



Guidelines for Transport and Storage of Expandable Polystyrene Raw Beads

This technical document has been developed by the members of the Expandable Polystyrene (EPS) Transport Group of Plastics Europe

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MAIN CHAPTERS

1. Introduction

The Cefic (European Chemical Industry Council) Responsible Care Programme requires that chemical companies demonstrate their commitment to continuously improve all aspects of performance which relate to protection of health, safety and the environment. An overview of the key elements of Cefic's Distribution Responsible Care Programme is contained in Appendix 1.

The EPS TRANSPORT GROUP has reviewed these updated guidelines, under the direction of the Plastics Europe Expandable Polystyrene (EPS) Committee as their execution programme with regard to the application of Responsible Care in the distribution of EPS. They are consistent with the Cefic Recommendations on Safe Management Practices in Distribution to promote high standards of safety for the distribution of EPS. The key elements of these management practices have been taken into consideration in compiling this document.

Although EPS is classified as dangerous goods during transport, it can be distributed and handled safely provided that appropriate precautions are observed. The distribution of EPS is already subject to regulations within most countries in Europe. In addition, the international movement of EPS by road, rail, sea or inland waterway is subject to international agreements which lay down specific requirements concerning distribution which must be observed by all parties involved. National regulations, however, may differ from international regulations.

These guidelines take into account the distribution of EPS packed in drums, octabins, bags and in bulk, transported in railcars, lorries or containers. They cover all aspects of the transport activity from loading to delivery point. The Plastics Europe EPS Committee recommends that these guidelines are adopted by all parties who are involved in the distribution of EPS. This includes Commercial Transactions, Swap, Toll or Trade agreements and Customer Collection Arrangements.

2. Product Information about Expandable Polystyrene (EPS)

2.1 Characteristics

Developed in 1952, EPS is a moulding material in bead or granular form consisting of polystyrene containing up to 7% by weight of a volatile hydrocarbon which is predominantly pentane. Small quantities of pentane are emitted from the raw beads. Pentane is a flammable liquid and may form explosive mixtures with air.

2.2 Physical Properties of the Blowing Agent

Some pentane will naturally evolve from the beads as a gas into atmosphere. Pentane is a mixture of isomers (n/iso).

Physical properties are:

	n	iso
Boiling point (101.3 kPa) °C	35-38	24-30
Flash point (TCC method) °C	-45	-50
Explosive limits in air/lower Vol.-%	1.4	1.3
Explosive limits in air/upper Vol.-%	7.8	7.6
Relative vapour density (air=1)	>2.00	>2.00
Ignition temperature °C	>240	>400

2.3 Implications for the Transport and Storage of EPS

- Pentane gas can ignite at a relatively low concentration of 1.3% volume in air. Ventilation will help to limit pentane concentration in all enclosed spaces. Any source of ignition must be avoided with special attention paid to sources of static electricity.
- Pentane vapours are heavier than air, so pentane concentrations are likely to be higher at ground level.
- UN classification: according to the recommendations of the Committee of Experts on the Transport of Dangerous Goods (UN Orange Book) EPS is described under UN 2211 polymeric beads, expandable, Class 9, packaging group III (Appendix 2).
- During storage a small proportion of the blowing agent will be released to the atmosphere with the rate of release increasing with temperature. EPS is therefore given a limited shelf life since the slow release of the blowing agent will result in product deterioration. The pentane loss may be reduced by using pentane-barrier film in all appropriate packaging.

3. EPS Related Hazards

Fire incidents involving EPS have resulted from the ignition of the flammable blowing agent/air mixture.

In analysing these incidents common factors become apparent:

- Staff working near or within enclosed spaces was not sufficiently aware of the potential danger, e.g., enclosed spaces should be labelled with appropriate safety information and staff should be trained accordingly.

Within the EPS-manufacturing industry, it is common knowledge that due to the release of small amounts of blowing agent, no welding, smoking, open fire, sparks, and static discharge should be allowed near any enclosed spaces containing EPS (including the transport equipment) since an ignitable blowing agent/air mixture may be present inside. This risk may be minimised through proper ventilation and by the elimination of ignition sources in the vicinity of such spaces.

The conclusion is that it is essential that all people involved in the transport and handling of EPS are informed of the hazards and potential risks in their own language.

4. Recommendations

These recommendations have been established taking into account the above information and the learning experiences of suppliers since 1952. The safety record of suppliers who have adopted these precautions indicate that their general implementation should minimise the potential risk associated with the transport, handling and storage of EPS.

The basic precaution for safe handling, transport and storage of EPS is the avoidance of an ignitable blowing agent/air mixture by proper ventilation or where this is not possible, by avoiding any ignition source including that resulting from static electricity.

All the recommendations and regulations are based on these two principles. An overview of existing regulations for each transport mode is given in Appendix 2.

4.1 Transport by Road or Rail

In Europe the land transport of dangerous goods is subject to the ADR for road transport and the RID for rail transport. Following the UN recommendations on the transport of dangerous goods EPS is classified as UN 2211, class 9, with the proper shipping name: "POLYMERIC BEADS, EXPANDABLE". This classification is valid for the ADR and RID. Due to the properties of EPS (see also Chapter 2.3) for all kinds of land transportation closed containers or boxes have to be avoided wherever possible.

For road transportation curtain sided trailers are recommended since sufficient ventilation is ensured. The sideboards of a curtain sided trailer may provide some extra protection in the event of a road traffic incident.

However, the strength and specification of curtain sided trailers is very variable, with an increasing trend towards light weight equipment. Therefore, it is necessary to secure the cargo internally within the trailer using securing straps of an appropriate strength. Trailer equipment is also generally acceptable preferably meeting the requirements of EN 12642 XL and the equipment specification (Guidelines for Transport Equipment used for Chemical Packed Cargo. Issue March 2007. ECTA and Cefic). Proper load securing must be used to secure the cargo within the trailer (Chapter 4.5 and Appendix 7).

For rail any type of wagon with side doors can be used. Checks to ensure adequate ventilation are recommended. Special attention should be paid to secure the goods inside the wagons and to avoid damage to the packaging. Fixed sections are helpful since the forces (e.g. shunting) in rail transport can be much greater than those in road transport.

4.2 Transport by Sea

The transport of dangerous goods by sea is subject to the IMDG Code. Following the UN recommendations on the transport of dangerous goods EPS is classified as UN 2211, class 9, with the proper shipping name: "POLYMERIC BEADS, EXPANDABLE". This classification is also valid for the IMDG Code. Regarding the stowage of containers loaded with UN 2211 a good ventilation must be guaranteed if it is stowed under deck (according to SW6, IMDG Code chapter 7.1.5). This is essential to ensure that ignitable concentrations of pentane are not formed within the ship.

The IMDG Code requires a cautious approach when entering or opening the doors of a freight container (cf. IMDG Code chapter 7.3.6.1). This regulation was introduced because a number of products may give rise to unsafe concentrations of toxic or flammable vapours or an oxygen depleted atmosphere.

Since January 1st, 2013, cargo transport units for transport of UN 2211 products are required to provide an adequate exchange of air in the unit (SP 965, IMDG Code). Container types which show adequate ventilation are e.g., open top, curtain sided or ventilated containers (Appendix 3). Also, the one door off operation of a standard container is possible. For containers with adequate exchange of air it is also recommended to use a supplementary label (Appendix 5). Additionally, the labelling requirements of the IMDG Code (Appendix 4) must be met.

4.3 Transport by Air

IATA guidelines are applicable.

4.4 Labelling of Packaging

Packaging requires labelling to meet the appropriate regulations (see Appendix 6).

4.5 Load Securing of Octabins

For road transportation packages have to be secured in such a way that movement in transit is prevented. The use of certified load securing systems is highly recommended. For transportation in Europe standard EN 12195 has to be observed. Best Practises for load securing of octabins in curtain side trucks are given in Appendix 7.

4.6 Specific Recommendations for Transport in Closed Units

Though it should be avoided wherever possible under ADR and RID closed containers or boxes are still allowed for transport of EPS. In all cases where proper ventilation cannot be guaranteed the measures hereinafter described should be taken to avoid the build-up of a potentially explosive gas mixture. A special label according to CV36 (ADR) or CW36 (RID) must be fixed: "WARNING NO VENTILATION OPEN WITH CAUTION"

4.6.1 Hermetically sealed packaging

If closed the proper way steel drums could be considered as a hermetically sealed packaging and this type of packaging is allowed.

Friction can generate sparks during transport of loosely stowed metal drums. To prevent this the load should be stowed in such a way that during normal transport operations movement is eliminated as far as possible. Stowage should be such that drums from the upper layer cannot fall down and cause any sparks, either in transit, or when the freight container or closed box doors are opened. Adequate dunnage should also be used to eliminate metal to metal contact.

4.6.2 Supplementary Label

To ensure that all those involved in the physical transport, storage and devanning of closed containers or closed box vans are aware of the potential hazards, all such transport equipment should be labelled with a supplementary label described in Appendix 5. It is important to avoid an ignitable pentane/air mixture coming into contact with an ignition source whenever the doors of such transport equipment are opened.

The recommended minimum ventilation time before devanning is 30 minutes.

5. Storage

The main risks associated with EPS are related to the flammable blowing agent and the combustible nature of the polymeric material. Explosion and/or fire are thus significant risks that must be prevented when storing EPS beads. The blowing agent pentane is liberated very slowly during storage. It is a highly flammable gas and can form explosive mixtures with air at concentrations between 1.3 % and 7.8 % volume. It is also heavier than air and sinks to ground level.

EPS beads are not easily ignited but once ignited burn readily. The major products of combustion are carbon dioxide, carbon monoxide, and soot (dense black smoke). Fire retardant grades can release small amount of hydrogen bromide.

EPS beads should always be stored in the original labelled, sealed container. If all beads are not used at once, octabins should be tightly closed (minimise the free space) and marked properly. Note that the inner plastic liner is specially designed for packing of EPS, it is strong and acts as a barrier to pentane loss.

Each European country may have legislation on the requirements for storage of Dangerous Goods. These should be checked to ensure compliance. It is good practise to ensure that EPS bead is stored in an environment that protects the product, ensures it is away from sources of ignition, and is stored in a safe environment that has fire extinguishing systems. There are some simple inexpensive precautions that can be taken, to reduce the risk of fire when storing bead. A Plastics Europe and EUMEPS DVD is available on "EPS Fire Safety".

Control Ignition Sources

The main sources of ignition are smoking and electrical sparks. A no smoking policy should be enforced in all warehouse and production facilities. Using a naked flame is obviously the single most dangerous act in a flammable environment. Electrical equipment should be grounded and checked for state of repair. It is also recommended to check pentane levels with a meter before starting any work. Static electricity should be controlled by earthing. To limit the risk of electrostatic discharge from octabin protective covers, they should be removed before entering the pre-foam area of the factory. The use of portable electric devices (e.g. mobile phones) should be avoided.

The warehouse used for storing EPS beads should be separated from the factory. Additionally, automatic fire detection systems, which will raise the alarm and activate a fire suppression system such as foam or water sprinklers are considered best practise. Realistically, however, to implement best practice could be prohibitively expensive for many companies. Fortunately, there are some simple inexpensive precautions which can be taken, to reduce the risk of fire, in any factory that handles expandable polystyrene and these should be considered as recommended or GOOD practice!

- Throughout the factory there must be adequate fire fighting equipment.
- Extinguishers and fire call points should be strategically placed in the warehouse and at high risk areas.
- All factory personnel should be trained in their use.
- Each company should appoint a responsible person to manage safety – he or she should check that the fire protection equipment works properly.

Ventilation & Isolation from Heat Sources

Octabins should ideally be stored indoors to protect them from environmental conditions such as rain and direct sunlight. However, two precautions are important with indoor storage: adequate floor level ventilation and isolation from sources of direct heat e.g., hot machinery and direct sunlight. This may accelerate the loss of blowing agent. The warehouse is required to have floor level ventilation to prevent the accumulation of blowing agent vapour. Ventilation either by air flow or fans to avoid is recommended. Particular attention should be given to the formation of pockets of pentane in areas below ground level.

Housekeeping

EPS beads are small spheres that are hard and mobile. Any product spillage must be cleaned up immediately to prevent accidents due to slipping.

EPS beads must be prevented entering drains and the water system. EPS will sink in fresh water but may float or sink in seawater depending on the salt content.

Personnel Protection Equipment

The use of eye-protection is recommended when handling EPS to prevent small beads entering the eye.

Damage to Octabins

If an octabin is accidentally punctured it should immediately be re-sealed with strong adhesive tape to avoid bead spillage. The product should be handled carefully and repackaged or used immediately.

Stacking

It is strongly recommended not to stack octabins more than one layer high. But if octabins are stacked in two layers always have a strong plywood sheet (thickness at least 15 mm) between octabins stacked on top of each other. Always avoid direct or indirect contact with moisture as this may weaken the octabin.

Silos

When EPS beads are stored in silos, an inert gas blanket should be applied. All storage silos should be properly earthed. Floor of the storage room should not consist of (or covered by) materials that may accumulate static electricity.

6. Chain of Information

Before delivery of EPS to any customer/processor, the supplier should inform the customer in writing of the proper precautions to be taken and emphasise the risks assessed in this document particularly when freight containers may be used.

Documents dealing with the safety of EPS in general and with transport and storage, particularly the Safety Data Sheet, should be provided to the customer.

The producer should take every care that all the means of information, like the package label, the safety data sheet, optionally additional written instructions for unloading and handling and the Instructions in Writing (see Appendix 8) are available/visible and properly updated.

7. Delivery in Bulk

The measures described in this document concentrate on packed EPS. It is however possible to deliver EPS in bulk to customers. This allows the transport of EPS with transfer at high flow rate from silo truck to customer's silo.

- Both the truck and product silo must be fully ventilated or always blanketed with nitrogen during operation in order to avoid ignition. The oxygen content of this atmosphere should not exceed 6% and there should be no possibility of air entry. The common practice is to use a slight overpressure of 0.2 bars or above.
- The truck and product silo must be properly earthed to prevent build-up of electrostatic charges during operation.
- The truck driver qualifications and truck labelling must fulfil all the ADR regulations. Delivery must be to a silo which meets all the appropriate regulations and blanketed with nitrogen as above.
- The unloading procedures must be clear and well understood by both the carrier and the customer with clearly defined division of responsibilities.
- The truck driver and washing station must be aware of the nitrogen atmosphere within the empty vehicle and the risk that these poses.

APPENDIXES

Appendix 1:

Responsible Care

As part of its commitment to Responsible Care, the chemical industry makes every effort to transport and handle its goods in a safe way and in full accordance with the relevant regulations. The chemical industry's efforts to deliver a continuous improvement in its safety standards are showing good results. Numerous initiatives have been taken by Cefic to drive this improvement:

- Cefic has developed a number of *Guidelines to promote Best Practices in the supply chain*, in co-operation with EPCA (European Petrochemical Association) and ECTA (European Chemical Transport Association).
- To help prevent chemical transport accidents, Cefic has developed *Safety and Quality Assessment Systems (SQAS)*. SQAS are systems to evaluate the safety and quality performance of transport companies and other logistics service providers by standardised assessments carried out by independent inspectors.
- *Instructions in Writing*: Instructions in Writing are part of the ADR and RID, and provide an aid during an accident emergency situation. The Instructions in Writing shall be provided by the carrier and shall be carried in the vehicle crew's cab. The form is standardized; several linguistic versions are available from the UNECE homepage (United Nations Economic Commission for Europe).
- *Intervention in Chemical Transport Emergencies (ICE)*: In order to minimize the adverse effects of accidents that may happen during the transport of chemicals, Cefic has set up ICE, a co-operative programme to provide in the event of an incident information, practical help and, if necessary and possible, appropriate equipment to the competent emergency authorities by the chemical industry.

- *ERICards (Emergency Response Intervention Cards)*: The ICE Emergency Scheme is supported by so-called Cefic Emergency Response Intervention Cards (ERICards). ERICards provide guidance on initial actions for fire crews when they first arrive at the scene of a chemical transport accident without having appropriate and reliable product specific emergency information at hand.
- Cefic has developed detailed *Guidelines for the transport and distribution of certain chemicals or groups of chemicals*.

Further information on these initiatives can be found on the Transport & Logistics Section of the Cefic website (<http://www.cefic.org/Industry-support/Transport-logistics>). More information on the initiative preventing pellet loss into the environment can be found on the "Operation Clean Sweep" website (<http://www.opcleansweep.eu>).

Appendix 2:

International Transport Regulations

According to the UN recommendations on the transport of dangerous goods EPS is classified as a dangerous good as follows:

UN Number	2211
Proper shipping name (PSN)	POLYMERIC BEADS, EXPANDABLE
DG Class	9
Packaging group	III
Tunnel Code (ADR)	(D/E)

The classification data are part of the transport regulations for dangerous goods, and affect the conditions and equipment as required by various transport modes. Typical transport regulations are the ADR (road), RID (rail), ADN (barge), the IMDG Code (sea shipment) or the IATA DGR (air shipment).

Appendix 3: Criteria for the Selection of Containers with adequate Exchange of Air

To avoid potential risk whenever the doors of containers are opened, a supplementary label (Appendix 5) should be used. Many shipping companies also offer different types of containers providing ventilation but in many cases ventilation of these types is inadequate. Therefore, the Plastics Europe EPS Transport Group recommends testing before usage.

Since January 1st, 2013, cargo transport units for transport of UN 2211 products are required to provide an adequate exchange of air in the unit (SP 965, IMDG Code).

Examples for containers with adequate exchange of air:

Open top container:



Curtain sided container:



Appendix 4: IMDG Labelling Requirements for Freight Containers

The IMDG code requires (section 5.3) that a cargo transport unit is placarded and marked, and that the information should be identifiable on transport units surviving at least three months' immersion at sea.

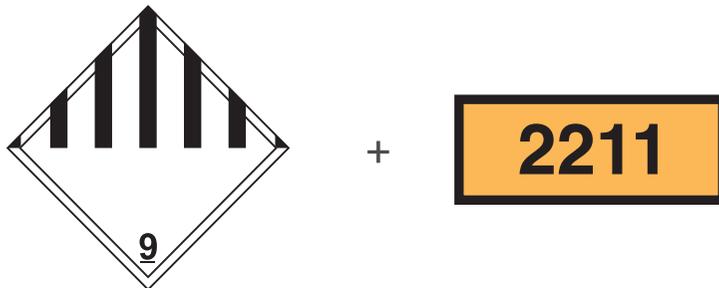
A freight container containing > 4 t of EPS is required to display a class 9 placard and a UN in front of the number, one on each side and one on each end of the unit.

Class 9 placards are: 250 x 250 mm.

This can be achieved in two ways:

Alternative 1:

UN number displayed in black digits not less than 65 mm high on an orange rectangular panel not less than 120 mm high and 300 mm wide with a 10 mm black border.



Alternative 2:

UN number displayed in digits not less than 65 mm high against a white background in the lower half of the class placard.



According to SP 965 it is required to mark cargo transport units with a warning mark including the words "CAUTION – MAY CONTAIN FLAMMABLE VAPOUR" which should be fixed to the doors of the container.

Appendix 5:

Supplementary Labelling for Containers

An optional label should be fixed to the inside and outside of the container next to the door handle. Recommended size of the label is A3.

It is recommended that this label covers the following aspects:

- avoidance of ignition sources during the unloading process (smoking, fire, welding, sparks, mobile phones)
- parking of the container at least 5 m (15 ft) away from buildings (e.g., warehouse, loading platform)
- the engine of the truck is switched off during ventilation and unloading process.
- lightning of the truck is switched off.
- attention that no drains are present 5 m (15 ft) of the doors.
- ventilation of the container with open doors for at least 30 minutes
- start of the unloading process after ventilation

Appendix 6: Labelling of Packaging

- The proper shipping name of EPS should be mentioned in English.
"POLYMERIC BEADS, EXPANDABLE"
 - UN 2211
 - Packages must be marked with the wording
"KEEP AWAY FROM ANY SOURCE OF IGNITION".
- Add:
 - Emergency telephone number
 - Your EPS Trademark
 - Company Name
 - Address of Production Site (voluntary)



Note

ADR requires the marking to be in the official language of the country of departure and, if that language is not English, French or German, in English, French or German.

For IMDG code and IATA, the following label is mandatory.

Class 9 Label (not required by ADR and RID)



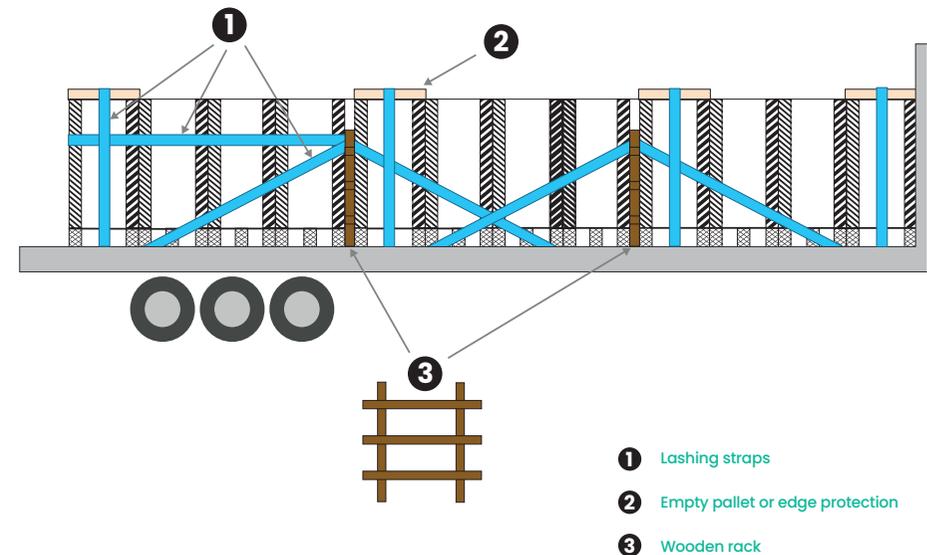
Appendix 7: Best Practises for Load Securing of Octabins in Curtain sided Trucks / Containers

Load securing can be achieved generally by friction-lock or form-lock securing or by a combination of both. Friction lock securing is achieved by lashing which can be supported using friction-enhancing bases and layer pads. For lashing the soft nature of the octabin packaging must be observed to prevent damage to the packaging unit. Form-lock securing means the use of headboards and sideboards or stanchions as load supports. There are different certified methods for load securing of octabins on the market. The following examples give an overview on the basic concepts.

Example 1: Use of Standard Straps and Wood*

Octabins in a certified curtain sider (EN 12642 XL) or in an open sided trailer (cover/stake body types or tilt).

A full load of octabins (according to weight limit restrictions) is divided in three groups with wooden racks. The wooden racks assure that the slope lashing stays in position. The top-over lashing is strapped over a pallet on top of the octabin to prevent damage. The last eight octabins are grouped together with a horizontal lashing. The gaps necessary to fulfil weight restrictions can be filled with pallets.



Picture 1: Schematic view on the system using straps and wood

* Footnote: This type of cargo securing can only be used in vehicles with a side protection that can withstand 30% of the maximum cargo weight.

Example 2: Use of Tarpaulins / Ribbons

Tarpaulins and ribbons are considered to be an alternative method for friction-lock securing. Different certified systems are available on the market. Import feature of all these systems is that octabins are not only lashed down but also secured in and against driving direction.



Picture 2: Examples for different load securing systems using tarpaulins or ribbons.



Example 3: Form-Lock Securing

Form-lock securing can be applied via the trailer construction. Frequently turnable side bars are used here. Two different approaches are used for form-lock securing. The trailer construction can be additionally strengthened, or the trailer construction is already constructively strengthened from the manufacturer (exceeding the requirements according EN 12642 code XL).



Picture 3: Examples for different load securing systems using form-lock securing

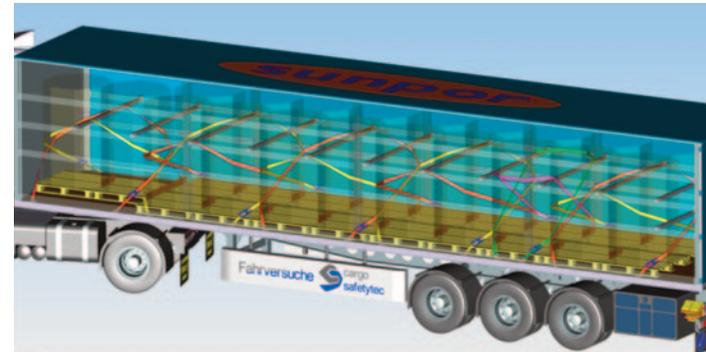
Turnable side bars can be used to obtain form-lock perpendicular to the driving direction without using additional filling material.



Picture 4: Typical turnable side bars and a typical octabin load; turnable side bars may be used to avoid airbags and other materials to fill up empty lateral space on the loading platform.

Example 4: Sunpor Quick Safe System

The Load Securing System "Sunpor Quick Safe" is a certified System developed by Sunpor. Octabins in a certified curtain sider (EN 12642 XL)



	Palette / pallet 1140x1140 incl. fiberboard IBC 11G	20 pcs
	tension belt min. > 7,5m + 0,5 m length	12 pcs
	Clamp-shoring beams – 1000 daN	10 pcs
	Plywood boards 50 x 25 x 0,9 cm	17 pcs
	Plywood boards 175 x 25 x 0,9 cm	1 pcs
	Clamp-shoring beams	2 pcs

Example 5: Sunpor D+ System

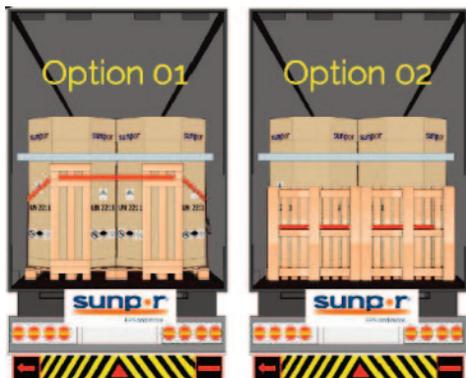
Securing of octabins in a certified curtain sider (EN 12642 XL) by the use of tension belts, clamp-shoring beams, cardboard edge protectors, pallets, wood timber, corner protectors, and anti-slip material.



18 octabins

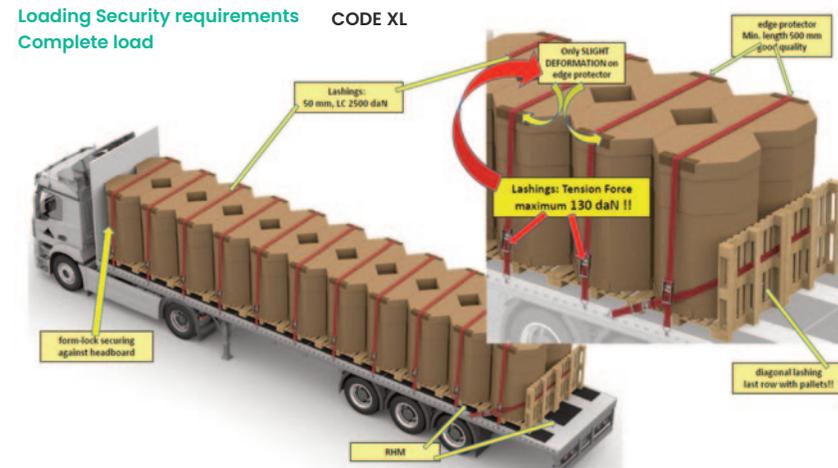


20 octabins



Example 6: Securing of Telescopic Octabins

For telescopic octabins from a specific producer, there is a certified way to secure these octabins, using these telescopic octabins in combination with edge protection and top-over-lashing with standard belts.



Appendix 8:

Instructions in Writing

For the transport of UN 2211 the “Instructions in Writing” are required. The Instructions in Writing are an aid during an accident emergency situation that may occur or arise during carriage. The following provisions shall be complied with:

- The form of the Instructions is specified in chapter 5.4.3.4 of the ADR.
- The Instructions in Writing shall be carried in the vehicle crew’s cab and shall be readily available.
- The Instructions in Writing shall be provided by the carrier to the vehicle crew in language(s) that each member can read and understand before the commencement of the journey.
- The carrier shall ensure that each member of the vehicle crew concerned understands and can carry out the instructions properly.
- Before the start of the journey, the members of the vehicle crew shall inform themselves of the dangerous goods loaded and consult the instructions in writing for details on actions to be taken in the event of an accident or emergency.

The instructions in writing are available from the UNECE homepage by this link:

http://www.unece.org/trans/danger/publi/adr/adr_linguistic_e.html

Appendix 9: Abbreviations

ADR	Accord européen relatif au transport des marchandises dangereuses par route European regulation concerning the international carriage of dangerous goods by road	IATA DGR	International Air Transport Association - Dangerous Goods Regulations
ADN	Accord européen relatif au transport des marchandises dangereuses par voie de navigation intérieure European regulations concerning the transport of dangerous substances in barges on inland waterways	EUMEPS	European Manufactures of Expanded Polystyrene
Cefic	Conseil Européen de l'Industrie Chimique European Chemical Industry Council	IMDG Code	International Maritime Dangerous Goods Code
DG	Dangerous Goods	RID	Règlement International concernant le transport de marchandises
ECTA	European Chemical Transport Association	SQAS	Safety and Quality Assessment System (Cefic)
EN	European Standard	SP	Special provision
EPCA	European Petrochemical Association	TCC	Tagliabue closed cup
EPS	Expandable polystyrene	UN	United Nations (number for dangerous goods)
		UNECE	United Nations Economic Commission Europe

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