

# RECOMMENDED MINIMUM SAFETY FEATURES FOR QUAY CONTAINER CRANE

A joint initiative from TT Club, ICHCA International and Port Equipment Manufacturers Association

This paper covers the main recommended safety features for quay container cranes that are not specifically described in national or international standards. It aims to inform terminal operators and OEMs about minimum safety features of quay container cranes to support them with retrofit and greenfield projects.



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# PREFACE

In a concerted effort to reduce injuries and loss of life, as well as to reduce damage and delays to port and terminal operations worldwide, TT Club, ICHCA International and the Port Equipment Manufacturers Association (PEMA) agreed in 2010 to jointly develop a set of recommended safety features as a minimum standard for all quay container cranes.

The genesis for the project was a TT Club global analysis of insurance claims by ports and terminals, which revealed that 34 per cent of the cost of asset-related claims worldwide was directly related to quay container cranes.

While a range of technologies now exist that can significantly improve the performance of quay container cranes, and help address some of the most common causes of accidents and claims, many of these features are not currently included as standard on new cranes.

The three organisations therefore set out to identify and recommend a baseline specification for quay container cranes in relation to safety features that should be included in specifications, tenders and quotations for new quay container cranes.

This document, first published in June 2011, is the result of this joint working initiative, and is intended for buyers and suppliers of quay container cranes. Subsequent revisions reflect improvements in language, clarity on risks and available mitigation options and other refinements from the original document based on best practice.

The recommendations provided here do not carry any force of law, and are independent of the various local, national and international regulatory regimes on the safe design, manufacture, specification and operation of cranes, which must be adhered to.

The goal of all three parties, however, is that the safety features outlined here will be embraced by buyers and suppliers as a voluntary industry standard.

## ABOUT TT CLUB

TT Club is the international transport and logistics industry's leading provider of insurance and related risk management services. Established in 1968, the Club's membership comprises vessel operators, ports and terminals, road, rail and airfreight operators, logistics companies and container lessors.

As a mutual insurer, the Club exists to provide its policyholders with benefits, which include specialist underwriting expertise, a worldwide office network providing claims management services, and first class risk management and loss prevention advice.

[ttclub.com](http://ttclub.com)

## ABOUT ICHCA INTERNATIONAL

ICHCA International is the only global association dedicated to the promotion of safety and efficiency in the handling and movement of goods by all modes and throughout the supply chain.

Originally established in 1952 and incorporated in 2002, the Association operates through a series of Local, National and Regional Chapters, Panels, Working Groups and Correspondence Groups and represents the cargo handling world at various international organizations, including the International Maritime Organization (IMO), United Nations Conference on Trade and Development (UNCTAD), International Labour Organization (ILO) and the International Organization for Standardization (ISO).

ICHCA International members include ports, terminals, transport companies and other groups associated with cargo handling and coordination. Members of its Panels represent a substantial cross-section of senior experts and professionals from all sectors of the cargo transport industry globally.

Members benefit from consulting services and informative publications dealing with technical matters, best practice advice and cargo handling news.

This document is assigned the number GS#7 in the ICHCA International General Series of publications.

[ichca.com](http://ichca.com)

## ABOUT PEMA

The Port Equipment Manufacturers Association (PEMA) was established in 2004 to provide a forum and public voice for the global port equipment and technology sectors, reflecting their critical role in enabling safe, secure, sustainable and productive ports, and thereby supporting world maritime trade.

Chief among the aims of the Association is to foster good relations within the world port equipment and technology community, by providing a forum for the exchange of views on trends in design, manufacture and operation of port equipment and technology.

PEMA also promotes and supports the global role of port equipment and technology by raising awareness with customers, the media and other stakeholders; forging relations with other port industry associations and bodies; and contributing to best practice initiatives and information.

PEMA's growing membership represents a cross-section of port equipment OEMs, suppliers of components including brakes, cable reels, controls, drive systems, tyres and more, providers of software, systems and other advanced technologies, and expert consultants in the field of port equipment and technology.

[pema.org](http://pema.org)

# 1 | INTRODUCTION

With more than 2,000 insured operations, including over 400 ports and terminals globally, the claims data gathered by TT Club provides a real perspective of the types and causes of accidents globally. An analysis of TT Club claims globally for ports and terminals for the five years from 2014 to 2018, as shown in Figure 1, identified that 24 per cent of costs are related to quay container cranes.

The global cost analysis of claims in ports and terminals was the catalyst for this paper, which recommends minimum safety features that can minimise or entirely prevent some of the most common causes of accidents involving this type of port equipment. In 2018, when the first edition of this document was published, the total percentage cost of global asset claims related to quay container crane accidents over the previous five years was 34 per cent. As indicated, by 2018, this figure had fallen to 24 per cent.

We believe that this document has contributed to this reduction. However, preventable incidents continue to occur. Therefore, we need to continue to make the industry aware of these minimum safety features.

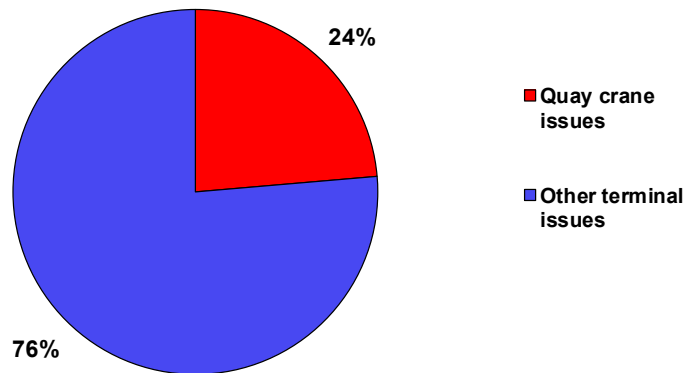


Figure 1: Global cost analysis of claims in ports and terminals (2014-2018)

The TT Club global analysis of quay crane claims data identified the leading causes of accidents and failures as shown in Figure 2:

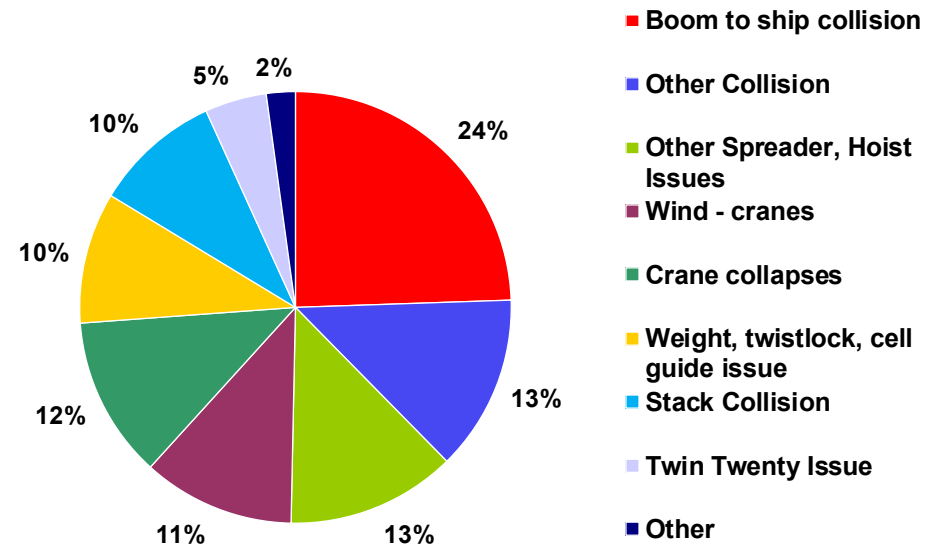


Figure 2: Global cost analysis of quay crane claims (2014-2018)

Each of the major causes of quay crane claims is described in further detail below, along with suggested ways to reduce the frequency of accidents in future.

### 1.1 BOOM COLLISIONS

Boom-to-vessel collisions are the single largest cost of quay crane claims. For example, a boom collision several years ago that bent the crane boom took six months and US\$2m to repair and caused a further US\$6m in lost revenue. See figures 3 & 4 for examples of damage typical to this type of incident. Many cranes have a trip wire boom collision prevention system that leads terminal operators to believe that they are protected from this sort of accident. However, trip wire systems tend to be maintenance-intensive, and depending on the speed of the gantry, can be ineffective in stopping the crane before a collision has occurred. The best proven technologies are electronic sensors or systems that provide coverage for a minimum of two zones, for example warning or/ with slow down and stop signals.



### 1.2 CRANE COLLAPSES

Quay crane structural integrity issues and crane collapses are not included in the minimum safety features list of this paper as it is not something that is specifically included in crane specifications as it is basically a maintenance issue. However, these issues are highlighted because structural failure is the third biggest insurance claim cost for quay cranes. Not only can this type of equipment failure be very costly in terms of repairs and operational down-time, but it can result in serious accidents and personal injuries.

It is essential for operators of ports and cargo handling facilities to establish and follow a regular schedule of maintenance and thorough examination of all the lifting appliances. Provisions for such examinations are specified in ILO Convention 152 and its accompanying Code of Practice, and together represent the international standard for the port industry. The purpose of a thorough examination is to ensure that cranes can continue to function safely and effectively. The integrity of cranes' structure is crucial to this.

It is also recommended that an independent examination is always performed when procuring any type of crane. The ILO Convention requires that, prior to commissioning, lifting appliances are tested, and thoroughly examined. It is also recommended that appropriate mechanical and electrical inspections are carried out, during manufacture and commissioning, to check quality and conformance to standards and specifications – beyond any ILO Convention requirement. Once commissioned, a crane should be examined regularly during its operational life regardless of crane type, condition, environmental conditions, etc. Damage resulting from relatively minor impacts, regular heavy-lifts close or equal to safe working load limits, intensive use and general wear and tear can affect the integrity of a crane's structure.

Often, such operational issues can arise without anybody being aware of them so regular examinations need to be conducted. Any reported incident should prompt an immediate examination of a crane's structural integrity. This advice applies not just to quay cranes but equally to fixed and mobile cranes of all types.

### 1.3 WIND DAMAGE

Wind damage, primarily involving cranes being blown along rails, is the largest preventable weather damage cost. While operating and securing procedures are a significant issue in reducing this type of accident, equipment type and design can reduce such claims. See Figures 5 & 6 for examples of equipment damage caused by wind.



Figures 5 & 6: Examples of wind damage



### 1.4 OTHER COLLISIONS

Other collisions include gantry and hatch cover collisions, spreaders and containers colliding with handrails, crane legs, and other mobile equipment.

### 1.5 HOIST, WEIGHT, TWISTLOCK, CELL GUIDE ISSUES

Spreaders and cell guides tend to be the most intensively used items of equipment in a terminal and as such require regular inspections and frequent preventative maintenance in accordance with manufacturers' (or Class) specifications. Recent advances in twistlock load sensing technologies can help mitigate some of these types of incidents. Many of the incidents where containers are stuck in cell guides are the result of poorly loaded containers tipping from the horizontal near the top of cell guides. Twistlock load sensing can detect eccentricity and allow side shifting of the spreader to level the container to prevent jamming. Besides weight and eccentricity measurement, this technology also detects whether all twistlocks have engaged and prevent hoisting if they have failed to do so.

### 1.6 STACK COLLISIONS

This is where the spreader, or a container under the spreader, collides with another container on the vessel. This can result in one or more containers being knocked from the stack, falling in the water or falling on the quay deck and causing container, cargo and equipment damage and often injuries.

### 1.7 TWIN TWENTY ISSUE

Accidents commonly occur when two (2) twenty foot containers in a hatch are lifted with the spreader in 40' mode. When nearing the top of the hatch, the middle ends of the two twenty foot containers risk dropping. This can result in damage to the cell guides, container damage, cargo damage and crane damage. Lengthy operational delays also result, especially if containers become stuck in cell guides.

## 2 | THE NEED FOR A NEW APPROACH

Technological solutions are now available for quay container cranes that dramatically improve safety and help address the issues outlined in Section 1. However, many of these features are not currently included as standard on new cranes.

TT Club, PEMA and ICHCA International are committed to supporting and promoting technological advances that will enhance safety and performance in port environments. For example, TT Club has recommended the installation of electronic boom anti-collision systems costing up to USD 24,000, which have been proven to prevent significant damage costs and business disruption that could cost as much as USD 8,000,000. These electronic systems also enhance safety for crane drivers, stevedores and vessel crews.

Based on the latest technologies now available, this joint initiative aims to provide the industry with a benchmark for minimum safety features that can be incorporated into specifications and quotations during the new crane procurement process. The entire recommended list of these safety features is shown in Figure 7 and Table 1. Just like seat belts in cars, such features, which have been proven to reduce injury and damage, should be standardized and not offered as optional extras.

Inevitably, crane procurement is price sensitive, requiring a significant budget, and buyers will not always be familiar with the most effective safety technologies. Furthermore, the process is frequently complex. Any quote needs to be carefully assessed against the invitation to tender, and subsequent change requests can be costly. For these reasons, all tender specifications should provide a standard safety baseline.

This document recommends that the features outlined below should be included in the tender specifications developed by buyers, and should also be listed as standard in initial quotations from suppliers, rather than as optional extras. The resulting safety enhancements will reduce injuries and damage costs over the life of the crane, and improve the reputations of both the container terminal and crane industries through the increased focus on safety.



### 3 | RECOMMENDED MINIMUM SAFETY FEATURES

All relevant stakeholders have been involved in the development of this project. PEMA represents the container crane and technology suppliers, and TT Club and ICHCA International represent the container terminals. Each group has liaised with its members to ensure input and ownership from all and the best result.

Crane manufacturers that choose to include the recommended minimum safety features in their initial quotation, and not as optional, will now be entitled to state in their tender quotation:

“This tender quotation includes all the minimum safety features recommended by the TT Club, ICHCA International and PEMA”.

The recommended minimum safety features, as shown in Figure 7 and listed in Table 1, are not all-inclusive, but rather a shortlist of key safety features that are both practical and effective to address commonly occurring risks associated with quay container cranes. Based on experience, accident records and analysis of insurance claims, this list covers the systems, structures, features, equipment and technology that have been most proven to reduce injury or damage, and which may not be currently provided as standard features, and often only offered by quay crane manufacturers as an option. Functional requirements for each respective item have been added to ensure that each respective risk is reduced.

The aim is for suppliers to include as standard, not as optional, the features on this list in all their quotations. Terminals and buyers are also recommended to include these features in their tender specifications. Many, if not all, of these safety features can be retrofitted to existing cranes and this is also highly recommended. Existing international, national and/or local regulatory standards must be also be satisfied.

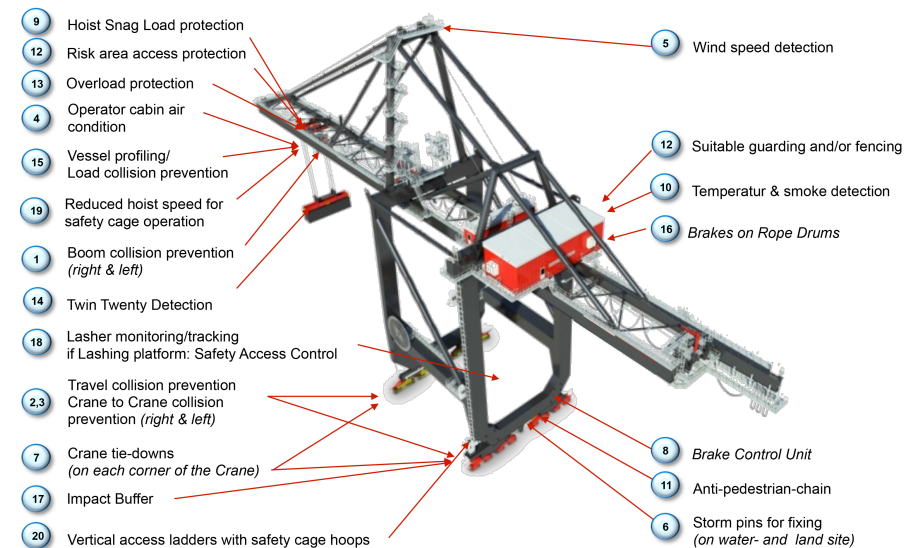


Figure 7. Recommended minimum safety features for quay container cranes

## RECOMMENDED QUAY CONTAINER CRANE MINIMUM STANDARD SAFETY FEATURES

	RISK	SAFETY FEATURE	FUNCTIONAL REQUIREMENT
1	BOOM COLLIDING WITH BERTHED VESSEL	ELECTRONIC BOOM COLLISION PREVENTION SYSTEM	<ol style="list-style-type: none"> <li>1. A minimum of two detection zones: <ul style="list-style-type: none"> <li>• Warning or slow down</li> <li>• Electrical stop</li> </ul> </li> <li>2. Detection range to detect an object, e.g. an antenna, shall be such that it will allow enough time for the crane to come to a "normal" stop. Annual test of stopping distance required due to wear, tear and aging of the braking system.</li> <li>3. Suitable electronic sensors or systems designed specifically for this application must be used. Lanyard or tripwire systems are inadequate.</li> <li>4. Suitable electronic sensors or systems must be installed correctly and maintained properly by certified or approved installers to ensure proper functioning.</li> </ol>
2	GANTRY COLLIDING WITH OBJECTS ON RAIL TRACKS OR VICINITY WHILE TRAVELLING	ELECTRONIC TRAVEL COLLISION PREVENTION SYSTEM	<ol style="list-style-type: none"> <li>1. A minimum of two detection zones: <ul style="list-style-type: none"> <li>• Warning or slow down</li> <li>• Electrical stop</li> </ul> </li> <li>2. Detection range shall be such that it will allow enough time for the crane to come to a "normal" electrical stop. Annual test of stopping distance required due to wear, tear and aging of the braking system.</li> <li>3. Suitable electronic sensors or systems must be installed correctly and maintained properly by certified or approved installers to ensure proper functioning.</li> </ol>

	RISK	SAFETY FEATURE	FUNCTIONAL REQUIREMENT
3	ADJACENT CRANES COLLIDING WHILE TRAVELLING	ELECTRONIC CRANE TO CRANE COLLISION PREVENTION SYSTEM	<ol style="list-style-type: none"> <li>1. A minimum of two detection zones: <ul style="list-style-type: none"> <li>• Warning or slow down</li> <li>• Electrical stop</li> </ul> </li> <li>2. Detection range shall be such that it will allow enough time for the crane to come to a "normal" electrical stop. Annual test of stopping distance required due to wear, tear and aging of the braking system.</li> <li>3. Suitable electronic sensors or systems must be installed correctly and maintained properly by certified or approved installers to ensure proper functioning.</li> </ol>
4	CRANE DRIVERS ADVERSELY AFFECTED BY VESSEL STACK EMISSIONS OR OTHER AIR POLLUTANTS	OPERATOR CABIN AIR CONDITIONING	The cabin shall be provided with a proven positive pressurised air filtration system with high efficiency particulate and gas absorbers, or similar, to protect the operator from harmful emissions from vessels' stacks or other air pollutants.

	RISK	SAFETY FEATURE	FUNCTIONAL REQUIREMENT
5	DAMAGE AND INJURY CAUSED BY OPERATING CRANES IN HIGH WINDS	WIND SPEED DETECTION AND ALARM TO ENABLE DRIVER TO STOP THE OPERATION, PARK AND SHUT DOWN THE CRANE SAFELY	<p>1. An anemometer shall be installed in clear air at the top of the crane, giving an indication in the driver's cab, both audible and visual, that the safe operating wind limit has been reached.</p> <p>2. An audible alarm shall also be installed to indicate to persons on the berth that this limit has been reached.</p> <p>3. The anemometer shall be capable of recording well over the expected worst case winds. The wind speed, direction and time shall be recorded. The recommended maximum operating wind speed should be set at 18 - 19m/s (*) (depending on the design of the crane).</p> <p>(*) operating wind speeds at quay level are lower than at ground level because a super quay crane wind speed at 90m high is 3 to 4m/s more as at 10m high.</p> <p>4. Crane must not shutdown automatically, even if the alarm sounds continuously. This allows the crane to travel to the storm pin/ tie-downs.</p>
6	CRANES BLOWN ALONG CRANE RAILS	MEANS TO ENGAGE THE CRANE HORIZONTALLY ON RAILS	<p>Crane storm pins shall be installed at the centre of the crane under the sill beams on both waterside and landside and one or more corresponding locking positions on dock in distance reachable within the expected time to high wind condition.</p> <p>The storm pins, the mounting on the crane, and the pin sockets in the quay structure must all be designed to withstand the maximum forecast forces exerted.</p>

	RISK	SAFETY FEATURE	FUNCTIONAL REQUIREMENT
7	CRANES BLOWN OVER	MEANS TO ENGAGE THE CRANE VERTICALLY TO PREVENT WHEELS BEING DETACHED FROM RAILS	<p>Substantial crane tie-downs on each corner and one or more corresponding locking positions on the dock at a distance reachable within the expected time to high wind conditions.</p> <p>The tie-down connections on the crane, and the anchor points in the quay structure, must all be designed to withstand the maximum forecast forces exerted.</p>
8	RUNAWAY CRANE DUE TO SUDDEN HIGH WIND CONDITIONS	GANTRY BRAKING	<p>To facilitate driving to the parking position, the gantry drive braking system shall be designed to stop and hold the crane at a wind speed of 28m/s from behind. To secure cranes from sudden gusts during operation, cranes shall also be equipped with rail brakes, which shall be designed for wind speeds of 35m/s."</p> <p>Design shall account for uneven weight distribution so that the braking force transfers to the crane rails. This means no wheel skidding under normal braking.</p>
9	STRUCTURAL OR LIFTING SYSTEM DAMAGE CAUSED BY SNAGGED SPREADER OR CONTAINER	HOIST SNAG LOAD PROTECTION	Detection system to activate "fast stop" of the lifting system, and a system to absorb or isolate the kinetic energy in the lifting system, to prevent the excess of designed load in the lifting system.
10	ELECTRICAL OR MACHINE ROOM FIRE	TEMPERATURE AND SMOKE DETECTION IN THE ELECTRICAL AND MACHINE ROOM	Temperature and smoke detection alarm systems inside electrical control and machinery rooms that give audible and visual alarms in the driver's cabin, electrical and machinery rooms, outside the machinery house access door, near the entrance of the crane, and on the landside sill beam.

	RISK	SAFETY FEATURE	FUNCTIONAL REQUIREMENT
11	COLLISION WITH PEOPLE WALKING BETWEEN QUAY CRANE BOGIES	ANTI-PEDESTRIAN-BARRIERS BETWEEN THE BOGIES	Cranes shall be fitted with an anti-pedestrian-fixed barrier between the bogies to prevent bodily injuries.
12	FALLING OR JAMMING BETWEEN MOVABLE PARTS OF CRANE WHILE PERSONNEL ENTERING ENCLOSED RESTRICTED AREAS	PREVENT UNINTENDED ACCESS TO RISK AREAS USING SPRING SET SELF-CLOSING GATES AND SAFETY INTERLOCKS	<p>1. Spring set self-closing gates with positive means to open.</p> <p>2. Any access gates to risk areas, (i.e. boom/trolley, cabin/boom etc.), shall be interlocked to prevent access when not in parked positions, or when in operation, and to prevent crane operation when gate is open</p>
13	STRUCTURAL DAMAGE DUE TO OVERLOADING CONTAINERS	OVERLOAD PROTECTION	<p>Overload protection by load cells or similar means to prevent cranes lifting more than the rated eccentric load.</p> <p>Warning alarms, (audible and visual), to detect overload and prevent the lifting of a container if still connected to another container/trailer/chassis/wagon.</p>
14	DAMAGE TO CARGO, LIFTING EQUIPMENT, AND VESSEL DUE TO LIFTING OF 2 X 20-FOOT CONTAINERS WITH SPREADER IN 40-FOOT MODE	TWIN TWENTY DETECTION AT SPREADER	<p>Reliable electronic sensor measurement system to detect the gap between two containers and therefore detect the presence of 2x 20-foot containers instead of 1x 40-foot container while spreader is approaching to lift container.</p> <p>In case of detection of 2 x 20 foot containers when spreader is in 40-foot lifting mode, an alarm must be triggered and hoist lifting must be prevented.</p>
15	DAMAGE FROM CONTAINER OR EMPTY SPREADER COLLIDING WHILE LIFTING OVER STACKED CONTAINER AT THE VESSEL	VESSEL PROFILING OR LOAD COLLISION PREVENTION SYSTEM	Reliable electronic sensor measurement system to monitor vessel profiling while lifting/handling container over container stacked on the deck of a vessel and with additional support functions and software evaluation to prevent an empty spreader or container connected to the spreader colliding with other containers in the stack.

	RISK	SAFETY FEATURE	FUNCTIONAL REQUIREMENT
16	DROPPING LOADS OR BOOM DUE TO HOIST FAILURES	BRAKES ON ROPE DRUMS	Main Hoist and Boom Hoist drive trains to be equipped with (low speed) brakes on their rope drums. Rope drum brakes to be set on E-Stops and "speed mismatch" of gearbox input / output shaft, detected by the relevant speed encoders.
17	CRANE COLLISION	IMPACT BUFFERS ON CRANE GANTRY	Impact buffers to be installed on crane gantries to absorb the kinetic energy in case of collisions.
18	LASHER INJURED BY GROUND TRANSPORTATION OR SPREADER HIT	SAFE HUMAN MONITORING/ TRACKING TECHNOLOGY  (IN CASE OF LASHING PLATFORM: SAFETY ACCESS CONTROL)	<p>1. Safe human monitoring/tracking technology shall be a system that detects an active or passive tag, (on personnel's helmet or shoes), to be used to stop immediately any hazard/critical movements at the quay crane or ground transportation. The system shall be sufficiently reliable that it detects the tag in any metal covered or harsh environmental situation.</p> <p>2. In case of a lashing platform: entrances of lashing platforms shall be equipped with a safety access control technology, (e.g. safety light curtain) to ensure a safety stop of hazard spreader movement while lasher entering or working on the lashing platform.</p>
19	LASHER INJURED WHILE SAFETY CAGE OPERATION	REDUCED HOIST SPEED FOR SAFETY CAGE OPERATION	To ensure safe safety cage operation, the hoisting speed is automatically reduced to lower hoisting speeds by automatic sensor detection of the safety cage.
20	FALLS FROM ACCESS LADDERS	VERTICAL ACCESS LADDERS WITH SAFETY CAGE HOOPS	To prevent personnel falling from access ladders, vertical ladders shall be equipped with safety cage hoops.

\* Please consult local and national safety standards as these safety features may be required.

# NOTES

This document has been jointly developed by TT Club, ICHCA International and PEMA according to the information available at the time of publication. It does not constitute professional advice, nor is it an exhaustive summary of the information available on the subject matter to which it refers. This document should always be read and used in conjunction with the relevant national and international legislation and any applicable regulations, standards and codes of practice.

Every effort is made to ensure the accuracy of the information but neither TT Club, ICHCA International, PEMA, nor any of their members, is responsible for any loss, damage, costs or expenses incurred, (whether in negligence or not), arising from reliance on or interpretation of the data.

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