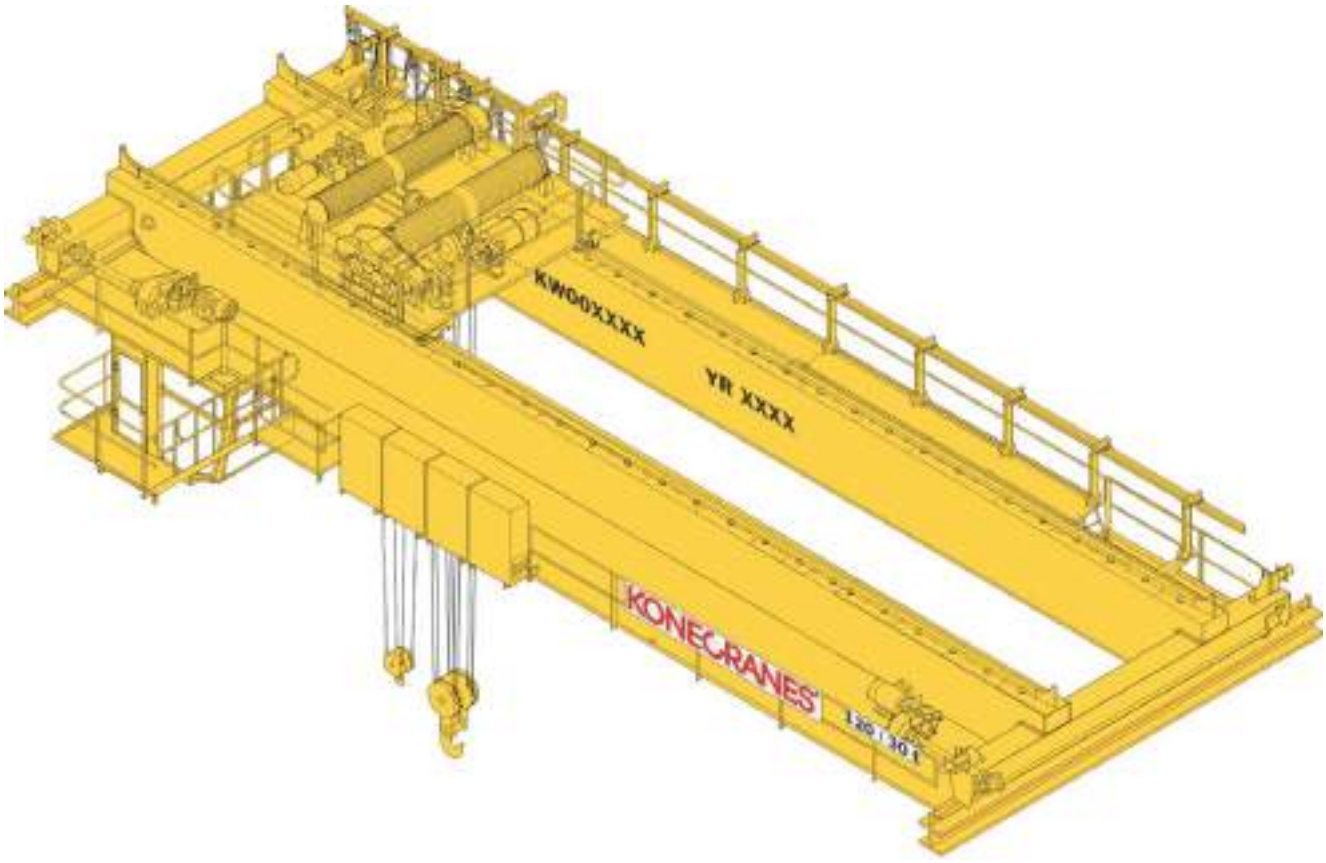
KONECRANES®
Lifting Businesses™

CRANE OWNER'S AND OPERATOR'S MANUAL



KC-IPC-002 / 18.09.2018

Original instructions

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1 GENERAL INTRODUCTION

1.1 Foreword: About this Manual

This manual offers guidance to enable safe, efficient operation and maintenance of the crane.

Taking the time to read this manual will help you to prevent damage to the crane, and, most importantly, personnel situated close to it. The crane is designed to be safe when used correctly. However, there are many potential hazards associated with incorrect operation and these can be avoided when you know how to recognize and anticipate them.

This manual will also make you aware of your responsibilities with respect to the crane and help you to ensure that it is kept in a safe operating condition throughout its lifetime.

This manual is not intended as a substitute for proper training but provides recommendations and methods for safe and efficient operation. The crane's owner must ensure that operators are properly trained prior to operation and, at all times, comply with all of the applicable and prevailing safety and other standards, rules and regulations.

1.2 Scope of this Manual

- This manual describes key parts of an EOT crane, various motions involved, general operation of an EOT crane, Identification data plates & Safety signs on a crane.
- Safety features on a crane for safe operation practices.
- Owner's responsibilities in terms of safe working conditions for the crane and training to operators & maintenance personnel to safely handle the crane.
- Operator's responsibilities in terms of safe working conditions for the crane, safe load handling practices and safety after crane usage.
- Safety during maintenance meaning precautions before & during maintenance of crane components.
- Hand signals and other methods of communication while operating cranes.
- Inspections to be carried out on a crane and respective frequencies of inspections.
- General lubrication instruction and chart which provides detailed information for Type of lubricants, method and frequency of lubrication. Also covers the lubrication points on different machineries on the crane in illustrative manner.
- General information of different types of controller devices (Chose the controller type that is supplied on your crane)
- Emergency Stop push button, Operational checks & setting on different controller devices.
- Tape pull chart for measuring crane span & trolley gauge.
- Disposal of waste materials- Care to be taken for protecting Environment.
- Spares & maintenance related services that Konecranes offers & recommends to customers, just for your information.
- Our branch offices and contact details.

1.3 Separate attachments with this manual

- Operation & maintenance instructions for all bought out components like Motors, Inverters, Geared motors, Air conditioners; Load handling devices (like Magnets, coil tongs, grab buckets), so on & so forth can be separately supplied along with this manual. Any specific information in those separate instruction manual supersede the relevant general contents of this Manual.
- Operation & maintenance instructions for Konecranes own manufactured components like Thrustor Brakes, Wheels, Gear Boxes, Pulley Blocks, Rope Drum components, Couplings, Limit Switches etc. can be separately supplied along with this manual. Any specific information in those separate instruction manual supersede the relevant general contents of this Manual.

1.4 Symbols Used in this Manual

Readers should familiarize themselves with the following symbols which are used in this manual.

1.4.1 General symbols

	Indicates that the crane is slowing down or is moving at its slowest speed.
	Indicates that the crane is accelerating or moving at its highest speed.
	Indicates items which require special attention by the reader.

1.4.2 Safety Alert Symbols

The following symbols are used in this manual to indicate potential safety hazards.

	Obey all safety messages that follow this symbol to avoid possible injury or death.
 CAUTION	Indicates a potentially hazardous situation, which if not avoided, MAY result in minor or moderate injury. It may also be used to alert against unsafe practices.
 WARNING	Indicates a potentially hazardous situation, which if not avoided, COULD result in death or serious injury.
 DANGER	INDICATES AN IMMINENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY.
NOTICE	Addresses situations not related to personal injury, such as likely or possible damage to crane.

1.4.3 Signal Words

Signal words used in this manual

Shall	Indicates that a rule is mandatory and must be followed.

Should	Indicates that a rule is a recommendation, the advisability of which depends on the facts in each situation.

1.5 Questions and Comments

Any questions or comments relating to the content of this manual and/or the operation, maintenance and/or service of manufacturer cranes should be directed to us through our URL:

http://www.konecranes.in/contact-us

1.6 Exclusion of Warranty

THE MANUFACTURER MAKES ABSOLUTELY NO WARRANTY WHATSOEVER WITH REGARD TO THE CONTENTS OF THIS MANUAL, EXPRESS OR IMPLIED, WHETHER ARISING BY OPERATION OF LAW OR OTHERWISE, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

1.7 Use of this manual

Every person exposed to the manufacturer's crane must, prior to OPERATING, SERVICING AND/OR MAINTAINING SUCH CRANES, read and understand the contents of this manual and strictly adhere AND CONFORM THEIR CONDUCT WITH AND TO THE INFORMATION, RECOMMENDATIONS AND WARNINGS mentioned herein.

Keep these instructions in a safe, accessible location for future reference by personnel operating the crane or exposed to the crane's operation.

	Read and understand the contents of this manual prior to operating, servicing, and or/maintaining the crane. Failure to do so can result in serious injury or death.

Manufacturer shall not be liable for and owner and READER shall release, and hold manufacturer, harmless from any and all claims, demands, AND damages, regardless of their nature or type losses and expenses , whether known or unknown, present or future, any and all liability, of and from any and all manner of actions, cause[s] of actions, all suits in law, in equity, or under statute, State or Federal, of whatever kind or nature, third party actions, including suits for contribution and/or indemnity on account of or in any way arising out of acts or omissions of the Owner or READER and relating in any way to this MANUAL or THE CRANES referenced herein, including, but not limited to the Owner's or READER'S use thereof or any other cause identified herein or that may be reasonably inferred HEREFROM.

1.8 Environmental Information

Environmental aspects have been taken into account in designing and manufacturing this crane. To prevent environmental risks during use, please follow instructions for safe lubricant handling and disposal of waste material. Proper use and maintenance improves environmental performance of this crane.

Energy Consumption

Energy consumption during the use phase is the biggest environmental impact. Electricity is needed for lifting and travelling motors as well as lighting, heating, cooling and other optional electrical components as part of the crane.

1.9 Terminology

The following terms and definitions may have been used in this manual:

Authorized personnel	Persons who are authorized by the owner and who have the necessary training to carry out operation or service actions.
Bridge	Main supporting structure of overhead type cranes over which the crab traverses, or structure between supports on portal and semi-portal cranes.
Check	A visual and functional assessment (not a test) of crane without dismantling.
Controller	The cabin (master controller), radio remote controller or pendant is used by the operator to give commands to the crane.
CT	Cross Traverse motion. Basically it is trolley travel motion.
DSL	Down Shop Lead, used for crane power supply.
Emergency stop button	Emergency stop button is used to stop all motions of crane in case of an equipment malfunction or other emergency situation.
Hoist	Drive mechanism for lifting and lowering the load.
Inspection	Looking at the crane for defects and checking the operation of the controls, limiting and indicating devices. This is much more than a check but does not normally require any part of the crane to be dismantled other than for removal or opening of covers or housings.
LT	Long Traverse motion. Basically it is crane travel motion.
Main isolation switch	The main isolation switch is used for disconnecting power supply for crane.
Maintenance	Maintenance is work that is carried out to preserve an asset (crane parts/components), in order to enable its continued use and function, above a minimum acceptable level of performance, over its design service life.
Manufacturer	It represents company which manufactures crane and delivers to customer.
Operator	The person who operates the crane in different motions for handling loads with crane controllers.
Owner	A party that possesses the exclusive right to hold, use and benefit from crane.
Runway	An assembly of rails, beams, girders, brackets, and framework on which a crane or trolley travels.
Service personnel	A person with service experience who is authorized by the crane manufacturer to perform service actions.
Storm lock (parking brake)	A brake that can be applied either automatically or manually and prevents linear motion of trolley or bridge travel.
Travel	Trolley transverse movement or crane longitudinal movement.
Trolley	Assembly designed to traverse the suspended load.

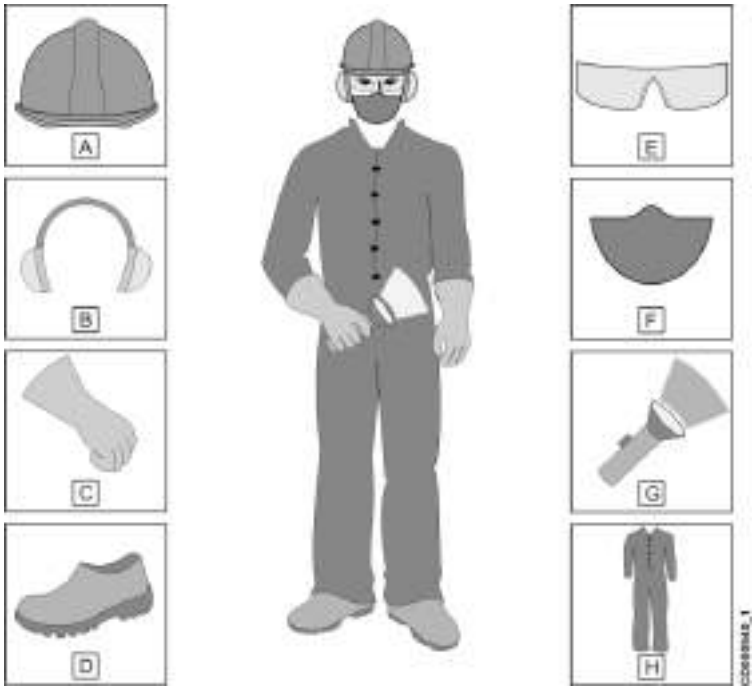
2 SAFETY FIRST!

Safety requirements must be understood and followed.

2.1 Personal Protective Equipment (PPE)

This chapter proposes personal protective equipment to ensure operator and persons working on or near crane. Local regulations and requirements of the working environment shall be followed.

For safety, the operator or whoever physically attend the crane or those in close proximity to the crane may be required to wear Personal Protective Equipment (PPE). Various types of PPE are available and must be selected according to the requirements of the working environment. Some examples of different types of PPE are:



Typical PPE
A. Hard hat (should be industrial helmet)
B. Hearing protection
C. Gloves
D. Safety shoes
E. Safety goggles
F. Face mask
G. Flashlight for use in case of power failure
H. Overalls

Appropriate clothing must be selected for each task. For example:

- Fire-resistant clothing must be worn when welding, flame cutting or using an angle grinder.
- Tear-resistant clothing must resist damage from sharp edges in the steel structure.
- Anti-static clothing must be worn when working on electrical circuits so that components do not get damaged by a discharge of static electricity.
- When working with lubricants, clothing must prevent direct skin contact with the lubricant.
- Clothing should be chosen with consideration to the temperature at the working site.

2.2 Fall Protection

While personnel are performing inspection or maintenance work at heights, they must follow fall protection procedures as required by local regulations. Fall prevention practices and fall protection equipment aim to protect personnel working on or around the crane from exposure to falls.

If the crane does not have a service platform or handrail, personnel must use a properly fitted safety harness that is attached to the dedicated fixing points on the building or crane in order to prevent falls.

If the crane does not have dedicated fixing points for fall protection, it is the owner's responsibility to make sure that there are suitable fixing points in the building structure.

If ladders must be used, personnel must practice setting and securing the ladders before using them for actual work.

A typical fall protection program may include:

- Documented and established site policies and procedures.
- Conducting site assessments for fall hazards.
- Selection of the proper fall protection system and equipment.
- Training on fall protection procedures and the proper use of fall protection systems.
- Inspection and proper maintenance of fall protection equipment.
- Measures to prevent falling objects.
- Rescue Plans.

If necessary, contact your supplier or service organization for assistance with designing your fall protection program.

2.3 Fire Safety

In the event of a fire, only attempt to fight it if you can do so without putting yourself in danger. Turn the power off if it is possible to do so. Evacuate the area. Notify other people about the potential danger, and call for help.

WARNING	Always use right type of fire extinguisher like Carbon Dioxide fire extinguishers on electrical equipments.

2.4 Main Isolation Switch

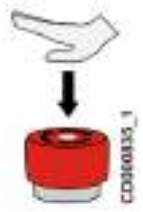
The crane can only be driven when power is turned on. The owner must identify and document the location and function of the **main isolation switch** and must communicate this information to all operators.

⚠ CAUTION	Owner/Operator shall be aware of main isolation switch functionality. Even though one switch is turned off, there may still be voltage present in some parts of the crane like lighting etc. This may result in exposure to electric shocks.

⚠	The operator shall not operate the crane unless he or she knows the location of the main isolation switch.

When the **main isolation switch** is turned on after being placed in the off position, the start-up procedure must be followed before the crane can be used.

2.5 Emergency Stop



In the event of an equipment malfunction or other emergency situation, all motions can be stopped immediately by pressing the red emergency stop button. In normal operation, the emergency stop button should not be used instead crane should be stopped by release of the speed command of controller/push button.

NOTICE	Only use the emergency stop button to stop movement in the event of a crane malfunction or other emergency situation. Using the emergency stop button can cause the load to swing unexpectedly.

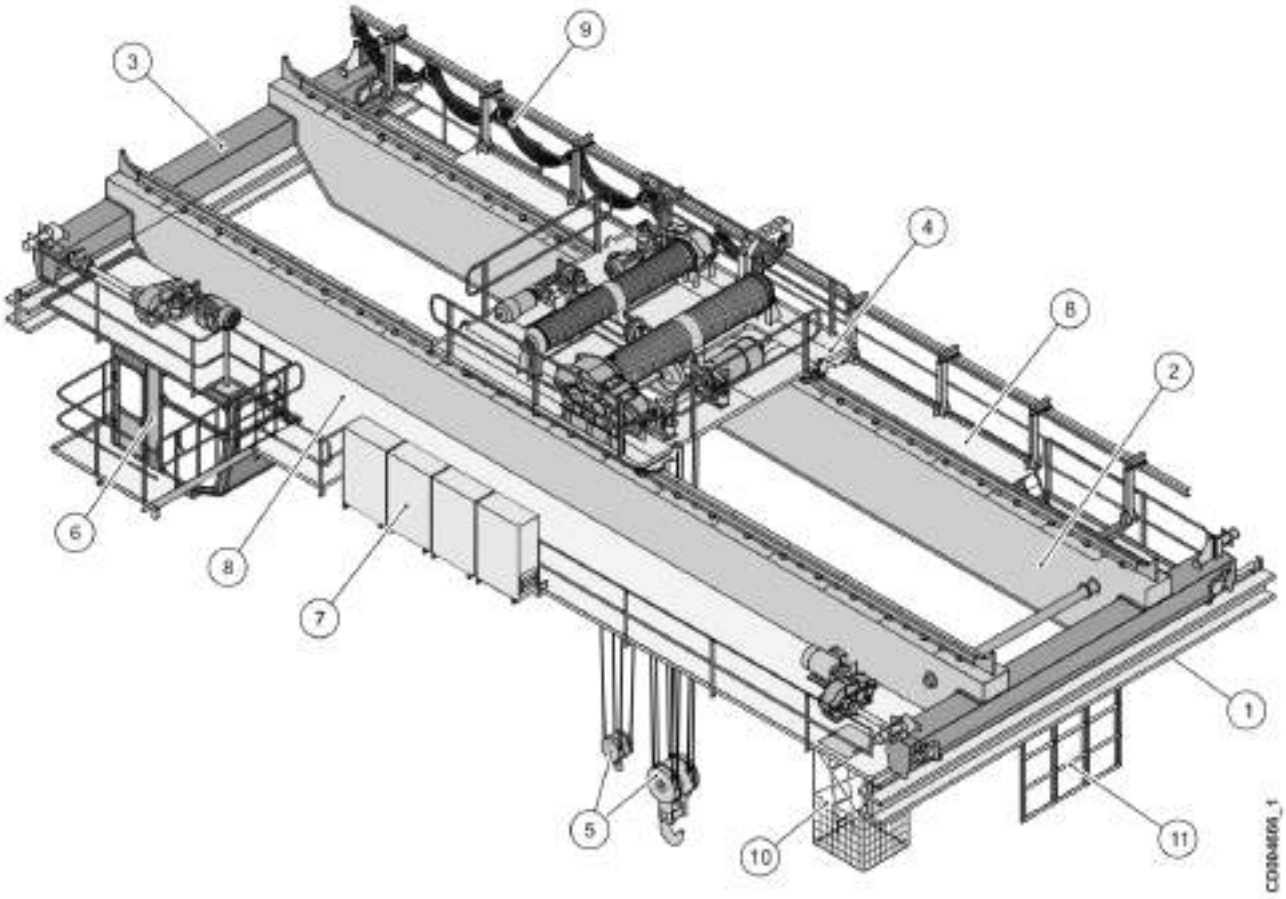
WARNING	Do not push the emergency stop button or turn off the crane if a if a free fall occurs on loaded hoist due to Brake Slip in unsafe area causing damage to person or property Raise alarm, Travel the loaded hook into a safe area and only then de–energize the crane for investigation.

	The operator shall not operate the crane unless he or she knows the location of the emergency stop button, other operating and safety controls.

3 CONSTRUCTION

3.1 Identifying Key Parts Of Your Crane

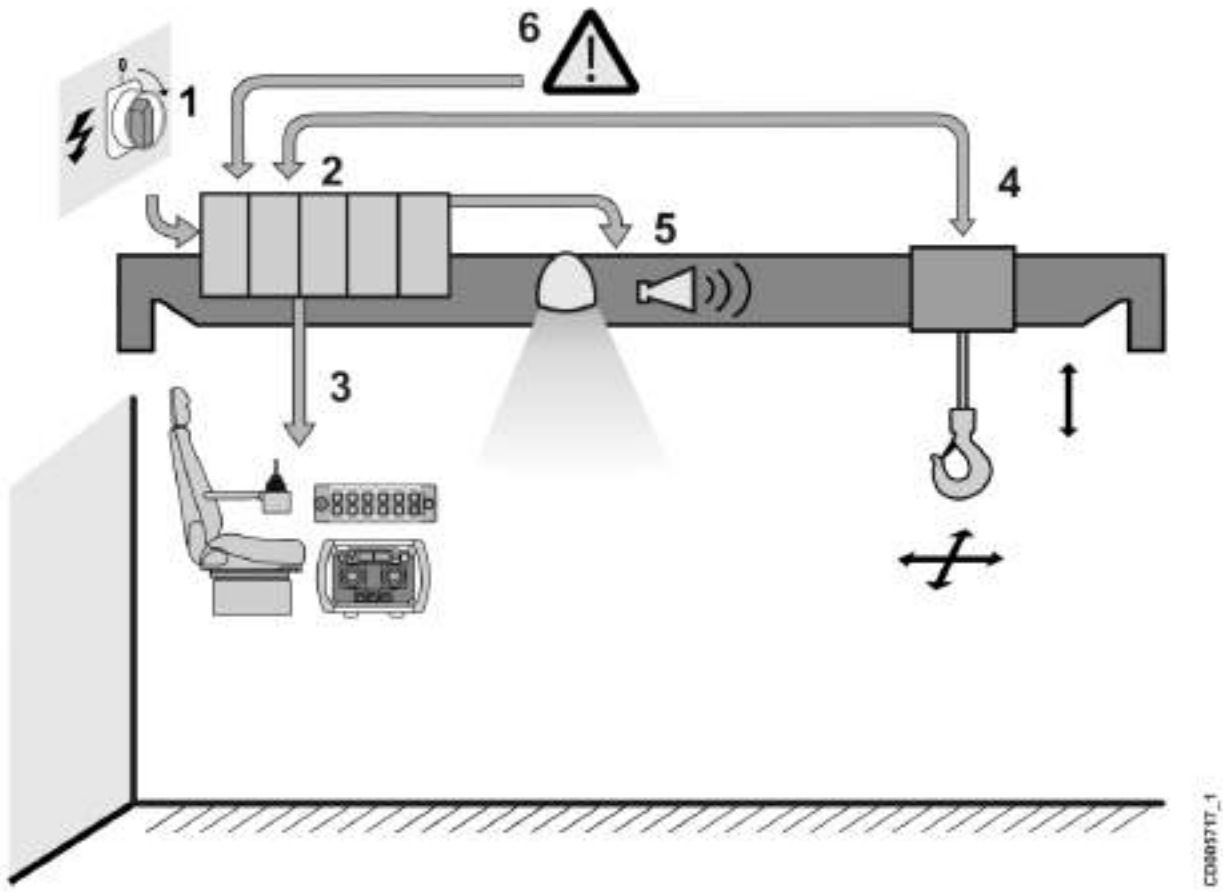
This illustration is provided as an example of a typical EOT crane only and may not be identical to the crane purchased by the owner. For example, the dimensions of the crane may be different and your crane may have additional equipment such as lighting, horns etc. Refer to the CAD drawings of the crane provided along with this manual.



No.	Part	Description
1	Runway	An assembly of rails, beams, girders, brackets, and framework on which a crane or trolley travels.
2	Bridge	Main supporting structure of overhead type cranes over which the crab traverses, or structure between supports on portal and semi-portal cranes.
3	End Carriages	Unit consisting of frame, wheels, bearings and axels that supports the bridge girders.
4	Trolley	Trolley comprises of hoisting machinery assembly and trolley traversing machineries that move the trolley along the bridge. There can be more than one trolley in the crane.
5	Lifting Device	The hoisting machinery lifts the hook that may include a rotating mechanism.
6	Cabin	The operator's compartment from which movements of the crane are controlled. There are many controller types in the cabin like control desk, master controller, switch to operate pendant or radio remote control.
7	Cubicle row	The cubicle row houses all the electric control equipment to operate and control the crane's movements. On a cubicle door there are safety switches for switching off the main and control currents and all special circuits for maintenance purposes.

8	Walkway	There is a walkway along the main girder for maintenance personnel for accessing the electric cubicles.
9	Power feeding system	The power feeding system supplies power to trolley and its components.
10	Maintenance cage	Enclosure for maintaining DSL.
11	DSL Guard	This guards and prevents collision of wire rope/snatch block /hook with live power conductors.

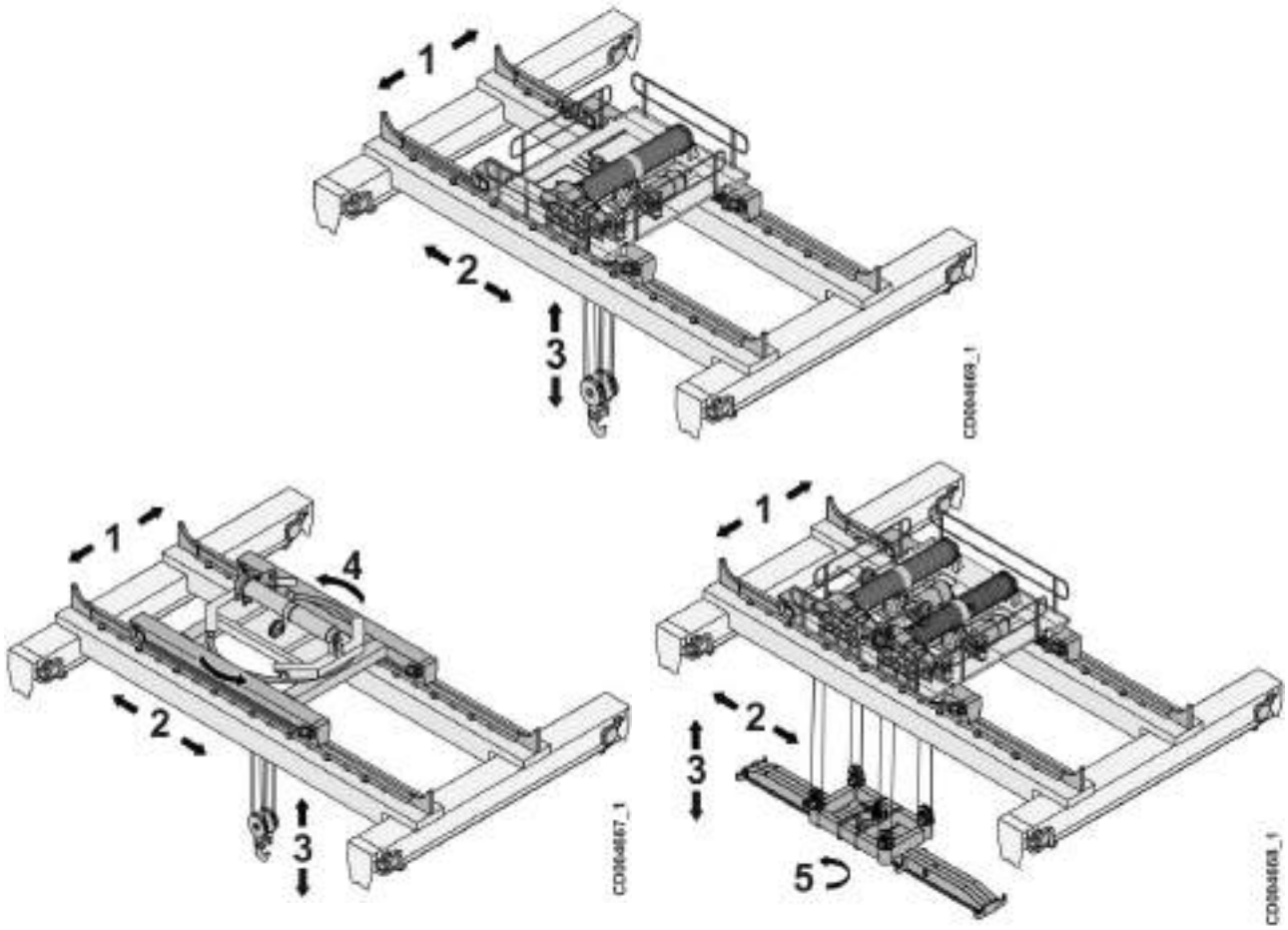
3.2 How a crane operates



1	Main Isolation Switch	The main isolation switch is used to switch crane power supply ON or OFF. The switch is located close to the crane.
2	Crane Control System	The crane control system is built into a row of cubicles, normally located on the bridge. The control system receives input signals from cabin controller, pendant or radio remote and drives the crane motors to make the required crane movements.
3	Controller	The master controller, radio remote controller or pendant is used by the operator to give commands to the crane.
4	Machinery	A crane has machinery for three or more motions: bridge travel, trolley traverse, and hoisting. The main machinery is driven by speed controlled electric motors. There can be other machineries for e.g., an auxiliary hoist and/or cable reel and/or hook rotation functions. Typically have three or more motors: bridge motor, trolley motor, and hoist motor. The motors for each machinery are operated by the control system according to the signals received from the controller.
5	Additional features	Cranes can have many types of other additional features including floodlights, warning lamps, horns etc. These features will be controlled from the cubicle row by the operator/logic/control unit.
6	Safety features	Cranes have several types of safety features that may prohibit crane operations.

4 CRANE MOVEMENTS

Different crane movements



The crane moves in the following directions:

Movements	Description
1. Long travel	Horizontal movements of the crane
2. Cross travel	Horizontal movements of the trolley
3. Hoist	Vertical up and down movements of the lifting device
4. Slew	Rotating trolley movement
5. Lifting beam slew	Rotating lifting beam movement

The example data in the above figure is shown for illustration purposes only and may not match the data on your crane.

A crane can have attachments for lifting the load according to requirements. Examples of detachable or non detachable type of attachments are Magnets, Tongs, Grab bucket, special customized attachment.

Essential pre-requisites for this section

WARNING	When operating the crane, make sure there are no people situated underneath or nearby the load. Operating the crane when people are underneath or near the load could cause death or serious injury to those situated underneath or near the load.

NOTICE	Do not wait for bridge, trolley or hoist limit switches to stop the motion of the crane. Always stop the crane motion by using the control devices on the controller.

NOTICE	If the controller has a hoist or crane selection switch, be sure to select the correct hoist or crane before operating the crane. Multiple crane selection is possible in case of tandem operations

NOTICE	If the crane malfunctions during use, remove speed commands or push the emergency stop button.

Motors get hot when they are rotating, even without a load on the hook. Operate the motors at the highest practical safe speed because low speeds generate more heat. Allow the motors to cool down as per duty requirement so that they do not overheat.

4.1 Travelling Movements

General information about travelling movements

Slow speeds should be used only for short periods, for example during precise positioning. Most movements, especially over longer distances, should be performed at higher speeds to improve ventilation of the motors.

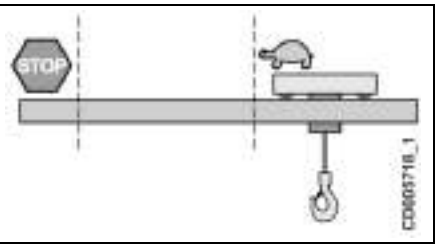
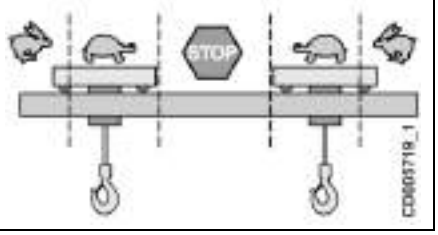
End stoppers are fitted to the **runway** and **girder** of the crane to limit travel of the **bridge** and **trolley** respectively. Buffers are fitted to absorb the impact if the **bridge** or **trolley** runs into the end stops. Buffers are also fitted to prevent collisions between multiple bridges or trolleys.

NOTICE	End stoppers and Buffers are intended for emergency stop after unintentional failure of limit switches. Do not use Buffers and end stoppers as an operational means to stop travel during normal operations. Never allow the trolley or bridge to collide with the buffers or other trolleys or bridges.

4.1.1 Crane movement limits

The crane is fitted with limit switch which slow-down and end stop the bridge motion to prevent the bridge from reaching the end of travel at full speed.

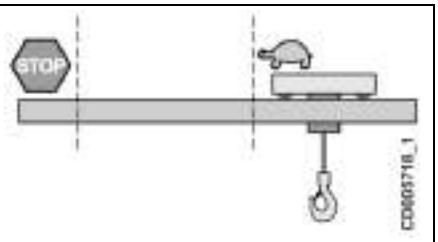
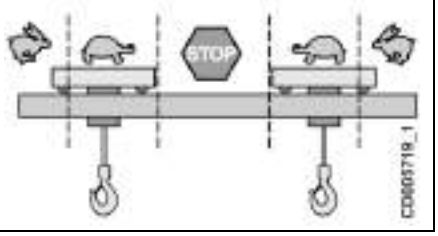
The crane is fitted with the following devices which work in conjunction with trolley movements:

1	2-Step limit switch The crane runway has 2-step limits at both ends. In either direction first step changes the bridge speed from fast to slow when activated. Second step stops the bridge when activated. With inverter use, the bridge does not stop mechanically but decelerates electrically to a near stop speed followed by mechanical braking.	
2	Anti-collision function (optional) The anti-collision device prevents bridges on the same runway from colliding with each other.	

4.1.2 Trolley movement limits

The trolley is fitted with slow-down and end-stop limit switches which prevent the trolley from reaching the end of travel at full speed.

The trolley is fitted with the following devices which work in conjunction with trolley/hoist movements:

1	2-Step limit switch The girder or trolley has 2-step stop limits at both ends. The striker or actuator is on girder or on trolley. In either direction first step changes the bridge speed from fast to slow when activated. Second step stops the bridge when activated. With inverter use, the bridge does not stop mechanically but decelerates electrically to a near stop speed followed by mechanical braking.	
2	Anti-collision function (optional) The anti-collision device prevents trolleys on the same bridge from colliding with each other.	

4.2 Combinations Of Movements

Qualified operators are able to move the crane in more than one direction at a time. This can increase efficiency provided that the operator does not exceed his capabilities. If you intend to combine movements:

- The operator must understand how the crane behaves in each direction individually before starting to combine movements. Different cranes have different driving characteristics.
- Be aware that simultaneous **trolley** and **bridge** motions can cause the load to swing diagonally or in circles rather than parallel to the **bridge** or **trolley**.
- To reduce load swing, do not combine vertical movements (lifting or lowering) with horizontal movements (**bridge** or **trolley**).
- Do not attempt to coordinate more movements than you can safely and confidently control. Good observation, concentration and coordination skills are needed to safely control simultaneous actions.

WARNING	Do not allow anything to divert your attention from the load and the movement of the crane. Failing to observe the movement of the crane and load could cause serious injury or death.

NOTICE	Lowering the load during trolley or bridge movements accelerates the load swing.

4.3 Position detection (optional - In semi or fully automated cranes)

The crane's control system tracks the position of the trolley and hook based on the data provided by the crane's sensors /inverters. The position is checked and calibrated with magnets installed in the runway.

For example, the lowest level for hoisting is detected when the crane's hook touches the ground. The highest level is at the height where the upper stop limit switch is activated.

The position of the trolley is calculated as the distance of the hook from the center of the power supply-side bridge rail.

4.4 Working limit(s) (optional - In semi or fully automated cranes)

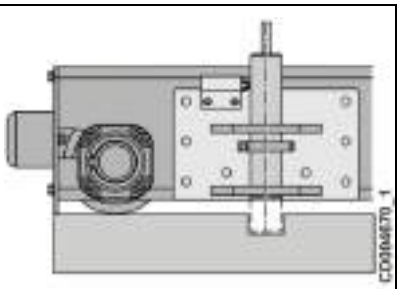
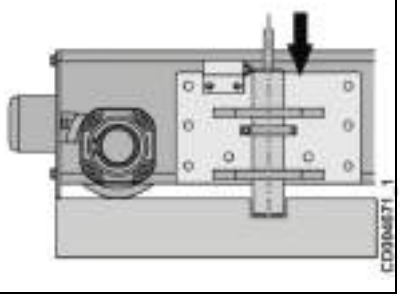
The crane operator can set points at which the crane movement automatically stops, horizontally and vertically. These points are called working limits. When the operator is moving several loads from and to the same locations, the task is simplified by setting working limits at both the lifting and lowering ends of the crane movement when moving the first load.

In a sense, a working limit creates a virtual wall through which the crane will not travel. It is still possible to drive the crane beyond a working limit by using the Working limit BYPASS setting.

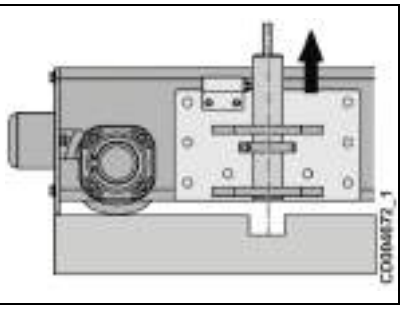
4.5 Crane Storm lock

The storm lock is a device which locks the crane to the runway to prevent crane movement in windy conditions. The storm lock is located on the side of the end carriage. Storm lock can be manual or with chains or motorised.

To engage the storm lock

1	Drive the crane to the locking location so that the locking pin is aligned with the hole in the side of the track.	
2	Manually lock the crane with the locking pin or with chain arrangement, if equipped electrically, use the button on the controller to lock the crane.	

To open the storm lock

1	Manually unlock the locking pin or with chain arrangement, if equipped electrically, use the button on the controller to unlock the crane.	

NOTICE	Do not drive the crane with the storm lock engaged.

5 DESCRIPTION OF SAFETY FEATURES

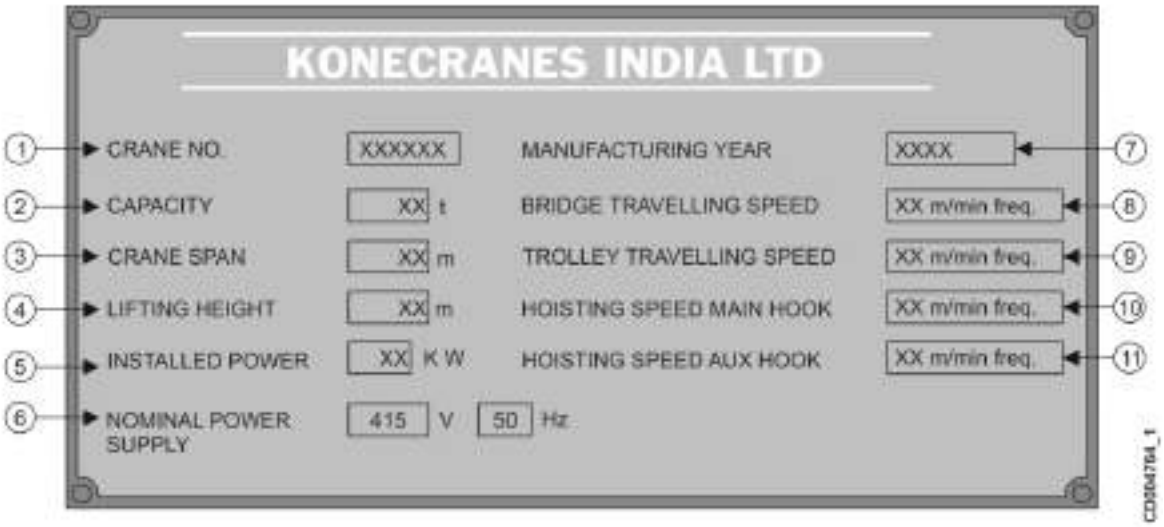
This chapter presents the safety features of your crane.

Device	Description
Overload device	The overload device protects the machinery against overloading. Overload occurs at above 100 % of the rated capacity of the crane or hoist. When activated, the overload device prevents further hoisting but it is still possible to lower the load. Never use the overload device to assess the weight of the load.
Upper stop limit	An operational hoist limit prevents hoisting above a preset point.
Lower stop limit	An operational hoist limit prevents lowering below a preset point.
Up safety limit/ Gravity limit switch	If the up stop limit fails, the up safety limit prevents the hook block from colliding with the rope drum. After activation, only downward movement is possible until the up safety limit has been reset. The crane shall not be used again until the reason for the up stop limit failure has been established.
Emergency stop switch	The emergency stop switch is used to turn off power to the system in a dangerous situation. The emergency stop switch cuts the supply voltage to the system from the main contractor. Always eliminate the danger before releasing the emergency stop switch.
Thermal overload protection	Thermistors are used in motors for this purpose. As the motor overheats it gives changing resistance value to the drive, which interns cut the supply to the motor.
Slow-down and stop bridge travel limit	As a standard, bridge has a lever type limit switch which makes the travel motion to switch from fast to slow before the end of the bridge and then stops motion at the end of the bridge travel.
Trolley anti-collision function	The trolley anti-collision function prevents trolleys on the same bridge from colliding at high speed. The exact operation depends on the crane application. The device can slow down and/or stop the trolleys when they come close together, and it may still allow the trolleys to meet at slow speed. Driving the trolleys away from each other is possible.
Crane anti-collision device	The crane anti-collision device prevents cranes on the same runway from colliding at high speed. The exact operation depends on the crane application. The device can slow down and/or stop the cranes when they come close together, and it may still allow the cranes to meet at slow speed. Driving the cranes away from each other is possible.
Buffers and End stopper	Buffers may collide with the end stopper if travel limit switches fail. This is a default safety feature for travel motions (Trolley and Bridge). Buffers and End stoppers are designed for 50 % of the rated travel speed as per Indian standard.
Wheel ramp	In case buffers fail to stop the CT motion wheel ramp comes into action and stops the motion.
Corner switches	It is an emergency switch provided on platform side at both ends. Its purpose is (a) to keep crane under stop condition while climbing in the crane from gantry (b) to stop the crane from gantry in case of emergency.
“0” position interlock	It is provided with the main contactor. Unless all motion speed controllers are at zero position, main contactor will not energize and the crane will not start.
DSL guard	It is provided in case of DSL. It prevents the hook or wire rope from colliding with the DSL
Hook latch	It prevents the rope or sling that carries the load from coming out of hook.
Emergency brakes	It is the ultimate safety for cranes handling molten metal or dangerous load. The emergency brake holds the drum and restricts its free rotation in case of failure of motor, brakes, gear box etc.

All the safety features in the above table may not be with your crane. If any extra safety feature required please contact manufacturer.

6 IDENTIFICATION PLATES

6.1 Crane Identification Data



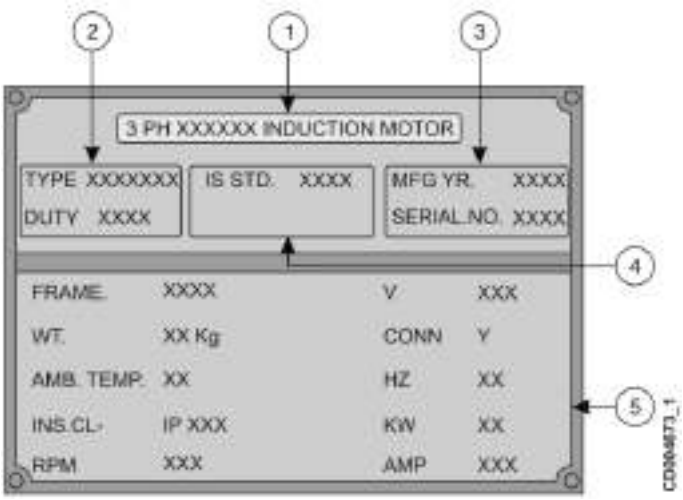
1	Crane number	A unique number which identifies the crane.
2	Capacity	Safe Working Load (SWL) which can be lifted with the crane.
3	Crane span	Distance between centre's of rails on which the crane runs.
4	Lifting height	Maximum lifting height of the hook.
5	Installed power	Power in K.W when the crane is using all the installed equipment.
6	Nominal power supply	Nominal power supply (3 phase+Earth 415 V, 50 Hz) of the crane.
7	Manufacturing year	Manufacturing year of the crane.
8	Bridge travelling speed	Maximum travelling speed of the bridge. Also called LT speed.
9	Trolley travelling speed	Maximum travelling speed of the trolley. Also called CT speed.
10	Hoisting speed main hook	Maximum hoisting speed of the main hook.
11	Hoisting speed aux hook	Maximum hoisting speed of the auxiliary hook.

The example data in the above figure is shown for illustration purposes only and may not match the exact data on your crane.

6.2 Motor Identification Data

Motor serial number and other motor information such as motor type are stated on the motor data plate which is located on the motor.

Hoisting and Travelling motor



1	Motor type	3 Phase Squirrel Cage/Slip ring Induction motor
2	Motor type code	Exact model of the product and it's classification according to its duty.
3	Serial number & Manufacturing year	Identification number of the motor and manufactured year, this number used when ordering spare parts.
4	Approvals and standards	Standards and regulations followed for Motor design
5	Motor specifications	Motor weight, Frame size, ambient temperature of motor, degree of protection, Acceptable main voltage range, frequency, Rated current, Rated speed and phase connection of the motor

The example data in the above figure is shown for illustration purposes only and may not match the exact data on your product.

6.3 Gearbox Identification Data

Gearbox serial number and other information such as gear type are stated on the gear data plate which is located on the gearbox.

Hoisting and Travelling gearbox

1	Manufacturing year	Manufacturing year of the gearbox
2	Job number	Unique number which identifies the crane
3	Quantity of oil	Viscosity class of the lubricant/ Quantity of oil in Liters
4	Gearbox type code	Exact model of the Gearbox
5	Transmission Gear ratio	Transmission ratio used in the gearbox with respect to output shaft.
6	Mechanism	Application of Gearbox in the crane (LT, CT, MH, AH, Slewing, Micro speed)

The example data in the above figure is shown for illustration purposes only and may not match the data on your product.

6.4 Signs

6.4.1 Safety Signs

Safety signs inform the operator about potential hazards and also about special features concerning the crane's operation.

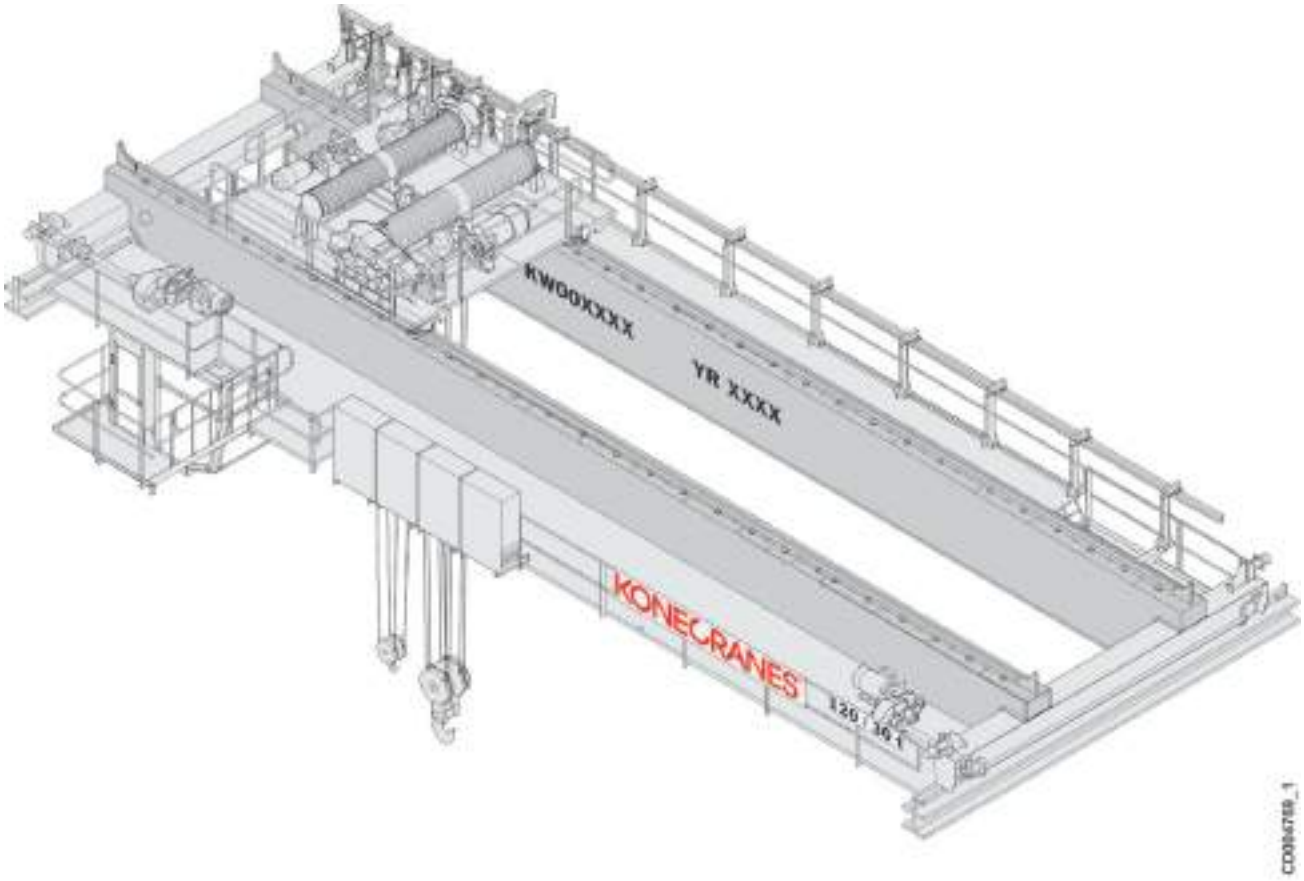
⚠	Failure to avoid dangers identified by these signs can result in death or serious injury.

Sign	Description	Location on crane
	Danger of death or serious injury caused by moving crane.	On **girder**
	Unauthorized persons prohibited	On **girder**

	Electric shock hazard	On all electrical panels and equipments

6.4.2 Data plates used on the Crane

Information signs present operational details which will help the operator to operate the crane.



Data plate	Description	Location on crane
KONECRANES	Manufacturer's Identification	On Handrails
120/30t	Load plate The crane's safe working load for main and auxiliary hoist	On Handrails
KW00XXXX	Crane Identification number The crane's identity number is indicated	On inner side of **Girder**, Adjacent to year of manufacturing on inner side of girder.
YR XXXX	Manufacturing Year Year of manufacturing of crane is mentioned	On **Girder**, Adjacent to crane identification data on inner side of girder.

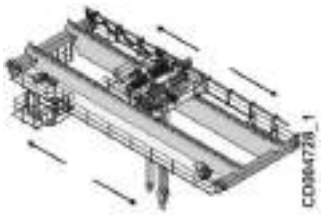
7 INSTRUCTIONS FOR THE OWNER AND OPERATOR

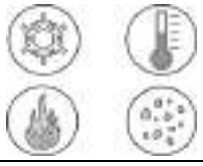
7.1 Owner's Responsibilities

7.1.1 General Safety Issues

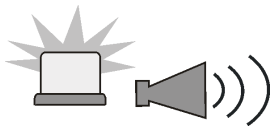
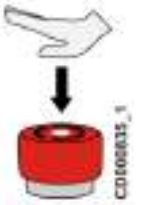
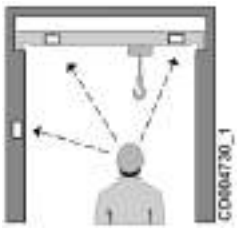
⚠ CAUTION	No modifications or additions to the crane structures or performance values are permitted unless they are first discussed with and approved by the manufacturer or manufacturer's representative of the crane.

NOTICE	Modifying the crane without the manufacturer or manufacturer's representative approval can invalidate the guarantee. Furthermore, the manufacturer does not accept responsibility for accidents which happen as a consequence of unauthorized modifications.

1	Maintain safe conditions under the load Owners SHALL make it clear to all parties (including operator, service personnel and visitors), that no-one must ever venture underneath the load for any reason. This rule must be respected at all times.	
2	Maintain the lighting Owners SHALL ensure that there is adequate lighting, in good working order, at the operating site so that the crane can be operated safely and efficiently at all times.	
3	Maintain safe exit from the crane Owners SHALL ensure that, if the control position is located on the crane itself, it is always possible to exit the crane safely, irrespective of its position on the runway. Escape routes must always be kept clear so that they can be used in an emergency.	
4	Maintain walkways and service platforms Owners SHALL ensure that there are adequate walkways and service platforms on the crane and/or adequate equipment at the operating site for servicing and inspecting the crane. Walkways and service platforms must be kept in a safe condition and free from obstructions.	
5	Maintain operating and safety requirements Owners SHALL ensure that the crane meets the applicable (local and global) safety and operating requirements.	

6	Maintenance Owners SHALL ensure that maintenance is carried out at the recommended intervals as determined by the manufacturer.	
7	Maintain the operating conditions Owners SHALL ensure that conditions at the crane operating site correspond to the operating conditions for which the crane is designed. For example, factors which affect the operating conditions include indoor/outdoor use, temperature, weather, dust, humidity, hazardous materials and fire risks.	

WARNING	Do not allow the crane to be used unless it is in proper condition. In case of doubt, contact a service agent authorized by the manufacturer or manufacturer's representative! The use of defective crane can result in serious damage, injury or death.

8	Keep the crane in a safe condition Owners SHALL ensure that the crane is kept in a safe condition. For example, all warning devices must be kept in good working order.	
9	Fire safety Owners SHALL ensure that personnel are prepared in case of fire and that the correct fire-fighting equipment is available and maintained.	
10	First Aid Owners SHALL ensure that, in accordance with local regulations, personnel are prepared in case of accidents and that a suitable first-aid kit is available and maintained.	
11	Emergency Stop devices Owners SHALL ensure that they, and the operators, know the locations of emergency stop devices so that they can be activated in emergency situations. Emergency stop devices should never be used as a substitute for making proper use of the direction controls.	
12	Ensure that signs are maintained in good condition Owners SHALL ensure that signs and warnings are present on the crane and are in good condition.	
13	Keep the working site clean The working site should be kept free of clutter and dirt. Oil spills must be cleaned up immediately to reduce the risk of slipping.	

7.1.2 Hoisting Machinery Safe Working Period (SWP)

Based on how the hoisting machinery will be used and on the actual hoisting machinery hardware supplied, the manufacturer will agree the anticipated hoisting machinery lifetime or safe working period (SWP) with the customer at the time of purchase.

The total lifetime of hoisting machinery consists of one or more Safe Working Period (SWP) where each SWP typically lasts around ten years when the crane is used in accordance with the designed usage. It is possible for different hoisting machineries on the same crane, for example main and auxiliary, to have a different SWP. The SWP is the period in which, provided the crane has been used and maintained in line with the original expectations, the crane can be safely operated.

In practice the lifetime of the crane can vary due to changes in the environment and usage of the crane. For safety, in accordance with the Indian standard, it is important for authorized service personnel to periodically check the crane duty group and operating conditions regularly for any changes, then to revise the remaining SWP % upwards or downwards accordingly. This action ensures that the crane is kept operating for as long as it is safely possible before a General Overhaul must be conducted.

7.1.3 How to Assess the Hoisting Machinery Safe Working Period

The hoist service organization assesses the hoisting machinery Safe Working Period but this table briefly describes how it is done.

Product	Method
Product equipped with condition monitoring unit	The SWP value can be read form the SWP-data counter display of the condition monitoring unit.
Product equipped with hour counter and log book	The remaining SWP % must be calculated in accordance with the relevant standard.
Product with log book	
Product without log book	

“Crane Reliability survey” package from the manufacturer gives SWP and lifetime data for crane. But the package is not automatically included with the crane; if needed please contact manufacturer.

7.1.4 Intended Usage of the Product

The crane for general use is an entity which has been designed to perform common lifting, travelling and lowering operations, within the limits specified by the crane’s duty group (see chapter “Duty group”). The hoisting machinery for general use must not be modified or used for any other purpose without the written approval of the manufacturer.

The hoisting machinery for general use is suitable for use in general manufacturing only; it is not suitable for use in harsh environments. Refer to “Operating environment”. Please contact the manufacturer or manufacturer’s representative in case of doubt.

The crane must be positioned directly above (perpendicular to) the load so that there are no side-pulling forces.

 CAUTION	Never allow the crane to be used to pull or drag a load sideways. Side pulling accelerates hoisting machinery wear and can damage the rope reeving system. The load must always be lifted clear of the ground before performing travelling movements.

CAUTION	Side pulling may cause wire rope to break and the load to drop causing serious damage, injury or death.

DANGER	DO NOT ALLOW THE CRANE TO BE USED FOR LIFTING PERSONNEL.

Modifying the crane without the permission of the manufacturer or manufacturer's representative can be dangerous and can invalidate the crane guarantee. Any fundamental modifications to the crane must be authorised in writing by the manufacturer. Examples of such modifications include:

- Welding or otherwise attaching new items to the crane.
- Attaching devices for special material handling such as turning the load.
- Alterations to load - bearing components.
- Alterations to drives and speeds.
- Replacement of major items such as trolleys.

CAUTION	No modifications or additions to the crane structures or performance values are permitted unless they are first discussed with, and approved by, the supplier of the crane.

NOTICE	Modifying the crane without the manufacturer or manufacturer's representative approval can invalidate the guarantee. Furthermore, the manufacturer does not accept responsibility for accidents which happen as a consequence of unauthorized modifications.

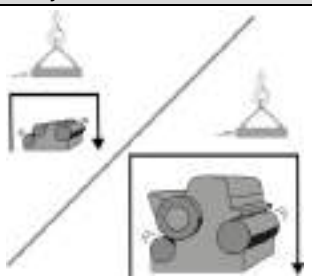
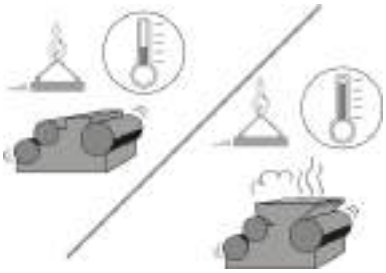
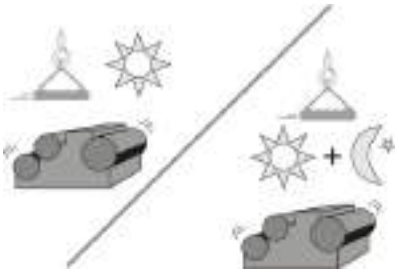
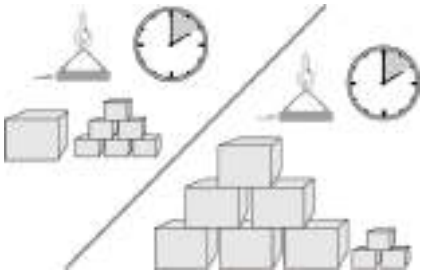
7.1.5 Duty Group

When the product is designed and purchased, the predicted lifetime of the product is agreed, based on the expected use of the product. This expected use is known as the duty group. Hoisting machinery which is used continuously to lift heavy loads is clearly in a very different duty group to a product of the same size which is used occasionally just to lift light loads. While the product is used in accordance with the designed duty group, the expected lifetime should be reached.

It is the owner's responsibility to ensure that the product is used according to the duty group that it has been designed for. By doing so, the product should reach the original predicted lifetime.

DANGER	DO NOT ALLOW THE PRODUCT TO BE USED OUTSIDE THE LIMITS OF THE SPECIFIED DUTY GROUP. DOING SO RAISES THE RISK OF MECHANICAL FAILURE AND CAN SHORTEN THE PRODUCT'S LIFETIME.

The duty group is based on many factors including the hardware, the predicted lifetime, the number of shifts and lifts, the distances travelled, the ratio of heavy to light items lifted and the environmental conditions the product is used in refer to manufacturer for change of duty group.

Parameter	Variables	Light use and heavy use
Lifting height and working distances	Actual hoisting time and the average distances being traveled by the trolley and lifting devices.	
Operating environment	The product is designed to work within specific parameters of temperature, humidity and cleanliness.	
Product process	The number of shifts.	
	The number of work cycles per hour and the average lifted loads.	

Authorized service personnel must periodically check whether the product is being used according to the duty group. Owners and operators should recognize that any changes to product usage could, if left unchecked, raise overall maintenance costs and considerably reduce the safe operating lifetime of the product. Changes to any of the parameters and variables can require the duty group to be revised.

If there will be significant permanent changes in the product usage, authorized service personnel must revise the duty group and SWP as necessary. Changes to hardware or servicing frequency may be required.

7.1.6 Operating Environment

DANGER	USING THE CRANE IN AN ENVIRONMENT FOR WHICH IT IS NOT DESIGNED CAN BE DANGEROUS. IT WILL ALSO REDUCE THE CRANE'S LIFETIME AND INCREASE THE MAINTENANCE REQUIREMENTS.

If the operating environment deviates from the environment specified when the product was ordered, contact the manufacturer or manufacturer's representative. Solutions are available to enable the product to work in a wide range of operating environments. If the product for general use will be used in exceptional ambient conditions/temperatures or to handle dangerous materials, consult the manufacturer or manufacturer's representative. Examples of exceptional ambient conditions include windy areas, earthquake zones and corrosive atmospheres. Molten metal is considered to be a dangerous material.

The product for general use may be used in a normal default industrial environment only, with the following limitations:

- Indoor cranes must be protected from outdoor weather conditions.
- Cranes must be operated within designed temperatures.
- Cranes must not be exposed to any corrosive chemicals or an explosive atmosphere.
- Cranes must not be located in an area prone to earthquakes.

There can be extra optional features in your crane which can allow operation in special environments such as outdoors, high temperature, etc. In case of doubt please contact your manufacturer or manufacturer's representative.

7.2 Operator's Responsibilities

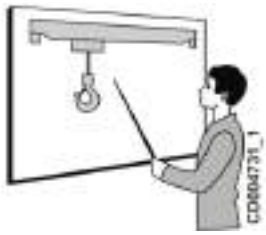
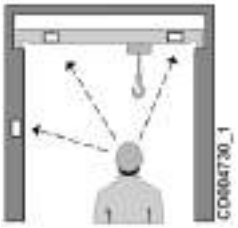
Hoists are used for various purposes, handle different types of loads and are operated different ways by many operators. Many workers, as part of their regular job responsibilities, normally operate hoists as non dedicated operators.

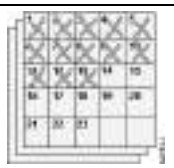
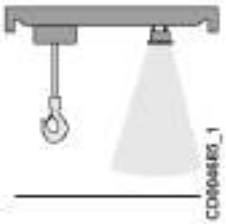
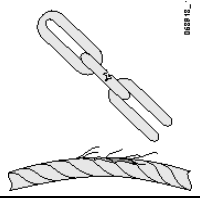
Because the manufacturer of the hoist has no direct involvement or control over the hoist's operation and application, conforming to good safety practices is the responsibility of the owner, and the crane operating personnel. Only those **Authorized Personnel** who can demonstrate that they have read and understood this manual and that they understand the proper operation of the crane should be permitted to work with it.

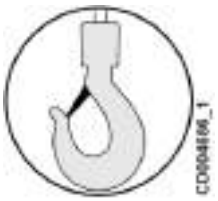
⚠	Failure to adhere to the instructions and warnings provided in this manual can result in serious injury or death.

Operators SHALL:

The operator SHALL make the following checks to ensure that the crane is in a safe operating condition. By carrying out these simple checks, the operator can identify potential problems at any early stage, thereby enhancing safety and minimizing down time.

1	Operators SHALL be trained by the owner of the crane or a qualified designee and be competent for the task.	
2	Operators SHALL learn how to operate the crane safely before actually starting to work with it.	
3	Operators SHALL know all the controls and must be able to use them correctly and safely.	
4	Operators SHALL learn how to control the movements of the hook and load.	
5	Operators SHALL be aware of any risk of accident posed by the operating site.	
6	Operators SHALL familiarize themselves with the signs and warnings marked on the crane.	
7	Operators SHALL use this manual to familiarize themselves with the crane and crane's controls.	

8	Operators SHALL learn the hand signals for directing crane movements.	
9	Operators SHALL be familiar with proper rigging procedures.	
10	Operators SHALL carry out scheduled inspections.	
11	Operators SHALL always follow the local regulations.	
12	If the working site is not illuminated, Operators SHALL turn on the crane lights before starting to check or operate the crane.	
13	Operators SHALL visually check the operating environment to make sure that there are no new hazards which might prevent safe use.	
14	Operators SHALL Visually check to see if there are any oil leaks from the crane.	
15	Operators SHALL visually check the ropes or chains for any deformation or damage (for example, broken wires, broken strands, kinks).	

16	Operators SHALL visually check the rope reeving. The ropes should all be properly seated in the grooves of the rope drum and rope sheaves. Check that rope is not twisted and that the ropes are not touching each other	
17	Operators SHALL inspect the hook for nicks, gouges, deformation of the throat opening, wear on saddle or load bearing point. Check that safety latch is working properly. Check free rotation of hook forging.	
18	Operator SHALL check brake operation on empty hook at start of each shift/day	
19	Operator SHALL check phase indication lamp on panel for power supply healthiness	
20	Operators SHALL check that all warning signs are in place, in good condition, and can be read easily	
21	Operators SHALL check that the crane is not locked or tagged out. Follow local safety procedures.	
22	Operators SHALL verify that nobody is doing maintenance work on the crane.	

NOTICE	If any abnormal condition or malfunction is noted during inspection or occurs during daily operation, report it to the supervisor immediately and remove the crane from use. Operation may only continue when safe operation is ensured.

WARNING	Operating a crane with an abnormal condition or malfunction can result in serious injury or death or serious damage to the crane.

Operators SHALL NOT:

1	Operators SHALL NOT operate the crane when under the influence of alcohol or drugs. Alcohol and drugs can impair judgment and thereby cause a hazard.	
2	Operators SHALL NOT operate the crane when under medication which may cause a hazard to the operator or others. If unsure, consult your doctor or pharmacist. Always comply with local regulations regarding working under the influence of medication.	
3	Operators SHALL NOT operate the crane while suffering from any illness or injury which might impair their ability to properly use the crane.	

7.3 Safety during Maintenance

Before and during crane maintenance, the owner must take the following precautions:

NOTICE	Safe access to the crane is the owner's responsibility.

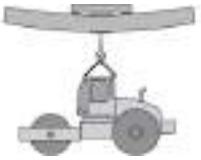
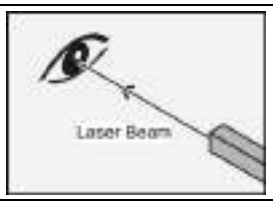
⚠ CAUTION	Use experienced service personnel, authorized by the manufacturer or manufacturer's representative, for servicing the crane. The person servicing the crane must be competent for the task and must be familiar with the servicing and inspection instructions.

⚠ CAUTION	After a collision or overload situation, inspection and repair operations to be carried out on the crane must be discussed with the supplier.

⚠ CAUTION	Only use genuine spare parts from the manufacturer.

Before and during crane maintenance, the crane's owner must be aware that the following precautions should be taken by maintenance personnel:

1	Choose a safe working location The crane should be moved to a location where it will cause the least disturbance and where it can be accessed easily.	
2	Prevent unauthorized access to the site Prevent unauthorized persons and bystanders from walking on or below the work site. For example, you can lock doors, install barriers and display notices. Ensure that the secured area is spacious enough to prevent injuries which could occur as a result of falling components or tools.	
3	Inform that crane will be undergoing maintenance Before starting maintenance, people must be properly informed that the crane is being removed from operation.	
4	Ensure that there is no load on the lifting device Before starting maintenance there should be no load on the hook or lifting device. Park the hook on the ground if there is any chance that the hoisting brake will be opened during maintenance. A raised empty hook will fall to the ground if the hoisting brake is opened.	
5	Turn all controllers and main switches off All controllers and main isolation switches must be placed in the off position before starting maintenance.	
6	Verify that power is completely disconnected Measure between the phases and between each phase to ground to ensure that power is completely disconnected from the crane. Lock in/Lockout or permit system should be introduced before starting maintenance activity.	

7	Use hand lines for lifting and lowering tools Hand lines, securely attached to the building structure, should be used for lifting or lowering materials and tools. Use proper safety equipment to prevent objects from falling when working in high places.	
8	Safety devices must be restored to operational status Ensure that any safety devices which have been bypassed for testing purposes have been restored to full operational status before allowing the crane to be used for normal operation.	
9	Minimize the risks of moving machinery Secure the area so that personnel are not at risk from the movements of machines, automatic doors or adjacent cranes at the installation site. Ensure that machinery and crane cannot start up accidentally and cannot move during installation and servicing. Be prepared in case crane moves in the wrong direction during testing.	
11	Returning the crane to operation after overload or collision After an overload or collision incident, the appropriate inspection and repair operations must be discussed with the supplier of the crane.	
12	Pay special attention to all safety-critical components The brakes, limit switches, hook, rope and controller are all safety-critical items which must always be kept in good order. Ensure that safety devices (overload protectors, limit switches, etc.) work properly so that they provide protection.	
13	Beware of high temperature components Some components, such as the motors, brakes, brake drums, brake flanges and heat dissipating equipments like heaters; heat exchangers etc can be hot during use. Check that components are cool before working on them.	
14	Perform regular inspections and preventive maintenance To ensure ongoing safe and efficient operation of the crane, carry out regular inspections and preventive maintenance in compliance with the instructions. Keep a record of all inspections and servicing. If in doubt, contact the supplier of the crane.	
15	Protection against Laser equipments Use protective eyewear in the form of spectacles or goggles with appropriately filtering optics to protect the eyes from the reflected or scattered laser light with a hazardous beam power, as well as from direct exposure to a laser beam.	

7.4 Safety during Load Handling

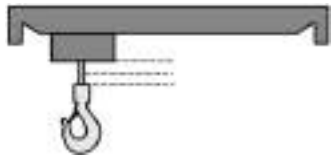
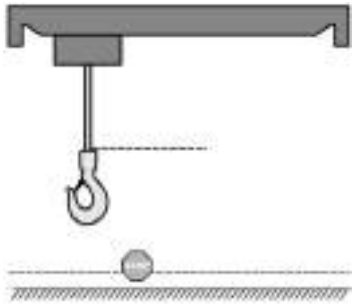
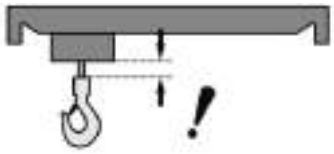
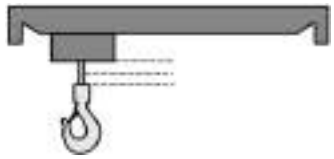
7.4.1 Before lifting

After securely attaching the load to the lifting device, the hoisting machinery must be correctly positioned and attached to perform the lift. The following steps must be followed before lifting.

WARNING	Moving a load that is not properly attached to the lifting device could cause death or serious injury.

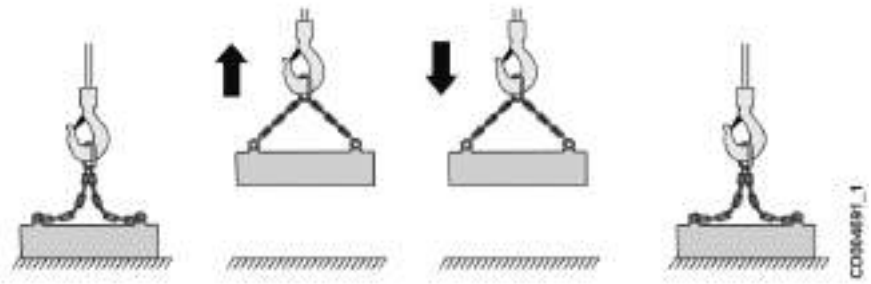
Do not attempt to lift a load which is fastened to the ground or to a base which will prevent it from being lifted.

The crane is fitted with the following devices which work in conjunction with lifting and lowering movements:

	Upper stop limit Stops the hoisting motion.	
	Lower stop limit Stops the lowering motion.	
	Up safety limit The crane is equipped with a safety up limit. This will stop the lifting motion if the up stop limit fails. Lifting device can be lowered until the up safety limit switch has been reset. The crane may not be used again before the failure has been investigated and repaired.	
	Working limit switch with bypass (programmable) (optional – in semi automation or fully automated crane) The crane is equipped with a working limit switch which can be used for stopping the movement for operational purposes. By bypassing the working limit switch the operator may drive to the up limit.	

7.4.2 Lifting and Lowering Motions

Correct load handling allows the operator to move loads quickly and safely.



WARNING	Handle the load safely at all times. During movements, ensure that the hook, the load, the crane and its moving parts will not collide with objects or people. Failure to do so could cause death or serious injury.

7.4.3 Evaluating the load

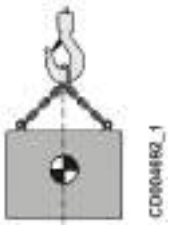
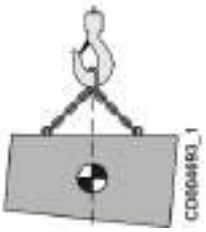
To prevent overloading, the operator shall determine the weight of the load before lifting. The operator shall only lift the load when he or she is sure that it weighs no more than the permitted load of the crane and accessories. The crane's overload device shall not be used to determine whether the load can be lifted.

Never attempt to lift a load that weighs more than the safe working load of the crane and accessories.

CAUTION	Attempting to lift a load that weighs more than the safe working load of the crane and accessories could cause death or serious injury.

7.4.4 Balancing the load

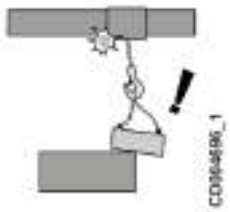
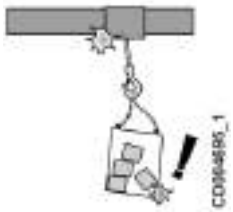
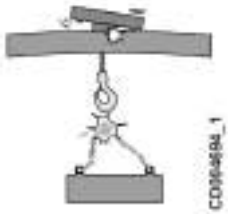
The hook, slings and harnesses must be positioned so that the pulling force of the crane lies on the load's centre of gravity so that the load is balanced. When the operator begins to hoist a load, he or she shall check that it is properly balanced before lifting it high off the ground. If the load is not balanced, lower it down and adjust the lifting point.

1	Lifting centrally balanced loads The centre of gravity will usually be in line with the centre of the load. Provided that the contents of the container cannot move around, the balance of the load stays the same.	
2	Lifting off-centre balanced loads The centre of gravity of an off-centre balanced load will usually be towards the heavier end of the load. Provided that the contents of the container cannot move around, the balance of the load stays the same.	

⚠ WARNING	Never try to balance an unbalanced load with your hands. Lower the load and adjust the lifting point. Trying to balance an unbalanced load with your hands could cause death or serious injury.

7.4.5 Shock loading

The crane and accessories are designed to take up the weight of loads gradually and steadily. They are not designed to withstand sudden increases or decreases in the apparent weight of the load. Shock loading can occur in any situation where the load on the crane suddenly increases or decreases. Some examples of how shock loading can occur are shown below.

1	Change of load balance A change in load balance can suddenly pull on the hoisting rope.	
2	Unstable load If the load is unstable, it can exert sudden force on the hoisting rope. The contents of packing cases should be securely fastened so that they cannot move around during lifting.	
3	Rapid load reduction A sudden loss of the load can cause the **trolley/hoist** to jump.	

NOTICE	Avoid shock loading the crane. Shock loading the crane could damage the crane or the load.

⚠ CAUTION	After a shock, crane shall not be used before authorized service personnel or an experienced service technician authorized by the manufacturer or manufacturer's representative has determined that the crane is safe to use. The usage of a defective crane can result in serious damage, injury or death.

7.4.6 Attaching the load

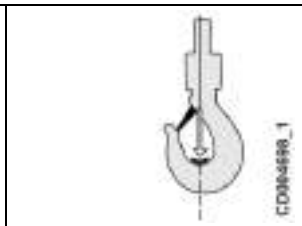
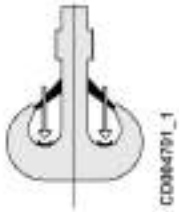
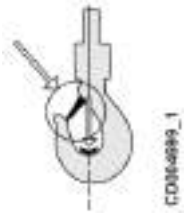
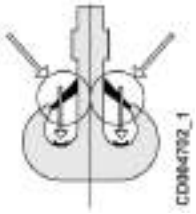
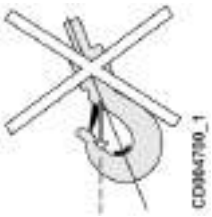
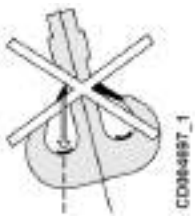
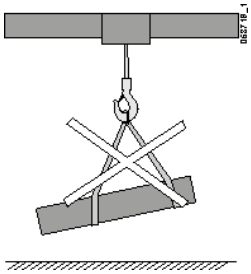
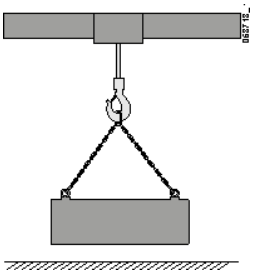
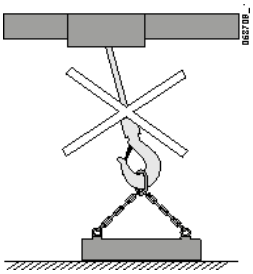
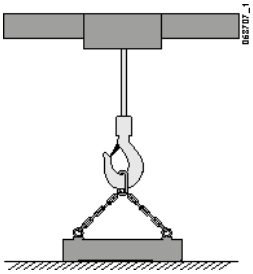
The load is usually attached to the crane by means of some kind of pre-tested and reliable lifting device. The most common pre-tested and reliable lifting devices are chains, wire rope slings and lifting belts. The operator shall select a lifting device designed for the crane being transported.

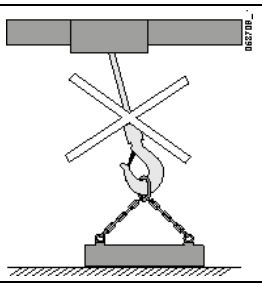
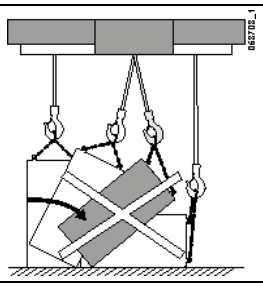
⚠	Always follow instructions provided by the lifting device manufacturer when using pre-tested and reliable lifting devices. Never use the crane's ropes or chains as a sling to attach to the load.

Lockable hook

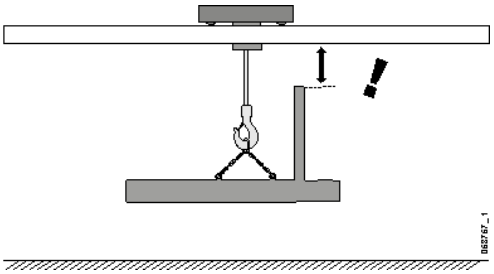
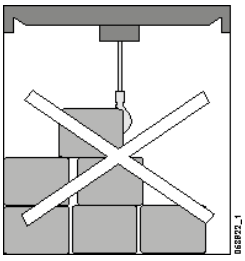
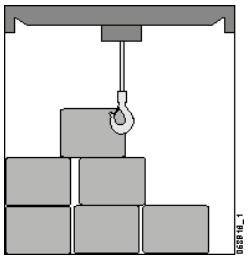
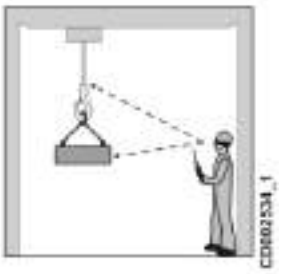
If a lockable hook block is used, it is possible to lock the hook forging in steps of 90 degrees, to prevent load handling problems caused by rotating the load.

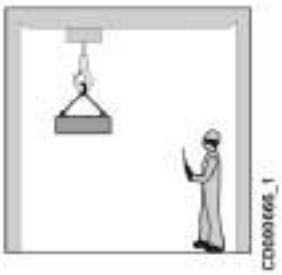
Load handling

1	To avoid damaging the hook, lifting devices must only be positioned on the load bearing surface of the hook. That is, the lowest point of the hook. Forces on ramshorn hooks must be equal on both load bearing surfaces.		
2	Ensure that the hook safety latches are closed. Check that the safety latch is not subjected to any force by the load.		
3	The weight of the load must be centered on the center line of the hook forging so that the load does not bend the neck of the hook. Never try to lift anything with the tip of the hook!		
4	Check that the load is balanced and safely fastened at the lifting points. The load must not be able to slide, slip or detach itself when suspended.		
5	The **hoist** must be positioned directly above (perpendicular to) the load so that there are no side-pulling forces.		

6	Do not drag the load along the ground.		

NOTICE	Never drag loads or pull loads from the side.

7	The operator shall ensure that the crane or the load does not collide with anything or fall from the lifting device.		
8	Check that you have a clear view from the **controller** position. Remove any visual obstructions.		
9	Do not divert attention from the load while operating the crane.		
10	Never leave the load hanging on the hook unattended.		

11	Avoid short, jerky motions. Unnecessary short starts cause the hoisting motor to overheat quickly. Do not switch the motor back and forth unnecessarily because it causes strain/ stress.		
12	The crane is designed for lifting and transporting material only.		

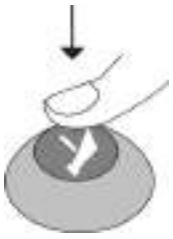
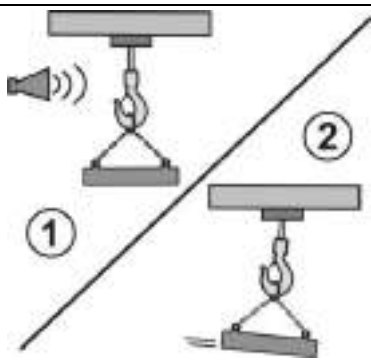
WARNING	Never touch the ropes, chains or slings during lifting. There is a risk of catching or trapping your hands in the hook block or hoist. Catching or trapping your hands in the hook block or hoist could cause serious injury or death.

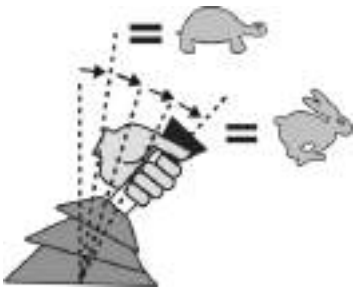
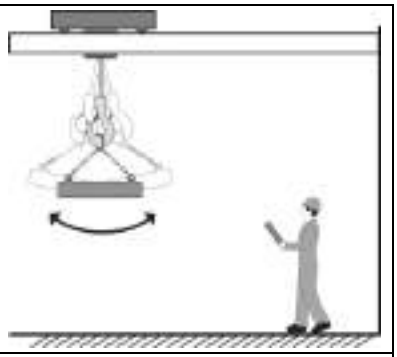
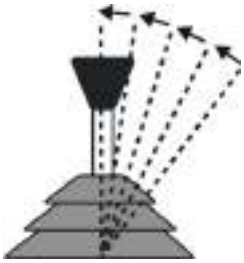
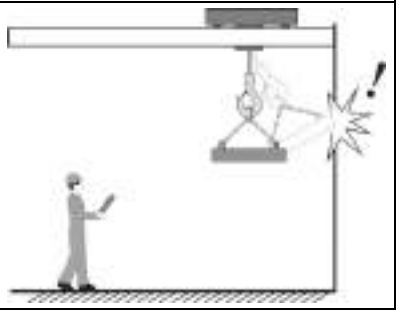
NOTICE	Do not allow the hook or other lifting device to strike the load on the ground while lowering the load. The crane ropes could dislocate from the pulley grooves if they go slack.

NOTICE	Always remove the load from the hook by hand. Never try to use crane motions to remove the load from the hook. The safety latch on the hook should prevent this.

7.4.7 Multistep inverter control

Inverter control stops the trolley smoothly by means of a preset deceleration ramp. The brake only activates AFTER the trolley has come close to stop. The operator must understand how the trolley behaves when decelerating to avoid overshooting the target or causing load swing.

1	If the crane has a horn, push the horn pushbutton to warn people nearby that a load is about to be moved.		

2	Starting: Always start the **bridge and/or trolley** motion slowly, by moving the joystick gradually step by step until the desired speed is reached.		
3	Stopping: Stop the **bridge and/or trolley** motion smoothly by bringing the joystick to the “off” position step by step. This reduces load swing and brake wear. In an emergency, use the emergency stop button to bring the **bridge and/or trolley** to an immediate stop.		

NOTICE	With inverter control, always allow time for the movement to decelerate to a smooth stop after releasing the direction control.

Load Control

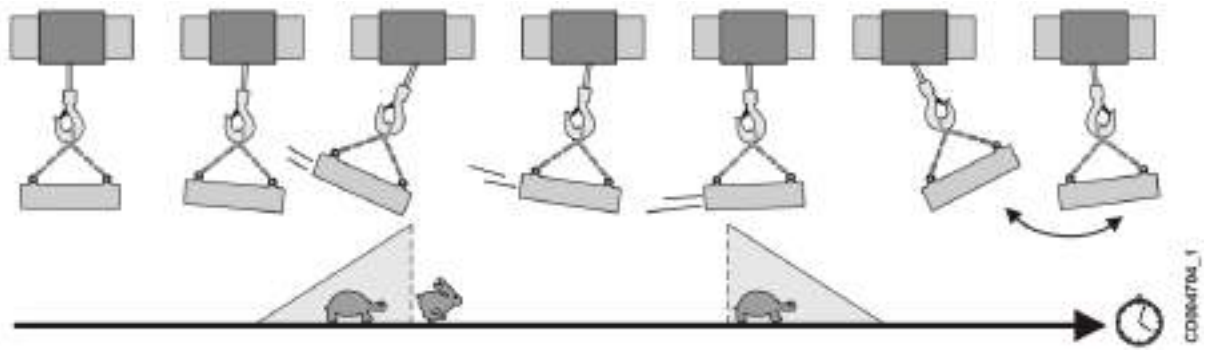
The operator must use the correct techniques to properly control the load at all times to prevent uncontrolled movements such as load swing or rotation.

Guiding or steadying loads by hand

WARNING	Never try to stop load swing with your hands. A swinging load moves with considerable force. Your hands or body could be seriously injured between the load and an obstacle or wall.

7.4.8 Load swing

Load swing is caused by sudden speed or direction changes in the **trolley** or **bridge** movements. When starting up or accelerating, the load lags behind the **bridge** or **trolley**. When stopping or decelerating, the load tends to swing ahead, pulling on the crane. If the crane moves at high speed and then decelerates quickly, violent swinging may result. The load will swing further on a long rope close to ground level than on a short one close to crane level.

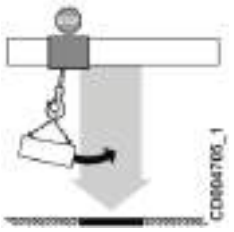
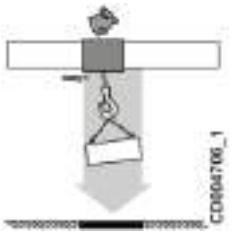
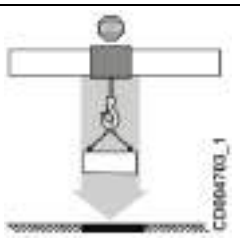


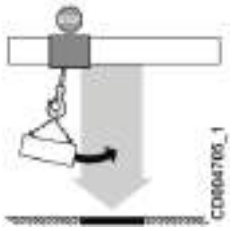
Preventing load swing

Load swing can be prevented or minimized by:

- Accelerating and decelerating as gently as possible.
- Moving the crane at a speed appropriate for the load (higher speeds increase the likelihood of swinging).
- Transporting the load close to the **hoisting machinery** with short ropes.
- Coming to a complete stop before changing direction.
- Avoid using multiple motions at the same time.

The operator can prevent swinging by taking advantage of the leading pull of the load when bringing it to a stop:

1	Anticipate the swing and stop the crane: Anticipate the swing of the load and stop the crane just before the final setting point of the load.	
2	Accelerate to catch up with the load: At the instant the load is directly over the setting point, accelerate the crane so that it catches up with the position of the load.	
3	Stop over the setting point: The load and crane can both be stopped simultaneously over the setting point.	

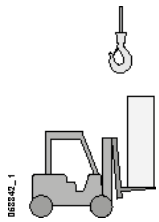
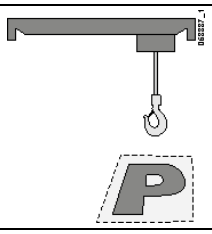
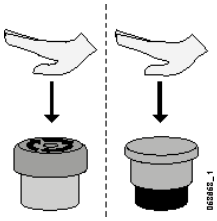
4	Automatic sway (swing) control (optional) Automatic sway (swing) control is to minimize system sway and achieve good positional accuracy in a minimum duration.	

You may need to repeat the above actions several times to completely eliminate the swing.

WARNING	Do not use sway control unless you have been properly trained to do so. The unusual crane movements during load swing can confuse the operator. Do not use sway control unless you are trained to do so.

7.5 Safety Procedure after Using the Crane

The following checks must be done **after every working shift** to ensure that the crane is left in a safe condition.

1	Ensure that there is no load on the lifting device.		2	Park the hook or other lifting device where it will not present a hazard to people or traffic but do not park at the top safety limit. Above head height is recommended.	
3	If applicable, park the crane in an approved parking area.		4	Engage the emergency stop button.	
5	Shut down the crane with given devices.		6	If applicable, close mechanical brakes (rail clamps, storm locks etc.).	
7	Visually check the crane.		8	Report all observed defects and abnormalities in crane or operation to the foreman and to the next operator.	
9	Store the radio controller and place the batteries on charge.		10	All controllers used for operating crane should be set to zero position.	

WARNING	Always remove the crane from service immediately if it is in a dangerous condition. Operating a crane that is in dangerous condition could cause death or serious injury.

7.6 Hand Signals and Other Methods of Communication

When one person is operating the crane and another is giving hoisting instructions, communication must be clear. Both people must agree on and understand the language they use to describe hoisting actions.

If electronic voice communication is used, such as telephone or radio, a dedicated channel must be used so that any commands from other personnel in the area will not confuse the operator.

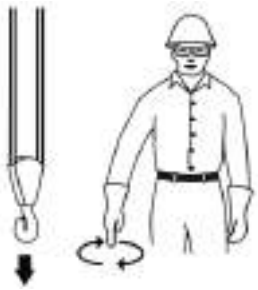
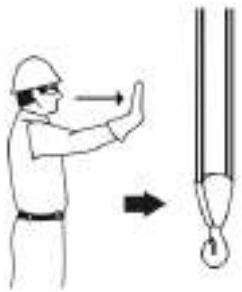
Hand signals can be used for communication. The operator must be trained to understand appropriate hand signals. A copy of the hand signals should be displayed at the operator's station and anywhere else where it could be useful.

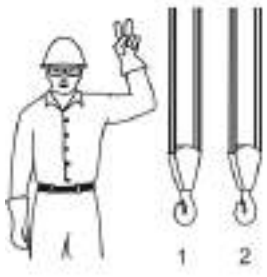
Special operations may require additional hand signals. Special signals must be agreed upon and understood before hoisting. It should not be possible to confuse special signs with the standard signs.

The operator should only respond to hand signals from the person giving hoisting instructions, except to obey a stop signal, regardless of who gives it. The operator takes overall responsibility for movement and should only follow movement instructions when he or she judges it safe to do so.

HAND SIGNALS

These are the most commonly used hand signals. A copy of the hand signals should be placed close to the operator's station for reference.

Description	ANSI hand signal	Description	ANSI hand signal
Hoist With forearm vertical, and forefinger pointing up, move hand in a small horizontal circle.		Lower With arm extended downward, forefinger pointing down, move hand in a small horizontal circle.	
Trolley travel Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally.		Bridge travel Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.	
Stop Arm extended, palm down and hold position rigidly.		Emergency stop Arm extended, palm down, move hand rapidly right and left.	

Multiple trolleys Hold up one finger for block marked “1” and two fingers for block marked “2”. Regular signals follow.		Move slowly Use one hand to give any motion signal and place the other hand motionless in front of hand giving the motion signal. (Hoist slowly as shown in example).	

Other standards for hand signals exist. All operators must agree on and understand the signals used to describe hoisting actions.

8 INSPECTIONS

The operator/owner of a crane shall carry out regular inspections to ensure the safe operation. The crane's owner shall also keep record of the inspections and findings.

Periodic inspections must be carried out by authorized service personnel or experienced service technician authorized by the crane's manufacturer or manufacturer's representative. Inspections must be carried out according to manufacturer's instructions.

If the working environment or crane usage changes, the inspection and maintenance intervals may need to be revised.

Cranes used under harsh conditions may require shorter service intervals. Consult with the manufacturer or manufacturer's representative for a tailored service agreement.

Periodic inspections SHALL be carried out in accordance with local regulations.

⚠ CAUTION	Any defects or abnormalities which are detected during the inspections must be investigated and corrected in accordance with the instructions relevant to component in question.

8.1 Inspections points

D: Daily
W: Weekly
M: Monthly
Q: Quarterly
HY: Half Yearly
Y: Yearly

Component	Checks	D	W	M	Q	HY	Y
Crane runway							
Runway	Check for signs of damage. Check the transition and connections of rails.				*		
Welded joints	Check for cracks and signs of damage.					*	
Connection bolts	Check the condition of the bolts and nuts.				*		
Grounding	Check the condition of the grounding system.			*			
End stop	Check the condition and fastening of the end stops.			*			
Crane and Trolley structures							
Span of crane and trolley	Measure span of the crane and trolley, ensure that it is within tolerance						*
Diagonal of crane and trolley	Measure Diagonal of the crane and trolley, ensure that it is within tolerance						*
Wheel base of crane and trolley	Measure Wheel base of the crane and trolley, ensure that it is within tolerance						*
End carriages and Bogies							
Buffers	Check for signs of damage.			*			
	Check for parallelism to runway				*		
Guide rollers (optional)	Check for signs of wear and the need for adjustment.			*			
Welded joints	Check for cracks and signs of damage. Check for signs of fatigue (cracks) and corrosion.					*	
Lubrication system	Check the grease nipples. Verify that there are no leaks.			*			
Rail sweep (optional)	Check for excessive wear. Verify that the sweep removes particles from the rail.				*		
End carriages and Bogies	Check that End carriages and Bogies are parallel to runway				*		
Connection bolts (structural and component mounting bolts)	Verify that the tightening torques correspond to the values presented in the “Tightening torques for Friction Grip Bolts (HSFG)” chapter. In case of machined bolts, check the condition of the bolts and nuts.					*	
Storm lock (optional)	Verify that the storm lock can be engaged and disengaged. Check for signs of damage.			*			
Anti-jumping device or earthquake support (optional)	Check for signs of damage. Verify that the catch reaches under the rail.					*	
Crane power towing arm	Check for signs of wear and damage, as well as need for adjustment. Verify that the arm is securely fastened to the structure.			*			
Main girder							
Welded joints	Check for and signs of damage. Check for signs of fatigue (cracks) and corrosion.					*	
Trolley rail	Check rail wear. Rail tread should be minimum 90% of original size					*	
Rail clamps	Check clamp bolts. Tighten or replace if required				*		
End stops	Check the condition and fastening of the end stops.			*			
CT Rail ramp	Check for and signs of damage. Check for signs of fatigue (cracks) and corrosion.			*			

Component	Checks	D	W	M	Q	HY	Y
Splice joint bolts	Verify that the tightening torques correspond to the values presented in the “Tightening torques for Friction Grip Bolts (HSFG)” chapter. In case of machined bolts, check the condition of the bolts and nuts.					*	
Service Platform							
Walkways	Check the condition and clear access on walkways.			*			
Hand rails	Check the condition and fastening of the hand rails.				*		
Ladders and Staircase	Check the condition and fastening of ladders and staircase				*		
Cubicle fixing	Check the condition of fixing of electrical cubicles, tighten the bolts if necessary				*		
Hoisting trolley							
Welded joints	Check for cracks and signs of damage. Check for signs of fatigue (cracks) and corrosion.					*	
Connection bolts (structural and component mounting bolts) & splice joint bolts	Verify that the tightening torques correspond to the values presented in the “Tightening torques for Friction Grip Bolts (HSFG)” chapter. In case of machined bolts, check the condition of the bolts and nuts.					*	
Hoisting trolley power supply							
Cables	Check the condition of the cables and terminals			*			
Cable trolleys	Check the condition of the cable trolleys for free movement. Grease the rollers if necessary. Replace if rollers are worn out.			*			
Cable clamps	Check proper clamping of festoon cables and tensioning chain. Tighten the clamps.				*		
Track for cable trolleys	Check the fastenings, condition and cleanliness of the track					*	
Controls							
Radio	Check the condition and functionality of the pushbuttons and switches.	*					
Master Controller	Check the condition and functionality of Master Controller.	*					
Pendant	Check the condition and functionality of the pushbuttons and switches.	*					
Electrical crane operating devices	Check all electrical operating devices like horn, start button, mode selection, emergency stop speed release devices etc	*					
Gearbox							
Noise level	Check unusual noise from gearbox for gear teeth wear and for bearings condition to ensure smooth operation of gears.			*			
Oil level	Check oil level in the gearbox		*				
Oil leakage	Check oil leakage from gearbox, avoid overfilling of lubricant.			*			
Teeth pitting or scoring	Check quality and cleanliness of lubricant.				*		
Breather	Check that the breather is clean.			*			
Rope drum							
Rope drum hub	Check for loose or missing fittings. Look for possible cracks or deformations.				*		
Rope drum grooves	Measure an unworn section of the drum to determine the baseline to establish the acceptable wear measurements.					*	
Groove crests	Check the crests between the grooves. If sharp edges are formed, grind to give smooth radii.			*			
Grooves	Check grooves and ensure that there is no excessive wear by wire rope on grooves.			*			
Drum thickness below the groove	Check the thickness. If the wear is excessive replace the drum.				*		

Component	Checks	D	W	M	Q	HY	Y
Rope Pulleys							
Grooves	Check grooves and ensure that there is no excessive wear by wire rope on grooves			*			
Groove edges	Check that the edges of the groove are not sharp due to wear. If any grind to give smooth radii.					*	
Cracks	Check for hair cracks on the pulley. If any replace pulley.					*	
Brakes							
Air gap measuring	Check air gap between brake liner and drum			*			
Brake liners	Check wear of brake lining. If required replace liners.				*		
Load slip	Check that the drum surface is free from oil / grease. Check the brake linings. Maintain required gaps between linings in DC brakes		*				
Thrustor Oil level	Check oil level in the Thrustor brake. Replace oil periodically as per Lubrication chart		*				
Performance	Braking performance stroke distance should be checked.	*					
Torque	Adjustment of brake liners for correct torque.			*			
Motors							
Bearing temperature	Check bearing temperature. If very hot then check quantity and quality of lubricant and alignment of drive machinery		*				
Connections	Check that the connections are in a good condition			*			
Abnormal noise	Listen for abnormal sounds. Check fitment in housing, wear of bearing and for accumulation of dust in the bearing.			*			
Overheat while running	Check that all leads are properly connected because motor may have a phase open. Also check the air gap for dust.			*			
Motor vibration	Check drive alignment, bearing condition and balancing of the rotor and take corrective action.			*			
Wire ropes							
Ropes	Check the rope for defects in strands and wires		*				
Rope clamp	Check the condition of rope clamps. Keep them tight and locked.		*				
Wheels							
Wheels	Verify that the wheels are securely fastened to the structure. Verify that the wheels and bearings are clean. Verify that the wheels sit properly on the rail.				*		
Wheel tread	Check wheel tread for hair cracks. Observe the size and their growth.			*			
	Check that wheel treads are free from oil.			*			
Wheel flange	Check for wear of flange, replace wheel if thickness is less than determined standards.			*			
wheel alignment	Measure vertical, horizontal and angular alignment of wheel					*	
Bearings							
Noise	Check sound of bearings. If unusually high, check lubrication and bearing alignment. Replace the bearing if worn out.				*		
Temperature	Check bearing temperature by feel of hand. If unusually high, check lubrication and bearing alignment.				*		
Gear coupling							
Noise level	Check sound of gear coupling during starting and stopping. If high check the gear teeth for wear. Check lubrication.	*					
Alignment	Check for misalignment of flexible coupling and floating shafts (if any) at input.					*	
Grease leakage	Check coupling alignment and the tightness of clamping bolts.					*	

Component	Checks	D	W	M	Q	HY	Y
Crane electrics							
Current collectors and insulators	Check the condition of the crane current collectors, contact with DSL angles, tighten connection if necessary. Replace broken insulators				*		
Emergency stop	Check the operation and condition of the emergency stop button.	*					
Main isolator switches	Check the operation and condition of the main isolator switches.	*					
Drives	Check for proper functionality			*			
Cabling	Check the condition of the wiring and its connections.					*	
Earthing	Check the earthing of each electrical component on the crane.			*			
Air conditioning	Check for compressor unit and electrical panel			*			
Limit switches	Check the operation of the limit switches.	*					
	Check for wear of contacts and if found replace the contact or complete component.			*			
	Check limit-switches and striker position. Check fixing bolts				*		
Electrical Cubicles & terminal boxes	Check the security of the fastenings in the electrical cubicle and louvers/filter on the door of the cubicle.				*		
	Check & tighten loose terminations			*			
Resistance boxes	Check resistor racks and ensure that they are supported rigidly.					*	
	Check terminal bolts and ensure that they are tight.				*		
	Check cleanness of resistors. Check that wires are securely fastened			*			
	Check for insulation and break in connection due to excessive heat.			*			
Delay relays	Check the operation of the delay relays.			*			
Contactors	Check for wear of contacts periodically. Do not apply grease or petroleum jelly on contacts.				*		
Contactors and switch gears	Check the operation and condition of the contactors & switch gears				*		
Over-current protectors	Check the adjustment of the over-current protectors.				*		
Fuses/MCB's	Check the condition of the fuses/ MCB's				*		
Signs/Stickers							
Signs/ Stickers	Check the condition of the signs/stickers for readability.						*
Data plates	Check the condition of the data plates for readability.						*

As per statutory requirements, all cranes are required to be checked and tested every year from Government Approved authority.

Complete full load test of crane must be carried out after every one year.

For structural inspection information refer section 8.2

8.2 Inspection of welded structures

8.2.1 General

Welded steel structures always contain small un-detectable cracks, usually at welded joints. When these joints are subject to fluctuating stresses beyond a very small value, the cracks grow. This is called fatigue crack growth.

The allowable stress levels used in the design of the structure, take this phenomenon into account. The allowable stress levels are determined by analyzing laboratory tests. Typical details are subjected to cycles of stress fluctuation. The allowable stress level is determined by applying a factor of safety to the lower limit of the test data scatter band. In a few laboratory tests, failure occurs at a stress level below the allowable.

There are thousands of welded details in the crane structure, which are subjected to repeated stress fluctuation. It is probable that fatigue crack growth will take place in some details, before the end of full service life. This is a consequence of the statistical nature of the phenomenon.

There are no recognized crane specifications used in the world today, that have stresses at such a low level that fatigue crack growth will not be expected to occur on a random basis. Eventually, the fatigue cracks will become large enough to be detectable by means of non-destructive testing methods, i.e. dye penetrant, magnetic particle or ultrasonic.

The use of very ductile steel in KC cranes, ensures that cracks are detectable by visual inspection, before fracture is likely. In many cases, even if fracture occurs, the remaining elements of the structure will prevent serious damage, if the crane is immediately taken out of service and repaired.

Periodic inspection is required to detect fatigue cracks that have grown to a significant size, in order to avoid serious failure in the crane structure. When a crack is found, a repair is necessary.

Restoring the structure to its original condition is always acceptable. Sometimes, this is not practical, and a change in geometry by means of cutting and grinding is more economic.

Sometimes, fatigue cracks are found with a frequency significantly greater than would be expected, considering the stress levels used in the design. This may be caused by over stress in the crane during its operation. If such cracking is found, a review of the operation should be made, to see if over stress is occurring. Remedial measures should be developed to avoid it in future.

Cracking may also be due to differences in geometry between the actual detail and the tested detail. In this case, it may be more economical to modify the geometry to allow a smoother stress flow in the joints.

8.2.2 Inspection methods

In general, non-destructive testing (NDT) is sensitive to the external conditions and to the characteristics of the structure. Inspections must be carried out by qualified professionals using recognized methods.

NDT inspection personnel should be qualified according to

ISO 9712 Non destructive testing. Qualification and certification of NDT personnel. General principles.

ISO 17635 Non-destructive testing of welds – General rules for metallic materials.

If there is any suspicion of a crack, the weld must be examined thoroughly, so that the extent of the defect can be fully assessed.

Visual Testing (VT)

Visual testing should be done according to

ISO 17637 Non-destructive testing of welds -- Visual testing of fusion-welded joints.

Dirt and grease should be removed from surface by wiping with a rag. The surface should be inspected for cracked paint and rust showing through the paint. A good light (torch) and a magnifying glass should be used.

Magnetic Testing (MT)

Magnetic testing should be done according to

ISO 17638 Non-destructive testing of welds – Magnetic particle testing.

Acceptance levels according to

ISO 23278 Non-destructive testing of welds -- Magnetic particle testing -- Acceptance levels.

The test surface must be free from loose rust scale and moisture. An even paint layer may be left in place over the inspected surface, providing that the thickness does not exceed 100µm.

Note! If there is any doubt that the paint coating is affecting the test results, it must be removed from the inspection area.

Heavy grinding, brushing, or blasting may affect the results of this testing method in some instances.

A magnetic field can be applied to the test material using one of the following methods:-

1. A permanent magnet.
2. A yoke which includes an electro-magnetic device.

Ultrasonic Testing (UT)

Ultrasonic testing should be done according to

ISO 17640 Non-destructive testing of welds. Ultrasonic testing. Techniques, testing levels, and assessment

Acceptance levels according to

ISO 11666 Non-destructive testing of welds -- Ultrasonic testing -- Acceptance levels

Before this method can be used, the surface must be prepared to the required flatness and smoothness conditions.

The scanning can be done using suitable direct and / or angled probes.

The inspection results should provide detailed information about any defects within the volume of the weld, in addition to any surface cracks.

8.2.3 Inspection intervals

The basic inspection frequency is as follows	
:Year	Inspection
1 – 4 (see note 1)	Visual inspection of all welds at the end of the first year after start-up, and after each succeeding year. This includes the most critical areas of main girder that are subject to NDT in case of any sings of cracks on visual inspection.
5	After five years since start-up, the first full-scale NDT of welds must be carried out for the most critical areas of main girder. All other welds, box type beams and support structures are subject to a visual inspection.
6 – 14 (see note 1)	Visual inspection of all welds after each succeeding year. This includes the most critical areas of main girder that are subject to NDT in case of any sings of cracks on visual inspection.
15	The full-scale NDT is repeated ten years after the first one. All other welds, box type beams and support structures are subject to a visual inspection.
16 – 24 (see note 1)	Visual inspection of all welds after each succeeding year. This includes the most critical areas of main girder that are subject to NDT in case of any sings of cracks on visual inspection.
25, 30, etc.	The full-scale NDT is carried out after 25 years, and then repeated every five years. All other welds, box type beams and support structures are subject to a visual inspection.
26 - 29, etc. (see notes 1, 2)	Visual inspection of all welds after each succeeding year. This includes the most critical areas of main girder that are subject to NDT in case of any sings of cracks on visual inspection.

Note 1 If the visual inspections give reason to suspect excessive crack growth, additional NDT inspections must be carried out. These additional test requirements are restricted to the specific welds that are showing crack growth

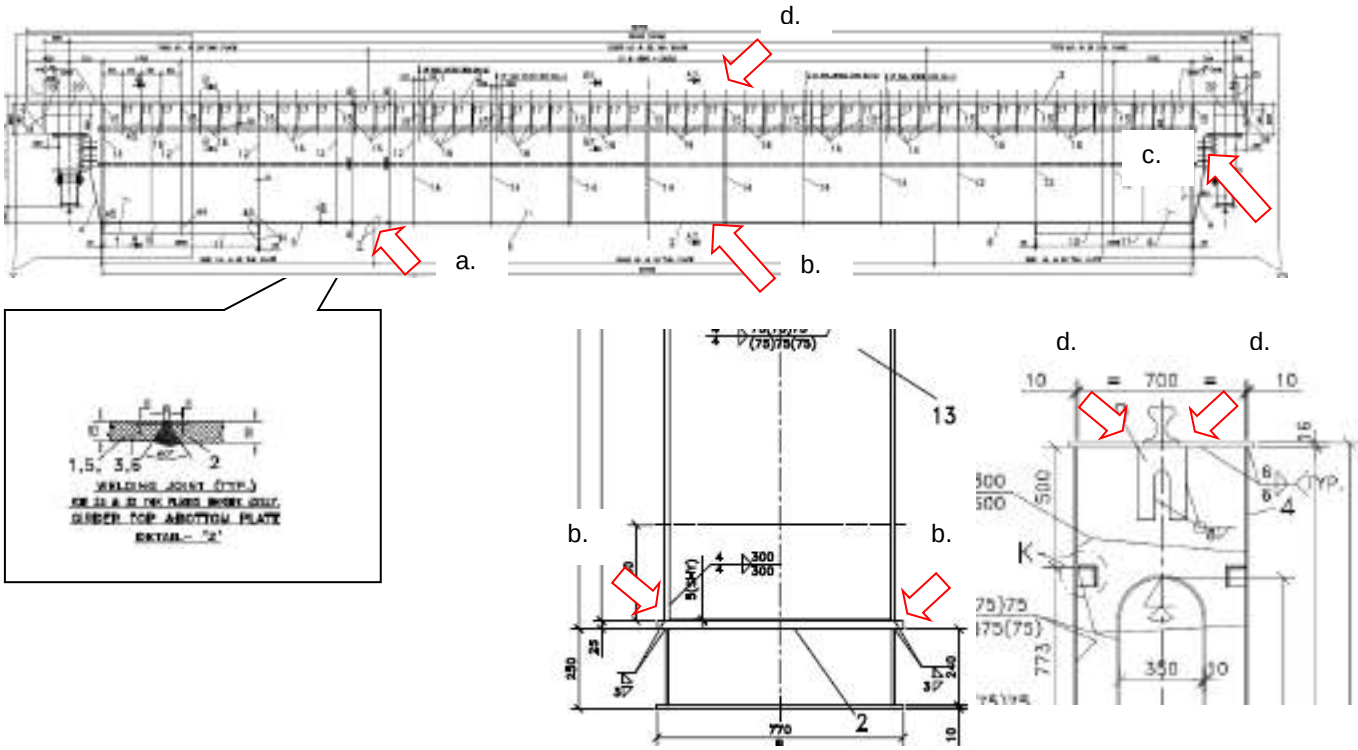
if use of crane is really heavy – inspection interval should be 2 times per year instead of ones per year during first 2 years

Note 2 After 25 years since start up, the NDT results for some weld details may show that there are a significant number of new cracks since the previous NDT inspection. This will occur if the stress levels in these details are close to the maximum allowable. For these welds, the NDT must be repeated every year, for the remaining life of the Crane.

8.2.4 Most critical areas of main girder

below on fig. 1 and 2 show most critical areas on main girder.

Figure 1. bottom flange welds and top flange.



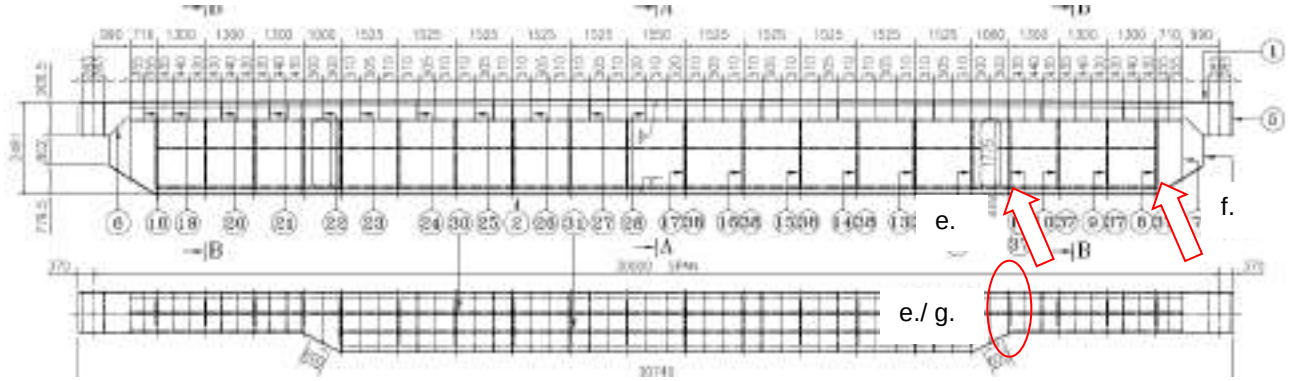
a. bottom flange joints, UT

b. welds near bottom flange near max. bending area on middle, MT

c. welds near end carriage and main girder joint, MT/UT

d. top flange near rail – Deformations or cracking base on local crushing (whole MG length), VT/MT

Figure 2. shape change areas on bottom flange.



e. Tapered beam areas on bottom flange – outside and also inside MG (inside when MG open – e room inside), UT/MT

f. All shape change areas on bottom plate, UT

g. Diaphragms inside main girder – especially area under rail (local crushing), VT

8.2.5 Reporting requirements for structural inspection

All indication of defects should be shown with the sketch and photograph of the weld detail.

Reports including:

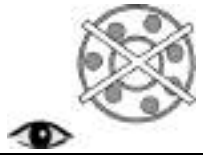
- Crane identification including: crane deliver year and start up / commission date and work cycle
- specification of crane use.
- Size and extend of defect.
- Whether defects are in the toe of weld, propagating into the base metal, etc.
- Defect location.
- Method of testing.
- Inspector’s comments and signature of approval by the AWS / IWI level inspector in charge.

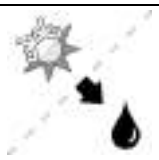
9 LUBRICATION

9.1 General Lubrication Instructions

If transmission oil has to be topped up, make sure that the lubricant being added is compatible. If transmission oil has to be replaced, flush out the gearbox before filling up.

The following table provides advice on the lubrication procedures which should be followed.

1	Usage of a low grade or incompatible lubricant can damage the gearing or bearings. Use only lubricants recommended by the crane's manufacturer. See the lubricant tables for more information. Use only fresh oils/greases. Different kind of greases shall not be mixed up. Information of chemical's safe handling, risks and handling as waste are described in Safety Data Sheet that is available from manufacturer of the lubricant.	
2	Handle lubricants carefully. Prevent leakages.	
3	Keep lubricants away from heat and open fires. Do not smoke when handling lubricants.	
4	Avoid contact with skin. Protection gloves and safety goggles shall be worn when handling lubricants. Hands shall be washed thoroughly after lubrication.	
5	Keep away from food and drink. Do not inhale any fumes or swallow lubricants.	
6	Used lubricant shall be handled as hazardous waste following local legal requirements. Store used lubricant in containers indicated for the purpose and dispose by a licensed company.	
7	Keep grease nipples clean.	
8	All slide bearings must be depressurized for the grease to be able to penetrate.	
9	While lubricating, check the functioning of the bearings and observe whether there is any bearing slackness.	

10	The specified lubrication periods apply in favorable conditions and normal use. More frequent lubrication is recommended in more demanding conditions and in heavy use, particularly of the slide bearings.	

Do not use excessive lubricant. Excessive grease may cause bearing to overheat and reduces the lifetime of the bearings.

9.2 Manual grease system in case grease solidifies

9.2.1 Pump

- Clean the reservoir of grease and fill in some lubrication oil (say Gearbox oil) available at site and operate the pump by few strokes of handle till the oil is discharged. Pump is then ready for use.

9.2.2 Progressive block

- Remove the inlet/outlet tubes from the progressive block. Then open the plug ports with allen key and remove the pins from the block.
- Put the block and pins in kerosene or diesel for half an hour and clean with compressed air. Refit the block and connect the pipes.
- Pump the grease in the block, the indication pin should move in and out about 5mm in each cycle. If indication pin is moving as said, then be assured that the progressive block is working properly and all outlet ports are getting greased. The progressive block is now ready for use.

Don’t plug any unused port of progressive block, otherwise it won’t work.

The progressive block should be of zinc alloy material and should not have any rubber parts.

9.2.3 Tubing

- Open all connecting tubing from pump, blocks, and lubrication points. Clean all tubes with compressed air. After cleaning, pass through some lubrication oil and refit the tubing.
- Apply the above said procedure and clean or flush the system as required in all hydraulic systems in case of blockages. The system is flushed with oil during first trials at our works.

9.3 Lubrication chart

No.	Components	Method of Lubrication	Lubricant Type	Frequency of Lubrication
1	Enclosed gearbox	Splash	L4	6 Month
2	Thruster brake	Manual	L5	Monthly
3	Wire Rope	Manual	L3	Half yearly
4	Motor Bearing	Grease gun	L2	Monthly
5	Geared coupling	Manual	L1	Monthly
6	Brake Lever pins, Open Gearing, Chain sprockets	Manual	L2	Monthly
7	Hook Bearing	Grease gun	L2	Monthly
8	Pulley Bearing	Grease gun	L2	Monthly
9	Line shaft Bearing	Grease gun	L2	Monthly
10	Rope drum pedestal Bearing	Grease gun	L2	Monthly
11	Gearbox Rope Drum Joint	Grease gun	L2	Monthly
12	Wheel bearing	Grease gun (Individual) / Grease gun (Grouped)	L2	Monthly
13	Cable trolley Bearings	Grease gun	L2	Monthly

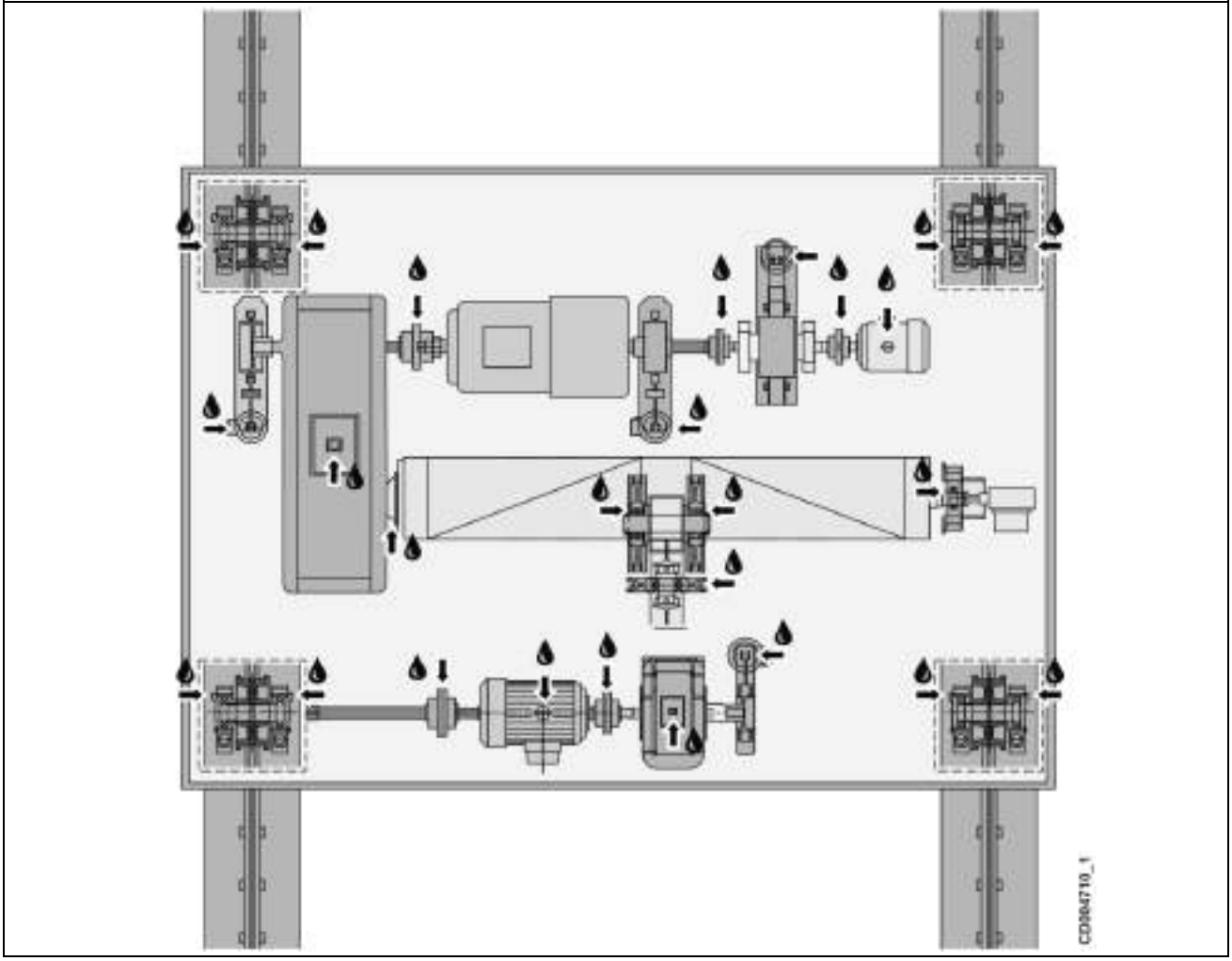
Recommended and Equivalent lubricants

Lubricant Type	Indian oil Corporation (IOC)	Bharat Petroleum (BP)	Hindustan Petroleum (HP)
L1	Servomesh SP 320	Amocam - 320	Parthan EP 320
L2	Servogem 2 or 3/ Servogrease MP	MP grease 2	Lithon 2 or 3
L3	Servo coat 140	Camex compound 'F'	HYTAK 2
L4	Servomesh 680	Amocaml 680	Parthan EP 680
L5	Transformer oil BS 148 or equivalent		

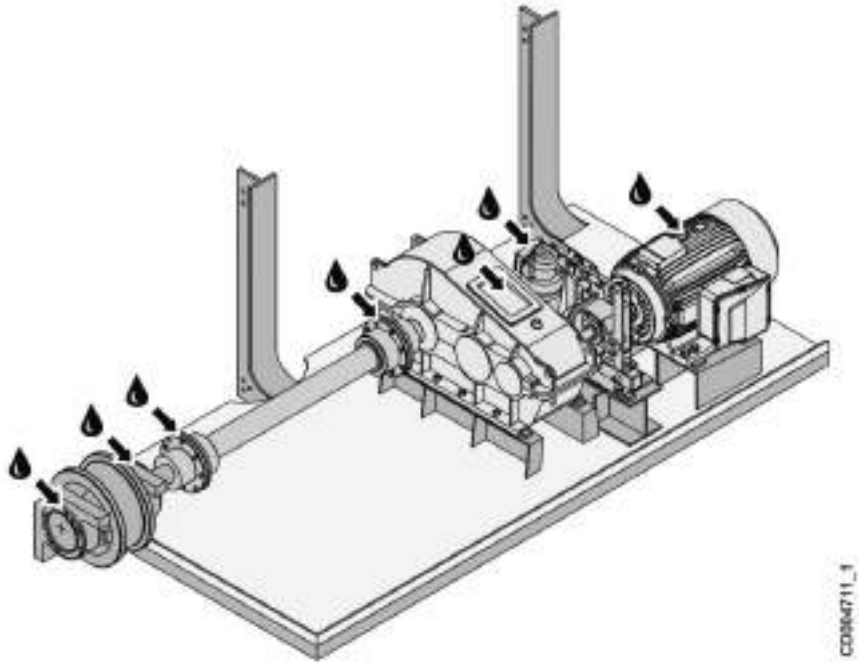
In case for vertical Gearbox a motorized pump may be used because of insufficiency of splash lubrication. In such case, please check weekly that the inlet and outlets of pump are not chocked or blocked due to slag.

9.4 Lubrication points on different machineries

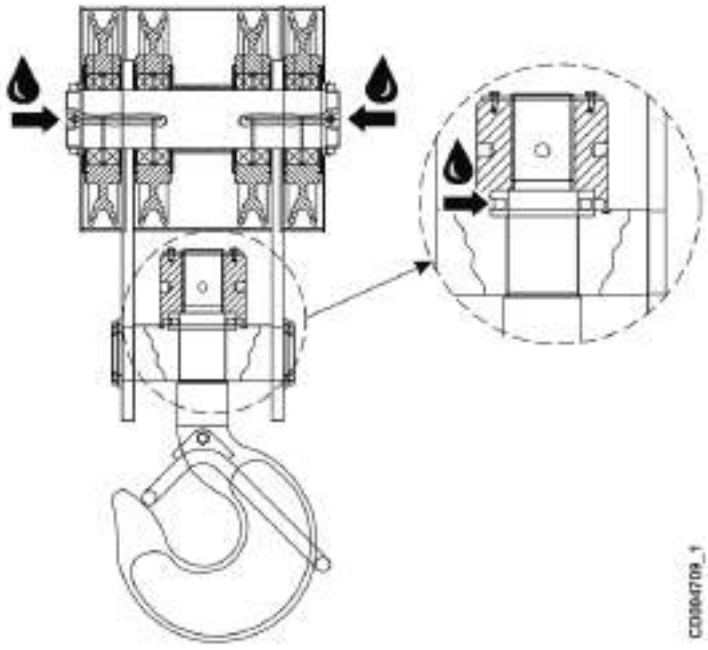
Trolley



LT (Long Traverse) Machinery



Hook Block



10 CONTROL DEVICES AND THEIR LOCATION

10.1 Cabin

10.1.1 Master controller

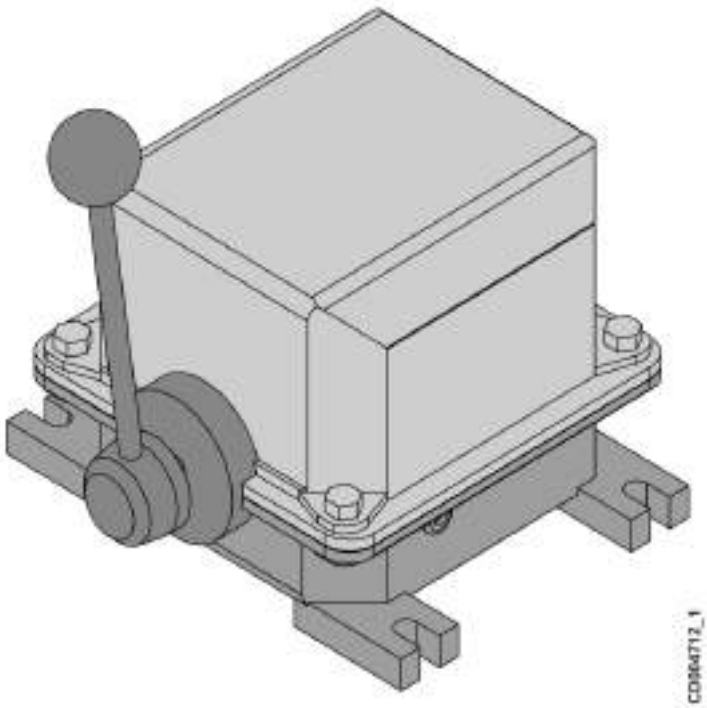
- Master controller controls the whole system of crane movements. It is in the cabin at a desk height of operator.
- The controllers are made of Water and dust proof of suitable IP class enclosure, up to 5 notches either side with adequate contacts as per desired sequence with steps/stepless/spring return arrangement/deadman's handle arrangement.
- Dual Master Controller bodies are provided with one common universal handle which allows operate both LT and CT travel motions simultaneously for efficient operation of the crane.
- Master Controllers are compact, suitable for Hoist; CT-LT maximum adequate contacts per motion with spring return arrangement & deadman's handle arrangement.
- Different master controller are used for different motions in the crane, for e.g.
  - Long traverse
  - Cross traverse
  - Main hoist
  - Auxiliary hoist (optional)

Deadman's control:

This consists of one auxiliary contact of two circuit block (1 NO+ 1 NC) operated through a spring loaded push button provided on joystick handle. In case of operator looses the grip over button during operation, motion will come to stop as main contactor will be de-energized.

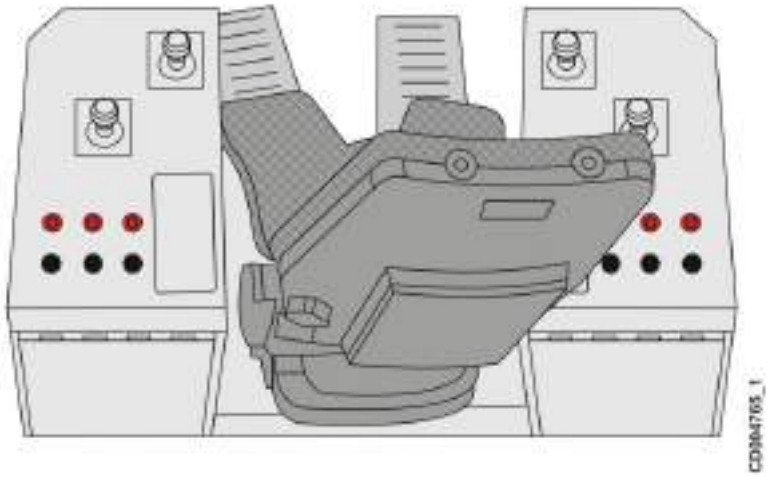
Spring Return arrangement:

The master/cam controller can be provided with spring return arrangement whereby handle returns to the neutral position when it is released. Spring return handle also serves as dead man handle.



10.1.2 Arm Chair/ Control Desk

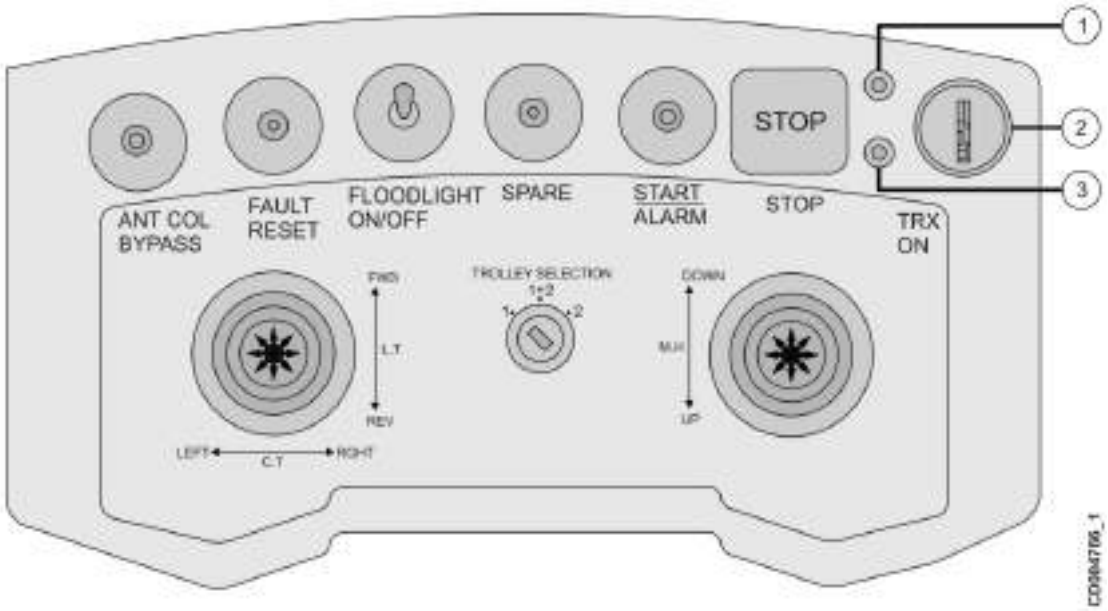
- Armchair has fully adjustable armrests and control consoles that offer horizontal, vertical, and longitudinal motions.
- It consists of left and right console on the arm rests. Consoles are equipped with joysticks, pushbuttons, indicating lamps.
- Arm Chair or Control Desk facilitates the operator a very clear view of the load being handled from the cabin and to enable him to adopt a firm and comfortable posture while operating.
- Arm chair ensure greater safety and comfort to the operator, more effective results, higher productivity.
- Everything the crane operator needs to operate crane is within his reach with Arm Chair.
- Armchair can be fixed or revolving.



The layout of controls may vary from crane to crane. The function of each control is indicated by a symbol and it is important that the operator knows what the symbols mean in order to operate the crane safely.

10.2 Radio Controller

- It consist of Transmitter which is with operator and receiver which is mounted on crane.
- Maximum 2 speeds for each motion can be achieved with radio remote having push buttons.However more speeds are possible with joystick type radio remote.
- Speeds depend on the settings made in respective motion inverter.

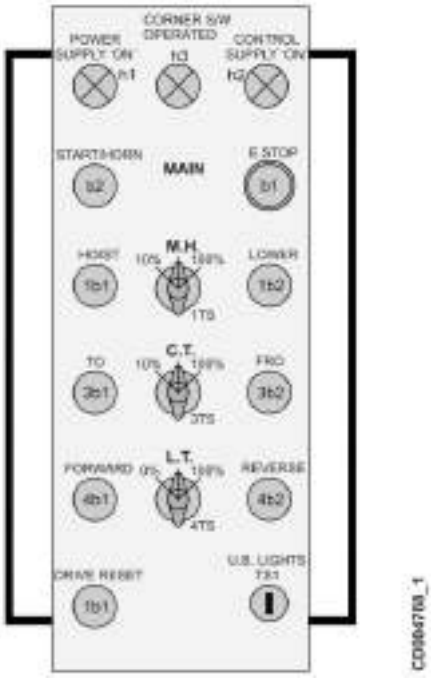


1. *Transmission ON*
2. *Key Switch*
3. *Battery Indicator*

WARNING	Operating the radio with a low battery can result in sudden loss of control and hazardous situations. Charge the battery promptly if the low battery lamp is lit on the radio.

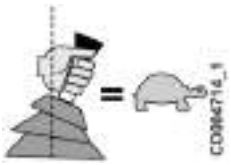
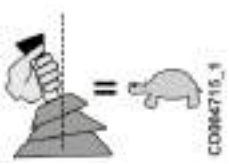
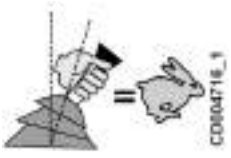
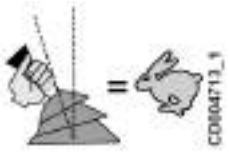
10.3 Pendant

- Pendants could be fixed type i.e. fixed to Crane Bridge or moving type i.e. is moving along crane bridge or moving with trolley.
- These are normally made of aluminum casting.
- For speed selection, separate selector switch is provided for each motion along with its direction pushbuttons.
- Control ON and Power On indication as standard are provided on pendant.
- On/Off switch for Under Bridge Lights, if applicable, also provided on pendant.



10.4 Controls for Movements

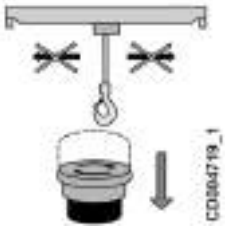
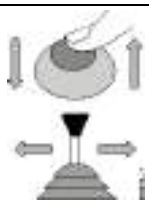
The speed corresponds to the direction control. Crane moves at the slowest speed when the joystick is partially pushed and at the maximum speed when the joystick is fully pushed. Crane stops moving when the joystick is brought to neutral position.

1	When the joystick is brought to neutral position, the crane will stop moving.		
2	When the joystick is moved lowest angular movement, the crane will move at a slow speed.		
3	When the joystick moved highest angular movement, the crane will accelerate up to the maximum speed.		

Joystick is applicable when the control is through Cabin or Arm Chair with master controller or Radio Controller with joystick controller. It is not applicable for Pendant with push buttons or radio remote with pushbuttons.

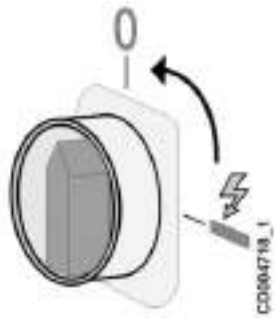
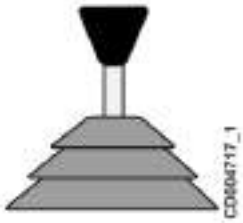
10.5 Operational Checks with the Emergency Stop Button Pushed Down

WARNING	If the emergency stop button is faulty, the crane might not stop when required leading to major accident.

1	Emergency stop button With the emergency stop button pushed down, check that the crane does not move when the direction controls are pushed. This verifies that the emergency stop button is working properly.	
2	Control devices without power Check for smooth mechanical operation of each pushbutton, joystick or safety switch on the controller. These devices should press and release smoothly, without sticking. The operator should be able to feel the positions where the pushbutton or joystick would engage higher speeds for step controllers.	

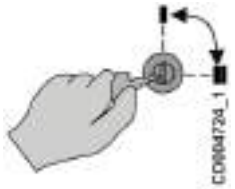
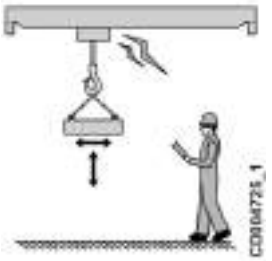
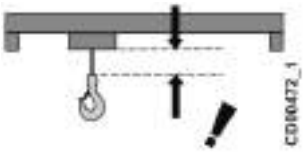
10.6 Crane start up

WARNING	Never release the emergency stop button and drive the crane until you are sure that it is safe to do so. Releasing the emergency stop button and driving the crane when it is unsafe to do so could cause death or serious injury.

1	Make sure that the main power isolation switch is ON. The crane only becomes operational (energized) after the necessary pre conditional steps have been followed to established communication between the crane and controller.	
2	Release the emergency stop button by turning it.	
3	Press the ON button.	
4	Bring all joystick controllers to zero position and other related multi mode operational switches in appropriate positions.	

10.7 Operational Checks with Controller enabled

Before every working shift, all of these checks must be done with the emergency stop button released and with the power turned on.

1	Crane selection If the **controller** has an crane selection switch, select the correct crane before carrying out these checks.	
2	Warning devices Check that all warning devices (for example, pilot lamps, LEDs, displays, horns, gongs, bells, sirens, beacons, strobe lights) are working correctly before using the crane.	
3	Control devices with power Starting at low speed, check that movements correspond to the **controller** labels. Check that the brakes operate in all directions and that speed increases as it should do in relation to the control. Listen for unusual noises. Check for braking distances in safe zones for minimum speed to maximum speed.	
4	Limit switches Check for correct operation for all limit switches specially the upper (primary) limit switch by raising the hook up and stopping it before the limit switch activates. Slowly inch the hook up until the limit switch activates and prevents further upward movement.	

⚠ CAUTION	Adopt cautious approach while testing/approaching all limit switches as limit switch failure may lead to major accident.

5	Safety latch Check to ensure that the hook safety latch is on the hook, is in good condition and closes automatically.	

NOTICE	The radio remote controller only works when it contains a battery which is adequately charged.

11 SPAN MEASUREMENT

Checking crane span and trolley gauge are among the inspection points listed in chapter 8.1
Following are the instructions for span measurement

- Branded steel tape of 13 mm width and 0.22 mm thick is used.
- Pull as per below table should be applied to the tape to get the exact span.
- The pull varies in accordance to the span. Tape pull chart (as provided below) gives the value of pull to be applied as per the span.
- Temperature value correction is not taken into account.

The given below pull (Tape pull chart) is the neutralized effects of tension and sag. Hence tape should be suspended during measurement. It is recommended to use Laser meter of good accuracy.

Span (in meters)	Pull (in kg)	Span (in meters)	Pull (in kg)
10	6	31	11.5
11	6	32	11.5
12	6.5	33	11.5
13	7	34	12
14	7	35	12
15	7.5	36	12.5
16	7.5	37	12.5
17	8	38	13
18	8	39	13
19	8.5	40	13
20	8.5	41	13.5
21	9	42	13.5
22	9	43	14
23	9.5	44	14
24	9.5	45	14
25	10	46	14.5
26	10	47	14.5
27	10.5	48	15
28	10.5	49	15
29	11	50	15
30	11	-	-

12 TIGHTENING TORQUES FOR FRICTION GRIP BOLTS (HSFG)

The recommended tightening torques for fastenings.

NOTICE	Values shown in the table are nominal values.

	Tightening torque			
Size	Strength 8.8		Strength 10.9	
	[Nm]	[Ft lb]	[Nm]	[Ft lb]
M4	2.7	2.0	4.0	2.9
M5	5.4	4.0	7.9	5.8
M6	9.3	6.8	14	10.3
M8	23	17.0	33	24
M10	45	33.0	66	48.5
M12	77	56.6	115	84.6
M14	125	92	180	132
M16	190	140	280	206
M18	275	202	390	287
M20	385	283	550	404
M22	530	390	750	552
M24	660	485	950	699
M27	980	721	1400	1030
M30	1350	993	1900	1398

Instruction for surface preparation for friction grip bolts

- Ensure that all drilled holes are free from burrs / paints / rusts.
- Just before assembly, surface in contacts must be made free from paints / oil / dust / protective coating etc which will prevent solid seating or would interfere in developing friction between them.
- No buffing / grinding / flame burning of the contact surface shall be done for removal of paints / protective films as it will affect the surface roughness.
- Before fixing any HSFG bolts, ensure that all the four corners of the joints are located firmly with drift pins.

13 DISPOSAL OF WASTE MATERIAL

Waste material from installation, maintenance or dismantling shall be handled and disposed of according to local regulations. From the sustainability point of view, the preferred waste handling methods are reuse, recycle as material, recycle to energy, and as a final resort, safe disposal.

As waste regulations and types of recovery and disposal methods vary so much regionally, no general detailed guidance can be given. The chart below gives example of manufacturer's proposals for adequate waste handling methods.

NOTICE	Use always licensed recycling companies.

1	**Metals** should be recycled.	
2	**Electronics and electromechanical components** should be collected separately and recycled. Some electrical parts may be treated as hazardous waste, e.g. standard fluorescent lamps contain mercury.	
3	**Batteries** and other energy storage components may contain hazardous substances. These items should be collected separately and recycled according to local regulations.	
4	**Plastics** should be either recycled as material or used for energy recovery or land filled. PVC plastic should be recycled according to local regulations.	
5	**Chemicals**, like oil, grease, paints and other liquids shall never be spilled onto the ground, soil or sewage. Waste oil and grease shall be stored in containers indicated for the purpose	
6	**Packing materials and waste**, like plastics, wood, cardboard, cotton waste, cleaning cloth and paper should be reused or recycled as material or to energy.	

14 SPARES AND SERVICES

14.1 Spares

Konecranes undertakes supply of spares for cranes manufactured or supplied by them. In some special cases spares are also supplied for Cranes not manufacured by Konecranes. Due to normal wear and tear of vital crane components, it becomes essential to go in for replacements.

Poor quality of spares purchased from other suppliers may affect the life of components as well as the whole crane. Also there is a high risk for crane break down because of wrong selection of equivalent spare parts. We srongly recommend that the customer should pay attention to the source and quality of spares that they purchase.

Konecranes recommend standard spares that the customer should buy along with the crane in order to avoid down-time of production line saving the valuable time of his cranes.

14.2 Services

Konecranes offers services for cranes and equipments. These services are provided not only for the cranes and components manufactured by Konecranes but also for other manufacturers.

Konecranes offers following services and assure dedicated support for these services whenever required.

14.2.1 CRS (Crane Reliability Survey)

CRS is an exhaustive analysis and comprehensive report available for all makes and models of crane. The CRS is performed by a team of highly trained and experienced specialists, using the most advanced technology. The results are presented in comprehensive report that outlines the condition of your crane and its current operating capacity.

The CRS is comprised of several modules:

Core Inspection and Analysis

An overall inspection and analysis of the crane, including:

- Service life analysis
- Detailed crane inspection
- Detailed crane identification
- CRS executive summary

Structures and working conditions

An examination of the crane’s condition by evaluating the operating environment, including:

- Ambient condition analysis
- Power supply analysis
- Geometric analysis (Rail Q)
- Steel structure analysis

Components

A detailed assessment of the present condition of the crane’s key components, including:

- Electrical component analysis
- Motor analysis
- Rope analysis
- Gear analysis
- Hook analysis

Maintenance and reliability

A maintenance and reliability study to identify the most critical elements that may cause downtime, including:

- Reliability analysis
- LCA environmental impact analysis
- Spare part analysis

- Cost analysis
- Maintenance Assessment Program (MAP)

14.2.2 ETA (Equipment Technical Audit)

The aim of ETA is to check all technical aspects (electrical and mechanical) associated with the crane components and as certain the health of the complete lifting system.

What we inspect in ETA?

- Runway
- Wheel Block
- Rope Drums
- Hook Block
- Gearbox
- Rope/ Chain
- Motors
- Brake
- Safety Components
- Steel structure
- Electrical Components
- Festoon System
- Bus bar & current collector

Features and Benefits:

- Is a comprehensive Health check service product.
- Modular design - can be customized as per need.
- Available in 2 configurations:
  - Dismantled condition.
  - Assembled condition.
- Audit is carried out by technically competent engineers.
- Provides critical information i.e. the actual working condition of each crane Component by using service life analysis.
- Highlights the condition of the crane safety devices.
- Helps to understand the seriousness / criticality of issues affecting productivity.
- Highlights the need for changes in Mechanical and Electrical components (Modernization) to meet the production demands.

14.2.3 AMC (Annual Maintenance Contract)

Konecranes' Annual Maintenance Contract program typically covers over 50 components and includes the inspection and servicing of the following:

- All components requiring lubrication.
- Control stations and wireless controls, for operation and safety functions.
- All wear items, for signs of fatigue or excessive wear.
- All structure and supports, visually for failures.
- Hooks and lifting devices.
- Load chains or wire ropes.
- All limit switches and safety devices, Motor brake, for operation and adjustments.

Different service levels:

- **CONTACT**: When you need a reliable service provider to fulfill your immediate needs. We provide the needed services, spare parts and other products, but leave you the responsibility and freedom to arrange and manage your maintenance activities.
- **CONDITION**: When you need a reliable service provider to take care of the periodic and scheduled inspections. We provide you the industry leading inspection services to guarantee the safety of your equipment.
- **CARE**: When you need a service provider to help you maintain and improve your crane condition. We take responsibility for planning, arranging and managing inspections and preventive maintenance activities.
- **COMMITMENT**: When you need a partner to share the responsibility to maintain and improve the productivity and availability of your crane. We offer you a full scope maintenance solution with long-term development plan.
- **COMPLETE**: It is a long-term (5-10 years) contract, where Konecranes provides full material handling services with full responsibility over the crane and personnel and may also entail operation services for specific parts of the production process.

KONECRANES®
Lifting Businesses™

BOLTED JOINT AND SPLICE JOINT

Original instructions

INDEX

1 ASSEMBLY AND MAINTENANCE OF FRICTIONAL SPLICE JOINTS

1.1 GENERAL

All of the bolts used in the same joint must come from a single production batch. This concerns also the test and calibration procedures of the tool.

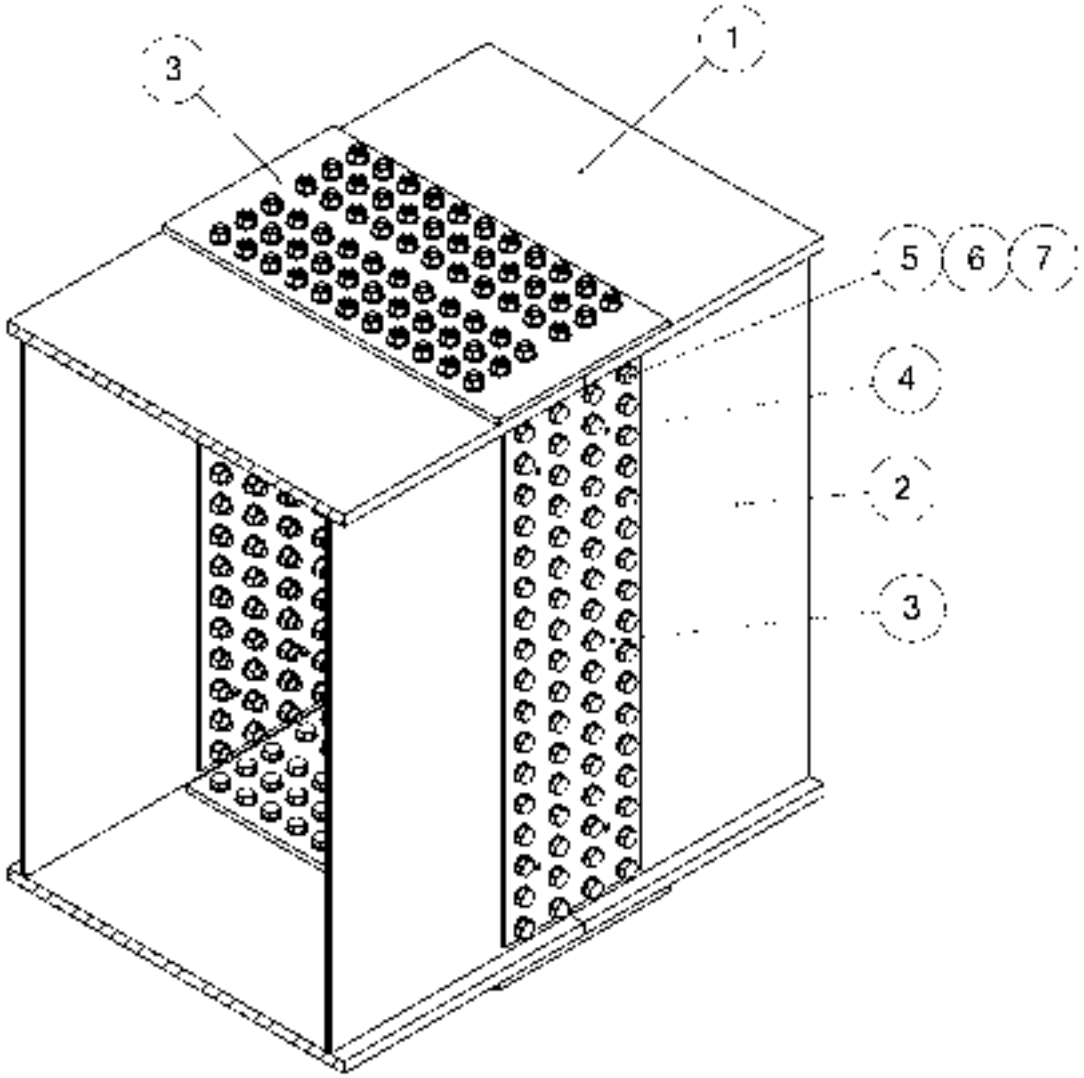
In order to maintain reliable tightness in a joint, the same tightening tool should be used both for initial tightening and for maintenance inspection.

The pre-tightening values of each particular bolted joint must be collected from the drawings or from the specific maintenance instructions of the joint.

The condition of the friction surfaces determines the capacity of the joint. The required roughness and cleanness shall be made sure anytime before assembly.

If there is any doubt concerning the roughness and cleanness of the friction surfaces the joint shall be checked.

Figure 1. Splice joint.



1. Beam flange plate
2. Beam web plate
3. Joint plate
4. Positioning pin
5. Screw
6. Nut
7. Washer

1.2 CONDITION OF THE SPLICE JOINT AND CONTACT SURFACES

1.2.1 Pre-erection at Workshop:

- Sand blast the friction surfaces of the joint plates and corresponding areas of the beam. Blast surfaces shall conform to the following quality: ISO8501-1 SA2 1/2 / ISO8503-2 class M.
- Cover the friction surfaces and all contact surfaces under washers after pre-erection with an anticorrosion agent which is strong enough to last the transportation conditions. The agent shall be washable so that it can be washed away from the surfaces when the joint is connected. One suitable agent is Dinitrol 110.
- Before covering ensure that the surfaces are as specified above.
- For transportation close the openings so that the interior of the beams is shielded against rain.

1.2.2 Erection of the Structure:

- Before the final erection, wash the friction surfaces and all contact surfaces under washers in the joint plates and in the beam with white spirit to remove the protection material properly.
- Before assembling ensure that the surfaces are as specified above.

The surfaces must not be brushed with power brush or equal.

- Join the beam first by joint plates on the webs. Use the positioning pins, if provided (figure 2 part 4).

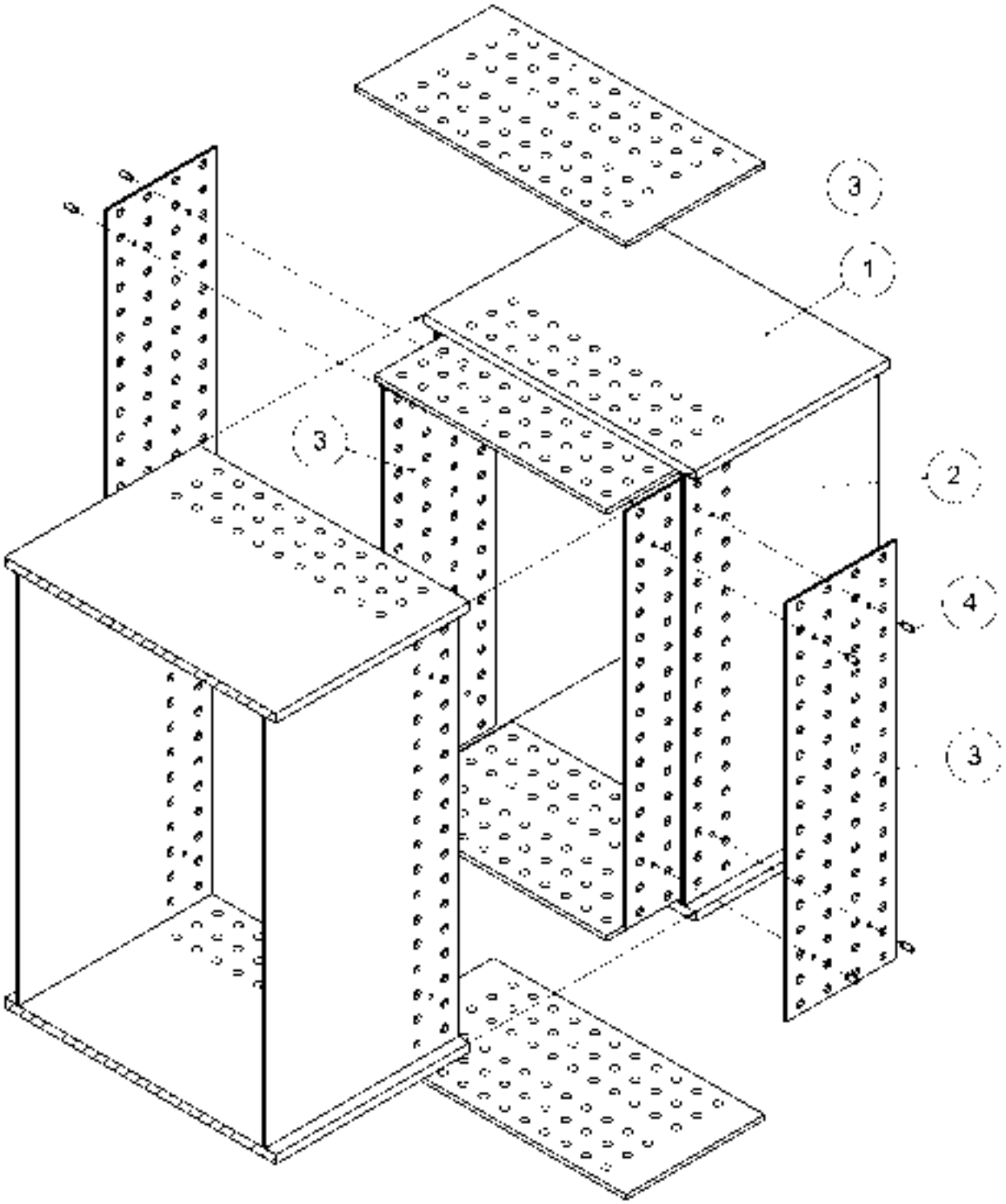
Joint plates must be free of all dirt and lubricating media.

- Bolts, nuts and washers to be lightly lubricated. –Lubricant must not come to the joint surfaces.
- In case bolt assembly is according to EN14399 quality lubrication has to be made only if screw manufacturer states it is required.
- See certificates and screw packages for tightening instructions. Follow manufacturer's instructions and do not exceed the torque values given for the particular set of goods. Refer to DOC001668 before continuing from this point on.

Remember to put the inner splice plates inside either of the beam halves before joining.

Friction surfaces and all contact surfaces under washers shall not be painted in any way!

Figure 2. Erection of the joint.



1. Beam flange plate
2. Beam web plate
3. Joint plate
4. Positioning pin

1.3 INITIAL TIGHTENING, TORQUE WRENCH PROCEDURE

Bolts up to the size M27 may be tightened to nominal torque value given in the KONECRANES drawings or instructions. During actual tightening, torque values indicated by the tool are compared to this nominal value.

For bolts of size M30 or larger, the torque wrench must be calibrated by bolt elongation tests according to maintenance instruction DOC001668. The final torque value for the wrench applied in the actual tightening is achieved from this test. The nominal torque values shown in drawings or in maintenance instructions are reference values, only for the calibration.

If bolts are certified according to EN14399 follow the tightening torque value given in the certificates or manufacturer's package. Refer to DOC001668.

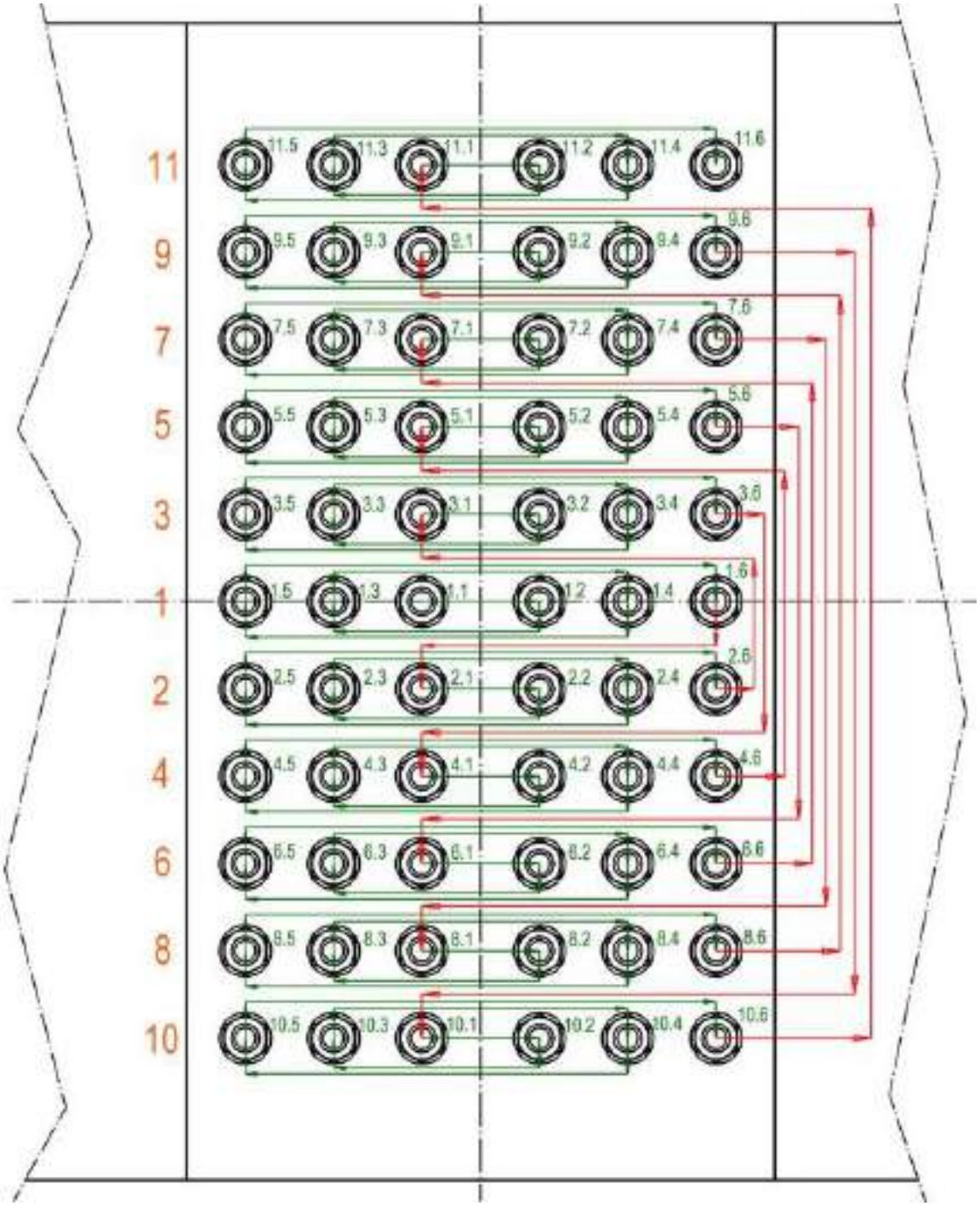
In case there is any suspicion about the torque value elongation test shall be made also for smaller than M30 EN14399 screw assemblies.

Tightening procedure is as follows:

- Check that the washers are exactly flat, and free of burrs and defects.
- Clean the bearing surfaces in the structure for washers and check that the surfaces are level.
- Clean and lightly oil the bolts and nuts.
- Set the washers so that beveled side is against bolt head or nut.
- Tighten the bolts first to 80 % of the full pre-tightening value. Start in the mid of the joint and proceed according to figure 3, until the whole joint has been gone through.

- Tighten the bolts to the full pre-tightening value. Start in the mid of the joint and proceed as shown in the figure, until the whole joint has been gone through.

Figure 3. Principal sequence of tightening.



1.4 FRICTIONAL SPLICE JOINT MAINTENANCE

1.4.1 General

During the operation of the crane, the bolted joints are subjected to varying loads. The loads on the bolts in a slice joint are little affected by the loading of the joint. For the joint is frictionally bonded, it is essential that condition of the friction surfaces remains original and all the bolts remain at a high and even pre-tightening level.

The purpose of the periodic check is to make sure that all bolts are giving full normal force to the joint and to make sure that the friction surfaces are in original frictional condition.

In operation, the bolts can become loose through settling of the joint surfaces or corrosion between the splice plates.

In a proper frictional splice joint there is never any movement between the joint plates and plates of the beam.

If elongated or suspect bolts are found, they are exchanged to new ones before fatigue fracture occurs in them.

1.4.2 Frequency of Frictional Splice Joint Inspection

For the main bolted joints, specific instructions of the inspection frequency may be given in the particular instructions of these joints. This concerns major structural joints, which are shown in the Structural Inspection Plan.

If other instructions do not exist, the following basic inspection frequency must be followed:

Table 1. Basic inspection frequency.

Inspection action	Time of action (Years after start up) Structural joints
Visual inspection	1 – 4 6 – 14 16 – 24 26 –>
Bolt tightening procedure	5 15 25, 30, 35
Replacement of all bolts	When needed, see chapters 4.4 and 4.5

1.4.3 Visual Inspection

For each joint, the visual inspection should include the following checks:

- There are no cracks in the paint covering the beam and splice plates.
- There has been no relative movement between the joint faces.
- There are no marks of corrosion in any of the joint parts (figure 1).

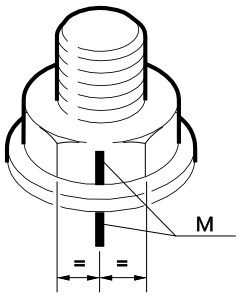
If there is any evidence of relative movement between the joint plates and beam plates, the joint shall be opened and checked as described in chapter 4.5.

If there is any doubt concerning the roughness and cleanness of the friction surfaces (e.g. corrosion) the joint shall be opened and checked as described in chapter 4.5.

1.4.4 Bolt Tightening Procedure

- The joint must be as unloaded as practical and the crane must be out of operation during the inspection.
- Spray thin, oiled corrosion release agent (CRC) onto all of the nuts and washers. Let it affect for 10…20 minutes.
- Record the initial position of each nut by stamping the nut and the structure next to the washer with checking marks (M).

Figure 4. Stamping the nut and the structure.



- Hold the other end of the screw properly so that it cannot be turned while the torque is being applied to the nut.
- Start in the mid of the joint and proceed according to figure 3, until the whole joint has been gone through.
- Apply a torque of 80 % of the nominal value onto each bolt.
- Check turning of the nut: If the nut has turned, mark this bolt by paint to be replaced.
- Repeat the above steps 3…5 for all of the bolts in the joint.
- Count how many bolts are marked to be replaced.

If more than 20 % of the nuts in the joint have been marked, do the joint overhauling as described in chapter 4.5.

If less than 20 % of the nuts in the joint have been marked to be replaced, the marked bolts and also one nearest bolt on either side of the marked ones must be replaced by new ones.

- Also mark these adjacent bolts by paint to be replaced!

Damage deliberately each removed bolt to prevent its reuse!

- Nuts which, have not turned must be retightened by following method bolt by bolt:
  - First loosen the nut by turning it 30 degrees.
  - Retighten the nut by the full pre-tightening torque.

1.4.5 Joint Overhauling

All of the bolts used in the same joint must come from a single production batch. This concerns also the tool operating and/or tool calibration tests.

Before the tightening work, carry out the described tool operating and/or tool calibration tests.

- The joint must be as unloaded as practical and the crane must be out of operation during the overhaul.
- Sand blast the friction surfaces of the joint plates and corresponding areas of the beam. Blast surfaces shall conform to the following quality: ISO8501-1 SA2 1/2 / ISO8503-2 class M.
- Check that the washers are exactly flat, and free of burrs and defects.
- Clean the bearing surfaces in the structure for washers and check that the surfaces are level.
- Clean and lightly oil the bolts and nuts.
- Set the washers so that beveled side is against bolt head or nut.

CAUTION	For the joint overhauling procedure, it is essential that only one pair of splice plates is slackened and removed from the joint at one time.

Before overhauling contact Konecranes for crane specific information.

- Tighten the bolts first to 80 % of the full pre-tightening value. Start in the mid of the joint and proceed according to figure 3, until the whole joint has been gone through.
- Tighten the bolts to the full pre-tightening value. Start in the mid of the joint and proceed as shown in the figure, until the whole joint has been gone through.

2 TIGHTENING AND MAINTENANCE OF BOLTED JOINTS

2.1 GENERAL

All of the bolts used in the same joint must come from a single production batch. This concerns also the test and verification procedures of the tool.

In order to maintain reliable tightness in a joint, the same tightening tool should be used both for initial tightening and for maintenance inspection.

The pre-tightening values of each particular bolted joint must be collected from the drawings or from the specific maintenance instructions of the joint.

2.2 INITIAL TIGHTENING, TORQUE WRENCH PROCEDURE

Bolts up to the size M20 may be tightened to nominal torque value given in the KONECRANES drawings or instructions. During actual tightening, torque values indicated by the tool are compared to this nominal value.

For bolts of size M22 or larger, the torque wrench must be verified by bolt elongation tests according to maintenance instruction DOC001668. The final torque value for the wrench applied in the actual tightening is achieved from this test. The nominal torque values shown in drawings or in maintenance instructions are reference values, only for the verification.

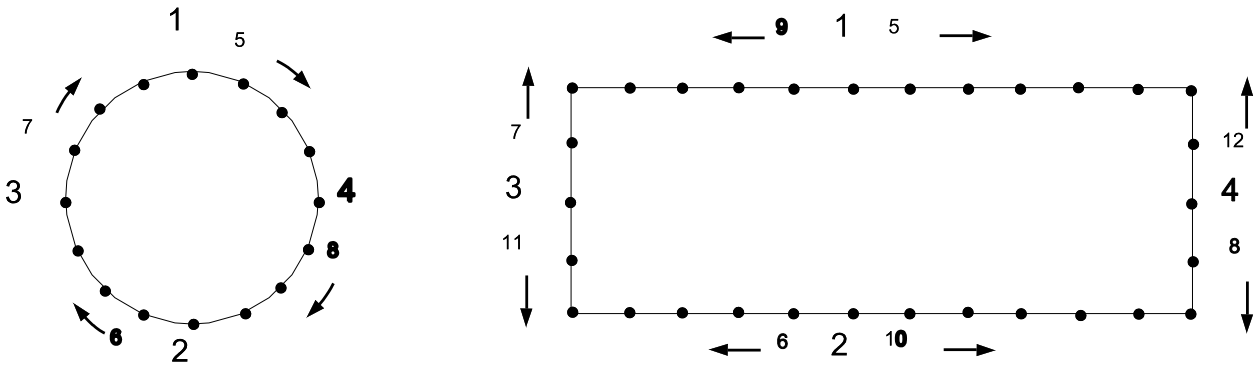
If bolts are certified according to EN14399 High-strength structural bolting assemblies for preloading, follow the tightening torque value given in the certificates or manufacturer's package. Refer to DOC001668.

In case there is any suspicion about the torque value elongation test shall be made also for smaller than M22 EN14399 screw assemblies.

Tightening procedure is as follows:

- Check that the washers are exactly flat, and free of burrs and defects.
- Clean the bearing surfaces in the structure for washers and check that the surfaces are level.
- Clean and lightly oil the bolts and nuts.
- Apply copper paste with a suitable wiper cloth or brush to the threads of the bolts and nuts as well as the surface between the nut (or bolt if tightened from the bolt side) and washer.
- Set the washers so that beveled side is against bolt head or nut.
- During assembly, fill the "JOB DATA SHEET FOR USE WITH TORQUE WRENCH" on page 11.
- Tighten the bolts first to 80 % of the full pre-tightening value. Start simultaneously on the opposite sides of the joint and proceed according to figure 1, until the whole joint has been gone through.
- Tighten the bolts to the full pre-tightening value. Start simultaneously on the opposite sides of the joint and proceed as shown in the figure, until the whole joint has been gone through.

Figure 1. Sequence of Tightening.

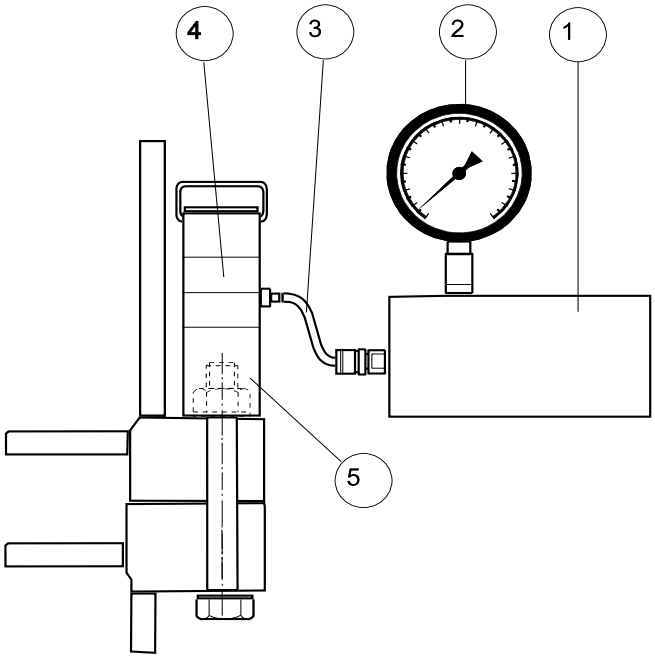


2.3 INITIAL TIGHTENING, HYDRAULIC TENSIONER PROCEDURE

2.3.1 Tool construction

The construction of a hydraulic tensioner varies according to actual make, but the principal parts shown in the figure can always be found.

Figure 2. Hydraulic tensioner.

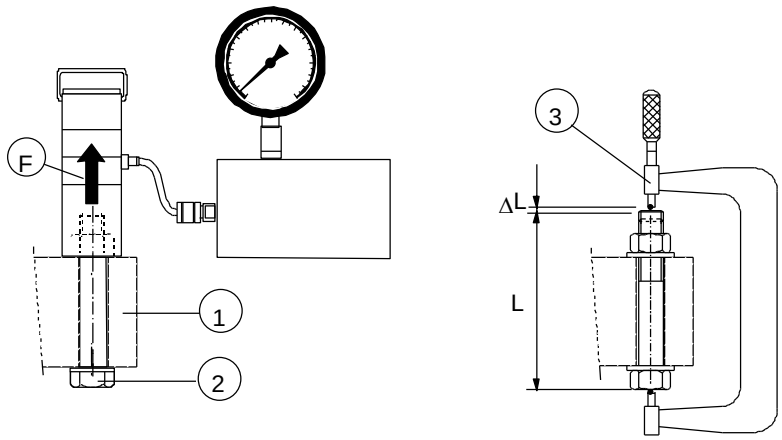


1. High pressure pump
2. Pressure gauge
3. High pressure hose
4. Hydraulic tensioner
5. Sleeve

2.3.2 Testing and verification of tool

Operating method of the tool must be practiced in the work shop before the actual tightening work is started. The correctness of the method is demonstrated by measuring the achieved bolt elongation (ΔL) and comparing this to the design value.

Figure 3. Testing arrangement.



1. Steel block
2. Test bolt
3. Micrometer

Test procedure is as follows:

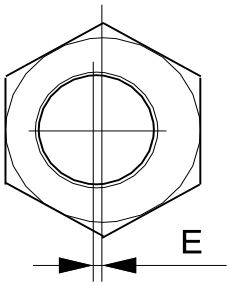
- Prepare a steel block with one bolt hole as the basement of the bolt tensioning. The test block must have the common thickness of the flanges of the actual joint.
- Take 5 bolts with nuts and washers of the same batch as the actual bolts for the joint. Clean the heads of the bolts, make centre borings to both ends and glue metal balls to the borings using a rigid epoxy adhesive.
- Measure and record the bolt length by a micrometer.
- Tighten the bolt to the full design tension. Follow the procedure described in chapter 3.3.
- Remove the tensioner from the bolt and measure the elongated length of the bolt.
- Compare the measured elongation (ΔL) to the design value.
- Repeat the steps 3 to 6 for all 5 bolts. Tightening procedure is acceptable, when the measured values for all bolts are within ±10 % of the design value.

2.3.3 Operating procedure

Both for the tool verification and the actual bolt tightening, the following procedure must be used:

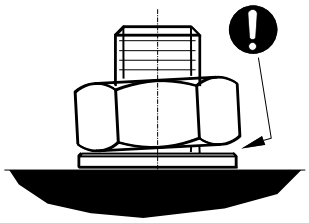
- Check the geometric shape of the nut:

Figure 4. Checking the geometric shape of the nut.



The eccentricity of the bore (E) must not be such that it disturbs the free rotation of the nut inside the tensioner sleeve.

Figure 5. Checking the geometric shape of the nut.



The misalignment of the bore must not prevent the nut from settling flush on the basement, when the nut is turned freely. No gap is accepted!

- Check that the washers are exactly flat, and free of burrs and defects.

For a hydraulic tensioner, the washers must be finished by grinding to exact flatness.

- Clean the bolts and nuts. Clean thoroughly the washers. Apply copper paste with a suitable wiper cloth or brush to the threads of the bolts and nuts as well as the surface between the nut and washer.
- Clean thoroughly the bearing surfaces in the structure for washers and check that they are level.
- Set the washers so that beveled side is against bolt head or nut.
- During assembly, fill the “JOB DATA SHEET FOR USE WITH HYDRAULIC TENSIONER” on page 12.
- Tighten the bolts first to approximately 80 % of the full pre-tensioning value. Start simultaneously on the opposite sides of the joint and proceed according to figure 1, until the whole joint has been gone through.

At this stage the aim is a rough tightness of the whole joint. A torque wrench can also be used, by a torque value of 80 % of the nominal torque.

- Tighten the bolts to the full pre-tensioning value. Start simultaneously on the opposite sides of the joint and proceed according to figure 1, until the whole joint has been gone through.

The tightening procedure in detail is as follows:

- Fit the tensioner to the bolt thread and apply the full tension force to the bolt.
- Tighten the nut so that it is hard against the washer.

Check the equipment so that nothing is preventing free rotating of the nut!

- Release the force from the tensioner, to allow the nut and washer faces to bed in.
- Apply the full tension force to the bolt.
- Re-tighten the nut so that it is hard against the washer.
- Release the force from the tensioner, and remove it from the bolt.

2.4 BOLTED JOINT MAINTENANCE

2.4.1 General

During the operation of the machine, the bolted joints are subjected to varying loads. To minimize the differences in loads on these bolts, it is essential that they all remain at a high and even pre-tightening level.

In operation, these bolts can become loose through settling of the joint surfaces.

The purpose of the periodic bolt tightness check is to make sure that all bolts are carrying an equal share of the loads, and to replace any elongated or suspect bolts, before fatigue fracture occurs.

2.4.2 Frequency of bolt inspection

For the main bolted joints, specific instructions of the inspection frequency may be given in the particular instructions of these joints. This concerns e.g. the slew bearing bolts and major structural joints, which are shown in the Structural Inspection Plan.

If other instructions do not exist, the following basic inspection frequency must be followed:

Table 2. Inspection intervals of bolted joints.

Inspection action	Time of action (Years after start up)	
	Structural joints	Slew bearing bolts
Visual inspection	1 – 4 6 – 14 16 – 24 26 –>	Every year
Bolt tightening procedure	5 15 25, 30, 35	Every year
Replacement of all bolts	When needed, see chapters 4.4 and 4.5	7, 14, 21 or when needed, see chapters 4.4 and 4.5

2.4.3 Visual inspection

For each joint, the visual inspection should include the following checks:

- The bolts and nuts are tight.
- Any locking devices that prevent the bolts and nuts from coming loose are in place and fitted correctly.
- There has been no relative movement between the joint faces.

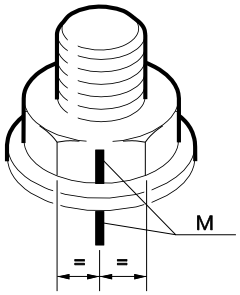
If a bolted joint fails any of these checks, all bolts in the joint must be tightened to the required level using the correct procedure, and then the locking devices must be fitted.

If there is any doubt that the bolt is seized or thread-bound and hence is not applying the force to the joint, the bolt must be replaced. Also, all of the bolts that have corrosion defects must be replaced.

2.4.4 Bolt tightening procedure, torque wrench

- The joint must be as unloaded as practical and the machine must be out of operation during the inspection.
- Spray thin, oil-based corrosion release agent (CRC) onto all of the nuts and washers. Let it affect for 10…20 minutes.
- Record the initial position of each nut by stamping the nut and the structure next to the washer with checking marks (M).

Figure 6. Stamping the nut and the structure.



- Apply a torque of 80 % of the nominal value onto each bolt.
- Check turning of the nut: If the nut has turned, mark this bolt by paint to be replaced.
- Repeat the above steps 3…5 for all of the bolts in the joint.
- Count how many bolts are marked to be replaced.

If more than 20 % of the nuts in the joint have been marked, all of the bolts and nuts in the joint must be replaced by new ones.

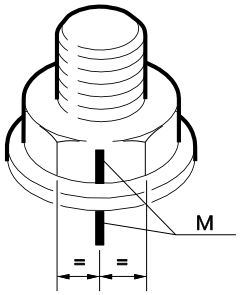
If less than 20 % of the nuts in the joint have been marked to be replaced, the marked bolts and also one nearest bolt on either side of the marked ones must be replaced by new ones.

- Also mark these adjacent bolts by paint to be replaced!
- Nuts which, have not turned must be retightened by following method bolt by bolt:
  - First loosen the nut by turning it 30 degrees.
  - Retighten the nut by the full pre-tightening torque.

2.4.5 Bolt tightening procedure, hydraulic tensioner

- The joint must be as unloaded as practical and the machine must be out of operation during the inspection.
- Clean all of the exposed bolt threads. Spray thin, oil-based corrosion release agent (CRC) onto all of the nuts, bolt threads and washers. Let it affect for 10…20 minutes.
- Record the initial position of each nut by stamping the nut and the structure next to the washer with checking marks.

Figure 7. Recording the initial position of each nut.

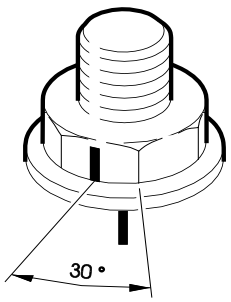


- Fit the tensioner to the bolt thread and apply the full tension force to the bolt.
- Loosen the nut on the bolt under tension.
- Re-tighten the nut so that it is hard against the washer.

Check the equipment so that nothing is preventing free rotating of the nut!

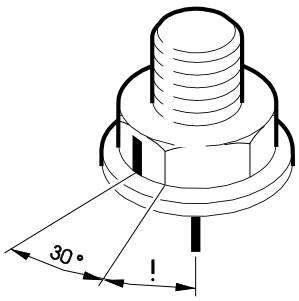
- Release the force from the tensioner, and remove it from the bolt.
- Check how much the nut has turned.
  - If it is less than 30 degrees, the bolt is acceptable.

Figure 8. Checking how much the nut has turned.



- If the nut has turned by more than 30 degrees, mark this bolt by paint to be replaced.

Figure 9. Checking how much the nut has turned.



- Repeat the above steps 3…8 for all of the bolts in the joint.
- Count how many bolts are marked to be replaced.

If more than 20 % of the nuts in the joint have been marked, all of the bolts and nuts in the joint must be replaced by new ones.

If less than 20 % of the nuts in the joint have been marked to be replaced, the marked bolts and also one nearest bolt on either side of the marked ones must be replaced by new ones.

- Also mark these adjacent bolts by paint to be replaced!

2.4.6 Bolt and nut replacement

All of the replacement bolts used in the same joint must come from a single production batch. This concerns also the tool operating and/or tool verification tests.

Before the tightening work, carry out the described tool operating and/or tool verification tests.

CAUTION	For the replacement procedure, it is essential that only one bolt and nut is slackened and removed from the joint at any time.

Carry out the check procedures for the fitting material, as described in the chapters 2 or 3 of Initial Tightening.

Tighten each new bolt immediately after fitting to 80 % of the full pre-tightening value.

Damage deliberately each removed bolt to prevent its reuse!

After replacing all of the marked bolts, carry out the Initial Tightening Procedure of chapters 2 or 3, depending on the type of the tool.

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JOB DATA SHEET FOR USE WITH TORQUE WRENCH

Joint data

Product: _____ Joint: _____

Bolt: _____ Nut: _____

Washer: _____

Lubricant: _____

Torque Wrench data

Manufacturer: _____

Model: _____

Torque Range: _____ Nm to_____ Nm.

Assembly data

First Pass at 80 % _____ Nm.

Final Pass at 100 % _____ Nm.

First Pass Completed: Date: _____ Time: _____

Final Pass Completed: Date: _____ Time: _____

Supervisor's Signature: _____

Notes:

KONECRANES®

JOB DATA SHEET FOR USE WITH HYDRAULIC TENSIONER

Joint data

Product: _____ Joint: _____

Bolt: _____ Nut: _____

Washer: _____

Lubricant: _____

Hydraulic tensioner data

Manufacturer: _____

Model: _____

Max Load: _____ kN.

Assembly data

First Pass at 80 % _____ kN.

Second Pass at 100 % _____ kN.

Final Pass at 100 % _____ kN.

First Pass Completed: Date: _____ Time: _____

Second Pass Completed: Date: _____ Time: _____

Final Pass Completed: Date: _____ Time: _____

Supervisor's Signature: _____

Notes:

3 VERIFICATION TEST OF TORQUE WRENCH WITH BOLT ASSEMBLY

3.1 BACKGROUND

Experiments and practice have shown that used tightening torques for certain pretension force for bolts larger than M20 differ widely from theoretical values.

The main reasons to these differences are the friction influences in the thread and between bolt head or nut and basement, for which we must rely on empirical or estimated values. In addition, settling will occur in bolted connections, which is mainly caused by the flattening out of surface roughnesses.

Because these factors have a significant effect to the theoretically calculated tightening torque, considerable variations in bolt preload may occur.

Therefore, a proper tightening torque for large bolts shall be determined by verifying the torque wrench with a bolt assembly (bolt, nut, washers), which will be done by measuring the bolt elongation as described in the following. At least 20 units of each bolt assembly shall be reserved for the verification tests.

In structural bolting assemblies certified according to EN14399 High-strength structural bolting assemblies for preloading, the problem described above has been solved by the manufacturer. This is made by lubricating the parts using some permanent media that normally gives a low friction.

This can lead to situations where the nominal tightening torque given in the drawing can even break the bolt or the thread. When joint parts are supplied according to EN14399 the correct tightening torque for 70 % preload level is given by the bolt manufacturer. The given value is guaranteed according to the standard and hence can be used without this test.

In case there is any suspicion about the torque value elongation, a test shall be made also for smaller than M22 EN14399 bolt assemblies.

3.2 WRENCH VERIFICATION TEST

All bolts being used, including the test bolts, must come from a single production batch. Washers must be hardened and tempered as well for wrench verification test as for the actual joint.

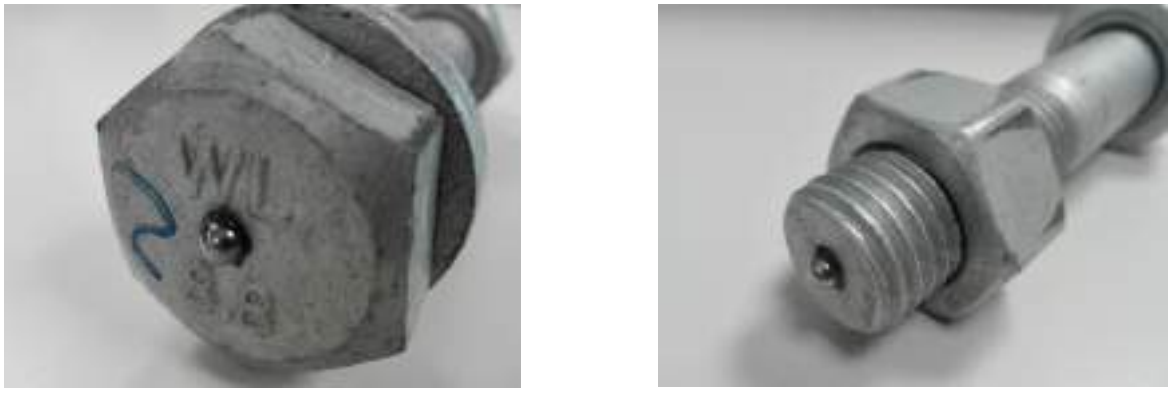
The same torque wrench must be used both in the verification test and in the tightening of the actual bolted joint. If the torque wrench or the dimensions of bolts or joint plates are changed, the test must be repeated.

The clamping length must be created with the help of a steel block having the same size, surface conditions and material as the actual assembly. The diameter of the hole in the steel block must be equal to one in the actual assembly. The hole must be deburred and the chamfer length must not be over 0.5 mm. In case the actual joint is equipped with threaded holes, the block thickness must correspond to a calculated value of the clamping length.

The test bolts must be provided with centre borings at both ends and metal balls glued on the borings (figure 1) to ensure that measuring points of the micrometer are located correctly.

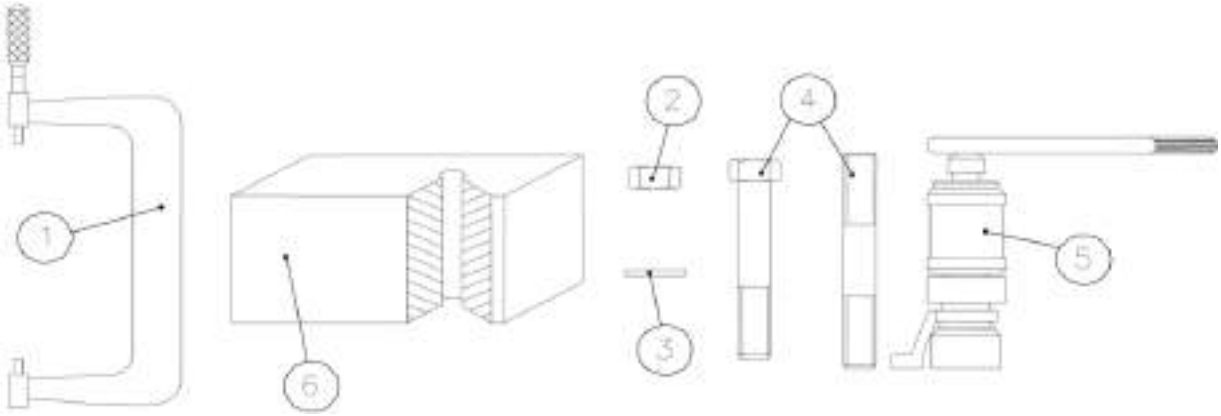
The test arrangement will be quite simple if both bolt ends are accessible in the actual construction. In structures where this is not the case (a threaded hole), it is recommended to carry out a test using an equivalent structure.

Figure 1. Balls glued on the centre borings.



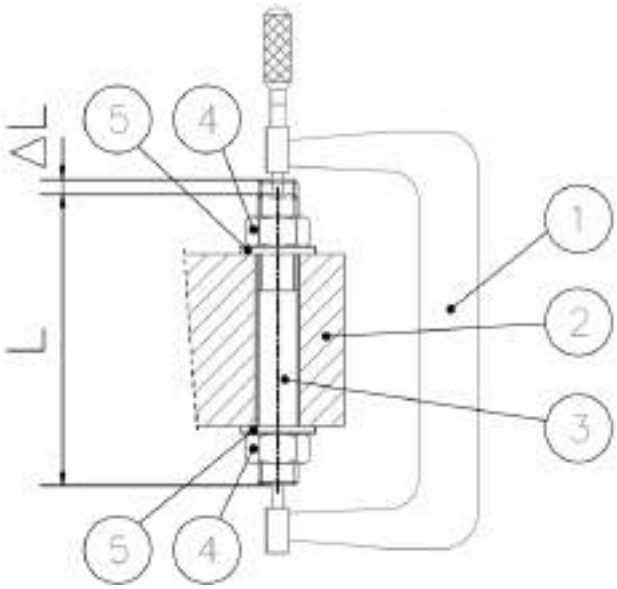
3.3 TEST ARRANGEMENT

Figure 2. Test equipment needed.



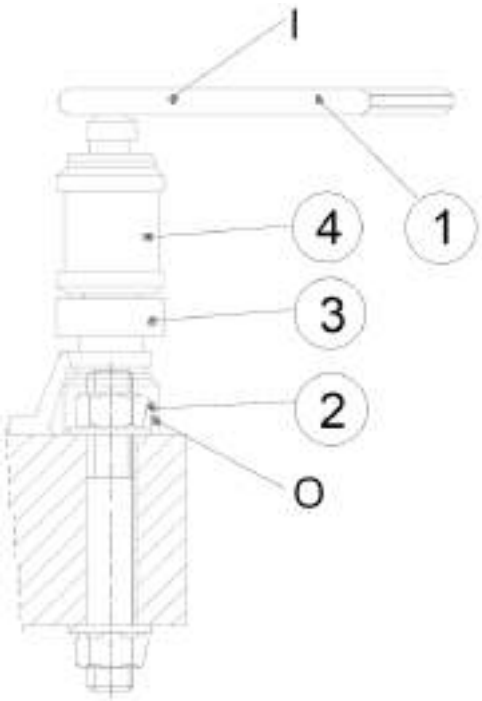
1. Micrometer	*1 pcs*
2. Nut	*1 or 2 pcs*
3. Washer	*2 pcs*
4. Bolt/Stud	*5 pcs*
5. Torque wrench	*1 pcs*
6. Steel block	*1 pcs*

Figure 3. Test arrangement.



1. Micrometer
2. Steel block
3. Bolt/Stud
4. Nut
5. Washer

Figure 4. Tightening.



1. Torque wrench
2. Sleeve
3. Leg
4. Multiplier
I. Input Torque
O. Output Torque

3.4 TEST PROCEDURE

The test shall be carried out using 5 bolts, which are tightened, and elongation is measured by the following procedure:

Step 1:	For the bolt to be used, the targeted elongation ΔL_M is calculated by the method shown on pages 8-9.
Step 2:	The test bolts and washers to be used are cleaned and checked that the flatness of the washers is within the tolerance.
Step 3:	Center borings for both ends of the bolts are made and metal balls glued on the borings using a rigid epoxy adhesive to ensure that the measuring points of the micrometer are located correctly.
Step 4	Apply copper paste with a suitable wiper cloth or brush to the threads of the bolts and nuts as well as the surface between the nut (or bolt if tightened from the bolt side) and washer. Install the test bolt with washers and nut(s) to the test block. Do not tighten it yet (figure 3).
Step 5:	The length of the bolt in unloaded state is measured and written down to measuring table (page 10).
Step 6:	The test bolt is then tightened by increasing the torque in four steps: firstly to 25 %, 50 % and 75 % of nominal torque and finally to the full nominal value. The elongation and the corresponding torque at each step are read off the micrometer and the torque wrench and both values are written down to “BOLT ELONGATION RECORD TABLE”- diagram (page 10). A clear difference between the input and output torques of the tool must be made, when filling in the test record sheets!
Step 7:	The load is released and the length of the bolt and its possible permanent elongation are written down to the measuring table.
Step 8:	The same procedure (steps 4…7) is repeated for all of the 5 test bolts.
Step 9:	“BOLT ELONGATION GRAPH” (page 11) which shows the used torques as a function of the elongation for each test bolt is then made according to the record table. An example is given on page 13.
Step 10:	A mean curve of the three most regular ones in the diagram is then determined graphically and drawn into the diagram.
Step 11:	Horizontal lines corresponding to elongations ΔL_M and ΔL_y are then drawn into diagram. See the examples on pages 12 and 13.

3.5 TEST RESULTS

The final result of the verification test is the torque value, unique for the used wrench and bolts, corresponding to the targeted elongation and consequently the targeted pre-tension.

The test results are drawn into the Torque-Elongation – diagram. The targeted torque is now chosen from the crossing point of the mean torque curve and the horizontal line of ΔL_M. See example on page 13.

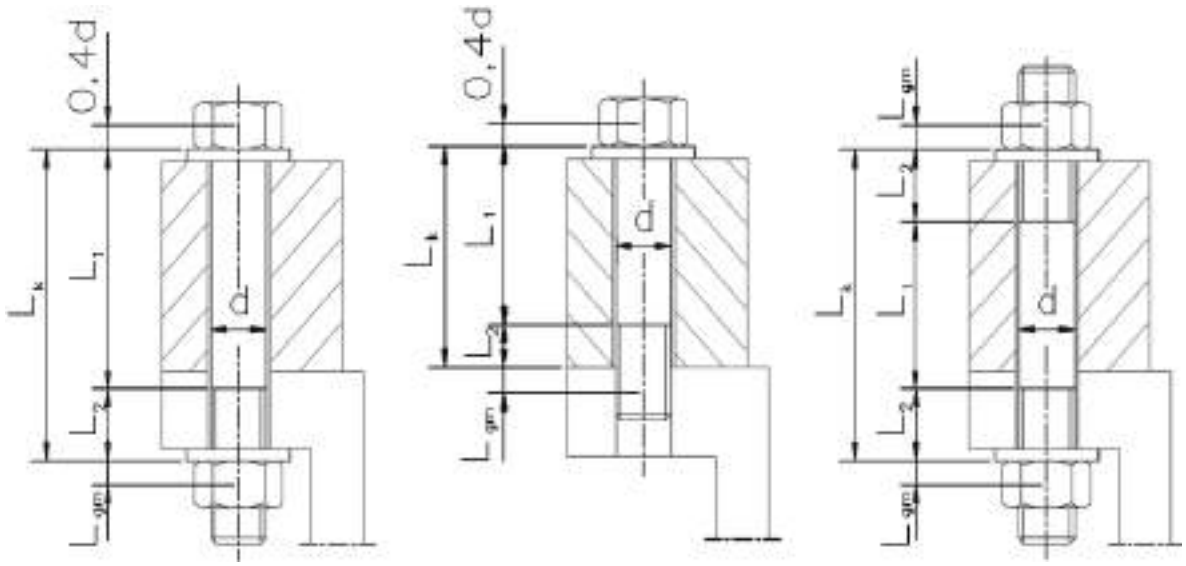
The chosen torque is unique for this individual wrench and for the bolts of this same production batch. This torque value shall not be used as a general value for other wrenches. For another wrench – even of the same type – and for other bolts, another verification test is needed.

If the spread of elongation curves is significant or the received torque differs largely from the nominal one, a new test with other bolts should be carried out. Additionally, the method of using the micrometer should be checked.

3.6 CALCULATION OF BOLT ELONGATION

A_N	Nominal bolt cross section	mm^2
A_3	Cross section of thread core	mm^2
A_S	Stress area of bolt thread	mm^2
E	Young's modulus of bolt	205 000 N/mm^2
d	Bolt's diameter	mm
F_M	Tightening force	N
F_{02}	Bolt load at yield limit	N
L_1	Elastic bolt length	mm
L_2	Elastic thread length	mm
ΔL	Bolt elongation during tightening of the bolt	mm
δ_S	Elastic resilience of bolt	mm/N
σ_Y	Yield stress of bolt material	N/mm^2
L_k	Clamping length of bolt	mm
L_{GM}	Thread length L_G and nut engagement L_M taken into account calculating the resilience of the thread:	$L_{GM} = L_G + L_M$
M	Nominal (output) torque for tightening (a catalogue value)	Nm

Figure 5. Symbol definitions of bolts and studs.



The basic formula for relative elongation:

$$\delta = \frac{L}{E * A}$$

For standard bolts according to DIN 931 (nuts DIN 934):

$$\delta_S = \frac{0.4 \times d}{E \times A_N} + \frac{L_1}{E \times A_N} + \frac{L_2}{E \times A_3} + \frac{0.5 \times d}{E \times A_3} + \frac{0.4 \times d}{E \times A_N}$$

For stud bolts according to DIN 939:

$$\delta_S = \frac{L_1}{E \times A_N} + \frac{L_2}{E \times A_3} + 2 \times \left(\frac{0.5 \times d}{E \times A_3} + \frac{0.4 \times d}{E \times A_N} \right)$$

Targeted pre-load for the bolt in tightening corresponds to a 70 % level of the yield load:

$$F_M = 0.7 \times \sigma_Y \times A_S$$

Corresponding targeted bolt elongation, which is marked into the diagram, becomes as follows:

$$\Delta L_M = F_M \times \delta_S$$

Bolt elongation at material yield limit ΔL_Y is also marked into the diagram:

$$\Delta L_Y = 1.4 \times \Delta L_M$$

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BOLT ELONGATION RECORD TABLE

Made by: _____ Date: _____

Crane/Joint: _____

Bolt: _____

Clamping length Lk = _____ Nominal torque M = _____

Targeted elongation ΔL_M = _____ Yield elongation ΔL_Y = _____

Used torque wrench: _____

Tightening steps						
	Unloaded	25 % M	50 % M	75 % M	100 % M	Torque released
TORQUE [Nm]						
BOLT 1 Length [mm]						
Δ L [mm]						
BOLT 2 Length [mm]						
Δ L [mm]						
BOLT 3 Length [mm]						
Δ L [mm]						
BOLT 4 Length [mm]						
Δ L [mm]						
BOLT 5 Length [mm]						
Δ L [mm]						

KONECRANES®

BOLT ELONGATION GRAPH

Made by: _____ Date: _____

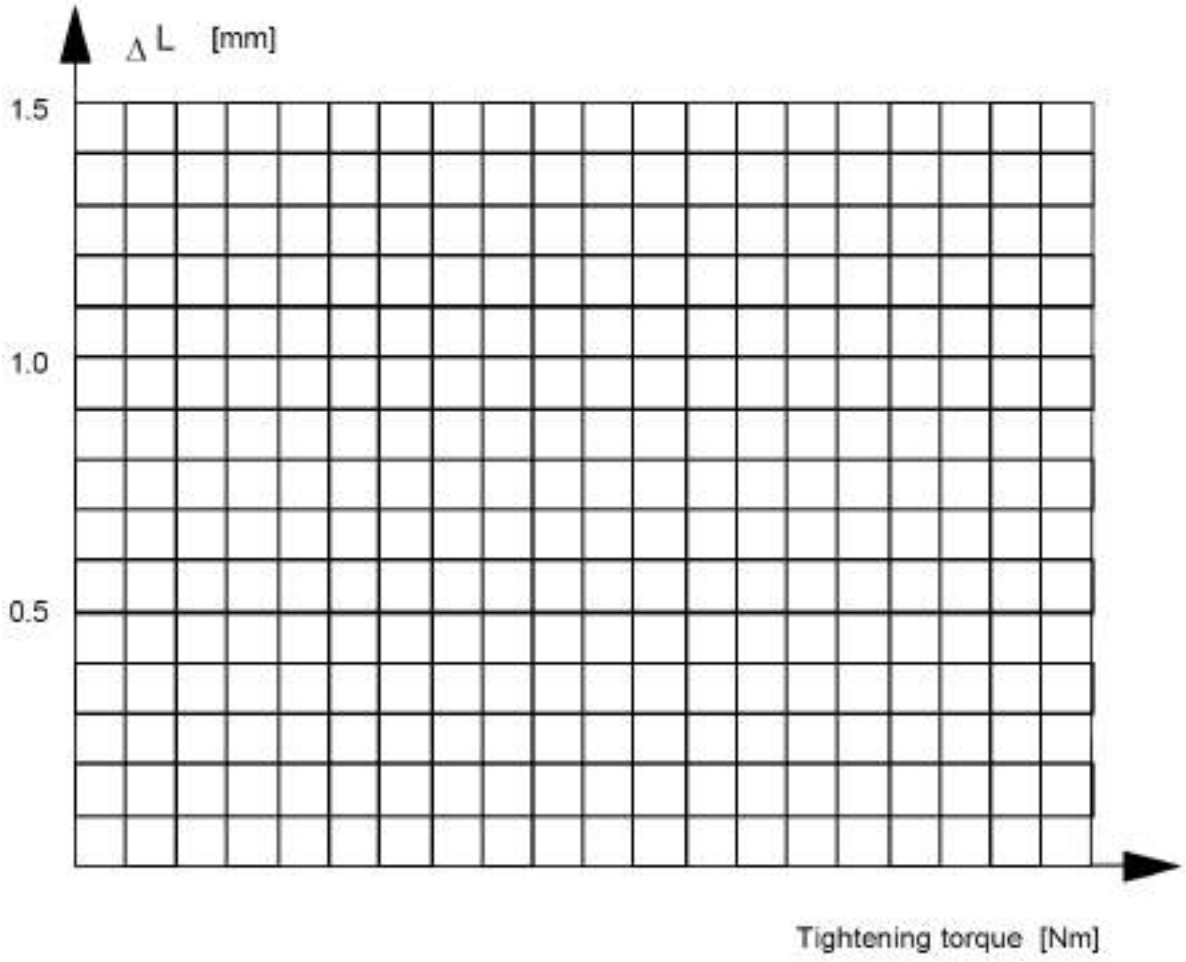
Crane/Joint: _____

Bolt: _____

Clamping length Lk = _____ Nominal torque M = _____

Targeted elongation ΔL_M = _____ Yield elongation ΔL_Y = _____

Used torque wrench: _____



Chosen torque for tightening: Output torque: _____ [Nm]

Input torque: _____ [Nm]

KONECRANES®

EXAMPLE – BOLT ELONGATION RECORD TABLE

Made by: K. Stenholm Date: 2.7.92

Crane/Joint: K30050 Bearing of vertical arm

Bolt: M36*230 DIN939-10.9

Clamping length Lk = 160 mm Nominal torque M = 3450 Nm

Targeted elongation ΔL_M = 0.65 mm Yield elongation ΔL_Y = 0.93 mm

Used torque wrench: Norbar 3AR + Juvwel-1030/03

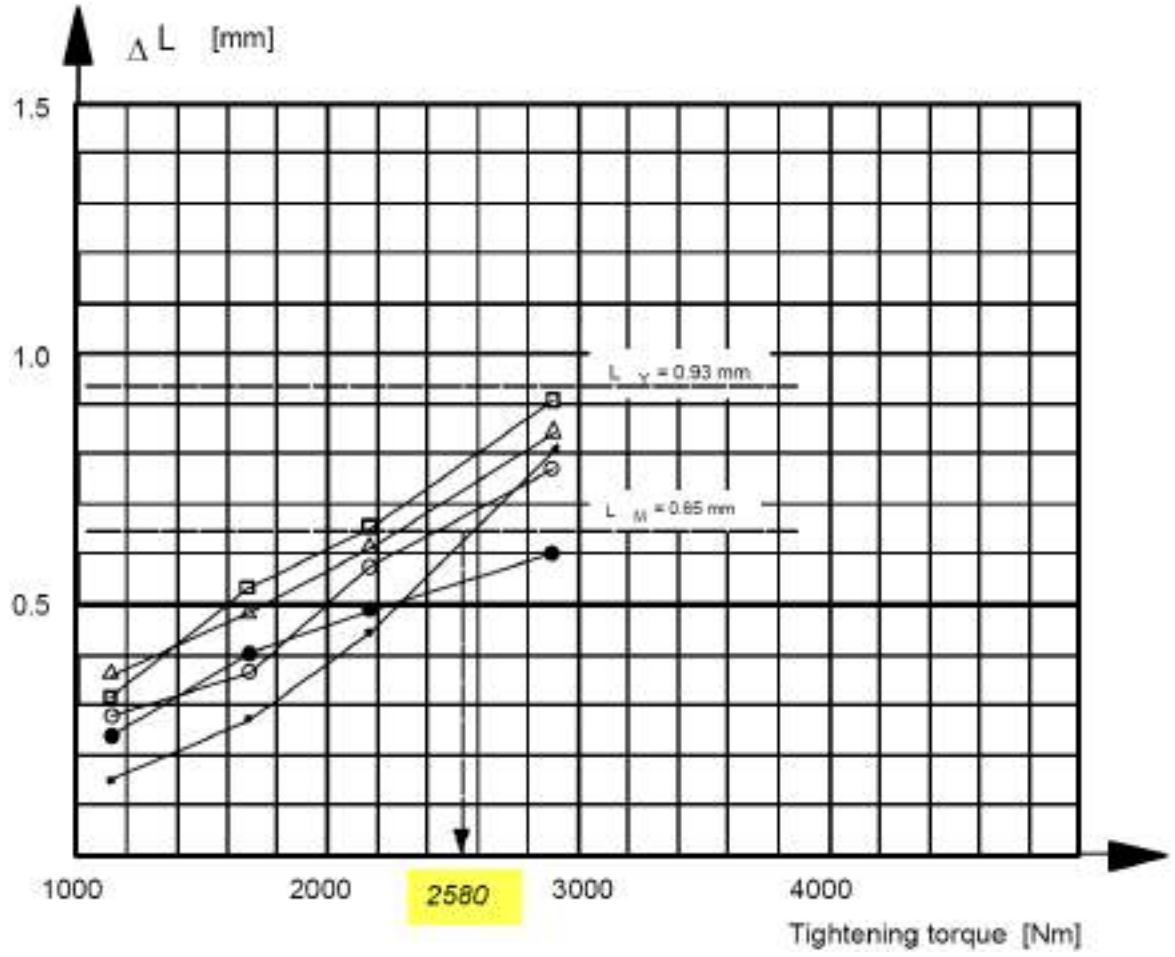
Tightening steps						
	Unloaded	25 % M	50 % M	75 % M	100 % M	Torque released
TORQUE [Nm]	0	100	150	200	270	0
BOLT 1 Length [mm]	275.05	275.32	275.45	275.54	275.65	275.06
Δ L [mm]	0	0.27	0.40	0.49	0.60	0.01
BOLT 2 Length [mm]	275.07	275.44	275.57	275.69	275.90	275.12
Δ L [mm]	0	0.37	0.50	0.62	0.83	0.05
BOLT 3 Length [mm]	275.05	275.37	275.42	275.64	275.84	275.09
Δ L [mm]	0	0.28	0.37	0.59	0.79	0.04
BOLT 4 Length [mm]	275.13	275.30	275.41	275.56	275.94	275.19
Δ L [mm]	0	0.17	0.28	0.43	0.81	0.06
BOLT 5 Length [mm]	275.10	275.50	275.63	275.80	276.00	275.15
Δ L [mm]	0	0.40	0.53	0.70	0.90	0.05

KONECRANES®

EXAMPLE-BOLT ELONGATION GRAPH

Made by:	K. Stenholm		Date:	2.7.92	
Crane/Joint:	K30050 Bearing of vertical arm				
Bolt:	M36*230 DIN939-10.9				
Clamping length	Lk =	160 mm	Nominal torque	M =	3450 Nm
Targeted elongation	ΔL_M =	0.65 mm	Yield elongation	ΔL_Y =	0.93 mm

Used torque wrench: Norbar 3AR + Juvwel-1030/03



Chosen torque for tightening: Output torque: 2580 [Nm]

Input torque: 238 [Nm]

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BOLT AND MATERIAL DATA

	ISO 898	Material	ANSI B1.1	(UNC)
Grade	8.8	10.9	A325	A490
Yield limit σY [N/mm^2]	640	900	558	896

Bolt Size DIN	Stress Area AS [mm^2]	Shaft section AN [mm^2]	Thread section A3 [mm^2]	Nominal torque [Nm] 8.8	10.9
M22	303	380	282	555	785
M24	353	452	324	710	1000
M27	459	573	427	1035	1455
M30	561	707	519	1405	1980
M33	694	855	647	1905	2680
M36	817	1018	759	2455	3450
M39	976	1195	913	3160	4445
M42	1121	1385	1045	3920	5510
M45	1306	1590	1224	4875	6855
M48	1473	1810	1377	5875	8265
M52	1758	2124	1652	7565	10640
M56	2030	2463	1905	9420	13245

Bolt Size (d – R)	Stress Area AS [mm^2]	Shaft section AN [mm^2]	Thread section A3 [mm^2]	Nominal torque [Nm] A325	A490
9/16 - 12	117	160	103	123	200
5/8 - 11	146	198	130	171	280
¾ - 10	216	285	195	305	490
7/8 - 9	298	388	270	490	780
1 - 8	391	507	355	725	1170
1 1/8 - 7	492	641	447	1030	1655
1 ¼ - 7	625	792	574	1445	2320
1 3/8 - 6	745	958	677	1905	3050
1 ½ - 6	907	1140	832	2515	4035
1 ¾ - 5	1225	1552	1123	3970	6375
2 - 5	1612	2027	1484	5960	9570
2 ¼ - 5	2095	2565	1948	8660	13900
2 ½ - 4½	2580	3167	2400	11860	19040

Our offices

Head Office

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