Approach

The smarter approach
Better connected systems mean faster turnaround and increased throughput, improved safety and lower operating costs.

Connecting decades of experience with a new, smarter approach to port and terminal equipment optimization, Trelleborg’s marine systems operation helps ports and terminals deploy smart, engineered solutions for port approach, berthing, docking and mooring. This enables better informed real-time and strategic decision making, both onshore and on board the vessel.

From port owners and operators to consulting engineers, Trelleborg works with customers to determine best fit solutions for specific applications, and supply a fully integrated solution. End-to-end service and a comprehensive product portfolio meet and exceed customer needs, enhancing safety and improving efficiency in all marine environments, from conception to completion and beyond.

Connect with The Smarter Approach
Visit: www.trelleborg.com/marineandinfrastructure
Connect: Trelleborg-Marine-and-Infrastructure
Discover: TrelleborgMarineandInfrastructure
Converse: @TrelleborgMI
Explore: MarineandInfrastructure
Discover: TrelleborgMarineandInfrastructure
Whatever bollard type your application requires, Trelleborg has a range of seven high-performance styles to suit you. Trelleborg bollards are precision engineered and manufactured in a variety of metals including premium grade SG ductile iron and cast steel to offer unprecedented levels of service life and resistance to corrosion and impact. We understand that safety is your number one priority. That's why Trelleborg Marine systems provides bespoke safety critical bollard, anchoring and fixing solutions quickly, to our customers' exact specifications. This guide will provide you with detailed and specific information of our full range of bollard solutions including installation, maintenance and specification advice, plus much more.

When installing or upgrading Docking & Mooring Systems, you need to ensure you choose the right partner. Ensure your provider can deliver the solution for you, on time and on budget, wherever you are in the world.

Ensure your solution is designed around the needs of you and your customers, with a dedicated team that has the experience to understand them.

Ensure your Docking & Mooring Systems feature technically superior products to maximize durability and reliability, whilst minimizing downtime and whole life costs.

Ensure your partner can offer you the maintenance and aftersales service you need.

Docking & Mooring

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A Smarter Approach at every stage

A smarter approach to...

**CONSULTATION**
Consultation from the earliest project phase to ensure the optimum fender, mooring, navigation and transfer solutions are specified, with full technical support from our global offices.

**CONCEPTS**
Conceptual design in your local office – with full knowledge of local standards and regulations, delivered in your language – for optimized port and vessel solutions.

**DESIGN**
Concepts are taken to our Engineering Center of Excellence where our team generates 3D CAD designs, application-engineering drawings, a bill of materials, finite engineering analysis and calculations for both our fender systems and marine technology solutions.

**MANUFACTURE**
Our entire product range is manufactured in-house, meaning we have full control over the design and quality of everything we produce. Our strategically located, state-of-the-art facilities ensure our global, industry leading manufacturing capability.
When you choose Trelleborg you ensure your expectations will be met, because we deliver a truly end-to-end service – retaining vigilance and full control at every stage.
When considering the selection of docking and mooring equipment, a holistic review of port and terminal operations should be undertaken. This should focus on how docking and mooring solutions can impact or improve facilities ability to transfer product or personnel. A docking and mooring system is far more than just a means to berth and moor a vessel. Like with any business case for investment, when reviewing Total Cost Of Ownership (TCO) of a docking and mooring system, return on investment should be first and foremost in the decision making process.

Proper selection of docking and mooring equipment can greatly reduce facility downtime and improve operational efficiency, safety and ultimately profitability.

Some of the key points that often get overlooked in this review are factors that can negatively impact operations and the solutions that are available. While the initial investment may be higher with a premium solution, the case for return on investment is overwhelming.

**FACTORS THAT NEGATIVELY IMPACT THE COST OF OWNERSHIP**

- Exposed berths having to slow or stop transfer operations when metocean conditions or passing ships result in vessel motions outside the guidelines for safe or efficient transfer.
- Inefficient mooring operations extending facility downtime and adding overheads for mooring crews, pilotage and tugs.
- Unbalanced mooring loads, parting lines and having to stop transfer to tend moorings.
- Using tugs to supplement mooring systems during extreme events – passing ship or environmental.

**HOW TRELLEBORG SOLUTIONS CAN MINIMIZE TOTAL COST OF OWNERSHIP AND IMPROVE PROFITABILITY OF PORT AND TERMINAL OPERATIONS**

- Automated mooring solutions that can dampen vessel motion and extend the range of metocean conditions in which efficient transfer can take place or combat effects from passing ships.
- SmartPort turnkey solutions integrating multiple port and terminal subsystems.
- Confidence that equipment complies with local regulatory requirements, design codes and standards.
- Class leading structural design to accommodate worst case loading conditions and provide superior integrity for dynamic loading.
- Global aftersales support network offering total lifecycle management packages, extending asset life and minimizing downtime.
- Accredited and best practice quality systems that ensure mooring solutions reliability.
Docking and Mooring

With just under 100 dedicated docking and mooring employees worldwide, Trelleborg has the largest and most experienced docking and mooring team to provide an unparalleled level of support and expertise throughout your docking and mooring journey.

Some of the key resources that form part of the docking and mooring lifecycle are:

<table>
<thead>
<tr>
<th>FUNCTIONAL AREA</th>
<th>PURPOSE</th>
<th>CORE COMPETENCY</th>
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</table>
| Technical Sales Managers      | The first point of contact in the Trelleborg experience, to understand your needs and establish an aligned technical and commercial solution. | • Application Engineering  
• Customer Management                                                               |
| Project Management            | An experienced project manager will oversee the design, manufacture and delivery of your docking and mooring solution; providing regular communication and ensuring project execution on time, to budget and in accordance with the project specifications and Trelleborg ISO9001 management system. | • Docking & Mooring Application Expertise  
• Contract and Risk Management  
• Customer Management                                                               |
| Project Design Engineers      | Bespoke design solutions to meet the project requirements from concept to inspection and testing.                  | • Structural & Mechanical Engineering  
• Electrical & Instrumentation Engineering  
• Software Development  
• Mooring Analysis  
• International Design Codes Compliance  
• Offshore Design Code Compliance (Class DNV, ABS)                                      |
| Research & Development        | Developing the next generation of docking and mooring solutions to improve safety, efficiency and throughput and in doing so reducing facilities’ overall total operating cost and improving profitability. | • Calibration Services  
• Routine Maintenance  
• Training                                                                     |
| Site Service Engineers        | Support for sites from commissioning, training and whole life product support.                                       | • Application Engineering  
• Customer Management                                                               |
| Quality Assurance              | Establish and ensure internal business processes and manufacturing activities are upheld to the highest achievable standards and in compliance with Trelleborg ISO9001 accredited Integrated Management System. | • Application Engineering  
• Customer Management                                                               |
## Applications Summary

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Application Summary

Quick Release Hook
Onshore
+ LMS/ERR/Capstan

Hawser Hook

Chain Stopper

Winches &
Hawser Reels

Quick Release Hook
Offshore
+ LMS/ERR/Capstan

AutoMoor

Environmental Monitoring

Docking
+ Display Board
+ Lasers

Integrated System
A range of hook sizes and capacities are available, as well as various mounting options. Typically, a cast QRH base is used for new installations. To upgrade older facilities, fabricated hook bases can be designed to suit existing hold-down bolt patterns.

For offshore applications, the QRH is class certified and designed for a new generation of ship-to-ship FLNG and bunkering applications.

Since 1972, Quick Release Hooks (QRH) have enabled mooring lines to be safely secured, and quickly and easily released, even when loaded to their safe working load limit.
QRH Onshore

FEATURES
- Safe, efficient and reliable mooring operations
- Options to suit all types of mooring ropes, loading conditions and foundations
- Low maintenance option available
- Integrated capstan available with speed and power options
- Low profile and compact footprint
- All hooks individually tested
- All hooks can be safely released, even at the hook safe working load (SWL)
- Compliant with international standards

APPLICATIONS
- LNG carrier berths
- Oil berths
- LPG berths
- Bulk liquids berths
- Bulk materials berths
- Small scale mooring

ADD-ONS
- Low maintenance, dual lock, safety keeper bars and grit guards (refer to page 17)
- Capstan (refer to page 20)
- Load monitoring (refer to page 21)
- Hook release (refer to page 23)
- Tugger winch (refer to page 27)
- Integration with the central monitoring system (refer to page 55)

QRH Offshore

FEATURES
- Safe, efficient and reliable mooring operations
- Low maintenance option available
- Integrated capstan available with speed and power options
- Low profile, compact footprint and efficient integration with ship deck super structure
- All hooks individually tested
- All hooks can be safely released, even at the hook safe working load (SWL)
- Class certificate including DNV, ABS, Lloyds or BV
- Stowing place for capstan foot switch to avoid damage due to ship movement

APPLICATIONS
- Ship-to-ship mooring
- Import LNG terminals
- Export LNG terminals
- Offshore ship-to-ship mooring on FLNG bunkering
Quick Release Hooks

COUNTERBALANCED HOOKS

The cast mooring hook is counterbalanced for easy reset by operators. The smooth hook profile, rope throat area and steep rake angle ensure the rope sits correctly, providing greater load monitoring accuracy, reduced stress concentrations and chafing.

MANUAL RELEASE

All hook release components are enclosed within the hook side plates, protecting the mechanism from debris and damage. A 20kg force is required to release the hook at full load while a single operator stands safely behind the hook.

BASES

Single or multiple hooks configurations are available. Bases can be cast or fabricated to suit new or retrofit installations.

LARGE MOORING ANGLES

Hooks can rotate under full load through horizontal angles up to +/-90 degrees and vertical angles 0 to +45 degrees or more.
Add Ons

INTEGRATED CAPSTANS
Capstans are fully enclosed within the base for ultra low maintenance, corrosion protection and reliability. Various load ratings and running speeds are available to suit all ship sizes and mooring line materials (refer to page 20).

ROPE GUIDE
Rope guide for efficient and safe line handling during capstan operation.

LOAD MONITORING
Load cells can be incorporated into each hook to provide monitoring and warning of mooring line tension for each QRH installed on the jetty efficiently and with increased safety (refer to page 21).

HOOK RELEASE
The hook release system allows for simple and safe release of mooring lines from each hook using local or remote pushbutton controls (refer to page 23).

SAFETY KEEPERS
Safety Keepers prevent slack mooring lines from accidentally detaching at high vertical angles (refer to page 18).

HAZARDOUS AREA OPERATIONS
All electrical components are certified for hazardous area operations (where required). The hook design prevents contact with the structure during mooring and on release, eliminating spark risk.
## Quick Release Hook - Onshore Options

<table>
<thead>
<tr>
<th>QUICK RELEASE HOOK &amp; BASE OPTIONS</th>
<th>SWL (T)</th>
<th>INTEGRAL CAPSTAN</th>
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### QRH 50 Series

#### DOUBLE HOOK

![Double Hook Diagram](image)

#### TRIPLE HOOK

![Triple Hook Diagram](image)
QRH 60-150 Series

SINGLE HOOK

DOUBLE HOOK

TRIPLE HOOK

QUADRUPLE HOOK
## Model numbers & Dimensions

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<tr>
<th>MODEL NUMBER</th>
<th>QTY</th>
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Dimensions available upon request

**Note 1**: Dimensions are in mm.
**Note 2**: Dimensions are typical. Always request a certified hook/base drawing before starting construction.
**Note 3**: Customized bases to suit bolt patterns are available upon request.
**Note 4**: Shipping mass includes base, capstan, hold down bolts and packing. Mass is for indication only.
Quick Release Hook - Offshore Options

**Note 1**: Closed chock height set to ensure mooring rope eye passes through at 0°.

**Note 2**: M56 studs grade 8.8 full screw thread into foundation plate and seal welded. Foundation plate flatness to be 1 to 500 ratio.

**Note 3**: Set back of QRH to ensure mooring rope eye is fully clear & inboard of closed chock.

**Note 4**: Consider deck camber & ensure foundation plate is installed level.

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**Note 1**: Closed chock height set to ensure mooring rope eye passes through at 0°.

**Note 2**: M56 Studs grade 8.8 full screw thread into foundation plate and seal welded. Foundation plate flatness to be 1 to 500 ratio.

**Note 3**: Set back of QRH to ensure mooring rope eye is fully clear & inboard of closed chock.

**Note 4**: Consider deck camber & ensure foundation plate is installed level.
Hook Options

LOW MAINTENANCE

The low maintenance range of QRH builds on Trelleborg Marine Systems’ renowned design to engineer a QRH that is virtually maintenance free, which is critical for operations where maintenance access is restricted or where there are extreme operating conditions.

Features

The upgrade uses a combination of custom self-lubricating bushes and stainless steel sleeves to provide a low friction bearing surface for all moving parts, offering excellent corrosion resistance and years of greatly reduced or maintenance free operation. This is available either as part of a new hook unit or as a kit for retrofit (requires rebuild).

Benefits

- Reduced maintenance costs and increased operational time.
- Increased protection against hook seizures caused by long periods of no maintenance.
- Increased lifespan in comparison to a standard hook.
Hook Options

SAFETY KEEPER BARS

The Keeper Bar improves safety and efficiency of mooring operations by eliminating inadvertent releases of mooring lines caused by positive line angles. This is done by increasing the safe vertical operating range of a QRH and ensuring correct positioning of the mooring line at the throat of the mooring hook.

How It Works

The Keeper Bar holds the mooring line in the throat of the QRH. As tension is applied to the mooring line the Keeper Bar lifts the QRH to ensure it is correctly aligned with the applied load / mooring line.

Benefits

- Improved safety and efficiency by eliminating inadvertent line release.
- Acts as a rope guide during mooring.
- Protects against paint damage when adjacent hooks clash together as mooring lines are tensioned.
**Hook Options**

**DUAL LOCK**

The dual lock QRH provides a robust solution to increase plant safety for bulk material terminals. These terminals are subject to an environment with airborne particulate matter which can deposit on the locking mechanism of a conventional QRH, jeopardizing safety.

Without regular maintenance and careful operational checks, such deposits can result in a QRH being set in a “hair trigger” position. Often, busy shipping schedules leave little time for maintenance and correct operation of the hook is reliant on the training and diligence of the operator.

The dual lock QRH utilizes a secondary locking latch that engages with the primary locking mechanism of the QRH. The system can be provided as a manual only option or fully integrated into Trelleborg Electric Remote Release System. An upgrade kit can also be provided for retrofit to existing hooks.

**GRIT GUARD**

In bulk material terminals, especially iron ore, dirt may accumulate over the QRH mechanism which requires more frequent maintenance.

The grit guard is fitted on the hook to prevent dirt build up and reduce the maintenance frequency without obstruction to normal operation.
Hook Options

INTEGRATED CAPSTAN

Capstans are fully enclosed within the base for ultra low maintenance, corrosion protection and reliability. Various load ratings and running speeds are available to suit all ship sizes and mooring line materials.

Refer to Free Standing Capstans on page 25 for additional information.

Features

- Ribbed capstan head and integral rope guide for improved line handling.
- Enclosed design for protection from harsh marine environment and mechanical damage.
- Reversible direction, emergency stop and automatic brake for improved operator safety.
- Rugged low profile footswitch for safer operations.
- Nominal line speed of 30 meters / minute (other speeds and line pull sizes available upon request).

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<td>11</td>
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<tr>
<td>Hazardous Safe</td>
<td>3</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

Motor starter enclosure with direction selector and emergency stop

Braked capstan motor + gearbox (oil-filled for life), enclosed in a protective structure

Footswitch
Load Monitoring Systems

Operating autonomously, or integrated with a central monitoring system, the Trelleborg SmartHook load monitoring system enables safe mooring and efficient line handling by providing real-time mooring line tension and alarm warning.

The Trelleborg load cell located in the QRH integrates seamlessly with the SmartHook on the QRH base. Local processing is then done before this data is sent to the central monitoring system; this also enables control of warning lights and sirens on the dolphin without a connection to a central monitoring system.

FEATURES

- Real-time monitoring of mooring tension
- Local processing and calculation of loads
- Autonomous operation
- Calibration data stored in load cell
- Logging of mooring tension (if connected to a central monitoring system)

SMARTHOOK

The SmartHook reads the calibration data stored in the load cell and uses this to calculate the mooring tension. A local display allows the mooring crew to quickly and easily see the current tension on the mooring rope. Alarms are also generated from the SmartHook and this can be connected to a warning light and siren to alert the ship’s crew.

<table>
<thead>
<tr>
<th>Load cells</th>
<th>Max of 4 load cells connected per SmartHook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications output</td>
<td>RS 485 Modbus RTU</td>
</tr>
<tr>
<td>LCD Display Information</td>
<td>Hook load, error information and alarm status</td>
</tr>
<tr>
<td>Area classification</td>
<td>Hazardous or non-hazardous</td>
</tr>
<tr>
<td>IP Rating</td>
<td>IP66</td>
</tr>
</tbody>
</table>
Load Monitoring Systems

LOAD CELL
Each load cell is manufactured from high quality stainless steel and load tested up to 150% of the safe working load (SWL). Calibration data is stored inside the load cell enabling load cells to be placed in any hook anywhere on the jetty.

<table>
<thead>
<tr>
<th>Calibrated range</th>
<th>0 to SWL (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>±2%</td>
</tr>
<tr>
<td>Material</td>
<td>Grade 431 or 630 stainless steel</td>
</tr>
<tr>
<td>Area classification</td>
<td>Hazardous or non-hazardous</td>
</tr>
<tr>
<td>IP Rating</td>
<td>IP66</td>
</tr>
</tbody>
</table>

WARNING LIGHT AND SIREN
The warning light and siren can be connected to the SmartHook to allow audible and visual indication of an alarm condition.
Hook Release System

The hook release system allows quick release hooks to be released from no load up to the SWL using either a manual release lever or an electric remote release system.

The electric remote release system has the added benefit of allowing the operator the option to release mooring lines safely from a distance.

FEATURES

- Release from no load to SWL
- Remote release keeps operators out of danger zone
- Manual release system as standard on all hooks

ADD-ONS

- Pushbutton remote release console
- PC based remote release console

Manual release

The manual release of the hook is possible up to the SWL. The release mechanism is designed so that only ~ 20kg of force is required to release the hook at the SWL.
Hook Release System

LOCAL RELEASE CONTROLLER

The local release controller enables the hook to be released by pushbuttons (on the front of the controller), or remotely from a release console. The hook release is achieved by an electric actuator connected to the hook via a stainless steel push-pull cable.

ENCLOSURE DETAILS

<table>
<thead>
<tr>
<th>Hooks</th>
<th>Max of 4 hooks connected per local release controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications output</td>
<td>RS 485 Modbus RTU</td>
</tr>
<tr>
<td>Area classification</td>
<td>Hazardous or non-hazardous</td>
</tr>
<tr>
<td>IP Rating</td>
<td>IP66</td>
</tr>
</tbody>
</table>

REMOTE RELEASE CONSOLE

The remote release console enables releasing of the hook from a remote location, such as the jetty control room or the upper deck of the jetty. Consoles can be either pushbutton or PC based.

PC based consoles can also include an optional hook release control station for arming the hook release system.
Free Standing Capstans

Trelleborg’s free standing capstans provide a field proven, safe and reliable method of hauling in the mooring line alleviating the need for mooring crews to haul in the lines manually.

FEATURES
- Ribbed capstan head and integral rope guide for improved line handling
- Enclosed design for protection from harsh marine environment and mechanical damage
- Reversible direction, Emergency Stop and automatic brake for improved operator safety
- Rugged low profile footswitch for safer operations

APPLICATIONS
- LNG carrier berths
- Oil berths
- LPG berths
- Bulk liquids berths
- Bulk materials berths
- Commercial (RoRo, ferry, container)
**Free Standing Capstan**

A critical part of the mooring operation, capstans need to be robust and reliable to ensure the line handling process is trouble-free and efficient.

Capstans can be supplied for non-hazardous areas or as an explosion-proof certified unit for installation in hazardous areas. A range of capacities are available to suit many line handling applications.

<table>
<thead>
<tr>
<th>LINE PULL (T)</th>
<th>STARTING PULL (T)</th>
<th>MOTOR SIZE (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>5.5</td>
</tr>
<tr>
<td>1.5</td>
<td>3</td>
<td>7.5</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

**Line Speed**
Nominal 30 meters / minute
Note: other speeds and line pull sizes available upon request

**Area Classification**
Hazardous or non-hazardous

**IP Rating**
Capstan motor and motor starter: IP55 minimum
Footswitch: IP68

**Holding Capacity**
Automatic, spring applied brake when de-energized holding torque > 150% of motor torque

**Capstan Controls**
Selector Switch: Counter clockwise / OFF / clockwise
Footswitch: Depress to operate

**Electrical Supply**
3Ø + Earth: 380 to 480 VAC(+/- 5%) @ 50 Hz or 60 Hz (+/- 5%) Note: voltages outside these ranges available upon request
The integral tugger winch improves safety and efficiency of mooring line retrieval for onshore and offshore applications through hands free control and industry leading safety features.

**FEATURES**

- More efficient and safer line handling using remote control
- "hands free" line retrieval and variable speed control
- Free spooling payout
- Built in torque limiting clutch
- Spooling device for retrieval
- Rotational swivel and rope guide allows retrieval from any direction
- Can be fitted to the Trelleborg Quick Release Hook (QRH) base structure or as a free standing unit

**APPLICATIONS**

- LNG carrier berths
- Oil berths
- LPG berths
- Bulk liquids berths
- Bulk materials berths
- Commercial (RoRo, ferry, container)
# Tugger Winch

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Line Pull</strong></td>
<td>Typically 1000kg (Torque limited)</td>
</tr>
<tr>
<td><strong>Line Speed</strong></td>
<td>Pay Out: Free spooling to match ship’s winch or line boat Pay In: Variable speed from 10 - 45m/min</td>
</tr>
<tr>
<td><strong>Area Classification</strong></td>
<td>Hazardous or non-hazardous</td>
</tr>
<tr>
<td><strong>IP Rating</strong></td>
<td>IP 66</td>
</tr>
<tr>
<td><strong>Holding Capacity</strong></td>
<td>Automatic, spring applied brake when de-energized holding torque &gt; 150% of motor torque</td>
</tr>
<tr>
<td><strong>Drum Capacity</strong></td>
<td>120m of 14mm Dyneema (HMPE) rope</td>
</tr>
<tr>
<td><strong>Tugger Winch Controls</strong></td>
<td>Joystick Direction and Speed – payout / off / retrieve, Emergency Stop</td>
</tr>
<tr>
<td><strong>Electrical Supply</strong></td>
<td>3Ø + Earth: 380 to 480 VAC(+- 5%) @ 50 Hz or 60 Hz (+- 5%) Note: voltages outside these ranges available upon request</td>
</tr>
</tbody>
</table>
Make your berthing operations smarter, safer and more efficient with AutoMoor from Trelleborg.

Many ports and terminals are looking towards automated technologies to cope with increased demand and to compete safely and effectively.

AutoMoor is a rope-free, automated mooring system designed to improve operational efficiency and safety using the latest vacuum and passive damping technologies to rapidly attach to and secure a vessel at berth, optimizing the window for product transfer in a broader range of environmental conditions.

**FEATURES**
- Rope-free vacuum mooring
- Faster berthing operations
- Patent-pending, passive damping system to reduce vessel motions
- Patent-pending electro-mechanical drive system for pad extension and retraction
- Operates with low power consumption and duty cycle
- Delivers greater control by displaying mooring loads and unit operating conditions continuously
- SmartPort enabled to allow integration with other port control systems
- Three control interfaces provided:
  - Wireless Handheld
  - Port Control PC
  - Mooring Machine PC
- Suitable for hazardous area operations
- Rotating base allows all maintenance to be undertaken onshore
- Self-contained units, with all motors, mechanisms and control systems located within – no external auxiliary items

**APPLICATIONS**
- Container Terminals
- Bulk Liquids Berths
- Bulk Materials Berths
- Ferry / RoRo Terminals
- Cruise Terminals
**AutoMoor**

**ADD-ONS**
- Hybrid Mooring - combinations of AutoMoor with conventional mooring equipment
- Adaptive Mooring - Using SmartPort to connect assets such as environmental monitoring or vessel traffic systems to AutoMoor to enable adaptive mooring decisions to be made
- Cold climate version available
- SafePilot piloting systems, for navigation of the ship into the berth and information from the AutoMoor units

Drive motor to dynamically adjust the pad position to provide greater reach

Passive damping to restrain ship movement

Vacuum system

Control system

Vacuum pad for ship connection

Comparison of vessel movement moored with conventional equipment versus AutoMoor using CFD mooring analysis software
## AutoMoor

<table>
<thead>
<tr>
<th>MODEL</th>
<th>QTY. PADS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>ANCHOR BOLT SIZE (mm)</th>
<th>ANCHOR BOLT (QTY)</th>
<th>SHIPPING MASS (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM-T20-01</td>
<td>1</td>
<td>1780</td>
<td>2400</td>
<td>3845</td>
<td>2450</td>
<td>M30 x 500</td>
<td>14</td>
<td>7800</td>
</tr>
<tr>
<td>AM-T40-02</td>
<td>2</td>
<td>3430</td>
<td>2470</td>
<td>4065</td>
<td>2465</td>
<td>M30 x 500</td>
<td>18</td>
<td>11000</td>
</tr>
</tbody>
</table>

### Description

<table>
<thead>
<tr>
<th>1 GENERAL SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1</strong> Max Outreach (from wharf edge)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>1.2</strong> Horizontal Range of Movement (Surge)</td>
</tr>
<tr>
<td><strong>1.3</strong> Vertical Range of Movement (Heave)</td>
</tr>
<tr>
<td><strong>1.4</strong> Vacuum Holding Capacity</td>
</tr>
<tr>
<td><strong>1.5</strong> Primary Fabrication Material</td>
</tr>
<tr>
<td><strong>1.6</strong> Temperature Range</td>
</tr>
<tr>
<td><strong>1.7</strong> Foundation Design Requirements</td>
</tr>
<tr>
<td><strong>1.8</strong> Hold Down Bolts (Anchors)</td>
</tr>
<tr>
<td><strong>1.9</strong> Anchor Template</td>
</tr>
<tr>
<td><strong>1.10</strong> Fasteners</td>
</tr>
</tbody>
</table>
## GENERAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Description</th>
<th>T20</th>
<th>T40</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.9 Remote Release</strong></td>
<td>Remote release from port control room, handheld wireless control device and control pedestal adjacent to mooring unit.</td>
<td></td>
</tr>
<tr>
<td><strong>1.10 Area Footprint</strong></td>
<td>5.4m² deck footprint</td>
<td>7.5m² deck footprint</td>
</tr>
<tr>
<td><strong>1.11 Peak Power Consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driveline Motor</td>
<td>5.5kW</td>
<td>7.5kW</td>
</tr>
<tr>
<td>Vacuum Motor</td>
<td>1.5kW</td>
<td>2.7kW</td>
</tr>
<tr>
<td><strong>1.12 Power Supply Type</strong></td>
<td>3-Phase, 440-480VAC 60Hz recommended</td>
<td></td>
</tr>
<tr>
<td><strong>1.14 SmartPort Enabled</strong></td>
<td>Data Logging &amp; Reporting: Multiple reporting levels available.</td>
<td></td>
</tr>
</tbody>
</table>

## QUALITY AND TESTING

<table>
<thead>
<tr>
<th>Description</th>
<th>T20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2.1 NDT</strong></td>
<td>ASTM E1444-05</td>
</tr>
<tr>
<td><strong>2.2 Welding</strong></td>
<td>AWS D1.1 or AS1554</td>
</tr>
<tr>
<td><strong>2.3 Testing</strong></td>
<td>Each unit is individually proof load tested using a specially designed test rig. Proof load testing equipment is calibrated by a certified body such as Lloyds Register. Each unit is functional control system tested in factory and series tested for multiple unit orders. AutoMoor units are commissioned once installed onsite to verify factory testing and system performance requirements.</td>
</tr>
</tbody>
</table>

## PROTECTIVE COATING

<table>
<thead>
<tr>
<th>Description</th>
<th>T20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.1 Surface Treatment</strong></td>
<td>Surface Preparation – Class 2.5 Blast (1). 1st Coat: Nominal 75μm DFT epoxy zinc-rich primer. 2nd Coat: Nominal 125μm DFT two-part epoxy, containing MIO. 3rd Coat: Nominal 75μm re-coatable two-part polyurethane. Color: As required to suit customer protective coating specifications. AS1627.4, USA, National Association Corrosion Engineers, NACE or Society for Protective Coatings, SSPC-SP10 Sweden, Sa 2.5).</td>
</tr>
</tbody>
</table>

## OPTIONAL SYSTEM UPGRADES (AVAILABLE AT ADDITIONAL COST)

<table>
<thead>
<tr>
<th>Description</th>
<th>T20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.1 Vessel Warping System</strong></td>
<td>Motor and system programming upgrade to allow AutoMoor units to warp a vessel along a berth.</td>
</tr>
<tr>
<td><strong>4.2 Extended Temperature Range</strong></td>
<td>-40°C to +70°C.</td>
</tr>
<tr>
<td><strong>4.3 Hazardous Version</strong></td>
<td>Electrical control system and motor upgrades to suit hazardous area operation.</td>
</tr>
<tr>
<td><strong>4.4 Class Design Approval</strong></td>
<td>Independent 3rd Party inspection &amp; certification.</td>
</tr>
</tbody>
</table>
Trelleborg’s Pelican Hook is a universal buoy hook used to moor vessels to single point mooring buoys.

**FEATURES**

- Safe Working Load (SWL) up to 120 T
- Accommodates a wide range of mooring rope sizes and types (nylon and steel rope)
- Simple single pin connection to buoy
- Able to release hawser, under no load, alongside the buoy

**APPLICATIONS**

Buoy Moorings
Pelican Hook

Mooring rope - suitable for sizes upto Ø100mm

Manual release – use a lanyard when the hook is under no load

Mounting - connected to buoy with single pin (Ø89 or Ø115).

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>LENGTH (L) mm</th>
<th>WIDTH (W) mm</th>
<th>HEIGHT (H) mm</th>
<th>MOUNTING PIN DIA (A) mm</th>
<th>MAX. SWL (T)</th>
<th>MAX. PL (T)</th>
<th>SHIPPING MASS (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH120-89</td>
<td>1200</td>
<td>210</td>
<td>580</td>
<td>89</td>
<td>120</td>
<td>120</td>
<td>215</td>
</tr>
<tr>
<td>BH120-115</td>
<td>1200</td>
<td>210</td>
<td>580</td>
<td>115</td>
<td>120</td>
<td>120</td>
<td>215</td>
</tr>
</tbody>
</table>
Trelleborg’s Hawser Hooks have been installed in over 100 FPSO facilities for tandem mooring or bow mooring during offloading.

**FEATURES**
- Safe, efficient and reliable mooring operations
- Low profile and compact footprint
- Load monitoring & high load warning system designed for shipboard operation
- Emergency release, local or remote release from the cargo control room (CCR) panel
- Class Approval to DNV, ABS, BV, Lloyds or RINA as applicable

**APPLICATIONS**
- Tandem mooring
- Bow mooring to a Single Point Mooring (SPM)
**Hawser Hooks**

**ADD-ONS**

- Hawser roller fairlead
- Bedding plate

**Load monitoring and remote release system** located in the CCR (Refer to page 21)

- Trelleborg’s horizontal or vertical drum hawser winches (Refer to page 41)

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>LENGTH (L) mm</th>
<th>WIDTH (W) mm</th>
<th>HEIGHT (H) mm</th>
<th>HEIGHT TO CHAIN CENTRELINE (A) mm</th>
<th>MAX. SAFE WORKING LOAD (T)</th>
<th>MAX. PROOF LOAD (T)</th>
<th>HD BOLT QTY</th>
<th>SHIPPING MASS (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H580</td>
<td>1560</td>
<td>560</td>
<td>540</td>
<td>440</td>
<td>250</td>
<td>313</td>
<td>14 x M42</td>
<td>950</td>
</tr>
<tr>
<td>H850</td>
<td>1790</td>
<td>680</td>
<td>540</td>
<td>580</td>
<td>350</td>
<td>550</td>
<td>14 x M56</td>
<td>1650</td>
</tr>
</tbody>
</table>

**Chain Angles between Chock and Hook**

- Horizontal Plane: +/- 5° of centreline
- Vertical Plane: 0 to + 5° above centreline.

**Mooring Connection**
The Hawser Hooks will accept an OCIMF standard (open) end link of 76mm chafe chain. Type A or B as per OCIMF MEG3.

**Area Classification**
Hazardous

**IP Rating**
IP66

**Local Control Unit**
Display of hook load, error information & alarm status. Pushbutton control to release the hawser unit.

**Hydraulic Power Pack**
For release system, located below deck in safe area.
The load monitoring bitt is typically installed on the bow of a vessel and replaces the traditional mooring bitt or Samson post.

FEATURES

- Safe, efficient and reliable mooring operations
- Replaces the traditional mooring bitt or Samson post, which do not provide mooring line load monitoring
- Reduces the risk of hawser damage by providing real-time monitoring and alarming of high mooring hawser tension
- Real-time monitoring means the ships mooring crew can better ensure a safe mooring pattern, improving the vessels’ stability
- Suitable for hazardous area operations
- Class compliance (OCIMF Mooring Equipment Guidelines (MEG 3) 2000, DNV, ABS, BV, Lloyds or RINA as applicable)

APPLICATIONS

- Tandem mooring
- Bow mooring to a Single Point Mooring (SPM)
### Hawser Load Monitoring Bitt

**ADD-ONS**

- Load monitoring system located in the CCR
- Deck mounted visible and audible alarm station for high loads

---

**Max Hawser Size:** Ø 275mm
**Area Classification:** Hazardous
**IP Rating:** IP66

**Local Control Unit**
Display of hook load, error information & alarm status

---

**Model Number**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Length (L) mm</th>
<th>Width (W) mm</th>
<th>Height (H) mm</th>
<th>Height to C/L of Hawser</th>
<th>Max. SWL (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMB430</td>
<td>2050</td>
<td>950</td>
<td>700</td>
<td>435</td>
<td>430</td>
</tr>
</tbody>
</table>
Chain Stoppers

Features

- Safe, efficient and reliable mooring operations
- Low profile and compact footprint
- Releaseable from zero and up to the Safe Working Load (SWL)
- Load monitoring & high load warning system designed for ship board operation
- Emergency release, local or remote release from the cargo control room (CCR) panel
- Class Approval to DNV, ABS, BV, Lloyds or RINA as applicable

Applications

- Bow mooring
- Single point mooring
- Spread mooring

Deck mounted chain stoppers to 1,210 T for bow or spread mooring applications where emergency release under load and load monitoring functionality is required.
Chain Stoppers

**ADD-ONS**

- Chain Tensioning Jack
- Chain Tensioning Winch / Pulley System
- Bedding Plate
- Load monitoring and remote release system located in the CCR (Refer to Page 21 and 23)

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>CHAIN SIZE/ GRADE</th>
<th>LENGTH (L) mm</th>
<th>WIDTH (W) mm</th>
<th>HEIGHT (H) mm</th>
<th>CHAIN CENTRELINE HEIGHT (A) mm</th>
<th>MAX. SAFE WORKING LOAD (T)</th>
<th>HD BOLT QTY</th>
<th>SHIPPING MASS kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS700</td>
<td>76mm R4</td>
<td>2650</td>
<td>850</td>
<td>1010</td>
<td>250</td>
<td>Up to 700</td>
<td>20 x M56</td>
<td>4800</td>
</tr>
<tr>
<td>CS1210</td>
<td>111mm R4</td>
<td>2650</td>
<td>850</td>
<td>1050</td>
<td>255.5</td>
<td>Up to 1210</td>
<td>24 x M56</td>
<td>5160</td>
</tr>
</tbody>
</table>

**Chain Size**

Up to 111 mm diameter stud or studless offshore chain.

**Mooring Chain Fleet Angle**

Horizontal plane: Max +/- 5 degrees each side of centerline of the unit.

**Mounting Options**

Bolt down or weld down to a levelled flat or elevated foundation plate.

**Local Control Unit**

LCD readout of load magnitude and load warnings. Pushbutton control to release the hawser unit.

**Hydraulic Power Pack**

For release system, located below deck in safe area.
Winches & Reels

Trelleborg’s modular solution for Tandem Mooring conversions (FPSO’s), using a hawser winch with a quick release hawser hook and spooling system.

FEATURES
- Safe, efficient and reliable mooring operations
- Minimizes deck space requirements
- Emergency quick release, providing safe release upto the SWL
- Load monitoring, enabling an early warning of increasing mooring tensions or surging mooring loads
- An independent winch, meaning it needs minimal under-deck stiffening
- Suitable for hazardous area operations
- Class Approval to DNV, ABS, BV, Lloyds or RINA as applicable

APPLICATIONS
- F(P)SO tandem mooring
Tandem Mooring Winch
Tandem Mooring Winch

- Hawser winch
- Spooling system
- Closed chock
- Hawser hook
- Operator console
**Drum Storage Capacity**  
One 150 m, up to 21 inch circumference hawser

**Winch Speed**  
Reel-in/out: 0 to 7.5 m/min  
Note: Free wheeling enabled for emergency only

**Winch Pull Capacity**  
Running pull 15 T and 3rd layer

**Winch Static Load Capacity**  
25 T

**Drum Dimensions**  
Diameter: 2.0 m  
Length: 1.8 m

**Winch Drive and Brake**  
Dual slow drive with integral brake. 50% hot redundancy.

**Hydraulic Power Unit**  
Self-contained, skid mounted unit with tank, motor and controls and closed loop system, located below deck in safe area

**Hawser Hook**  
Option to use either a model H580 or H850 hawser hook

---

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th><strong>SHIPPING MASS (kg)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>4300</td>
<td>5200</td>
<td>4000</td>
<td>2000</td>
<td>450</td>
<td>600</td>
<td>3000</td>
<td>4800</td>
<td>2070</td>
<td>20000</td>
</tr>
</tbody>
</table>

Note: Dimensions (mm) may change subject to equipment layout and spooling system provisions.
Docking Aid Systems (DAS)

Docking Aid Systems provide feedback essential to the safe docking of vessels and to reduce berthing velocities to prolong fender and jetty life.

FEATURES
Safe, efficient and reliable docking operations
Day and night visibility
Long range
Vessel database and data logging, including ship details and pilot name
3 modes of operation – Approach, Drift and Depart

APPLICATIONS
LNG carrier berths
Oil berths
LPG berths
Bulk liquids berths
Bulk materials berths
Offshore berths and ship-to-ship docking
Docking Aid Systems (DAS)

Speed and distance information can be viewed on the display board from the ships’ bridge using lasers located on the jetty. Logging of data can also be used to diagnose any damage caused by abnormal events and help prolong the life of the fenders and jetty structure.

DAS Lasers

Highly accurate laser sensors are used to measure the distance of the ship to the fender line. The Central Monitoring System processes this into speed, distance and longitudinal angle for use by the pilot and operations personnel.

Laser sensors are eye safe and can be used in all weather conditions.

<table>
<thead>
<tr>
<th>Range</th>
<th>0 to 300m¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area classification</td>
<td>Hazardous or non-hazardous</td>
</tr>
</tbody>
</table>

¹ The maximum range of the laser is dependent on the angle, reflective quality and color of the ship’s hull.

DAS Display Board

The display board provides speed and distance information for the vessel, as produced from the DAS lasers. Vessel angle relative to the fender line can also be shown as an option.

A traffic light system (red, amber, green) gives visual indication of whether the vessel is moving too fast toward the fender line.

Mounting options for the display board include both fixed and rotating pedestals.

<table>
<thead>
<tr>
<th>Distance Display</th>
<th>0 to 199m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed Display</td>
<td>0 to 99cm/s</td>
</tr>
<tr>
<td>Speed Warning Lamps</td>
<td>Red/Amp/er/Green</td>
</tr>
<tr>
<td>Viewing Angle</td>
<td>Horizontal ±60º Vertical ±50º</td>
</tr>
<tr>
<td>Rotating Pedestal Range</td>
<td>±150º</td>
</tr>
<tr>
<td>Area Classification</td>
<td>Hazardous or non-hazardous</td>
</tr>
</tbody>
</table>
SafePilot

SafePilot provides high accuracy piloting and navigation solutions for offshore and pilotage operation to the highest reliability and safety levels.

### PRODUCT OVERVIEW

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>OVERVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>SafePilot CAT ROT</td>
<td>The CAT ROT is a small and compact pilot unit primarily designed to connect to a ship’s AIS pilot plug and transmit data via Wi-Fi to the Pilot’s tablet/notebook.</td>
</tr>
<tr>
<td>SafePilot CAT I</td>
<td>The CAT I is a standalone high accuracy GPS receiver with the capability of GPS/GLONASS and available SBAS systems such as EGNOS, WAAS, MSAS and GAGAN.</td>
</tr>
<tr>
<td>SafePilot CAT II</td>
<td>The SafePilot CAT II offers a precise, reliable tool for navigation and berthing, providing all required navigational data.</td>
</tr>
<tr>
<td>SafePilot CAT III</td>
<td>For more demanding piloting applications requiring accuracy to the centimeter as well as heave, pitch and roll monitoring.</td>
</tr>
<tr>
<td>SafePilot Piloting Software</td>
<td>The SafePilot Piloting Software is a professional piloting/navigation iOS based software that is developed in collaboration with marine pilots worldwide.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAT ROT</th>
<th>CAT I</th>
<th>CAT II</th>
<th>CAT III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed Accuracy</td>
<td>From ships instruments</td>
<td>1 cm/sec</td>
<td>1 cm/sec</td>
</tr>
<tr>
<td>Position Accuracy</td>
<td>3.0m</td>
<td>0.6m</td>
<td>DGPS – 0.4m, SBAS - 0.6m, Stand-alone – 1.5m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DGPS – 0.4m, SBAS – 0.6m, Stand-alone – 1.2m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RTK – 1 cm + 1ppm</td>
</tr>
<tr>
<td>Rate of Turn</td>
<td>0.5 deg/min</td>
<td>–</td>
<td>0.5 deg/min</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.3 deg/min</td>
</tr>
<tr>
<td>Heading Accuracy</td>
<td>0.1 deg</td>
<td>–</td>
<td>0.05 deg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.05 deg</td>
</tr>
<tr>
<td>Roll &amp; Pitch</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Battery Life</td>
<td>22 hrs</td>
<td>17 hrs</td>
<td>9 hrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 hrs</td>
</tr>
</tbody>
</table>
Accurate real-time environmental and MetOcean monitoring is vital to the safe docking and mooring of vessels, as well as prolonging the life of the fender and jetty assets.

FEATURES

- Meteorological monitoring options
- Oceanographic monitoring options (MetOcean)
- Deployment and retrieval systems
- Safe and efficient docking and mooring operations
- Accurate, real-time data
- Integrated with mooring and docking systems or as a standalone system
- Can be installed remotely with solar power and telemetry options available

APPLICATIONS

- LNG carrier berths
- Oil berths
- LPG berths
- Bulk liquids berths
- Bulk materials berths
- Buoys
- Commercial (RoRo, ferry, container)
Meteorological Monitoring

WEATHER STATION

Monitoring capabilities:
- Wind Speed
- Wind Direction
- Temperature
- Air Pressure
- Humidity
- Rainfall
- Lightning detection (optional)
- Solar radiation (optional)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-50 to 60°C</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>0 to 100%</td>
</tr>
<tr>
<td>Solar Radiation Spectral Range</td>
<td>300 to 1100 nm</td>
</tr>
<tr>
<td>Solar Radiation Measuring Range</td>
<td>1400 W/m²</td>
</tr>
<tr>
<td>Lightning Detection</td>
<td>Number of lightning events</td>
</tr>
<tr>
<td>Pressure</td>
<td>300 to 1200 hPa</td>
</tr>
<tr>
<td>Wind Direction</td>
<td>0 to 360°</td>
</tr>
<tr>
<td>Wind Speed</td>
<td>0 to 30 m/s</td>
</tr>
<tr>
<td></td>
<td>0 to 75 m/s (optional)</td>
</tr>
<tr>
<td>Area Classification</td>
<td>Non-hazardous</td>
</tr>
</tbody>
</table>

WIND

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Speed</td>
<td>0.6 to 100 m/s</td>
</tr>
<tr>
<td>Wind Direction</td>
<td>0 to 360°</td>
</tr>
<tr>
<td>Area Classification</td>
<td>Hazardous or non-hazardous</td>
</tr>
</tbody>
</table>
# Meteorological Monitoring

## VISIBILITY

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring Range</td>
<td>10 to 20,000 m</td>
</tr>
<tr>
<td>Area Classification</td>
<td>Non-hazardous</td>
</tr>
</tbody>
</table>

## LIGHTNING DETECTION

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection Range</td>
<td>30 nautical miles</td>
</tr>
<tr>
<td>Detection Bearing</td>
<td>0 to 360°</td>
</tr>
<tr>
<td>Area Classification</td>
<td>Non-hazardous</td>
</tr>
</tbody>
</table>
Oceanographic monitoring

WAVE TIDE LASER
- Significant wave height
- Long wave height
- Short wave height
- Period of significant waves
- Water level

<table>
<thead>
<tr>
<th>Measuring Range</th>
<th>2.5 to 30 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Classification</td>
<td>Hazardous or non-hazardous</td>
</tr>
</tbody>
</table>

SINGLE POINT CURRENT METER
- Current speed
- Current direction
- Water temperature (optional)
- Salinity (optional)

<table>
<thead>
<tr>
<th>Current Speed</th>
<th>0 to 300 cm/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Direction</td>
<td>0 to 360°</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>-4 to +36°C</td>
</tr>
<tr>
<td>Conductivity Range</td>
<td>0 to 7.5 S/m</td>
</tr>
<tr>
<td>Depth Rating</td>
<td>2000 m</td>
</tr>
</tbody>
</table>

SALINITY
- Conductivity
- Water temperature

<table>
<thead>
<tr>
<th>Conductivity</th>
<th>0 to 70 mS/cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Temperature</td>
<td>-5 to +35°C</td>
</tr>
<tr>
<td>Depth Rating</td>
<td>250 m</td>
</tr>
</tbody>
</table>
Oceanographic Monitoring

SIDE LOOKING CURRENT PROFILER
- Multiple cells for readings at different distances
- Current speed
- Current direction
- Water temperature
- Tide level

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Speed</td>
<td>0 to 6 m/s</td>
</tr>
<tr>
<td>Current Direction</td>
<td>0 to 360°</td>
</tr>
<tr>
<td>Tide Level</td>
<td>0.2 to 18 m</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>-5 to +40°C</td>
</tr>
<tr>
<td>Depth Rating</td>
<td>30 m</td>
</tr>
</tbody>
</table>

BOTTOM MOUNT CURRENT PROFILER
- Multiple cells for current readings at different depths
- Current speed
- Current direction
- Water temperature
- Max wave height
- Mean wave period
- Significant wave frequency (long and short)
- Significant wave height (long and short)
- Peak wave period (long and short)
- Wave direction (optional)
- Tide level

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Speed</td>
<td>0 to 5 m/s</td>
</tr>
<tr>
<td>Current Direction</td>
<td>0 to 360°</td>
</tr>
<tr>
<td>Water Temperature</td>
<td>-5 to +45°C</td>
</tr>
<tr>
<td>Conductivity Range</td>
<td>1 s</td>
</tr>
<tr>
<td>Depth Rating</td>
<td>200 m</td>
</tr>
</tbody>
</table>
Integration is the key to maximum safety and optimum productivity.

Trelleborg Marine Systems operation can combine the Docking, Mooring and Environmental systems into a logical and easy to operate IMS (Integrated Monitoring System). Key information and statuses are then distributed to the right people at the right time whether they are on board the vessel, at the control room or on the jetty.

The IMS is built into either a small or large 19” equipment rack or a compact wall mount enclosure.
Integrated Monitoring System

FEATURES

- Presents an overall view of docking, mooring and metocean
- Improves safety and operations
- Provides information to the right people at the right time
- Flexible architecture between the IMS and field equipment (Multidrop, Star, Ring options)
- Various communications methods available (Serial, Ethernet and Fibreoptic options)
- Redundant server and/or communications facilities
- Dedicated server system to connect field equipment and provide information to operations staff, with logging of all docking, mooring and environmental data
- Fully integrated with other Trelleborg Marine Systems products

APPLICATIONS

- LNG carrier berths
- Oil berths
- LPG berths
- Bulk liquids berths
- Bulk materials berths
- Small scale mooring

ADD-ONS

- Additional workstations, mobile tablets/laptops and handheld devices
- Radio systems for Carry-On-Board (COB) tablets/laptops and the Portable Marine Monitor
- Interface module to Ship to Shore Link System
- SafePilot Navigation System
Integrated Monitoring System (IMS)

SYSTEM ARCHITECTURE KEY COMPONENTS

- The LMS controller connects and communicates with:
  - Workstations, tablets, laptops using Ethernet, WiFi, 3G/4G to display docking, mooring and environmental information, and VHF/UHF to pagers
  - Field equipment using serial, Ethernet and/or fibre optic systems

MOBILE DEVICES

- 4G
- WiFi
- Workstations

CENTRAL SYSTEM

- LMS Controller

FIELD EQUIPMENT

IM Equipment Rack Options
- Small or large 19” racks
- Wall mount enclosures

LMS controller communicates with equipment and logs all docking, mooring and environmental data, and provides alarms and generates reports.

Other modules that may be included in the rack for field equipment include:
- SmartDock controller (JCU replacement)
- SSL Interface module to go to the Ship to Shore System
- Telemetry Interface Module for mobile communications devices
- Hook Release Interface Module for QRH units
Integrated Monitoring System (IMS)

WORKSTATIONS

Typical user interface displayed on the workstation:

- Docking
- Mooring
- Environmental
Integrated Monitoring System

**MOBILE DEVICES**

Mobile tablets and laptops (using one of WiFi, 3G/4G, VHF or UHF)

Handheld devices (using one of WiFi, 3G/4G)

Portable marine monitor – pagers (using one of VHF or UHF)
By their very nature, marine terminals and installations are located in hostile environments. Industry bodies such as SIGTTO and OCIMF recognize how critical it is for mooring and monitoring equipment to function correctly to ensure safety.

To help meet the challenge in these demanding environments Trelleborg Marine Systems offers clients a full range of Aftersales Services across the Docking and Mooring range.

Trelleborg also recognizes that the maritime industry is inherently a global business and is uniquely positioned to provide rapid response through our Global Service Network.
Service Agreements

Leading companies recognize that it is the total cost of ownership which really matters in the purchase of capital equipment. Without doubt, regular preventative maintenance reduces downtime, improves productivity and manages risk.

A tailored service program gives you inside access to Trelleborg product experts and allows you to leverage our experience and product knowledge for your benefit.

A Trelleborg aftersales representative can work with you to tailor a service solution including some or all of the following:

- Programmed maintenance and inspection
- Call out service with defined response times
- Onsite calibration
- Refresher training
- Audit of spare parts holdings
- Remote technical support and diagnostics
- Comprehensive reporting and recommendations

Training Programs

Our experienced trainers can help you invest in your most important asset — your people. Training can be customized to your needs, whether at our factory or onsite.

Training is offered in three levels:

- Level 1 – System Overview
- Level 2 – Operator Training
- Level 3 – Maintenance Training
Calibration and Inspection Services

LOAD CELL CALIBRATION
Trelleborg offers a number of convenient options to keep your load cells calibrated to meet SIGTTO guidelines.

- Factory Calibration
- Onsite Calibration
  - Trelleborg portable calibration equipment is shipped to site
  - A Trelleborg engineer completes calibration checks together with your team
- Load Cell Exchange Programs
  - A full jetty set of calibrated load cells with cables are delivered ready for installation
  - A Trelleborg engineer will be onsite (if needed) to work with your team to perform the exchange
  - Removed load cells are returned to Trelleborg
  - Exchange agreements typically run for 3 – 5 years

ONSITE INSPECTION
Our experienced and knowledgeable Service Engineers are ready to assist in assessing your installed Trelleborg equipment for:

- General equipment condition
- Damage inspections
- Onsite technical advice
- Maintenance tips and recommendations
- Replacement and upgrade options for existing equipment – Trelleborg or others

Warranty
All new Trelleborg docking and mooring projects are backed by an 18 month back to base warranty. For warranty extensions or details please talk to your Trelleborg sales representative and they’ll be happy to discuss your needs.

Spare and service warranty is valid for 12 months and non-extendable.

Technical Support
If you have any queries on the operation of your Trelleborg docking and mooring products, please contact your local Trelleborg representative. We can provide both remote and onsite support options.

For mission critical technical support, Trelleborg offers Priority Support Packages with defined response times.
Trelleborg recognizes the decision to upgrade equipment requires more than just a set of equipment specifications. What’s needed is a deeper understanding of port operating parameters and the condition and functionality of existing equipment.

Whether you’re upgrading equipment which is worn out, superseded or adding functionality, our broad industry knowledge and extensive experience means we can tailor a solution to meet your operational needs and budget.

### Spare Parts, Equipment Overhaul & Repair

Leveraging our extensive experience across our customer base, we are able to make recommendations for consumable, operation and capital spares holdings across multiyear time periods, e.g., 1, 2 or 3 years, to help ensure maximum equipment availability.

We also offer a number of options to support and extend the life of your existing equipment through factory repair and overhaul. Services include:

- **QRH hook refurbishment and testing**
- **Capstan motor / gearbox refurbishment and testing**
- **Load cell repairs and overhaul**
- **General equipment repairs**

### Upgrades

Trelleborg recognizes the decision to upgrade equipment requires more than just a set of equipment specifications. What’s needed is a deeper understanding of port operating parameters and the condition and functionality of existing equipment.

Whether you’re upgrading equipment which is worn out, superseded or adding functionality, our broad industry knowledge and extensive experience means we can tailor a solution to meet your operational needs and budget.

From upgrading footswitches to entire jetty equipment replacements, some examples of upgrades we can provide include:

- **Adding functionality to existing Quick Release Hooks (QRH) and bases**
  - Load monitoring
  - Remote release
  - Capstans
  - Increased operating line angles
  - Fitting safety keeper bars
- **Replacing obsolete or worn QRH utilizing existing bases or bolt patterns**
- **Replacing bollards with QRH**
- **Low maintenance QRH for jetties with limited maintenance windows**
- **Upgrading obsolete computer software / hardware**
- **Upgrading or replacing environmental monitoring systems**
- **Replacing capstans with tugger winches**
Trelleborg Marine Systems is the world leader of onshore and offshore docking and mooring applications. We pride ourselves in maintaining and continuously developing the highest industry practices, exceeding applicable codes and standards in all aspects of design, manufacturing and testing of equipment.

Explore our pursuit of excellence!

- Total Cost of Ownership
- Our Commitment to Quality
- Materials
- Paint Systems
- Electrical Load List
- Instrumentation, Signal and Control Cables
- Industry Guidelines Codes and Standards
- Classification Societies
- Trelleborg Quality Management
Total Cost of Ownership

- What to look for to ensure class leading solutions
- Comparing bollards with QrH
- Supplier selection criteria for customers

**WHAT TO LOOK FOR TO ENSURE CLASS LEADING SOLUTIONS**

- Cast bases and hooks provide superior corrosion resistance and higher strength.
- Weld free hooks and bases offer extended design life and excellent fatigue resistance.
- Cast hooks with optimal throat size minimizes rope wear.
- Compact and strong cast hook design offers double the yield strength of forged mild steel hooks by others.
- Unobtrusive release mechanism (no protruding components outside the hook body which could act as rope catching points).
- Enclosed capstan design offers significantly increased protection from harsh marine environment and mechanical damage during operation, maximizing service life.
- Compact footprint with an all-in-one design minimizes deck space usage and installation costs.
- Standard capstan design has reversible control with automatic brake, enabling operator to take in or let out the line while tension and control is maintained.
- Superior insulation design insulates hooks and capstans from the base, as opposed to “under the base” insulation pads by others which are susceptible to cracking due to movement under load over a period of time.
- High quality three-coat paint specification offers industry best protective coating.

**COMPARING BOLLARDS WITH QRH**

- Mooring lines on a bollard cannot be released under tension whereas a QrH is designed to release the lines up to full SWL.
- Multiple lines on a bollard can cause departure delays if entangled. One line per QrH is the normal practice to assist with accurate line load monitoring.
- No facility to upgrade bollards with integral capstans, load monitoring and electric release.
- Bollards are normally installed closer to edge of the dock which increases the risk of mooring crew falling in to water while handling heavy mooring lines. QrH units require minimal line handling when compared to bollards.
- Mooring crews are at risk in close proximity of mooring lines that may be under high tension and/or are prone to failure due to their bad condition. The port often has little control over the condition of the mooring lines which are the property of the visiting vessel. The associated risks can be mitigated by using a QrH with remote release fitted.
- The number of personnel required to release a vessel can be minimized on facilities with QrH and remote release systems fitted. This also ensures that mooring personnel are not required to be in the “risk zone” in case of an emergency situation i.e., fire.
Total Cost of Ownership

SUPPLIER SELECTION CRITERIA FOR CUSTOMERS

- Does the supplier have in-house design engineering, manufacturing and testing capabilities?
- Is the supplier outsourcing an entire subsystem from a third party? If so then who controls the design, manufacturing, QA and aftersales?
- Is the supplier taking “single point responsibility” for complete system?
- Is the supplier capable of offering custom solutions to meet project requirements?
- Is the supplier providing 100% proof loading of the complete hooks’ assembly prior to dispatch? Be aware some suppliers only test components, not complete assemblies!
- Is the supplier offering a comprehensive system warranty (not just product warranties)?
- Does the supplier have a documented track record in similar product handling berths?
- Is the supplier confirming to project location specific hazardous area compliance?
- Does the supplier have current ISO9001 QA certification for the offered solution?
- Is the supplier offering aftersales service support capability?
- Is the supplier capable of offering annual service programs in accordance with SIGTTO/OCIMF guidelines i.e. “JETTY MAINTENANCE AND INSPECTION GUIDE”? 
- Does the supplier have ability to interface with third party systems i.e. PLC/DCS, SSL etc.?
- An “apple to apple” comparison of detailed technical specifications and product features to ensure compliance with project requirements and to evaluate the inherent commercial implications of overall solution (which may not be visible from a line by line price comparison).
Our Commitment to Quality

Trelleborg's commitment to quality drives the way we work and operate and includes:

- Global commitment to customers around the world with almost 100 dedicated docking and mooring employees worldwide, to provide an unparalleled level of support and expertise.
- Business processes developed and regularly audited and validated through the ISO9001 quality process.
- Key products and associated manufacturing processes audited through certification bodies such as Simtars/CSA for hazardous area products and DNV GL/ABS/BV/Lloyds for classified equipment for use on vessels including FPSOs/FSOs, FLNG and FSRUs/FSUs.
- A proven track record of hazardous area product design and manufacturing capabilities, with numerous products manufactured under the IECEx and ATEX hazardous schemes. Certificates are available upon request.
- Bringing manufacturing and certification of critical products into the Trelleborg business to ensure total control over the design, sourcing, manufacturing and testing of products such as QRH, load cells, hook release systems and docking displays.

1. SURFACE ROUGHNESS CHECK
2. CNC IN OPERATION
3. DMG HNC 6300 CNC
4 & 5. LOAD CELL GAUGING
CLEAN ROOM.
Materials

Trelleborg mooring fittings are designed in compliance with international standards including:

1. OCIMF: Mooring Equipment Guidelines
2. BS6349-4: Code of Practice for design of fendering and mooring systems
3. MOTEMS: Marine Oil Terminal Engineering and Maintenance standards
4. AS3990: Mechanical equipment steel work
5. AS4100: Steel Structures

The selection of the engineering material used for various components has been conducted in light of the following criteria:

- Performance (Mechanical properties)
- Resistance to wear
- Resistance to corrosion
- Practical and compact design
- Sustainability
- Reliability in extreme temperatures

QUICK RELEASE HOOK

<table>
<thead>
<tr>
<th>Component</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame (side plates)</td>
<td>Carbon Steel ASTM A572 Grade 50 equivalent to AS 3678 Grade 350</td>
</tr>
<tr>
<td>Hook body, main pivot block, primary release block and cross shaft</td>
<td>High strength alloy steel to ASTM A148 Grade 115-95, equivalent to AS 2074</td>
</tr>
<tr>
<td>Vertical pin</td>
<td>High tensile alloy steel grade SAE4140</td>
</tr>
<tr>
<td>Load cells, dummy pins</td>
<td>ASTM A276 431 equivalent to AS 2837 431</td>
</tr>
</tbody>
</table>
## Materials

### ONSHORE BASE

<table>
<thead>
<tr>
<th>Hook base</th>
<th>Spheroidal graphite cast iron, ASTM A536 65-45-12 equivalent to 400-12 to AS1831</th>
</tr>
</thead>
</table>
| Holding down bolts | BS4190 equivalent to ISO898. Property Class 8.8  
Finish: Hot-dip galvanizing to ISO 10684:2004 (E) or Xylan coated |

### SHIP-TO-SHIP HOOK BASE (OFFSHORE)

<table>
<thead>
<tr>
<th>Hook base</th>
<th>Fabricated steel plate AS 3678 / ASTM A572</th>
</tr>
</thead>
</table>
| Holding down bolts | BS4190 equivalent to ISO898. Property Class 8.8  
Finish: Hot-dip galvanizing to ISO 10684:2004 (E) or Xylan coated |
**Materials**

**HAWSER HOOK**

Structural carbon steel grade 350 to Australian standard AS / NZS 3678:1996 or equivalent ASTM A572

<table>
<thead>
<tr>
<th>Casting</th>
<th>Alloy Steel AS2074:2003 or equivalent to ASTM A148</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding</td>
<td>American Welding Society AWS D1.1</td>
</tr>
<tr>
<td>Load cell</td>
<td>Stainless steel Grade 630</td>
</tr>
<tr>
<td>Holding down bolts</td>
<td>BS4190 equivalent to ISO898. Property Class 8.8</td>
</tr>
<tr>
<td></td>
<td>Finish: Hot-dip galvanizing to ISO 10684:2004 (E) or Xylan coated</td>
</tr>
</tbody>
</table>

**CHAIN STOPPER**

Structural carbon steel grade 350 to Australian standard AS / NZS 3678:1996 or equivalent ASTM A572

<table>
<thead>
<tr>
<th>Casting</th>
<th>Alloy Steel AS2074:2003 or equivalent to ASTM A148</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding</td>
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</tr>
<tr>
<td>Holding down bolts</td>
<td>BS4190 equivalent to ISO898. Property Class 8.8</td>
</tr>
<tr>
<td></td>
<td>Finish: Hot-dip galvanizing to ISO 10684:2004 (E) or Xylan coated</td>
</tr>
</tbody>
</table>
## Materials

### WINCHES AND REELS

<table>
<thead>
<tr>
<th>Structure &amp; drum</th>
<th>Fabricated structural carbon steel to ASTM A 572</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding</td>
<td>American Welding Society AWS D1.1</td>
</tr>
</tbody>
</table>

### AUTOMOOR

Low Alloy Steel Grade Q345B to GB/T1591-2008 equivalent to ASTM A572 Grade 50.
Paint System

HIGH CORROSIVITY RESISTANT PAINT SYSTEM

Trelleborg Marine Systems produces various mooring systems, which operate in harsh marine environments. These systems are expected to operate for many years and it is therefore crucial that a high standard corrosion protection system is applied.

Trelleborg designed a paint system in conformance with ISO 12944-5 category C5-M which is the highest atmospheric-corrosivity category according to ISO 12944. The system also conforms to ISO 12340 and NORSOK M-501.

Carbon steel surfaces are painted to the following system:

Each surface is sandblasted to class 2.5 to SSPC-SP10.

A three coat system is then applied:

- 60 - 80 μm DFT Zinc-rich epoxy primer
- 160 - 280 μm DFT two part epoxy, containing MIO
- 60 - 80 μm DFT re-coatable two-part polyurethane

Standard color is gloss black but other colors are also available as required.

TESTS CONDUCTED

<table>
<thead>
<tr>
<th>TEST</th>
<th>APPLICABLE STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Cleaning of Surfaces</td>
<td>SSPC-SP1</td>
</tr>
<tr>
<td>Surface Preparation</td>
<td>ISO 8501-1</td>
</tr>
<tr>
<td>Surface Profile Determination</td>
<td>ISO 8503-5</td>
</tr>
<tr>
<td>Dry Film Thickness Measurement</td>
<td>ISO 19840</td>
</tr>
<tr>
<td>Adhesion</td>
<td>ISO 16276-1</td>
</tr>
</tbody>
</table>

TRELEBOG QUALITY

- All equipment used for application of the painting system are maintained, calibrated and inspected in accordance with Trelleborg inspection and test plan
- All environmental conditions are recorded at various stages of the paint process.
- Dry film thickness is measured after each coat and verified statistically according to applicable standards.
- A paint report is generated that covers all the steps of surface preparation and paint application.
- Two test reference panels are prepared for each batch of painted items. One reference panel is used for testing during surface preparation and paint application and the second is retained for future reference. To ensure traceability, each panel is stamped with a unique identifier traced back to the relevant batch.
- Trelleborg engages only qualified and experienced paint applicators and third party paint inspectors qualified to NACE Level II or III as required.
## Electrical Load List

The following tables provide guidelines for commonly used Trelleborg products. Refer to product datasheets for more specific information and for products not shown below.

<table>
<thead>
<tr>
<th>LINE PULL (Tonnes)</th>
<th>POWER SUPPLY&lt;sup&gt;1&lt;/sup&gt;</th>
<th>POWER SUPPLY BY</th>
<th>LINE SPEED IN METERS / MINUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>3 Ø</td>
<td>Others</td>
<td>5.5</td>
</tr>
<tr>
<td>1.5</td>
<td>3 Ø</td>
<td>Others</td>
<td>5.5</td>
</tr>
<tr>
<td>2</td>
<td>3 Ø</td>
<td>Others</td>
<td>7.5</td>
</tr>
<tr>
<td>2.5</td>
<td>3 Ø</td>
<td>Others</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>3 Ø</td>
<td>Others</td>
<td>11</td>
</tr>
</tbody>
</table>

<sup>1</sup> Including infeeds, mains, and compensation

**Note:** This table represents general guidelines and may not cover all specific products or scenarios. Always consult the product datasheets for specific requirements and additional details.
## Electrical Load List

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>POWER SUPPLY³</th>
<th>POWER SUPPLY BY</th>
<th>POWER IN kW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REMOTE RELEASE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Release</td>
<td>1 Ø</td>
<td>TMS²</td>
<td>0.2</td>
</tr>
<tr>
<td>Single to Quadruple Hook arrangement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Release Push Button Console</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.3</td>
</tr>
<tr>
<td>16-32 Hooks</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.3</td>
</tr>
<tr>
<td>33-48 Hooks</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.3</td>
</tr>
<tr>
<td>Virtual Release Console (PC Workstation)</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>LOAD MONITORING - SMARTHOOK®</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controller Unit with Load Cells</td>
<td>24 VDC</td>
<td>TMS²</td>
<td>0.1</td>
</tr>
<tr>
<td>(Single to Quadruple Hook Arrangement)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warning Light &amp; Siren (Optional)</td>
<td>1 Ø</td>
<td>TMS²</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>LOAD MONITORING &amp; REMOTE RELEASE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Monitoring &amp; Remote Release</td>
<td>24 VAC</td>
<td>TMS²</td>
<td>0.3</td>
</tr>
<tr>
<td>Single to Quadruple Hook Arrangements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DOCKING AID SYSTEMS - SMARTDOCK®</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lasers</td>
<td>24 VDC</td>
<td>TMS</td>
<td>0.02</td>
</tr>
<tr>
<td>Main Display Board</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.2</td>
</tr>
<tr>
<td>Electric Rotator</td>
<td>3 Ø</td>
<td>Others</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Weather Station - Wind, Temperature, Pressure, Humidity</td>
<td>24 VDC</td>
<td>TMS</td>
<td>0.1</td>
</tr>
<tr>
<td>Current Meter (Doppler)</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.1</td>
</tr>
<tr>
<td>Non-Contact Wave Tide Laser</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated Docking, Load Monitoring, Remote Release, Environmental, complete with Portable Monitor transmitter, Server PC Monitor</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.5</td>
</tr>
<tr>
<td>PC Workstation, Monitor, Printer</td>
<td>1 Ø</td>
<td>Others</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Note¹: 1 Ø = Single Phase Power Supply, 3 Ø = Three Phase Power Supply.
Note²: In the standard arrangement, the power supply is taken from the capstan supply. If there is no capstan, or if client requires independent power, then ‘Others’ to provide a single-phase power supply into each Hook Release Controller.
# Instrumentation Signal and Control Cables

The following table indicates the acronyms used in Trelleborg drawings as well as the cable types and maximum recommended distances.

<table>
<thead>
<tr>
<th>NO.</th>
<th>TYPE</th>
<th>CABLE CONFIGURATION</th>
<th>MAXIMUM RECOMMENDED DISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAB1</td>
<td>Communications</td>
<td>4 twisted pair, 1.5 mm² shielded, 13.6 ohm / K</td>
<td>600 m with communications only. 500 m typical for QRH, Remote Release and Laser Sensor.</td>
</tr>
<tr>
<td>CAB2</td>
<td>Communications</td>
<td>2 twisted pair, 0.5 mm² shielded, 13.6 ohm / K</td>
<td>600 m</td>
</tr>
<tr>
<td>CAB3M</td>
<td>Fibre Optic</td>
<td>Multimode 50/125 uM 4 Cores with SC Connectors Or Multimode 62.5/125 uM 4 Cores with SC Connectors</td>
<td>2 km</td>
</tr>
<tr>
<td>CAB3S</td>
<td>Fibre Optic</td>
<td>Single Mode 9/125 uM 4 Cores with SC Connectors</td>
<td>Upto 20 km</td>
</tr>
<tr>
<td>CAB4</td>
<td>Control</td>
<td>XC + E size, construction and armoring dependant on installation requirements.</td>
<td>Distance dependant on power demand and conductor cross sectional area.</td>
</tr>
<tr>
<td>CAB5</td>
<td>Network</td>
<td>CAT5</td>
<td>100 m</td>
</tr>
<tr>
<td>CAB6</td>
<td>Printer</td>
<td>USB</td>
<td>3 m</td>
</tr>
<tr>
<td>CAB7</td>
<td>Control</td>
<td>1.5 mm² shielded, number of cores to suit.</td>
<td>20 m</td>
</tr>
<tr>
<td>CAB8</td>
<td>Antenna VHF, UHF or GPS</td>
<td>RG213 / CNT400</td>
<td>30 m</td>
</tr>
<tr>
<td>CAB9</td>
<td>Single Phase Power</td>
<td>2C + E</td>
<td>Distance dependant on power demand and conductor cross sectional area.</td>
</tr>
<tr>
<td>CAB10</td>
<td>Three Phase Power</td>
<td>3C + E</td>
<td>Distance dependant on power demand and conductor cross sectional area.</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Please confirm distance limitations with Trelleborg engineers as actual configurations can affect maximum distances.
2. Construction and armoring of cable dependant on regional installation requirements.
3. Trelleborg to be notified where neutral can not be provided with three phase power.
Industry Guidelines Codes and Standards

The following tables provide a listing of industry guidelines, standards and codes applicable to Trelleborg Marine Systems.

**Applicable Standards** – Standard to which the Trelleborg business process or product has been developed in accordance with.

**Trelleborg Specifications** – Internal Trelleborg document detailing explicit set of requirements to be satisfied by a material, product, or service. Typically based on an internationally recognized standard.

### QUALITY MANAGEMENT SYSTEM

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>QM0001 - Integrated Management System Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Standards</td>
<td>AS/NZS ISO 9001 Quality Management System - Requirements</td>
</tr>
<tr>
<td></td>
<td>AS/NZS 14001 Environmental Management System</td>
</tr>
</tbody>
</table>

### INDUSTRY GUIDELINES

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Standards</td>
<td>OCIMF MEG3 - Mooring Equipment Guidelines</td>
</tr>
</tbody>
</table>

### CASTINGS – ALLOY CAST STEEL (QRH COMPONENTS)

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Standards</td>
<td>ASTM A148-05 Standard Specification for Steel Castings, High Strength, for Structural Purposes. (Grade 115-95) AS2074-2003 Cast Steels. (Grade. LB6-2)</td>
</tr>
</tbody>
</table>

### CASTINGS – SPHEROIDAL GRAPHITE IRON (HOOK BASES)

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>D00108 – Cast Base Process Map D00059 – Cast Base Heat Bars D00109 – Tensile Test Report D00095 – Cast Base NDT D00086 – Cast Base Dimension Checks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Standards</td>
<td>ASTM A536-2004 Standard Specification for Ductile Iron Castings (Grade 65/45/12) AS1831 Ductile Cast Iron. (Grade 400/12)</td>
</tr>
</tbody>
</table>
# Industry Guidelines Codes and Standards

## MILD STEEL PLATE (HOOK FRAME)

| Trelleborg Specifications | D00113 – Hook Machining Process Map  
D00118 – Hook Steel Traceability |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Standards</td>
<td></td>
</tr>
<tr>
<td>ASTM A572</td>
<td>Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel. (Grade 50)</td>
</tr>
<tr>
<td>AS3678-2011</td>
<td>Structural steel - Hot-rolled plates, floor plates and slabs. (Grade 350)</td>
</tr>
</tbody>
</table>

## PINS AND SHAFTS

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Standards</td>
<td>ASTM A56/A564M Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes. (Grade 630)</td>
</tr>
<tr>
<td></td>
<td>AS2837-1986 Wrought alloy steels - Stainless steel bars and semi-finished products. (Grade 630)</td>
</tr>
<tr>
<td></td>
<td>ASTM A29/29M Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements. (Grade 4140)</td>
</tr>
<tr>
<td></td>
<td>AS1444-1996 4140 Wrought alloy steels - Standard, hardenability (H) series and hardened and tempered to designated mechanical properties. (Grade 4140)</td>
</tr>
</tbody>
</table>

## NON-DESTRUCTIVE TESTING OF CASTINGS

| Trelleborg Specifications | D00153 - Hook Casting Component Non-Destructive Testing  
D00095 - Cast Base Non-Destructive Testing |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASTM E1444-05 Standard Practice for Magnetic Particle Testing</td>
</tr>
<tr>
<td></td>
<td>ASTM A370-07a Standard Test Methods and Definitions for Mechanical Testing of Steel Products.</td>
</tr>
<tr>
<td></td>
<td>AS3998 Non-destructive testing - Qualification and certification of personnel.</td>
</tr>
</tbody>
</table>
## Industry Guidelines Codes and Standards

### Fabrication Construction & Testing of Steel Structures

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>D00128 - Fabrication Construction Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applicable Standards</strong></td>
<td></td>
</tr>
<tr>
<td>AS 1554.1</td>
<td>Structural steel welding – Part 1: Welding of steel structures.</td>
</tr>
<tr>
<td>AS 2207</td>
<td>Non-destructive testing - Ultrasonic testing of fusion welded joints in carbon and low alloy steel.</td>
</tr>
<tr>
<td>AS 1171</td>
<td>Non-destructive testing - Magnetic particle testing of ferromagnetic products, components and structures.</td>
</tr>
</tbody>
</table>

### Protective Coatings - Steel & Iron

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>D00135 - Standard Paint Specification for Steel &amp; Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applicable Standards</strong></td>
<td></td>
</tr>
<tr>
<td>AS 1627.4</td>
<td>Preparation and pretreatment of surfaces - Abrasive blast cleaning of steel.</td>
</tr>
<tr>
<td>AS 3894.3</td>
<td>Site testing of protective coatings - Determination of dry film thickness.</td>
</tr>
</tbody>
</table>

### Structural Design

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applicable Standards</strong></td>
<td></td>
</tr>
<tr>
<td>AS4100</td>
<td>Steel Structures.</td>
</tr>
<tr>
<td>AS3990</td>
<td>Mechanical Equipment Steelwork.</td>
</tr>
</tbody>
</table>

### Fasteneners

<table>
<thead>
<tr>
<th>Trelleborg Specifications</th>
<th>D00094 – Anchor Bolt Manufacturing and Traceability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applicable Standards</strong></td>
<td></td>
</tr>
<tr>
<td>BS4190</td>
<td>ISO metric black hexagon bolts, screws and nuts. Specification. (Grade 8.8)</td>
</tr>
<tr>
<td>ISO 3506</td>
<td>Mechanical properties of corrosion resistant stainless steel fasteners.</td>
</tr>
</tbody>
</table>
### Industry Guidelines Codes and Standards

#### Electrical Equipment for Explosive Atmospheres

<table>
<thead>
<tr>
<th>Applicable Standards</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC60079/EN60079</td>
<td>Parts 1 - 28 Explosive Atmospheres.</td>
</tr>
</tbody>
</table>

#### Packaged Electrical Equipment

<table>
<thead>
<tr>
<th>Applicable Standards</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS/NZS 3000</td>
<td>Electrical installations.</td>
</tr>
<tr>
<td>AS/NZS 3008.1.1</td>
<td>Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV - Typical Australian installation conditions.</td>
</tr>
<tr>
<td>IEC60529</td>
<td>Degrees of Protection Provided by Enclosures.</td>
</tr>
</tbody>
</table>

#### Environmental Monitoring Systems

<table>
<thead>
<tr>
<th>Applicable Standards</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMO - No. 8</td>
<td>Guide to Meteorological Instruments &amp; Methods of Observation.</td>
</tr>
</tbody>
</table>

#### Wireless Communication

<table>
<thead>
<tr>
<th>Applicable Standards</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60945</td>
<td>Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results.</td>
</tr>
</tbody>
</table>

#### Satellite Navigation Systems

<table>
<thead>
<tr>
<th>Applicable Standards</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61108</td>
<td>Maritime navigation and radio communication equipment and systems – Global navigation satellite systems (GNSS).</td>
</tr>
</tbody>
</table>
Classification Societies

QRH and other mooring fittings used on board of vessels for offshore applications in tandem, spread or ship-to-ship mooring are required to comply with stringent design and quality requirements to ensure the structural integrity of the ship is met. These are applicable for FPSOs/FSOs, FLNG and FSRUs/FSUs and any offshore facility.

Trelleborg mooring fittings for offshore applications are designed in compliance with:

1. OCIMF Mooring Equipment Guidelines MEG-3
2. IMO MSC / 1175 (Guidance on Ship Towing and Mooring)
3. Classification Societies Rules as applicable including:
   a. DNV-GL
   b. American Bureau of Shipping (ABS)
   c. Bureau Veritas (BV)
   d. Registro Italiano Navale (RINA)
   e. Lloyds

The mooring system will be provided with a “Product Certificate” issued by the relevant classification society as assigned by the ship owner. The Product Certificate covers the following compliance requirements:

<table>
<thead>
<tr>
<th>SURVEY</th>
<th>COMPLIANCE REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design survey conducted</td>
<td>The mooring fitting, its support structure holding down bolts and foundation plate must satisfy the design rules of the classification society. See picture on the right. The design is then assessed by the classification society. When approved, a “Design Verification” document is issued to demonstrate compliance.</td>
</tr>
<tr>
<td>Manufacturing survey</td>
<td>A surveyor deputed by the classification society inspects each manufacturing step to ensure compliance with class rules from a material testing and traceability points of view. These inspection activities are: a. Witness plate cutting b. Sample stamping c. Witness sample testing d. Welding qualification e. Witness welding testing f. Casting or forgings process witness and sample cutting g. Witness sample testing for castings or forgings Each inspection activity is documented by a “Statement of Fact” issued by the surveyor. At the conclusion of this step, a “Manufacturing Survey” document is issued detailing the inspection activities in accordance with class rules and as specified in the design verification document.</td>
</tr>
<tr>
<td>Hook proof load and calibration witness</td>
<td>A surveyor deputed by the classification society witnesses the proof load of each mooring fitting to the nominated proof load and the calibration process to the safe working load. A “Proof Load and Calibration Certificate” is then issued to document this step. The proof load and calibration certificate is also a statement of fact.</td>
</tr>
<tr>
<td>Manufacturing Documentation Records (MDR) review</td>
<td>In this step, all documents issued above are compiled and reviewed by the classification society to ensure full compliance. Any of the documents issued in the previous steps does not demonstrate compliance on its own. Only a “Product Certificate” does that once all records have been checked by the surveyor.</td>
</tr>
</tbody>
</table>
1 Foundation plate
2 Support structure
3 Mooring fitting

Image courtesy of OLT Offshore LNG Toscana
**Trelleborg Quality Management**

Mooring fittings are critical for the operation of a terminal. Failure of any component can have a significant impact on the safety of the personnel, port infrastructure and vessels. The cost to human life and assets is catastrophic. Therefore, the selection of reliable mooring equipment is crucial

Trelleborg has a global supply chain to deliver to our customer the best quality product at a competitive price. Trelleborg’s quality system exceeds the requirements of international standards and includes many tests and check points before the final product is delivered to site.

**PRODUCT QUALITY**

While ISO 9001 accreditation provides a certain level of confidence in accredited suppliers, practical experience shows that this alone does not guarantee purchasing a quality product.

Trelleborg has put in place a quality system that ensures the quality of its products, focusing on the following aspects:

1. **Material specification**: The material mechanical properties and chemical composition is in line with specifications.

2. **Material integrity**: Depending on the manufacturing method - whether the material is machined, formed, cast or fabricated, correct manufacturing procedures complying with international standards must be followed.

3. **Size**: The product dimensions and weight are an important factor of conformance. Checkpoints are put in place to ensure any non-conformance is picked up and rectified in a timely manner.

4. **Functionality**: The product must be fit for the purpose for which it’s intended to be used.

Traceability of samples and product material is ensured throughout the manufacturing process.

To ensure the quality of supplied products, the following steps are taken:

**SUPPLIER EVALUATION**

Every supplier must be evaluated according to a set of corporate rules including a review of their quality accreditation, track record and ability to sustain and support their product and ethical responsibility.

These aspects are reviewed in rigorous processes following strict procedures by our purchasing and quality personnel.

**ONGOING SUPPLIER EVALUATION**

All suppliers are reviewed on periodic basis against a number of criteria including compliance with specifications, on time delivery, quality control procedures and quality documentation.
Trelleborg Quality Management

MATERIAL TRACEABILITY

To maintain traceability, Trelleborg goes above and beyond the requirements of international standards and codes and industry practices. To ensure full traceability, Trelleborg uses its own employee or an internationally recognized third party (e.g. Lloyds, SGS, BV … ) to witness the cutting of test samples. Major structural components such as hooks and bases include a built-in test sample that is extracted from the finished product and is available to our customer for testing purposes.

MATERIAL SPECIFICATION

To ensure compliance with material specifications, the following tests are conducted for structural components:
- Mechanical and chemical testing of samples by manufacturer
- Mechanical and chemical testing of samples by internationally recognized third party
- Random mechanical and chemical testing of samples by Trelleborg

SIZE

All products are dimension checked by Trelleborg to ensure compliance with the requirements.

FUNCTIONALITY

A range of tests and checks is conducted in accordance with our inspection and test plan specially designed for each project.

MATERIAL INTEGRITY

To ensure the integrity of the material produced, the following tests are put in place:
- Non-destructive testing of 100% of cast components (MPI and/or Ultrasonic)
- Random radiographic testing for a full scan on selected batches
- For all QRH:
  - Proof load testing of assembled hooks to 125% or 150% of its safe working load three times
  - Releasing the assembled hook at the nominated safe working load
DISCLAIMER

Trelleborg AB has made every effort to ensure that the technical specifications and product descriptions in this catalog are correct.

The responsibility or liability for errors and omissions cannot be accepted for any reason whatsoever. Customers are advised to request a detailed specification and certified drawing prior to construction and manufacture. In the interests of improving the quality and performance of our products and systems, we reserve the right to make specification changes without prior notice. All dimensions, material properties and performance values quoted are subject to normal production and testing tolerances. This catalog supersedes the information provided in all previous editions. If in doubt, please check with Trelleborg Marine Systems.

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For a smarter approach to your next project, get in touch today.

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Trelleborg is a world leader in engineered polymer solutions that seal, damp and protect critical applications in demanding environments. Its innovative solutions accelerate performance for customers in a sustainable way.

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