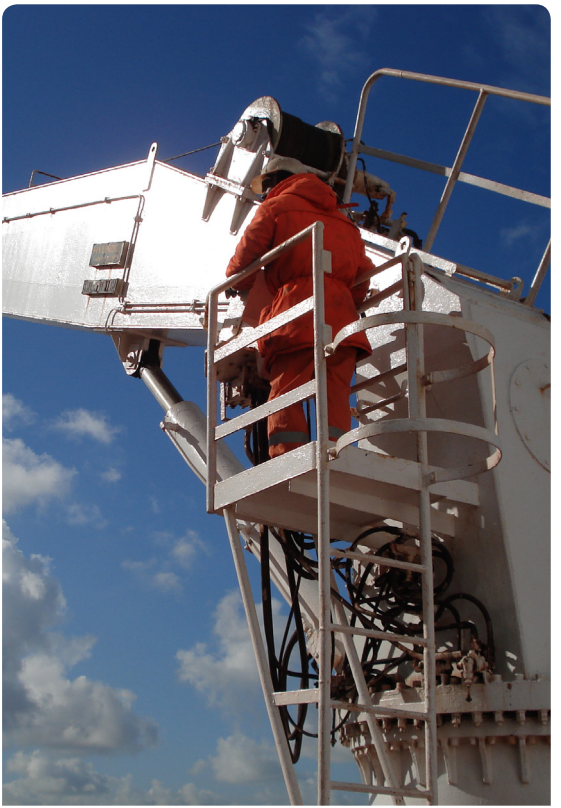
Survey and Examination of Ships' Lifting Appliances

In conjunction with:

UK P&I CLUB MACGREGOR LIEBHERR



Lloyd's Register

LIFE MATTERS

1.0 Introduction

When a lifting appliance fails the consequences can be far-reaching. Serious injury and death can occur, not just to personnel but to the general public. When equipment fails, the cost of disrupted operations can also be considerable.

This pocket guide is intended to help ship operators understand the importance of good maintenance, what happens during the examination of lifting appliances and what is required of them before an examination takes place.

This document will focus on the following types of lifting appliances:

- deck cranes
- derricks
- engine room cranes, provisions cranes and stores cranes
- Life Saving Appliance (LSA) davits

A typical engine room crane

A typical rope luffed deck crane

2.0 Why are lifting appliances 'thoroughly examined'?

A lifting appliance generally has no 'redundancy'– so a single failure is enough to cause a major accident.

Various national regulatory schemes require that lifting appliances should be thoroughly examined by a 'competent person' at least once every 12 months. Some legal frameworks may require more frequent examinations, depending on the national authority, the competent person, and whether the equipment is used for lifting personnel.

Lifting appliances are examined in accordance with two main legal frameworks, depending on the type of equipment and its purpose.

- Ships' deck cranes, engine room cranes, and lifting equipment are examined in accordance with:
  - the Merchant Shipping Regulations
  - flag state requirements
  - International Labour Organization (ILO) Convention 152, where it applies.

- Ship-mounted life saving appliances are examined in accordance with:
  - Safety Of Life At Sea (SOLAS) 1974
  - International Maritime Organization (IMO) LSA Code
  - the IMO Maritime Safety Committee (MSC) circulars
  - individual flag state requirements.

Classification societies such as Lloyd's Register offer two survey and examination services for lifting appliances (excluding LSA davits):

- certification
- classification

Classification is used in two situations:

- Mandatory – where the lifting appliance is the essential feature of a classed ship. This applies for example to a heavy lift crane on a heavy lift barge, or lifting arrangements for diving operations on diving support ships.
- Optional – when the owner requests classification, even though the lifting appliance may not be an essential feature of a classed ship.

An example of a lifting appliance being the essential feature of a ship

3.0 Procedure for a thorough examination of a lifting appliance, including preparation required by the owner

3.1 Documentation

Before commencing a thorough examination of a lifting appliance (excluding LSA davits), it will be necessary for the attending surveyor to see the Register of Lifting Appliances and Cargo Handling Gear (the Register book). The surveyor will need to:

- check the existing certificates for the appliances, the ropes, and the loose gear
- look at the survey history of the appliance
- check for any issues which are outstanding from the last examination
- check if there are any recurring problems which will require particular attention in the examination
- review rocking test/grease sampling data, where applicable (please refer to the end of this guide for further information).

Secondly, it will be necessary to see any maintenance and service records and check:

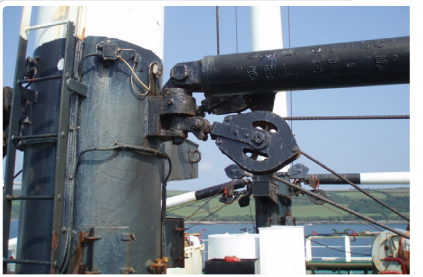
- what has been serviced
- which components have been replaced
- what lubrication has been carried out.

Finally, to confirm everything is in its correct location, it will be necessary to look at:

- general arrangement plans
- reeving diagrams
- block lists.

This is particularly important for ships with derrick rigs.

To prevent unnecessary delay, please ensure this documentation and information is available in order for the surveyor to be able to proceed with the thorough examination.



A typical derrick assembly

3.2 The examination

For derricks, deck cranes, hose handling cranes and engine room cranes, annual thorough examinations are to be held once in every 12 month period, unless otherwise stated by the ship's flag administration.

For deck cranes, derricks and engine room cranes, the surveyor will be required to examine the following items:

Deck cranes	Derricks	Engine room cranes
Loose gear	Loose gear	Loose gear
Ropes	Ropes	Ropes
Protection and limitation devices	Protection and limitation devices	Protection and limitation devices
Winches, brakes and drums	Winches, brakes and drums	Winches, brakes and drums
Built-in sheave units	Deck fittings	Built-in sheave units
Hydraulic cylinders and pins (ram luffed cranes)	Derrick booms	Bridge structure supporting crab
Jibs	Mast fittings	Long travel trolleys/ saddles
Jib heel pins	Masts, derrick posts and guy posts	Traversing unit (crab)
Slewing columns and machinery deck	-	Wheels (traversing and longitudinal)
Slew bearings and bolts	-	-
Pedestal and foundations	-	-
Note **Functional testing may be required at the surveyors discretion.**		

Please note – the items listed above and over the page are not exhaustive and should be used for guidance purposes only.

For LSA davits the approved service providers will need to examine the following items, which will also be verified by the attending surveyor at the appropriate survey:

LSA davits
Loose gear
Limit switches
Ropes and strops
Winches, brakes and drums
'A'-frames, roller and guide tracks
Built-in sheave units
Davit arms
Free-fall ramps and slewing columns
Jib heel pins
Release gear

A typical davit system

For further information on LSA davits surveyed as part of the safety equipment certification, please refer to the Lloyd's Register LSA pocket checklist, available from www.webstore.lr.org

3.3 Testing

Proof load testing is a legal requirement and is needed for Lloyd's Register certification for almost all lifting appliances and loose gear. It must be carried out:

- **before new equipment is taken into service**
- **at set periods as required by national regulations, typically every five years**
- **after structural modification and repair.**

Where test weights are used to apply test loads, the weights are to be certified as accurate to within ±2%. Suitable precautions are to be taken before commencing the test to ensure the stability of the ship and the adequacy of the supporting structure to bear the test loads.

Testing machines may also be used under limited conditions to apply test loads, attached to a suitably strong point on the ship structure. They are to be of a type approved by the relevant organisation (e.g. Lloyd's Register) as suitable for the intended purpose. The machine is to be calibrated biennially by a recognised authority and the accuracy is to be within ±2%. Test machines are not to be used for initial testing or for ships trading with Australia.

Measures are to be taken to ensure that the appliance can be controlled during the test and to avoid injury or damage which might occur in the event of failure under load.

Testing of derricks and cranes	
SWL of derrick or crane, in tonnes	**Test load, in tonnes**
Up to 20 t	1,25 x SWL
Exceeding 20 t but not exceeding 50 t	SWL + 5
Exceeding 50 t	1,1 x SWL

Notes
1. Hand operated pulley blocks are to be proof tested to 1,5 x SWL.
2. For initial testing, the appliance is to hoist, luff and slew the test load, but not simultaneously. This is also recommended for subsequent re-testing.
3. As an alternative to test weights, certified water bags are permitted.

Proof loads for loose gear	
Item	**Proof load, in tonnes**
Single sheave block	4 x SWL
Multi-sheave blocks:	
SWL ≤ 25 t	2 x SWL
25 < SWL ≤ 160 t	(0,933 x SWL) + 27
160 < SWL	1,1 x SWL
Hooks, shackles, chains, rings, swivels, etc:	
SWL ≤ 25 t	2 x SWL
25 < SWL	(1,22 x SWL) + 20
Lifting beams, spreaders, frames:	
SWL ≤ 10 t	2 x SWL
10 < SWL ≤160 t	(1,04 x SWL) + 9,6
160 < SWL	1,1 x SWL

Notes
1. The safe working load (SWL) for a single sheave block including single sheave blocks with beckets is to be taken as one half of the resultant load on the head fitting.
2. The safe working load for a multi-sheave block is to be taken as the resultant load on the head fitting.
3. Where the item is to be used in diving operations, the proof load is to be 1,5 times the proof load value given above for the particular item.

Table above extracted from Lloyd's Register's Code for Lifting Appliances in a Marine Environment, 2009, available from www.webstore.lr.org

Deferments of 5-yearly load tests are not permitted under ILO convention 152. LSA davits must be periodically tested in accordance with SOLAS requirements. Refer to MSC 81 (70) for more information.

3.4 Safe access

Access arrangements will be necessary, enabling the surveyor to examine within touching distance, all parts of the lifting appliance. In order to avoid delays, access arrangements should be considered well in advance. On the date of the examination, the appropriate access equipment should be fit for purpose and ready for use in accordance with health and safety guidelines.

Tip: It is often the hard-to-reach areas of the crane which lead to failures. They are often out of sight for long periods of time and poorly maintained due to access difficulties. Close examination is vital.

Access arrangements required by the surveyor may include:

- cherry picker
- mobile access platform
- scaffolding
- well maintained built-in access e.g. ladders with cages, walkways and platforms with handrails
- ladders.

Lifting of personnel is only acceptable when the crane has been certified for personnel handling and any additional requirements of the National Authorities have been complied with.

4.0 What happens if the lifting appliance does not pass the examination?

4.1 Lifting equipment

If the surveyor finds defects and the lifting appliance does not meet the requirements, or there is insufficient preparation, the surveyor may:

- instruct that it is taken out of service, and endorse the LA Register accordingly
- impose conditions of class, or recommend withdrawal of class (if it is a classed item)
- restrict the use of the appliance, depending on the type of deficiency found.

Note: If there is insufficient preparation for the examination of the appliance, the surveyor may suspend the thorough examination.

4.2 LSA equipment

If the surveyor is not satisfied with the condition of the davits or the associated equipment and remedial action is required, the surveyor may:

- contact the flag state and advise them of the deficiencies
- instruct the Master that the davit is to be taken out of service
- check that sufficient alternative survival equipment is provided before the ship sails

- endorse the safety equipment certification accordingly or raise a memorandum item in the records of the ship, depending on advice from the flag state.

  N.B. If insufficient alternative survival equipment is available, the ship is at risk of detention by the flag state or port state control inspectors.

The points mentioned above are likely to have significant implications for the operation of a ship. A condemned lifting appliance can affect cargo operations, delay the departure of a ship and ultimately give rise to unexpected costs.

Important: following structural damage to a lifting appliance, the use of the appliance even at a reduced capacity is not recommended.

5.0 Safety hazards associated with lifting appliance examinations

Lifting appliances are used in a wide range of situations, all of which may pose a significant risk to the operator and persons nearby.

Ultimately, it is the responsibility of the ship owner/operator to ensure that all lifting equipment is safe to use, all lifting operations are carried out in a safe manner and all examinations of lifting equipment are carried out at the right time and in a safe way, with the necessary controls, procedures and access in place.

All work should be conducted in accordance with a safe method of work.

Carrying out a lifting appliance examination without suitable health and safety controls in place would be intolerable according to Lloyd's Register's risk management procedures. Owners and operators need to ensure that controls are in place to reduce the risk to as low as is reasonably practicable.

Common hazards encountered during lifting appliance surveys include:

- inadequate safe systems of work
- inadequate safety briefings
- poor access arrangements
- working at height
- confined space entry
- falling or dropped objects
- lack of training for key personnel
- working over water
- poor housekeeping on site
- adjacent operations
- inadequate protection for electrical equipment
- adverse weather
- poor lighting
- poor visibility
- uncontrolled traffic movement, inadequate segregation of people and vehicles and issues associated with road safety
- extremes of temperature.

As a surveyor, operator, owner or manager, if you ever feel your safety or the safety of others is at risk, STOP and reassess the situation, and take the appropriate mitigating action until you consider the arrangements to be safe. Remember, a number of serious accidents on board ships have resulted due to entry into confined spaces and premature release of lifeboat release hooks.

6.0 Common problems associated with lifting appliance thorough examinations

Common problems associated with examinations include:

- lack of documentation
- lack of adequate safe access
- wear of the slew bearing and loss of bolt integrity
- loose gear - identification , certification and maintenance
- wire ropes - identification, certification, maintenance and discard
- excessive corrosion
- lack of maintenance
- incorrect operation
- non-functioning safety devices.

6.1 Lack of documentation

If a Register of Lifting Appliances and Cargo Handling Gear is not available, and there is no other evidence onboard confirming that the lifting appliances have been certified by a competent body/person, surveyors are under instruction not to carry out the thorough examination or any other inspection.

Additionally, if no certificates for loose gear and ropes are available, delays will be encountered while testing and re-marking is carried out in order to certify these items. The lifting appliances will not be allowed to operate without properly certified loose gear and ropes.

The importance of correct, up-to-date and identifiable documentation cannot be over-emphasised.

For LSA davits, original type approval certificates and records of periodical examinations and tests should be available, including on-load release gear where fitted.

6.2 Lack of adequate safe access

It is very important to liaise with the surveyor before the examination to agree which areas of the lifting appliance need to be examined.

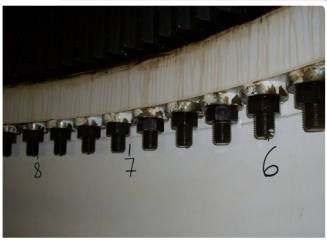
If the surveyor is not satisfied with the access arrangements being provided to examine the lifting appliance, the examination will be stopped and postponed until adequate safe access is provided.

6.3 Wear of the slew bearing and loss of bolt integrity

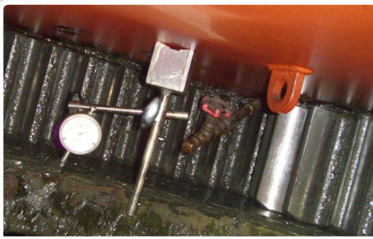
Slew bearings are the mechanical components which allow the crane to rotate, or slew. Slew bearings are subjected to continuous wear. There are commonly three types of slew bearings fitted to ships' cranes:

- single ball bearing – generally found on deck cranes
- twin ball bearing – generally found on deck cranes
- three roller bearing – generally found on offshore and heavy lift cranes.

Several slew bearings have failed in recent years with catastrophic results. The failures have mainly been on cranes more than 10 years old, fitted with the single ball bearing type.



Bolts should be checked for tightness using a torque wrench



Measuring wear of the slew bearing

It is important to monitor the wear of a slew bearing. Always follow the recommendations of the crane/slew bearing manufacturer. There are two commonly recommended practices:

- Grease sampling – this measures the metallic content found in the grease which gives an indication of the wear taking place.
- Rocking test – this measures the play (or relative movement) between the inner and outer bearing race, to give an indication of the wear taking place.

Typical rocking test and grease sampling procedures can be found in section 8 of this guide.

In addition to the above, it will be necessary to monitor the condition and torque of slew bearing bolts.

6.4 Loose gear – identification, certification and maintenance

Loose gear is any item which attaches the load to the appliance or an interchangeable item in the load path, not permanently attached to the lifting appliance. Loose gear may also be known as lifting gear or lifting accessories. Loose gear items include:

- hooks, blocks, chains, shackles, swivels, rings, links, slings, grab buckets, spreaders, lifting beams and lifting frames

Loose gear should be thoroughly examined by a competent person at least once every year, or more often as required by a national authority, company procedure, a competent body, or competent person.

Metallic loose gear items are generally to be made of steel or alloy steel. Wrought iron is no longer permitted and any wrought iron items are to be condemned and replaced immediately.

Fabric strops are also considered to be loose gear items.

Loose gear items are to comply with an appropriate national/international standard. Where this is not possible, for example non-standard items, their suitability and SWL are to be determined by calculation and checked by the certifying authority.

To prepare the item for examination you should ensure:

- the item can be identified against its test certificate
- paint is removed if necessary to inspect the surface and the identity mark
- the item is clean to allow visual examination.

Ramshorn hook assembly

Non-destructive examination of a hook

The surveyor may require:

- hammer tests to investigate extent of corrosion
- non-destructive examination to investigate any cracking, where necessary
- dismantling of moving or concealed parts to investigate wear and tear, where necessary.

Common problems include:

- lack of or obscured identification markings
- overloaded components
- poor maintenance
- missing documentation/certificates.

If there is any doubt over the condition of an item, the surveyor may wish to proof load test and re-certify the item at an approved test facility.

6.5 Wire ropes – identification, certification, maintenance and discard

Ropes should be regularly greased and lubricated in accordance with manufacturers' guidelines, throughout their working life.

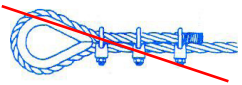
Ropes must be clearly marked in a way which relates them uniquely to their test certificate. The surveyor will need to see:

- the tag, tally or disc attached to the rope, or filed within the vicinity of the winch or marking on the ferrule of the end connection
- the marking including the surveyor's or manufacturer's stamp
- the rope details on the related certificate

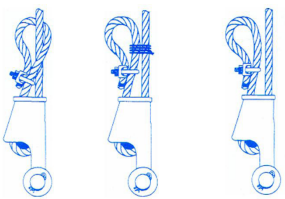
Typical problems include broken, worn or corroded wires. The surveyor will assess wire ropes in accordance with the discard criteria laid out in ISO 4309, available from www.iso.org. The standard establishes general principles for the care, maintenance, inspection and discard of steel wire ropes used on cranes and hoists.

For LSA equipment, falls should be corrosion resistant, rotation resistant steel wire rope.

Wire rope showing crushing damage



Unacceptable primary termination method



Correct termination of an asymmetric wedge socket

Attention: It is important to be aware that wire rope grips are not permitted to form a primary load bearing termination. If using asymmetric wedge sockets, the dead end must not be clamped to the live rope.

6.6 Excessive corrosion

Lifting appliances and related components should be kept clean, and where applicable, a paint system should be in place to reduce corrosion in what is generally a highly corrosive environment.

Particular attention should be paid to box sections and other locations where access is difficult and moisture can be trapped.

Surveyors may require ultrasonic thickness measurements to quantify the effects of any corrosion.

Limits of weardown and corrosion		
Item	**Limits**	**Remarks**
Structural members	Reduction of 10% maximum at any point, based on the material thickness	
Loose gear	Reduction of 5% on any diameter Reduction of 2% on any diameter of a pin in a hole	
Wire ropes	5% of broken, worn or corroded wires in any length of 10 rope diameters Attention is also drawn to the detailed criteria given in ISO4309 Cranes - Wire ropes - Care and maintenance, inspection and discard	Item may not be able to sustain the proof load

Table above extracted from Lloyd's Register's Code for Lifting Appliances in a Marine Environment, 2009, available from www.webstore.lr.org

6.7 Lack of maintenance

A well structured maintenance regime, in accordance with the manufacturer's recommendations can reduce the chances of unexpected defects occurring and can ultimately improve the reliability and operational life of the lifting appliance. Surveyors will check that regular maintenance has been carried out in accordance with the manufacturer's recommendations, using approved spare parts.

6.8 Incorrect operation

It is important that lifting appliances are operated as intended by the manufacturer. Any operation outside the recommended practice can impose loads that the lifting appliance was not designed to take and reduce the operating life of the appliance and possibly lead to failure.

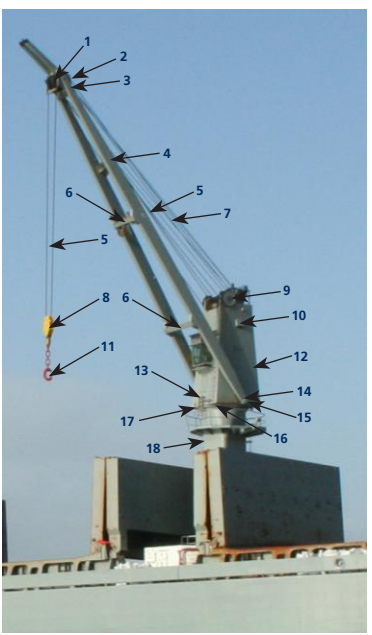
Derricks rigged in union purchase should be used in the positions and configurations they were designed for, in accordance with the manufacturer's recommendations.

Overloading of a lifting appliance can lead to permanent deformation, buckling and eventual failure of the appliance at much lower loads than the approved SWL.

6.9 Non-functioning safety devices

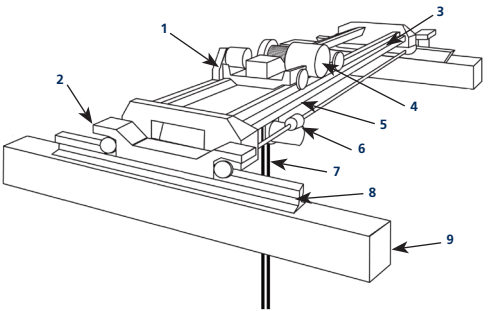
Limit switches, load limiters and other safety devices are vulnerable to damage and corrosion and should be tested regularly to ensure they continue operating satisfactorily, preferably before each loading operation.

Important: Particular attention should be paid to the cable sealing arrangements of junction boxes, switches and terminals for evidence of water ingress.



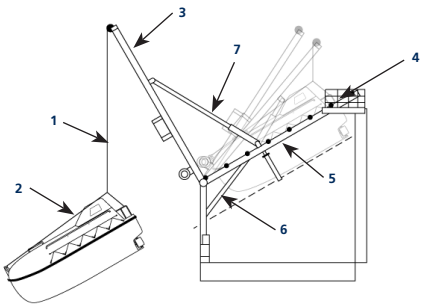
1. Jib head
2. Jib head sheaves
3. Luffing sheaves
4. Main chords of jib
5. Cargo hoist ropes
6. Transverses or cross-members of jib
7. Luffing ropes
8. Hook block
9. Slew column head sheaves
10. Jib stop
11. Hook
12. Slewing column, upper post or housing
13. Machinery deck
14. Jib heel
15. Jib heel pin
16. Slew ring bearing
17. Slew ring bolts
18. Pedestal

Typical rope luffed crane



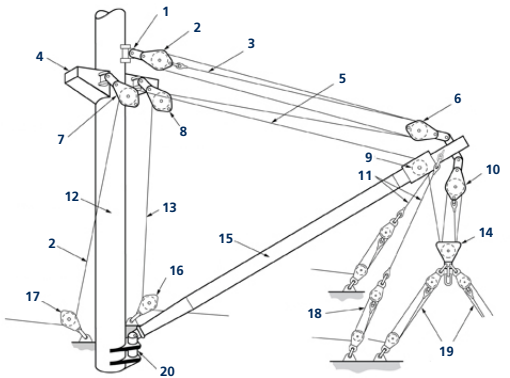
Typical engine room crane

1. Crab or trolley
2. End truck, trolley or saddle
3. Traverse/crab rail
4. Hoist unit
5. Long travel drive
6. Bridge drive
7. Hoist rope
8. Long travel rail
9. Longitudinal girder



Typical LSA davit (free fall)

1. Main fall
2. Strops
3. Controlled launch and recovery gantry or arm
4. Release hook
5. Free fall ramp
6. Corner brace
7. Hydraulic cylinder



Typical derrick system

1. Mast head span
2. Mast head span block
3. Span tackle
4. Cross trees
5. Cargo runner
6. Derrick head span block
7. Mast head span lead block
8. Mast head cargo runner lead block
9. Built-in sheave
10. Derrick head cargo block
11. Slewing guy pendants
12. Mast or derrick post
13. Span rope
14. Lower cargo block
15. Derrick boom
16. Derrick heel span lead block
17. Derrick heel cargo runner lead block
18. Derrick slewing guy tackles
19. Cargo slewing guy tackle
20. Gooseneck and derrick heel assembly

8.0 Monitoring slew bearing wear

8.1 Typical rocking test procedure

It is important that any rocking test is carried out in accordance with the crane manufacturer's recommendations. Measurements are typically taken in four positions on the slew bearing, with the jib pointing:

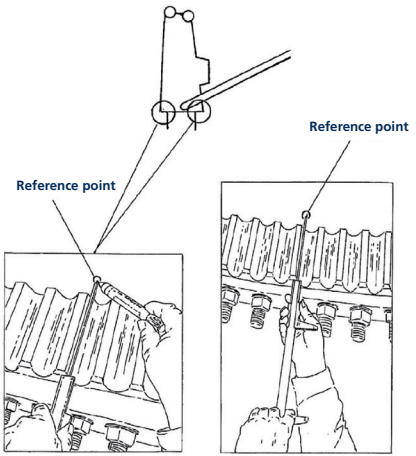
- forward to the ship
- starboard
- aft
- port side.

Neither a load nor any cargo handling equipment should be attached to the hook.

It is important for the same positions to be marked as a datum reference for future measurements.

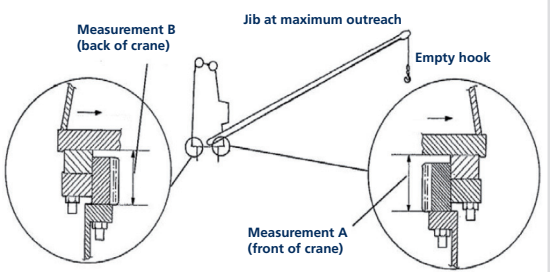
If there is a machined surface, this shall be used as a reference point. In other cases a reference point must be marked.

Consequences of failing to maintain a slew bearing can be far-reaching

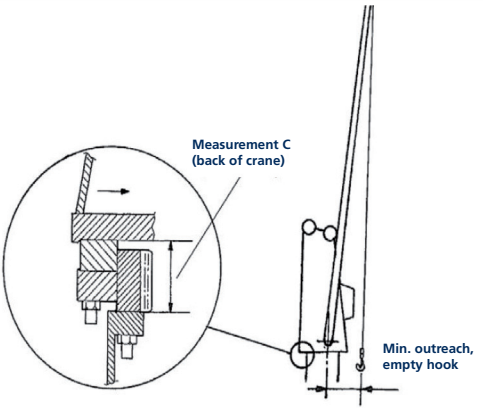


Reference points

Measurements must be taken for each position above with the jib at maximum and minimum outreach. Measurements must be taken at the front and back of the crane.



Jib at maximum position

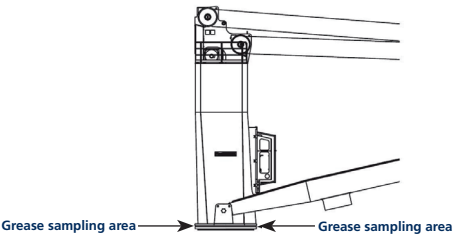


Jib at minimum outreach

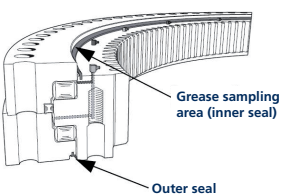
Measurements should then be used in accordance with the manufacturer's guidelines and the play (or relative movement) calculated accordingly. If the measurements exceed the manufacturer's recommendations, the crane should be immediately taken out of service.

8.2 Typical grease sampling procedure

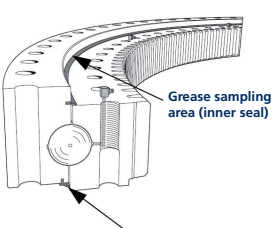
Grease sampling is a recognised alternative method of obtaining information about the condition of slew bearings and their corresponding wear. However, it will be necessary to send the grease samples to an approved laboratory for analysis.



Grease sampling areas



Slew bearing with roller bearing



Slew bearing with ball bearings

Key points:

1. Take four samples at 90° around the ring
2. One sample should be taken in the area under the jib and one sample 180° in the opposite direction
3. Clean up the seal and the surrounding area where the sample will be taken
4. Push new grease into the grease nipples/bearing without rotation and collect the first used grease which comes out at the seal (typically 2-3 cm^3)
5. The grease samples are to be taken as far away from the grease nipple as possible, to ensure old grease is collected
6. The grease should typically be taken at the inner seal of the bearing

Warning: Do not take fresh grease for analysis.

Good maintenance of lifting appliances offers both safety and commercial benefits

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