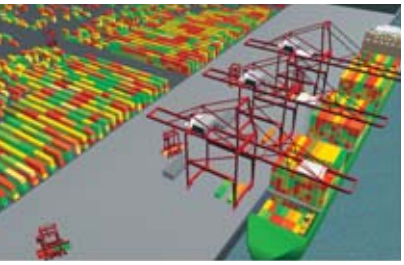
KALMAR CONTAINER HANDLING SYSTEMS

COMPLETE RANGE OF PRODUCTS AND KNOWHOW

Terminal Operations



Increasing Demands

To plan and to run a succesful container terminal is a demanding task. There will be more and more pressure to cut operational costs in the future, but also to improve service level and operational efficiency.

The new, bigger vessels currently being built are causing new challenges to terminal operators of how to further increase vessel loading and unloading efficiency.

This not only calls for bigger and faster ship-to-shore cranes, but also for yard equipment that can keep up with the vessel operation. Operating the existing equipment more efficiently is important, also new handling methods are required in some cases to meet the new demands.

Terminal Development

Kalmar Terminal Development® is available to assist our customers when planning new terminals and when improving the efficiency of existing terminals. With it's wide customerbase and product range Kalmar is in an ideal position to colllect, analyze and use operational information, so that each application can be handled individually.

Layout drawings, equipment recommendations, estimates of number of equipment and overall cost calculations are available. Operational simulation is available also. This service is useful for planning new terminals, but also for improving efficiency of existing terminals.

Choice of handling system

Choice of handling system normally depends on several criteria, such as required storage capacity vs space available, labor costs, required selectivity both in vessel and landside operation, shape of terminal, ground limitations and size of operation.

Kalmar can assist in analysing these factors. Kalmar works together with port consultants, in order to give the best possible service.

Ship-to-Shore Cranes

Critical for Productivity

Ship-to-shore crane performance is essential for efficient operations. Kalmar ship-to-shore cranes are specifically designed for efficient loading and unloading of containerships.

When unloading the ship, containers are placed either on terminal tractor trailers or directly on the ground, depending on the type of operation. Normally containers are placed under the ship-to-shore crane portal and hatch covers of the vessel placed under the backreach.

Increasing Size

Rail span i.e. distance between the rails can vary a lot, however 30.5 metres (100 ft) is the most common rail span. Wider rail span increases stability of the ship-to-shore crane without increasing wheel and corner loads drastically, therefore longer outreach will most likely result into growing rail span in the future.

Outreach of the crane depends on the width of vessels to be handled, the largest cranes today are designed for 22 rows of containers.

Faster Speeds

Hoist capacity of the crane also varies going up to 80 metric tons in twin lift (2x20 ft) and even higher in tandem lift (2x40 ft) operations. Many of the ship-to-shore cranes today are equipped with twin-lift spreaders.

Requirements for both hoisting and trolley speeds have increased. Today in most terminals yard equipment and it's inability to keep up with the ship-to-shore cranes has become the bottleneck limiting productivity.

Innovator in the Industry

There are additional features available for improved productivity, such as a second trolley system where in unloading the vessel the container is first placed on a platform on the crane.

A secondary trolley is used to move the container from the platform to the terminal tractor trailer or to the ground. Second trolley system makes handling of semi-automatic twistlocks safer and faster, as this work can be done at the platform without disturbing the main work cycle. Second trolley was first introduced by Kalmar.

Kalmar ship-to-shore cranes are well known for their high performance and reliability, combined with minimum maintenance requirements.

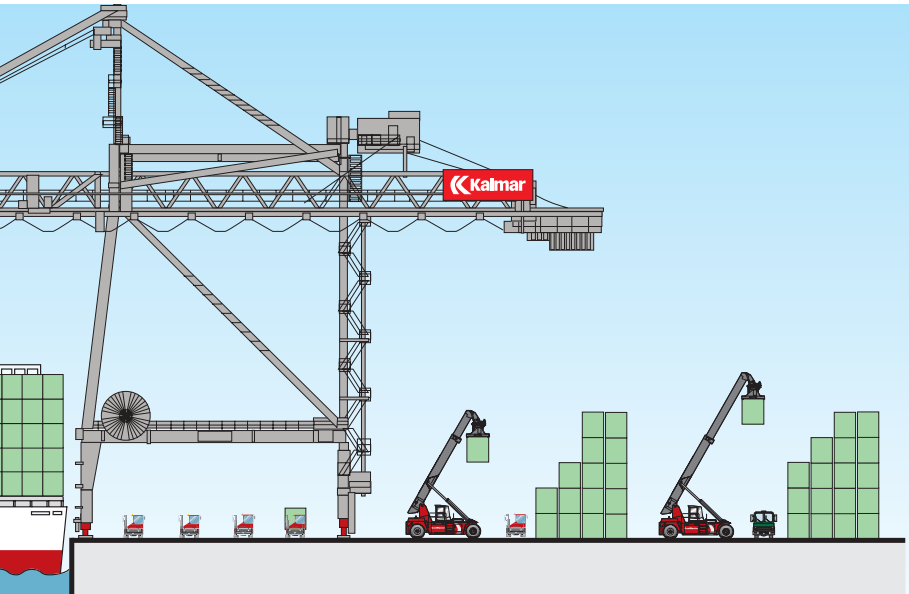
Reach Stackers and Heavy Lift Trucks

Popular Choice
Reach stackers have in most markets gained ground in container handling, because of their flexibility and higher stacking and storage capacity when compared to lift trucks. Using reach stackers container blocks can be kept 4-deep due to the second row access. Aisles between container blocks can also be kept narrower than with lift trucks, thus improving space utilization. Operator's visibility is enhanced improving safety.

Easy to Start
In small and medium size terminals and in multi-purpose terminals reach stackers are often the best choice due to their versatility in operation. Reach stackers have a clear resale value and are easy to transport between terminals. Therefore risks are reduced, especially when starting a new terminal.

Two Choices
Kalmar offers two reach stacker alternatives to choose from: ContChamp with a wide variety of options to suit all container handling and intermodal applications and ContMaster as a simple, reliable workhorse for port operations. Kalmar is the leading manufacturer of reach stackers in the world.

Lift Trucks
Traditionally lift trucks with gantry spreaders have been the prevailing handling equipment in the ports. Heavy lift trucks are often the best choice when a combination of containers and general cargo is handled with the same machinery. Kalmar has a wide range of models to choose from for different types of loads.



- Reach stackers used for stacking and for loading and unloading of road trucks and terminal tractors
- Reach stackers can also be used for short distance transportation, especially in small terminals
- Terminal tractors used for transporting of containers between vessel and container yard
- Estimate 3-4 reach stackers and 4-5 terminal tractors required per ship-to-shore crane, including landside operation
- Storage capacity approx. 500 TEU per hectare 3-high (max. 5-high)
- Low capital costs
- Optimum solution for new terminals, multi-purpose terminals and small to medium size operations

Straddle Carriers

High Crane Productivity
Straddle carriers are often used in medium-size and large terminals. Straddle carrier system is labor efficient and enables high crane productivity, because an effective buffer zone is created under the ship-to-shore crane. This makes it possible for the ship-to-shore cranes to operate at maximum efficiency thus maximizing vessel productivity.

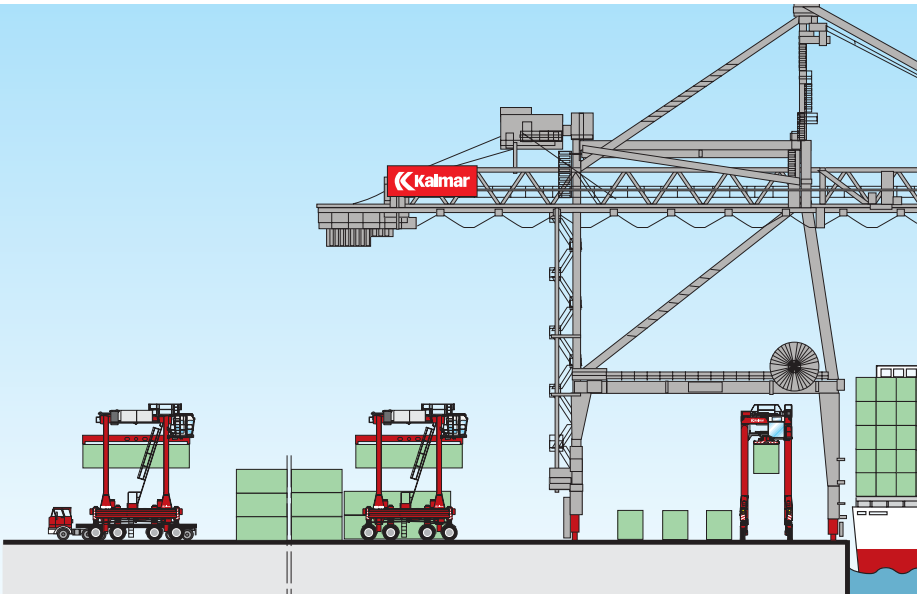
Straddle carrier system gives high selectity because of a relatively low stacking height. Because of this straddle carriers are ideal for terminals with import/export cargo or transhipment terminals with lot of smaller feeders making high stacking impractical.

Flexibility
Straddle carrier system is flexible to changes: straddle carriers can be easily moved within the terminal based on operational requirements and layouts are easy to change since no runways are needed. Straddle carriers are most economical, when travelling distances are reasonable. Separate workshop facilities for straddle carriers are normally needed.

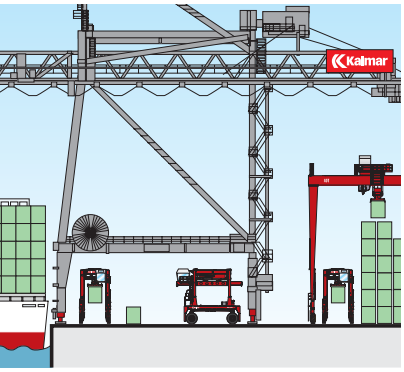
Two Choices
Kalmar has two alternatives to choose from, based on customer preferences: Electrical model with low maintenance requirements and environmentally advanced design and a more conventional, simpler design with mechanical powertrain and hydraulic hoist system. Both are available for 3- or 4-high stacking and with single or twin-lift spreaders.

Smartpath® system for automatic container positioning is available as an option, resulting into virtually no misplaced containers. Kalmar is the leading manufacturer of straddle carriers in the world.

- Straddle carriers used for all functions: stacking, transportation and loading and unloading of road trucks
- Estimate 4-5 straddle carriers required in total per ship-to-shore crane, including landside operation
- Storage capacity approx. 500 TEU per hectare 2-high (3-high SC) and up to 750 TEU per hectare 3-high (4-high SC)
- Low labor usage
- Optimum solution for medium to large size operations, when high flexibility and selectivity are required and labor usage needs to be reduced



Rubber Tired Gantry Cranes



High Storage Capacity

Rubber tired gantry (RTG) cranes are often used in large and very large terminals. RTG crane system gives very high stacking density because of high stacking capability and block stacking.

Efficient Block Stacking

RTG cranes are an efficient way of handling high block stacks as work cycle times are short when moving containers. RTG cranes are more flexible to changes than rail mounted equipment. Long travelling distances in the terminal are not problematic, as terminal tractors are transporting containers. Maintenance requirements are low and special workshops for RTG cranes are normally not needed.

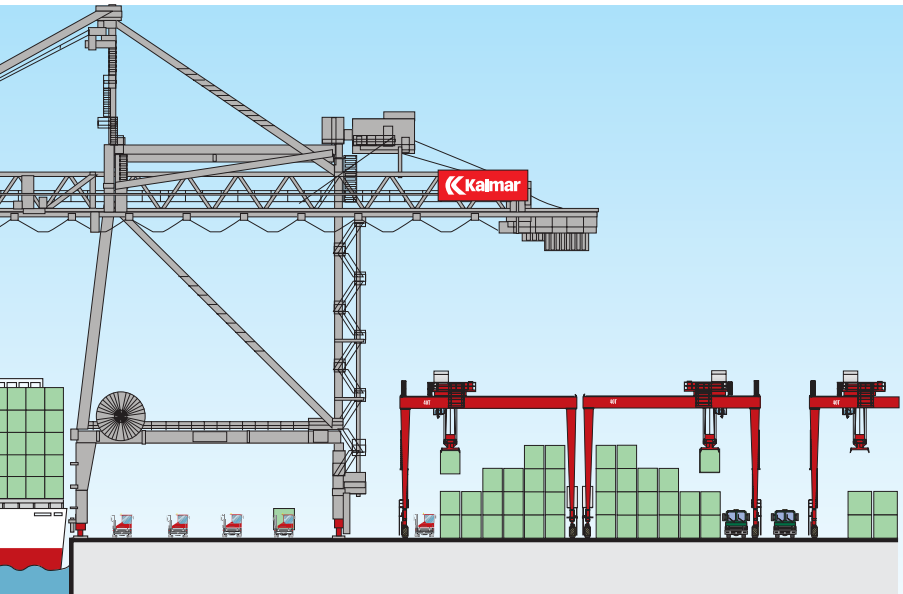
Wide Range of Choices

Kalmar RTG crane is available for up to 1 over 7-high stacking with either single or twin-lift spreader. E-One features a low-emission diesel engine and is fitted with electric trolley, wheel turning and spreader. It contains fewer critical mechanical components and therefore provides less opportunity for mechanical failures. The E-One features an impressive service interval of up to 1,000 hours for both the crane and the engine.

Also a zero emission model with no diesel engine is available. Optional Smartrail® automatic steering and container positioning verification both increases productivity and helps to avoid misplaced containers.

RTG Cranes with Shuttle Carriers®

In transhipment terminals with high productivity requirements and in high labor cost markets, Shuttle Carriers® are the ideal solution.



- RTG Cranes used for stacking and for loading and unloading of road trucks and terminal tractors
- Terminal tractors used for transporting of containers between vessel and container yard
- Estimate 2-3 RTG cranes and 4-5 terminal tractors required in total per ship-to-shore crane, including landside operation.
- Storage capacity approx. 1 000 TEU per hectare 4-high (max. 8-high)
- Low operating and maintenance costs
- Optimum solution for large and very large terminals with long travelling distances and when high storage capacity and efficient block stacking is required

Unmanned Container Handling

When to Automate

In market areas with high labor costs, labor accounts to more than 50% of overall costs in a terminal. Therefore automation can result in significant savings in overall costs and improved profitability. Automation also makes it possible to go into 24 hrs / 7 days operation at very low or no incremental costs.

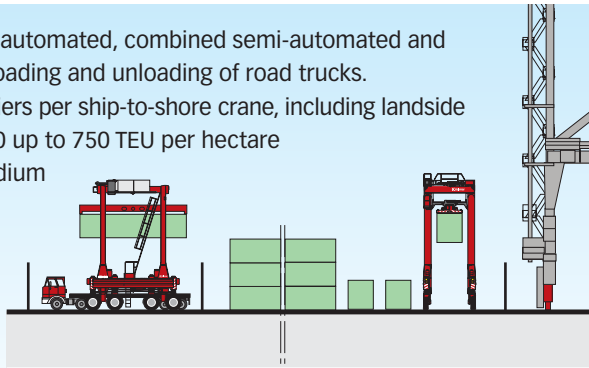
Where to Focus

It is important to identify the areas that are most suitable for automation and which give the biggest benefits. Automatic stacking cranes are easy to automate and are already widely used in container handling. When combined with Shuttle Carriers®, they give high vessel productivity and high storage capacity at very low labor costs.

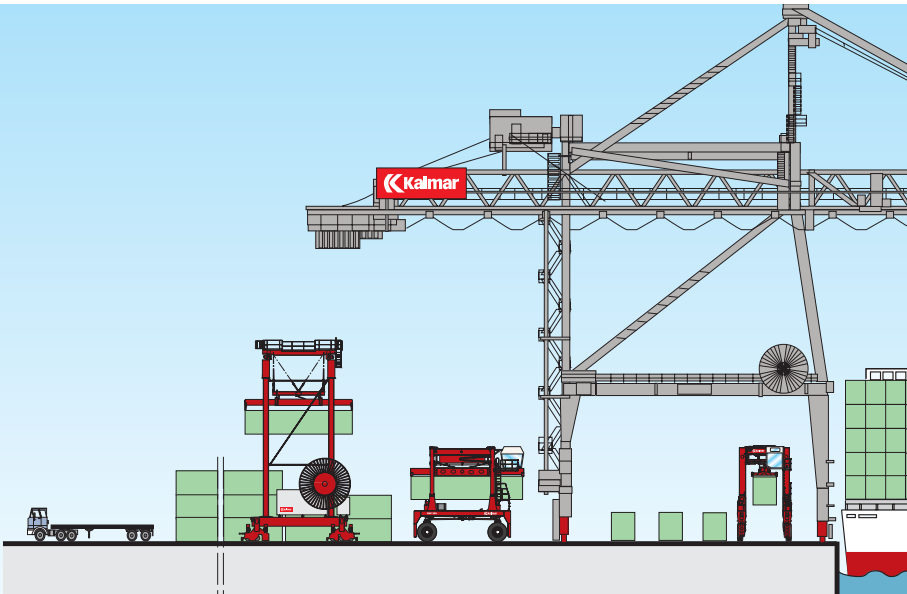
Automatic stacking cranes can also gradually be introduced to an existing straddle carrier operation.

Another attractive and cost effective alternative is Autostrad automated straddle carrier operation, with even higher operational flexibility. Automation can be applied in many cases also to the existing straddle carriers.

- Straddle carriers are fully automated, combined semi-automated and remote control used for loading and unloading of road trucks.
- Estimate 4-5 straddle carriers per ship-to-shore crane, including landside
- Storage capacity from 500 up to 750 TEU per hectare
- Optimum solution for medium to large size operations, when high flexibility and selectivity are required and labor usage needs to be minimized



- Automatic stacking cranes (ASC) used for stacking and inside stack transportation
- Automatic stacking cranes can also be used for loading and unloading of road trucks via remote control
- Shuttle Carriers used for transporting of containers between vessel and front end of container yard
- Estimate 4 ASCs and 2 Shuttle Carriers required on vessel side in total per ship-to-shore crane
- Storage capacity approx. 1 000 TEU per hectare 3,5-high
- Low labor, operating and maintenance costs
- Optimum solution for large and very large terminals when high storage capacity is required and labor usage needs to be minimized



Terminal Tractors

RoRo Operation

In Roll on-Roll off operation loads stay on trailers, which are transported in special RoRo vessels, equipped with ramps. RoRo tractors are used to move trailers in and out of the ship via these ramps. There are several types of trailers and cassettes used depending on the loads.

For RoRo vessels with steep ramps and especially in climates with harsh winter conditions, 4-wheel drive tractors are required in order to achieve sufficient traction. Small turning radius and capability of driving in both directions is required for RoRo operations in order to get maximum vessel fill ratio. Trailers are normally parked in the container yard in a fishbone pattern.

Terminal Operation

In terminal operations terminal tractors are commonly used for moving containers on trailers between the ship-to-shore cranes and container stacking area. Trailers are specially built for inside terminal usage only and with guides, wich makes it easier to place containers on them. Normally the trailer is permanently attached to the terminal tractor.

Multi trailer systems (MTS) with 2-5 trailers in combination are becoming more popular, especially if containers are moved long distances. With multi trailer systems normally a towing coupling and a heavy counterweight are used. 2-wheel drive tractors with fixed forward facing driving position are common.

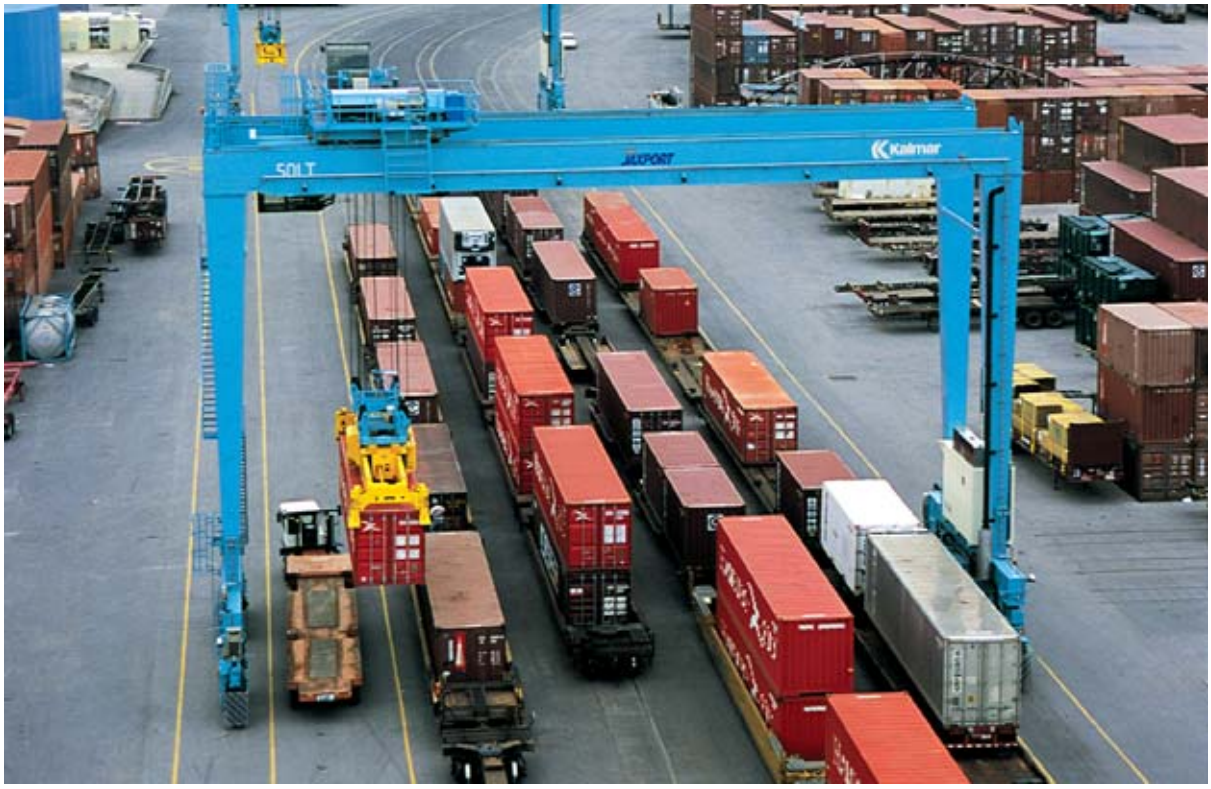
Chassis Operation

Chassis operation is commonly used in North America. In chassis operation containers are not stacked on the yard but stored on regular road chassis. Terminal tractors move containers on chassis between the ship-to-shore cranes and the container yard. In the container yard chassis are parked with their rear ends facing each other as in a parking area.

Road trucks are directed from the gate to the correct slot, where they either leave or pick-up the chassis. 2-wheel drive tractors with fixed seat position can be used.

Terminal tractors are used in various applications, also other than the three main aplications described above. Kalmar is the leading manufacturer of terminal tractors in the world with Kalmar and Ottawa brand names.

Intermodal Handling



Reach Stackers

Handling of containers on railcars is a common task in most ports today. Reach stackers are widely used in intermodal operations due to their flexibility and speed. One or two rail tracks can be accessed from the side. Also lift trucks with extended gantry spreaders can be used for accessing the first rail.

If second rail access is required, a longer wheelbase reach stacker is needed. With a combihandler spreader, trailers can also be handled easily. Reach stackers or lift trucks can be moved easily within the railyard or between the rail and yard operations.

Long wheelbase reach stackers can also be used for loading and unloading containers directly on barges.

RTG Cranes

RTG cranes can be effectively used also for handling of containers or trailers on railcars. Up to four rail tracks can be covered simultaneously and containers can be stored also at the side of the rail tracks. RTG cranes are most effective when high numbers of railcars are handled systematically. RTG cranes can be allocated into yard operations within the same terminal, if necessary.

RMG Cranes

RMG cranes are commonly used in large rail operations as several tracks can be covered simultaneously. With cantilevered RMG cranes road truck traffic can be easily separated from the rail operations. RMG cranes are normally dedicated to a specific area, as they can not be moved long distances, for example between rail and yard operations.

Straddle Carriers

Straddle carriers can also be used in handling of containers on railcars. This requires an on-dock railyard with a short distance to the main container yard, in order to be economical.

Empty Container Handling and General Cargo

Dedicated Area
Empty containers are normally handled in separate areas, sometimes in dedicated empty container depots far away from the vessel operations. This releases valuable space for loaded containers.

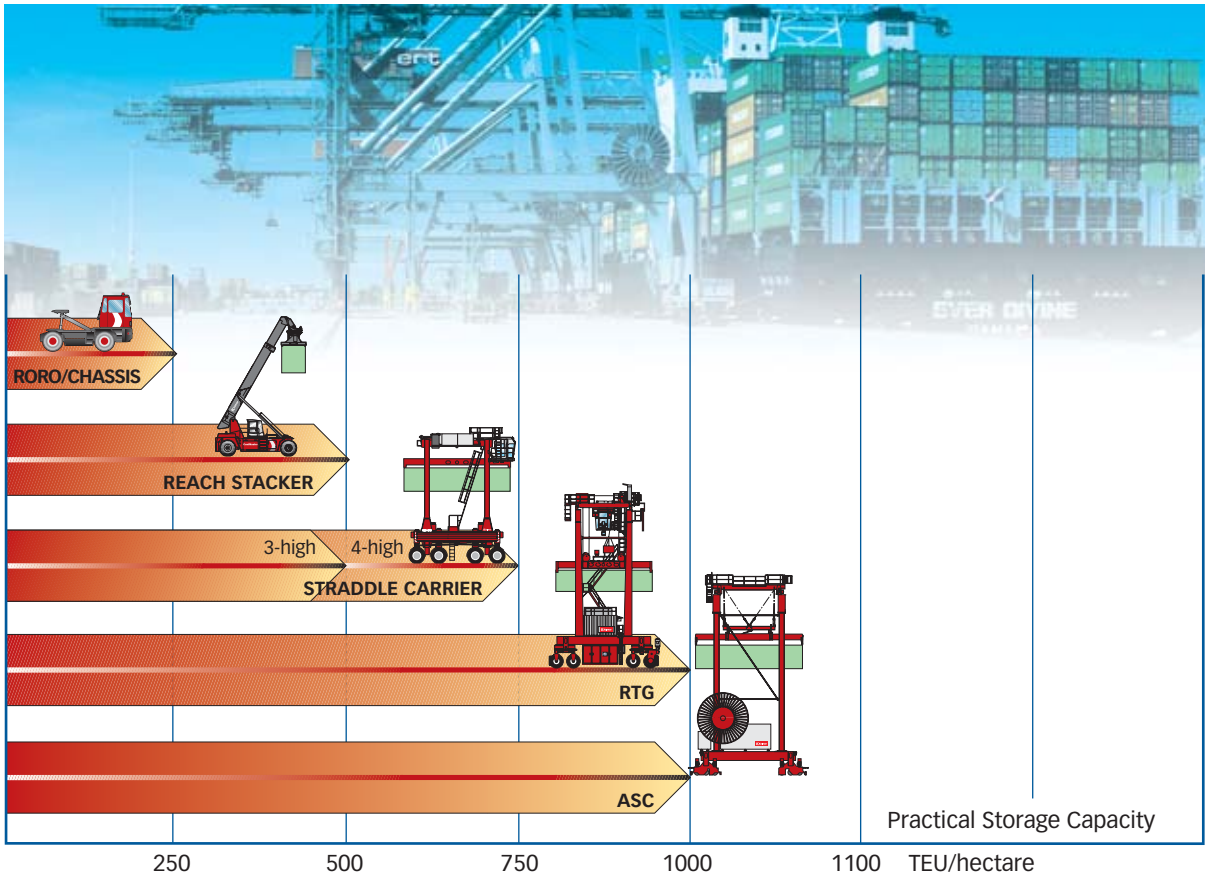
Specialized Equipment
Most common way of handling empty containers is to use empty container lift trucks or empty container reach stackers. These machines are specifically designed for empty container handling with lower hoist capacity, but with excellent stability and visibility when stacking high. This improves productivity and minimizes operating costs, but also allows high density block stacking up to 8+1 -high.

Selectivity Not Critical
Empty containers can be block stacked high, as selectivity requirements for empty containers are normally not critical. Double handling of empty container is possible with empty container lift trucks. Empty container reach stackers further increase flexibility by allowing second row access.

Different Types
Kalmar offers both empty container lift trucks and reach stackers based on customer preference. For occasional empty container handling with lower stacking height, also normal fork lift trucks can be used.

General Cargo
For general cargo and special loads there is always need for regular fork lift trucks. Kalmar has a complete range of fork lift trucks for all kinds of applications and loads starting from 6 metric tons up to 90 metric tons. When talking about heavy materials handling, Kalmar has the correct products and knowhow to meet your specific needs.

Optimal Solution for Every Development Stage



Note: actual storage capacity depends on operational aspects such as required selectivity etc.

Container Handling Systems / Selection Criteria:

	RS+TT	SC	RTG+TT	RTG+SHC	ASC+SHC	ASC+AGV
Vessel productivity	••	•••	••	•••	•••	•
Gate/road truck service	••	•••	••	•••	••	••
Stacking density	••	••	•••	•••	•••	•••
Selectivity	•	•••	••	••	••	••
Labor usage	•	••	•	•	•••	•••
Capital costs	•••	••	•••	••	•	•
Operating costs	••	•	•••	•	••	••
Ground works	••	•••	•••	••	•	•
Automation potential	•	••	•	••	•••	•••

Markings: Excellent •••, Good ••, Modest •

RS=Reach Stacker, **SC**=Straddle Carrier, **RTG**=Rubber Tired Gantry Crane, **ASC**=Automatic Stacking Crane, **SHC**=Shuttle Carrier, **TT**=Terminal Tractor, **AGV**=Automatically Guided Vehicle.

Note: For new, small terminals reach stackers are often the best alternative due to it's flexibility and easy start up of operations.

Contact Information:

Kalmar Industries

Lifetime Business Partner

Kalmar is a global provider of heavy-duty materials handling equipment and services to ports, terminals and industrial users. We supply handling solutions, which enable our customers to operate with a high level of efficiency and reliability. Every 4th container or trailer transfer at terminals around the world is handled by a Kalmar machine.

Global Operation

Kalmar has manufacturing plants in Sweden, Finland, the Netherlands, Malaysia, China and the USA, more than 10 sales companies and over 150 dealers around the world. Today, more than 65.000 Kalmar machines are in operation in environments ranging from sub-zero arctic climates to tropical humidity and heat. Our global experience and understanding of local conditions enable us to serve customers in all corners of the world.

Services for Full Response

As customers seek to focus more on their core business, Services offers flexibility and a switch from ownership to equipment availability. Our customer support services include spare parts, field service, financial solutions, service packages, refurbishing, upgrades and Total Fleet Management. Services not only facilitates better equipment performance and continuous innovations, we also make an impact on your operational revenue growth.

Kalmar
Terminal Development®

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