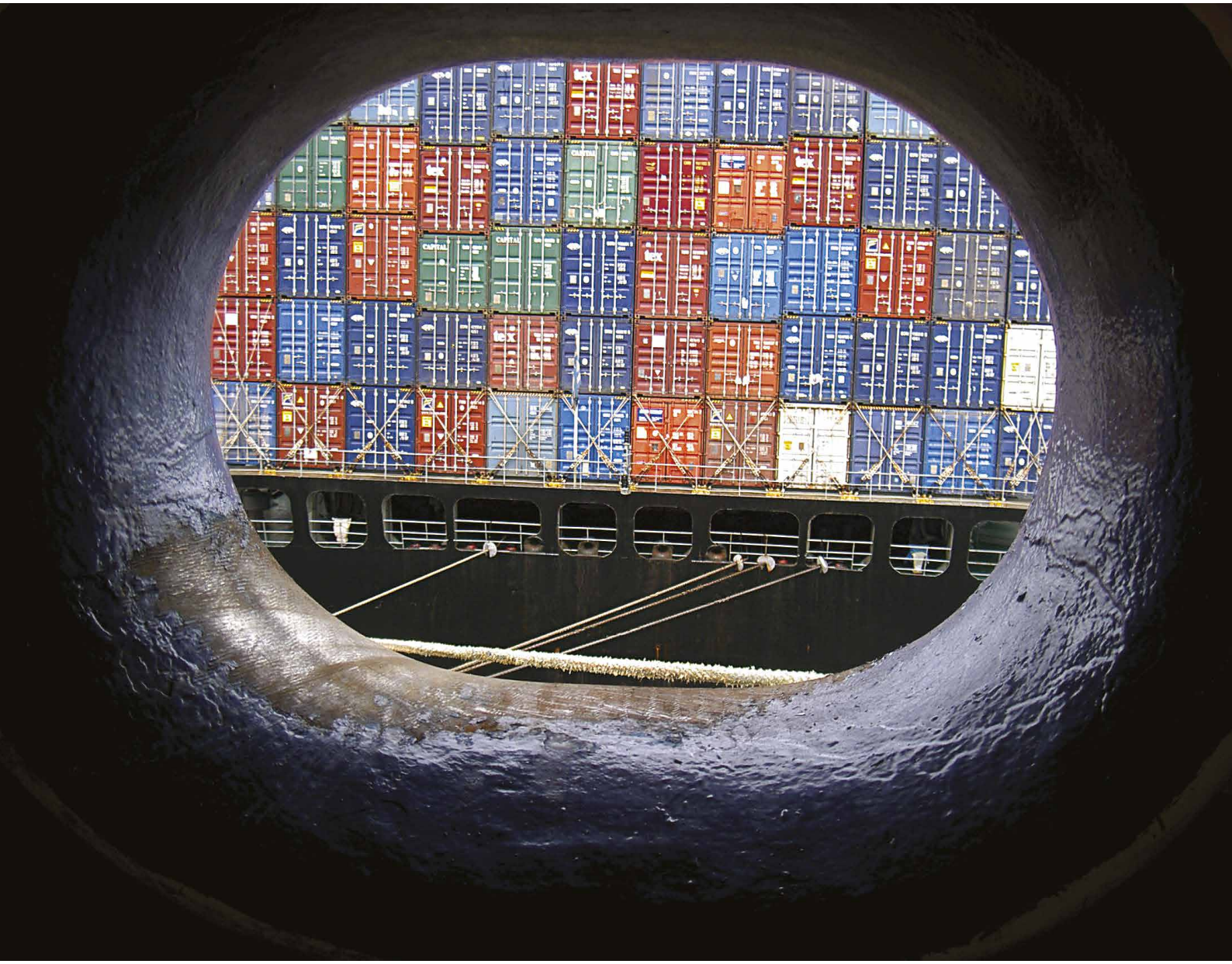
Container cargo system booklet

From design to lifetime support



MACGREGOR

For the latest information, please visit our website www.macgregor.com

Contacts:

New Building:

Arto Toivonen (arto.toivonen@macgregor.com)
MacGregor Finland Oy
Hallimestarinkatu 6
FI-20780 Kaarina, Finland

After Sales:

Finland, Denmark, Greece,

Satu Saari (satu.saari@macgregor.com)
MacGregor Finland Oy
Hallimestarinkatu 6 FI-20780 Kaarina, Finland

Europe, Middle-East, Africa

Jens Fuge (jens.fuge@macgregor.com)
MacGregor Germany GmbH
Max Born Straße 2 / 22761 Hamburg

Asia

John Tan (john.tan@macgregor.com)
MacGregor Pte. Ltd.
Singapore, 31 International Business Park

Distributor for United States, Canada and Mexico

sales@buffersusa.com
Buffers USA Inc
10180 New Berlin Road Jacksonville, FL 32226 USA
Tel: +1-904-696-0010
www.buffersusa.com

Agent for Taiwan

hengcherng@hengcherng.com / lashingsalesorder@macgregor.com
Heng Cherng Enterprises Co.,Ltd
Tel: +886-2-25 65 20 63 or 25 65 20 64

Contents

Passion for performance – united by the sea

MacGregor is a family of innovators. By engineering solutions that make the sea more accessible, safe and reliable, we support you whose livelihood depends on the changing conditions of the sea. To enable that we have a variety of strong product brands and committed experts with a passion for solving challenges – and the power of the sea is sure to provide those.

Our founders braved new frontiers in different times and places. Those origins merge at today's MacGregor, inspiring us to continue the stories, and create new ones. The spirit of our founders lives on in the pride we have for what we do, and our determination to find new solutions for the people we work with. Together with you we will write the next chapters.

We are a global team of professionals, who create value for you; the shipbuilders, owners and operators, in the offshore and marine industries. Understanding your business and way of life is key to our work. It is the foundation to addressing your needs with tailored solutions for load handling, cargo handling, mooring or essential auxiliary equipment. Your productivity, sustainability, and equipment lifetime benefit from our combination of expertise and technology. As innovators, we work together with you to set benchmarks in innovative solutions and value creation. Our deep respect for and experience of the sea lays the foundation for adapting to its challenging conditions. Wherever we work around the world, we work together with a passion for performance and a love of challenges — united by the sea. Our shared values - integrity, quality and safety - propel us forward, and are an important factor in our ability to continue to deliver what our customers need to succeed; solutions that are designed to perform with the sea.


HYUNDAI
MAERSK
Hapag-Lloyd

The birth of a ship

The design criteria for a feeder vessel's container stowage solution differ completely from the criteria for an ultra large container carrier, and so do their container securing systems. Whatever the size of the vessel, MacGregor knows how to design and deliver an efficient cargo handling and stowage system for containerised cargo.

We know how to get all the parts of this system to work in unison, ensuring that your vessel sails with the best possible performance.

A vessel designed for its cargo

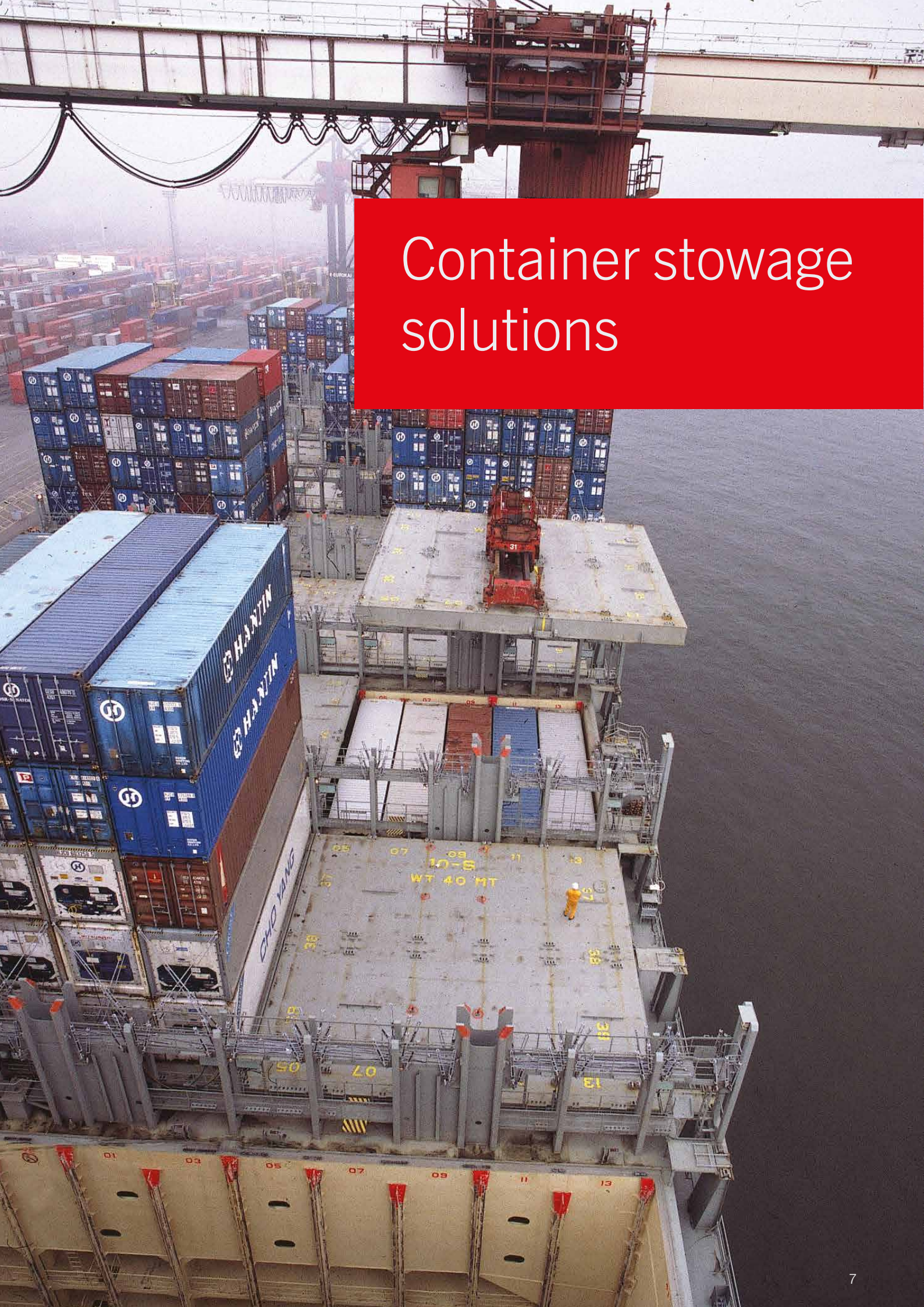
Building a new vessel is a major investment and the decisions taken at the early design phase will define the loading capacity throughout the vessel's lifetime. Optimisation of the loading capacity can lead to increased earnings. For example, a lower centre of gravity allows a better cargo mix, or in a best case scenario, the vessel may be able to carry one extra tier of loaded containers.

We can be your advisor from when the earliest ideas for your new vessel are conceived, your design expert during the project through to delivery, and your service partner throughout the vessel's lifetime.

MacGregor's involvement at an early stage in the process makes it possible to achieve an optimised custom-made container stowage solution, with a lashing system designed for all operational criteria.

The design of the container stowage solution for a new vessel involves many different steps. At MacGregor we know what is needed to ensure that all parties get the correct information at all stages of the project. We can deliver the total solution including all documentation from, for example, the initial loading concept and full vessel stack weight calculations to the offset drawing needed for fixed fitting welding positions and the final cargo securing manual.

Before the final design is fixed we perform a full scale mock-up test to verify the performance of the lashing system. We also consider elements such as the locations of hand rails and other structures that might interfere with lashing equipment. When everything is designed, tested, manufactured and approved, all relevant documentation is made available in the cargo securing manual needed on board for the vessel's maiden voyage.



Container stowage solutions

The best container stowage solutions are built around their intended cargo

All elements of the container stowage solution influence each other; understanding all these elements is necessary to define critical areas and find the best possible solutions.

An efficient container stowage solution can only be achieved by treating the ship's hull and its cargo handling system as a single optimised entity, not as separate blocks. Consequently, parts of the container stowage system, such as the hatch covers, lashing bridges, container stanchions, loose and fixed container fittings on deck and in the holds, and the cell guide system in the cargo holds, should be considered from an overall container stowage solution point of view, not as separate products.

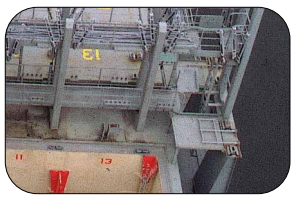
MacGregor is unique as the only supplier who can design and deliver all these products for you and this enables us to take a whole-ship approach to make the most of each ship's container stowage system.

Hatch covers

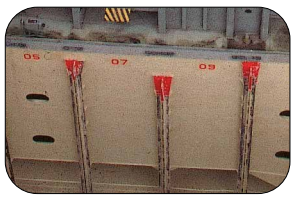
Lashing bridges

Container fittings on deck

Loose container fitings (twistlocks, lashing bars, turnbuckles)



Container stanchions



Cell guides in hold

Built-in efficiency:

"The more efficient the container stowage solution is, the greater the number of TEUs a ship can carry, which, in turn, reduces the cost and emissions per carried TEU and subsequently per transported commodity, and at the same time increases the ship's profitability and income."

Container lashings from drawing board to operation

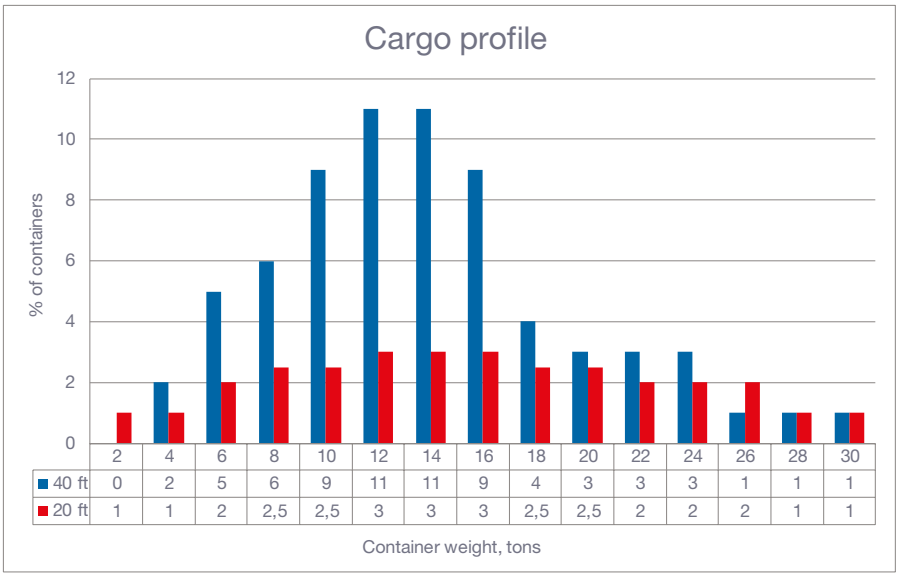
Why should we know about your cargo profile?

One of the cornerstones of the way we work is to improve the productivity of our customers' cargo handling systems, helping them to increase both their competitiveness and their environmental efficiency.

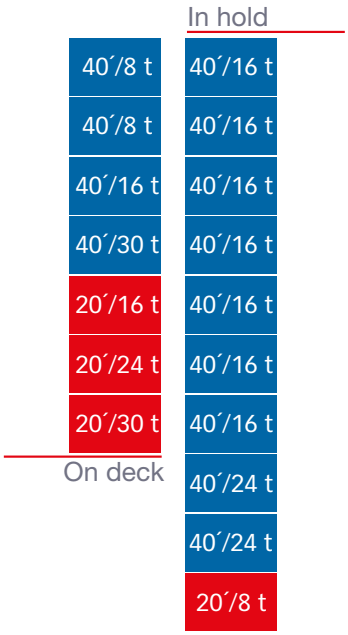
With the right indicators, which lead to the right design parameters for your vessel and its cargo handling system, we can maximise the amount of cargo carried in relation to deadweight tonnage. The onboard distribution of heavy and light containers, and subsequently total cargo weight, should therefore be one of the main factors when making decisions around a new vessel project.

We believe that defining the cargo profile should be the cornerstone and starting point for the ship design process and its container stowage solution. A container vessel is designed to carry a maximum number of containers loaded in hold and on deck. The traditional method for deciding this figure has been twofold: the first being the total number of boxes allowed by visibility rules from the bridge; and the second one is the homogeneous loading limited by the displacement of the hull. Both of these considerations lead to different maximum capacity calculations, with a significant dispersion. To avoid this we need to know more about the ship's cargo profile at an early stage of the project.

Change is inevitable and can happen if a vessel is re-located to operate on another route or when the charter period ends and a new charterer takes up the operation. Therefore, when designing the ship, consideration must be given both to the initial cargo profile and to the flexibility necessary to accommodate possible future changes to the cargo profile.

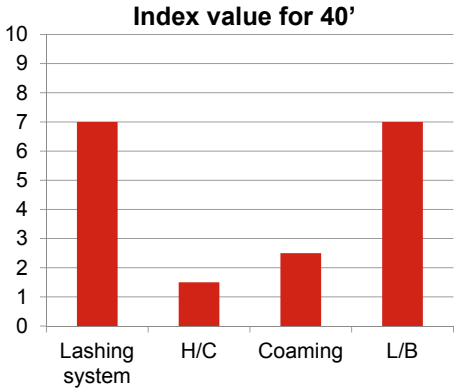


MacGregor defines cargo profile as the distribution of containers on board a ship in terms of container sizes and container weights, on a certain route



Critical components of the container stowage solution

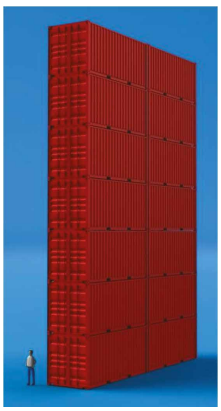
With regard to deck systems, the different components of the container stowage solution have individual design features for different container loading scenarios, which depend on the cargo profile, the number of different container sizes and the weight range.

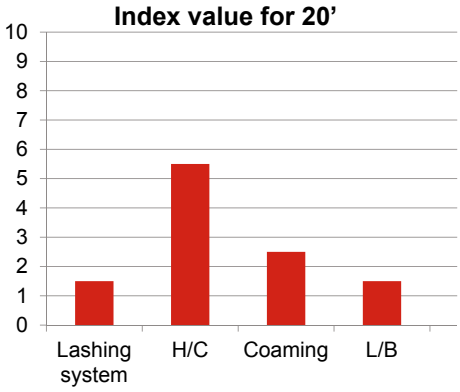


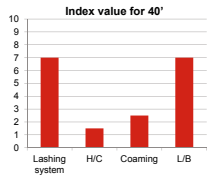
Cargo system index value of 40' containers

When determining the container stowage system, it is important to consider the effect of different loading requirements that have an impact on individual components.

From the 40' container loading example, it can be seen that major effects come from the container lashing system and lashing bridge design, leaving hatch covers and coamings playing a smaller role, as shown in Figure 1.



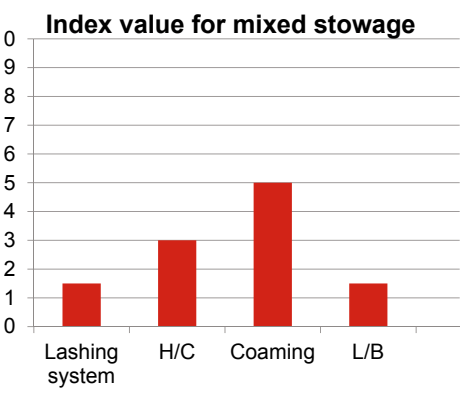


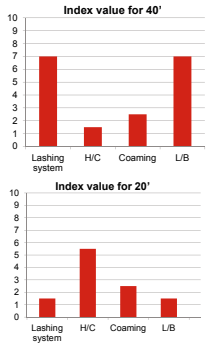


Cargo system index value of 20' containers

On the other hand, for 20' container loading, hatch covers play a significant role, but can be easily handled with the 40' container lashing system, as seen in Figure 2.

Finally, mixed loading of 20' and 40' containers has a significant effect on the coaming, through the increased slot weight, as shown in Figure 3. This means that the arrangement of the bearing pad system on the coaming needs careful consideration.





Cargo system index value of mixed stowage

Container securing

It is all about cargo safety.

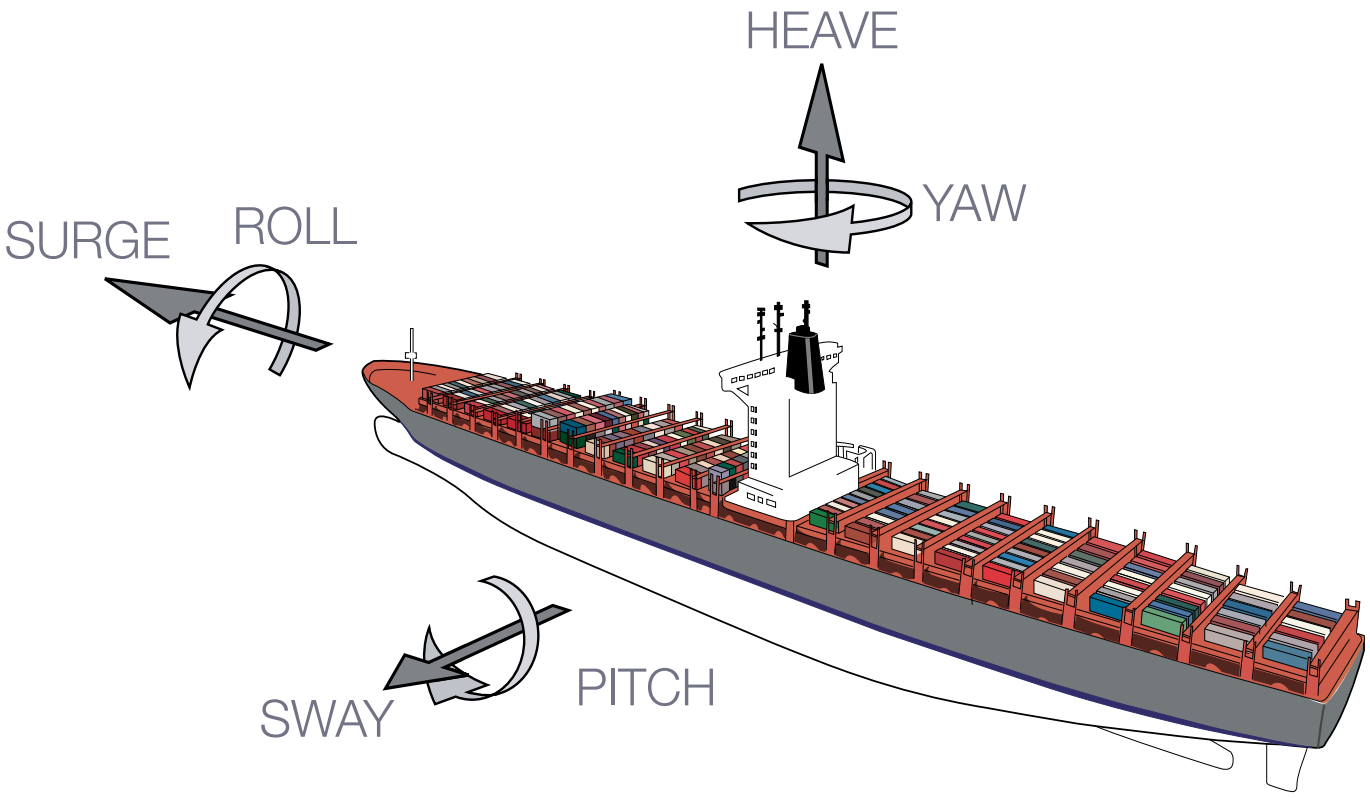
The container is a weak box loaded with heavy cargo inside and above. The mass of the cargo is accelerated by the six types of movement of a ship in response to sea conditions and by additional forces from wind and green seas. To handle these forces, and to secure the valuable cargo, containers need to be further stabilised and secured by lashing equipment.

MacGregor container stowage solutions are your first choice for the highest cargo safety standards. Innovative product design, together with high grade materials and uncompromised quality standards, ensure that your vessel will perform at its peak from its maiden journey throughout its lifetime.

MacGregor has always been the pioneering brand in the container cargo securing market, bringing value adding solutions to your container vessel operation. And we continue to do so with our intensive cargo system solutions research and development activity.

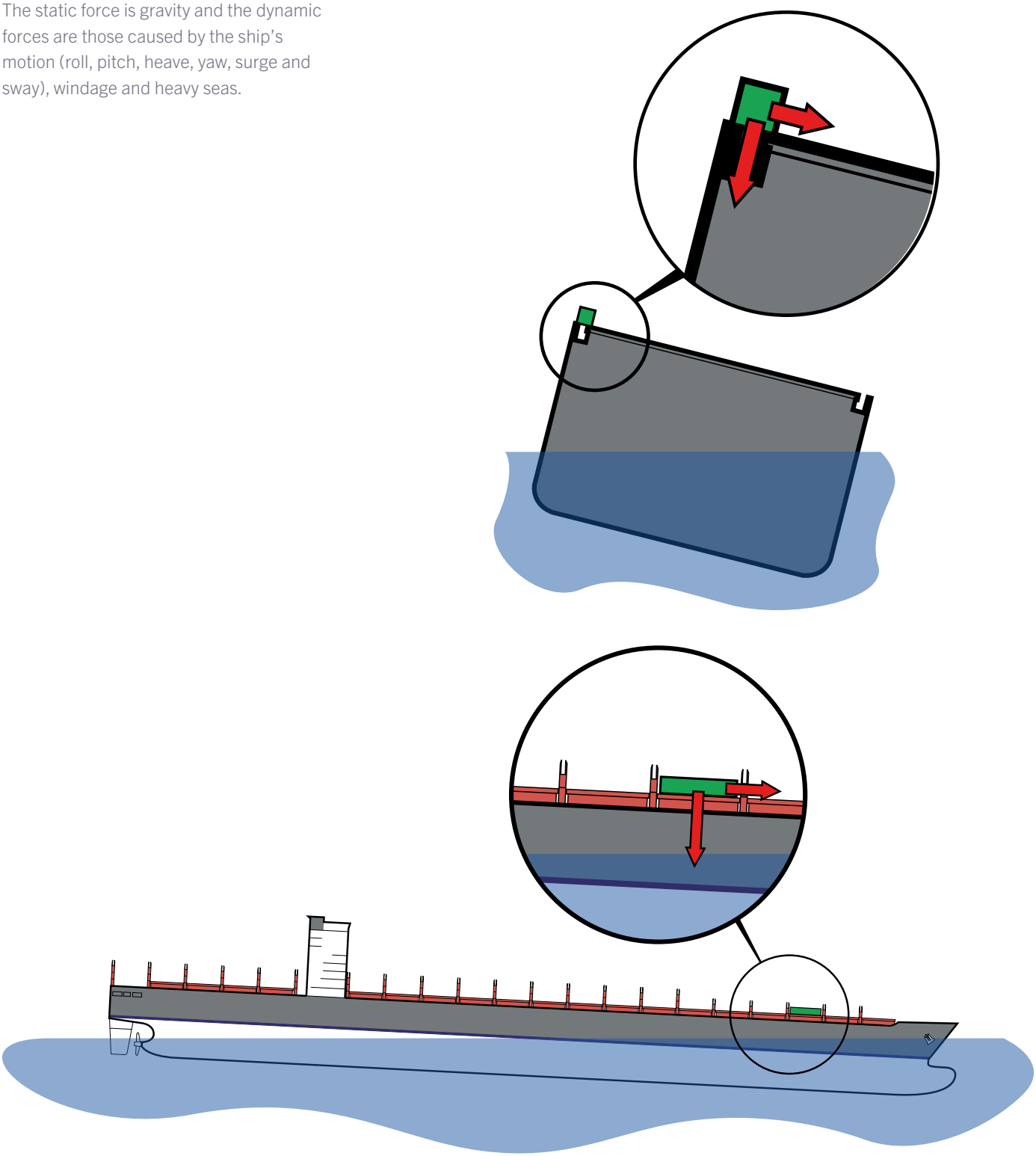
Our package for improving your container securing system performance and cargo safety:

- Lashmate® stowage calculation software ensures that the lashing system can handle the cargo, based on what has actually been loaded and where
- Lashing products and systems with margins for unintentional overload included
- Lashing products that incorporate margins for rough handling
- Lashing products designed for limiting and eliminating incorrect operation
- Lashing products that include design margins for fatigue, wear and corrosion
- Global spares and service support throughout the vessel's lifetime

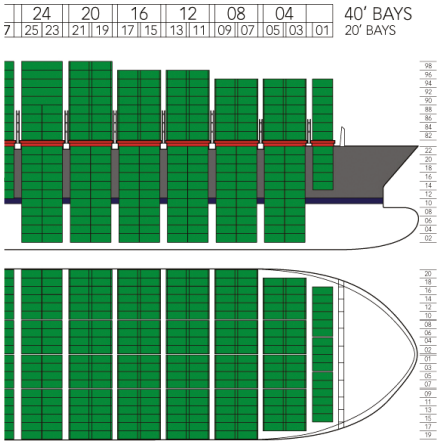


Static and dynamic components

The forces acting on the container in both longitudinal and transversal sliding depend on the static and dynamic forces. The static force is gravity and the dynamic forces are those caused by the ship's motion (roll, pitch, heave, yaw, surge and sway), windage and heavy seas.



Code of container position



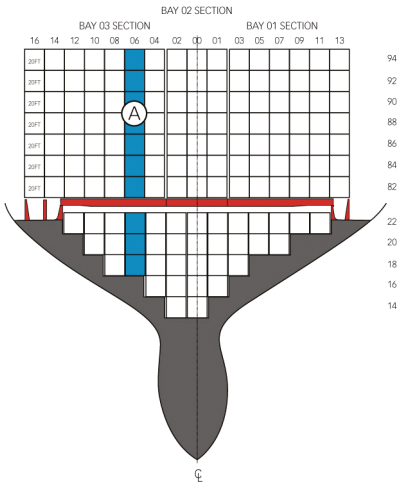
Definition

Ⓐ Position of a stack → Bay no. Row no.

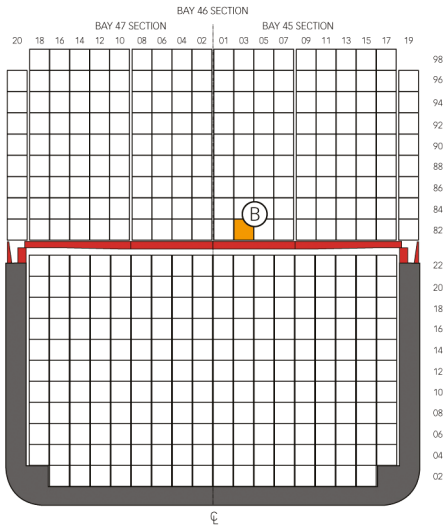
Example of a 20' stack → 03 - 06

Ⓑ Position of a container → Bay no. Row no. Tier no.

Example of a 40' stack → 45 - 03 - 82

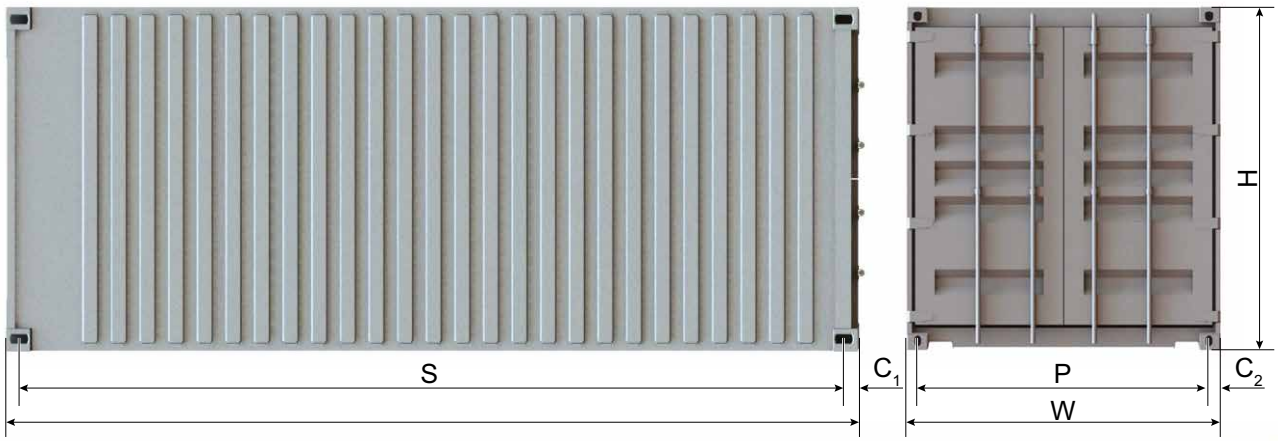


A: BAY 03, ROW 06



B: BAY 45, ROW 03, TIER 82

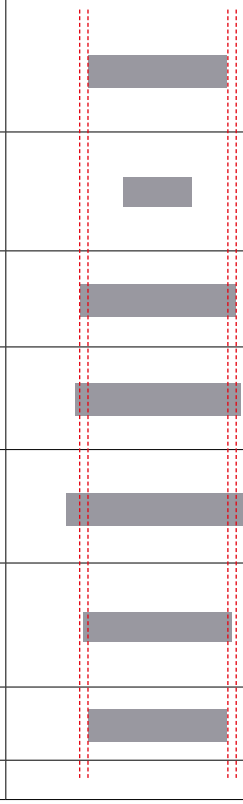
Container dimensions



Designation			ISO 668										
			40'				30'				20'		
			1A	1AA	1AAA	1AX	1B	1BB	1BBB	1BX	1C	1CC	1CX
Height	H	[ft]	8'	8'6"	9'6"	<8'	8'	8'6"	9'6"	<8'	8'	8'6"	<8'
		[mm]	2438 0/-5	2591 0/-5	2896 0/-5	< 2438	2438 0/-5	2591 0/-5	2896 0/-5	< 2438	2438 0/-5	2591 0/-5	< 2438
Length	L	[ft]	40'				29'111/4"				19'101/2"		
		[mm]	12192 0/-10				9125 0/-10				6058 0/-6		
	S	[mm]	11985*				8918*				5853*		
	C_1	[mm]	101,5 0/-1.5										
Width	W	[ft]	8'										
		[mm]	2438 0/-5										
	P	[mm]	2259*										
	C_2	[mm]	89 0/-1.5										
Difference D_1-D_2			≤ 19 mm				≤ 16 mm				≤13 mm		
Max. Gross; Mass [kg]			30480				25400				24000		

(*) The tolerances to be applied for S and P governed by the tolerances shown for the overall length and width in the ISO 668 and ISO 1161.

Comparison of container sizes

ISO	Designation	Length		Height		Width		Weight 1)
	Side view	ft	mm	ft	mm	ft	mm	kg
1AAA 1AA		40’	12192	9’6” 8’6”	2896 2591	8’	2438	30480
1CC 1C		20’	6058	8’6”	2591	8’	2438	30480
1EEE		45’	13716	9’6”	2896	8’	2438	30480
*		48’	14630	9’6½”	2908	8’6”	2591	30480
*		53’	16154	9’6½”	2908	8’6”	2591	30480
*		43’	13107	8’6”	2591	8’	2438	32500
*		40’	12192	9’6” 8’6”	2896 2591		2500	30480
1BB		30’	9125	8’6”	2591	8’	2438	25400

(*) Containers are not standardised by ISO. Given dimensions may differ from container variants.

(1) Weights are maximum gross weights and may differ from container variants.

Tolerances:

Width: +0 -5 mm for all containers

Height: +0 -5 mm for all containers

Length: +0 -10 mm for 53’ - 30’ containers

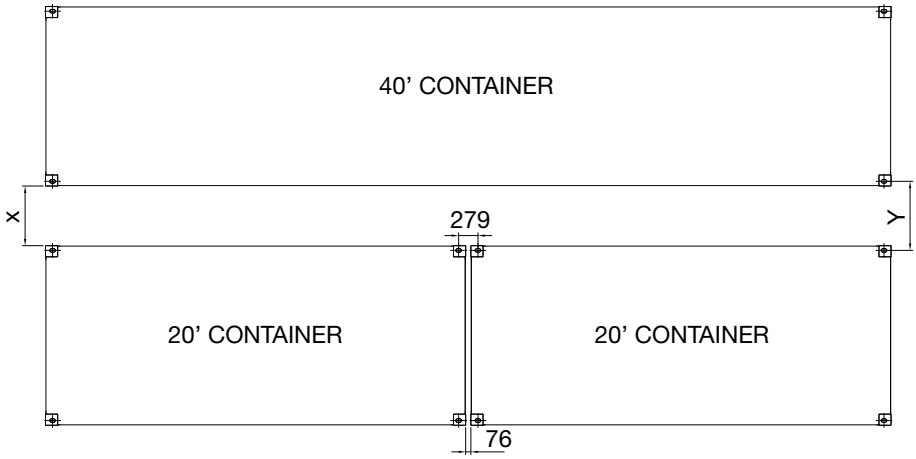
+0 -6 mm for 20’ containers

Common for all containers is the transverse measure from centre to centre point of the holes of corner fittings, approx. 2259 mm.

Common container spaces*

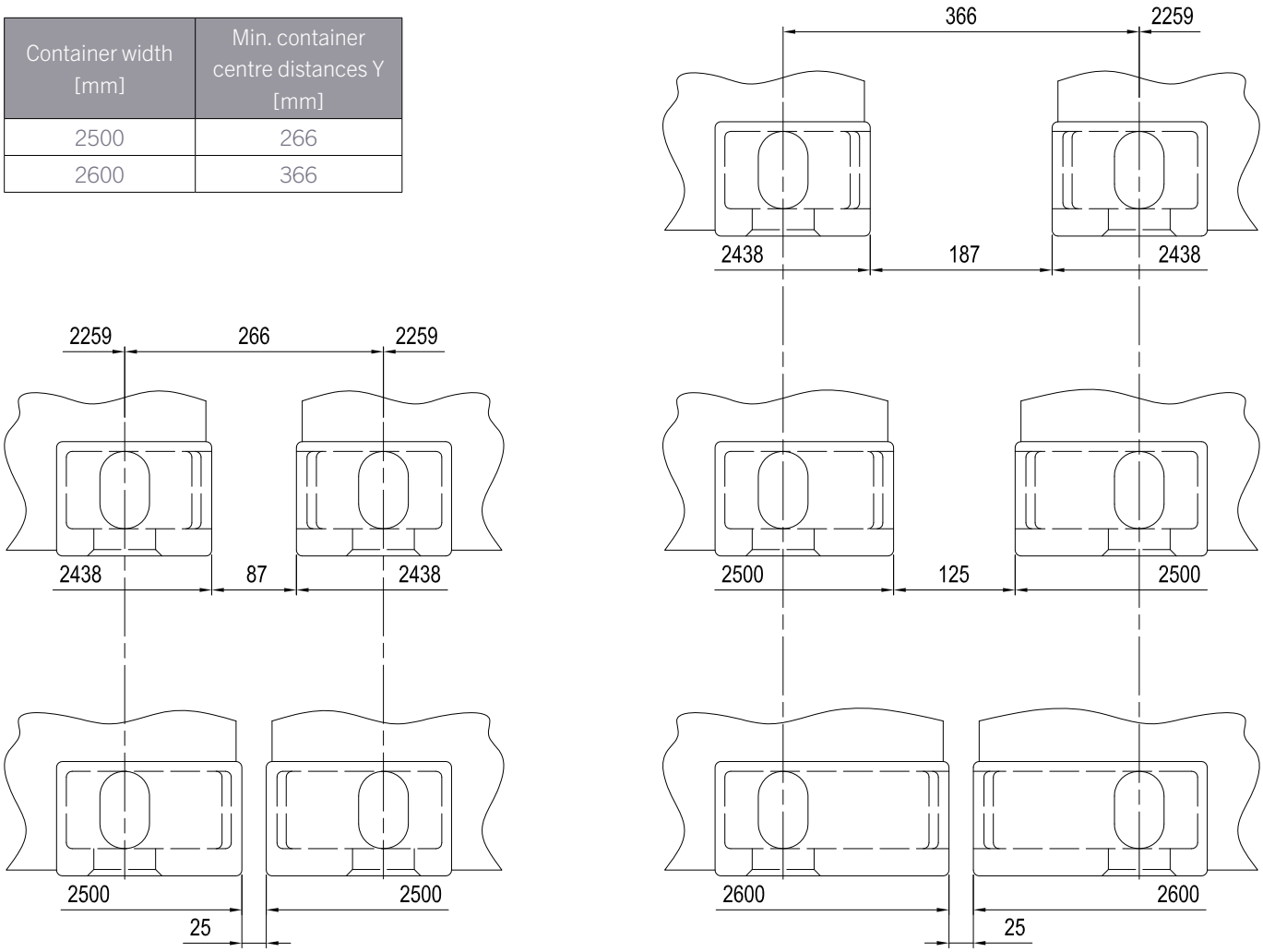
*also other spaces/distances possible

Container spaces X [mm]	Container centre distances Y [mm]
25	203
38	216
80	258
187	366



Transversal distances of wide-body containers

Container width [mm]	Min. container centre distances Y [mm]
2500	266
2600	366



Special attention must be given when wide body containers are stowed in cellguides.

Container securing system design

What do we need to know about your new ship project?

Our container securing system design process starts in close cooperation with our customers by creating a full picture of the ship's cargo profile and defining effective lashing patterns. Crucial information like weight distribution calculations and the comparison of total costs for different container securing systems help our customers to decide the best fit for their ships. A container stowage plan can also be designed as part of a complete container securing system.

We begin by defining the lashing arrangement, the scope of loose container fittings and the lashing lengths and by creating a preliminary container securing arrangement. For this, we need to know the following:

- Ship's details
- Classification society
- Container data
- Container heights on deck
- Container heights in hold
- Required stackloads on hatch covers and on main deck/ poop deck and forecastle deck, and in holds for 20', 40' and possible other container sizes
- Transversal distances between the containers on deck and in hold, as well as longitudinal distances between two 20' containers
- Type of twistlocks
- Preferred type of lashing system
- Lashing bridge particulars
- Type of fixed container fittings and securing points on deck and in hold

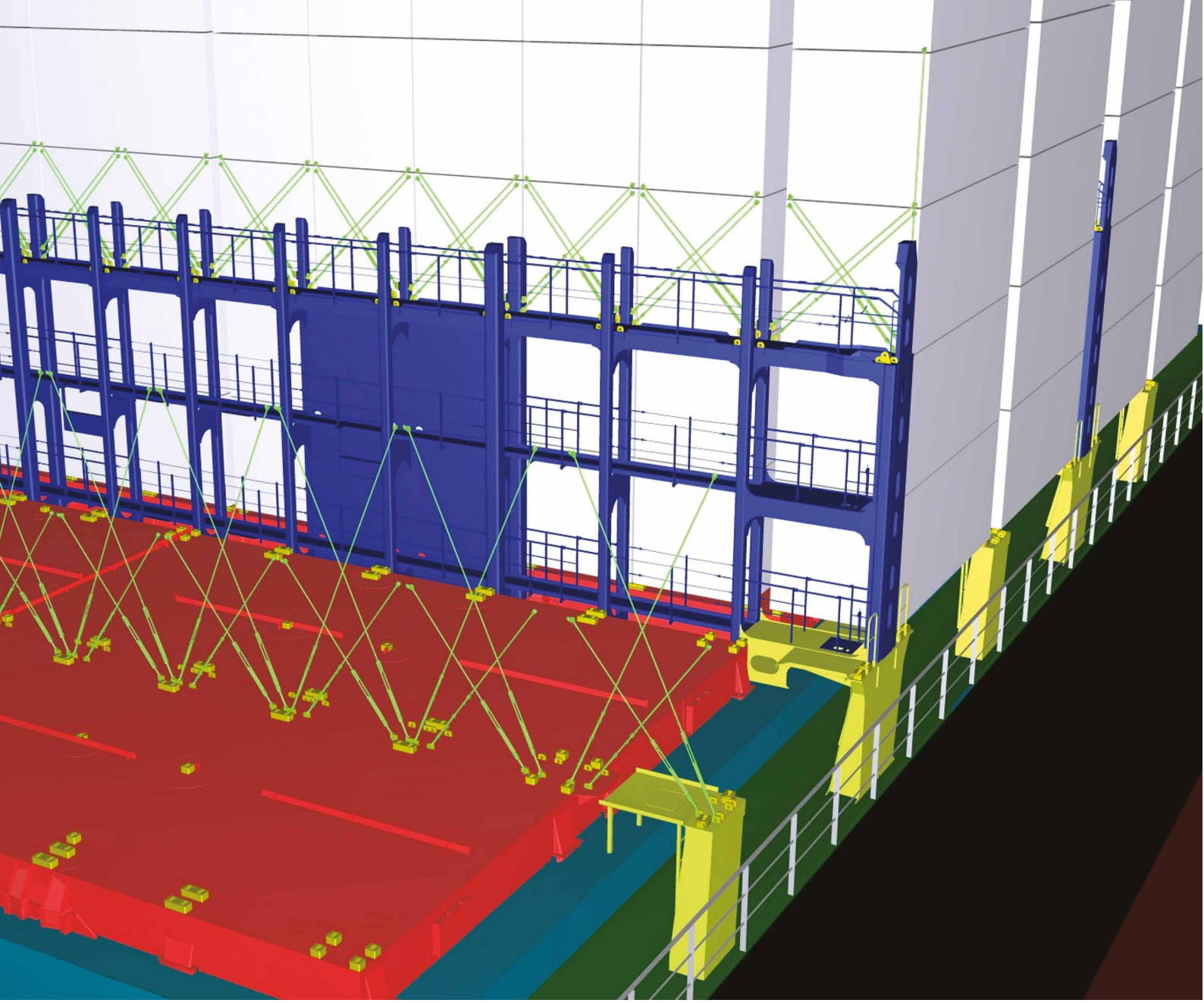
When our experts are involved in the design of the container securing system at an early stage of the ship project, we can help by making proposals around these details and compare the various arrangements to find the best possible system for each ship.

When the container securing system details have been decided, we finalise the container securing arrangement (CSA), which can be tested and verified efficiently by a full-size mock-up test. The CSA, once approved by the customer, is then reviewed in a design review meeting and sent to the classification society for its approval. At the same time, the lashing gear delivery arrangements begin in order to meet the requested delivery date.

When classification society approval has been received, the CSA forms a part of the cargo securing manual (CSM), which again is sent to the classification society for approval. At the same time, our designers finalise all related documentation and software.

As a result of the container securing system design process, our customer receives the approved cargo securing manual and all completed documentation, while at the same time the hardware delivery reaches its destination at the shipyard.

All system details are documented in our product data management system for easy reference later on.



Responsible industry members should also evaluate container securing systems using realistic conditions based on a broader perspective. They should consider:

- The actual cargo, what is being loaded and where
- Margins against unintentional overload (reasons: incorrect loading and/or extreme weather)
- Margins against rough handling
- Safety of designs to prevent incorrect operation
- Design margins for fatigue, wear and corrosion, which reduce the system's original strength over time
- Material's strength, durability and resistance in relation to ambient conditions

Your cargo profile requirements | Lashing system design | System verification | Production | Documentation | Delivery | Lifetime support

Mock-up tests - peak performance verified

The purpose of a cargo securing system mock-up test is to verify the function and performance of the designed system.

This verification process ensures at an early stage of the project that the calculated lashing lengths are correct, and that the lashing bridge structures and the loose lashings, such as turnbuckles and lashing rods, do not interfere with each other during securing operations and on passage.

This early confirmation that the cargo securing system performs according to its design ensures easy and safe operation throughout the vessel's lifetime.

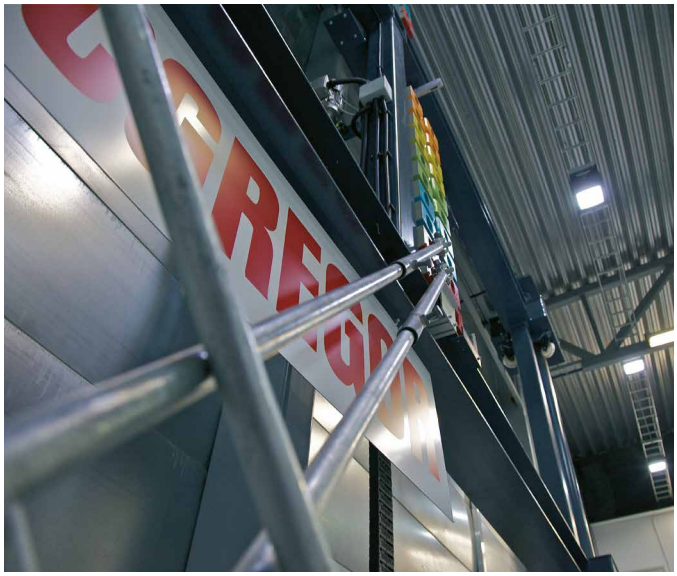
Mock-up tests are always a necessity for container vessels with lashing bridges as these systems have a high number of load scenarios. The mock-up test is particularly important in a situation where the loose lashing system and the lashing bridge design come from two different suppliers. In such cases, eventual discrepancies may not be found during the ship's basic design due to separate design documents.

Mock-up tests are convenient and cost-effective for all parties involved. Possible discrepancies and associated modification requirements can be identified and rectified at an early stage of the design, removing the need for costly adjustments on board an in-service vessel.

Mock-up tests demonstrate possible interference between lashing elements and the ship's steel structures, such as lashing bridges and hatch covers. Lashing bar and turnbuckle lengths are checked for optimised operations and for enough margin to handle tolerances in the final fitting of socket and eye arrangement on board the vessel.

Advantages:

- All loading scenarios can be tested in presence of all parties involved
- The simplest and easiest way to lash can be found and verified
- Cost savings: need for adjustments on board an in-service vessel removed, additional lashing material avoided
- Simpler after sales by optimised product portfolio



Your cargo profile requirements | Lashing system design | System verification | Production | Documentation | Delivery | Lifetime support

Approved production methods ensure quality and competitiveness

Today's open global markets call for competitive pricing and allow for no compromise on quality.

A highly qualified and motivated workforce equipped with the most modern designs, planning instruments and production techniques, coupled with sophisticated logistics, ensures that our products are successful everywhere in the world.

Our own quality assurance ensures consistent and continuously controlled production.

Our production processes comply with classification society rules and ISO standards. We have approved partner suppliers and permanent quality control at their premises.

Our production is located close to our customers and consists of a network of carefully chosen partner suppliers to ensure a steady supply flow and competitive prices.

All deliveries are tested and approved by the relevant classification societies. All approval tests, reports and documents are delivered in accordance with the technical requirements and regulations relevant to classification society rules.

Development of new and advanced systems and products is the daily business of our R&D team, as well as optimising products for production-friendly design and improved onboard operations.

All new products under development are carefully tested with dedicated equipment and on-the-spot follow-up prior to undertaking mass production.

Practical testing employs mock-up devices where functionality is verified at the full scale level. Further tests are carried out on our dynamic load test machine. Our mock-up arrangements allow for product demonstration, practical instruction and customer training, along with internal trials for new system investigations.

Priority number one - production quality

Quality is the highest priority at all our production facilities. All components are sourced from leading, certified industry manufactures and the manufacturing equipment in use is calibrated by recognised authorities.

All suppliers are approved by the corresponding classification societies and, in addition, we carry out regular audits of our suppliers. During an audit, the supplier's quality management system is monitored, the production processes are reviewed, and improvements, based on related non-conformity reports, are examined.

Continuous internal training ensures that our specialists' knowledge is always up to date.

All our personnel are also trained to report any non-conformities. For smooth communications, all non-conformities or possible claims are handled by our contract managers who are familiar with our customers and their projects. Corrective actions are recorded and followed up by our Quality Assurance team and improvements are implemented.

Forcing process

Benefit of forging compared to casting is twofold; The structure of a forged part is better when considering the strength and the CO_2 emissions are lower compared to similar part made by casting.

Structural benefit

The grain structure inside of a casted part is mixed when in forged part the grain forms clear lines, a “flow”. This linear structure increases the strength of the product. Furthermore, forged parts do not have porosity or cracks.

Switching from casting to forging leads to carbon reduction

Switching from cast parts to forged parts in the production of lashing equipment will significantly reduce their environmental impact, as demonstrated by MacGregor’s approach with the lashing gear. Life Cycle Assessment (LCA) studies, conducted by us in accordance with the ISO 14040 and ISO 14044 standards, reveal that this change will lead to a significant reduction in CO_2 emissions. By optimizing the manufacturing process, forging not only enhances the structural strength of the lashing gear but also minimizes the carbon footprint associated with its production.

Forging is inherently more efficient than casting, as it requires less energy and produces fewer material byproducts, reducing the environmental burden associated with resource extraction and disposal. The process eliminates the need for energy-intensive melting operation common in casting, and ensures a higher yield of usable material per unit of raw input. This manufacturing transition aligns with our commitment to sustainability.

Forging process

Mould production

Forging moulds are based on the 3D CAD files received for our R&D team. Moulds are machined from a high tensile steel in an automatic machining center. When in use the moulds are regularly inspected and re-machined before they are too worn for production.

Raw material

Raw material for forging is steel round bar cut to suitable length. The length & diameter of the bar depends on the size & shape of the part to be forged.

Forging

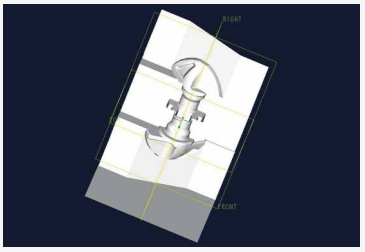
The piece of round bar is first heated with induction near melting point. After this the hot piece placed on the bottom part of the mould and shaped as a ready product by punching it with the top part of the mould in forging machine. The excess material (“flash”) is also cut off from the part during this stage of the process. This excess material is recycled either as raw material to be used for casting or to steel mill for producing new steel plates, round bars etc.

Post-processing

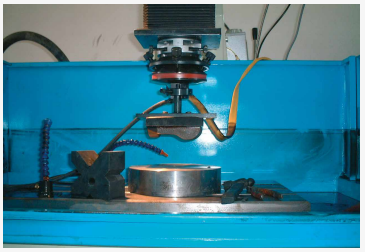
After forging parts are cleaned by abrasive blasting, machined (if necessary), heat treated (if necessary) and hot dip galvanized. After this the parts are ready to be used e.g. in a twistlock assembly.

Forging process

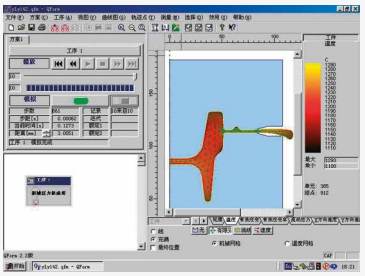
1. Mould design
2. Mould manufacturing
3. Raw material cutting
4. Preheating
5. Forging
6. Punching off the leftover material
7. Grinding
8. Inspection



Mould designing



Mould manufacturing



Forging process analysis

Forging factory

Sample of a forged product

Precision casting process

Casting is a traditional method for manufacturing parts for lashing equipment. Especially for producing parts with complicated shapes casting is better and sometimes even the only possible production method.

Wax injection
Wax models of the desired precision castings are produced by injection moulding or by using rapid prototyping. The injection moulds are based on the 3D CAD files received for our R&D team. The wax models prepared with injection moulds are referred to as patterns.

Assembly of the wax stick
Patterns are then attached to a central wax stick, called the gating system, to produce a form on which to build up a ceramic shell.

Ceramic shell building
The shell is built by alternately immersing the wax model in liquid ceramic slurry and placing it in a bed of fine sand. Up to eight layers can be applied in this manner, depending on the shape and weight of the part.

De-wax
Once the ceramic shell is dry, the wax former is melted out, creating a negative impression of the assembly within the ceramic and sand shell.

Conventional casting
Molten metal is gravity poured into the ceramic shell. As the metal solidifies and cools, the part, the gating system, the sprues and the pouring cup become one solid casting.

Knock-out
Once the metal is solid and cool the ceramic shell is broken off.

Cut-off of parts
The gating system and sprues are then cut away using a high speed saw.

Finished metal investment castings
Following further operations such as abrasive blasting, machining, heat treatment, galvanising, assembly, final quality control and classification society approval, the precision metal castings, identical to the original wax patterns, are ready for shipment to the customer.

Casting process

1. Wax injection
2. Assembly of the wax stick
3. Ceramic shell building
4. De-wax
5. Conventional casting
6. Knock-out
7. Cut-off of parts
8. Finished metal investment castings

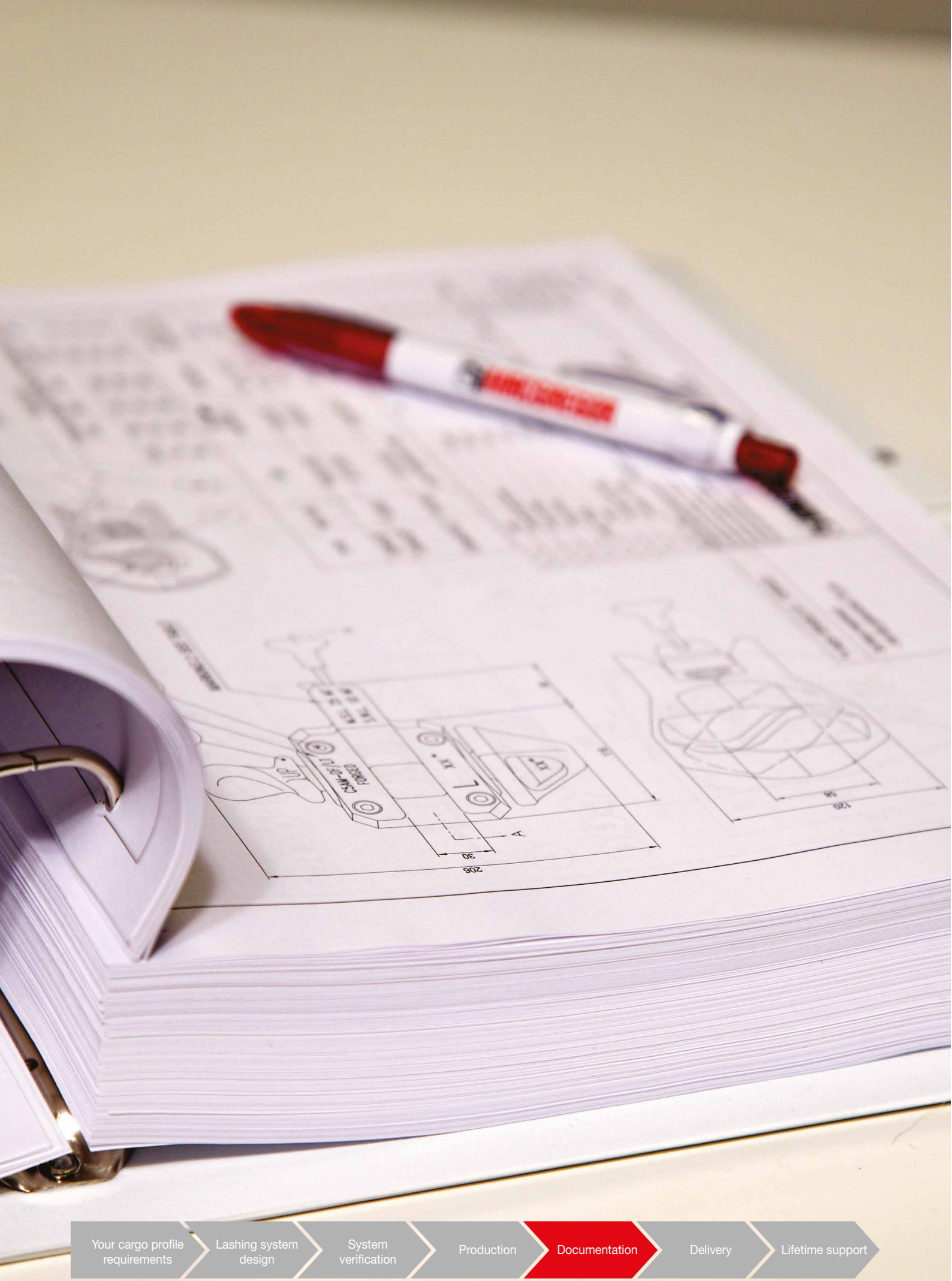

Wax injection


Assembly of the wax stick


Ceramic shell buildinf


Conventional casting


Finished metal investment castings



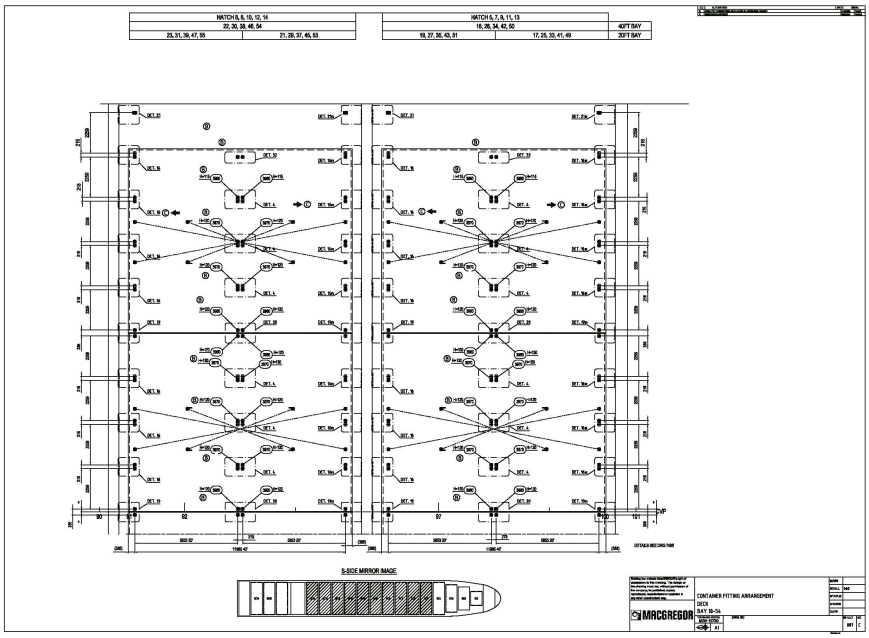
Your cargo profile requirements | Lashing system design | System verification | Production | Documentation | Delivery | Lifetime support

Documentation

Offset plans form the basis for installing fixed container fittings

These plans indicate the position of all MacGregor fixed container fittings delivered to the vessel. They show, for example, the correct position of twistlock foundations and lashing plates on weatherdecks and positions of guide fittings and welding cones in cargo holds. The offset plan drawings include all the necessary dimensions, together with bay-by-bay installation tolerances, for the correct positioning of container securing elements.

The offset drawings are an essential part of the scope of supply for fixed container fittings. Unlike other documents, such as the cargo and container securing manuals, offset plans are not subject to classification society approval.

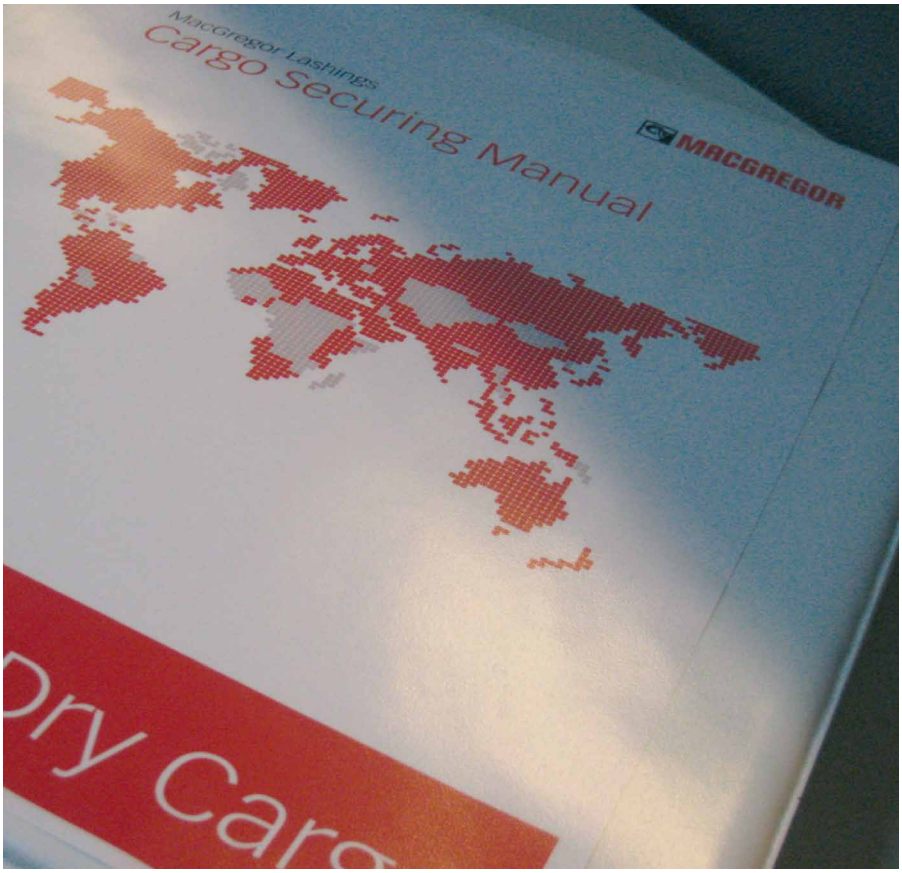


Offset plan - top view

Clear documentation ensures safe and efficient loading of containers.

System verification documentation

The cargo securing system function is verified by a mock-up test, during which all crucial lashing cases are tested. The test is carefully documented and the results are used for adjusting the arrangement where needed to provide the best possible lashing system.



Delivery documentation

Delivery documentation consists of documents that are vital from the ship's operational point of view. Some of them are required by classification societies, while others are optional and delivered on request to further support the vessel's smooth operation.

Cargo- and container securing manual

According to the International Maritime Organisation, all operating vessels need to be provided with a cargo securing manual (CSM) approved by classification societies. The content of the cargo securing manual defines what kind of cargo can be carried on the vessel and how it should be secured to ensure safe working conditions. The CSM consists of five main parts:

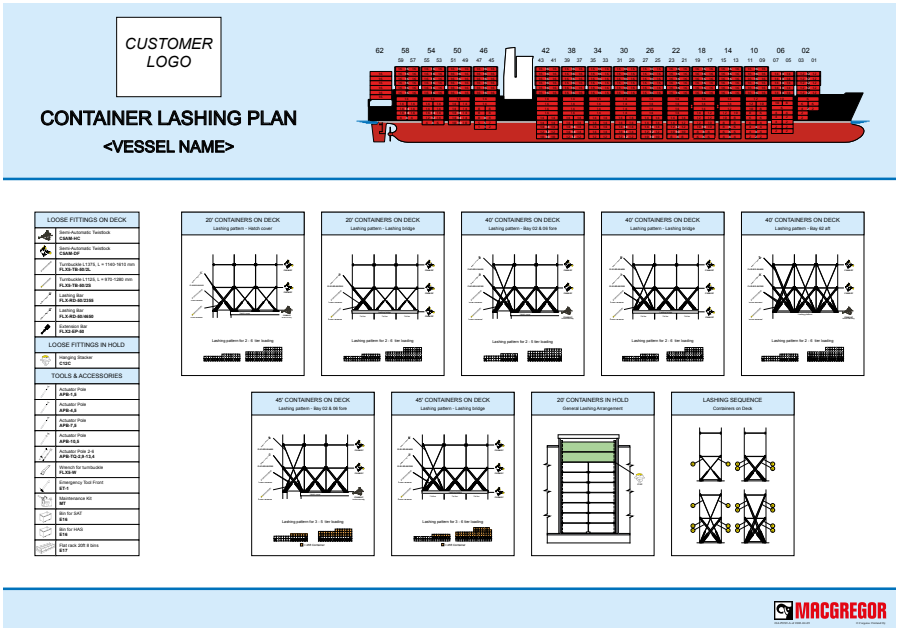
- General information
- Securing equipment
  - Loose fittings
  - Fixed fittings
  - Operation, inspection & service
- Stowage and securing of non-standard cargo
- Stowage and securing of containers
  - Container securing arrangement (CSA)
  - Calculation examples
- Annexes

The CSM includes all the necessary information for container loading. Our target is that the manual will improve the effectiveness of container operations and support our customers so that all the information that they need for their lashing systems, and after sales, can be found easily even after years of operation.

Lashing posters and instruction boards

To improve the working environment and ensure that the crew has a good overall knowledge of correct container securing, we provide lashing posters and instruction boards upon request. While lashing posters show the overall situation on one sheet, the instruction boards show different lashing principles in each bay. This information supports the stevedores for efficient and correct container securing.

The instructions are made from weatherproof self-adhesive material and fixed to visible locations, for example, hatch cover coamings. Their size is normally A4, but other layouts are available on request.



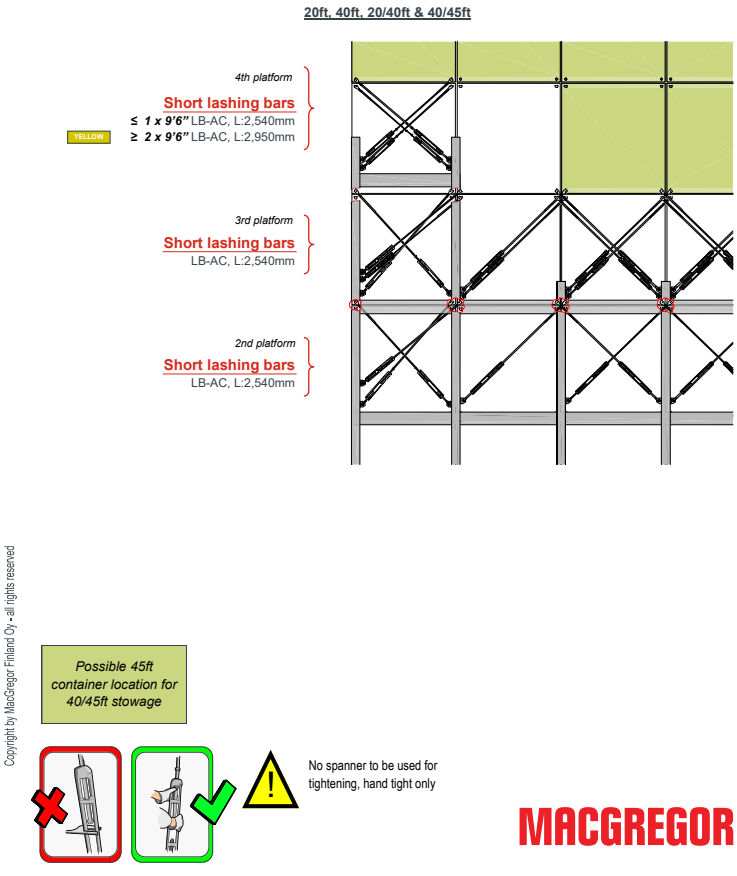
Lashing poster

Maintenance manuals

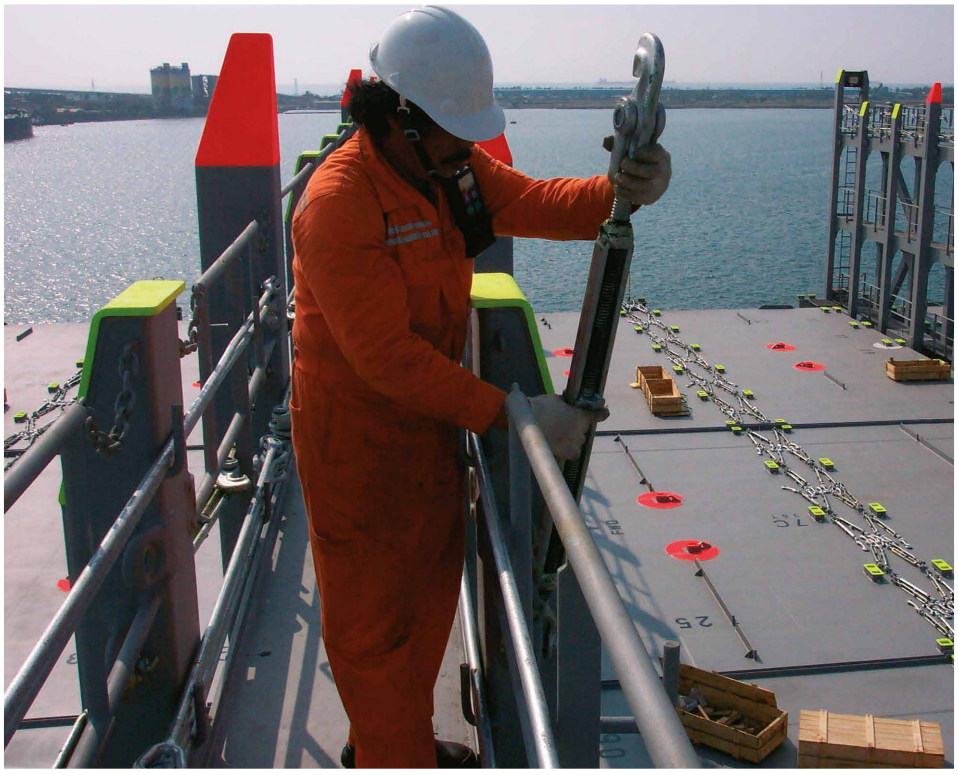
Maintenance manuals are available upon request. Our products have been designed and manufactured to withstand tough marine conditions, but the vessel's working efficiency over years of operation can be enhanced and improved by proper maintenance. This manual gives basic instructions for onboard maintenance and maintenance frequency requirements.

Lashings

Bay 42



Lashing pattern



Your cargo profile requirements | Lashing system design | System verification | Production | Documentation | **Delivery** | Lifetime support

Optional services

We deliver lashing equipment that is a perfect fit for your cargo securing system, together with cargo securing manuals, lashing posters and stickers for its safe and efficient use, but that is not all.

Our experts are ready to provide a range of additional optional services to give your vessel a flying start:

- When the equipment arrives, we help to position it on board
- We arrange for crew training to ensure the efficient and safe operation of the equipment
- We install the Lashmate® stowage calculation software and provide user training and guidance
- Our authorised experts carry out CSC (International Convention for Safe Containers) safety approvals for flat racks
- Compatibility Check: We are performing a Compatibility Check, which involves verifying that the lashing software, container securing manual, and lashing hardware on board are aligned.
- Productivity Care is a service where MacGregor monitors the first ship in series of ships by reviewing the actual baplie files and investigating any bottlenecks discovered to determine their cause.

If you are interested in these optional services, we will be pleased to tailor a suitable package to meet your needs. An early agreement ensures availability of our experts at the chosen time.

A safety approval plate, conforming to the specifications set out by the CSC convention, will be fixed to every approved flat rack in a readily visible position

Commissioning and training

Case examples from a MacGregor Lashing Project Manager's log

Reason for boarding:

Lashing affairs

Location: Shipyard

Participants: Chief officer

April 2nd and 3rd: Meeting with Chief Officer for a full review and discussion of the lashing system delivery

- Lashing gear delivery (April 3rd, April 17th)
- Lashing gear onboard installation/on-position and distribution
- Lashing patterns and lashing arrangements
- Lashmate® software (installation and training)

April 3rd: First delivery of loose lashing gear (all lashing bars, turnbuckles and HC-twistlocks) arrived at yard on time. Counted all quantities, together with the Chief Officer, no problems. We also discussed loose lashing gear installation, distribution and spare storage with the engineer in charge and foreman of the shipyard.

April 4th, 10th, 16th: Supervise the installation work of the HC-twistlocks, turnbuckles and lashing bars together with the shipyard staff.

April 17th: Second delivery of loose lashing gear (DF-twistlocks and hanging stackers) arrived. Checked the quantities with the Chief Officer, no problems.

Lashmate(R) software installation and training

Software installed and tested, and its functions demonstrated to the Chief Officer, until program is fully understood.

Outcome: Chief Officer understands the program and its functions very well; no problems with operating the system.

Reason for boarding: Crew training in loose lashing gears

Location: Shipyard
Participants: Chief Officer, Deck Officers, Bosun and other deck crew on board

April 20th: We started with a practical example of operating the gear on deck for the following items:

1. CV-8B, Hatch cover twistlocks, ACV-1 “Hippo”, Intermediate twistlocks: The crew can understand the functions of these items very well. Nevertheless, the demonstration has been carried out and their function has been explained, as well as outlining the emergency tool for twistlock. The crew had no problems whatsoever.

2. AFC-3, Midlock: The crew has had no experience of this equipment before, but they understood the functionality of the AFC-3 very well after the demonstration They were also reminded that this item should be used only on both inner ends of 20’ containers.

3. SDL 5, Hanging stacker in cargo hold: Went through the operational demonstration, and the crew do not show any problems with its use. Their operation is well-understood by the crew.

4. TBS-AC turnbuckle: This turnbuckle is equipped with a special patented ‘Slack reducer’ design to ensure the turnbuckles remain in tension during a voyage. The demonstration to the crew showed how the safety lock nut worked, and as carried out with a lashing bar in tandem to ensure the crew’s full appreciation of its use. The crew now fully understand the operation and function of the ‘Slack reducer’.

5. LB-AC lashing bar, lashing rod: To make the crew fully understand how this lashing rod works, we used a turnbuckle in tandem to demonstrate how the knob on the lashing bar is secured onto the turnbuckle. The crew understood totally its operation.

After these practical demonstrations on deck, all participants moved to the deck office, for a full explanation and discussion of the lashing system; lashing pattern instructions and the operation of all loose lashing gear was discussed and demonstrated in accordance with the cargo securing manual (CSM).

I also inspected the condition of the loose lashing gear installation (in position) on random rows. All of the lashing gear inspected/witnessed were installed correctly in position.

Always in the lead

It has always been clear to us that an integrated container stowage solution is more than a sum of its parts. Therefore, lashings for container securing form an important part of our product portfolio for container ships - together with hatch covers, lashing bridges and shipboard cranes. We are able to offer our customers integrated solutions that perfectly fit any cargo profile. Since 1992, MacGregor has been a pioneering brand for container securing systems as a natural and essential part of its reliable and efficient cargo flow solutions.

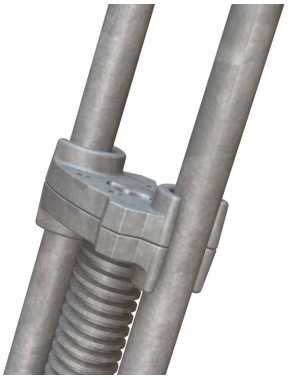
The roots of our lashing knowledge are in Germany and Sweden. In 1992, the company acquired the world leading container lashing manufacturer, Conver and its product portfolio. Our design knowledge was further strengthened by acquiring the Swedish company Allset Marine Lashing in 2005.

Examples of Conver's ground-breaking solutions were the first one-piece housing twistlock, the first semi-automatic dual wire twistlock, removable cell guides and multi-lash systems. As for Allset Marine Lashing, the company always combined product development and design skills with the ability to interpret its customer's needs, converting them into solutions that create value. An important milestone was the introduction of the first one-wire semi-automatic twistlock in the 1990s, which set a new standard for the industry.

By combining the strengths of Conver and Allset Marine Lashing, today MacGregor can provide dedicated solutions for container securing to container ship owners and operators worldwide.

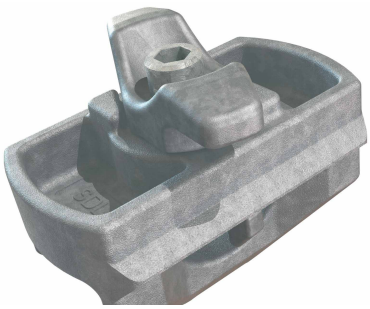
A-class lashing bar for wider use of external lashing

First fully automatic twistlock C8A



Allset safety lock

Heavy-duty bottom twistlock CV-8B



Terminal stacker SDL-1

2025 Cloud based Lashmate lashing calculation software

2024 TBS-B balancing type turnbuckle

2023 ACV-1 "Hippo" fully automatic twistlock

2020 Concept of horizontal lashing system

2018 IA-Q ISO-gap adapter

2017 New design for external turnbuckle & lashing bar (TBS-AC & LB-AC types)

2016 SDL-5 terminal stacker & AFC-3 midlock

2015 CV-16 twistlock

2014 FLT-40-16 flat rack, new 40ft flat rack

2013 A-class lashing bar

2012 CV-20 twistlock, new design

2011 Fully automatic twistlock C8A

2008 Ultra strength lashing bar

2005 EZ-lock safety-lock for turnbuckles

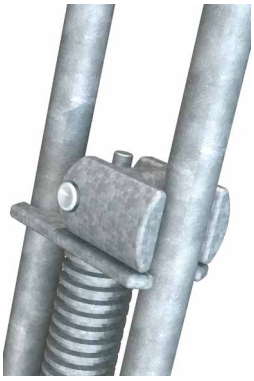
2005 Allset Marine acquired by MacGregor

2004 Top lashing bridge system

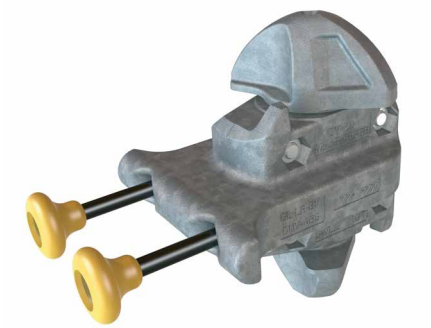
2004 Heavy-duty bottom CV-8B twistlock

2002 Slack-reducer for turnbuckles
Speedlash with bending moment eliminator
Advanced mixed stowage system with SDL-1 terminal stacker

2001 Combined bottom and intermediate AFC-1 Midlock introduced



MacGregor slack reducer



First symmetrical Dual SAT CV-20

All-purpose Midlock AFC-1L for 20´ ISO gap and lashing cap

Semi-automatic dual function twistlock C5AM-DF

Lashing bridges

First one-piece housing twistlock CV-1

1999 Hanging stacker C16A developed

1999 OSHA pressure stacker introduced

1998 Lashmate lashing calculation software developed

1996 First symmetrical dual semi-automatic twistlock, CV-20, introduced

1993 First midlock (AFC-1) and dual-function twistlock (C5AM-DF) introduced

1992 Conver-OSR acquired by MacGregor-Navire

1991 LashSet calculation software launched

1990 Equalash lashing system developed Semi-automatic twistlock, C5-AM,

1989 Slewing eyes, SAT CV-14, introduced First lashing bridges introduced

1988 Allset Marine Lashing established One-wire semiautomatic twistlock C5A

1986 First semi-automatic CV-11/CV-12 twistlocks developed

1985 Sliding foundation, four-knob Multilash system introduced

1983 Sawfish tension/pressure element developed

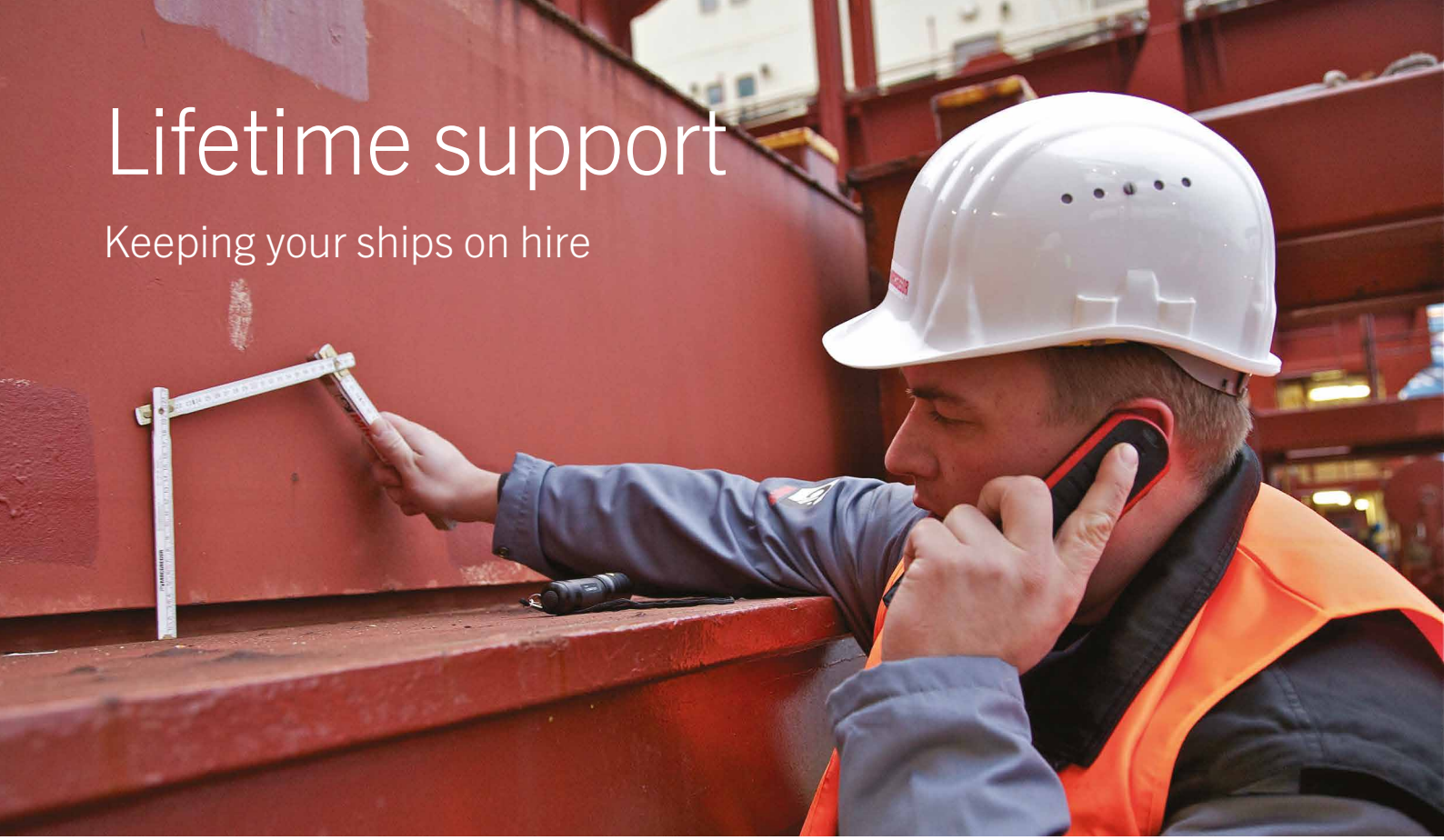
1982 Paralash system introduced

1976 Removable 20' slim cell guides introduced

1975 First one-piece twistlock housing developed, the CV-1

1971 Lashing company Conver established

1929 First MacGregor steel hatch cover patent accepted



Lifetime support

Keeping your ships on hire

MacGregor operates in more than 50 countries. Our global service network consists of approximately 60 service centres providing service, maintenance and spare parts with 24-hour availability, dedicated to maintain your cargo handling equipment.

We can support you to keep your operation “on hire”, wherever you are in the world, throughout the lifetime of your ship or fleet.

By providing inspections at regular intervals, reports on findings, recommendations for remedial action, and maintenance programmes we ensure long-term trouble-free safe and fast cargo securing and handling.

Do not compromise on safety or efficiency. Make sure stevedores, yard experts and your crew are trained in all aspects of correct operation during normal and emergency operation, to enable troubleshooting and correctly maintained lashing equipment. Tuition sessions can be theoretical and practical, and arranged in the port or at shore-based facilities – yours or ours.

Global presence. Local service.
We can ensure operative availability of your cargo flow systems, supply original MacGregor spare parts and repair services on a planned schedule, on demand, or on an emergency basis.

Our service portfolio covers all cargo handling equipment on board:

- Spare parts
- Service and maintenance
- Damage repairs
- Modernisations
- Conversions
- Inspections
- Installations
- Dry-dockings
- Training for crew and personnel
- 24/7-support services
- Consultancy services

MacGregor Onboard Care service agreements offer you sustainable ship operations and revenue earning capabilities by ensuring that equipment works when it is needed through flexible planned maintenance.

MacGregor Onboard Care is a modular service concept; each module can be adjusted. Modules are grouped under four main categories; Availability support, Onboard Maintenance, Spare Parts Management and Customer Training.

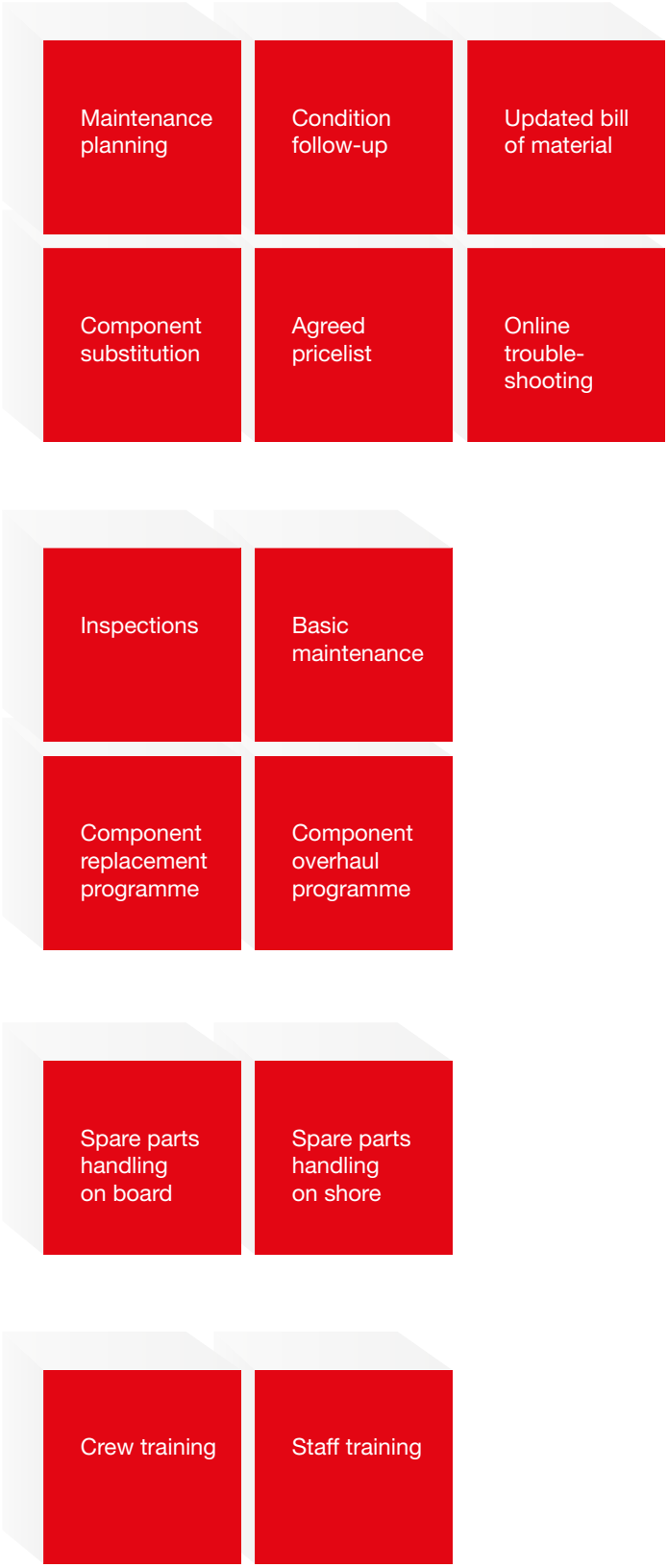
This is MacGregor Onboard Care (MOC):

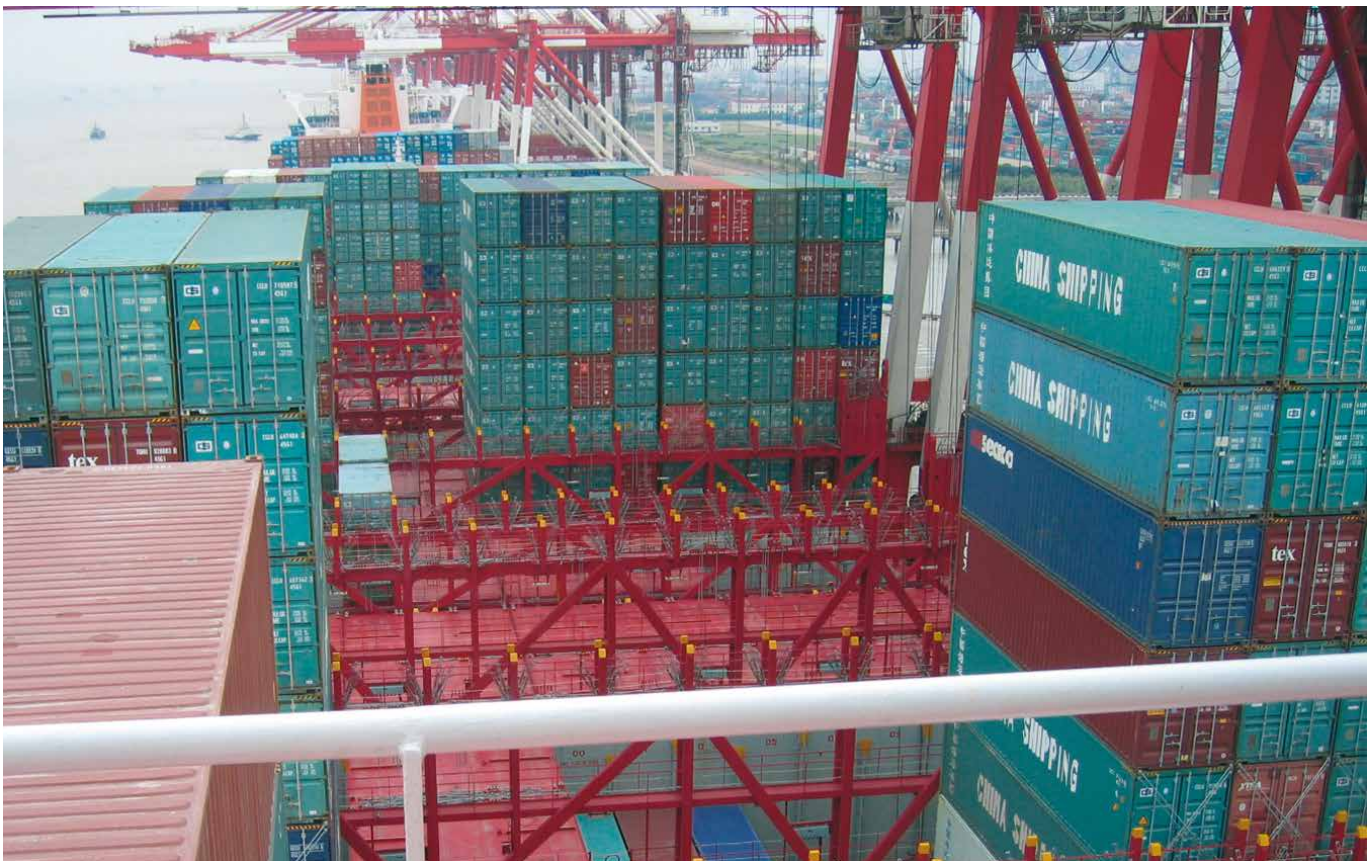
AVAILABILITY SUPPORT prepares and supports you to maintain optimum operation. With availability support, necessary issues like budget prediction and planning procedures become easier. Availability support contains one basic element – a nominated coordinator as a single point of contact – this is included in all of the MOC agreements, regardless of the chosen services.

ONBOARD MAINTENANCE offers a wide range of preventive, corrective and/or condition-based maintenance work on board. Its main objectives are to avoid breakdowns and keep equipment ready for their designed operation at all times. The degree of planned maintenance can be separately agreed for each piece of your equipment.

SPARE PARTS MANAGEMENT makes sure that you have the spare parts and components you need, and relieves you of inventory management. Onboard spare parts management consists of a stock inventory and a spare parts kit, while ashore, it comprises a unique, customer specific management of spare parts, as well as taking care of the availability of standard components. Purchase, management and stock are all handled by MacGregor.

CUSTOMER TRAINING allows you to take the most out of your investments. It familiarises your personnel with the operation and maintenance of the equipment. Training programmes are available for crew on board and management (officers & superintendents) ashore.





Cargo securing systems

Container lashing systems need to have design margins for rough handling and tough sea conditions. A safe and robust design made for active duty is therefore important in reducing operational delays and ensuring durability throughout years of service. We offer a wide range of MacGregor and Allset lashing products and cutting-edge lashing systems, which have designs based on decades of experience. Our lashings offer the highest possible cargo safety standards and are quick and easy to operate to meet tight port schedules and minimise downtime.

Container lashing systems form an integrated part of our container stowage system, consisting of fixed and loose container lashings on deck and in the hold, software, lashing bridges, hatch covers and the hatch cover coaming arrangement. These products can also be used on general cargo ships and can be custom-made for projects involving container handling.

Our in-house developed stowage calculation software, Lashmate®, helps evaluate actual loading with respect to your vessel's real stability conditions, taking into account the vessel's installed lashings system and the forces to which they are exposed.

Our mission is to keep your operation up and running, wherever you are in the world, throughout the lifetime of your ship or fleet. For more information regarding MacGregor's after sales services for lashing systems, you are welcome to contact our after sales personnel.

Internal lashing

The MacGregor internal lashing system has some unique features promoting cargo and working safety throughout its long working lifetime.

The fail-safe turnbuckle locking system with slack-preventing function and the design of the swage-fitted rod head on the lashing bar make sure that the turnbuckles stay safely tightened under all conditions.

The same technical features contribute to working safety by ensuring that components cannot work loose, fall out and cause injury. In addition, the sliding nut reduces the amount of lifting involved in hooking on, and the equipment can be instantly reduced to its minimum length for storage. High grade steel alloys and fully forged components give the internal lashing system highest durability and ensure a long working lifetime. The small diameter and hard surface of the lashing bars substantially reduce wear at the intersection of two lashing bars. All internal lashing components are hot-dip galvanised.

Related lashing products:

LB-11 Lashing bars

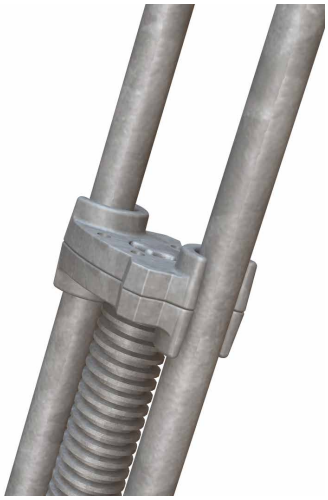
LB-28 Lashing bars

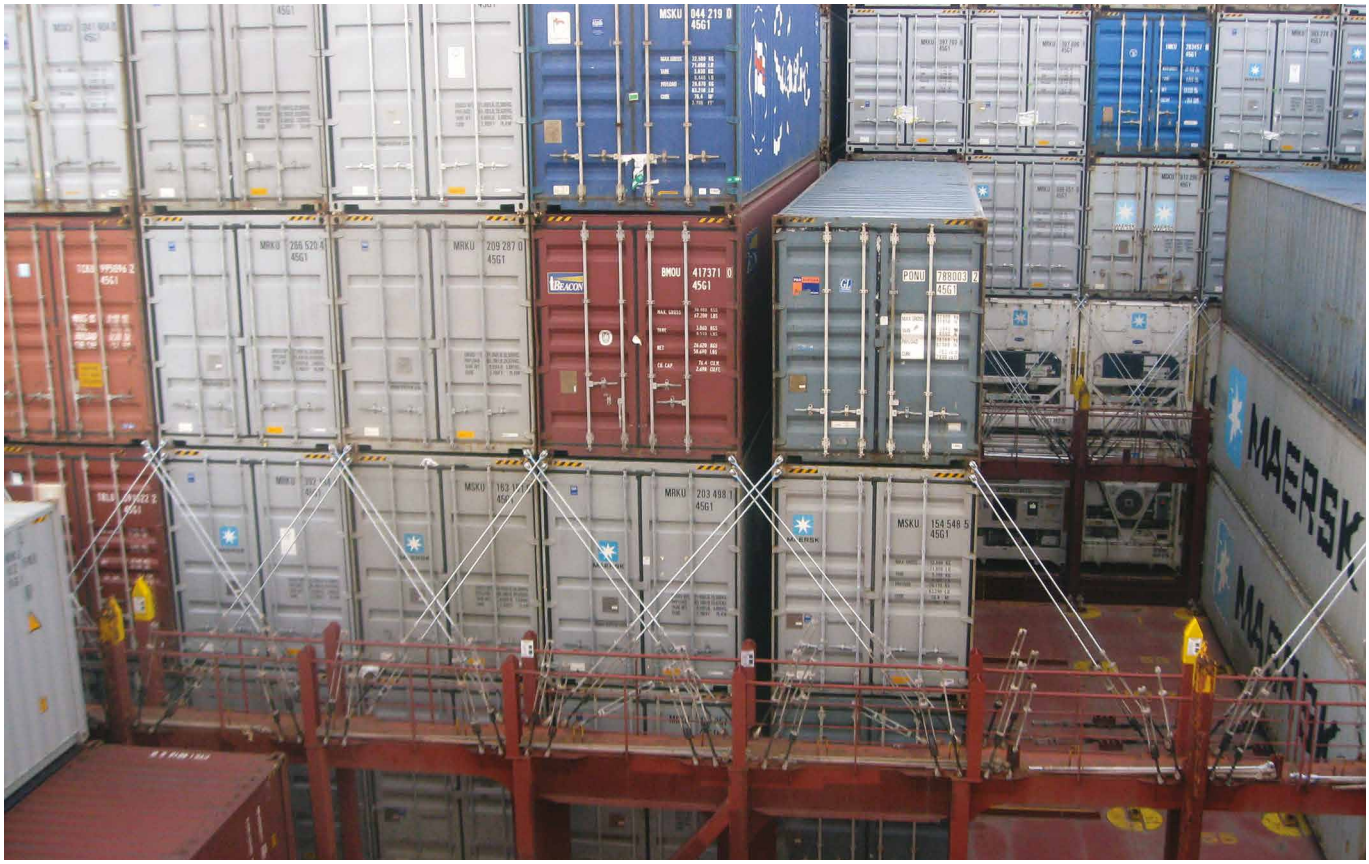
LB-31 Lashing bars

FLX-RD Lashing bars

TBS-3G Turnbuckles

FLX5-TB Turnbuckles





External lashing

The external lashing system is the most commonly used system on bigger container vessels (from 6,000TEU upwards) today.

Unlike internal lashings, the external lashing system secures the lifting side of the container instead of the compressed side, which reduces both forces. This allows the container stacks to be loaded with a better weight distribution, with heavier containers higher up in the stacks, compared to an internal lashing system.

MacGregor's external lashing system uses lashing bars and turnbuckles specially designed for this purpose. Tailor-designed distances between knobs on the lashing bars will minimise the length of the turnbuckles and optimise handling when lashing different container heights. All external lashing systems are tailor-made to fit your vessel's design.

All external lashing components exposed to the marine environment are hot-dip galvanised for the highest durability. The MacGregor external system is well recognised worldwide, which ensures its correct and easy operation at your port of call.

by ensuring that components cannot loosen, fall out and cause injury. All external lashing system equipment is hot-dip galvanised to ensure the best possible durability and lowest lifecycle costs.

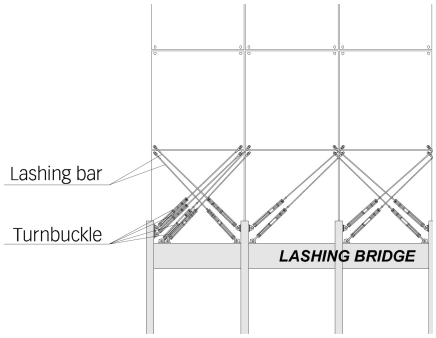
Related lashing products:

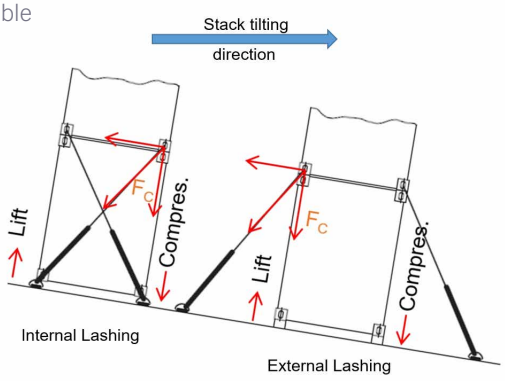
LB-AC Lashing bars

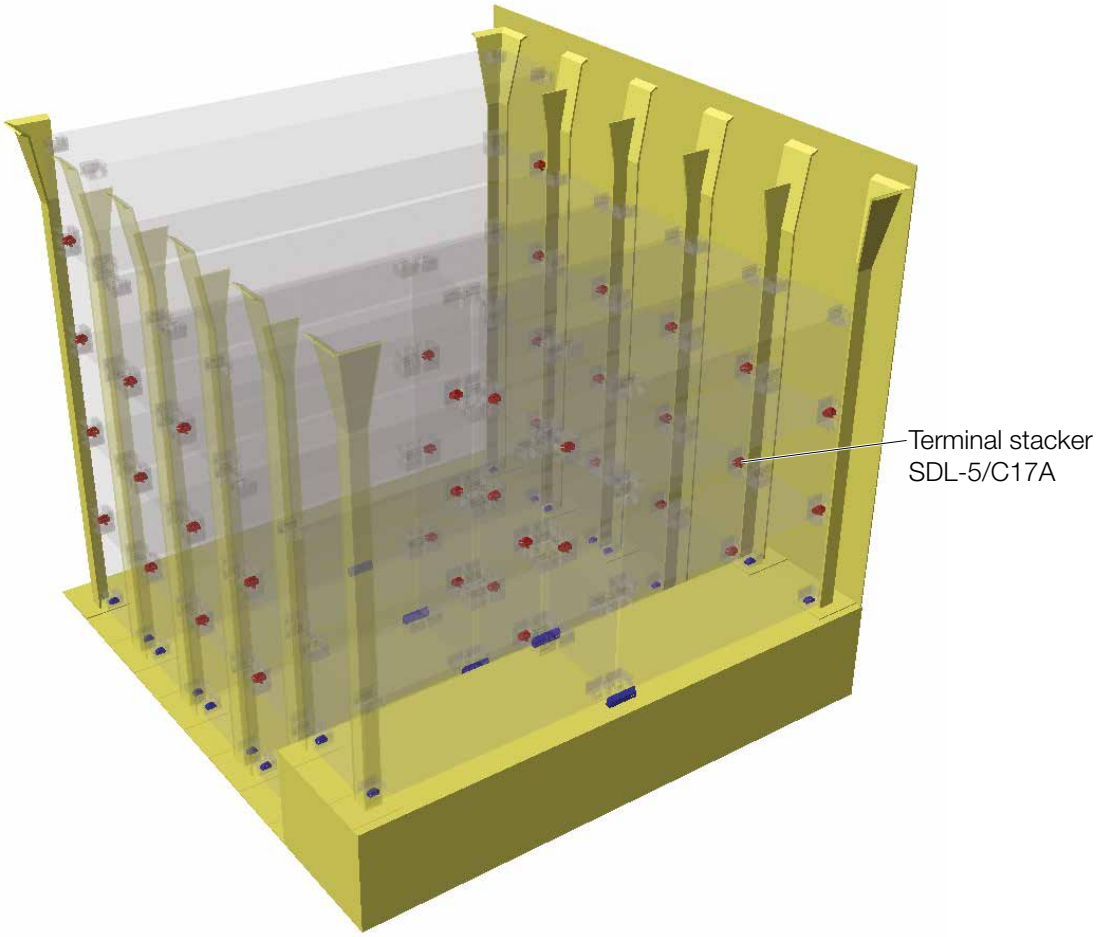
LB-A-ULS Lashing bars

TBS-AC Turnbuckles

FLX5-S Turnbuckles







Mixed stowage in hold

It is possible to stow 20ft containers in 40ft cell guides when secured by positive securing devices such as terminal stackers, with or without flange. The mixed stowage system with terminal stackers complies fully with OSHA requirements in holds. In conjunction with our 'mixed stowage system', the flangeless terminal stacker reduces the number of fittings needed by 50 percent compared to stackers with flanges. In addition to this, the number of flat racks and storage bins might also be reduced, depending on the ship's size.

The simple 'one stacker per container end' rule guarantees a fool-proof system. These terminal stackers are arranged with one piece per container end only (left or right), so that the risk of them being wrongly inserted through human error is reduced to an absolute minimum.

This mixed stowage system will stow up to the maximum possible number of tiers according to valid class rules. The permissible container weights differ and depend on class rules, number of stacks and accelerations. If the 20ft stack is 'topped' by one or more 40ft containers higher stack weights can be realised. For discharging, it is not necessary for stevedores to work on top of containers because the terminal stackers for this system remain on the lower container corner of the lifted container and will be dismantled on the quayside.

This securing system offers a high degree of flexibility in container stowage with a minimum number of fixed elements. Reinforcements at the longitudinal bulkhead are not required. The simple handling method of the container stackers ensures fast trouble-free operation by the stevedores. In addition, the flangeless stacker will slightly decrease the centre of gravity in the container stacks, which is an advantage for ship stability.

Related lashing products:

Flangeless terminal stackers (two required per 20ft container, one at each end of container)

SDL-5 Terminal stacker (flangeless)

C17A Terminal stacker (flangeless, Allset design)

Terminal stackers with flanges (four required per 20ft container, two at the ISO gap end to avoid transversal sliding and two at the cellguide end for leveling purpose only).

SDL-4 Terminal stacker (with flange)

Pressure system

Containers in a hold can be secured using a ‘block stowage pressure system’.

With this system, container blocks are generated using double stacking cones, single stacking cones, bridge fittings and pressure elements. The container stacks in a block are coupled transversally by double stacking cones and on top of the upper tier by bridge fittings.

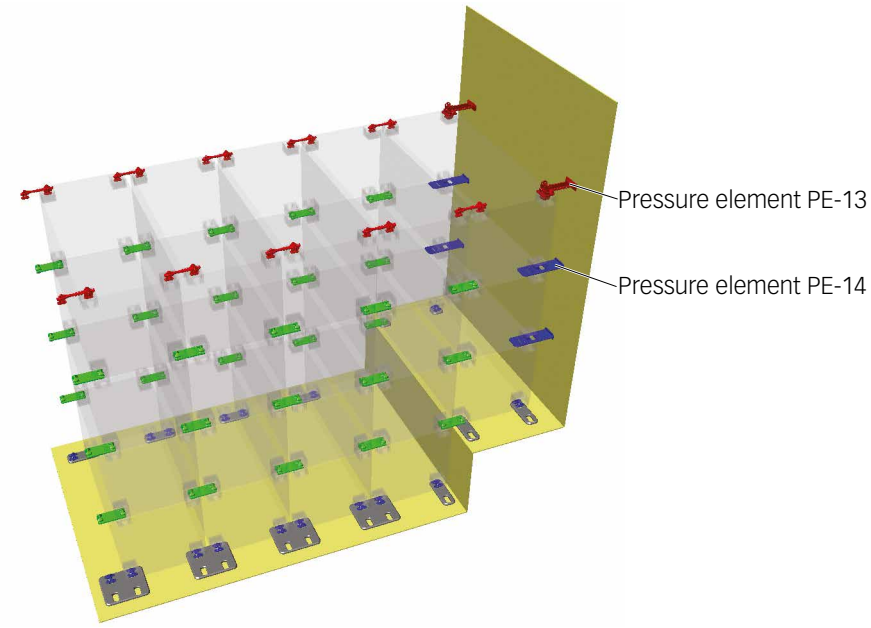
The pressure elements, for example, PE-14 units between the container tiers and PE-13 units on top of the uppermost tier, are arranged between the longitudinal bulkhead and the outermost container stack.

This ensures that the transverse pressure forces acting on the containers are transmitted to the longitudinal bulkhead of the vessel. The bulkhead has to be reinforced accordingly, but the installation of counter bearings is not required.

The pressure elements for the longitudinal bulkhead can be omitted when a fixed pressure rail at the bulkhead is installed.

With this stowage system, the container tiers have to be loaded completely and each tier has to be loaded with containers of uniform height only. The containers need to be loaded or discharged layer by layer.

The permissible container weights differ and depend on class rules, the number of stacks and accelerations. As the permissible weight decreases with the number of stacks, this system is applied especially on smaller multi-purpose vessels and on older ships without a cell guide system.



For smaller vessels, the system is also used for 20ft container stowage in 40ft cell guides, which realises higher stack weights for the 20ft containers.

For container loading and discharge, it is necessary for stevedores to work on top of the containers to fit or remove the loose stowage elements.

Related lashing products:
Pressure element PE-13
Pressure element PE-14

OSHA compliant terminal pressure stacker system

Containers in the hold can be secured by using an OSHA compliant ‘terminal pressure stacker system’.

This system is based on a conventional ‘block stowage pressure system’, but the conventional loose lashing gear, including double stacking cones, single stacking cones and pressure elements, have been replaced by the special terminal pressure stacker TPS-1.

TPS-1 stackers are fitted and dismantled on the quayside before and after loading in the same way as semi-automatic twistlocks on deck are used.

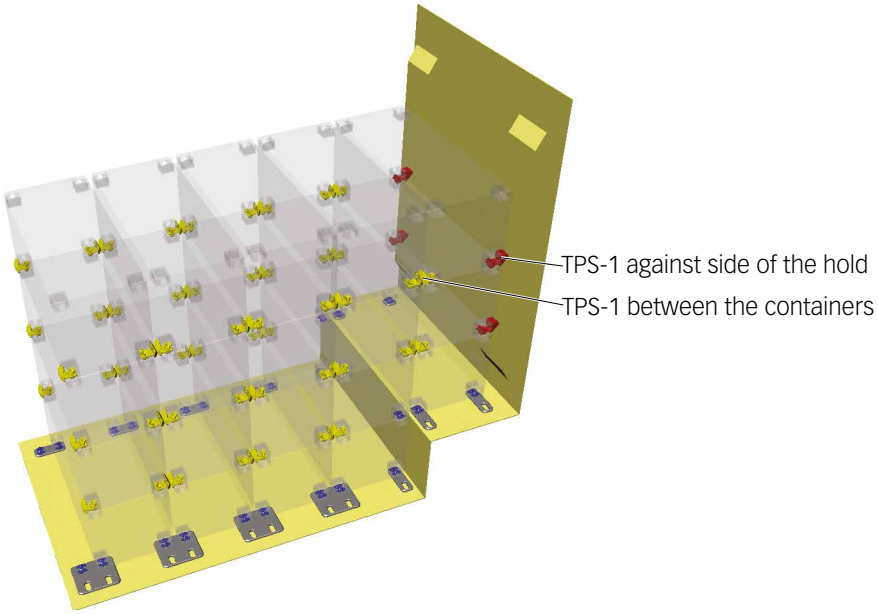
When the vessel is rolling, container stacks can lean against the next and transfer the transversal forces to the outermost stack, which transmits them to the longitudinal bulkhead.

The permissible container weights differ and depend on class rules, number of stacks and accelerations. As the permissible weight decreases with the number of stacks, this system is especially applied on smaller multi-purpose vessels.

With this stowage system, container tiers have to be loaded completely and each tier has to be loaded with containers of uniform height only. The longitudinal bulkhead has to be reinforced accordingly, but the installation of counter bearings is not required. Fixed installed pressure rails at the longitudinal bulkhead are recommended.

The TPS-1 facilitates the safe handling of containers in accordance with OSHA requirements, which effectively ban stevedores from climbing on top of containers to release securing devices. Moreover, the TPS-1 allows independent and flexible loading and unloading of both 20ft and 40ft containers without restriction and without the need to reduce weights in accordance with Germanischer Lloyd requirements

Related lashing products:
Terminal pressure stacker TPS-1,
see page 88



Tension pressure system

Containers in a hold can be secured by the use of a 'block stowage tension/ pressure system'.

This system generates container blocks by using double stacking cones, single stacking cones, bridge fittings and tension/pressure elements. To avoid the effect of external forces from the vessel's deflections, generally two container blocks are created per bay.

The container stacks in a block are coupled transversally by double stacking cones and on the top of the upper tier by bridge fittings.

The tension/pressure elements – for example, TPE-13 units between the container tiers and TPE-25 on the top of the uppermost tier – are arranged between the longitudinal bulkhead and the outermost container stack. Single stacking cones are used in the transverse gap between the container blocks.

The transversal tension and pressure forces on the containers are transmitted to the vessel's longitudinal bulkhead. The bulkhead has to be reinforced accordingly and counter bearings for the tension/ pressure elements at the longitudinal bulkheads are necessary.

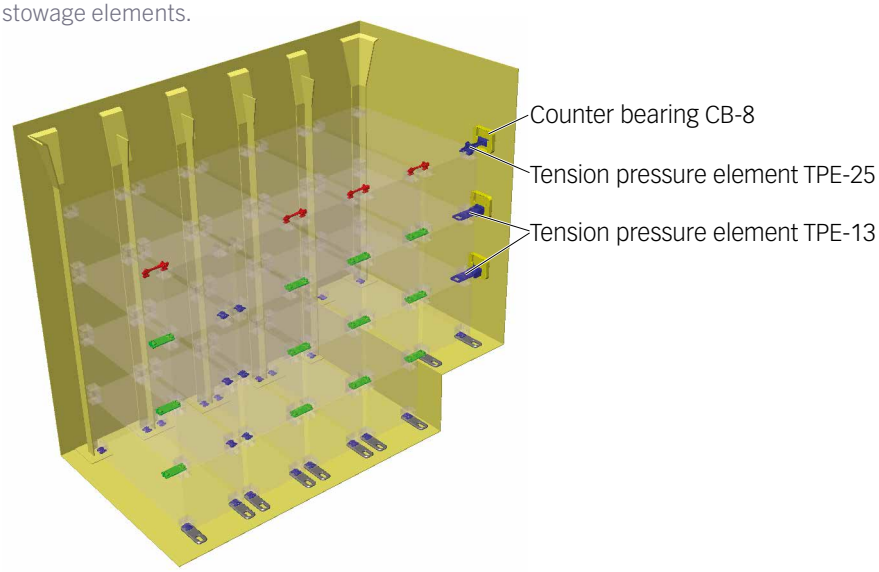
The blocks of container tiers have to be loaded completely and each tier has to be loaded with containers of uniform height only. The containers need to be loaded or discharged layer by layer.

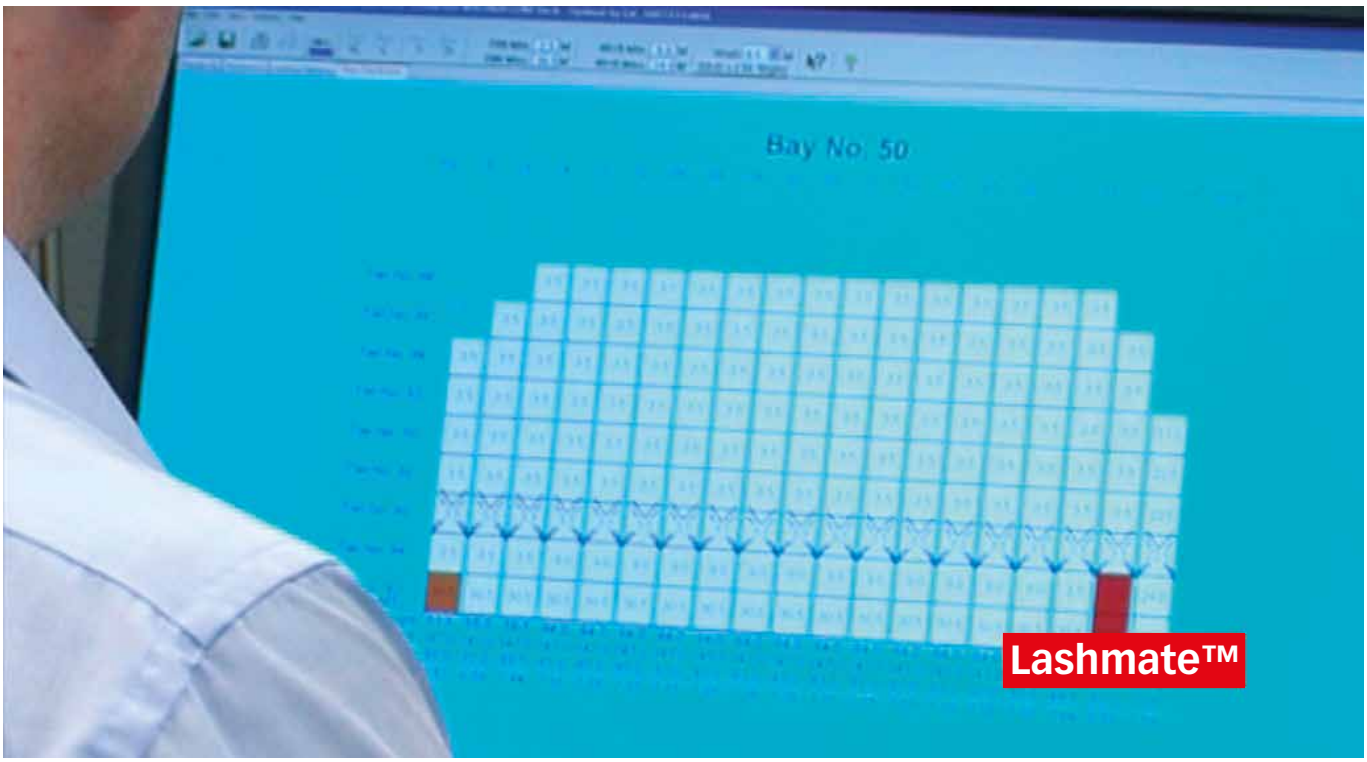
The permissible container weights differ and depend on class rules, number of stacks and accelerations. In comparison with a pressure system, either the permissible container weight is higher or the number of stacks is larger with similar weights. So this system is especially applied on multi-purpose vessels with high stack weights, on con-bulkers and on older vessels without a cell guide system.

For container loading and discharge, it is necessary for stevedores to work on top of containers to fit or remove the loose stowage elements.

Also a mixture of tension/pressure system is possible. The container stacks in one bay form three blocks. One on each side works as the described tension pressure system and the centre block works as a pressure system. The centre block leans towards the adjacent block on the port or starboard side according to the vessel's direction of roll.

Related lashing products:
Tension pressure element TPE-13
Tension pressure element TPE 25
Counter bearing CB-8





Lashmate for easy and efficient cargo planning

MacGregor is a complete solutions provider, and that also applies when it comes to container stowage solutions. Our Lashmate™ stowage calculation software has been developed with the benefit of decades of lashing system design experience, providing an efficient, easy to use cargo planning tool.

With Lashmate™ on board, the safety of the cargo is easily verified. The Lashmate™ software uses export files from the onboard loading computer with the actual cargo profile. Lashmate™ then checks the loaded cargo with the vessel's particulars and lashing system to verify that all safety conditions are fulfilled. If there are excess forces detected, Lashmate™ can also propose alternative stack distributions.

The main features of Lashmate™:

- Calculates the lashing forces for the entire ship's lashing system and actual loading cases
- Gives a warning if excessive forces are detected
- Can calculate and suggest an optional stack distribution
- Calculations can be made according to DNV, LR, ABS, BV and KR rules
- Lashmate™ uses interface files from loading computers as input files
- Can read standard EDIFACT BAPLIE and several other input file formats
- Be sure that your lashing system can handle your cargo based on what you have actually loaded and where you have put it - Lashmate™.


MACGREGOR