COMMISSION OF THE EUROPEAN COMMUNITIES

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INTEGRATED CONCEPT

ON COMMERCIAL VEHICLE DIMENSIONS

(Communication from the Commission)

CONTENTS

1. Introduction

1.1. Reason for the paper

When Directive 89/461/EEC on the dimensions for articulated vehicles was adopted on 18 July 1989 by the Council of Transport, the following statement was entered in the minutes of the meeting:

"The Council asks the Commission to develop an integrated concept covering the following areas :

- commercial vehicle dimensions;
- minimum dimensions for the cabins of combined vehicles;
- load area dimensions;
- dimensions of load units such as swap bodies and containers;
- compatibility with existing infrastructure;
- traffic safety;
- efficiency of transport;
- environmental protection;
- reduction of road congestion;
- pneumatic suspension of vehicles and equivalent types of suspension less harmful to highways and bridges.

For this purpose the Commission could usefully take account of the present discussions between the IRU (International Road Transport Union) and the automobile industry and of the work being carried out in the framework of the Economic Commission for Europe (ECE, Geneva) on the dimensions of swap bodies and containers.

Such an integrated concept should curb the constant increase in the dimensions of vehicles and load units and should avoid the need for individual decisions to be taken on the basis of de facto situations. It should also enable consideration to be had for the problems of developing European-wide combined transport, which failed to be resolved by increasing the maximum authorized length of articulated vehicles to 16.5 metres."

This paper, together with the annexed reports, cover the subjects mentioned in the Council statement. It concludes with guidelines that should form the basis for a global policy.

1.2. Structure of the paper

The different items in the Council statement, such as safety and environment, cover wide areas which could be examined in great detail.

It is obvious that for the purposes of this paper these areas should only be dealt with in so far that they are related to the other issues and in particular to the issue of commercial vehicle dimensions which was the basic reason for the Council request.

Moreover the areas listed in the Council declaration do not all have the same character; some of them are rather general policy aims, others are more specific means to fulfill these aims.

In this paper the general political objectives will be considered one by one in their relation to dimensions of commercial vehicles.

The issue of pneumatic suspension has less relationship with dimensions of vehicles but is important for the maximum permitted weights of axles and vehicles. Given the different character of this subject it will not be dealt with in this paper. However, the Commission will shortly submit a proposal in which the equivalence to air suspension systems is reflected in objective parameters. The possibility of a retroactive introduction of air suspension or equivalent systems to 5 and 6 axle vehicles will also be considered in the proposal. The proposal should be seen as establishing a firm base for future standards on "road friendly suspensions" for all heavy goods vehicles.

2. Efficiency of Transport

2.1. General

Efficiency of transport in the purely internal economic sense means transport at the lowest cost. In relation to the means of transport this means that the quantity of transported goods should be as high as possible and the time and costs for the transport operations should be as low as possible.

Therefore it is not difficult to estimate that in general, efficiency of transport requires the largest possible loading capacity.

If the efficiency of loading and unloading is also considered, then the loading unit should be a function of the basic modular units such as pallets which can be handled automatically.

In a combined transport operation the loading unit by itself should fit different modular systems and should be compatible with the physical limitations of the modes of transport involved.

As regards the efficiency aspects of the new standards for maritime containers, the cost of new harbour installations, ships, railway infrastructure, vehicles and load units have to be compared with the benefits in loading capacity in order to assess the economical feasibility of a change. The ISO meeting on freight containers held in London in June 1989 has called for such a worldwide evaluation of all the economic aspects before a new standard for maritime containers can be established.

This request was reinforced by the ECE seminar on increasing loading units on 13-16 November 1989 in Geneva. For these reasons the Commission has initiated a COST action in which these studies for EC and EFTA countries will be coordinated.

2.2. Loading unit standards and standardization

In the report of Annex I to this paper an extensive inventory is covering about the following issues:

- the current state and decision making process of standardization of ISO maritime containers,
- the development of domestic containers and swap bodies,
- the modular systems of packaging and the current discrepancies between the modular dimensions and the dimensions of current ISO containers,
- the psysical restrictions imposed on dimensions of loading units by
  * road infrastructure
  * railways
  * inland waterways
  * the Alpine north-south transit infrastructure.

The main conclusions of the report are the following :

- To date the dimensions of maritime containers were fixed following Americain domestic road legislation without taking into account compatibility with pallet systems or European domestic road legislation.
  At present, European road legislation is adapted to 20 ft and 40 ft ISO containers (98 % of all maritime containers) but not to 45 ft (high cube) containers nor to any larger types which may come in the future. (According to replies given to a Commission inventory in 1989 the total number of 45 ft containers that entered European harbours in 1988 was approximately 1000).

  In the current discussions for a new generation of sea containers the Community is playing a more active role and has made it clear that European infrastructure sets limits to dimensions of containers and that a new container should be compatible with modular pallet systems and the European inland container and swap body standards.

- The European inland containers and swap bodies have been developed taking into account the Community road legislation and the modular system of basic unit loads. Nevertheless, there seems to be a trend to increasing the width from 2,50m to 2,55m for non-refrigerated bodies in order to facilitate automatic loading of pallets (par. 4.3 and 4.4 of the Annex I).
  As regards length, 13,6 m for the long swap body and 7,15; 7,42 and 7,82 m for the short type are now being considered but there is also a strong wish to standardize a swap body of more than 8 m.
  The long swap body of 13,6 m is fully compatible with standard pallet sizes and fits in with recently adopted European legislation (Directive 89/461/EEC) for articulated vehicles.
  Of the lengths of short swap bodies the 7,42 m has the preference if the modular palletizes and automatic loading systems are taken into account.
  It should be noted here that a swap body of more than 8 m (8,22 m) has advantages if 1000 x 1200 pallets are transported but that only two swap bodies of such a length fit on a road train if very short cabins and couplings are used and/or the overall length of 18 m is exceeded by a metre or more.

- For the railways the dimensions of loading units are influenced by the gauges and the rolling stock. In some areas large investment will be needed to accomodate other dimensions than now.

- For the inland waterways the width especially is important. This mode of transport is better suited to the current ISO containers (2,44 m).

2.3. The influence of loading units on Community legislation

The described interaction between legislation on road vehicles and standard loading units makes clear that legislation for commercial vehicle dimensions plays a decisive role.

The maximum authorized dimensions in the EC Directives set direct or indirect limits to the dimensions of loading units.

However, as EC Directive 85/3 only applies to international traffic, different standards in national technical legislation and/or special permits lead to continuous pressure to adapt the EC legislation to newly developed loading unit standards. The most obvious example is the width of the vehicle, where in most national legislations a greater dimension is allowed because of the pressure from industry to facilitate the transport of two adjacent pallets which is the most efficient method (par 4.3 of Annex I).

A second example is the 45 ft container a limited number of which are transported in national transport operations although in Directive 85/3 as amended by 89/461 the maximum load length is fixed in such a way that 45 ft containers cannot be transported as it would necessitate an extra length of 0,50 m of the articulated vehicle.
Similar problems can be expected when the Commission proposal on the maximum load length of the road train is adopted and Member States allow longer load lengths in their territory.

Therefore it is essential that the maximum authorized dimensions as fixed for international traffic should also be applied for national transport.

Agreement should be reached that special permits for exceptional transport are only issued to real indivisable loads and not to vehicles, such as car transporters and vehicles transporting oversized containers, whose contents can be carried in other vehicles with no difficulty.

Finally it is necessary to develop common rules about the way loads should be allowed to project at the front or rear of a vehicle. Current interpretation of some Member States leads to 18 m long vehicles that including the cargo have a total length of 20 m (e.g. car transporters).

It is clear that the load area dimensions of vehicles will only be stabilized when these are fixed in such a way that no local nor national variations are advantageous and/or permitted any more.

2.4. Compatible systems of loading units

An important question is how far legislation on vehicle dimensions should be adapted to the loading units in order to promote certain kinds of interchangability in combined transport. This case is of special importance when the load lengths of road trains and of articulated vehicles are fixed by legislation for reasons that will be explained in the following paragraphs.

If these load lengths were fixed so that they were totally compatible, this would mean that it would be possible to transport the same two swap bodies on a road train or on a semi-trailer. Especially for transalpine combined transport it would be preferable that the same swap bodies be carried by both types of vehicle at both ends of the train journey.

In order to make an assessment of the effect of such an approach it is necessary to consider the current situation.

In Europe the two combined vehicle types, road train and articulated vehicle are not equally distributed. Annex II reflects the distribution in 1988.

At present in virtually all international and national legislation the permitted overall length for road trains is longer than the total length for articulated vehicles. This difference results in a longer load area for the road train.

The reason for this difference is the road performance of the two systems. The road train can better be turned around corners and the sweeping out of the back of a road train is less than that of an articulated vehicle of the same length. Therefore the latter in some cases must be equipped with steering axles on the semi-trailer. In addition the braking performance of a road train can be better than that of an articulated vehicle. These factors have been assessed by legislating authorities and have resulted in a greater admitted overall length for the road train than for articulated vehicles.

In the recently adopted Directive 89/461/EEC, the total authorized length of an articulated vehicle is 16,50 m. This length is the upper limit to which most government experts and the Commission wish to go, taking into account the fact that longer vehicles would require in all cases steering axles on the semi-trailer and the manoeuvring of such longer vehicles in traffic would be detrimental to road safety. Self-steering axles are also considered to render this combination inherently unstable.

As a next step in Community legislation there is the proposal on the load length and overall length of the road train (1). The following two approaches were possible in this context.

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- Using the same philosophy as for the articulated vehicle means fixing the dimensions at the upper limits which are technically and politically feasible and leaving it to users to find the optimum dimensions for their purposes within these limits.

- Fixing load areas on the road train which are compatible with the shorter load areas allowed for articulated vehicles in order to provide integrated combined transport.

Although the promotion of combined transport is certainly one of the political priorities, the Commission has chosen the first of these two approaches for the following reasons:

- It is unjustifiable and inefficient to limit the possibilities of many users of road trains who do not use combined transport.

- If it is necessary to apply a fully compatible system, then the road train can be used with dimensions below the maximum admitted matching those of articulated vehicles.

- It should be recognized that articulated vehicles and road trains are two different systems with different advantages and disadvantages that should not be harmonized along the lines of the most limited possibilities.

- It is very possible to have two systems of combined transport co-existing, namely short swap bodies and 20 ft containers along with long swap bodies and 40 ft containers.
  Taking into account the high percentage of road trains both in the FRG and Italy the industry has already adapted to this situation.

3. Cabin dimensions

3.1. Introduction

The concern about decreasing cabin dimensions caused by the tendency to make vehicles more productive, was the main reason why the Commission proposed amendments to Directive 85/3/EEC for the dimensions of articulated vehicles (adopted in Dir. 89/461/EEC) and for the road train (on the table of the Council).

In order to clarify the situation on cabins the following should be examined:

- which types of existing cabins are now on the market and which are the current tendencies;

- what kind of cabins should be envisaged and how should the legislation on road vehicles be adapted in order to promote cabins which are socially acceptable.

3.2. Existing cabins and tendencies

In Annex III an overview is given of the cabins which are produced by the European truck manufacturers. These cabins can be classified into two types:

A. Short cabins, with or without a bed above the seats (top sleeper);

B. Long cabins with a bed behind the seats (back sleeper).

Taking into account only the cabins that are considered to be economically and socially acceptable, the difference in length between short cabs and long cabs, which are currently on the market, is about 40 cm.

However, also ultrashort cabins are produced by manufacturers and specialized firms in order to create additional load length. In these cases the difference between them and long cabins is certainly more than 40 cm

The general tendency for volume transport is certainly further to decrease the dimensions of cabins. Furthermore, manufacturers or transport operators that do not wish for these cabins are forced to use them for competitive reasons.

3.3. Legislation for better cabins

As regards the desired type of cabin, the discussions in special working groups of the social partners have until now not resulted in final conclusions. However, it was agreed that 1,60 m should be considered as a minimum for a cabin without a bed (the day cab). For the sleeping place the unions expressed the wish to have a width of 80 cm and to have this sleeping place behind the seats (back sleepers). The employers were of the opinion that also a sleeping place above the seats should be possible (top sleepers).

The discussion concerning top sleepers is a difficult one. The unions have provided a list of arguments against the top sleeper (Annex IV) and a survey in the Netherlands of 400 drivers, has shown that about 50% of the drivers are of the opinion that the top sleeper, even if it fulfils all conditions on comfort, is still not acceptable and another 25% prefer a back sleeper. Employers argue that in the future only a maximum of 9% of transport is high volume transport which may involve top sleepers and that only the drivers who accept top sleepers would drive with it.

The outcome of the on-going discussions is not clear and economic interests will certainly influence the positions.

The Commission has taken on safety and social grounds the view that enough space should be available for a drivers cabin with a bed behind the seats. An additional argument for this position is that future requirements on comfort and insulation may create problems for placing the engine in short cabins.

The proposals made by the Commission for articulated vehicles (adopted June '89) and for road trains fix the load length of vehicles in order to guarantee enough space for a cabin of the long type.
If short day cabs are fitted, this will not lead to increased productivity but to a shorter vehicle.

It is also to be expected that if the Commission proposal for road trains is adopted the economic pressure for short cabins will be removed and a more fruitful discussion on the detailed specifications of different types of cabin can take place.

In this context it may be useful to mention the experience in the USA where at the end of the seventies ultra short cabins gave rise to union actions and the establishment of a commission to study cabin dimensions. After several years of discussion without results the US authorities decided to fix the load length of vehicles and this resulted in the well known large and comfortable cabins on the American roads and the abolition of the cabin commission.
Although the European situation makes it necessary to fix both the load length and the overall length of vehicles, it can be expected that the approach in the Commission proposal will lead to similar developments.

4. Environment and road safety

4.1. General

For inland transport, any decision on dimensions of loading units and consequently on the dimensions of road vehicles has, as well as the economic implications, also to take account of the political aspects and the impact on environment and safety.
For road transport these additional effects in fact set the real limits to the dimensions of vehicles bearing in mind the obvious economic advantages of greater vehicle dimensions for operators and the fact that infrastructure costs are paid by governments.

A rather simple approach of the interested parties which are in favour of larger units is to point out that a larger volume of vehicles will reduce the number of vehicle trips and consequently will lead to less environmental pollution, fuel consumption, traffic congestion and accidents. In other words, a direct link is made between the effectiveness of transport and safety and environmental advantages.

The conclusion of such a simplification is "the bigger the better" and this would lead to enormous dimensions of vehicles. Obviously the political and technical reality is different.

Increased dimensions of load units and consequently vehicles, will reduce the number of trips for the same quantity of high volume goods.
However, this reduction will only affect the fully laden trips of about 9% of the lorries and differs widely in its effect depending on the kind of cargo.
For instance in the case of automatic loading of palletized goods the difference in loading capacity between 7,42 and 7,82 swap bodies is zero! (see fig. 4 and 5 of Annex I).

For palletized goods to have an advantage in loading capacity only the introduction of considerable differences in loading volume to coincide with the modular system of 800 x 1200 or 1000 x 1200 will make sense.

The beneficial effects of less trips for certain types of vehicles with certain types of cargo may be reduced or even turned into disadvantages by the fact that less cargo is transported by means of combined rail/road transport. This may be caused by a more competitive position of road haulage if larger units are allowed or by the fact that certain loading units are not compatible with existing railwagons.

4.2. Specific road safety aspects of combined vehicles

Next to the influence of the number of vehicle trips the configuration of the vehicle itself has an obvious effect on road safety.
The most important aspects are:
A. manoeuvrability
B. space occupied by the vehicle (length, width),
C. driving performance such as braking, stability etc.

Ad A In Directive 85/3/EEC lastly amended by 89/461/EEC technical parameters are given in order to control the above-mentioned factors. All vehicles must be able to turn within a swept circle with an outer radius of 12,5m and an inner radius of 5,3m (see Annex V). This condition is an indication of the manoeuvrability of a vehicle. However, a vehicle that is able to turn within the swept circle cannot automatically be considered to fulfil all the essential requirements for manoeuvring safely in traffic.

It is for instance important that the back of the vehicle, in a turn follows as far as possible the track of the steering axle. If this is not the case, street corners are cut or the back swings out and the vehicle can be considered to be unsafe for other road users.
In some national legislation next to the swept circle the turning around a right angled corner in a narrow street is introduced as an additional requirement for manoeuvrability (see Annex VI).

The EC swept circle, together with the length restriction for the different types of vehicles, provide a good and easy means of indicating vehicle performance. However, bearing in mind the above considerations, it is not realistic to isolate from these restrictions only the swept circle and conclude that any vehicle meeting the swept circle requirement should be acceptable for EC traffic. Especially in the case of articulated vehicles it is, by fitting steering axles to the semi-trailers, possible to go further than the present length limit but safety will certainly decrease.

Ad B As regards the width of vehicles, the width for which roads were designed is important taking into account the necessary space for other road users and overtaking manoeuvres.

Present Community legislation allows 2,50m for normal vehicles and 2,60m for certain refrigerated vehicles. The latter dimension was introduced in order to facilitate the loading of two adjacent pallets in vehicles with insulated thick walls. It was acceptable on the assumption

that this concerns only a small part of the vehicles which would limit the danger for other road users.
In national legislation the dimensions allowed vary from 2,50 to 2,60 m (see Annex I). There is clear pressure to also increase the width for normal vehicles with rigid walls in order to facilitate automatic loading etc.
Several Member States have indicated for road safety reasons that 2,55 m is really the upper limit that can be allowed taking into account the width of the roads.

The most important influence of the length of a vehicle on road safety is obviously the longer overtaking time that is needed. It should be noted though that this time does not increase proportionally with the length. All overtaking vehicles use long distances before and after the vehicle that is to be overtaken.
A traffic study was performed in Sweden by National Road & Traffic Research Institute in order to elucidate the effect of vehicle length on the accident risk when overtaking long vehicle combinations. Also the influence of a vehicle mounted sign indicating the length of the vehicle was investigated. The experiment was performed as a full scale test in a real traffic environment. Two test vehicles, 18 and 24 metres long respectively, were driven simultaneaously along the test sections at a constant speed of 70 km/h and 10 km apart. Overtaking processes were recorded by means of film cameras on the roof of the test vehicles. The test vehicles covered a total mileage of 13.640 km during the test period of eight weeks.

The time gap was used as a measure of accident risk, i.e. the number of seconds elapsing between the conclusion of an overtaking operation and the time when the overtaking vehicle meets or could have met an oncoming vehicle. The differences in mean values of time gaps between the two vehicle lengths were very small. There was a slight tendency for the 24 metre vehicle to induce a greater number of hazardous overtakings than the 18 metre vehicle, but this difference has not been statistically proved. The signs mounted on the vehicle and indicating vehicle length were found to improve meeting margins.
It is clear that the lengths used in Sweden are out of the question in Europe but the results of their study indicate that the real impact on road safety of an increased length is probably rather limited.
At present the maximum permitted length in the Community is 18,00 m but many Member States allow a certain tolerance up to 18,35 m.
This length seems to be at present a political limit and the current proposal of the Commission for the road train is based on this length.

Ad C The driving performance of a vehicle related to safety concerns its stability when manoevring, braking etc.
For vehicle combinations, the reliability and construction of the mechanical coupling systems and the stability against jack-knifing play an important role.

As regards coupling systems, the demand for more load length has led to development of space saving systems especially for road trains.

At present in principle three systems are used:

- Normal coupling systems which require a distance of about 1,50 m between truck and trailer (Annex VII).

- Short coupling systems where the coupling beam is fixed under the truck in order to increase the radius of turning of the trailer. For this system a minimum distance of 0,70 m is required and it can only be applied with a central axle trailer. These trailers are safe in so far as the load is well distributed (Annex VIII).

- Extendable couplings which are systems where the distance between the truck and the trailer is automatically increased when necessary (Annex IX)

This last system is a rather expensive device by which the distance between truck and trailer in stationary circumstances can be reduced to less than 10 cm. The only reason for operators to buy such an expensive system is that it reduces the overall length of the combination when measured in a stationary position. However, if the vehicle is driven around bends and on slopes, this overall length is increased by the extendable system. Apart from the question that such a system breaks the spirit of the law which is made for circulation and not for the parking place, there are doubts as to whether such systems will stay reliable in all circumstances on all roads.

The risk of jack-knifing depends on the distribution of brake forces if a vehicle combination brakes. In general it could be said that articulated vehicles have more tendency to jack-knifing because of the relatively lower mass of the tractor unit compared with the semi-trailer.

4.3. Conclusions on environment and safety

The environmental performance of road vehicles is improving steadily but this effect is erased by the continuous growth of traffic. A change of the load length will have an effect on the number of trips needed but it could also influence competitiveness of rail transport. Moreover the effect of a changed load length should be seen in a realistic light.

Assuming that 9% of road haulage concerns volume transport and assuming that an average change of load length is about 5%, that would mean in the worst case a change of trips of about 0,5%. This is probably an overestimate since on not all trips will the full load length be used.

If a 0,5% change is considered in the context of the normal annual 4% increase of road haulage by economic growth, then it is clear that the solution to environment problems is not to allow larger volumes since they would only cover the normal economic growth of a few weeks. Environmental protection should be tackled by an improvement of vehicle conditions within the technical possibilities and a major promotion of combined transport.

As regards the road safety aspects, it is clear that legislation should steer technology into safer developments. However even if a further increase of length and width may be possible on technical grounds, any proposed change must take account of the political will which is invariably based on public acceptances; it is clear that acceptance of greater dimensions becomes more and more difficult, whether or not this is based on economical arguments.

5. Conclusions and guidelines as regards commercial vehicle dimensions

Following the request of the Council, in this paper the issues related to commercial vehicle dimensions have been considered . The following conclusions summarize the contents of the paper.

- Legislation is the main tool of governments to steer the process that should lead to the compatibility of transport systems. However, as argued above, the key role of legislation is in principle a restrictive one as, for efficiency reasons, there will be a continuous pressure for greater dimensions. In legislation the factors that set limits to this tendency, such as safety, infrastructure and social requirements are reflected.

  Current Community legislation has developed after long discussions and should be seen as compromises taking into account the factors described above.

- Industry has always quickly adapted its vehicle types to the legal possibilities and legislation has also been amended in cases of structural problems where these could be solved within the limits set by the other factors. Examples are the increased width for refrigerated vehicles and the recently fixed amended dimensions for articulated vehicles.

  Therefore, it would be a mistake to assume that the current situation is lacking in coherence. The 20 ft and 40 ft containers can be transported by all modes and types of vehicles, swap bodies are compatible with pallet sizes and combined transport systems etc.

Interactive adaptation of industry and Community legislation has led to a certain integration of transport systems. However, it should be pointed out that at the same time tendencies towards divergences in this field are caused by the fact that Community legislation until now only concerns international transport and national authorities have laid down different legislation which often gives relative advantages to their own industry, harbours, hauliers etc. The only way to stop this process and the consequent on-going pressure to change international legislation is to extend the scope of the Community Directives to national transport and to set clear standards for the issuing of special permits for exceptional transport.

- To force transport systems to become compatible by means of legislation would limit the possibilities of operators that use other systems. EC legislation on road vehicle dimensions should set realistic and fair limits and the industry should have the freedom to develop compatible systems within this framework.

- At present Community legislation is contained in six Directives (85/3/EEC and its amendments) and covers most characteristics of commercial road vehicles for the carriage of goods and passengers transport in international traffic. Furthermore, a proposal to fix the load length and the total length for road trains is on the table of the Council.

It is important that the missing elements in EC legislation are adopted as soon as possible in order to give clarity to the transport world.

Bearing in mind the above considerations the following guidelines should be followed for the completion of the package of legislation and standards related to the dimensions of commercial vehicles.

- Any standardization in the fields of maritime and inland containers should take into account the intermodal transport of the standardized loading units and the limits set by European road and rail regulations,

- The sizes of European loading units to be considered in an intermodal concept should be based upon the basic modules 800 mm x 1000 mm and 1000 mm x 1200 mm;

- The maximum vehicle dimensions and weight limits that have been secured for international transport in Directive 85/3/EEC should also apply to national operations;

- The regular authorization by way of special permits for the movement of commercial vehicles with weights and dimensions above those contained within the Directives should be prohibited;

- Common rules should be developed on the limits of projecting cargo at front and rear of vehicles.

- The standardization of containers should be endorsed and the negative effects of enlarging load volumes at the expense of drivers cabins or coupling systems should be avoided by fixing load lenths;

- The setting of maximum authorised dimensions of vehicles should be based on the different technical possibilities of the different types of vehicle combinations.

ANNEX I

REPORT ON LOADING UNITS STANDARDS AND STANDARDIZATION

PART A: Actual situation as reagards load unit standards

PART B: Impact of standardized load units in transport infrastructure

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A. Actual situation as regards loading unit standards

1. World-wide standardization of maritime containers

1.1. Standardization bodies

International standardization of intermodal containers to be used in road, rail and sea transport is exclusively done by the Technical Committee 104 of International Standardization Organization (ISO). ISO is an international private organization with its head office in Geneva. Members of ISO are the national standardization bodies whether these national organizations are private industrial associations or governmental authorities.

Technical Committee 104 (TC 104) "Freight Containers" deals since the early 1960s with the standardization of freight containers.

At present, TC 104 has the following structure: Sub-Committee 1 (SC 1) deals with all matters concerning general-purpose containers, i. e. those containers having no special features to accommodate specialized cargo. Within SC 1, the Working-Group 1 (WG 1) deals with dimensions, ratings, specifications and testing procedures of general purpose containers. As far as possible, these features are applied, as well, to all special purpose containers. This gives the decisions of TC 104/SC 1/WG 1 a far reaching impact.

Within SC 1, Working-Group 2 (WG 2) is active in the standardization of handling and securing of containers.

Sub-Committee 2 (SC 2) deals with special-purpose containers. Within that sub-committee, a working group works on the standardization of thermal containers, i. e. containers with temperature-isolation, with or without a machinery to produce cold (or hot) air. Another working group works on tank-containers for the intermodal transportation of liquids and gases, while a further working group works on tank-containers for the intermodal transportation of liquids and gases, while a further working group works on special containers to transport materials such as granulate, powder or similar in bulk; these containers will be discharged by gravity. Finally, a working group has been installed to standardize the interface of remote temperature control systems for refrigerated containers.

All these working groups report to the appropriate sub-committee.

Two further working groups have been set up which both report directly to the Technical Committee: Working Group 3 deals with marking and coding of containers; i. e. with all systems to identify the identity of a container, to name special features of this container and to transmit this information correctly to the interested parties. This working group has been transformed into a Sub-Committee and is named Sub-Committee 4. Finally, a Working Group 4 is elaborating the basic principles of future containers, i. e. of such containers that deviate from the containers in use today.

Some years ago, a joint committee of ISO/TC 104 and ISO/TC 20 Air Transport had been established to work on a standard for an air/-surface transport intermodal container. After the completion of this standard, the working group had been disbanded.

Outside TC 104 some international standardization bodies work on containers that are outside the interest of this study; such containers have mainly the character of standard packages, air transport units or similar devices.

On European level, a Technical Committee 119 of European Standardization Committee (CEN) works on the Standardization of European domestic containers for road and rail intermodal transport. These containers share many technical features with ISO freight containers. A similar task is done in North America by a US national standardization group.

1.2. Decision making structure

All international standardization work is based on the establishment of an international consensus as broad as possible. Decisions are taken in international meetings either by voting or in writing by a letter ballot. Most decisions are prepared in the appropriate working group. Members of those working groups are experts who are nominated by the national standardization committee dealing with containers. These experts are - of course within the limits of reasonable action - free to decide and suggest whatever they feel to be appropriate. They do not vote on behalf of a national standardization organization.

In Sub-Committees and in the Technical Committee, the decision making is more formalized. In these bodies, the votes are given on behalf of a national standardization body.

Those national standardization bodies only that have been registered as "Participating Members" ("P" members) of the Technical Committee may vote. Other member associations that have the status of an "Observing Member" ("O" member) may not vote.

The membership of TC 104 is by no means closed. Any national standardization organization that feels inclined to work on the international container standardization can easily become a "P" member of TC 104. Just recently, e. g., the German Democratic Republic has announced its wish to participate in the work of TC 104 as a "P" member.

Some final observations have to be made: Since all experts or participants to the meetings of international container standardization have to cater for their own travel expenses and costs of living during the meetings - these costs in most cases either being raised by their employers or by a national organization -, the attendance and influence capacity is limited to those that are capable to get the necessary funds. This might exclude some interested but financially weak parties from participation in the standardization work.

All voting procedures try to arrive at a very high majority. In the field of containers, everybody knows that the vast majority of container ownership is concentrated within a few countries, i. e. USA, Japan and the EEC countries. So, any voting that does not take into account vital interests of those countries will, most likely, lead to a standard that will finally not be used. In fact, up to now any standardization activity in the field of containers had been based on a compromise that included a positive approach of these countries.

1.3. Current state of standardization of ISO series 1 containers

In the 1960s, three series of ISO containers had been standardized. Since only the large containers of "series 1" have been effectively used in international trade, the standards for smaller containers (series 2, series 3) have been dropped later on.

From the very beginning, a constant trend to include larger and stronger containers into the ISO standards could be observed. This enlargement concentrated on height because the width and the length of the containers had been limited by legal limitations and by the size of the cells of the container-ships.

The width had been limited to 2438 mm (8 ft.) because at that time many countries including North America and a large part of the English speaking world allowed this width as a maximum in road traffic.

The length had been standardized, finally, in a 10 ft. modular concept, arriving at a maximum of 40 ft. (12.2 m). This clearly exceeded the maximum length allowed for semi-trailers in many countries of Europe and some states of the USA at that time. So, smaller containers dominated in some trades, e. g. 30 ft. (9.1 m) in the trade between the European continent and Great Britain.

In the early state of standardization, a height of 2438 mm (8 ft.) had been standardized for all containers. But soon the transport industry deviated from this standard and introduced containers of 2591 mm (8 1/2 ft.) height. In the end, the vast majority of containers had been built to that height and did no longer comply in all details with the ISO standard. When the majority of the world container fleet had arrived at that height, ISO followed this development and included the 2591 mm high container in its standards.

This development created some problems to the road transport industry: The transport of a container of that height on a container chassis within the common overall road vehicle height limitation of 4000 mm, made a goose neck construction for the semi-trailer that carried the container necessary. This added total length to the articulated vehicle, so that a 12.2 m long container of 2591 mm height would clearly exceed the 15 m length limit for articulated road vehicles being in force at that time. In consequence, a 12.2 m long and 2591 mm high container had to be transported over the road by use of an extra permit. These extra permits were easily issued in most countries on the European continent, because no authority wanted to exclude the traffic of 40 ft. containers from their national ports.

Meanwhile, an increasing number of containers has a larger height than the current standard. These "high cubes" have an external height of 2900 mm (9 1/2 ft.). There had been, in the past, several attempts to include these containers into the ISO standards. Meanwhile, these containers have been included in the ISO standards at the last meeting of ISO/TC 104.

Table
DIMENSIONS AND RATINGS OF CURRENTLY MOST USED ISO-CONTAINERS

Denomination	1AA 40 ft.	1BB 30 ft.	1CC 20 ft.
Length outer	12 192 mm	9 125 mm	6 058 mm
inner	11 998 mm	8 931 mm	5 867 mm
Width outer	2 438 mm	2 438 mm	2 438 mm
inner	2 330 mm	2 330 mm	2 330 mm
Height outer	2 591 mm	2 591 mm	2 591 mm
inner	2 350 mm	2 350 mm	2 350 mm
Volume inner	65.7 cu.m	48.9 cu.m	32.1 cu.m
rating/ gross mass	30 480 kg	25 400 kg	24 000 kg

1.4. Standardization of a 2nd generation of maritime containers

Since the basic outer dimensions of ISO containers had been fixed, some important developments within the legal framework concerning road vehicle dimensions have occurred. First of all, many countries using the imperial system of units switched over to the metric system. This resulted in most cases in a small increase of vehicle maximum width from 2438mm to 2500mm.

The most important change could be observed in the USA. While in the past the regulations concerning dimension of road vehicles would vary from state to state, today a rather generous uniform size regulation is applied to the entire highway network throughout the USA. The single states of the USA may allow larger dimensions, but the US-wide regulations have to be observed as the minimum to be allowed by state legislation on the highway in each state. According to these rules, the maximum width of road vehicles was increased to 2600 mm (8 ft. 6 1/2 in) and the length of a semi-trailer was increased at first to 13.7 m (45 ft.), later to 14.6 m (48 ft.).

As far as intermodal transport was concerned, this had initially its main impact on TOFC (Trailer On Flat Car) transport, i. e. the US piggyback system in which two semi-trailers are transported on a platform rail-car with a loading length of 27.5 m. (90 ft). Even when containers were moved in intermodal transport, they often were first fixed on semi-trailers and then carried, together with the semi-trailers, on the rail-car.

These transport patterns changed gradually in the 1980s. High capacity block trains moving containers in double stack were introduced. The economics of these double stack trains were so high, that most of the container moves from the Pacific sea ports into the US hinterland switched over to this technique of transport. Some US railroad companies, such as the Santa Fe, combined the move of seaborne container traffic with domestic transport in double stack. In this endeavor, they designed the first US domestic containers according to US road regulations and no longer to ISO standards.

At the same time, American President Lines purchased the first special containers of 13.7 m length for their maritime trade. These containers are transported on deck of the container ships while the cells of the ship continue to accommodate ISO containers.

Being aware of this development, American National Standards Institute (ANSI) called together a working party on the standardization of US domestic containers.

This had been the situation when in June 1987 ISO/TC 104 Plenary convened in Ottawa, Canada. The national delegations in this meeting were well aware of two facts:

- At least in North America, some transport enterprises will continue to develop and to use containers larger than ISO.
- If the standardization work on such units was set up early and progressed quickly, a proliferation of non-standard sizes could possibly be avoided.

So, ISO/TC 104 decided to re-convene WG 4 "Future Containers" and to allocate this standardization work to that group.

The US standards association volunteered to take over the secretariat of this group.

Meanwhile, three meetings of this Working Group 4 have been convened. Up to now, these meetings did not result in compromise suggestions. Basically, the US delegation suggests the standardization of a container with the dimensions

- 14,67 m length,
- 2,60 m width,
- 2,90 m height.

The Commission of the European Communities has communicated that the member states of the Community do not intend to allow containers of these dimensions to be transported in road traffic. According to the Directives 85/3/EEC and 89/461/EEC the following dimensions are possible in road traffic:

- 13.60 m length,
- 2,50 m width.

The Europeans have, on the other hand, asked for a concept for a future container that fits into the European distribution patterns, especially those using modular built unit loads with the basic dimensions of 800 x 1,200 mm and 1,000 x 1,200 mm. The width of 2.600 mm has been questioned in this context and the length has been judged as not useful. As far as length is concerned, some Europeans suggested a concept of 7.42 m + 7.42 m = 14,84 m (49 ft.). A combination of this length can be transported on a European road train. This suggestion was recently accepted by the USA delegation.

1.5. The US viewpoint

Containerization as a transport system has originated in the USA. A large part of the container vessels are under US steamship line management. More than 50 % of all containers existing in the world are owned by leasing companies, and almost all major leasing companies are domiciling in the USA.

This describes why, from the very beginning, the USA have influenced container technique development and standardization, and why the USA continues to do so.

A second item in this field is the size of the USA. Outside the trans-Sibirian rail link there is virtually no container inland link as long as the USA and Canada transcontinental trade. As a result of this, issues of transport economy in inland haulage are of high interest in the USA. This interest is growing since in the recent years some institutional barriers against the cooperation of maritime and inland transport modes have been removed in USA.

So, the US experts participate in the discussion concerning larger containers taking the following viewpoints:

- Larger containers give so many economic benefits in the long US inland haulage that they even pay off if, on the other side of the Atlantic ocean, they are not permitted to move inland.

- In the past, many countries had difficulties to move ISO series I containers due to restrictions of their infrastructure. Most of these countries meanwhile got accustomed to these containers. Today, ISO series 1 containers are operated in almost all industrialized countries without difficulty. The same may be predicted for future container sizes.

- In containerization - as in many other systems of advanced technology - the USA had taken the lead. The more conservative Europeans often have complained at first, but later they had followed the US development.

Some figures show the estimated the use of containers larger than in ISO 668 standardized in the United States.

At present, there is a limited number of two basic types in use:

45 ft. narrow body, i. e. 45 ft. long, 8 ft. wide and 9 ft. 6 in. high.

48 ft. wide body, i. e. 48 ft. long, 8 ft. 6 in. wide and 8 ft. 6 in. high.

Furthermore, a US steamship line has bought a limited number of containers
53 ft. long, 8 ft. 6 in. wide and 9 ft. 6 in. high.

All these oversized containers counted together give a number of approximately 10,000 - 20,000.

Container types

- 45 ft. wide body (i. e. 45 ft. long, 8 ft. 6. in. wide) and
- 48 ft., narrow body (48 ft. long and 8 ft. wide)

do virtually not exist.

1.6. European port competition

Since the report "Containerization - the key to low cost transport" by Mc Kinsey & Co. had been published, the European seaports are very sensitive in all questions concerning containerization. The report, elaborated in the 1960s, had predicted that only a small number of seaports will survive in the container age - and no European seaport is willing to be the one that will die.

In consequence, each minor change in competition arrangements creates hasty political counteraction. In this economic environment, it is most likely that one or the other seaport tries to gain a better position in competition by offering terminal facilities for larger containers and easy access to anextra license for its inland transport. Because in all European continental ports some liaison exists between port operators and political government, it is rather easy for the port representative to persuade the local politicians to change road regulations in favor of larger containers.

This situation gets even more complicated as most ports serve different hinterland countries, while their political influence ends in most cases at the border of their own country.

This gives large space for delicate discussions: If, e. g., Federal Republic of Germany allows large containers that have moved through its ports to be operated in road transport into the hinterland, does Germany consequently have to allow the same for large containers imported through Netherlands seaports? If France gives as easy road transit regime for containers carried to Marseille, must France grant the same for transit to Barcelona?

This port competition problem cannot be solved by actions that are aimed at international intra-European transport only.

In the common market of 1992 this question gains additional problems. If the Netherlands grant road transport of larger containers for their national territory, these containers may move to a warehouse at for instance in Venlo or Maastrich - in short delivery distance of one of the largest German markets. Under these conditions, the German seaports will fiercely ask for the same possibility: The inland transport permit for larger containers at least to warehouses some 300 km south. If Federal Republic of Germany grants this for its inland transport, they will be asked: Why do they stop containers coming through Netherlands port at their border?

Summing up, the development of larger containers will most likely become a problem of port competition. Any European approach to that problem must include national and international hinterland road transport.

2. Development of domestic containers

2.1. Economic questions of domestic containers

When the ISO container standards had been finalized in the late 1960s, a common view of many experts predicted that these containers were to become the basic part of a uniform world-wide standardized transport system. These containers were expected to come in use not only in maritime, but as well in inland and even in air transport. For many of these experts the development of domestic containers that deviated in some important features from ISO containers created a shock. The idea of a world-wide uniformity ended.

To understand this development, one has to face the nature of an international standard: it is a compromise taking into account most of the serious restrictions of all environments where the standardized item will be used.

In the case of the ISO container, the restrictions of road vehicle width were the limiting factor. As many countries at that time did not allow more than 2438 mm width for road vehicles, it was clear that the ISO container had to take this into account if it should move without serious restrictions. And the exclusion of road traffic operation in USA, Great Britain, Canada, Australia etc. had been certainly such a serious restriction.

On the other hand, Switzerland had an even more restricted road vehicle width, i. e. 2300 mm, that had not been taken into account in container standards. In this case the experts in ISO/ TC 104 did not wish to restrict the economics of their new transport system to the conditions of the most restrictive country in the industrialized world. Such a concept certainly would have hampered the overall economics of the ISO container transport system too far.

So, the process of compromise in international standardization was the decision of which restrictions in the world transport infrastructure had to be taken into account and which not.

The standardization of maximum length of ISO container did not take into account the legal restrictions of United Kingdom, Japan, and some states of the USA in that time. Similar aspects were true with the rating of the largest units.

This was decided so expecting that some countries would adapt their infrastructure to the new values fixed. At least, where this could not be achieved, the use of smaller ISO containers could give these countries the benefit of participation in the world-wide transport system, even if their infrastructure had not been developed so far.

Since the ISO container had to take into account almost any serious restriction, the ISO container is not competitive against specialized transport systems in their own environment. While the ISO container quickly took the lead in the door-to-door transport chains that included a deep sea link, it was not used independently in such transport chains that were entirely inland. Because the ISO container had to bear the burden of the width restriction of the USA and the extra strength of the maritime transport mode, it could not compete against the more specialized road transport systems in Europe. When the European railways established their domestic container system they had to leave the ISO standards wherever these standards had taken account of special conditions of transport chains outside the European continent.

2.2. Swap bodies and inland containers in Europe

European railways very clearly identified the chance of a container transport concept: pick-up and delivery via road transport, line haul on rail. With regard to ISO containers, they had to face two shortcomings: strength and dimensions.

The ISO container concept included a high racking strength for the container (needed to accommodate the forces induced by containers on deck where up to three containers overstack the bottom one and severe transverse and diagonal racking forces occur), and a high stacking capability (a container in a ship cell may be overstacked by 8 other containers; the forces induced by the movements of the ship on sea has to be added). Both strength features can be considerably lower in pure inland transport. This enables railways to use a lighter construction - thus saving tare weight - and to add side doors to the container. The latter had been important because the railways often deliver the container through private sidings on a wagon. In this position, the container cannot easily be loaded and discharged. So, the necessity for side doors emerged. (Side doors can be, as well, applied to containers built to ISO standard strength, but only with technical difficulties and at considerable additional costs.)

The other feature was the dimension. The outer width of 2438 mm led to an inner width of 2330 mm which was not suitable to palletized traffic. In European inland transport, a growing proportion of the shipments is palletized using standard pallets of 800 x 1200 mm or 1000 x 1200 mm. (picture 1)

So, the (European) International Union of Railways UIC, at first, designed a so called "T" container, the "T" standing for

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"terrestre". This container had the same dimensions as ISO standard but less strength.

Some time later, Deutsche Bundesbahn added a revolutionary deviation of the ISO concept: They designed a container of 2500 mm outer width with an inner width of 2440 mm - just enough to accommodate two 1200 mm wide pallets side by side. This container was included in the national German Standards (DIN 15190). Its length configuration followed the ISO system with 12.2 m and 6.05 m. Later on, other railways followed this development. Today, this container type circulates throughout Europe in intermodal road/rail transport and forms the basis for the present European railway container pool. (picture 2)

Road transport developed its own units that deviated even more from ISO standards. The basic width was 2500 mm outside. The length made full use of the dimensional patterns offered by the road train:

```
          18.0 m overall length
     ./.   2.2 m driver cabin
     ./.   1.5 m coupling device
     -------------
  =       14.3 m
```

14.3 m made either a 2 x 7.15 m or a 6.05 + 8.20 m combination. Over the time, the 2 x 7.15 m combination dominated. These swap bodies had been, as well, nationally standardized in Germany in DIN 17013. (picture 3)

To be competitive with transport offers of swap body users, Deutsche Bundesbahn finally designed domestic containers of 7.,15 m length and introduced these with great commercial success into the intermodal transport market.

The swap body concept demonstrated to be the most successful transport technique in intra-European intermodal road/rail transport. Meanwhile, more than 50 % of all piggyback consignments moved internationally by UIRR Companies and more than 30 % of all Intercontainer moves are executed by swap bodies.

Since some years, CEN/TC 119 works on common European standards for swap bodies. In a first pre-decision, the following dimensions seem to be standardized most likely:

width	2.500 mm
height	2.670 mm
lengths	7.150 mm, 7.420 mm, 7.820 mm. (pictures 4 and 5)
length	13.600 mm (picture 6)

CEN/TC 119 will, most likely, standardize only such swap body sizes that can be transported on road vehicles according to the maximum outer dimensions laid down in directives 85/3/EEC and 89/461/EEC. Larger dimensions, as width and length had been concerned, were under discussion in CEN/TC 119 but have not been included into the European standards up to now.

2.3. Domestic containers in USA

Domestic containerization in USA is a considerable new development. It followed the introduction of double stack container trains between US Pacific ports and the continental hinterland.

All domestic containers that have been developed up to now make full use of the generous semi-trailer dimensions allowed in USA:

2 600 mm width
14 640 mm length
up to 2 900 mm height.

As some major states in the Western part of the USA allow meanwhile semi-trailers up to 53 ft. length, first domestic containers with this length (= 16.1 m) are built.

The strength of the US domestic containers is lower as that of ISO maritime containers, this being quite similar to European inland containers.

As corner fittings are concerned, the US development obviously goes the same way as the Europeans had gone: Bottom corner fittings are located at the same place as those of similar ISO containers, so that domestic units can be handled and transported with the same equipment as maritime containers.

3. Modular concepts in transport and their impact on transport systems

3. 1. Modular concepts in packaging and in palletization

Before the container transport system emerged, intensive standardization work had been executed on palletization and packaging. In the 1950s the discussion on European pallet concentrated on two sizes: 800 x 1200 mm and 1000 x 1200 mm. In the following years, European industry decided to adapt both sizes: one part, e. g. the chemical industry, preferred the 1000 x 1200 mm concept, while others, e. g. retail commerce, concentrated on 800 x 1200 mm. The packaging industry finally developed a modular system of packages based on the module 400 x 600 mm. This module fitted in both standard pallet sizes. Meanwhile, the majority of warehousing and loading activities are based on palletized units, most of them using one of the two standard sizes.

In this context, the arrival of a standard container with a loading width of 2330 mm created major concern, because this dimension did not at all fit into any of these modular systems (picture 1). A lot of debates followed the ISO decision.

In the packaging and unit load standardization activities, a new modular concept was suggested. This concept was based on the internal dimensions of the ISO container. The majority of European countries fiercely opposed such ideas, taking account of the billions of ECU invested in automated warehouse systems, material flow installations and handling equipment based on the modular system and its standard pallets.

In the end, the ISO Technical Committee dealing with unit loads and packaging standardized a unit load of 1000 x 1200 mm internationally.

The discrepancies between these modular dimensions and the internal width of ISO containers did not come out as disastrous as it had been expected. In international maritime trade, the vast majority of containers are loaded with mixed consignments, so that a uniform pallet system is not existing anyway. Some containers go out fully packed by unitized packages with consumer goods or spare parts of the automobile industry. In these cases, the exporters have made the necessary arrangements to alter their packages in a way that they fit into the ISO container. Today, only a few problems remain as result of the discrepancies between ISO container standardization and modular unit load dimensions.

An important impact to the solution of this problem had been the design of the domestic units with 2500 mm outer and 2440 mm inner width (pictures 2, 3). They are able to accommodate standard unit loads, but only with certain restrictions. Two unit loads of 1200 mm width each leave a nominal space of 40 mm for maneuvering - and this has to be divided by three. If the pallet has only a small plus tolerance, or if the load on the pallet is stowed with a small overhang, this concept does no longer work.

For the time being, unit loads are transported in domestic units side by side. But they need to be adequately stowed - e. g. by shrink wrapping - to fit into the system.

As result of this development, the ISO container could not operate commercially competitive in the European inland transport market. Some operations may occur, when an ISO container takes cargo on a pure inland movement on an otherwise empty positioning run, but it never played a role as a competitive means of transport compared to conventional wagon or truck, or to inland containers and swap bodies.

3.2. Loading volume of transport vehicles and modular concepts

To understand the development in the field of container standards, and to be well aware of the future desires concerning transport systems, some ideas have to be mentioned as far the optimum dimensional configuration of a container is concerned.

First of all it has to be stated that the internal volume of a container does give some information, but by far not all for its capacity to accommodate cargo.

If, e. g., the trade offers only palletized unit loads to be transported, the load carrying capacity can only be counted in pallet accommodation places. Any additional space that does not give enough stowage possibility for an additional pallet is wasted and will not count commercially.

The next item is the loading height: Some items or some unit loads may be stacked above each other. Some may be not. If the trade offers only non stackable items of, say, 1.80 m height, any loading capacity in height above these 1.80 m to 2.00 m is wasted space and does not count commercially.

Another value that influences these loading patterns is the mass-/volume ratio. If this ratio is, say, in the area of 1, this will lead to a situation where the container arrives at its weight limit before it is fully loaded.

Finally, all these calculations have to take into account the question how much labor and efforts the consignor of the container will take to load the container. If this loading is executed very carefully and done by skilled personal, many more items will go into the container than in the case of a hasty loading. So, another question has to ask: Is there a transport price arrangement that gives a bonus to the shipper if he loads the container so careful that it takes more cargo? Generally speaking, one can assume that the longer the transport distance, the more care is taken for loading. This is because the loading (and unloading) cost is not dependent from the distance which the container moves, while the transport cost depend from the transport distance. So, at a smaller distance it is more important so save costs on loading and discharging, even if the transport costs are higher, while in longer distances the additional costs for careful stowage easier can be offset by the benefits of the additional cargo accommodated in the container and transported over a larger distance. For European transport practice, these theoretical deliberations may lead to the following principles:

- Since a large proportion of European transport volume is palletized, any dimension characteristic of containers has to be made up in standard pallet accommodations, i. e. in squares of 800 x 1200 mm or 1000 x 1200 mm plus 10 to 20 mm intermediate maneuvering space between each unit load and between the cargo and the inner walls of the container.

- Since the loading height of European unit loads is in general 1.10 m for the normal item and 1.80 m for the extra high loaded one, an internal height of 2.40 m (2 normal units either stacked onto each other or with intermediate deck) for the container will be sufficient for general cargo trade.

- In the case of liquids and other materials to be transported in bulk, and in the case of many items in the family of semi-finished iron and steel products, the question for additional loading volume does not make sense. But in the majority of the cargo items being subject to European trade flows a constant desire ıor additional volume exists.

- As European transport flows are moved over relatively small distances compared to overseas trade, the question of easy and efficient loading and discharging of containers is far more important than in maritime trade.

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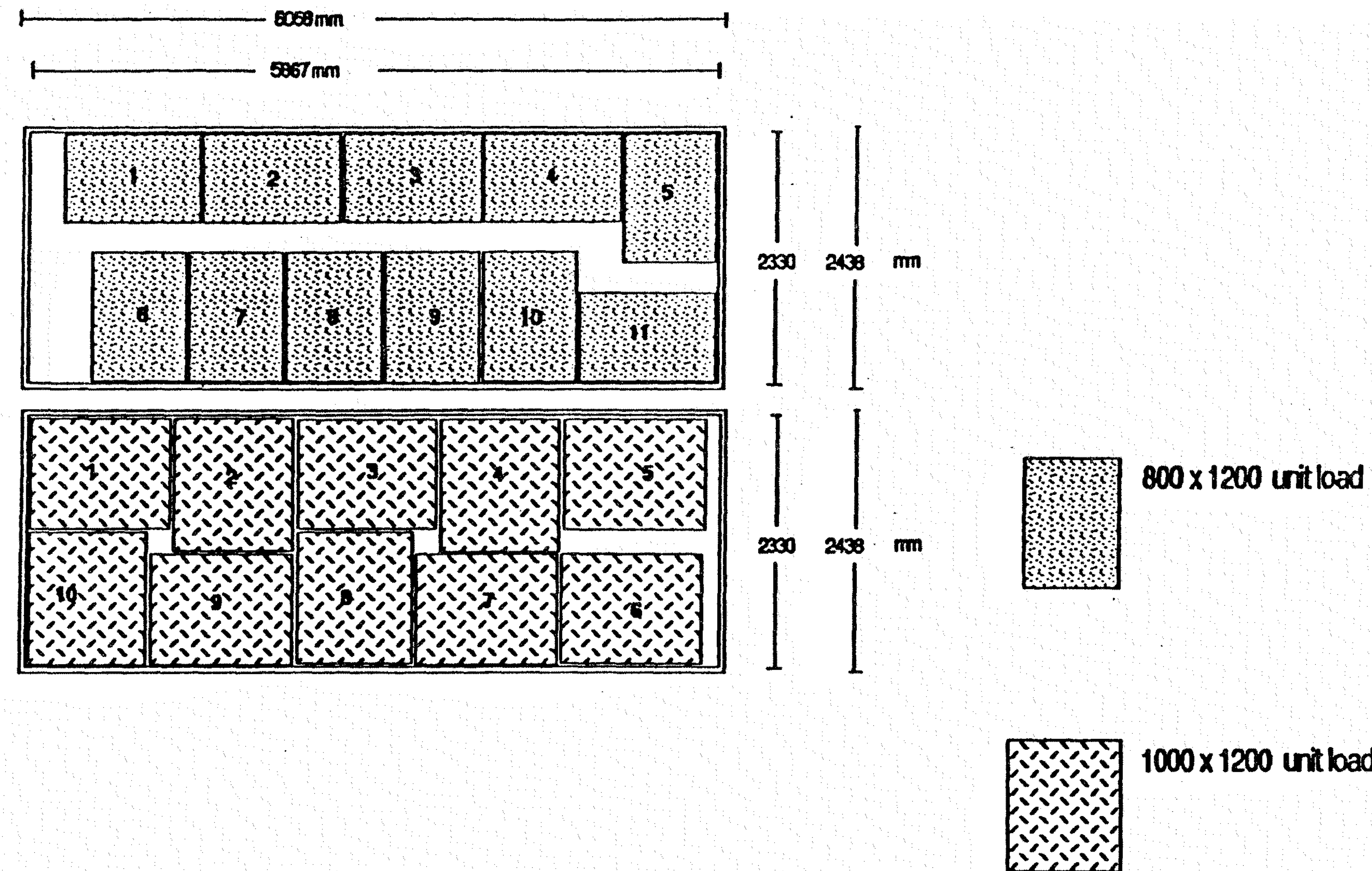
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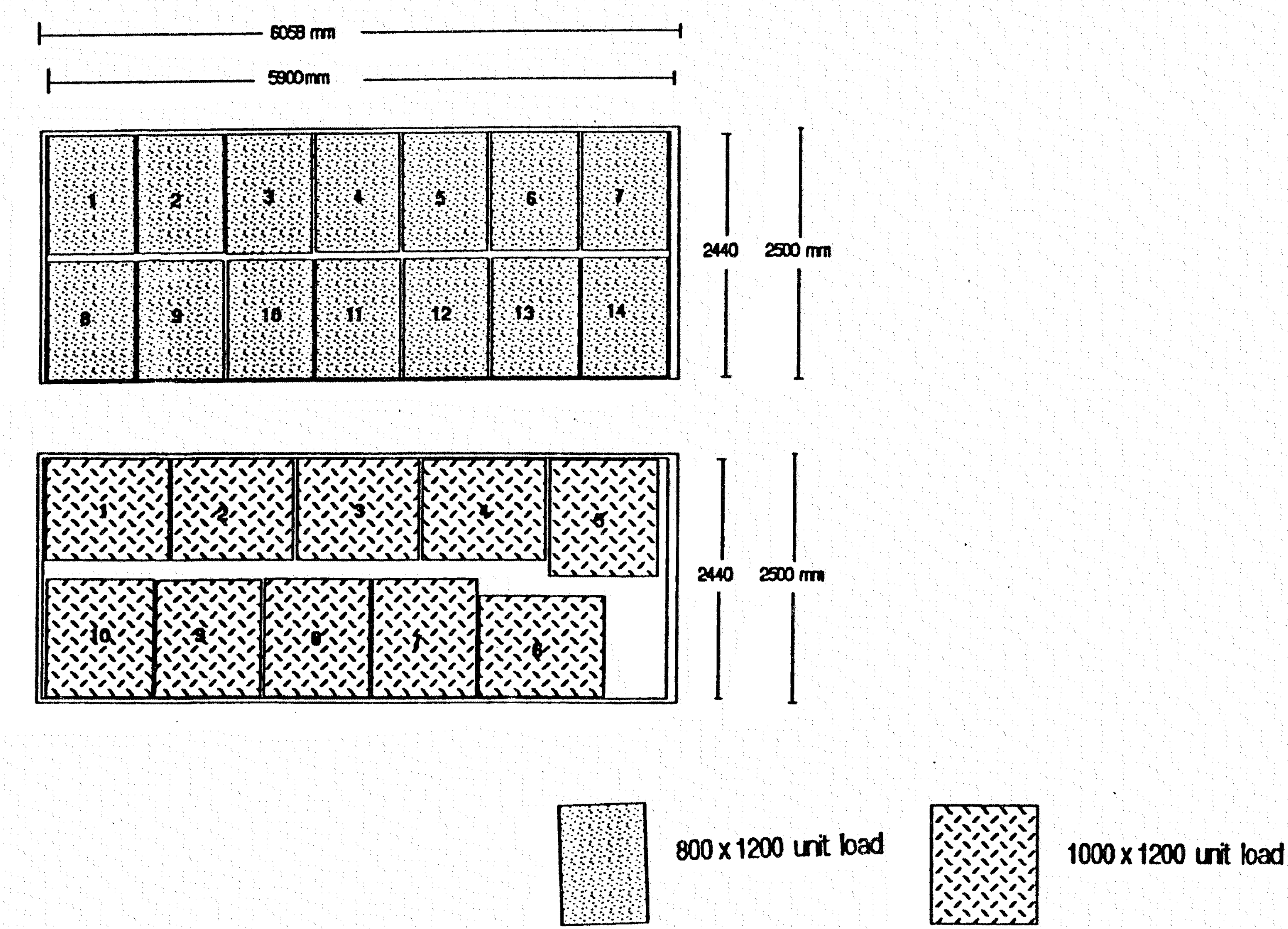


Bild 2: 20' - Binnencontainer

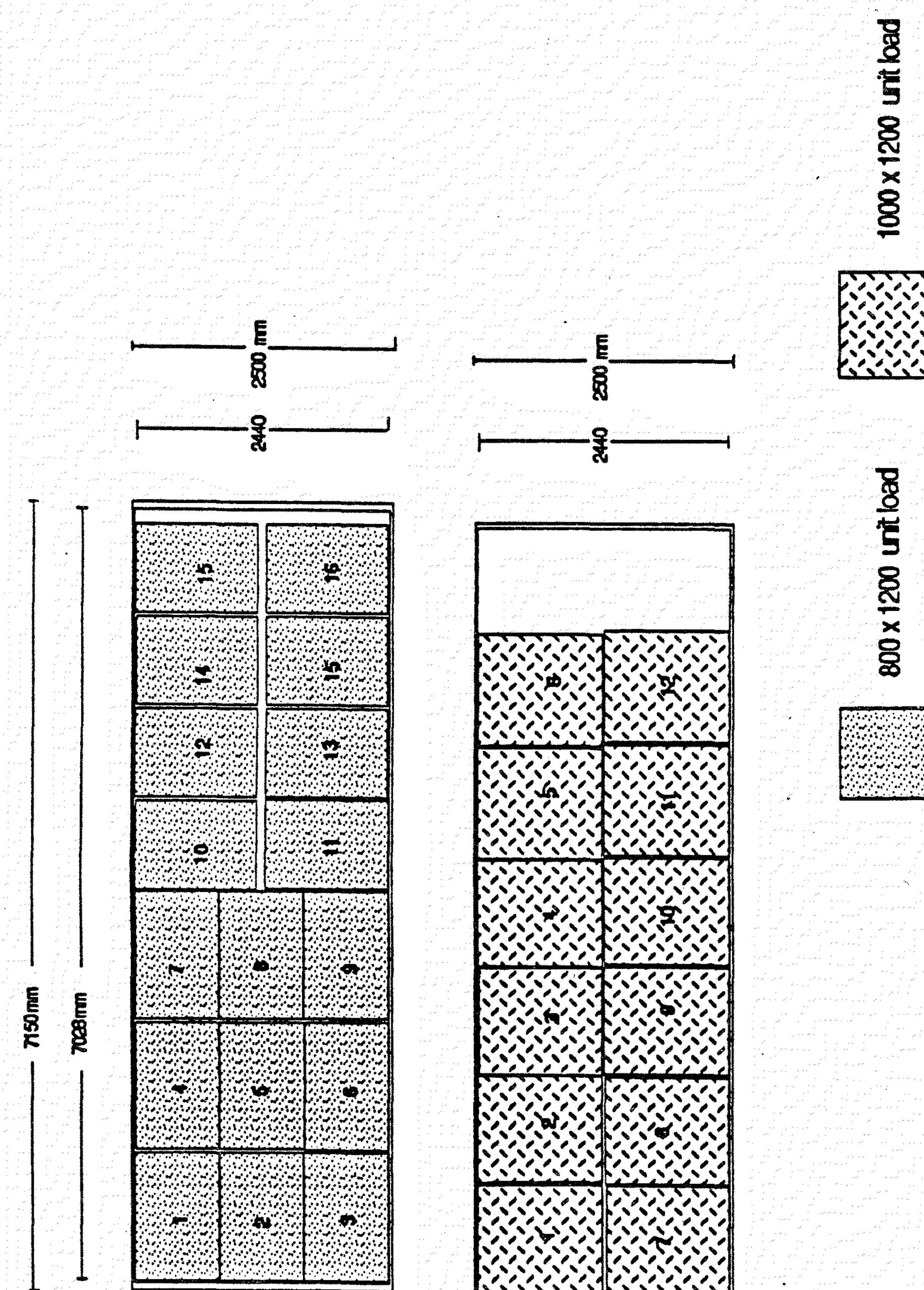


Bild 3 : 7.15 m - Binnencontainer

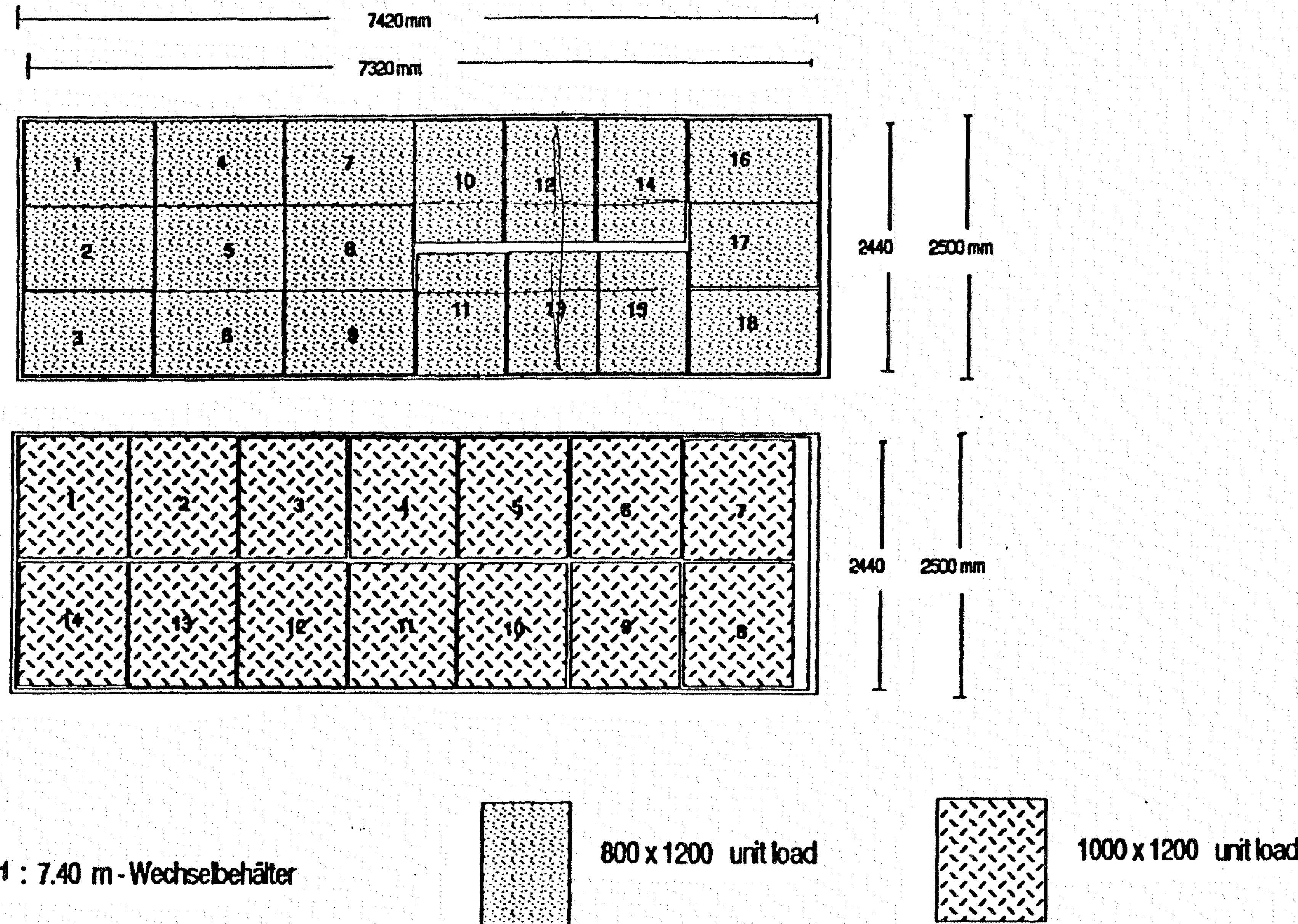


Bild 4 : 7.40 m - Wechselbehälter

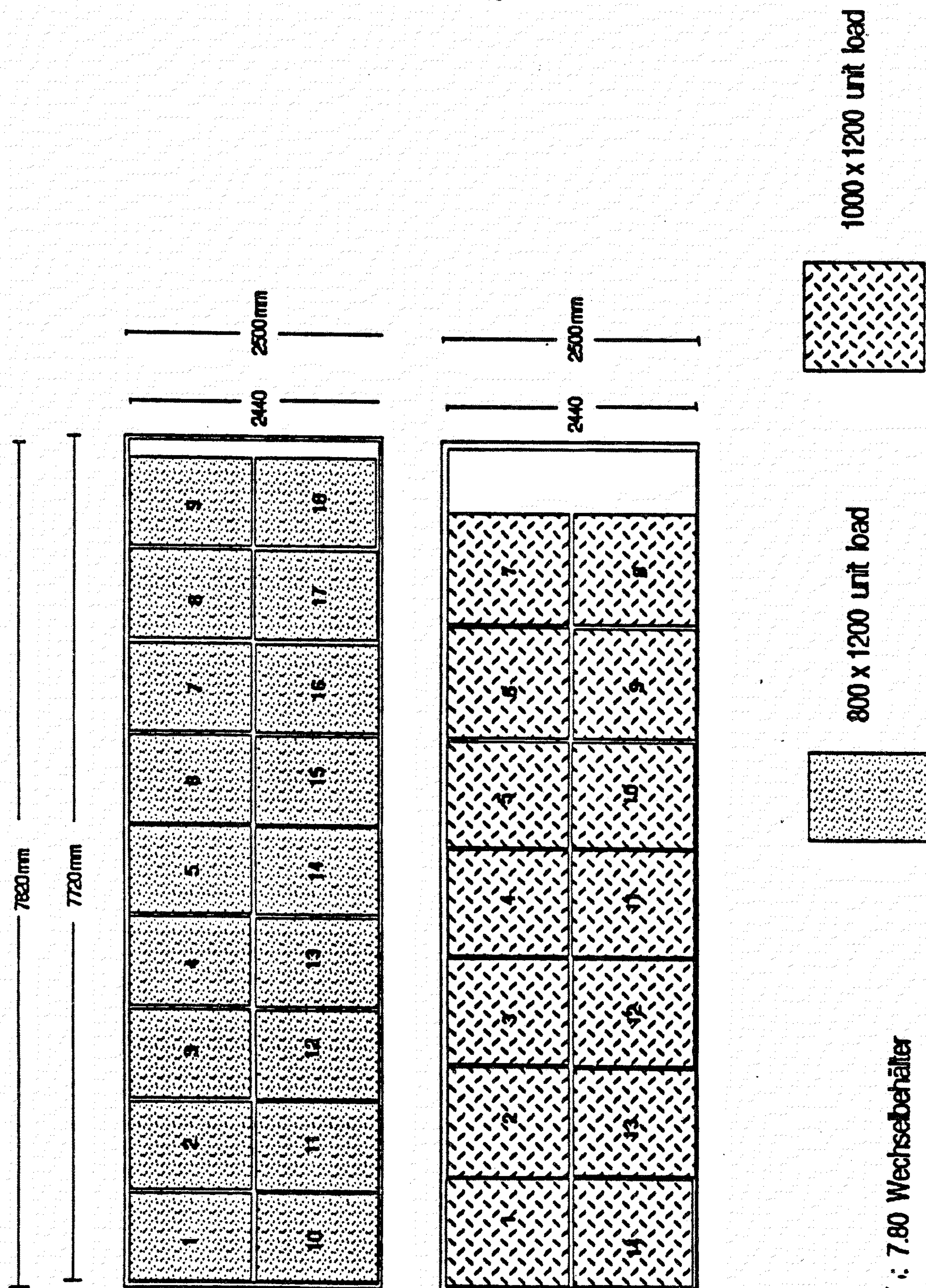
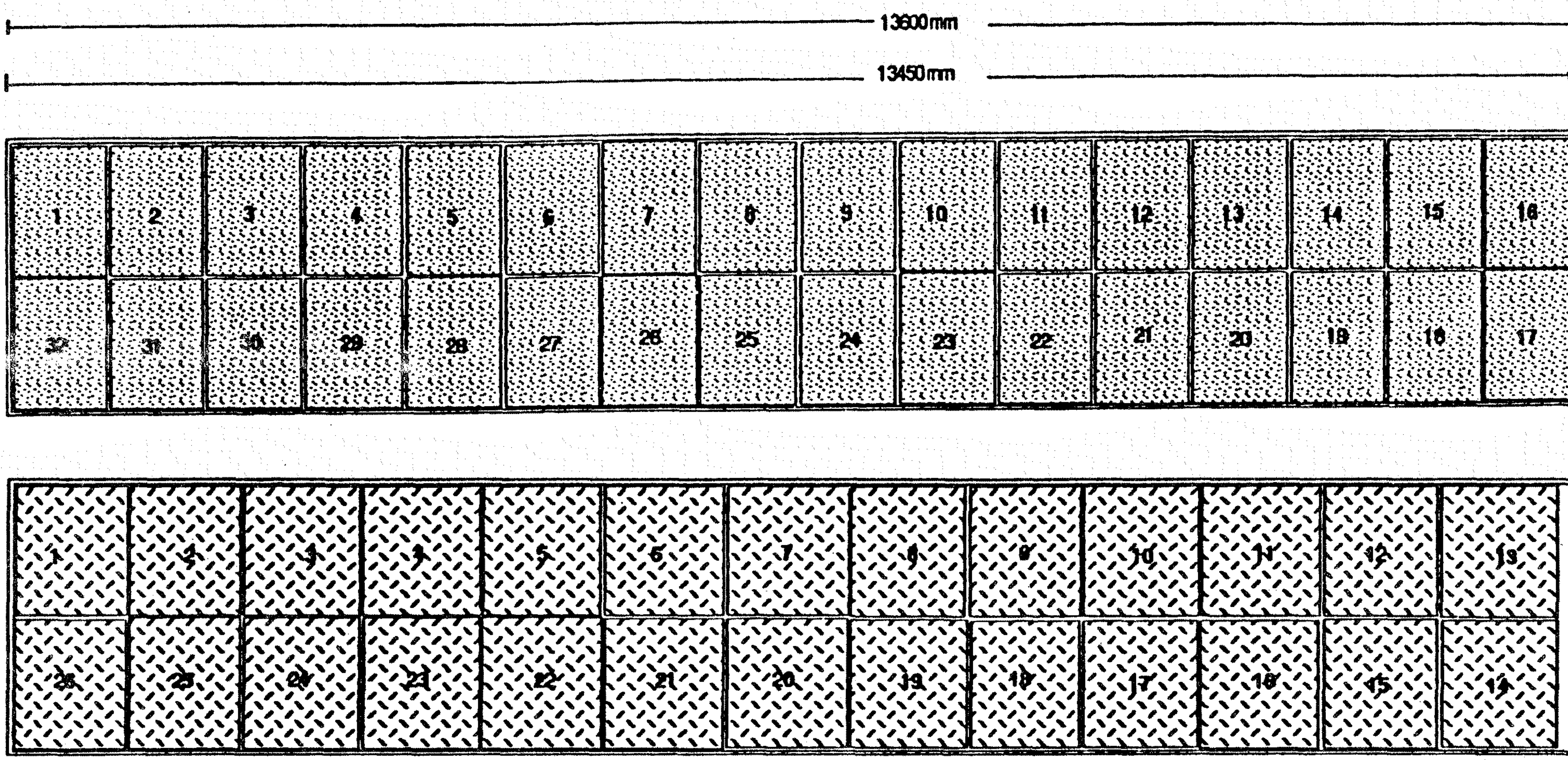


Bild 5 : 7.80 Wechselbehälter



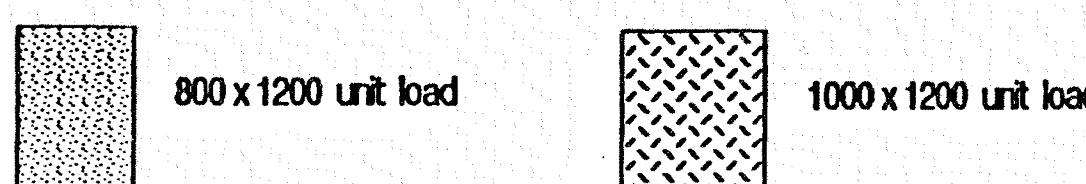


Bild 6 : 13.60 m Wechselbehälter

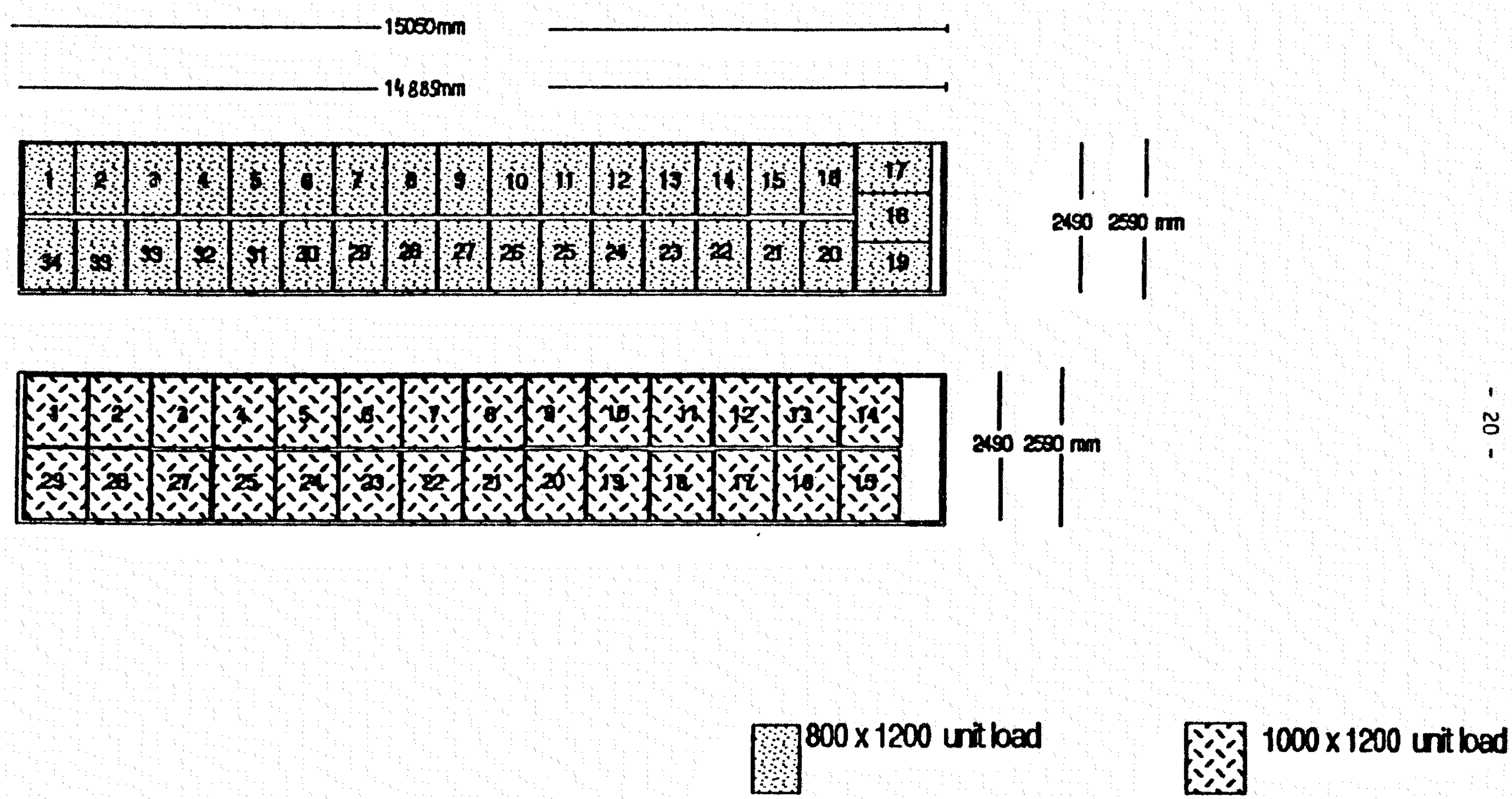


Bild :7 49' - Container

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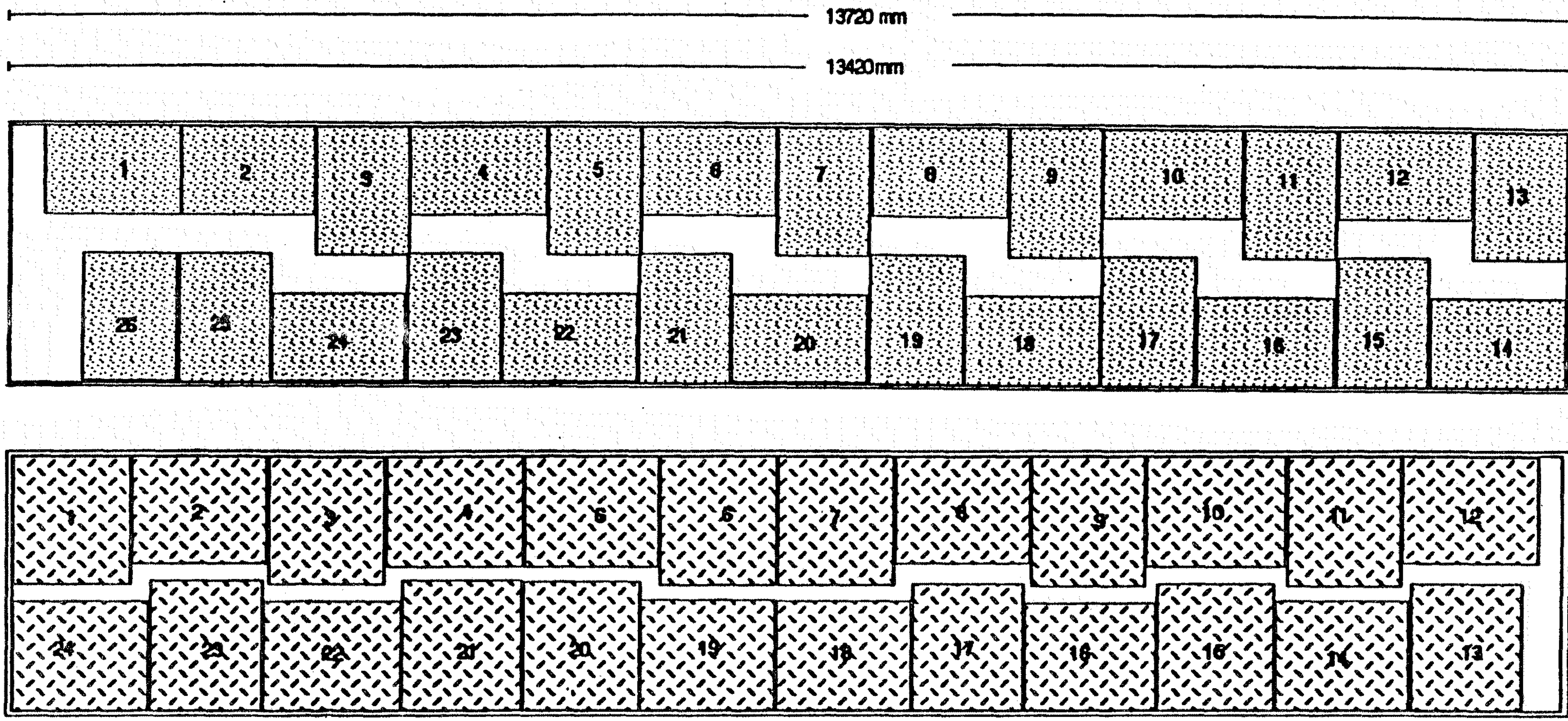

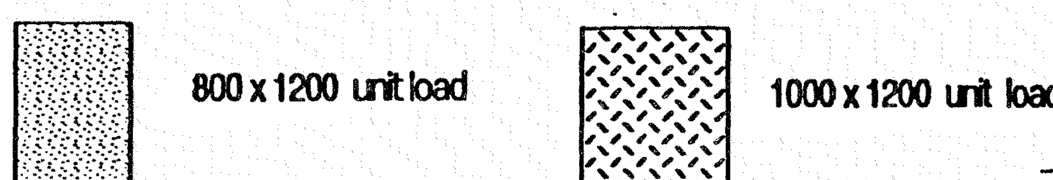

Bild 8 : 45' - Container

B. Impact of standardized load units on transport infrastructures

4. Impact of container standardization on road vehicle design

4.1. General

Road vehicle design is a most important issue for all deliberations concerning container standardization. Maritime transport grants a rather wide freedom with regard to the dimensions of a container. Whether the ships cell is built for a container of 14,670 mm x 2,600 mm basic dimension or for a container with 12,192 mm x 2,438 mm, is no matter of principle.

The only mode that gives severe dimensional restrictions on the one hand, and, on the other hand, is an indispensable part of almost any door-to-door transport chain, is road transport. So the influence of road vehicle design on containers is a most serious matter.

The influence between road vehicle design and container dimensions is indirect. In most cases, the limits of road infrastructure and the national legislation give an outline that describes the overall length, height and width of a road vehicle, its turning circles and axle load configurations. Now the designer must decide what part of that space is needed for the technical system "road vehicle" and what can be granted to the cargo carrying device, i. e. the container. If tires of large diameter are used together with a spacious suspension system, a larger part of the overall vehicle height is used for the running gear and a smaller part can be given to the container. The similar applies to the length.

The relation between a container and the road vehicle design will be, thus, influenced by two main factors:

- the national legislation concerning road vehicles
- the state of the art of road vehicle construction, i. e. the space which the road vehicle designer uses for technical features and the space he can leave for the containers carried.
  This has led to the proliferation of short, and in some cases excessively short, drivers cabins and, for the road train extremely close coupled motor vehicles and trailers. The directive for articulated vehicle length (Directive 89/461/EEC) and the proposal for drawbars in restricting load length to 15,3 m recognises the need to provide ergonomic condition for the driver without necessitating irrealistic vehicle lengths.

4.2. ISO series 1 containers

WIDTH

ISO series 1 containers took over the width limitation for road vehicles existing in many countries at that time, i. e. in the late 1960s. So, the 2 438 mm width of the container did not create any difficulties for road vehicle design. The only exemption has been some parts of the Swiss road network.

HEIGHT

The height of 2591 mm for a standard ISO container does no longer create difficulties for road vehicles with an overall height limit of 4000 mm. In the past, when tires of larger diameter had been used, some difficulties existed with regard to the transportation of these containers on semi-trailers; these difficulties mainly arrived with 12,191 mm long containers.

LENGTH

Since the EEC allows today articulated vehicles of 16,500 mm overall length, containers of 2591 mm height and 12,191 mm length can be carried within the legal limit, especially when using a goose-neck chassis.

In the early time of containerization, when many countries limited the overall length of an articulated road vehicle to 15,000 mm or the length of a semi-trailer to 12,000 mm, the 12,191 mm long container created difficulties. This is, even today, in many countries outside the EEC the case. These containers needed at that time an extra permit, which was granted after a while without greater bureaucratic problems.

TURNING CIRCLE

Articulated vehicles with 12,191 mm long containers have no difficulties to manage the turning circle as described by legislation. They need partly special features in the rear axle combination which might add in cost.

WEIGHT/MASS

Taking into account the limit of 40,000 kg gross mass for a road vehicle circulating within EEC, the largest ISO container when fully loaded would have difficulties, because some 8,000 kg for the truck and some 3,000 kg for container chassis have to be added to the gross weight of the container of 30,480 kg. The EEC regulation allowing 44,000 kg gross weight for road vehicles when carrying containers in intermodal runs caters for this problem meanwhile. Only the restrictions in North-South transit - 28,000 kg max. gross weight in Switzerland, 38,000 kg max. gross in regular transit through Austria, 40,000 kg upon payment of a "penalty" - applied by the non-EEC countries create problems. But these restrictions do not hamper the traffic very much because Intercontainer and UIRR piggy-back companies provide at present a very competitive intermodal link between Italy and the North of Europe without such weight restrictions.

50

4.3. ISO 2nd generation containers

WIDTH

The planned width of 2600 mm for ISO future containers clearly goes beyond the limit of EEC directive. Few EEC and non EEC European countries allow today an outer width of 2600 mm. Nevertheless, such a width is allowed for certain temperature-insulated vehicles and containers fulfilling the conditions of ATP.

Table
max width for road vehicles

Country	max width	remarks
Austria	2.5 m	
Finland	2.6 m	
Norway	2.5 m	
Sweden	2.6 m	
Switzerland	2.5 m	on main transit roads
Belgium	2.6 m	
Denmark	2.55 m	
France	2.5 m	2.55 m on superstructure 2.6 m on reefer
FR Germany	2.5 m	2.6 m on reefer
Great Britain	2.5 m	2.6 m on reefer
Italy	2.5 m	2.6 m on reefer
Luxemburg	2.5 m	2.6 m on reefer
Netherlands	2.6 m	

HEIGHT

The height of 2900 mm for some present ISO containers and for future containers can be included in road vehicle design with a limit of the overall height of 4000 mm, when using small diameter tires. This has some disadvantages: Either the total gross weight of the road vehicle is further limited, or a costly double tire arrangement has to be used. The pressure of these tires towards the road surface might increase, causing increased road maintenance costs.

LENGTH

As lengths are concerned, two concepts for the future ISO container are under discussion.

14,640 mm (48 ft.)
14,950 mm (49 ft.), eventually divided into 2 modular half units.

Both length dimensions when not divided clearly go beyond anything that can be accommodated within the legal frame of 16,500 mm for an articulated vehicle.

The 14,950 mm length, when divided into 2 modular half units, would fit on a European road train, even if the envisaged limitation of the total loading length of 15,000 mm will be decided by the Council.

TURNING CIRCLE

Experts from the road vehicle building industry have given the view, that an articulated road vehicle can be built to any length up to 18 000 mm in a way that it fits into the present turning circle.

This would not include the ability of such vehicles to maneuver round rectangular bends in narrow streets in towns.

WEIGHT/MASS

No severe increase of maximum gross mass for future containers has been seriously suggested up to now, so that at present one can assume that these containers will have the same rating as the ISO 12,191 mm length container.

4.4. European inland containers and swap bodies

WIDTH

European inland containers are built to a width of 2500 mm taking fully into account the EEC regulations.

The same applies to the state of the discussions in CEN/TC 119 "Swap bodies" as far as the width is concerned. But in this standardization body the question has been raised, whether a small increase in width (possibly up to 2550 mm without plus tolerance) would result in a swap body with better pallet loading features. This discussion is well aware of the fact that some European Countries allow 2600 mm width, while others give an interpretation of the legal 2500 mm as being "a plus tolerance of up to 2 % to be added" which would equal a regulation "2550 mm without plus tolerance".

The formula for such a scheme could be as such:

unit loads accommodated: 2 x 1.200 or 3 x 800 mm	= 2.400 mm
maneuvring space min. 3 x 10 mm = 30 mm	
maneuvring space max. 4 x 20 mm =	80 mm
2 side-walls 30 mm each =	60 mm
design tolerance	10 mm
	--------
total outer width including plus tolerance	2.550 mm

HEIGHT

In practice and in standardization process, all units are designed at a maximum height of 2670 mm. This should not create difficulties in road vehicle overall height limited to 4000 mm.

S2

LENGTH

Inland containers are standardized ~~at~~ lengths of

6 050 mm,
7 150 mm,
12 191 mm.

All these lengths do not create any difficulties as EEC regulations are concerned.

In swap body standardization, the following lengths are under discussion:

7,150 mm,
7,420 mm,
7,820 mm.

All three lengths fit into the concept of a road train of 18,000 mm total length, where two swap bodies of identical length are transported.

The 7,420 mm length, and especially the 7,820 mm length assume that the road train is equipped with a short coupling device and a rather short driver cabin. This would mean a coupling distance between motor vehicle and trailer of less than 1,000 mm length. If the total loading length of road trains would be limited to 15,300 mm, the transport of 2 swap bodies of 7,820 mm each will no longer possible. If such swap bodies are used, they can only be transported together with a unit of 7,150 mm length. But the transport of two units of different length creates organizational and technical problems in operations and is not a desirable feature.

A query to include swap bodies with a length of more than 8000 mm into the work has been postponed.

For the articulated vehicle, the discussion about swap body length has been postponed as well, expecting the results of ISO work on future containers and the recent EEC decision on articulated vehicle lengths.

TURNING CIRCLE

No problem.

5. Specific Problems with Regard to European Railways

5.1. General

European railway networks have, in some countries, a major market share in the hinterland transportation of maritime containers. This applies mainly to France, Federal Republic of Germany, Great Britain and the container traffic flows between North Italy and the North Sea ports.

Furthermore, railway has gained a major share of the high-value goods transport market by its offers in road-rail intermodal transport services. Intermodal transport traffic today counts for less than 10 % of the tonnage carried by Deutsche Bundesbahn (German Federal Rail), this transport market is quickly growing in volume compared to most other market sectors of rail which are declining. The US rail-road Atchinson, Topeka & Santa Fe reports that their intermodal operations have meanwhile arrived at a total share of 40 % of their tonnage carried.

The issue of intermodal road-rail operations are politically very sensitive, bearing in mind the following facts:

1.
Rail transport is generally regarded to be not to the same extent detrimental regarding the environment than road transport.

2.
Rail transport relies to a much smaller degree on energy based on mineral oil than road transport; it can produce transport services with lower energy consumption than road transport, if well organized.

3.
Almost all railway networks are owned by the EEC member States. These States are interested, amongst others, for fiscal reasons in a larger transport volume of their railways generating additional income and reducing the present deficit of the railways.

4.
Many railway lines are not at their capacity limits, while the highway network is in many parts overcrowded. So, a shift of transport volume from road to rail can improve the overall traffic situation.

The capacity argument could, in future, aggravate if new high speed passenger rail lines are built, and, as a consequence, a large part of present express passenger services is transferred to the new lines thus creating additional capacity possibilities in the traditional rail network.

5.
Rail transport is regarded as safer than road transport.

At least the States whose railways have today a major intermodal traffic volume will avoid any development toward intermodal loading units (ISO containers, non-ISO maritime containers, domestic containers, swap bodies) that are disadvantageous for their railway systems.

5.2. Width and Height

The possibilities of European Railway to carry containers of extended height and width are influenced by a number of factors. So, a very differing picture must be drawn with regard to that question.

Generally speaking, all railway networks have an infrastructure limit set by the tunnel gauge. Since this is a semi-circular

5y

limitation line formed like an arch, it gives a joint limit to the width and the height of the upper corner of any item carried over the rail.

It depends on the degree of the angle of this arch, whether the limitation is more serious with respect to the height or to the width.

To make matters more complicated: Each railway administration has its own "standard" tunnel gauge differing of the others, and almost all railways have, within their networks, lines with a tunnel gauge more generous than the general standard, and some lines with further limitations. Lines with increased tunnel gauge may or may not be of some importance for container movements.

To bring some order into that puzzle, the following basic statements can give a general guidance:

1.
If a gauge limit is desired that allows absolute free movement within all EEC countries, Switzerland and Austria, one would arrive at a very low limit that would seriously affect rail transport efficiency.

2.
British rail has the smallest tunnel gauge in West Europe. France, parts of Belgium, Italy and most Alp crossing lines have a medium size tunnel gauge. Germany, Denmark, Netherland, parts of Switzerland and Austria have a generous tunnel profile.

3.
In all networks, those lines that have been electrified in the years after 1950 offer mostly an improved tunnel profile.

For the further discussion of the possible height and width extension of intermodal loading units, another feature has to be taken into account as well: the platform height of rail wagons that carry such units.

To bring order into the various relations between this factor and the tunnel gauge, again some thesis are compiled:

1.
If rather high and/or wide unit have to be transported in railway systems with limited tunnel gauge, the design of low platform wagons can give improved possibilities.

2.
The offer of a very low platform comes soon to a limit, partly commercially partly technical.
Low platform wagon can be designed by use of very small wheels. This results in a multi-axle wagon, costly to build and to maintain.
Alternatively, low platforms can be achieved by accommodating the load carrying platform between the bogies, i. e. to form a "well". This results in train configurations with a greater length. In all cases, where train length is the limiting factor of rail lines, this will result in reduced capacity use.

3.
Whatever design is made, no wagon can be created that allows in any European rail network a double stack container transportation.

4.
Commercial road vehicles making full use of Directive 85/3/EEC, i. e. having a height of 4.000 mm and a width of 2.500 mm, can be transported in piggyback mode only on selected main lines of the German, Netherlands, Danish and Austrian network. They cannot pass the Alp crossing lines.

5.
Containers of 2900 mm height and 2440 mm width will need specialized wagons in France, Italy, South Belgium and very specialized low platform wagons in Great Britain. The same applies for Alp crossings. When containers of 2900 mm height have an external width of 2600 mm, these problems are aggravated.

"Specialized rail wagons" mean that the railway administration is forced to invest in new rolling stock - which might create problems since the investment budget of most railways is limited.

Furthermore, this will result in a mixed rolling stock for railways with additional costs for control, positioning and maintenance.

5.3. Length

Wagons used in intermodal transport have differing loading lengths. Generally speaking, the following types occur mostly:

- 12.2 m loading length (40 ft.), 2 axles
- 14.3 m and more loading length (1 semi-trailer or 2 swap bodies), 4 axles
- 18.3 m loading length (60 ft.), 4 axles
- 18.5 m very low platform, 8 axles ("Rollende Landstrasse").

From the point of view of most efficient use of rail intermodal transport capacity, a limited number of modular lengths for intermodal units is desirable. Furthermore, utmost stability in the development of length standards over the time is desirable, since rail wagons often are depreciated over a period of 30 years; wagons are in service over a long time period. Any basic change in length of intermodal units to be carried by rail could result in premature obsolescence of rolling stock.

The total loading length of 18,3 m offered today by standard container wagons is rather the length limit for a non-articulated unit. So, as regards length, all present or future containers can be, from a technical point of view, transported by rail mode without technical difficulties. However, length is critical as far as economic utilization of the railwagon is concerned.
Fixing the loading length (in place of or additional to the total length) of commercial road vehicles would add to the economics of intermodal road-rail transport, because this would add to the stability in length of the units in commercial road transport and hamper a development where these unit grows millimeter by millimeter over the years according to technical progress in design of shorter driver's cabins or coupling systems. The same applies to

different loading lengths of articulated road vehicles and road trains. These differences lead to intermodal loading units of differing sizes creating additional problems for intermodal operations. From the point of view of combined transport, a unique loading length for both articulated road vehicles and for road trains is desirable. It must be pointed out, though, that this argument applies only to the economic features of intermodal transport.

6. Specific Problems with Regard to Inland Waterway Transport

6.1. General

Inland waterway transport of containers plays a major role in the Rhine valley. Traffic flows between the highly industrialized areas in the Rhine valley (Ruhrgebiet, Cologne-Bonn, Rhein-Main, Rhein-Neckar, Strasbourg, Basel) and the seaports Amsterdam, Antwerpen and Rotterdam are very large. Inland waterway of containers contributes in this traffic flow very much to a well balanced transport scheme, since both rail and road networks parallel to the Rhine valley are very heavily used and partly at the end of their capacity limits.

Furthermore, inland waterway transport of containers is a rather agreeable from a point of view of environmental protection: The noise level of inland waterway motor vessels is, at least in the towns on the riverside, rather low. The pollution level - emission of noxious gases per ton-km produced - is equally low. The cost of infrastructure maintenance in the Rhine river is very low. The energy consumption is very low, as well. So, all political indicators show the political important position of inland waterway transport of containers in the Rhine valley.

Outside this area, some transport lines have been established, as well. The major of these combine Bremen and Bremerhaven or Rotterdam and Antwerpen, mostly for re-positioning of containers. Some transports of minor importance are observed on the rivers Seine, Rhone and in the Central European canal network.

6.2. Width of Containers

Inland waterway vessels may not exceed a total outer width of 10,000 mm. This is due to the width of most locks and ship lifting installations in the inland waterway network. Only on the middle and lower part of the river Rhine, a passage without locks is possible. If ships are built wider than 10,000 mm, their operations will be definitely limited to this considerable small part of the Central European inland waterway network.

An outer width of 10,000 mm results in an internal space that can accommodate up to 4 rows of ISO Containers side by side, as long as their width remains at the standardized figure of 2,440 mm. If the width of containers is enlarged beyond this limit - may it be up to 2,500 mm or 2,600 mm - only three rows of containers can be accommodated per ship. This would result in a capacity loss of 25 % per ship, and increase the transportation costs per container carried by the similar value, thus affecting seriously the competitiveness of inland waterway transport mode.

6.3. Length

Present inland waterway vessels are built according to the 20 ft. length module of ISO containers. If containers with a greater length come into operation, this modular optimum will be affected to a degree that will vary according to the future mix of container sizes.

Anyway, the consequences of longer containers would not be as serious as those of wider containers with regard to the future economics of inland waterway transport of containers.

6.4. Height

Normally, containers are stacked 3 to 4 high on board of an inland waterway vessel. The total height is limited by factors of the ship stability. Further limits are set by the height of passages underneath bridges crossing inland waterways.

Since the pilot's cabin is normally situated in the rear of an inland waterway vessel, it has to be built in a way that it can be lifted such as to give a free view forward over the top of the container stacks. In modern purpose built containerships, the pilot's cabin is built in a way that it can be lowered and elevated to meet differing situations.

If the height of containers in increased over the today figure of 2,591 mm, and if new containers with a greater height form a large part of the container population, there might arrive a limit in the stacking possibilities compared to the situation today.

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7. Implications of Alp north-south transit

In some major European trade routes, a transit through one of the non-EEC countries Switzerland or Austria is implied. Both countries argue that road transit is detrimental to their national welfare and try to limit such activities. The most successful limitation is executed by the Swiss authorities: With its limit of 27,000 kg for gross mass of road vehicles, Switzerland shifts a potential road transit volume of estimated 10 million tons from its roads to those of Austria.

Success invites for imitation: All transit countries have learnt that the easiest way to limit unwanted transit traffic flows is a legislation that sets narrow limits for road vehicle dimensions and total mass. The first lesson of this kind has been told by Austria when this country refused to join EEC regulation to allow 40,000 kg gross weight for road vehicles. If the EEC allows anything larger than today on its roads, it might easily be predicted that these non-EEC transit countries will not follow. Any of these larger vehicles carrying larger containers will not be allowed to operate into Italy and Greece by road.

The piggyback service between Italy and North Europe is an important trade link between Italy and its EEC partners because

- Swiss road transit is limited to a 28,000 kg maximum gross weight for road vehicles

- - Austrian road transit is subject to major limitations,

- conventional rail transport often does not fit into quality needs of modern transport and distribution systems.

The Swiss piggyback transit would be subject to serious difficulties if road trains larger than today come into service. At present, the total fleet of wagons for the transport of road trains crossing the Alp in Swiss transit is built to accommodate rod trains of

- 18.3 m length, partly 18.0 m length,
- 40,000 kg total gross mass.

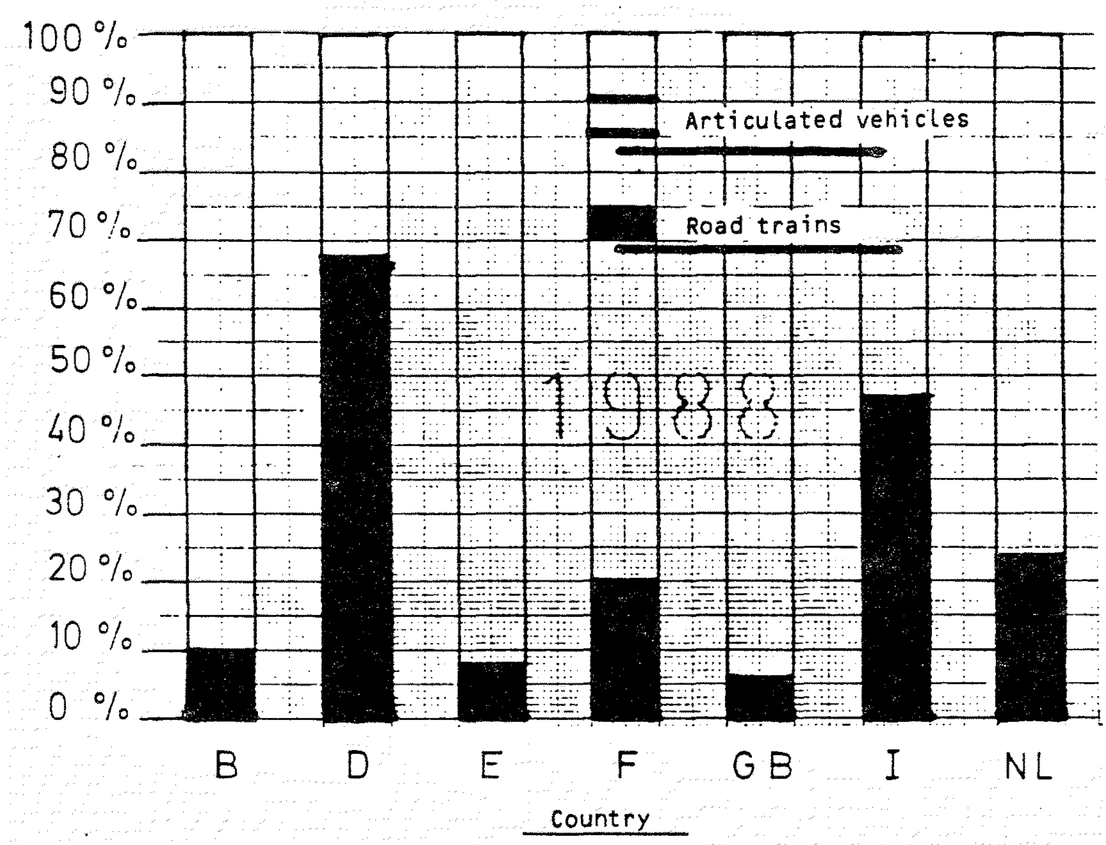
The following routes are linked by daily block trains using these wagons:

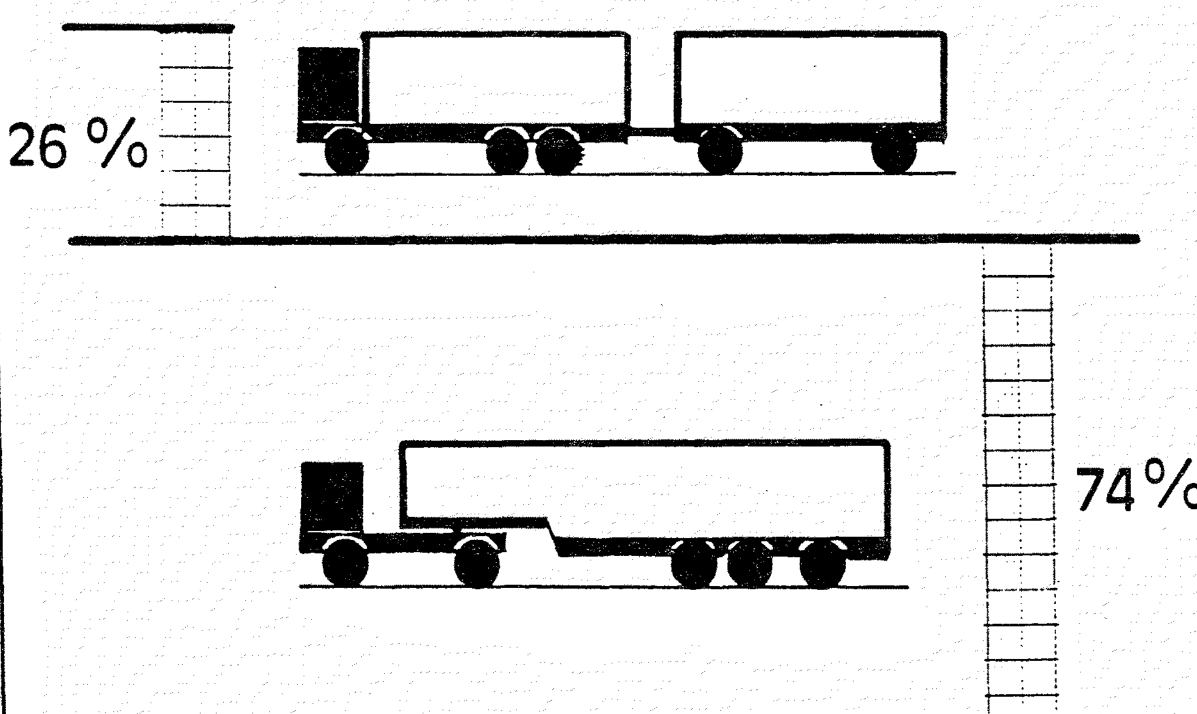
Freiburg - Milano (b)
Freiburg - Lugano (a)
Rielasingen - Milano (b)
Basel - Lugano (a)

All roues designated (a) allow for a road vehicle corner height of 3,800 mm, all designated (b) for 3,600 mm.

For swap bodies, a corner height of 2,900 mm and more would create difficulties, as far as present rolling stock is concerned. A limited number of "jumbo" wagons is in preparation; these will allow for an combined transport unit corner height up to 3,000 mm in Swiss piggyback transit.

DISTRIBUTION OF ARTICULATED VEHICLES AND ROAD TRAINS IN THE E.C.





ANNEX III

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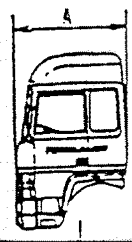
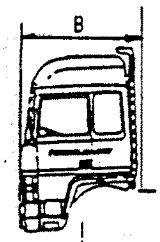
DIMENSIONS OF CABINS AS PRODUCED IN THE E.C.

CONSTRUCTEUR	TYPE DE CABINE	COTE A LA TOLE (mm)		ENTREE DE CAISSE (Porteurs) (mm)		OBSERVATIONS
		Courte	Longue	Courte	Longue	
						
VOLVO	FL Courte	1.680		1.827		Top Sleeper
	FL Profonde		2.180		2.327	
	F Courte	1.720		1.900 (1)		(1) 1.765 en version grand volume
	F Profonde		2.045		2.215	
SCANIA	CG Courte	1.630		1.670		
	CP Courte	1.630		1.670		
	CP Courte	1.630		1.650		Grand volume
	CP Profonde		2.200		2.210	
	CR Courte	1.630		1.960		
	CR Courte	1.630		1.700		Grand volume
	CR Profonde		2.200		2.250	
MERCEDES	NG 72 Courte	1.570		1.670*		*1.770 } en version Powerliner
	Moyenne	1.940		2.060*		2.125
	Profonde		2.170		2.260*	2.305
	Espace		2.170		2.260	
MAN	NF Grd volume	(1.370)*		(1.430)		19.331 ULL
	F 90 Courte	1.715		2.140		
	F 90 Longue		2.165		2.250	* Ultra courte
DAF						F 249 = Gamme 95
	F 220 Courte	1.615		1.730		
	F 220 Profonde		2.045		2.120	
	F 241 Courte	1.615 (2)		1.800		(2) 1.595 pour l'option grand volume
	F 241 Profonde		2.045		2.170	
	F 249 Courte	1.620		1.750		
	F 249 Profonde		2.000		2.190	
IVECO	Cargo	1.595		1.965 (3)		
	Type 2 Courte	1.780		1.980		(3) 1.765 pour option grand volume
	Type 2 Profonde		2.140		2.350	
	Turbostar		2.140		2.350	
RVI	G 875					
	Courte	1.590		{1.760 / 1.680		Standard / Grand volume
	Profonde		2.140		2.350	
	R 2480					
	Courte	1.750		{2.150 / 1.800		Standard / Grand volume
	Profonde		2.065		2.150	

2.12.88

Joint Committee for Road Transport, Working Party on "dimensions of the drivers cabin" Meeting of 22 May 1989

list of Trade-Union Arguments against the Top-sleeper

1. Access to the top-sleeper is through a hatch in the roof of the cab and this presents additional risk of accidents when climbing up and down.

2. Lighter-than-air fumes can rise and collect in the top-sleeper and are a threat to health.

3. Top-sleepers are not properly ventilated and this is a threat to health.

4. If the occupant of the top-sleeper is incapacitated, it could be impossible for another person to enter and rescue him as the occupant may be lying on top of the hatch.

5. If there is a fire in the cab there is no escape for the top-sleeper occupant. It has been suggested that an escape hatch be fitted at the side, but how does the occupant get out ? Head first and fracture his skull on the road or feet first and break his legs or back ?

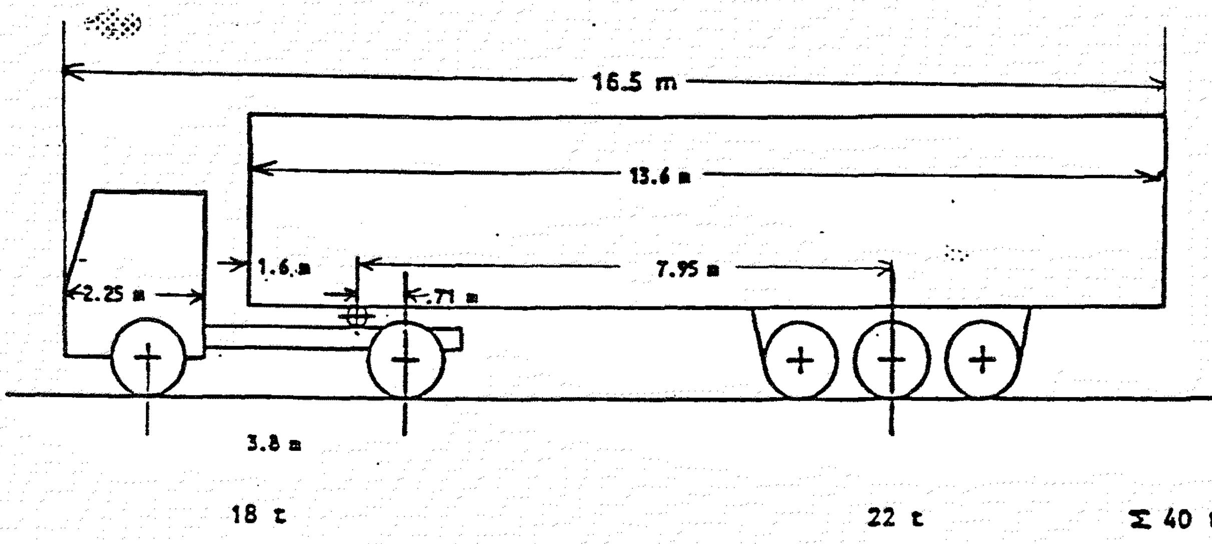
6. Top-sleepers are not tested to the impact-resistance standards for cabs laid down in ECE Regulation 29 and almost certainly do not meet these standards.

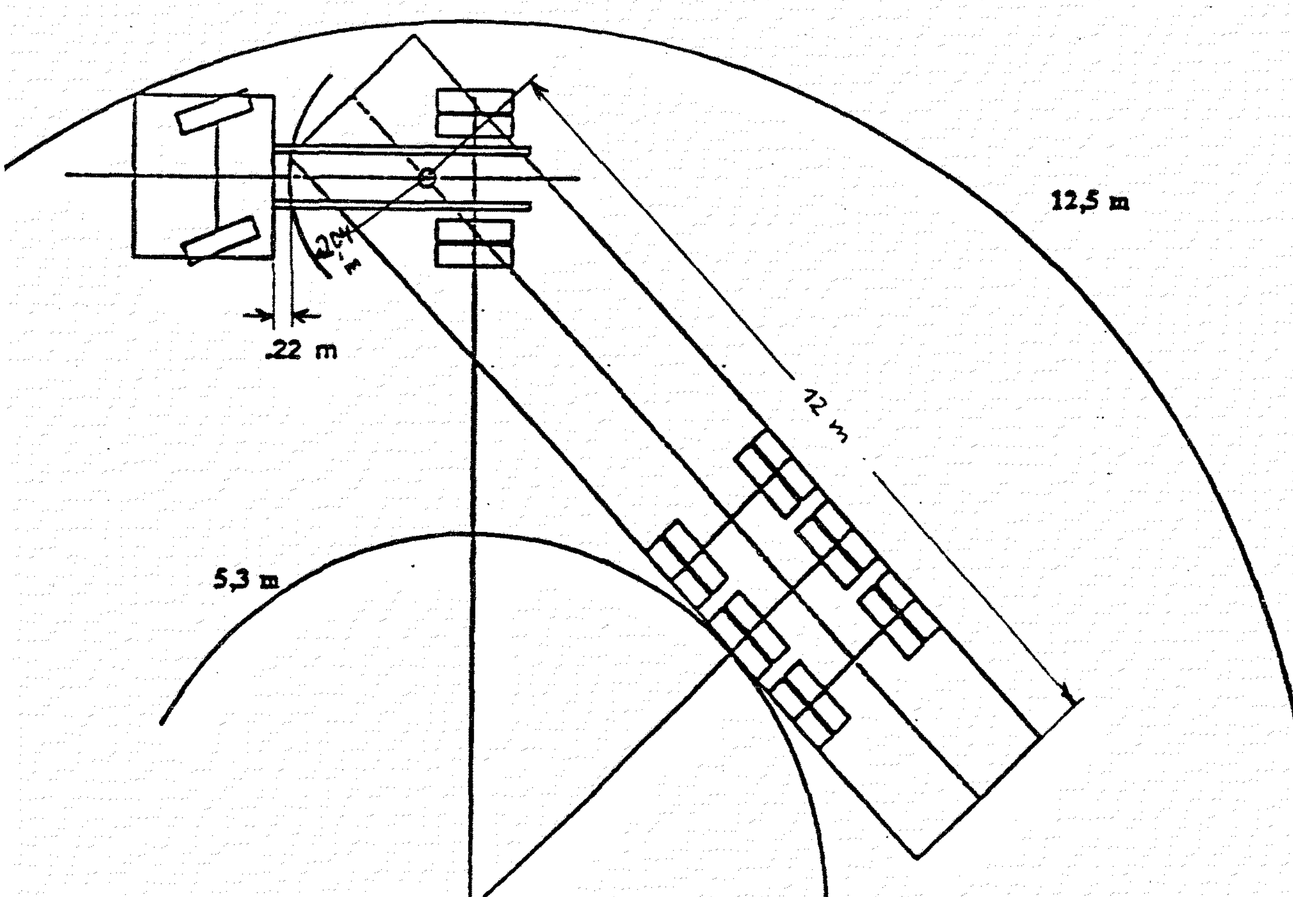
7. Where a top-sleeper is fitted afterwards as a conversion of a standard cab, this involves cutting a hole in the roof of the cab and almost certainly means that the structural integrity, and therefore impact-resistance, of the cab is diminished.

8. Where a lorry is double- or triple-manned it is common for a driver who is not driving to rest on the bunk. If the vehicle is involved in an accident when the top-sleeper is occupied, there is a greater risk of the anchorages which hold a cab - designed to tip forward for access to the engine - breaking as an occupied top-sleeper raises the centre of gravity to a considerable degree. The raising of the centre of gravity also increases the risk of the cab anchorages breaking if the load is projected forward under rapid deceleration and hits the rear of the cab.

9. Research has shown that roll-over accidents place much greater stress on the cab than was assumed when ECE Regulation 29 was drawn up. Roll-over accidents cause a relatively high proportion of deaths among occupants of standard cabs. Any occupant of a top-sleeper involved in a roll-over accident is at great risk of being crushed.

Swept circle for
Articulated vehicle according to 89/461/EEC
(no steering axles)





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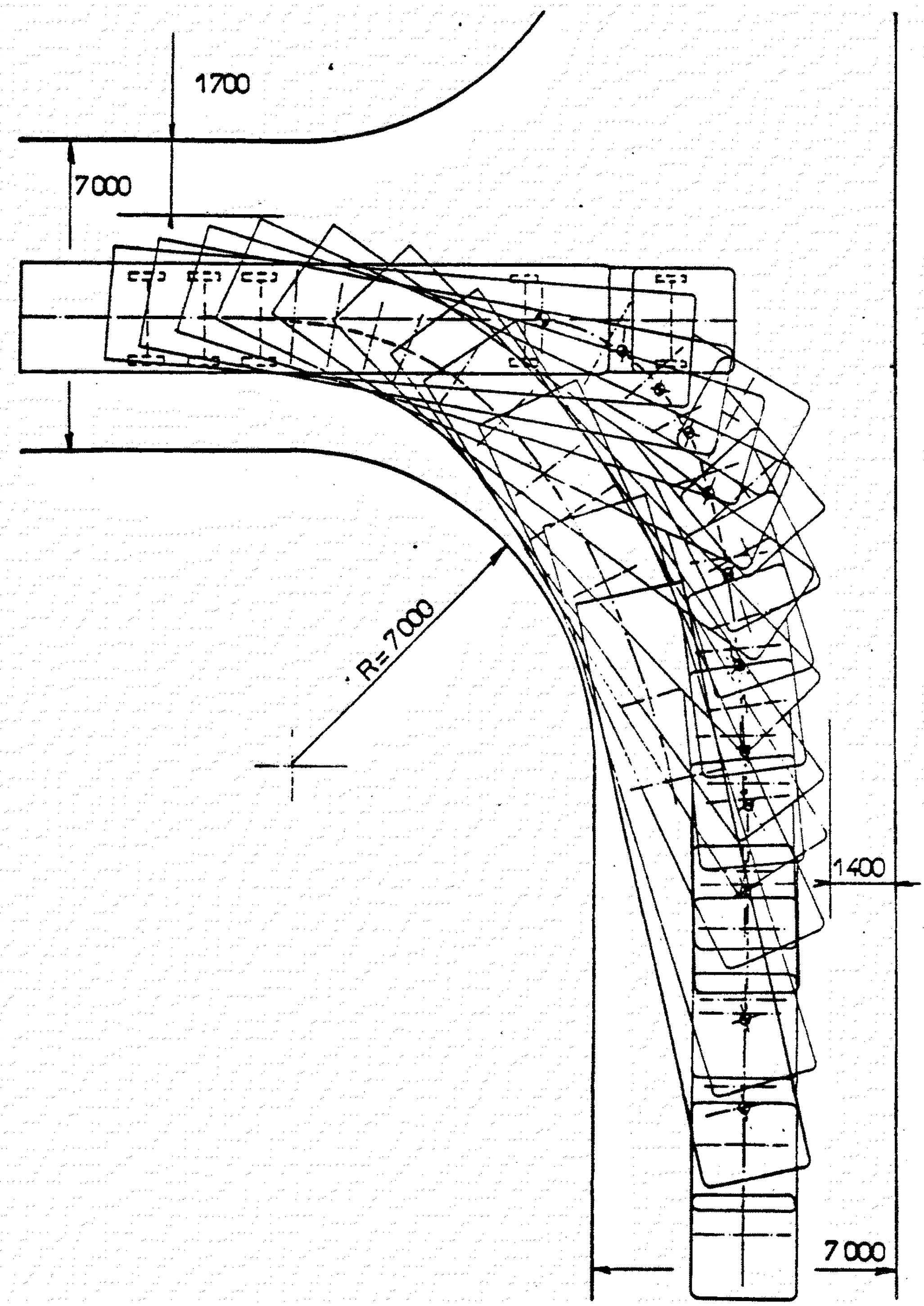
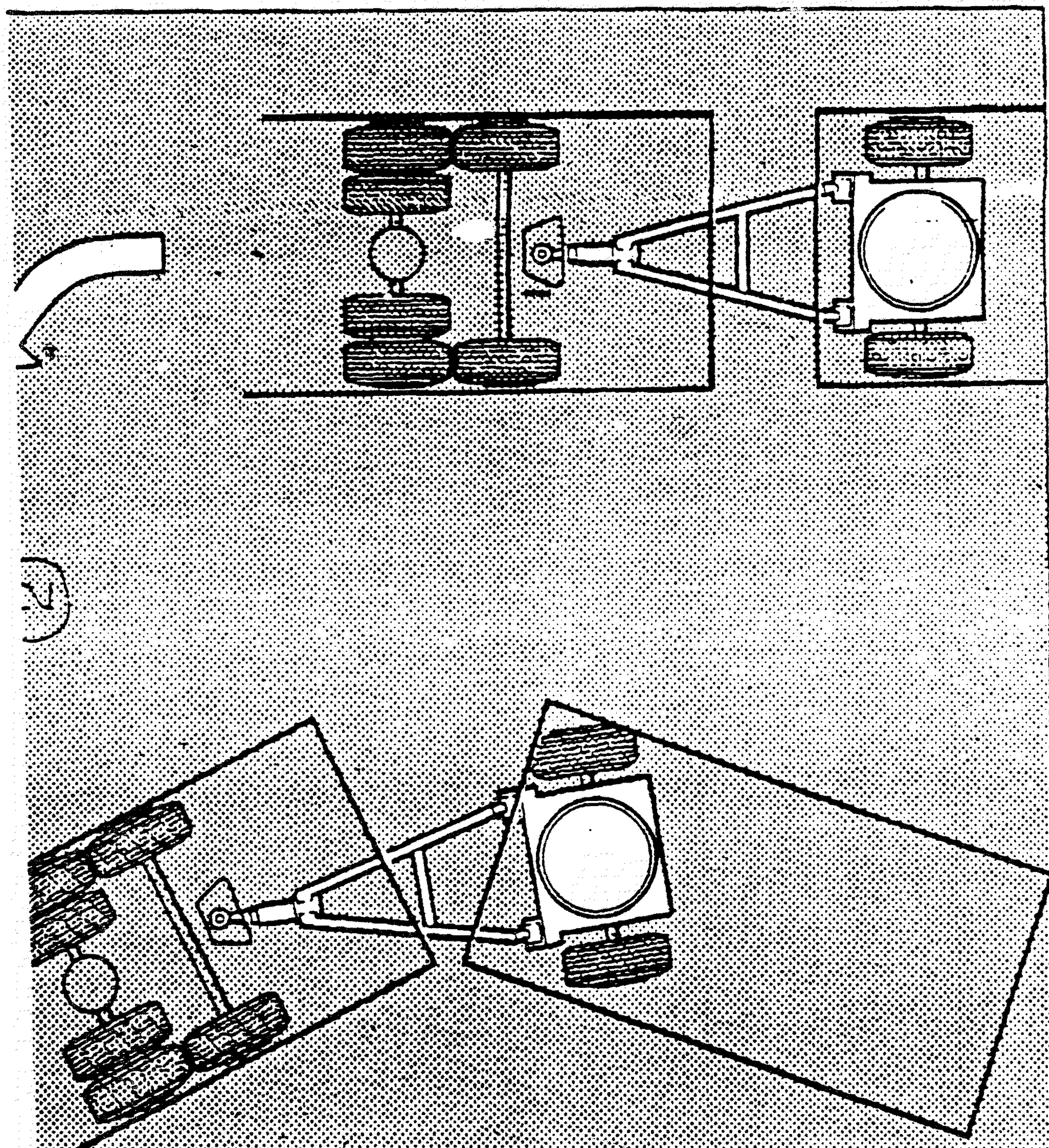
TURNING AROUND THE CORNER OF THE ARTICULATED VEHICLE



NORMAL COUPLING

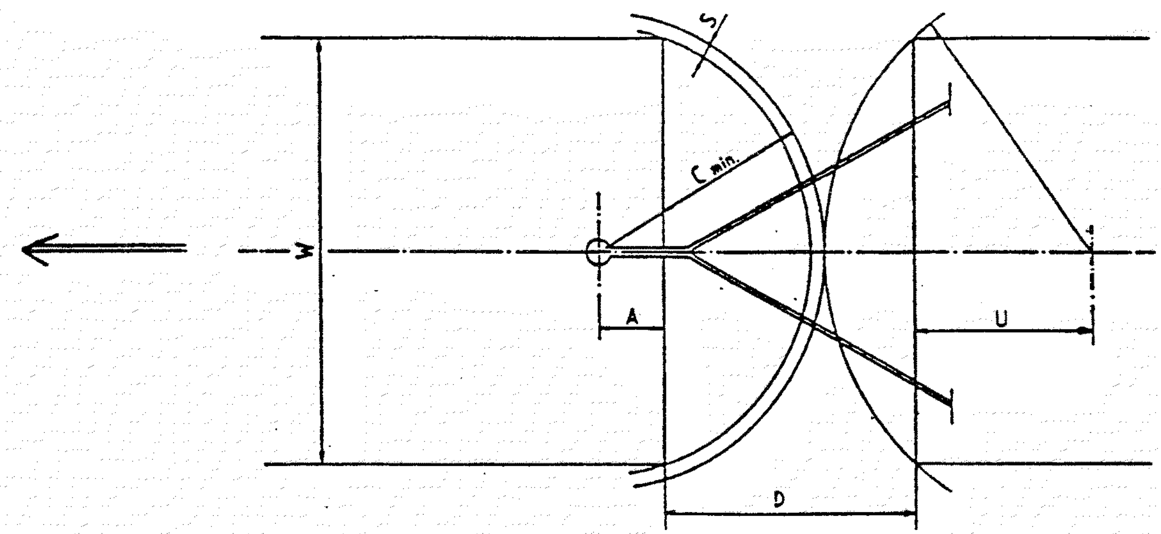


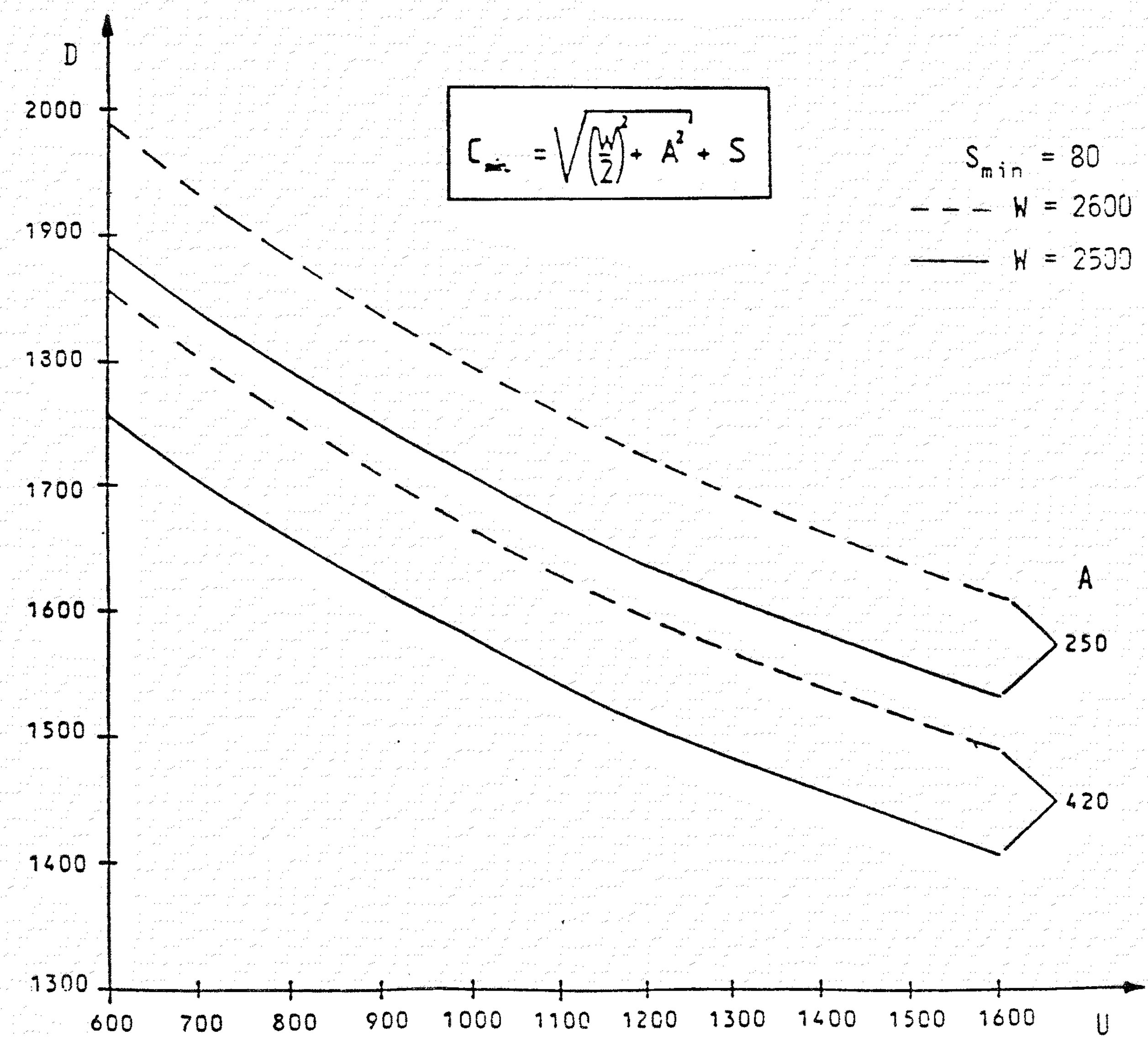
Draft proposal of the ISO-Subcommittee 15, Working group 4

"Mechanical couplings"

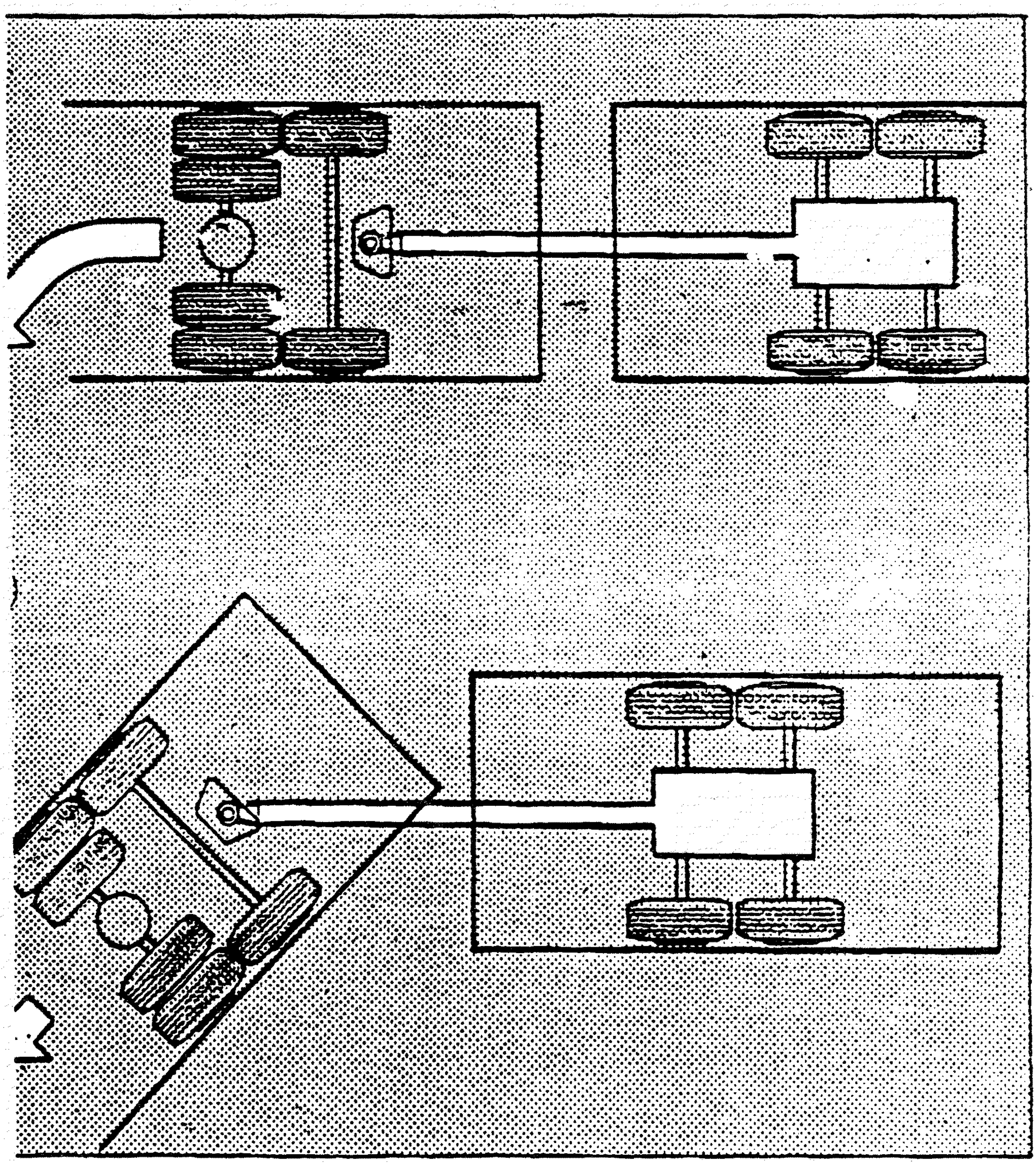
65

Subject: Truck with conventional trailer (normal coupling)

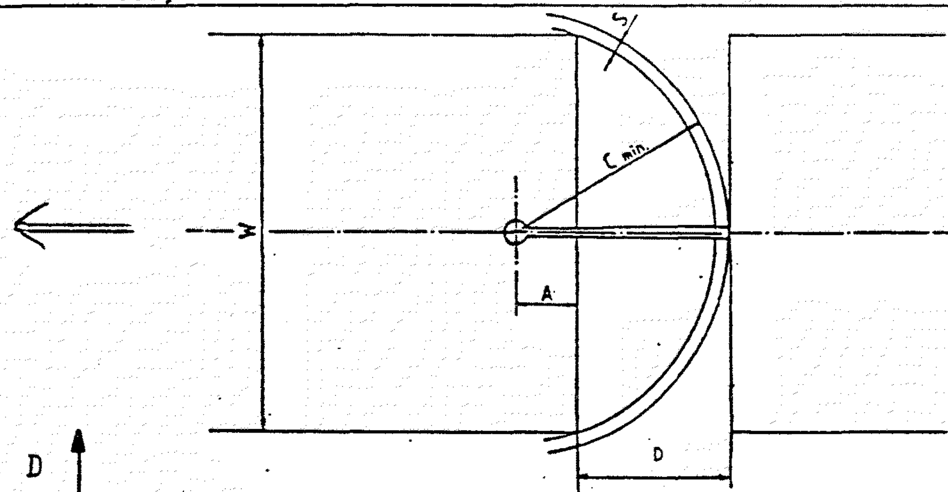


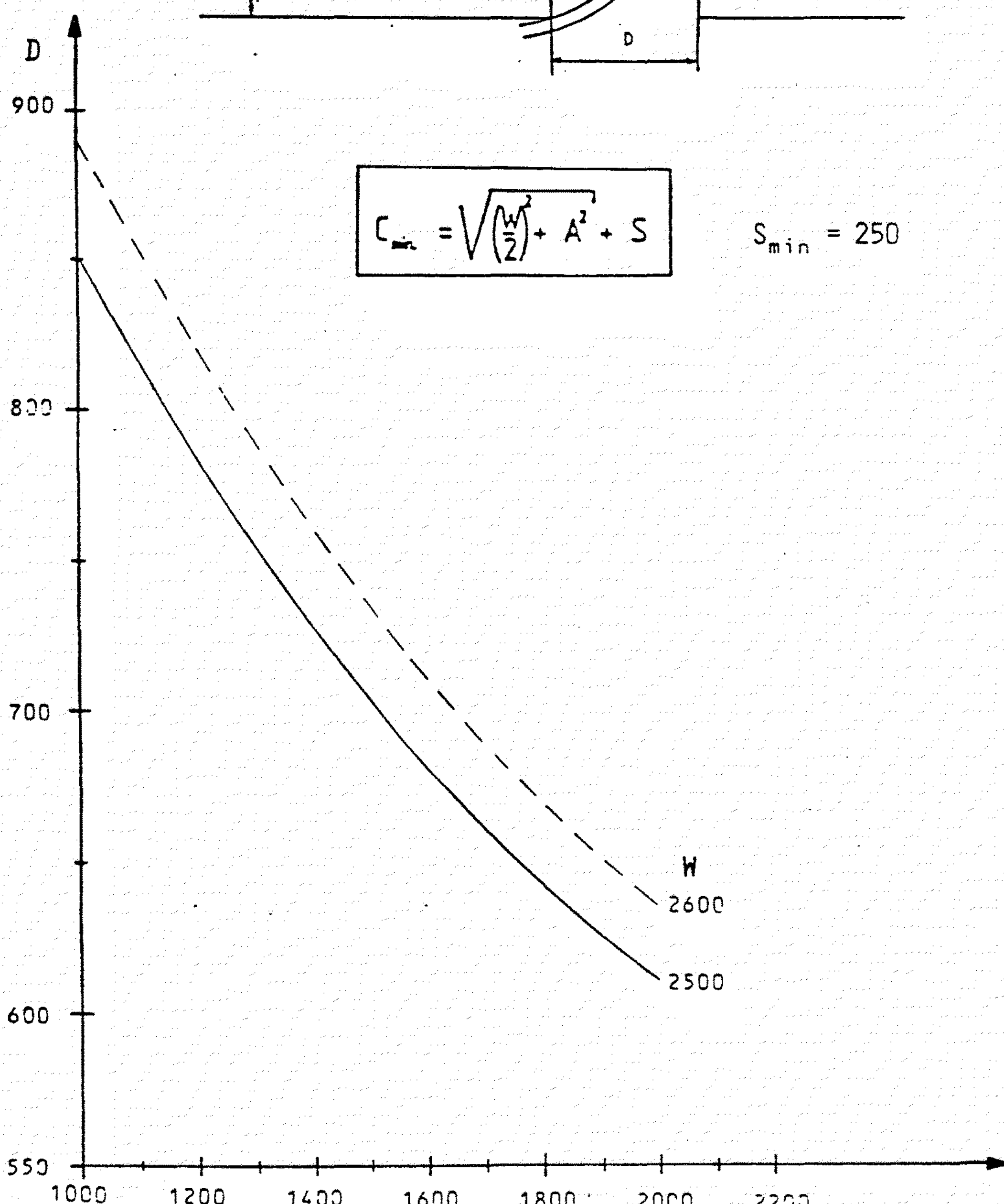


SHORT COUPLING



Draft proposal of the ISO-Subcommittee 15, Working group 4
"Mechanical couplings"
Subject: Truck with central axle trailer (short coupling)



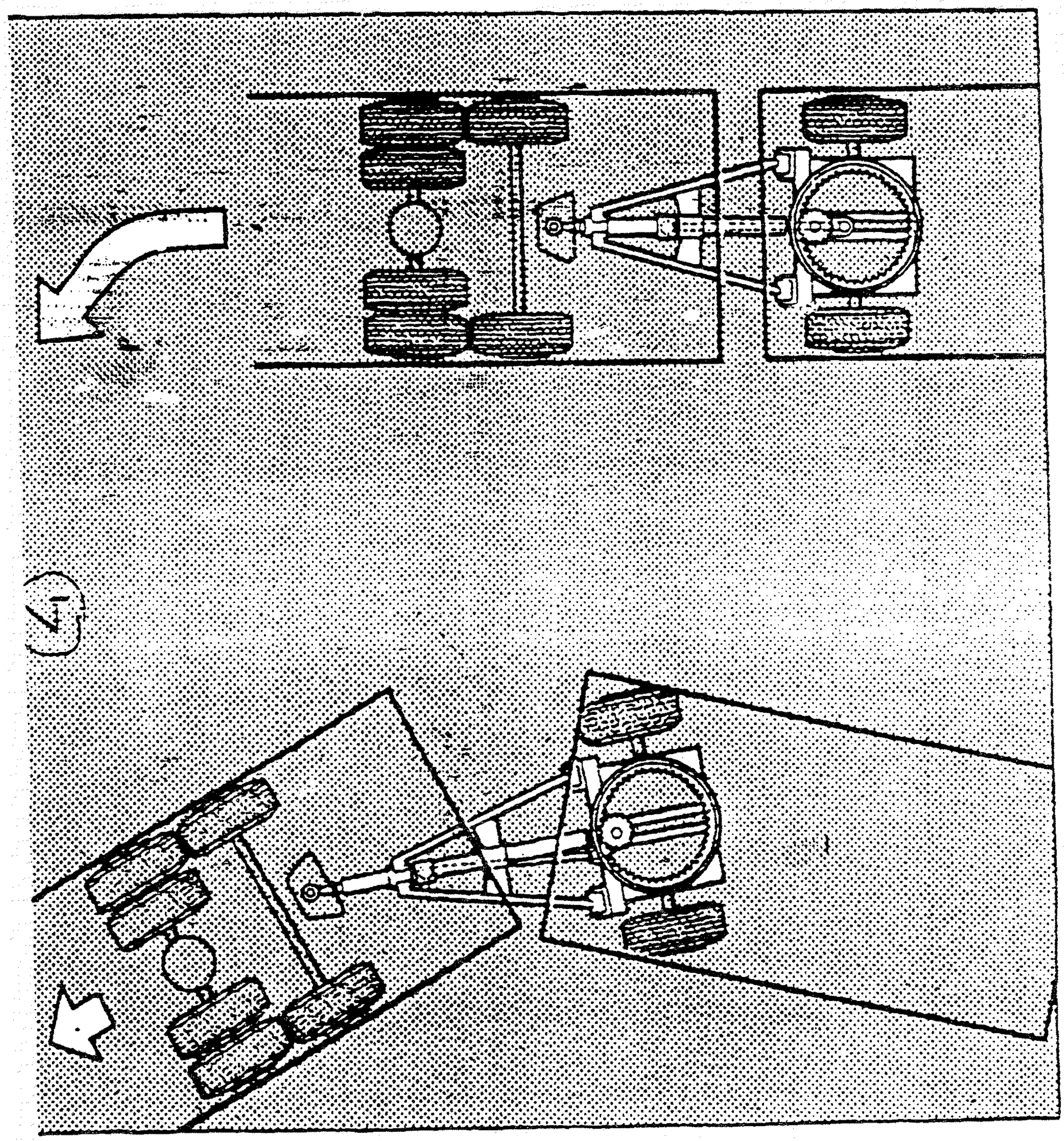


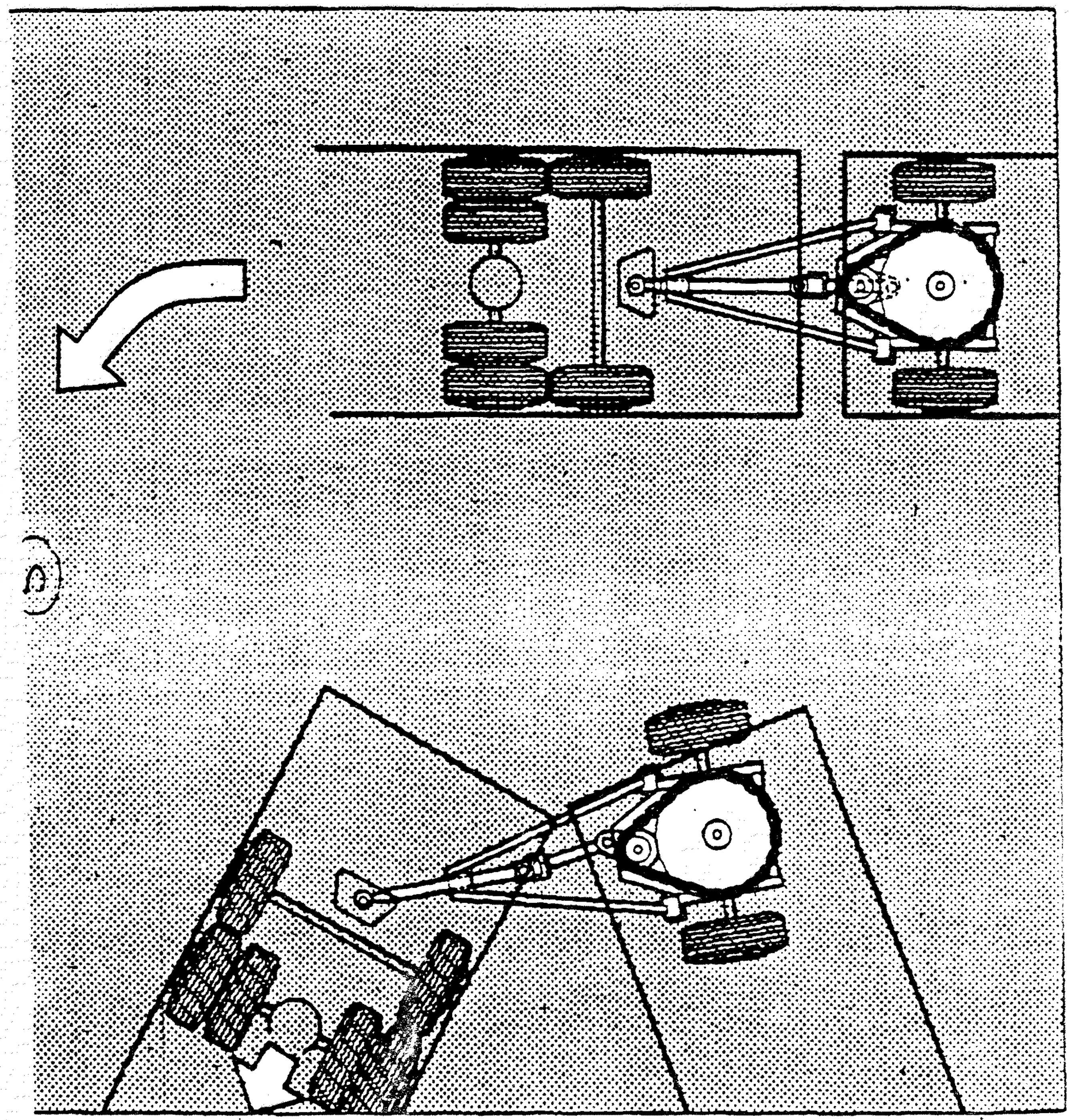
$$C_{min} = \sqrt{\left(\frac{W}{2}\right)^2 + A^2} + S$$

$S_{min} = 250$

ENZ/TE 26.10.89

EXAMPLES OF EXTENDABLE COUPLINGS





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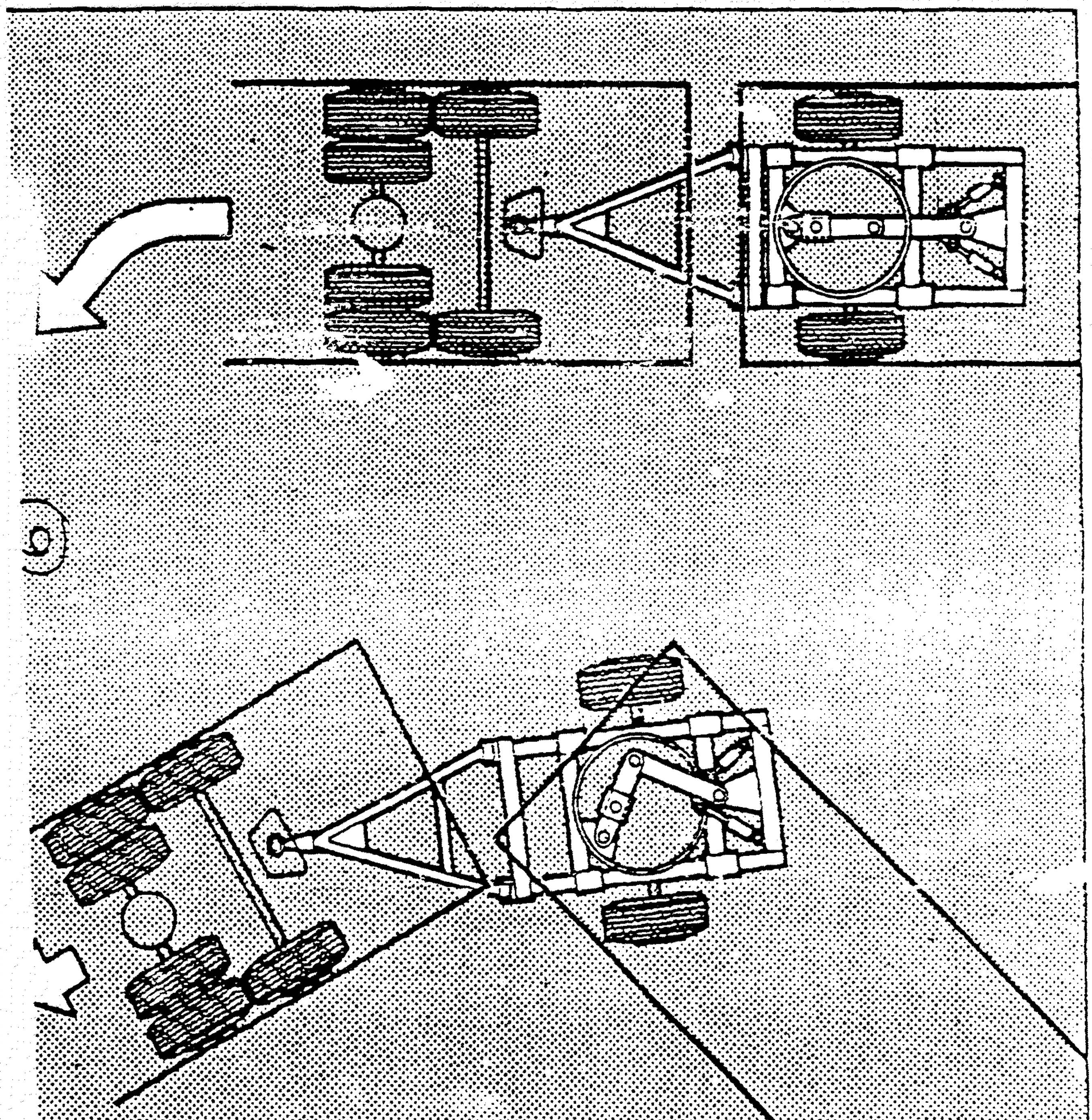

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