Container technology can transport mainly piece goods over great distances. The strong container protects good during the transport, the standardized dimensions let them store in well defined stacks and handle them by well defined standard methods and machinery. The biggest technical problem of containers that the standard ISO containers inner width is smaller than a EUR pallet, therefore these cannot be placed in the container without a significant loss of transport volume.

**Container design and types**

**ISO containers**

<table>
<thead>
<tr>
<th>Container designation</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
<th>Gross mass</th>
<th>Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>ft</td>
<td>mm</td>
<td>ft lb</td>
<td></td>
</tr>
<tr>
<td>I1EE</td>
<td>13 716</td>
<td>45</td>
<td>2 438</td>
<td>8 2 806</td>
<td>9 6 30 480</td>
</tr>
<tr>
<td>I1E</td>
<td>13 716</td>
<td>45</td>
<td>2 438</td>
<td>8 2 591</td>
<td>6 30 480</td>
</tr>
<tr>
<td>I1AA</td>
<td>12 192</td>
<td>40</td>
<td>2 438</td>
<td>8 2 896</td>
<td>9 6 30 480 27 000</td>
</tr>
<tr>
<td>I1A</td>
<td>12 192</td>
<td>40</td>
<td>2 438</td>
<td>8 2 591</td>
<td>8 6 30 480 27 000</td>
</tr>
<tr>
<td>I1A</td>
<td>12 192</td>
<td>40</td>
<td>2 438</td>
<td>8 2 591</td>
<td>6 30 480 27 000</td>
</tr>
<tr>
<td>I1</td>
<td>12 192</td>
<td>40</td>
<td>2 438</td>
<td>8 2 591</td>
<td>6 30 480 27 000</td>
</tr>
<tr>
<td>I1B</td>
<td>9 125</td>
<td>30</td>
<td>2 438</td>
<td>8 2 806</td>
<td>9 6 25 400 23 000</td>
</tr>
<tr>
<td>I1B</td>
<td>9 125</td>
<td>30</td>
<td>2 438</td>
<td>8 2 591</td>
<td>8 6 25 400 23 000</td>
</tr>
<tr>
<td>I1B</td>
<td>9 125</td>
<td>30</td>
<td>2 438</td>
<td>8 2 591</td>
<td>8 6 25 400 23 000</td>
</tr>
<tr>
<td>I1C</td>
<td>6 058</td>
<td>20</td>
<td>2 438</td>
<td>8 2 501</td>
<td>8 6 20 400 18 000</td>
</tr>
<tr>
<td>I1C</td>
<td>6 058</td>
<td>20</td>
<td>2 438</td>
<td>8 2 501</td>
<td>8 6 20 400 18 000</td>
</tr>
<tr>
<td>I1D</td>
<td>2 991</td>
<td>10</td>
<td>2 438</td>
<td>8 2 438</td>
<td>8 10 160 8 700</td>
</tr>
</tbody>
</table>

The ISO 1 freight containers build the mass of the container traffic worldwide. About 80% of the containers are 40’containers, 15% are 20’containers, and all other containers are only 5%.
Containers can be of normal height and high cube. It is important to underline that there have been several effort

**Container design and types**

**ISO containers**

<table>
<thead>
<tr>
<th>Container designation</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>2AAA</td>
<td>14 945 mm, 49 ft in</td>
<td>2 595 mm, 8 ft 6 5/32 in</td>
<td>2 896 mm, 9 ft 6 in</td>
</tr>
<tr>
<td>2AA</td>
<td>14 945 mm, 49 ft in</td>
<td>2 595 mm, 8 ft 6 5/32 in</td>
<td>2 896 mm, 9 ft 6 in</td>
</tr>
<tr>
<td>2CCC</td>
<td>7 378 mm, 24 ft 2.5 in</td>
<td>2 595 mm, 8 ft 6 5/32 in</td>
<td>2 896 mm, 9 ft 6 in</td>
</tr>
<tr>
<td>2CC</td>
<td>7 378 mm, 24 ft 2.5 in</td>
<td>2 595 mm, 8 ft 6 5/32 in</td>
<td>2 591 mm, 8 ft 6 in</td>
</tr>
</tbody>
</table>

**Basic dimensions and masses of freight containers ISO 2**

Advantage: worldwide utilized
Disadvantage: inner dimensions
don’t fit EURO-pallets

These are further standardized containers. In Europe above 45’ no containers are used, but in US there exist even 53’containers.

**Container design and types**

**Unit 45’**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>External dimensions</th>
<th>Internal dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>13 716 mm</td>
<td>13 556 mm</td>
</tr>
<tr>
<td>Width</td>
<td>2 500 mm</td>
<td>2 444 mm</td>
</tr>
<tr>
<td>Height</td>
<td>2 896 mm</td>
<td>2 695 mm</td>
</tr>
<tr>
<td>Cargo capacity</td>
<td>89.2 m³</td>
<td>-</td>
</tr>
<tr>
<td>Europallets</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>Tare mass</td>
<td>4 260 kg</td>
<td>-</td>
</tr>
<tr>
<td>Payload</td>
<td>29 740 kg</td>
<td>-</td>
</tr>
</tbody>
</table>

The largest containers transported in Europe the pallet wide 45’containers. These can accomodate 33 row of EUR pallets in each row 3 pallets. That means the container is filled with no space loss. The 45’ pallet wide containers are at the limit of transportability both regarding outer dimensions and weight. Further pallet wide containers cannot be transported in high-sea transport and weigh several tons.
Container design and types

Swap bodies

<table>
<thead>
<tr>
<th>Category</th>
<th>Max. mass</th>
<th>Range</th>
<th>Lengths (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>34 t</td>
<td>12-13 m</td>
<td>12.19; 12.5; 13.6</td>
</tr>
<tr>
<td>B</td>
<td>34 t</td>
<td>9-10 m</td>
<td>9.125; 10.35</td>
</tr>
<tr>
<td>C</td>
<td>16 t</td>
<td>6-8 m</td>
<td>7.15; 7.28; 7.42; 7.82</td>
</tr>
</tbody>
</table>

Advantages: dimensions compatible with EURO-pallets, lower tara weight, multiple handling possibilities

Disadvantages: cannot be (or max. 4 layers) stacked lower strength

The previous containers have strong steel structure, which is not necessary if the containers are not placed at the top of each other. Because of the limited carrying capacity of roads there have been new unit loads constructed, the light weight swap bodies. These were originated from the changeable attachments for trucks which helped multifunctional use. The swap bodies are constructed in different lengths. These have mainly only lower corner fittings and equipped with foldable support legs.

Swap bodies are lifted using grapple arm at the gripping edges. This handling possibility is normally not supplied for normal ISO containers.
Container design and types

General purpose containers, dry cargo containers or box containers.

Features:
- Closed steel construction
- End / side doors
- No ventilation
- Corner fittings
- Forklift pockets

These are the most basic versions of containers. The number of doors is variable. More doors mean shorter loading time but more costs as well, and the stiffness of the container is also decreasing. Handling possibilities for the upper container are: lifting at the top/lower corner fittings, and lifting at the forklift pockets in the middle.

Container design and types

Open-sided containers

Open-top containers

There are special dry cargo containers for example for loading with a crane from above.
Container design and types

Open-sided, open-top containers

Platforms, flatracks (collapsible end or fixed)

Collapsible containers benefit as they are transported empty, they require far less space.

Dry cargo containers can be used for bulk materials, if it is equipped with a container liner. It is a sack like holding element for bulk material. The filling of the container is carried out using e.g a pneumatic or belt conveyor. Unloading is made by tilting back the container.
Container design and types

Bulk containers

Unloading by tilting max 30°

Unloading through side openings

There are however specialized bulk containers, but these are quite expensive.

Container design and types

Tank containers

Light weight structure

Swap-tank

Tank containers can transport only liquids or gases. The structure of the tank is because of the inner pressure so strong that it is the main structural element of the container as well.
Flexitanks enable the use of a normal dry cargo container for non-hazardous liquids. If an appropriate logistics chain is found these can be very economic. The Flexitank can be reusable as well.

First type of refrigerated containers need a central cooling device at the ship.
Container design and types

Refrigerated containers

There are two basic types of refrigerated container (reefer) which have each developed differently over the course of time:

Porthole refrigerated containers, also called insulated or Conair containers, do not have their own refrigeration unit. They are thus reliant on an external supply of cold air. Refrigeration units of various types, permanently installed on the ship, permanently installed in the terminal or clip-on units for individual containers, are used for this. (see below)

Integral refrigerated containers, on the other hand, have an integrated refrigeration unit, which is generally powered nowadays using a 3-phase electric power supply.

Roll-off containers are absolutely not compatible with the ISO containers. Shape and dimensions are different, these have usually no corner fittings. These carry normally bulk materials, their success comes from the easy handling possibility.
(Container handling)

Lifting at the top corner fitting

- Spreader
- Twistlock

Ship to shore container gantry cranes

Container gantry cranes or Quay cranes are the most expensive machinery at ports, therefore the material handling systems is optimized regarding their aspect.

(Container handling)

Lifting at the top corner fitting

- Automatic stacking crane systems

Rubber tyred gantry crane

Automatic stacking cranes work at the container yard, these are continuously handling the container puffer (containers waiting for the transport vessels, trains). Rubber tyred gantry cranes move at lower speed than the rail version but is capable of move freely between the stacks. Lifting at the top corner is the most common handling possibility of containers. Machines for this are listed at the previous 2 and the next slide.
Container handling

Lifting at the top corner fitting

Reachstacker

Straddle carriers

Container handling lift trucks

Lifting at the forklift pockets

Side loaders

Side loaders are versatile machines these can transport and set down containers at smaller companies, where there is no container handling equipment. The problem comes from the weight of the machine which is loaded with a container sometimes too heavy for roads. The machine is rather expensive as well.
Container handling

Grapple arm lift

The spreader can adjust its length to lift containers from 20’ to 40’ using ISO floating twistlocks. It also features grapple arms to lift trailers, swap bodies (C715, C745) and bottom lifting containers. Powered Pile Slope (PPS), tilt (optional), rotation and side shift features enable easy location onto containers or near pick-up points achieved with smooth control technology.

Folding legs

Special truck required
Limited load on the legs
Requires great accuracy

This is mainly for swap bodies. It is in many cases integrated with the spreader, like on the top right image.

Container handling

Rail to road systems
(special truck+carriage)

ACTS

Mobiler

Mobiler is a special solution for loading from train to truck and back with a side telescopic motion. It requires an exact positioning, and requires specially modified truck and railway carriage. ACTS is a system for roll-off containers, requires specially modified railway carriages.
Container handling

Rail to road systems
(special railway carriage)

Cargobeamer

Cargobeamer is the latest development which helps not only container but straddle carrier change between rail and road. It requires specially modified stations railway carriages, therefore it is an expensive solution.