared to swap bodies).

Domestic (inland) containers are containers to UIC (International Union of Railways) that can be used in combined transport road/rail. They may differ from ISO containers as to strength and dimensions. It is possible to have land containers with a total weight higher than the maritime.

A **swap body** is an article

- of a permanent character and accordingly strong enough to be suitable for repeated use,
- specially designed as an intermodal equipment to facilitate the carriage of goods mainly by road or rail in land transport, by inland waterway, short sea and ferry traffic, without intermediate reloading,

[1] For accompanied combined transport, road trains, articulated vehicles and single trucks represent the ILUs, but this transport form is not to be observed in this WP.
[2] Of course, pallets are very important loading units. But for today, throughout Europe they represent load platforms put into loading units rather than intermodal loading units.

- fitted with devices permitting its ready handling, particularly its transfer from one mode of transport to another such as corner fittings and grappler arms recess, by vertical transfer,
- designed as to be easy to fill and empty,
- having a length of 6 m or more.

The term swap body includes neither vehicles nor conventional packing. A swap body is typically designed to less strength requirements than ISO container but strong enough to fulfil the demands of intermodal transport.

A **semi-trailer** is a vehicle intended to be coupled to a motor vehicle in such a way that part of it rests on the motor vehicle and a substantial part of its weight and the weight of the load is borne by the motor vehicle. These may have to be specially adapted to be transferred by lift on/lift off in combined transport.

The specific characteristics of these ILUs can be described as follows:

1.1.2 Interior and exterior dimensions

a) Maritime containers (ISO 668 and ISO 1496)

Type	Outer Length (mm)	Outer Width (mm)	Outer Height (mm)	Inner Length (mm)	Inner Width (mm)	Inner Height (mm)
20' ISO - series 1	6.058	2.438	2.438-2.896	5.900	2.340	2.228-2.687
30' ISO - series 1	9.125	2.438	2.438-2.591	8.965	2.330	2.228-2.380
40' ISO - series 1	12.192	2.438	2.438-2.896	12.030	2.330	2.228-2.687

The ISO discussed a second series, which comprised containers of 24' or 49' outer length, with an outer width of 8,5' and a height of 9,5'. But in the end, the series was not accepted. Further, there are sea containers which have an outer length of 45' and an outer width of 8'.

b) Domestic containers (DIN 15190, or UIC 592-2)

Type	Outer Length (mm)	Outer Width (mm)	Outer Height (mm)	Inner Length (mm)	Inner Width (mm)	Inner Height (mm)
20' Domestic	6.058	2.500	2.591	5.900	2.440	2.380
7,15 m Domestic	7.150	2.500	2.600	6.990	2.440	2.500
30' Domestic	9.125	2.500	2.591	8.965	2.440	2.380
40' Domestic	12.192	2.500	2.591-2.896	12.030	2.440	2.380-2.685

It has to be mentioned that there also exist domestic containers for U.S. inland transport (road or combined road-rail). The outer width of these boxes is 8,5', the outer length is 48' or 53', respective.

c) Swap bodies (CEN EN 452 and 284)

Type	A 1219 (mm)	A 1250 (mm)	A 1360 (mm)	C 715 (mm)	C 745 (mm)	C 782 (mm)
Outer Length	12.192	12.500	13.600	7.150	7.450	7.820
Outer Width	2.500 /2.550	2.500 /2.550	2.500 / 2.550	2.500 / 2.550	2.500 / 2.550	2.500 / 2.550
Outer Height	2.670	2.670	2.670	2.670	2.670	2.670

For the recently-build swap bodies, an outer width of 2.550 mm is dominant. Isolated swap bodies built for the transport temperature-sensible goods are allowed to have an outer width of 2.600 mm (if the walls are thicker than 45 mm). The inside dimensions depend very much on the construction scheme of the swap bodies. Generally speaking, 2.550 mm outside-wide units show an inside width of about 2.460-2.480 mm. Units of an outside width of 2.500 mm show an inside width of about 2.420-2.440 mm. According to the European CEN-standards, intermediate solutions are allowed.

There also exists a technical specification of CEN (TS 13853) for a stackable swap body with the outer length 7.450 mm, outer width 2.550 mm and maximum outer height of 2.900 mm.

d) Semi-trailers

The dimensions of semi-trailers mainly depend on legal standards. There is a European consensus about which maximum semi-trailer dimensions have to be accepted throughout Europe. Besides, there is national legislation. The maximum dimensions according to §32 German StVZO are outer width 2.550 mm, maximum overall outer height 4.000 mm, and outer length 12.000 mm from the kingpin to the end plus 2.040 mm radial overhang at the front end (this goes in line with 96/53 EC rule on maximum dimensions). For temperature-isolated vehicles, there is the same exception rule as for the swaps: the maximum outer width is 2.600 mm. The inside dimensions naturally depend on the construction type (box type, soft superstructure with tarpaulines on a skeletal frame).

1.1.3 Tare weight and maximum loading weight

a) Maritime containers (ISO 668 and ISO 1496)

Type	Tare Weight[3]	Maximum Gross Weight
20' ISO - series 1	from about 1,9 t to 2,2 t	24,00 t

[3] average tare weight

30' ISO - series 1	about 2,7 t	25,40 t
40' ISO - series 1	from about 3,5 t to 4,0 t	30,48 t

Special-purpose containers show other values: The non-standardized tank containers, for example, are heavier units while showing the same lengths (20', 30' and 40').

b) Domestic containers (DIN 15190, or UIC 592-2)

Type	Tare weight	Maximum Gross Weight
20' Domestic	about 2,5 t	24,00 t
7,15 m Domestic	about 3,0 t	16,00 t
30' Domestic	Different	25,40 t
40' Domestic	about 3,75 t	30,48 t

The tare of domestic containers usually is a bit higher than the tare of swap bodies of corresponding length. This is because of the stronger structure.

c) Swap Bodies (CEN EN 452 and 284)

Type	A 1219 (mm)	A 1250 (mm)	A 1360 (mm)	C 715 (mm)	C 745 (mm)	C 782 (mm)
Tare weight	ca. 4,1 t	ca. 4,1 t	ca. 4,8 t	ca. 2,2 t	ca. 2,35 t	ca. 2,45 t
Maximum gross weight	34 t	34 t	34 t	16 t	16 t	16 t

The stackable swap body class C745 according to CEN TS 13853 has a maximum gross weight of 16 t.

Tank swaps and tank containers are heavier units:

Type	7,15 m tank swap	20' tank container	30' tank container	40' tank container
Tare weight	ca. 5 t	ca. 4 t	ca. 6 t	ca. 8 t
Maximum gross weight	30 t	28 t	32 t	36 t

In the European tank and bulk transport market, a growing number of loading units with a gross weight of 35.000 kg is in operation. Such loading units would need in road operation a total mass of vehicle in the range of 48 t which is allowed in some European states.

d) Semi-trailers

First, the "legal" maximum gross weight of a semi-trailer depends on the weight of the corresponding motor vehicles, second on the number of axles, and third on the fact whether the transport mode is combined transport (combination 44 t) or pure road transport (combination 40 t). The "technical" maximum gross weight of many 3-axle semi-trailers is 35 tons.

A semi-trailer with an outer height of about 4 m has a tare weight of about 8 tons (there also exist semi-trailers with a tare of about 7,5 tons). Semi-trailers suitable for vertical load transfer (for using combined transport) are, because of their stronger superstructure, heavier: Their tare is about 200 kg up to 2 tons higher than for conventional semi-trailers (depending on the type of superstructure: box type, soft type).

1.1.4 Optimal pallet pattern

In intra-European trade, most transport loads are palletised. Therefore, an important logistical requirement for the transport chain is the use of loading units which fit into the pallet system. There are standardized pallet dimensions specified in ISO 6780:

Pallet type	Dimensions	Tare weight	Maximum gross weight
Pool pallet	0,80 x 1,20 m	ca. 30 kg	1,00 t
Industrial pallet	1,00 x 1,20 m	ca.35 kg	1,50 t

In intra-European trade, pool pallets (Euro-pallets) are more important than industrial pallets. The following table shows how many Euro-pallets fit into the specific loading units and how good the capacity use of the loading units is:

Loading Unit	Euro-Pallet capacity (theoretical, max.)	Capacity use of loading units (% of interior area)
20' ISO-1 maritime container	11	76 %
30' ISO-1 maritime container	18	83 %
40' ISO-1 maritime container	24	82 %
20' non-ISO palletwide sea container	14	94 %
40' Bell Lines palletwide sea container	30	98 %
20' domestic container	14	93 %
7,15 m domestic container	17	96 %
30' domestic container	22	97 %
40' domestic container	30	98 %

45' container (A1371)	33 (34)	ca. 95 %
Swap body C715	17	depending on inner width
Swap body C745	18	depending on inner width
Swap body C782	19	depending on inner width
Swap Body A1219	30	depending on inner width
Swap Body A1250	30	depending on inner width
Swap Body A1360	33	depending on inner width
Semi-trailer	33 (34)	ca. 95 %

1.1.5 Transhipment procedure

a) Maritime containers

Maritime containers are fitted with top fittings for vertical transhipment according to ISO, so that a spreader operating under a crane (ship-to-shore, mobile harbour, RTG, RMG etc.) or a reachstacker can handle them safely using the twist locks.

b) Domestic containers

The transfer of domestic containers is done in the LoLo-mode (usually top-lift with a spreader). The units with 7,15 m outer length show side rails for lifting by means of grappler arms.

c) Swap Bodies

Today, most of the swap bodies have grappler arm side rails for the transhipment via grappler arms. But there are more and more swap bodies fitted with upper fittings (castings) suitable for top lift with spreaders. There even are some stackable swap bodies built without grappler arm side rails, transhipped only in the LoLo mode by spreader.

Class C swap bodies can be transferred from road vehicle to another road vehicle by horizontal technique using the air suspension of the road vehicle.

d) Semi-Trailers

As they are equipped with own wheels, semi-trailers principally are to be transhipped in the RoRo mode. For combined transport road-rail, there are some semi-trailers equipped with a special stronger superstructure suitable for grappler arm lift and transfer in the LoLo mode.

1.1.6 Stackability / Strength of construction

It seems evident that an economic container transport on waterways requires stackable units. *Maritime containers* like ISO-1 series containers or 45' sea containers, therefore, are stackable. For providing the stackability, the strength (and therefore the construction) has to avoid the risk of static or dynamic demands through the load. The basic construction of a container consists of a strong upper and lower frame, which are connected via corner posts. This frame construction is able to cope with the stacking forces. In the four upper and lower corners, there are strong castings integrated, usually made of steel, which represent the contact between the stacked boxes.

Furthermore most containers are designed to withstand considerable racking forces. Such forces are introduced into a container stack on deck of a ship and the ship moves in rough sea. Then the upper layers of the container stack exercise specific transversal forces into the lower stacked containers. Such racking forces are normally taken over by the assembly of corner fittings, container frame construction and the metal sheets of side and end walls. Since in inland waterway transport the ship´s moves are minimal, the racking capability of loading units might be a negligible issue.

Domestic containers (both UIC and U.S. type) show, if ever, only a limited stackability, mainly for empty stacking at container depots (3 times empty stacking maximum). There are, although, some types which may be stacked loaded, but then, only inland containers of the same type (length).

Some of the *swap bodies* are stackable, others are not. Many of the stackable swap bodies are of the closed-built box type C 715, C 745 and C 782. Their maximum outer width is between 2.500 and 2.600 mm, and their outer height is, in most of the cases, 2.670 mm (except high cubes). Besides, suitable for stacking are „closed“ swap bodies with the outer dimensions 7.450 mm x 2.550 mm x 2.730mm (length, width, height), but also swap bodies with one open side or tarpaulized open-siders can be built stackable. For swap bodies class A with a length up to 45', it does not make sense for all of the units to build them stackable. Especially for the open-side swap body class A, a stackable version causes further production cost and tare, therefore less payload. For the swap bodies class A with an open front door, the situation is different: these units often are 3 times stackable (loaded). Some latest pallet-optimised Europe containers with swap body dimensions are stackable up to 9 times high under dynamic conditions (short sea shipping).

Semi-trailers, optimised for road transport, are not stackable.

1.1.7 Life-time costs and maintenance costs

The cost of purchase of a swap body with soft superstructure, principally, is lower than the cost of purchase of swap bodies with stronger superstructure or the cost of containers. The latter have a lower cost of purchase than semi-trailers, because the semi-trailers also have a chassis.

Inland (domestic) containers have a higher tare weight than swap bodies, and therefore, they might cost more than swaps. It is said that a domestic container only shall be bought when a company plans to take part in combined transport road-rail.

Generally speaking, one may say that the more customer-tailored the loading unit is made, and the heavier (stronger, e.g. for stackability) the unit is, the more expensive it is.

Many maritime containers are manufactured in China at a low level of cost, and container prices are quite low (1.350 $ per 20' dry freight container). Semi-trailers and swaps used in European transport business are mainly manufactured in Europe (Swap bodies: Germany, Italy, Eastern Europe).

During a certain period of time, maritime containers are less times transshipped than swap bodies, because they normally are engaged for longer trips (an intercontinental sea vessel trip takes more time than an intra-European transport between Belgium and Italy, for example). Because of this fact, in average they are less stressed through transhipment procedures and, therefore, may have a longer lifetime, such as 10-12 years.

Otherwise, since new units can be purchased very cheap, there might occur early replacement when containers are damaged.

At this moment, there is no regulation on a European basis about the control and maintenance cycles of swap bodies. Semi-trailers, because of their chassis, regularly have to be certified by road vehicle surveillance.

Although, maintenance is needed. At many intermodal terminals, there are companies located offering container maintenance and repair services. For shipping lines, the average repair cost is about 0,25 $ per container and day. In the 1990s, the repair cost of containers had shrinked. This was because of IICL`s maintenance standards concentrating on the repair of structural damage at the containers and neglecting questions of design (container paintings). Today, it is said that the lifetime of the boxes cannot be prolonged through intensive maintenance and repair.

After a transport, tank containers have to be cleaned before other load is allowed to be filled in. Because of this fact, the responsible companies usually wait until there is another load consisting of the same type of commodity as the latest one, so that the cleaning becomes redundant. This procedure requires storing facilities for the boxes and therefore space. To save space, most of the tank containers are built stackable, for empty stacking.

1.1.8 Safety Performance

ISO containers underlay the CSC (Convention on Safe Containers, Geneva 1972) that stipulates that such containers must be controlled to check their operational safety in intervals not longer than 30 months. The date of the next inspection must be indicated on the CSC approval plate. Companies that, as an internal routine, control their containers at shorter intervals may indicate this with the letters "ACEP" on the approval plate and are then exempted from the duty to show a specific next inspection date.

The representatives of the Transport Ministers of the European Union and the European Commission have agreed in the 1980s that swap bodies that cannot be stacked and/or lifted by top corner fittings do not underlay the prescriptions of the CSC (but they may, if the client wishes so, be tested according ton CSC and equipped with a CSC approval plate).

As far as transhipment is concerned, a spreader lift with twist locks is not only faster and more efficient than a grappler arm lift, but also safer. This means that the risk of damaging the loading unit and the risk of accidents is lower with spreader lift. Therefore, ILUs with fittings for spreader lift show a better safety performance. Regarding this aspect, sea containers and some domestic containers or stackable swap bodies are to be preferred against semi-trailers and swaps without these top lift fittings.

If one has a look at transport processes, it is important to mention the securing of cargo, because it is one of the main problems in intermodal transport nowadays. On the one hand, the ILUs shall be equipped with cargo securing devices (criteria: accurate number, right location within the loading unit, strong enough). On the other hand, there is the problem with the palletised cargo: As the table in 1.1.4 indicates, especially at the ISO maritime containers, there is the problem of relatively bad capacity use and a quite high empty space where unsecured palletised cargo can move without mutual support. Not only the risk of damaging cargo and/or container walls during transport exists, but there is also the problem with the balance of the load under spreader during transhipment (different forces on the contact points). The pictures[4] show to which consequences a missing or a non-appropriate securing of cargo inside the container as well as a wrong distribution of the load over the

container floor can lead.

1.1.9 Suitability of the ILUs for the different forms of intermodal transport

For which combined transport mode are the considered ILUs suitable?

Maritime containers are used for Load-On Load Off (LoLo) European short sea shipping (feeder operations), but they are loaded upon trailers or cassettes and then are moved by Roll-On Roll-Off (RoRo) ships for coastal or ferry operations, too. Maritime containers are the dominant ILUs for inland waterway shipping. Especially in "hinterland" traffic of the European seaports, but sometimes also in European land transport, lots of them are carried in combined transport road-rail mode.

Inland containers, as the definition above suggests, are used for combined transport road-rail. As they are not stackable, they are not suitable for waterway transport, besides special technical solutions.

Swap bodies are the dominant ILUs for European combined transport road-rail. Generally speaking, only the stackable ones may also be carried in inland waterway shipping or on short sea operations (besides special technical solutions, see above). Like for the ISO

[4] References: GDV (2002), online; The Swedish Club (2003), online

containers, some non-stackable swaps are put upon trailers and then are shipped on RoRo vessels (e.g. at Baltic Sea or Skagerrak operations).

Semi-trailers are heavily used in RoRo shortsea (or ferry) traffic, for instance in the North Sea, the Baltic Sea or the Mediterranean Sea. On the other hand, they may be equipped with top fittings for LoLo transfer allowing them to be carried in special pocket-wagons in the combined road-rail mode. As far as inland waterway navigation is concerned, there are very few relations on the river Danube where semi-trailers are carried in RoRo mode.

1.1.10 ILU modal split

How does the distribution (share) of the ILUs used in the different transport modes look like?

In European combined transport road-rail, 68 % of the loading units are containers and swap bodies, and 9 % are semi-trailers (the rest is accompanied combined transport). Regarding only the semi-trailers used in long distance road transport, only 2 % are extra-fitted for a transport in the pocket-wagons, while 98 % are tailor-made for road transport only.

In European combined transport on inland waterways, more than 95 % (estimated) of the ILUs are maritime containers (including some pallet-wide sea containers/stackable swap bodies equipped for top lift transfer), the rest are very few semi-trailers (Danube shipping). There are nearly no non-stackable swaps used in inland waterway shipping.

In European short sea shipping, the dominant loading units are semi-trailers (RoRo operations in the North, Baltic, Adriatic Sea), and ISO containers (feeder traffic in the Baltic, Mediterranean, and North Sea, or the Atlantic Ocean). A certain number of non-stackable swap bodies is used in tri-modal combined transport road-rail-short sea between Scandinavia and Germany/Switzerland/Italy. Sea containers and stackable swap bodies are carried mainly on the North Sea.

In total, nowadays 16 million maritime containers (measured in twenty-feet equivalent units =TEU) are circulating around the world, with a further growing anticipated. Inland containers were heavily ordered (lots of hundreds) in the 1980s, for instance by German Railways (DB), but this process has nearly stopped. As far as pallet-wide boxes are concerned (some stackable, some not), in the 1990s and today there is a trend towards the 45’ outer length, e.g. operated by Geest NSL, Ambrogio, P&O, or BNS Consent Norge. For the tank business, actually there are about 7.000 tank swaps and about 35.000 IMO tank containers operated in Europe.

1.2 Development in the near Future

A first impression about the development of the loading units carried in the near future gives the statistics of the European box manufacturers for the year 2002. Of the 91.000 TEU built by European box manufacturers in 2002, 35.000 were swap bodies, 8.500 were pallet-wide boxes, 41.000 were ISO maritime containers (50/50 dry freight and reefers), and 5.500 tank units.

More and more swap bodies of the loaded stackable type are going to enter the market in the near future. The actual orders of leasing companies and transport operators confirm this expectation. This is partly because of the further integration of short sea shipping into intermodal transport chains. The other reason is the pallet-wideness of the stackable swaps compared to ISO containers. As now about 300 million Euro-pallets are circulating in Europe, the ILUs shall be compatible with these pallets.

Estimation for road transport: In international long distance pure road transport, the share of articulated units consisting of semi-trailers steadily grows, compared to road trains. On the other hand, the manufacturers say that the share of new-built semi-trailers suited for vertical lift is only about 2 %.

Estimation for rail transport: It is assumed that the relative share of domestic containers is going to shrink, compared to the other ILUs. For North-South relations linking Scandinavia, the semi-trailers still will be important. Tank containers and tank swaps will remain popular, but their diversity will not diminish.

Estimation for inland waterway shipping: The ISO containers will certainly be the dominant loading unit, but the share of stackable swap bodies will increase. For the river Danube, there are plans to further promote the shipment of unaccompanied semi-trailers.

Estimation for short sea shipping: For the Mediterranean Sea, experts say that in spite of the developing “maritime motorways” there is a slow, but steady shift from accompanied/unaccompanied RoRo-traffic towards LoLo container traffic. For the Baltic Sea, the development depends on the specific transport relation observed (traffic with Russia/Sweden/Poland?), although there also might be a shift towards unaccompanied traffic with semi-trailers and maritime containers. For the North Sea, stackable swaps and sea containers will remain strong, as well there is future for trailer traffic. The Atlantic Ocean shipping lines will continue to carry mainly boxes.

Overall, from the market demand side, there is a trend towards loading units which exhaust the maximum legal dimensions in road transport.

2 INTERMODAL LOADING UNITS AND TRANSSHIPMENT

2.1 Transhipment of Maritime Containers

First of all, maritime containers and other stackable units are suited for LoLo transhipment by spreaders, and also should be transferred in this mode, for economic[5] and for safety reasons. The spreader top lift can be described as follows:

A spreader is a (normally telescopic) frame construction (traverse) fastened on handling equipment. It is fitted with four twist locks located in the corners of the frame, which engage in the top lift fittings of the ILU and are locked by a 90° turn. The design of the corner castings facilitates an automatic engaging of the twist locks in the openings of the fittings. If the spreader arms are telescopic in the longitudinal direction, they are able to handle ILU of different length (although the majority of spreaders ends at 40'). Furthermore, spreaders quite often are equipped with traversable flippers, that enable the a fast and exact positioning of spreader towards the container. No additional grappler arms are needed („spreader handling").

As mentioned in 1.1.5, maritime containers are equipped with top fittings made of steel for vertical transhipment according to ISO, so that a spreader operating under a crane (ship-to-shore, mobile harbour, RTG, RMG etc.) or a reach stacker can handle them safely using its twist locks. These symmetrically-allocated corner fittings are very important for a fast and safe handling. For the maritime containers, not only the container dimensions and strength is standardized, but also the corner fittings. The standard is ISO 1161. According to this standard, the lateral distance between the holes is 2.259 mm while the outer width of the maritime ISO container is 8'. That is why most of the spreaders are designed according to these dimensions derived from ISO container standards.

It has to be mentioned that maritime containers, as well as swap bodies, also can be put upon certain trailers (e.g. MAFI) and transhipped in the RoRo mode using certain (terminal) tractor vehicles like "tugmasters". A tugmaster is a heavy duty tractor which can take cargo

[5] If a certain volume of ILUs to be transhipped is achieved.

up the ramps and into the ship. It is equipped with a hoistable trailer attaching device called the “fifth wheel”.

Another transfer technique uses cassettes: The containers are set e.g. by reach stackers into a steel frame (“cassette”) that rests on the ground, fixed by its own gravity. Now and then containers are set into this cassette in double stack; in this case, some fixing device connects the lower corner fittings of the upper layer container with the top corner fittings of the lower container. The cassette with the container(s) in it is taken by a transfer vehicle, lifted off ground and carried from quayside on board of the ship into the RoRo deck. There it is lowered to the ground and fixed mainly by its own gravity.

This is not uncommon in Northern European short sea shipping, but the specific design of the maritime container makes the transhipment by spreader (usually) more efficient, especially if maritime containers represent the dominant loading units to be transhipped.

2.2 Transhipment of Inland Containers

The transfer of domestic containers is done in the LoLo-mode. This usually is done by a top lift using a spreader. Principally, for domestic containers the same argumentation can be referred to as for the maritime containers.

On the other hand, there may be disadvantages resulting from a construction according to spreader top lift: Corner castings according to ISO lead to constructive limitations regarding the roof of the loading unit, whenever the ILU should have an outer width of 2,50/2,55/2,60 m. Domestic containers have an outer width of 2,50/2,55 m. As all of the spreaders in use are built for a container outer width of 2.438 mm, the corner castings of the currently used domestic containers (with an outer width of 2.500 mm) have to be arranged in a way that they are “shifted” a little bit inside. This implicates a limitation of the loading space and the maximum size of the back door of the container.

Besides arrangements for top lift by spreader, the domestic units with 7,15 m outer length show side rails for mechanical lifting by means of cranes with grappler arms (see below “non-stackable swap bodies”). Unfortunately, this transhipment through grappler arms, which is only common in transhipment road-rail (or rail-rail), usually cannot be provided by the transhipment equipment fitted with the conventional spreaders mentioned above, so special equipment is required. There is a disadvantage resulting from grappler arm side rails because there always has to be some space left on both sides of the container to enable the operation of the grappler arms.

Concerning transhipment, there is also the problem of stackability, because of limited space at the terminals. The construction of domestic containers differs from the construction of sea containers especially when regarding the ability to be stacked onto another. Because they are of less strength, inland containers in most cases show a stackability of 3 layers loaded (for 7,15 m domestic containers empty only). On the other hand, at inland terminal operation (unlike in seaport operation) done in the indirect transhipment mode, a stackability of more than three layers could become inefficient because a frequent repositioning of the ILUs cannot be avoided even at well-organized facilities. In other words: In inland terminals, because of the smaller throughput and because of smaller planning horizons, stacks mostly do not top 2 or 3 layers. Long term stacking of empty loading units is not affected by suich limitations.

2.3 Transhipment of Swap Bodies

Due to their rather “fragile” structure, today most of the swap bodies used for European logistics (and all of the **non-stackable swap bodies**) show no top lift fittings, but must be taken from beneath a lifting device, punctually on the bottom structure support points of the chassis. They have grappler such arm side rails for the transhipment via grappler arms. At terminal handling, these grappler arm lifting devices are grapped by the grappler arms. To provide technical compatibility, the length of the grappler arm lifting devices is standardised (e.g. TS 13853 says the length should be 4.876 mm).

That, in terminal or transport operation, requires a considerably bigger distance (min. 300 mm) between two adjacent boxes, which is a disadvantage compared to top lift-compatible units: These units make the efficiency of the terminal capacity use worse. This is especially true for empty units staying longer in terminal grounds. But there are further disadvantages:

Daily business of terminal handling has shown that, for the transhipment of empty units, the crane operators have a limited view into the grappler arm action zone, so that an additional person has to supervise the handling process. It appears that the grappler arms show difficulties to find the exact positioning. This will slow down the handling process. Spreaders, on the other hand, sometimes have the flippers to facilitate the positioning and the contacting of the loading unit (see above).

Also safety aspects should to be considered: Especially for the handling of longer swap bodies (12-13,60 m) with an unevenly distributed load within the ILU (gravity point of the load not centralized) there is the risk of sliding out of the grip. This risk is smaller when the unit is lifted by its top and when there is a fixing between the transhipment equipment and the four contact points at the ILU.

Last but not least many experts prefer the use of top fittings together with spreaders because this technique is said to be more suitable for automation.

The transhipment of non-stackable swap bodies is not only done by grappler arm lift, but also by combination spreaders ("combi-spreader"). These spreaders show twist locks **and** grappler arms. Of course these spreaders are not cheaper than the conventional ones, and most the container terminals (especially these along the inland waterways) would have to be equipped with these spreaders, while they do not provide these combination spreaders.

If transhipment volume at a terminal is very low, as an exception there is the option of a transhipment with the help of a row with harness. The most simple way for LoLo transfer is the use of hooks and ropes: the hooks are fixed in the container top corner fittings, and then any 30 t crane can do the lift. The first container transfer on inland waterway is reported with this method. It was in 1968 in the port of Köln, and the inexperienced port crew needed more than two hours to transfer an ISO container from ship to quay, so these transhipment modes take more time and are connected with relatively high switching cost, so spreader handling is to prefer. This implicates that spreaders eventually have to be equipped with grappler arms.

Overall, there are more and more swap bodies (of the **stackable** type) fitted with stronger corner posts and a stronger top structure. Because of these features, a top lift on upper fittings (castings) on the roof is possible. There even are some stackable swap bodies built without grappler arm side rails, transhipped only in the LoLo mode by spreader. As the spreaders on reach stackers or cranes (and used for the top-lift) are tailored to ISO containers, the top lift fittings have to be located on top of the swap body in the same manner than the corner fittings for maritime ISO containers (same distance between the four fittings). As a consequence, swap bodies suitable for top lift show upper fittings with a horizontal and lateral distance like the fittings of the ISO containers (opening distance 2.259 mm).

This leads to a disadvantage: For the distance of the upper fittings, the same limitation as for the domestic containers is true for swap bodies, which show an outer width of 2.500 mm or more, and sometimes even a higher outer length. The disadvantage of these ISO-type top corner fittings is that they raise inside the swap body and, first, limitate the maximum height of the back door, and second, hamper the transmission of the forces in the roof construction. This leads to a punctual limitation of the loading space nearby the roof.

For class C swaps with an outer length of 7.450 mm, this disadvantage seems of lower importance, because the top lift fittings are located at the end of the ILU within the framework construction. Compared to the class C swaps, the top lift fittings for the longer class A swaps (e.g. with an outer length of 13.600 mm) are not located nearby the corner posts, but further inside the roof. This is because many 40' spreader can maximally be extended up to 12,20 m. This makes the class A 1360 swap suited for top lift less attractive for shippers and hauliers.

One possible solution to overcome this problem is the location of the corner castings on top of the roof. Besides constructional implications this would result into a limitation of the ILU height, of which the logistic providers are not fond, too. Alternatively, the design of the corner castings would lead to lowered chassis for road or rail transport (because of maximum legal dimensions or gauges).

A better solution might be the transfer of the fittings to the outer framework of the top, corrsponding to the 2,50 or 2,55 m outer width, so that they would be located within the side walls (like for the ISO container). As a consequence, all of the spreaders in use at the transhipment points should be substituted by corresponding spreaders, e.g. spreaders that can be extended in length and width. Because of the lack of compatibility to current systems still part of the intermodal market (e.g. ISO container) it would not be sufficient to simply widen the distance of the twist locks of the spreader. In addition, the twist locks of the future should be longitudinal *and* lateral telescopic, at least at two positions. Besides these technical problems the economic implications of this solution should be taken into account.

Alternatively, one could develop new corner fittings needing less space. For instance, a modified corner casting was developed, small enough to be located in the side wall construction of the ILU and under the roof, and which could be reached by small grapplers part of the spreader. Each spreader could be equipped with these small grapplers in a relatively simple way.

In the short term mode, concerning the long ILUs (40-45' outer length) it might make more sense to substitute the 40'-telescopic spreader traverses at a number of strategic important terminals by 45'-telescopic traverses. The French operator CNC Transports, for example, has started equipping its new intermodal terminals with 45'-compatible spreaders. Similarly, inland waterway terminals on the Rhine take over the 45' spreader technique. In other words: An adaption of the ILUs towards the existent spreaders would be more expensive or complicated without giving the ILUs further attractive features for its users, and certainly this causes superfluous tare or limits the space within the ILUs.

The stackability of swap bodies is also related with the question of the nature of the stacks, which means the ability or necessity to form mixed or pure stacks regarding box length. In theory, there is a wide range of possibilities, from the pure stacking of swaps of the same length up to a mixed stacking within the same swap class (A or C) or even a class A/class C mixed stacking (e.g. two class c swaps upon one class A swap).

One reason for preferring single mode stacks or no stacks against mixed stacks A/C is the simpler terminal operation. Especially when repositioning the ILUs within the terminal stacking area a related frequent change of the spreader length would take time and require a higher power of concentration of the crane operator. Regarding box construction, additional plates to strengthen the middle of the longer class A swaps would be a necessity to cope with the forces deriving from the outer posts of the boxes stacked above the swap.

For single mode stacks (A stacks and C stacks) there exist pros and cons. A stacking of boxes of different lengths within the same class enables a more flexible and faster terminal operation. But: To keep low the space needed, and for safety reasons – to avoid mistakes in grapping – a stacking of boxes with the same length is advantageous. Regarding box construction again, this question affects box tare as well as the location and design of corner castings. If the upper corner castings at a class C swap body stayed in a 20' (ISO) position, and if the forces were transmitted there, a stacking of swaps of one class would be no problem. Unfortunately, this implicates disadvantages:

The force transmissions would occur within the side wall of the swap, and not at the corner posts, which would lead to a trickier and heavier – and, thus, more expensive - box design. Additionally, open-siders to be opened along the full side length would be excluded. Instead, it is simpler and cheaper to provide the force transmission with the help of the stronger corner posts, which means the positioning of the corner fittings at the outer ends of the swap body. Then, for the case of stacking, the contact points at the bottom of the upper box should meet their counterparts in the top area of the lower box. In other words, the swap bodies need bottom fittings at 20' length for locks of the container chassis plus additional bottom fittings at the ends for the force transmission in stacks. In spite of these facts, this solution seems more effective because, on the one hand, constructional requirements are minimal, on the other hand, the swap body still can be used flexible. Then, only a stacking of boxes with the same length is possible.

So, for class C swaps, modified corner castings can be located at the outer ends of the box. Telescopic spreaders today can be upgraded for an operation between 20' and 40' with little additional cost. For the majority of the spreaders, normally one just has to mark the additional positions as new positions through further end switches.

This solution is not suitable for class A swaps, because practically all spreaders in inland terminals are telescopic for only 40' length. For these, the corner castings have to be located in exactly this position. As a consequence, the transmission of the forces has to occur at these positions. The other solution, as described above, would implicate a changing of the spreaders, with the new ones compatible up to 45' box length. This trend should be promoted to facilitate handling of future European loading units.

It has to be mentioned that in combined transport road-rail, there exist various solutions and demonstrators with *horizontal* transhipment of swap bodies. The European project InHoTra deals with these techniques.[6] Besides, there are research projects with demonstrators dealing with RoRo transhipment of non-stackable swap bodies in inland waterway and short sea shipping between Duisburg and Great Britain using vessels fitted with intermediate decks and connecting ramps.

As far as solely road transport is regarded, additionally, non-stackable class C swap bodies can be transferred from road vehicle to another road vehicle by horizontal technique using the hydraulic/pneumatic air suspension of the road vehicle. They are usually equipped with retractable undercarriage legs that enable self-loading/unloading on the truck platform without the need for fork-lift truck, crane or other expensive heavy-load lifting device. This is a certain advantage of a swap body compared to a container: For the indirect transhipment of a container at land (indirect transhipment at a terminal, truck-truck transhipment at a shipper´s or haulier´s facility) the ILU must be lifted once more, which means additional handling, additional use of resources, and therefore additional transhipment cost.

2.4 Transhipment of Semi-Trailers

As they are equipped with own wheels, semi-trailers principally are to be transhipped in the RoRo mode. This is common for the transhipment at European short sea terminals (short sea shipping and ferry services). Usually, then, terminal tractors or corresponding motor vehicles are used to pull the semi-trailers aboard. But there are also exceptional RoRo transhipments of semi-trailers onto inland waterway vessels. And in accompanied combined transport, there is RoRo transhipment, too, plus (very rarely) in transport of unaccompanied trailers on railway wagons.

[6] Further informations provides the website http://www.inhotra.org in the Internet.

All this transhipment goes via special RoRo-ramps. These are flat or inclined ramps usually adjustable, which enable road vehicles to be driven onto or off a ship or a rail wagon.

For combined transport road-rail, there are some semi-trailers equipped with a special stronger superstructure suitable for grappler arm lift and transhipment in the Lift on/lift off mode (vertical transhipment) by reach stackers or cranes with combi-spreaders. The European research programme SAIL ("Semitrailers in Advanced Intermodal Logistics"), for instance, deals with such units.[7] These semi-trailers show a certain disadvantage compared to semi-trailers only used for road transport: The ability to be vertically craned requires a special (stronger) structure, which leads to additional tare and volume of the ILU, and this causes less payload and less cargo hold. These trailers will be more costly to build. These additional construction costs amount some 1.000 € per trailer. So these disadvantages have to be overcome and compensated by additional benefits resulting from the use of different transport modes. Unfortunately, the feature "suitable for vertical transhipment" has become more expensive today.

A special solution are bimodal semi-trailers rail-road (e.g. the "RoadRailer"). These are road semi-trailers of a stronger structure to which rail bogies can be added for transport by rail and form an entire train. The concept that the bimodal semi-trailers have to be used all together to form an entire train, rather than a series of simple wagons, is to be underlined. These specific units, besides their appeal, are even more expensive to buy and less competitive as the semi-trailers suited for vertical transhipment.

2.5 IT Support for the Transhipment of ILU

To provide solutions to the bottlenecks concerning the ILU and their transhipment, there, principally, are two fields of action: The first one is the technical design in terms of constructional design of the ILUs and the handling equipment. Examples are the switch to 45' compatible spreaders or a box design suited to stackability and spreader top lift without limiting cargo hold and without making the ILU too expensive for the market. The other field of action is information technology: IT can play a role in providing solutions to at least some of the bottlenecks mentioned in the sections above.

New Terminal Operation System with visual ID

[7] Further informations provides the website http://www.sail-project.org in the Internet.

For instance, a new terminal organisation system[8] was developed which improves the productivity of harbour cranes and reach stackers at handling containers. The system consists of three modules, and one of these modules contains an integrated visual identification system module. This ID-system is not only able to read the container identification numbers throughout the terminal, but it is also able to support the equipment operator automatically. The data are registered by single onboard computer units installed on all transport vehicles within the terminal. These data are wirelessly and online transmitted to the terminal operation system by radio.

How does the module work? When the operator of the handling equipment (here: the driver of a reach stacker) starts his work on the terminal yard, to handle a container, he has to insert the spreader twist locks on the four holes on the corner castings at the container top. The strain-gage sensors mounted on the spreaders check the correct insertion of the twist lock inside the corner castings. The main phases of this operation are highlighted to the operator by means of a light signal system. When the twist locks are connected, on the control panel a yellow light switches on; when the twist locks are locked a green light switches on, otherwise a red light is switched on. The green light signal works as trigger command that starts the arm descent until the “acquisition position” is reached. A camera is positioned in front of the “region of interest”, and the green light acts as the consent to camera positioning.

A magnetic reed sensor located on the cylinder, used to control all the arm movements, provides an electrical signal when the arm is in acquisition position. After the code localization process, there is the code recognition process. This second processing recognizes each single character and selects the eleven elements of the ID code from all among the recognized string. It is the electrical signal coming from the magnetic reed sensor triggers this visual identification modules´ recognition process. The process starts with the containers´ right part, where container identification code is depicted. The camera starts to acquire at the rate of 25 frames/sec, and after one second the “moving up arm” command is sent. The camera stops acquisition process, and the arm moves towards its rest position.

The acquired frames are coming from the camera are coded using the CCIR format (video standard) and transmitted to the elaboration unit by an opportune coaxial cable. The whole

[8] The system is the result of the international project “Mocont” (MOnitoring the yard in CONtainer-Terminals), co-financed by the European Union (EC DG INFOSO). At the moment, the project partners continue their efforts with Mocont II, which examines the practical use of the system. There already exists an “end user club” consisting of important European terminal operators like Cosmos Port of Antwerp, Eurogate Bremerhaven, ECT Rotterdam, Voltri Terminal Europe Genova, General Manutention Portuaire Le Havre, Terminal Darsena Toscana Livorno, and Salerno Container Terminal.

frame sequence is digitalized and stored by the frame grabber to allow the following processing. The frame grabber stores and makes digital conversion of the frame sequence and the data processing start. These steps are computed consecutively and independently to the arm movements operations.

A visual ID software manages the input and the recognition process. If a user interacts with the system he can select the type of source. He can load an image stored in the PC or he can acquire a new image using the camera.

<u>Terminal operation systems:</u> There are numerous terminal operation systems, especially developed for combined transport road/rail or for maritime terminals. Theoretically, these mathematical optimisation systems are capable to handle the interdependencies of cranes, vehicles and management of the stacking area. But in daily business, these terminal operation systems often fail, mainly because of missing data and/or wrong data input. This can be referred to unexpected loading units arriving at a terminal without adequate documentation.

Automatic Identification of ILU in Combined Transport Road-Rail

For combined transport road/rail, research and development department of Austrian Railways ÖBB presented the automatic identification of ILU „AILWS“ (<u>A</u>utomatische <u>I</u>dentifikation von <u>L</u>adeeinheiten und <u>W</u>aggons im <u>S</u>chienenverkehr), which shall substitute the time intensive, costly and inexact manual measurement of loading units. The objective is the completely automatic identification of loading units to improve the quality of data and to automate the disposition in the terminals. Two central questions are the laser measurement to check the loading gauge and the automatic identification and processing of markings and numbers of loading units by video recording and video documentation. Intermodal trains entering a terminal go through a video gate and are scanned. A special software digitalizes the pictures, and afterwards the automatically recorded data are transmitted into the terminal IT system and assigned to the transport. This helps to automate the disposition in the terminals to a certain extent.

Unfortunately, a recognition of 100 per cent of the marking data cannot be achieved by this technology because of the large bandwidths of optical identification of the ILU markings, and because of the different optical visibility conditions in such a large area. And: The ID code on many containers is corrupted or covered by dirt so that automatic visual recognition is hampered. On the other hand, some positive development can be reported: European loading units will, in the days to come, receive a new ID marking according to EN 13044. This marking shall be fully interoperable with that of ISO containers.

Remote Control Spreader

Spreader manufacturer Smits offers remote-controlled telescopic spreaders.[9] The data transmission, which is also possible over longer distances, goes through a mobile phone-modem connection. The unit was developed to provide a high transhipment productivity, a high transhipment reliability and easy maintenance. The first system was installed on a Smits 7200 Piggyback spreader in Berlin and is reported to work: The control system is reported to be nearly 100 per cent reliable. The spreader is available in a European ISO/UIC version as well as with US-American intermodal specifications. According to Smits, the control system located at the spreader is totally PLC-controlled (absorbtion of shocks). This control system provides real time monitoring of the spreader and helps to detect defaults. The order of the functions at the positioning of the spreader can individually be defined by reprogramming the PLC. If problems occur or maintenance is needed, depending on the type of software installed there a connection to Smits is acitvated. Alarm signals arise before the operator notices a problem.

Anti-gearing System for Transhipment

Austrian harbor crane manufacturer Liebherr Werk Nenzing GmbH has introduced a new, real time controlled load control system, which reduces gearing movements of ILUs.[10]

[9] Internet: http://www.smits-spreader.com
[10] Internet: http://www.lwn.liebherr.at

Gearing is a natural swinging effect occuring at rotary cranes whenever the movement of turning stops. This swinging movement is difficult to handle, not only because the jib moves in three dimensions, but also the spreader rotates.

The control system with the name „Cycoptronic“ (= „Cycle Optimising Electronic“) shall reduce lead times of transhipment. A demonstrator was presented in the port of Jurong (Singapur) on a Liebherr-harbour mobile crane LHM 400 (see picture), after having tested the system in Austria for one year and further research in Singapur. It was developed together with project partner University of Ulm. „Cycoptronic“ refers to gyroskopic sensors in the SMAG rotator/hook-system, whose signals are transmitted through a radio-modem directly to Liebherrs crane control system „Litronic“, to regulate swinging and luffing momentums. The crane operator can concentrate on the control of the load, while the jib top has not to be controlled by him because it moves without the swinging of the load. References for the success of the system can be reported from tests in the ports of Antwerp and Rotterdam: Average productivity especially of unexperienced crane operators improved clearly. The system can be introduced to existing cranes by upgradings. There also exists another system of US-based manufacturer „SmartCrane“, which consists of a camera and a vision processing unit.

3 INTERMODAL LOADING UNITS AND INLAND WATERWAY SHIPPING

3.1 The Width Problem

European inland waterway transport shows one major problem: Most barges[11] are built to be able to pass the locks of the canal network for full flexibility of operation. This creates a limitation in width resulting in a maximum external vessel width of 11.4 m and therefore a maximum internal vessel width of some 10 m (about 10.10 m). This would allow to stow four rows of ISO maritime containers with an outer width of 2.438 mm or European loading units (swaps) of 2.50 m width side by side, but not four rows of boxes with an outer width of more

[11] This means barges of the multi-purpose GMS type and similar convoys.

than 2.50 m. This would mean that a common barges´ load factor (measured in the number of loading units carried) is high for ISO containers, pallet-wide sea containers, domestic containers and swaps of an outer width of no more than 2.50 m, but 25 % lower for 2.55 m wide swaps and semi-trailers. At least it is quite sure that, for financial and economic reasons, it cannot be expected that on most main corridors of the inland waterway network transport infrastructure (especially the locks) will be enlarged to offer a greater width than today.

On the other hand, the main market for European inland waterway transport is the Rhine river system. This system has, in its most important part, no limitations by locks. Ships can be built and operated that have a width that can accommodate four rows of 2.55 m wide European loading units side by side.

Second, as mentioned above, the pallet-pattern is an important economical and logistical feature of an ILU. It seems to be clear that, in a total cost perspective, the shippers´ and the forwarders´/ hauliers´ / 3PL´s main interest are based on the maximum total number of pallets carried in a ship. Calculations of SGKV had led to the result that a mixed stowage of 2.55 m-wide and 2.438 mm-wide ILUs is optimal with respect to this goal: Two rows of both kinds of units each side-by-side. The following exemplary comparison is made for a “GMS”-ship of 110 m outer length and 11.4 m outer width; stowing tolerances are respected:

Number of pallets (Euro type) carried on a common „GMS“ barge with pure and mixed stowage at a one layer box transport			
4 rows ISO 20’ side by side	**3 rows swaps class C745 side by side**	**3 rows ISO 20’, 1 row swap class C745 side by side**	**2 rows ISO 20’, 2 rows swaps C745 side by side**
17x4x11 = 748 pal.	14x3x18 = 756 pal.	(17x3x11)+(14x1x18) = 813 pal.	(17x2x11)+(14x2x18) = 878 pal.

Note: The first number is the number of ILUs carried on the ship length-by-length, the second number is the number of ILUs carried side-by-side, and the third number is the ILU´s pallet capacity.

The last stowing option shows the maximum pallet capacity for this kind of ship. There are also smaller multi-purpose inland waterway vessels designed for inland canal traffic. For many of these vessels (e.g. with a width of the loading room 7.50 m), a mixed stow is favourable, too.

This scenario seems not too unrealistic: A normal barge offers a transport capacity of more than 100 TEU in the river Rhine area. Today, and in foreseeable future, such volumes are not available in intra-European inland waterway transport with European ILUs. So, the palletised intra-European cargo flows using inland waterway transport will take the opportunity to accompany existing flows of maritime containers from or to the seaports. This makes sense, since the main client of combined transport, the chemical industry, has many large working sites direct at the shores of the river and in the port areas of Rotterdam and Antwerp. In such a case, a barge can carry a mix of sea-born containers and of 2.55 m wide ILUs. Three rows of ISO containers plus one row of pallet wide ILUs occurs as normal job in daily operation already. Only if inland waterway transport with European 2.55 m wide ILUs grows, the flows of ISO containers and the other units have to be separated because they underlie different logistic systems. Once this occurs, the width problem arises again.

Then, another promising approach can lead to a result: European engineering yet is on the way to design a type of a barge that can pass the standard lock width but offers some 10.25 m inside loading width for a stowing of four rows of 2.55 m wide ILUs side by side (respecting five times 50 mm tolerance). This may be achieved by a modified sideboard. But safety rules in shipbuilding require additionally two gangways having a width of at least 650 mm on each side along the ship. The strategy “barge with wider holds” today is uncertain in its results. Nevertheless, it will be worth while to have tried, so it is recommended to go this way.

Non-stackable swap bodies are not transhipped by top-lift, but by grappler arms. For the grappler arm operation, some additional space is needed on the side of the ILU, so the loading patterns shown above are not suitable. A considerably bigger distance between two adjacent boxes is requires and estimated to be about 300 mm. Conclusion: The loading room of inland waterway vessels is better used with units equipped for top-lift. On the other hand, research of VBD[12] proved that the conventional intermodal spreader (lifting device) can be modified so that the side space allowance needed for catching the swap body and hence the stowage ratio in hold is improved. The modification cost of an existing spreader device is assessed to about 75.000 €.

Only for shorter swap bodies (class C) and pallet wide containers (20’, 30’), there still is an option to consider a transversal stowage of these ILUs. Stowage rate is slightly higher than by longitudinal stowage. This solution even remains the only option for insulated bodies for which road transport legislation allows an outer width of 2.6 m to maintain an inner width of about 2.47 m.

A remaining problem is that some cellular sips have been built to operate on the river Rhine, and these ships can only accommodate ISO containers or pallet wide sea containers in the 20’/40’ module. These cellular ships had to be seriously modified to fill them economically

[12] Versuchsanstalt für Binnenschiffbau e.V.

with containers or ILUs in the 7 m or 13.6 m length class. Nevertheless: Within the cells, tolerances do exist for boxes with an outer width of 2.50 m. Unfortunately, daily business sometimes showed that the use of these 2.50 m wide units in cellular sea ships led to damages on the boxes.

Solution to the width problem: Semi-trailers and boxes not suited for top lift are not as efficient because grappler arm operation needs additional space in width, reducing stowing space in the vessels. ISO containers are not as efficient because of their bad pallet loading scheme. For technical, logistical and economical reasons one better uses pallet wide sea containers or, instead, swap bodies or domestic containers both suited for top lift. The swaps shall have a minimum inner width of 2.44-2.48 m and a minimum outer width of 2.50-2.55 m. Note: An outer width of 2.52 m or more may be necessary whenever pallets are packed manually, plus 2.55 m is the dominating outer width in competing road transport and is what most customers (shippers, forwarders) require.

3.2 The Height Problem

A height problem in inland waterway shipping only occurs when the loading units are stackable. This is true for maritime containers and stackable pallet wide units (swap bodies, domestic containers). The stacking height during transport is limited by the water level of the inland waterways and the height of the bridge underpasses (air clearance). Other points are the weights of the vessel and the weights of the loading units (number of empty units!), which determine the vessels´ draught and therefore the air clearance, too. Especially bulk ships used to carry containers are designed for the carriage of goods like coal and ore and to have only a slight draught, so the problem is increased.

For the transport of standardised maritime containers, there is a common sense for the air clearance values needed for the carriage of a certain the number of layers. These values can be taken as reference values for the carriage of stackable domestic containers and swap bodies, too:[13]

Number of Layers	2	3	4
Min. Air Clearance (above high water allowing shipping)	5.25 m	7.00 m	9.10 m

[13] It seems evident that the use of High Cube units leads to other values.

The Western and Central European canal network mainly can accommodate barges with two layers of boxes on board. River Elbe and parts of the French network can accommodate up to three layers of boxes. The Rhine and the lower part of the Danube and some major canals in the Netherlands can accommodate up to four layers, in extreme cases even five layers.

If at a certain inland waterway there is enough draught clearance, there will be the option to use ballast to overcome the problem of too less air clearance under the bridges. There are some possibilities like the use of ballast water.

Solution to the height problem: Sometimes, the inland waterway infrastructure (even one single bridge) limits the number of layers of stackable units carried on a inland vessel. Then, one can refer to ballast techniques, or otherwise, reduce the number of layers. Both causes additional cost. The carriage of non-stackable units, instead, lowers ships´ productivity.

3.3 The Length Problem

A similar problem to the width problem appears in length: Locks on the canal network limit the ships´ total and inner length, and Euro-pallets require certain inner lengths of the ILU. The conclusions might be the same as above, but three additional constructional aspects have to be considered:

First, pallet wide sea containers, for stowage under deck in cells of cellular ships, on the front and the back end side are only 2.438 mm wide to comply with the ISO outer width. This causes a limited pallet width, because inside the box, the stowing tolerance of the first and the last row of pallets is about 10 mm and therefore quite tight. For this reason, in swap bodies and domestic containers of similar length, pallets can be stowed more comfortable. On the other hand, it can be stated that the sea container at least is pallet wide.

Second, for combined transport road/inland waterway a pre- or post-haulage on roads is necessary. In road transport the EU legislation and in particular Directive 96/53 EC specifies a maximum overall length for articulated vehicles of 16.5 m, with a maximum load length of 12 m behind the trailer kingpin and a swing clearance radius of 2.04 m in front of the kingpin. What are the implications for the ILUs? Of course maximum length of the ILU is limited. But when trucking traditional 45’ (13.716 mm) containers of 8’ width or SeaCell-style pallet-wide units with 8’ end frames, it is only possible to meet one or the other of these parameters but crucially, not both. Fortunately, there are engineering solutions to these problems: chamfered corner castings at the front end of boxes, like it is known from semi-trailers.

Third, the length of the ILU is tackled whenever mixed stacking of boxes is involved, in terminal operation as well as during transport on inland waterways (see above 2.3 “transhipment”).

Solution to the length problem: ISO containers are not as efficient because of their bad pallet loading scheme. For technical, logistical and economical reasons one better uses pallet wide sea containers or swap bodies or domestic containers suited for top lift. The boxes shall show a length optimised with regard to pallet space.

3.4 The Stackability Problem

The specific cost structure of inland waterway vessels with rather high investment costs and small costs per ton-km requires, for a cost-effective operation, more than one layer of loading units. Depending on the ships´ size, the infrastructure pricing and other factors, it is said that in inland waterway business, at least two layers of loading units are necessary to achieve the break-even, and that at least three, better four layers of loading units are necessary to achieve sustainable profits.

Semi-trailers are not stackable. As a consequence, in most cases their carriage on inland waterway vessels is not economically viable (exceptions do exist). All kinds of maritime containers are minimum three times stackable, so they show no problem with regard to this aspect. If domestic containers are stackable, they mainly are built for empty stacking. But what is needed for intermodal goods transport is laden stacking capability. Only some of the swap bodies are laden stackable, mainly of the “box” type.

Some possibilities exist for non-stackable swap bodies and domestic containers, regarding stackability: special racks with ramps and lifts, swap bodies as an uppermost layer over stacked containers or one layer in hold and upper layer on strengthened hatch covers.

The construction of a special stowage rack within the hold, for instance, would result in additional weight of about 2.75 tons per swap body. The costs for building and installation are estimated to about 10.500 € per swap body (class C). Again, the width problem occurs: The minimal space requirements in hold are 10.050 mm for stowage of three swap bodies abreast and even 13.250 mm for four rows. Thermally insulated swaps require 50 mm more per each box. In addition, the minimal inner height of the hold in case of such a construction with two swap bodies one above another and high cube boxes is 6.32 m, so the overall vertical clearance for loadings is lowered, and the height problem occurs more stringent.

Instead, of course it is possible to load non-stackable loading units (swap bodies, domestic containers) on top of the upper layer of maritime containers. This is already practiced, also with stackable units wider than ISO containers. It is recommended that these units lying above touch the others at standardised points (for stacking, racking and security reasons), e.g. castings complying to ISO 1161.

The constructive solution “strengthened hatch covers” can be provided through hatch-covering frames and lately was assessed in a research project concerning combined transports of bulk and container freight on inland waterway barges, with bulk cargo in the hold and containerised cargo upon the hatch. The bad effects are additional investment costs as well as additional ship calls at bulk terminals which hamper service quality. Furthermore, the logistical implications of bulk cargo and containerised cargo differ widely. But it has to be mentioned that the height problem would totally be overcome.

For inland waterway vessels on their way, rough sea does not occur, so safety measures for ILU stowing are not as restrictive as in deep sea transport. But the inland waterway vessels carrying some layers of containers must comply with the stability and racking requirements: The ships shall not capsize. The national legislation, hence, contains stability requirements.[14] The determinants are the height of the gravity point (vessel plus load), the vessels´ width, and liquids with a free surface (rain water in the cargo hold, ballast water in tanks etc.). The gravity point of an empty inland barge is on about 30-40% of its side height. If container loads are carried, the gravity point of the ship moves upwards, and the barge looses its stability. There are methods to calculate these implications. Sometimes, as a consequence, there are cargo securing measures like lashings used to avoid movements and shifts of the upper layers of boxes (and, of course, to avoid movements of the load within the holds of the loading units) so that the gravity point moves towards a ships´ side. The natural inclination forces do influence these facts: the wind tackling the surfaces of the ILUs, the lateral stream of rivers, the grounding of the vessel, and ship manoeuvres.

Solution to the stackability problem: European loading units better show stacking capability for four layers (laden/full), so that ship productivity is maximised. This also allows an easy transfer from and onto seagoing vessels, and therefore a frictionless multimodal transport operation inland waterway-road-rail-sea. The stowing of non-standardised units requires intelligent stowing concepts provided by software tools and personal skills of the stevedores. Sometimes, lashings and other measures have to be used to maintain ships´ stability. ILUs shall comply with the (in inland waterway shipping low) racking forces.

[14] For Germany it is the „Rheinschifffahrts-Polizeiverordnung“ (RheinSchPV).

3.5 The Transhipment Problem

Lift on/Lift off transhipment should be preferred in inland waterway shipping: Roll-on/Roll off transhipment is in theory possible for inland waterway shipping, and sometimes is practised, such the case for the delivery of new-built cars and other vehicles. But for cargo handling, RoRo transhipment needs more space, on deck as well as at the terminal facilities along the rivers and canals. It can be stated that there is no economic chance to operate the RoRo facilities in competition to other technical choices in intermodal transport. Besides, only semi-trailers have own wheels, so all the other loading units would have to be put on trailers to be transhipped in the RoRo mode.

The width problem already showed that ILUs shall be loaded into the hold of a barge without intermediate gap between them. This means that the traditional lift by grappler arms is not possible. The units must be handled by use of top corner fittings. As a consequence, piggyback trailers and many swap bodies and domestic containers are not favourable ILUs for inland waterway shipping.

As handling between barge systems and road transport (about 30 € per transhipment)[15] is more expensive than in traditional road/rail terminals (about 16 € per transhipment), the economics of “short” loading units will be limited. A terminal transfer of a class C swap body or 20’ container practically moves only half of the cargo volume than a transfer of a class A swap body or 40’ container, so that many trades that may become competitive with class A swaps may not be commercially successful with class C swap bodies. In other words: The handling of one loading unit can move over the quay between 11 Euro-pallets (20’ ISO container) and 34 Euro-pallets (semi-trailer or 45’ swap), so the costs per pallet-move can range from 0.90 € to 2.70 € (=3 times 0.90 €!). This difference becomes the more important the higher the number of transhipments within the supply chain is.

To illustrate this, the following example illustrates the implications of the transhipment costs for a transport of (Euro-)palletised loads from Bruchsal in Southern Germany to the Far East via the port of Rotterdam, using the river Rhine vessels. The costs shown in the tablet are costs per box and per pallet, from the consignor in Germany to the seaport in the far east (delivered ex ship =DES Far East).

Intermodal Loading Unit	40’ ISO container € per	40’ pallet-wide € per	1 stackable swap body class A (45’)	2 stackable swap bodies class C 745

[15] Prices in Germany.

	consignment/*per pallet*		consignment/*per pallet*		€ per consignment/*per pallet*		€ per consignment/*per pallet*	
Trucking (about 50 km)	60	*2,50*	60	*2,00*	60	*1,82*	60	*1,67*
Inland Terminal Handling (Rhine river)	30	*1,25*	30	*1,00*	35	*1,06*	70	*1,94*
Inland Waterway Carriage (about 430 km)	365	*15,21*	365	*12,17*	400	*12,12*	615	*17,08*
Sea Port Handling (ARA)	70	*2,92*	70	*2,33*	80	*2,42*	160	*4,44*
Ocean Carriage (about 20.000 km)	500	*20,83*	500	*16,67*	550	*16,67*	550	*15,28*
Total DES Costs(€) per Consignment / *per Pallet*	**1.025**	***42,71***	**1.025**	***34,17***	**1.125**	***34,09***	**1.455**	***40,41***

Assumptions: The ocean carriage sea freight rate per TEU Rotterdam-Far East is assumed to be € 250, the transfer from/onto the inland barge to/from the sea vessel is assumed to be 70 € (a transfer off or onto rail in seaports is charged lower and about 55 €). For the stackable swap bodies, additionally, a 15 % higher transhipment price is assumed because of the more complex stowing scheme (higher planning costs). The pallet-wide 40’ unit and the ISO 40’ unit fit into the cellular structure, so no additional costs occur during carriage on cellular ships. For the stackable swap bodies, a 10 % higher sea freight and inland waterway freight rate are assumed, because of stowing losses with these wider/longer units not conforming with sea cells. The last assumption is a “worst case” scenario, because if these units are carried only in a limited number, a stowing on the uppermost layer of the maritime boxes on deck may be carried out without additional cost.

It depends on the specific, individual view (ILU perspective vs. pallet perspective) which mode is advantageous. But it is clear that longer loading units are favourable because of the relatively high impact of transhipment costs. Insofar, we expect a clear dominance of larger loading units in inland waterway transport, and all problems mentioned concerning class C swap body compatibility may not be much severe. Another interesting conclusion is that, to a certain extent, transport and handling costs are substitutable through the use of different loading units.

There still is the problem of spreader extensibility mentioned in chapter 2. But: More and more terminals in the Rhine river valley purchase in these days spreaders with a maximum extension of 45’, so that they can handle all types of loading units using the outside corner fittings set. Today, inland waterway operators carry 45’ containers that are unloaded from deep sea container ships in Antwerpen, Zeebrugge and Rotterdam. An A-class European swap body with 13.60 m / 13.71 m length would not create any other problem than these containers that are already carried today. The same is true for railway transport: The French combined transport road-rail operator CNC Transports equips its new terminals with 45'-spreaders, and other operators like Geest and Ambrogio trust in 45' units. It is thought that the adaption of spreaders to the boxes in use is simpler and cheaper than the adaption of the boxes to the currently used spreaders, for constructional, logistical and economic reasons.

Solution to the transhipment problem: European loading units for transport in the European inland waterway transport system must be equipped with top corner fittings for top lift by spreader. Because of the transhipment costs, the units shall have an outer length of 40' or more. Terminals at inland waterways shall be encouraged to install 45' extension spreaders.

3.6 The preferred ILU from the Inland Waterway Sectors´ Perspective

In inland waterway shipping, the most promising and dominant loading units for the next 20 years will belong to two business areas:

- maritime containers according to ISO specifications,[16] for multimodal port hinterland traffic in international deepsea/overseas trade,
- at least three layers full stackable, pallet-optimised, long "European" loading units suited for top-lift,[17] for multimodal long-distance traffic in intra-European trade.

For the latter of both groups, today, there are intense discussions about the outer width (is 2.50 m or 2.55 m preferable?) and the length (is sea containers´ or swap bodies´ length preferable?) of such units. There are good reasons for a success of units providing the maximum dimensions legally allowed in road transport (shippers, hauliers, truckers and vehicle manufacturers´ will), while other stakeholders (sea and inland waterway shipping industry, terminal operators) favour 2.50 m-wide sea containers of 40' length for other good reasons, e.g. because of the sea cell problem. The markets´ outcome will be interesting.

It can be assumed that the other transport modes like RoRo-traffic with semi-trailers on inland waterways as well as the carriage of non-stackable swap bodies and domestic containers will remain niche markets of inland waterway shipping. A new development from the Netherlands, by the way, is pallet ships used for the short-distance carriage of commodities in the food sector.

[16] For details see chapter 1.
[17] For details see chapter 1.

As far as the transhipment modes are concerned, in inland waterway shipping LoLo with top-lift is certainly going to remain dominating, because this mode can achieve a higher spatial productivity. For instance, a high spatial productivity is important because of the scarce space in some inland ports located in inner cities. Regarding the transhipment facilities, a high use justifies the more expansive gantry container cranes with spreaders, while more and more smaller terminals with lower transhipment volumes will be served by spreader-equipped reach stackers that can operate alongside the quay and load and unload inland waterway vessels´ hold up to the third or fourth row of boxes (side-by-side).[18]

4 DISSEMINATION OF THE PREFERRED INTERMODAL LOADING UNIT

4.1 Standardisation

One important measure for the dissemination of the preferred ILU is standardisation. In general, standardisation is a kind of a type cartel. Usually, a cartel consists only of manufacturers, *or* users of a specific product. In standardisation, the cartel consists of manufacturers, users *and* other interest groups who might benefit from the technical cartel. The aim of this cartel is to reduce the number, the diversity and complexity of technical variants of the specific products. While there is a common sense to establish an anti-trust behaviour in the markets by legal or other action, there exist benefits of the type cartel, and therefore, the stakeholders involved (e.g. suppliers, manufacturers, users) agree with a certain product standard. This is also true for intermodal transport, where many actors can coordinate their actions through technical agreements only. Another important feature of this type cartel is that in standardisation, penalties do not occur when a standard is ignored. The use of a technical standard is voluntary. Hence, standardisation, when keeping the rules, is not covered by anti-trust law.

One of the benefits of standardisation is its contribution to a fast, efficient and sustainable diffusion of technologies, be it products or processes. As far as ILUs are concerned, this means that a standard on the ILU coordinates the activities of ILU manufacturers, ILU operators, providers of port infrastructure, transport companies, national and/or European legislation, forwarders and shippers so that the technical compatibility of the transport system

[18] Such the case at the smaller German terminals Minden (Weser) or Dörpen (Ems canal).

is achieved in a safe and efficient way. This is also true for the use of European ILUs to overcome technical and economical barriers to promote inland navigation.

In the context of this working paper, a larger standardisation project of European standardisation concerning intermodal transport seems promising. The project deals with standards on stackable swap bodies. The background lies in the need for these units from the market actors´ perspective as well as from policy decision makers. As it was shown in section three, and as many experts agree, inland waterway navigation also needs such stackable, pallet-wide ILUs to increase its transport volume.

European experts recruited from all modes of the transport industry work together in a technical committee (TC) 119 of the European standardisation organisation CEN. The title of the technical committee is “Swap bodies for combined transport”. In this committee, the creation of standards for stackable swap bodies came on the agenda. Currently, two projects are on the way to be published as a full European standard:

The first one deals with stackable swap bodies class C (shorter type). The basic dimensions for these units are as shown in the tablet:

Dimensions	Outer Length	Outer Width	Outer Height
Stackable Swap Body Class C 745	7.450 mm	2.550 mm	2.900 mm

These basic dimensions fulfil all requirements for compatibility with Euro-pallets and European road transport legislation mentioned in the sections above.

The swap body is designed to have a maximum gross weight (a rating) of 16 tons. As the box is mainly thought to be used for (lighter) commercial goods transport, this would provide enough payload, keeping in mind the constructional costs.

The bottom of the swap, according to the proposed standard, is similarly built to the non-stackable swap bodies class C according to EN 284, equipped with supporting legs and a funnel.

This „European box“ can be used in intermodal transport chains consisting of road, rail, inland waterway or sea transport without difficulties. It has an ISO series 1 freight container specific structural strength, in particular full ISO stacking capabilities (laden), to permit conveyance by short sea and coastal sea transport as well: It was meant to add safety in transport and easy handling especially in water transport where such swap bodies will be moving in mix with ISO containers. Some experts questioned this policy. They felt that full ISO strength compatible swaps would be too heavy and too costly, and that some of the ISO strength features are not really needed in European transport. A lighter design box, according to them, would be more competitive with current road transport.

Also, the corner castings allow top-lift transhipment by spreader. Furthermore, the standard defines the required minimum safety and reliability levels during the operation of these, we may say, “European containers” (e.g. specifications for a lifting by fork-lift pockets).

In february/march 2000, the draft proposal for a European standard prEN 13853 „Swap bodies for combined transport – Stackable swap bodies type C 745-S16 – Dimensions, design requirements and testing“ was provided through TC 119. In 2001, the proposal went through the formal voting process. The outcome of the voting was that prEN 13853, instead of a Euro-norm (EN), would be published as a Technical Specification (TS). It is a preliminary standard. This implicates that the box specification is going to be evaluated by the markets. The parties concerned are invited to make their experiences. If needed, the standard will be changed according to market partners´ requirements. The result of the formal vote on the draft TS ended in 85 % positive weighted votes (min. condition for approval is 71 %). The publishing as a TS 13853 was expected to be finished in 2003. There already exist some stackable swap bodies according to the basic normative requirements of this standard. It is very likely that the new boxes, if the standard is well-accepted by transport industry, will be built in the Far East (China) or in the MOE countries as it is already practised today.

It will take some time until transport industry moves towards the more standardised loading unit. But some inland waterway shipping operators (e.g. Bonamare) signalised that the stackable swap bodies will have a future in European inland waterway shipping, at least in Rhine river shipping. The transitional period may be shorter than thought.

The second standardisation project of TC 119 dealing with stackable swap bodies is about a stackable swap body class A with a length of 13.6 m or so. The main advantage compared to the short unit (7.45 m) is the higher transhipment productivity. There already exists a proposal for a European standard worked out by TC 119 “Swap bodies for combined transport – Stackable swap bodies type A 1371 – Dimensions, design requirements and testing”. Although some details still have to be elaborated and/or discussed, some basic features of this European box may be listed:

- outer length 45',
- outer height 2.900 mm,
- pallet-wide load areas (proposed outer width 2.500 or 2.550 mm),
- chamfered front corners to comply with EU directive on maximum vehicle dimensions (96/53 EC),
- rating (maximum gross mass) of 34 tons,
- capable to be lifted by spreader top-lift,
- multiple stacking capability for inland waterway and short sea transport,
- less strength than ISO maritime containers show, because of the danger of a too heavy and too costly over-design,
- minimum safety and reliability requirements for the operation.

Some units very similar to those described in the proposal are already in use, e.g. those operated by multimodal operators Geest or Norfolkline. The vast majority of new 45' equipment operated in Europe is of pallet-wide construction and comes fitted with the special chamfered "Euro" corner castings. At the same time, the overall swap body fleet is becoming more container-like in its basic construction. Most recent equipment has end doors, steel corrugated panels, corner fittings in the ISO positions, and some stacking capability.

As the inland waterway shipping industry, for often cited reasons, wants to overcome the width problem, there actually is a strategy within TC 119 to standardise a set of European loading units with 2.500 mm outside width which can be recommended. But politics and experts have to observe carefully how far European logistic economy accepts such loading units. History showed that especially road transport industry as well as shippers and hauliers for long distance transport often tended to prefer truck/trailer combinations and loading units exhausting the maximum legal vehicle dimensions, which, for today, means an outer width of 2.550 mm.

Summarized, the main differences between the two standardisation projects are full ISO-stacking vs. not full ISO stacking capability, a different outer width, and a special construction of the longer unit at its front end because of its length of 45' and 96/53 EC directive. The most intense discussions for both types are about the strength of construction. This is because ILUs to be carried in stacks in waterway transport need to be designed to certain strength criteria, and there are severe cross-references between manufacturing costs and tare weight (economy of operation), certain restrictions for operation in stack (technique of operation), and traffic safety. And there still are discussions about the chamfered corner castings of the class A version. The solution to these problems is more difficult with 13.7 m boxes than with stackable class C units.

Unfortunately, the stackable swap bodies (rather pallet-wide containers) do not have attained the critical fleet size necessary for universal acceptance yet. They are regionally operated, namely in Europe. On the other hand, these units gain of importance: Stackable, pallet-wide Euro containers have increased in the last decade. The fleet of European stackable boxes has been growing at the fastest rate in recent years. This fleet, be it of cellular or non-cellular width, increased by about 9 % in the year to mid-2002, and by nearer 14 % during the preceding 12-month period. Much of the pallet-wide containers growth can be attributed to the sizeable recent investment in 45' equipment, with the swap body additions mainly concerning equipment of 7.45 m size.

At mid-2002, the count of pallet-wide, but non-cellular European containers was 82.000 (127.000 TEU). The fleet almost belongs to combined transport operators, rather than ocean carriers or leasing companies. This fleet is distinct from the count of cellular pallet-wide containers (8' cell-guide width), which largely are maritime build and deployed mainly in Europe. That cellular pallet-wide fleet amounted to over 50.000 units at mid-2002. There are some interest groups who favour the additional standardisation of a cellular pallet-wide container like the ones manufactured by Cronos Containers or SeaCell, too. Already widely used in European short sea trades, deepsea operators moving palletised cargoes are also starting to opt for cell-compatible 40' pallet-wide designs.

Besides, there is another possibility, which is unlikely to occur, but has to be kept in mind: There is some radical consideration of the standardised Euro-pallet sizes. While today, about 75 % of all pallets used in European transports are Euro-pallets measuring 1.200x800 mm, and an additional 6 % share of ISO pallets 1.000x800 mm matches inland containers and stackable swap bodies, for some people matching the pallet size with the narrowest boxes (that is ISO containers) would be quite reasonable from a transport logistic point of view. But: In certain cases that would be difficult or even impossible, because some products like bottles in standardised plastic crates ideally match existing standard Euro-pallets not allowing any changes in their length and width. The basic package module of European industry is 400x600 mm and is closely linked with many product specifications.[19] On the other hand, there is the idea of a standard “sea container” pallet having 770x1.165 mm, i.e. just 30 mm narrower and 35 mm shorter than the “Euro” type, so that each kind of container could be stuffed with them economically.

European Community (and/or national bodies) may accelerate the standardisation project “stackable swap bodies” by co-financing the project to provide additional incentives to the peer groups to engage in the standardisation process. This would facilitate the engagement and arrangements of the stakeholders involved, because to a wider extent, standardisation is based on voluntary engagement of experts recruiting from industry and R&D.

[19] This had already been assessed in former studies.

4.2 Other Promotion Activities

Promotion by EC Directive on ILUs

One possibility for the dissemination of the European stackable swap bodies is legal action by the national and/or European bodies. The European Commission (EC) published with its document COM (2003) 155 final suggestions about the design of a future European loading unit. The EC sees one measure in the proposal of a EU directive which specifies a European ILU.

The evaluation of the possible internal length and width and palletised unit load accommodation figures as given in the EC document, interestingly, are reflected by Draft Standards under development in CEN TC 119. But, other than foreseen by the proposal, the EILUs are discussed with a height of 2.900 mm to maximise volume. Loading units of this height can be, without greater difficulties, carried all over European road and rail network, with exception of the British rail network. The height of 2.900 mm offers more volume and is more competitive to road transport and therefore, the height of 2.900 mm should be preferred.

In the annex of the EC document published, safety and security features are described. A basic feature are periodic controls similar with the ones foreseen by the CSC[20] for all units excepting the existing ones. Practically all EU member countries have signed CSC Convention. A stackable EILU with top corner fittings is mandatory subject of CSC. Nor formal act and no discussion is needed whether or not EILUs shall be subject of CSC. CSC stipulates that the signature countries shall not prescribe any requirements in addition to those shown in CSC as far as safety of intermodal type loading units is concerned. No production surveillance and maintenance requirement other and additional to those given in CSC may be introduced, otherwise the danger of legal conflict arises. If some actors might consider that the prescriptions of CSC are not covering all safety needs related to an EILU, the discussion must concentrate on eventual amendments of CSC.

Some *safety* related prescriptions of CSC are under discussion these days. These discussions are mainly conducted in International Maritime Organisation (IMO), Maritime Safety Committee. Such discussions typically concentrate on safety transport, which might, or might not include aspects of inland waterway transport.

[20] For CSC see section 1 “Safety performance”.

All issues on *security* of transport are internationally discussed only from a viewpoint of international maritime ISO container transport including a deep sea voyage. This attitude is mainly created by the viewpoint of the US administration who, based on the specific conditions of exterior trade of the USA, concentrates on the security aspects of import consignments entering their territory by deep sea trade. The current international discussions take place in IMO as well as in World Customs Organisation (WCO). Instead, EILUs will move mainly in European land or short sea transport, in most cases on trade routes where customs requirements do not apply.

As a consequence, current discussions on security aspects of containerised trade do not relate to any specific aspect of EILUs or their operation inside Europe. If the results of these discussions shall be applied to EILUs also, it is almost sure that the regulations will render inappropriate in many aspects and by far more hamper efficient trade operation than improve security of Europe.

Recommendation: The EC is invited to check with the current wording of CSC and to confirm that the EILUs foreseen in the proposal and in European standards are included in CSC. Then, also maintenance and repair questions are covered.

Another important feature of the EC proposal (annex 1) is the harmonisation of handling and fixing interfaces of all new European ILUs. As far as handling interfaces are concerned, the long EILU as currently discussed in CEN TC 119 type A 1371 will be equipped with a set of top corner fittings at 40’ position and an extra set of top corner fittings in the 45’ position. These additional corner fittings are designed in a way that is covered by the legal framework set out in European Directive 96/53/EC. Vertical transfer of such loading is more efficient when using the set of outer corner fittings at 45’ position rather than the set of 40’ position for speed and easiness of handling. Basic requirement for such handling procedures are spreaders with an extension to 45’.[21] The use of spreaders with 45’ extension in European inland waterway terminals does not necessarily create a trend towards violation of 96/53/EC and therefore shall be tolerated.

Promotion by other EU activities

Besides the Directive, there are other measures for the European Union to promote the use of the preferred ILU. The first one was described in section 4.1: An acceleration of EILU standardisation by co-financing the project.

[21] As stated above, such spreaders are yet only available in some European terminals.

Another way is the establishment of a principle of preference for standardised loading units in the European research and market development programmes.

If the European Commission wishes to accelerate the current development towards a wider use of European ILUs, it should consider the pro´s and con´s of a European promotion program to increase the number of such stackable 13.710 mm length swap bodies in operation. France had, in the early 1990s, introduced such a promotion program for swap bodies and achieved a critical mass of units in national operation.

European Commission should abstain from any discrimination of such EILUs, e.g. by imposing tougher and more costly safety regulations upon them as upon semi-trailers in international use, or by extra taxation, or by more limitations in size and height than applicable for semi-trailers. And: EC should continue to observe the development in that field with a view to early identify upcoming problems.

Furthermore, education offers for actors such as forwarders, terminal operators, policy makers or railway operators should be considered.

Last but not least, the European Union could support the terminals along the inland waterways in substituting their spreader equipment so that they are able to handle 45' units without difficulty.

Promotion by associations

Another possibility for promotion campaigns can be provided through the actions of transport associations. These show the required know-how, plus important contacts to their members, plus they know their members interest. The International Union of combined road-rail transport companies (UIRR) for example in May 2003 published a position paper on the standardisation of an EILU. There, the finalising of the standardisation of European stackable swap bodies is welcomed to reduce diversity of European box units, although there is some doubt on the sustainability of the success of these units in European transport market. At least, UIRR points out to the success of the box type stackable swaps with "continental" dimensions used by road-rail operators CNC and Transfracht. According to the association, the existing standards mentioned by the EC consultation paper have helped in a way to harmonize the transport system. And if one succeeds to maintain these actual maximum dimensions and ratings in road transport, intermodality would be further promoted.

In a similar manner, other associations recruiting from European forwarding (e.g. CLECAT), inland waterway shipping (e.g. EBU) or port (e.g. EFIP) industry may promote the dissemination of multimodal, pallet-wide stackable swap bodies. In April 2002, when a wide range of professional associations was consulted on the proposed EC Directive, there was a general consensus on the usefulness of standardising and harmonising certain characteristics of ILUs, “without banning the use of other units for the remainder of their working lives”.

German national Bundesverband Güterkraftverkehr Logistik und Entsorgung (BGL) e.V. already engages in standardisation and reacted to the European Commissions´ plans. It claimed that, for the shorter version of the ILU, it would favour an outer length of 7.45 m, instead of 7.82 m. The reason would be that for the road haulage, there are more vehicles able to cope with 7.45 m units than vehicles suited for the carriage of 7.82 m units.

5 RECOMMENDATIONS

5.1 Actions to be taken by the Market Parties

The following strategy implications with regard to ILUs can be recommended to the market parties involved in inland waterway shipping:

1. The owners of ILUs (shippers, forwarders, leasing companies, shipping lines) shall invest in at least 4+1 stackable loading units (laden, under short sea conditions) suited for top lift by spreader, predominantly for productivity reasons (terminal stacking, terminal operation, sea and inland waterway vessel load factor). Whenever the ILUs are dedicated for worldwide use, they shall be compatible to the cells of cellular sea vessels (this means ISO maritime containers or pallet-wide containers such as SeaCell). Whenever the ILUs are thought to be used in Intra-European trade, they shall be compatible to Euro-pallets (this means stackable swap bodies or SeaCell pallet-wide containers). To provide tolerances in stuffing with Euro-pallets, it is recommended to exhaust maximum legal dimensions for road transport in Europe (swap bodies with 2.55 m outer width). In addition, an increase of the modal share of inland waterway shipping requires acquisition of transport volume currently carried by trucks, so road transport business with its logistical features such as dimensions, reliability is decisive.

2. Until the transport volume of Intra-European traffic with European ILUs on inland waterways does not economically justify the dedication of complete inland waterway barges, a mixed stowing of maritime containers and European ILUs will be necessary

to operate the barges profitably and to make full use of the economies of scale. Then, the width problem might occur. This implicates for a common vessel (GMS type) a stowing scheme of either one or two rows of European ILUs and two or three rows of maritime units side-by-side, or a carriage of the European units on the uppermost layer. Operators can already handle this question of stowing patterns in their daily business, using the stevedores´ knowledge as well as intelligent stowing software systems.

3. The more often frictions within a multi-modal transport chain occur and the more often transhipment is needed (e.g. between the UK and Switzerland using different transport modes), the higher becomes the importance of transhipment costs. As inland waterway shipping shows economies of scale in pure waterway transport, it is important to keep the transhipment costs in an adequate measure. This can be achieved through a use of the “long” class A loading units (length 40’ or more) because of less transhipment costs per pallet/per ton.

4. Inland waterway terminal operators should consider to invest in 45’ spreaders to comply with the trend towards 45’ long ILUs, especially when the handling equipment is to be purchased new / refurbished.

5. Market parties involved could engage in ILU standardisation process. They should coordinate their activities by following the standards elaborated.

6. Shipbuilding industry shall continue with the development of inland waterway barges with wider holds and simultaneously compatible to existing locks on inland waterways.

7. Associations and stakeholders shall promote the use of the recommended ILUs and disseminate successful examples and best practises of their commercial use.

5.2 Actions to be taken by the EU

The European Union (EU) can also contribute to a wider acceptance of European ILUs and intermodal transport in inland waterway shipping:

1. The initiative of the European Commission (EC) for a proposal of a EU-Directive concerning the harmonization of ILUs to promote intermodal transport, containing questions like harmonisation of handling and fixing interfaces of all new ILUs, or the standardisation of a new “European ILU”, is to be welcomed in the intermodal and

inland waterway industries´ view. The question is whether a Directive created by legal actors is suitable to enforce the wide use of the ILUs. Instead, one could rely on the result of a standardisation process, whose outcome would be achieved by the market. Then, the support for such a Directive (or standard) would be higher.

2. EU may accelerate the standardisation project "stackable swap bodies" by co-financing the project to provide additional incentives to the peer groups to engage in the standardisation process. This would facilitate the engagement and arrangements of the stakeholders involved, because to a wider extent, standardisation is based on voluntary engagement of experts recruited from industry and R&D. One measure would be an official mandate to European Committee for Standardization CEN.

3. EU should refrain from legal actions concerning periodic controls similar with the ones foreseen by CSC, because CSC already covers all boy type ILUs anyway: It covers stackable units with top lift fittings. Every action concerning safety in ILU operation etc., therefore, shall be discussed in context with CSC. The EC is invited to check with the current wording of CSC and to confirm that the EILUs foreseen in a possible directive proposal and in European standards are included in CSC.

4. EU initiatives like the PACT or the Marco Polo Programme help to enhance intermodality, also in the inland waterway sector. Such programmes support actions in the freight transport, logistics and other relevant markets. These actions should contribute to shift the road freight traffic to short sea shipping, rail and inland waterways or to a combination of modes of transport in which road journeys are as short as possible. A use of European ILUs might be one of the measures to achieve the modal shift, and for this reason, it justifies European support (be it in operation or in dissemination of some "learning actions").

5. Concerning inland waterway infrastructure, to overcome the "width" problem mentioned above with the bottlenecks "locks on inland waterways", it is not recommended to consider to rebuild the network of European inland waterway transport locks. Even without a deeper cost/benefit analysis it seems clear that the enormous costs cannot be justified by the benefits of an accommodation of wider or an additional row of European loading units within the holds of inland waterway vessels.

6. One could start a European initiative to intensify the change from 40' spreaders to 45' spreaders at the terminals, be it by a promotional campaign or possibly even by a

European Commission subsidy program. This would help to increase transhipment productivity and to make inland waterway transport with ILUs more competitive.

7. Concerning R&D, EC should continue to observe the development in that field "ILU in inland waterway shipping " with a view to early identify upcoming problems.

8. Furthermore, education offers for actors such as forwarders, terminal operators, policy makers or railway operators should be considered to promote the acceptance of European ILUs in connection with inland waterway shipping.

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